Reference Manual

Graphical User Interface
Industrial Security Router
EAGLE20/30
The naming of copyrighted trademarks in this manual, even when not specially indicated, should not be taken to mean that these names may be considered as free in the sense of the trademark and tradename protection law and hence that they may be freely used by anyone.

© 2022 Hirschmann Automation and Control GmbH

Manuals and software are protected by copyright. All rights reserved. The copying, reproduction, translation, conversion into any electronic medium or machine scannable form is not permitted, either in whole or in part. An exception is the preparation of a backup copy of the software for your own use.

The performance features described here are binding only if they have been expressly agreed when the contract was made. This document was produced by Hirschmann Automation and Control GmbH according to the best of the company’s knowledge. Hirschmann reserves the right to change the contents of this document without prior notice. Hirschmann can give no guarantee in respect of the correctness or accuracy of the information in this document.

Hirschmann can accept no responsibility for damages, resulting from the use of the network components or the associated operating software. In addition, we refer to the conditions of use specified in the license contract.

You find the latest user documentation for your device at: doc.hirschmann.com

Hirschmann Automation and Control GmbH
Stuttgarter Str. 45-51
72654 Neckartenzlingen
Germany
## Contents

Safety instructions ...................................................................................................................... 7

About this Manual .......................................................................................................................... 9

Key .............................................................................................................................................. 10

Notes on the Graphical User Interface .......................................................................................... 11
   Banner .................................................................................................................................... 11
   Menu pane ............................................................................................................................... 13
   Dialog area ............................................................................................................................... 15

1 Basic Settings .............................................................................................................................. 19
   1.1 System ............................................................................................................................... 19
   1.2 Network ............................................................................................................................. 24
      1.2.1 Global ......................................................................................................................... 25
      1.2.2 IPv4 .......................................................................................................................... 27
   1.3 Software ............................................................................................................................. 28
   1.4 Load/Save ........................................................................................................................... 31
   1.5 External Memory ................................................................................................................. 41
   1.6 Port .................................................................................................................................... 44
   1.7 Restart ................................................................................................................................. 49

2 Time ........................................................................................................................................... 51
   2.1 Basic Settings ...................................................................................................................... 51
   2.2 NTP ..................................................................................................................................... 52
      2.2.1 Global ......................................................................................................................... 53
      2.2.2 Server ......................................................................................................................... 55

3 Device Security ............................................................................................................................ 59
   3.1 User Management ............................................................................................................... 59
   3.2 Authentication List .............................................................................................................. 64
   3.3 LDAP .................................................................................................................................. 66
      3.3.1 LDAP Configuration ................................................................................................. 67
      3.3.2 LDAP Role Mapping ................................................................................................. 72
   3.4 Management Access ......................................................................................................... 74
      3.4.1 Server ......................................................................................................................... 75
      3.4.2 IP Access Restriction ............................................................................................... 86
      3.4.3 Web ............................................................................................................................ 89
      3.4.4 Command Line Interface ......................................................................................... 90
      3.4.5 SNMPv1/v2 Community ......................................................................................... 92
   3.5 Pre-login Banner ............................................................................................................... 93

4 Network Security ....................................................................................................................... 95
   4.1 Network Security Overview .............................................................................................. 95
   4.2 RADIUS ............................................................................................................................ 96
      4.2.1 RADIUS Global ...................................................................................................... 97
      4.2.2 RADIUS Authentication Server ............................................................................. 98
   4.2.3 RADIUS Authentication Statistics ............................................................................ 100
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.2</td>
<td>Routing Interfaces</td>
<td>281</td>
</tr>
<tr>
<td>8.2.1</td>
<td>Routing Interfaces Configuration</td>
<td>282</td>
</tr>
<tr>
<td>8.2.2</td>
<td>Routing Interfaces Secondary Interface Addresses</td>
<td>288</td>
</tr>
<tr>
<td>8.3</td>
<td>ARP</td>
<td>289</td>
</tr>
<tr>
<td>8.3.1</td>
<td>ARP Global</td>
<td>290</td>
</tr>
<tr>
<td>8.3.2</td>
<td>ARP Current</td>
<td>292</td>
</tr>
<tr>
<td>8.3.3</td>
<td>ARP Static</td>
<td>294</td>
</tr>
<tr>
<td>8.4</td>
<td>Open Shortest Path First</td>
<td>295</td>
</tr>
<tr>
<td>8.4.1</td>
<td>OSPF Global</td>
<td>297</td>
</tr>
<tr>
<td>8.4.2</td>
<td>OSPF Areas</td>
<td>305</td>
</tr>
<tr>
<td>8.4.3</td>
<td>OSPF Stub Areas</td>
<td>307</td>
</tr>
<tr>
<td>8.4.4</td>
<td>OSPF Not So Stubby Areas</td>
<td>309</td>
</tr>
<tr>
<td>8.4.5</td>
<td>OSPF Interfaces</td>
<td>312</td>
</tr>
<tr>
<td>8.4.6</td>
<td>OSPF Virtual Links</td>
<td>317</td>
</tr>
<tr>
<td>8.4.7</td>
<td>OSPF Ranges</td>
<td>320</td>
</tr>
<tr>
<td>8.4.8</td>
<td>OSPF Diagnostics</td>
<td>322</td>
</tr>
<tr>
<td>8.5</td>
<td>Routing Table</td>
<td>333</td>
</tr>
<tr>
<td>8.6</td>
<td>Tracking</td>
<td>336</td>
</tr>
<tr>
<td>8.6.1</td>
<td>Tracking Configuration</td>
<td>338</td>
</tr>
<tr>
<td>8.6.2</td>
<td>Tracking Applications</td>
<td>344</td>
</tr>
<tr>
<td>8.7</td>
<td>L3 Relay</td>
<td>345</td>
</tr>
<tr>
<td>8.8</td>
<td>Loopback Interface</td>
<td>350</td>
</tr>
<tr>
<td>8.9</td>
<td>L3-Redundancy</td>
<td>352</td>
</tr>
<tr>
<td>8.9.1</td>
<td>VRRP</td>
<td>352</td>
</tr>
<tr>
<td>8.9.1.1</td>
<td>VRRP Configuration</td>
<td>353</td>
</tr>
<tr>
<td>8.9.1.2</td>
<td>VRRP Statistics</td>
<td>363</td>
</tr>
<tr>
<td>8.9.1.3</td>
<td>VRRP Tracking</td>
<td>365</td>
</tr>
<tr>
<td>8.10</td>
<td>NAT</td>
<td>366</td>
</tr>
<tr>
<td>8.10.1</td>
<td>NAT Global</td>
<td>367</td>
</tr>
<tr>
<td>8.10.2</td>
<td>1:1 NAT</td>
<td>369</td>
</tr>
<tr>
<td>8.10.2.1</td>
<td>1:1 NAT Rule</td>
<td>371</td>
</tr>
<tr>
<td>8.10.3</td>
<td>Destination NAT</td>
<td>374</td>
</tr>
<tr>
<td>8.10.3.1</td>
<td>Destination NAT Rule</td>
<td>376</td>
</tr>
<tr>
<td>8.10.3.2</td>
<td>Destination NAT Mapping</td>
<td>381</td>
</tr>
<tr>
<td>8.10.3.3</td>
<td>Destination NAT Overview</td>
<td>383</td>
</tr>
<tr>
<td>8.10.4</td>
<td>Masquerading NAT</td>
<td>384</td>
</tr>
<tr>
<td>8.10.4.1</td>
<td>Masquerading NAT Rule</td>
<td>386</td>
</tr>
<tr>
<td>8.10.4.2</td>
<td>Masquerading NAT Mapping</td>
<td>389</td>
</tr>
<tr>
<td>8.10.4.3</td>
<td>Masquerading NAT Overview</td>
<td>391</td>
</tr>
<tr>
<td>8.10.5</td>
<td>Double NAT</td>
<td>393</td>
</tr>
<tr>
<td>8.10.5.1</td>
<td>Double NAT Rule</td>
<td>395</td>
</tr>
<tr>
<td>8.10.5.2</td>
<td>Double NAT Mapping</td>
<td>398</td>
</tr>
<tr>
<td>8.10.5.3</td>
<td>Double NAT Overview</td>
<td>400</td>
</tr>
<tr>
<td>9</td>
<td>Diagnostics</td>
<td>403</td>
</tr>
<tr>
<td>9.1</td>
<td>Status Configuration</td>
<td>403</td>
</tr>
<tr>
<td>9.1.1</td>
<td>Device Status</td>
<td>404</td>
</tr>
</tbody>
</table>
WARNING

UNCONTROLLED MACHINE ACTIONS

To avoid uncontrolled machine actions caused by data loss, configure all the data transmission devices individually.

Before you start any machine which is controlled via data transmission, be sure to complete the configuration of all data transmission devices.

Failure to follow these instructions can result in death, serious injury, or equipment damage.
About this Manual

The “Configuration” user manual contains the information you need to start operating the device. It takes you step by step from the first startup operation through to the basic settings for operation in your environment.

The “Installation” user manual contains a device description, safety instructions, a description of the display, and the other information that you need to install the device.

The “Graphical User Interface” reference manual contains detailed information on using the graphical user interface to operate the individual functions of the device.

The “Command Line Interface” reference manual contains detailed information on using the Command Line Interface to operate the individual functions of the device.

The Industrial HiVision Network Management software provides you with additional options for smooth configuration and monitoring:
- Auto-topology discovery
- Browser interface
- Client/server structure
- Event handling
- Event log
- Simultaneous configuration of multiple devices
- Graphical user interface with network layout
- SNMP/OPC gateway
Key

The designations used in this manual have the following meanings:

- List
- Work step
- Link: Cross-reference with link
- Note: A note emphasizes a significant fact or draws your attention to a dependency.
- Courier: Representation of a CLI command or field contents in the graphical user interface

Execution in the Graphical User Interface

Execution in the Command Line Interface
Notes on the Graphical User Interface

The prerequisite to use the Graphical User Interface of the device is a web browser with HTML5 support.

The responsive Graphical User Interface automatically adapts to the size of your screen. Consequently, you can see more details on a large, high-resolution screen than on a small screen. For example, on a high-resolution screen, the buttons have a label next to the icon. On a screen with a small width, the Graphical User Interface displays only the icon.

Note: On a conventional screen, you click to navigate. On a device with a touchscreen, on the other hand, you tap. For simplicity, we only use "click" in our help texts.

The Graphical User Interface is divided as follows:
- Banner
- Menu pane
- Dialog area

Banner

The banner displays the following information:

Display and hides the menu. The banner displays the button if the web browser window is too narrow.

Brand logo

Click the logo to open the website of the manufacturer in a new window.

Dialog name

Displays the name of the dialog currently displayed in the dialog area.

Displays that the Graphical User Interface cannot contact the device. The connection to the device is interrupted.

Displays if the settings in the volatile memory (RAM) differ from the settings of the "Selected" configuration profile in the non-volatile memory (NVM). The banner displays the icon if you have transferred the changes to the volatile memory (RAM), but not yet saved them in the non-volatile memory (NVM).
When you click the button, the online help opens in a new window.

When you click the button, a tooltip displays the following information:
- The summary of the Device status frame. See the Basic Settings > System dialog.
- The summary of the Security status frame. See the Basic Settings > System dialog.
- The summary of the Information frame. See the Diagnostics > System > Configuration Check dialog.

A red dot next to the icon means that at least one of the values is greater than 0.

When you click the button, a submenu opens with the following menu items:
- User account name
  The account name of the user that is currently logged in.
- Logout button
  When you click the button, this logs out the currently logged in user. Then the login dialog opens.
Menu pane

The graphical user interface hides the menu pane if the web browser window is too narrow. To display the menu pane, click the button in the banner.

The menu pane is divided as follows:
- Icons bar
- Menu tree

Icons bar

The icons bar displays the following information:

Device software

Displays the version number of the device software that the device loaded during the last restart and is currently running.

Displays a text field to search for a keyword. When you enter a character or string, the menu tree displays a menu item only for those dialogs that are related to this keyword.

The menu tree displays a menu item only for those dialogs in which at least one parameter differs from the default setting (Diff to default). To display the complete menu tree again, click the button.

Collapses the menu tree. The menu tree then displays only the menu items of the first level.

Expands the menu tree. The menu tree then displays every menu item on every level.
Menu tree

The menu tree contains one item for each dialog in the Graphical User Interface. When you click a menu item, the dialog area displays the corresponding dialog. You can change the view of the menu tree by clicking the buttons in the icons bar at the top. Furthermore, you can change the view of the menu tree by clicking the following buttons:

+  

Expands the current menu item to display the menu items of the next lower level. The menu tree displays the button next to each collapsed menu item that contains menu items on the next lower level.

−  

Collapses the menu item to hide the menu items of the lower levels. The menu tree displays the button next to each expanded menu item.
**Dialog area**

The dialog area displays the dialog that you select in the menu tree, including its controls. Here, you can monitor and change the settings of the device depending on your access role.

Below you find useful information on how to use the dialogs.

- Control elements
- Modification mark
- Standard buttons
- Saving the settings
- Updating the display
- Working with tables

**Control elements**

The dialogs contain different control elements. These control elements are read-only or editable, depending on the parameter and your access role as a user.

The control elements have the following visual properties:

- **Input fields**
  - An editable input field has a line at the bottom.
  - A read-only input field has no special visual properties.

- **Checkboxes**
  - An editable checkbox has a bright color.
  - A read-only checkbox has a grey color.

- **Radio buttons**
  - An editable radio button has a bright color.
  - A read-only radio button has a grey color.

**Modification mark**

When you modify a value, the corresponding field or table cell displays a red triangle in its top-left corner. The red triangle indicates that you have not yet transferred your modification to the volatile memory (RAM) of the device.

**Standard buttons**

Here you find the description of the standard buttons. The special dialog-specific buttons are described in the corresponding dialog help text.

✓

Transfers the changes to the volatile memory (RAM) of the device and applies them to the device.

Information on how the device retains the modified settings even after a reboot you find in section “Saving the settings” on page 16.
Undoes the unsaved changes in the current dialog. Updates the fields with the values that are saved in the volatile memory (RAM) of the device.

**Saving the settings**

Saving transfers the modified settings to the volatile memory (RAM) of the device. To do this, perform the following step:

- Click the ✓ button.

**Note:** Unintentional changes to the settings can terminate the connection between your PC and the device. To keep the device accessible, enable the *Undo configuration modifications* function in the *Basic Settings > Load/Save* dialog, before changing any settings. Using the function, the device continuously checks if it can still be reached from the IP address of your PC. If the connection is lost, then the device loads the configuration profile saved in the non-volatile memory (NVM) after the specified time. Afterwards, the device can be accessed again.

To keep the modified settings even after restarting the device, perform the following steps:

- Open the *Basic Settings > Load/Save* dialog.
- In the table, mark the checkbox far left in the table row of the desired configuration profile.
- When the checkbox in the *Selected* column is unmarked, click the ✓ button and then the Select item.
- Click the ✓ button to save your current changes.

**Updating the display**

If a dialog remains open for a longer time, then the values in the device have possibly changed in the meantime.

- To update the display in the dialog, click the ✓ button. Unsaved information in the dialog is lost.

**Working with tables**

The dialogs display numerous settings in table form. You have the option of customizing the appearance of the tables to fit your needs.

You can find useful information on how to use the tables in the following sections:

- Filter rows
- Sort rows
- Select multiple table rows
**Filter rows**

The filter lets you reduce the number of displayed table rows.

Displays a second table row in the table header containing a text field for every column. When you enter a string in a field, the table displays only the table rows that contain this string in the corresponding column.

**Sort rows**

Every column in the table header contains an icon that lets you change the order of the table rows.

Displays that the table rows are sorted by a criterion other than the values in this column.

Click the icon to sort the table rows in descending order based on the entries of the corresponding column. You might be able to restore the initial sorting in the table only after logging off and logging in again.

Displays that the table rows are sorted in descending order based on the entries of the corresponding column.

Click the icon to sort the table rows in ascending order based on the entries of the corresponding column.

Displays that the table rows are sorted in ascending order based on the entries of the corresponding column.

Click the icon to sort the table rows in descending order based on the entries of the corresponding column.

**Select multiple table rows**

You have the option of selecting multiple table rows at once and then apply an action to them. This is useful for example, when you want to remove multiple table rows at the same time.

To select individual table rows, mark the leftmost checkbox in the desired table row.

To select every table row, mark the leftmost checkbox in the table header.
1 Basic Settings

The menu contains the following dialogs:

- System
- Network
- Software
- Load/Save
- External Memory
- Port
- Restart

1.1 System

This dialog displays information about the operating status of the device.

Device status

Displays the device status and the alarms that currently exist. When at least 1 alarm is present, the background color is red. Otherwise, the background color is green.

You specify the parameters that the device monitors in the Diagnostics > Status Configuration > Device Status dialog. If a monitored parameter differs from the desired status, then the device triggers an alarm.

A tooltip displays the cause of the currently existing alarms and the time at which the device triggered the alarm. To display the tooltip, hover the mouse pointer over or tap the field. In the Diagnostics > Status Configuration > Device Status dialog, the Status tab displays an overview of the alarms.

Note: If you connect only 1 power supply unit to a device that supports 2 redundant power supply units, then the device reports an alarm. To disable this kind of alarm, deactivate the monitoring of the missing power supply units in the Diagnostics > Status Configuration > Device Status dialog.
Security status

Displays the security status and the alarms that currently exist. When at least 1 alarm is present, the background color is red. Otherwise, the background color is green.

You specify the parameters that the device monitors in the Diagnostics > Status Configuration > Security Status dialog. If a monitored parameter differs from the desired status, then the device triggers an alarm.

A tooltip displays the cause of the currently existing alarms and the time at which the device triggered the alarm. To display the tooltip, hover the mouse pointer over or tap the field. In the Diagnostics > Status Configuration > Security Status dialog, the Status tab displays an overview of the alarms.

Signal contact status

The device can contain several signal contacts.

Displays the signal contact status and the alarms that currently exist. When at least 1 alarm is present, the background color is red. Otherwise, the background color is green.

You specify the parameters that the device monitors in the Diagnostics > Status Configuration > Signal Contact > Signal Contact 1/Diagnostics > Status Configuration > Signal Contact > Signal Contact 2 dialog. If a monitored parameter differs from the desired status, then the device triggers an alarm.

A tooltip displays the cause of the currently existing alarms and the time at which the device triggered the alarm. To display the tooltip, hover the mouse pointer over or tap the field. In the Diagnostics > Status Configuration > Signal Contact > Signal Contact 1/Diagnostics > Status Configuration > Signal Contact > Signal Contact 2 dialog, the Status tab displays an overview of the alarms.

System data

The fields in this frame display operating data and information on the location of the device.

System name

Specifies the name for which the device is known in the network.

Possible values:

- Alphanumeric ASCII character string with 0..255 characters
  - The device accepts the following characters:
    - 0..9
    - a..z
    - A..Z
    - !#$%&'()*+,-./:;<=>?@[\]^_`{}~
    - device type name-TMAC address  (default setting)
When creating HTTPS X.509 certificates, the application generating the certificate uses the specified value as the domain name and common name.

The following functions use the specified value as a host name or FQDN (Fully Qualified Domain Name). For compatibility, it is recommended to use only lowercase letters, since some systems distinguish uppercase from lowercase in the FQDN. Verify that this name is unique in the whole network.

- **Syslog**

**Location**

Specifies the current or planned location.

Possible values:
- Alphanumeric ASCII character string with 0..255 characters

**Contact person**

Specifies the contact person for this device.

Possible values:
- Alphanumeric ASCII character string with 0..255 characters

**Device type**

Displays the product name of the device.

**Power supply 1**

Displays the status of the power supply unit at the respective voltage supply connector.

Possible values:
- present
- defective
- not installed
- unknown

**Uptime**

Displays the time that has elapsed since the device was last restarted.

Possible values:
- Time in the format $day(s), \, ...h \, ...m \, ...s$

**Temperature [°C]**

Displays the current temperature in the device in °C.

You activate the monitoring of the temperature threshold values in the Diagnostics > Status Configuration > Device Status dialog.
Basic Settings
[Basic Settings > System]

Upper temp. limit [°C]
Specifies the upper temperature threshold value in °C.
For further information about specifying the temperature threshold values, see the “Installation” user manual.
Possible values:
► -99..99 (integer)
   If the temperature in the device exceeds the specified value, then the device displays an alarm.

Lower temp. limit [°C]
Specifies the lower temperature threshold value in °C.
For further information about specifying the temperature threshold values, see the “Installation” user manual.
Possible values:
► -99..99 (integer)
   If the temperature in the device falls below the specified value, then the device displays an alarm.

Upper humidity limit [%]
Specifies the upper humidity threshold value as a percentage.
Possible values:
► 0..100 (default setting: 95)
   If the humidity in the device exceeds the specified value, then the device displays an alarm.

Lower humidity limit [%]
Specifies the lower humidity threshold value as a percentage.
Possible values:
► 0..100 (default setting: 5)
   If the humidity in the device falls below the specified value, then the device displays an alarm.

**LED status**
For further information about the device status LEDs, see the “Installation” user manual.

Status

●
There is currently no device status alarm. The device status is OK.

●
There is currently at least 1 device status alarm. For details, see the Device status frame.
Power

- Device that supports 2 redundant power supply units: Only 1 supply voltage is active.
- Device that supports 1 power supply unit: The supply voltage is active.
- Device that supports 2 redundant power supply units: Both supply voltages are active.

ACA

- No external memory connected.
- The external memory is connected, but not ready for operation.
- The external memory is connected and ready for operation.

Port status

This frame displays a simplified view of the device ports at the time of the last display update. In the initial view, the frame only displays ports with an active link. When you click the button, the frame displays every port.

You can easily identify the port status from the indicator:
- Ports with an active link:
  - The background color is green.
  - The port speed is displayed next to the port number.
- Ports with an inactive link:
  - The background color is gray.
- Ports in a Blocking state due to a redundancy function:
  - The border is dashed.

When you hover the mouse pointer over or tap the appropriate port icon, a tooltip displays detailed port state information.
1.2 Network

The menu contains the following dialogs:

- Global
- IPv4
1.2.1 Global

This dialog lets you specify the VLAN and HiDiscovery settings required for the access to the device management through the network.

Management interface

This frame lets you specify the VLAN in which the device management can be accessed.

VLAN ID

Specifies the VLAN in which the device management is accessible through the network. The device management is accessible through ports that are members of this VLAN.

Possible values:

- 1..4094 (default setting: 1)
  - The prerequisite is that the VLAN is already configured. See the Switching > VLAN > Configuration dialog.
  - Assign a VLAN ID that is not assigned to any router interface.

When you click the ✓ button after changing the value, the Information window opens. Select the port, over which you connect to the device in the future. After clicking the Ok button, the new device management VLAN settings are assigned to the port.

- After that the port is a member of the VLAN and transmits the data packets without a VLAN tag (untagged). See the Switching > VLAN > Configuration dialog.
- The device assigns the port VLAN ID of the device management VLAN to the port. See the Switching > VLAN > Port dialog.

After a short time the device is reachable over the new port in the new device management VLAN.

MAC address

Displays the MAC address of the device. The device management is accessible via the network using the MAC address.

HiDiscovery protocol v1/v2

This frame lets you specify settings for the access to the device using the HiDiscovery protocol.

On a PC, the HiDiscovery software displays the Hirschmann devices that can be accessed in the network on which the HiDiscovery function is enabled. You can access these devices even if they have invalid or no IP parameters assigned. The HiDiscovery software lets you assign or change the IP parameters in the device.

Note: With the HiDiscovery software you access the device only through ports that are members of the same VLAN as the device management. You specify which VLAN a certain port is assigned to in the Switching > VLAN > Configuration dialog.
Operation

Enables/disables the HiDiscovery function in the device.

Possible values:
- **On** (default setting)
  The HiDiscovery function is enabled.
  You can use the HiDiscovery software to access the device from your PC.
- **Off**
  The HiDiscovery function is disabled.

Access

Enables/disables the write access to the device using for the HiDiscovery function.

Possible values:
- **readWrite** (default setting)
  The HiDiscovery function has write access to the device. The device lets you change the IP parameters in the device using the HiDiscovery function.
- **readOnly**
  The HiDiscovery function has read-only access to the device. The device lets you view the IP parameters in the device using the HiDiscovery function.

Recommendation: Change the setting to the value **readOnly** only after putting the device into operation.

Signal

Activates/deactivates the flashing of the port LEDs as does the function of the same name in the HiDiscovery software. The function lets you identify the device in the field.

Possible values:
- **marked**
  The flashing of the port LEDs is active.
  The port LEDs flash until you disable the function again.
- **unmarked** (default setting)
  The flashing of the port LEDs is inactive.
1.2.2 IPv4

This dialog allows you to specify the IPv4 settings required for the access to the device management through the network.

Management interface

IP address assignment

Specifies the source from which the device management receives its IP parameters.

Possible values:

- **Local**
  
  The device uses the IP parameters from the internal memory. You specify the settings for this in the **IP parameter** frame.

IP parameter

This frame lets you assign the IP parameters manually. If you have selected the **Local** radio button in the **Management interface** frame, **IP address assignment** option list, then these fields can be edited.

IP address

Specifies the IP address under which the device management can be accessed through the network.

Possible values:

- **Valid IPv4 address**

Verify that the IP subnet of the device management is not overlapping with any subnet connected to another interface of the device:

- router interface
- loopback interface
Netmask

Specifies the netmask.

Possible values:
- Valid IPv4 netmask

Gateway address

Specifies the IP address of a router through which the device accesses other devices outside of its own network.

Possible values:
- Valid IPv4 address

If the device does not use the specified gateway, then verify that another default gateway is specified. The setting in the following dialog has precedence:
- Routing > Routing Table dialog, Next hop IP address column, if the value in the Network address column and in the Netmask column is 0.0.0.0

1.3 Software

This dialog lets you update the device software and display information about the device software.

You also have the option to restore a backup of the device software saved in the device.

Note: Before updating the device software, follow the version-specific notes in the Readme text file.

Version

Stored version

Displays the version number and creation date of the device software stored in the flash memory. The device loads the device software during the next restart.

Running version

Displays the version number and creation date of the device software that the device loaded during the last restart and is currently running.

Backup version

Displays the version number and creation date of the device software saved as a backup in the flash memory. The device copied this device software into the backup memory during the last software update or after you clicked the Restore button.
Basic Settings

[Basic Settings > Software]

**Restore**

Restores the device software saved as a backup. In the process, the device changes the *Stored version* and the *Backup version* of the device software.

Upon restart, the device loads the *Stored version*.

**Bootcode**

Displays the version number and creation date of the boot code.

**Software update**

Alternatively, when the image file is located in the external memory, the device lets you update the device software by right-clicking in the table.

**URL**

Specifies the path and the file name of the image file with which you update the device software.

The device gives you the following options for updating the device software:

- **Software update from the PC**
  
  When the file is located on your PC or on a network drive, drag and drop the file in the area. Alternatively click in the area to select the file. You also have the option of transferring the file from your PC to the device through SFTP or SCP. Perform the following steps:
  
  - On your PC, open an SFTP or SCP client, for example WinSCP.
  - Use the SFTP or SCP client to open a connection to the device.
  - Transfer the file to the directory `/upload/firmware` in the device.

  When the file transfer is complete, the device starts updating the device software. If the update was successful, then the device creates an `ok` file in the directory `/upload/firmware` and deletes the image file.

  The device loads the device software during the next restart.

**Start**

Updates the device software.

The device installs the selected file in the flash memory, replacing the previously saved device software. Upon restart, the device loads the installed device software.

The device copies the existing software into the backup memory.

To remain logged in to the device during the software update, move the mouse pointer occasionally. Alternatively, specify a sufficiently high value in the *Device Security > Management Access > Web* dialog, field *Web interface session timeout [min]* before the software update.
Table

File location

Displays the storage location of the device software.

Possible values:

- **ram**
  - Volatile memory of the device
- **flash**
  - Non-volatile memory (**NVM**) of the device
- **sd-card**
  - External SD memory (ACA31)
- **usb**
  - External USB memory (ACA21/ACA22)

Index

Displays the index of the device software.

For the device software in the flash memory, the index has the following meaning:

- **1**
  - Upon restart, the device loads this device software.
- **2**
  - The device copied this device software into the backup area during the last software update.

File name

Displays the device-internal file name of the device software.

Firmware

Displays the version number and creation date of the device software.
1.4 Load/Save

This dialog lets you save the device settings permanently in a configuration profile.

The device can hold several configuration profiles. When you activate an alternative configuration profile, you change to other device settings. You have the option of exporting the configuration profiles to your PC or to a server. You also have the option of importing the configuration profiles from your PC or from a server to the device.

In the default setting, the device saves the configuration profiles unencrypted. If you enter a password in the Configuration encryption frame, then the device saves both the current and the future configuration profiles in an encrypted format.

Unintentional changes to the settings can terminate the connection between your PC and the device. To keep the device accessible, enable the Undo configuration modifications function before changing any settings. If the connection is lost, then the device loads the configuration profile saved in the non-volatile memory (NVM) after the specified time.

External memory

Selected external memory

Specifies the external memory that the device uses for file operations. On this external memory, the device stores for example copies of the device configuration.

Possible values:

- **sd**: External SD memory (ACA31)
- **usb**: External USB memory (ACA21/ACA22)

Status

Displays the operating state of the selected external memory.

Possible values:

- **notPresent**: No external memory connected.
- **removed**: Someone has removed the external memory from the device during operation.
- **ok**: The external memory is connected and ready for operation.
- **outOfMemory**: The memory space is occupied in the external memory.
- **genericErr**: The device has detected an error.
Configuration encryption

Active

Displays if the configuration encryption is active/inactive in the device.

Possible values:

► marked
  The configuration encryption is active.
  If the configuration profile is encrypted and the password matches the password stored in the device, then the device loads a configuration profile from the non-volatile memory (NVM).

► unmarked
  The configuration encryption is inactive.
  If the configuration profile is unencrypted, then the device loads a configuration profile from the non-volatile memory (NVM) only.

If in the Basic Settings > External Memory dialog, the Config priority column has the value first or second and the configuration profile is unencrypted, then the Security status frame in the Basic Settings > System dialog displays an alarm.

In the Diagnostics > Status Configuration > Security Status dialog, Global tab, Monitor column you specify if the device monitors the Load unencrypted config from external memory parameter.

Set password

Opens the Set password window that helps you to enter the password needed for the configuration profile encryption. Encrypting the configuration profiles makes unauthorized access more difficult. To do this, perform the following steps:

- When you are changing an existing password, enter the existing password in the Old password field. To display the password in plain text instead of ***** (asterisks), mark the Display content checkbox.
- In the New password field, enter the password. To display the password in plain text instead of ***** (asterisks), mark the Display content checkbox.
- Mark the Save configuration afterwards checkbox to use encryption also for the Selected configuration profile in the non-volatile memory (NVM) and in the external memory.

Note: If a maximum of one configuration profile is stored in the non-volatile memory (NVM) of the device, then use this function only. Before creating additional configuration profiles, decide for or against permanently activated configuration encryption in the device. Save additional configuration profiles either unencrypted or encrypted with the same password.

If you are replacing a device with an encrypted configuration profile, for example due to a defect, then perform the following steps:

- Restart the new device and assign the IP parameters.
- Open the Basic Settings > Load/Save dialog on the new device.
- Encrypt the configuration profile in the new device. See above. Enter the same password you used in the defective device.
- Install the external memory from the defective device in the new device.
- Restart the new device.
  When you restart the device, the device loads the configuration profile with the settings of the defective device from the external memory. The device copies the settings into the volatile memory (RAM) and into the non-volatile memory (NVM).
Note: The prerequisite for loading a configuration profile from the external memory is that in the Basic Settings > External Memory dialog the Config priority column displays the value first or second. This value is set as the default setting.

Delete

Opens the Delete window which helps you to cancel the configuration encryption in the device. To cancel the configuration encryption, perform the following steps:

- In the Old password field, enter the existing password.
  To display the password in plain text instead of ***** (asterisks), mark the Display content checkbox.
- Mark the Save configuration afterwards checkbox to remove the encryption also for the Selected configuration profile in the non-volatile memory (NVM) and in the external memory.

Note: If you keep additional encrypted configuration profiles in the memory, then the device helps prevent you from activating or designating these configuration profiles as "Selected".

Undo configuration modifications

Operation

Enables/disables the Undo configuration modifications function. Using the function, the device continuously checks if it can still be reached from the IP address of your PC. If the connection is lost, after a specified time period the device loads the “Selected” configuration profile from the non-volatile memory (NVM). Afterwards, the device can be accessed again.

Possible values:

- **On**
  The function is enabled.
  - You specify the time period between the interruption of the connection and the loading of the configuration profile in the Timeout [s] to recover after connection loss field.
  - When the non-volatile memory (NVM) contains multiple configuration profiles, the device loads the configuration profile designated as “Selected”.

- **Off** (default setting)
  The function is disabled.
  Disable the function again before you close the Graphical User Interface. You thus help prevent the device from restoring the configuration profile designated as “Selected”.

Note: Before you enable the function, save the settings in the configuration profile. Current changes, that are saved temporarily, are therefore maintained in the device.

Timeout [s] to recover after connection loss

Specifies the time in seconds after which the device loads the “Selected” configuration profile from the non-volatile memory (NVM) if the connection is lost.

Possible values:

- **30..600** (default setting: 600)

Specify a sufficiently large value. Take into account the time when you are viewing the dialogs of the Graphical User Interface without changing or updating them.
Watchdog IP address

Displays the IP address of the PC on which you have enabled the function.

Possible values:
- IPv4 address  (default setting: \texttt{0.0.0.0})

Information

NVM in sync with running config

Displays if the settings in the volatile memory (\texttt{RAM}) differ from the settings of the "Selected" configuration profile in the non-volatile memory (\texttt{NVM}).

Possible values:
- \texttt{marked}  The settings match.
- \texttt{unmarked}  The settings differ. Additionally, the Banner displays the icon !.

External memory in sync with NVM

Displays if the settings of the "Selected" configuration profile in the external memory (ACA) differ from the settings of the "Selected" configuration profile in the non-volatile memory (\texttt{NVM}).

Possible values:
- \texttt{marked}  The settings match.
- \texttt{unmarked}  The settings differ.
Possible causes:
- No external memory is connected to the device.
- In the Basic Settings > External Memory dialog, the Backup config when saving function is disabled.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

\textbf{Remove}

Removes the configuration profile selected in the table from the non-volatile memory (\texttt{NVM}) or from the external memory.

If the configuration profile is designated as "Selected", then the device helps prevent you from removing the configuration profile.
Save

Transfers the settings from the volatile memory (RAM) into the configuration profile designated as “Selected” in the non-volatile memory (NVM).

When in the Basic Settings > External Memory dialog the checkbox in the Backup config when saving column is marked, then the device generates a copy of the configuration profile in the external memory.

Displays a context menu with further functions for the corresponding dialog.

Save as..

Opens the Save as.. window to copy the configuration profile selected in the table and saves it with a user-specified name in the non-volatile memory (NVM).

- In the Profile name field, enter the name under which you want to save the configuration profile.
  - To save the configuration profile under a new name, click the + button.
  - To overwrite an existing configuration profile, select the corresponding entry from the drop-down list.

If in the Basic Settings > External Memory dialog the checkbox in the Backup config when saving column is marked, then the device designates the configuration profile of the same name in the external memory as “Selected”.

Note: Before creating additional configuration profiles, decide for or against permanently activated configuration encryption in the device. Save additional configuration profiles either unencrypted or encrypted with the same password.

Activate

Loads the settings of the configuration profile selected in the table to the volatile memory (RAM).

The device terminates the connection to the Graphical User Interface. To access the device management again, perform the following steps:

- Reload the Graphical User Interface.
- Log in again.

The device immediately uses the settings of the configuration profile on the fly.

Enable the Undo configuration modifications function before you activate another configuration profile. If the connection is lost afterwards, then the device loads the last configuration profile designated as “Selected” from the non-volatile memory (NVM). The device can then be accessed again.

If the configuration encryption is inactive, then the device loads an unencrypted configuration profile. If the configuration encryption is active and the password matches the password stored in the device, then the device loads an encrypted configuration profile.

When you activate an older configuration profile, the device takes over the settings of the functions contained in this software version. The device sets the values of new functions to their default value.
Select

Designates the configuration profile selected in the table as “Selected”. In the Selected column, the checkbox is then marked.

When applying the Undo configuration modifications function or during a restart, the device loads the settings of this configuration profile to the volatile memory (RAM).

► If the configuration encryption in the device is disabled, then designate an unencrypted configuration profile only as “Selected”.

► If the configuration encryption in the device is enabled and the password of the configuration profile matches the password saved in the device, then designate an encrypted configuration profile only as “Selected”.

Otherwise, the device is unable to load and encrypt the settings in the configuration profile the next time it restarts. For this case you specify in the Diagnostics > System > Selftest dialog if the device starts with the default settings or terminates the restart and stops.

Note: You only mark the configuration profiles saved in the non-volatile memory (NVM).

If in the Basic Settings > External Memory dialog the checkbox in the Backup config when saving column is marked, then the device designates the configuration profile of the same name in the external memory as “Selected”.

Import...

Opens the Import... window to import a configuration profile.

The prerequisite is that you have exported the configuration profile using the Export... button or using the link in the Profile name column.

☐ In the Select source drop-down list, select from where the device imports the configuration profile.

► PC/URL

The device imports the configuration profile from the local PC or from a remote server.

► External memory

The device imports the configuration profile from the selected external memory. See the External memory frame.

☐ When PC/URL is selected above, in the Import profile from PC/URL frame you specify the configuration profile file to be imported.

– Import from the PC

When the file is located on your PC or on a network drive, drag and drop the file in the area. Alternatively click in the area to select the file.

You also have the option of transferring the file from your PC to the device through SFTP or SCP:

On your PC, open an SFTP or SCP client, for example WinSCP.

Use the SFTP or SCP client to open a connection to the device.

Transfer the file to the directory /nv/cfg in the device.
When *External memory* is selected above, in the *Import profile from external memory* frame you specify the configuration profile file to be imported. In the *Profile name* drop-down list, select the name of the configuration profile to be imported.

In the *Destination* frame you specify where the device saves the imported configuration profile. In the *Profile name* field you specify the name under which the device saves the configuration profile.

In the *Storage type* field you specify the storage location for the configuration profile. The prerequisite is that in the *Select source* drop-down list you select the *PC/URL* item.

- **RAM**
  The device saves the configuration profile in the volatile memory (*RAM*) of the device. This replaces the *running-config*, the device uses the settings of the imported configuration profile immediately. The device terminates the connection to the Graphical User Interface. Reload the Graphical User Interface. Log in again.

- **NVM**
  The device saves the configuration profile in the non-volatile memory (*NVM*) of the device.

When you import a configuration profile, the device takes over the settings as follows:

- If the configuration profile was exported on the same device or on an identically equipped device of the same type, then:
  The device takes over the settings completely.

- If the configuration profile was exported on an other device, then:
  The device takes over the settings which it can interpret based on its hardware equipment and software level.
  The remaining settings the device takes over from its *running-config* configuration profile.

Regarding configuration profile encryption, also read the help text of the *Configuration encryption* frame. The device imports a configuration profile under the following conditions:

- The configuration encryption of the device is inactive. The configuration profile is unencrypted.
- The configuration encryption of the device is active. The configuration profile is encrypted with the same password that the device currently uses.

**Export...**

Exports the configuration profile selected in the table and saves it as an XML file on a remote server.

To save the file on your PC, click the link in the *Profile name* column to select the storage location and specify the file name.

**Back to factory...**

Resets the settings in the device to the default values.

- The device deletes the saved configuration profiles from the volatile memory (*RAM*) and from the non-volatile memory (*NVM*).
- The device deletes the HTTPS certificate used by the web server in the device.
- The device deletes the RSA key (Host Key) used by the SSH server in the device.
- When an external memory is connected, the device deletes the configuration profiles saved in the external memory.
- After a brief period, the device reboots and loads the default values.

**Back to default**

Deletes the current operating (*running config*) settings from the volatile memory (*RAM*).
### Storage type

Displays the storage location of the configuration profile.

**Possible values:**

- **RAM** (volatile memory of the device)
  - In the volatile memory, the device stores the settings for the current operation.

- **NVM** (non-volatile memory of the device)
  - When applying the Undo configuration modifications function or during a restart, the device loads the “Selected” configuration profile from the non-volatile memory.
  - The non-volatile memory provides space for multiple configuration profiles, depending on the number of settings saved in the configuration profile. The device manages a maximum of 20 configuration profiles in the non-volatile memory.
  - You can load a configuration profile into the volatile memory (**RAM**). To do this, perform the following steps:
    - Select the table row of the configuration profile.
    - Click the **...** button and then the **Activate** item.

- **ENVM** (external memory)
  - In the external memory, the device saves a backup copy of the “Selected” configuration profile.
  - The prerequisite is that in the **Basic Settings > External Memory** dialog you mark the **Backup config when saving** checkbox.

### Profile name

Displays the name of the configuration profile.

**Possible values:**

- **running-config**
  - Name of the configuration profile in the volatile memory (**RAM**).

- **config**
  - Name of the factory setting configuration profile in the non-volatile memory (**NVM**).

- **User-defined name**
  - The device lets you save a configuration profile with a user-specified name. To do this, select the table row of an existing configuration profile in the table, click the **...** button and then the **Save as.** item.

  To export the configuration profile as an XML file on your PC, click the link. Then you select the storage location and specify the file name.

  To save the file on a remote server, click the **...** button and then the **Export...** item.

### Modification date (UTC)

Displays the time (UTC) at which a user last saved the configuration profile.

### Selected

Displays if the configuration profile is designated as “Selected”.

The device lets you designate another configuration profile as “Selected”. To do this, select the desired configuration profile in the table, click the **...** button and then the **Activate** item.
Possible values:

- **marked**
  - The configuration profile is designated as “Selected”.
  - When applying the *Undo configuration modifications* function or during a restart, the device loads the configuration profile into the volatile memory (*RAM*).
  - When you click the button, the device saves the temporarily saved settings in this configuration profile.

- **unmarked**
  - Another configuration profile is designated as “Selected”.

**Encrypted**

Displays if the configuration profile is encrypted.

Possible values:

- **marked**
  - The configuration profile is encrypted.

- **unmarked**
  - The configuration profile is unencrypted.

You activate/deactivate the encryption of the configuration profile in the *Configuration encryption* frame.

**Encryption verified**

Displays if the password of the encrypted configuration profile matches the password stored in the device.

Possible values:

- **marked**
  - The passwords match. The device is able to unencrypt the configuration profile.

- **unmarked**
  - The passwords are different. The device is unable to unencrypt the configuration profile.

**Note:** The device applies script files additionally to the current settings. Verify that the script file does not contain any parts that conflict with the current settings.

**Software version**

Displays the version number of the device software that the device ran while saving the configuration profile.

**Fingerprint**

Displays the checksum saved in the configuration profile.

When saving the settings, the device calculates the checksum and inserts it into the configuration profile.

**Fingerprint verified**

Displays if the checksum saved in the configuration profile is valid.

The device calculates the checksum of the configuration profile marked as “Selected” and compares it with the checksum saved in this configuration profile.
Possible values:

- **marked**
  - The calculated and the saved checksum match.
  - The saved settings are consistent.

- **unmarked**
  - For the configuration profile marked as “Selected” applies:
    - The calculated and the saved checksum are different.
    - The configuration profile contains modified settings.
  - Possible causes:
    - The file is damaged.
    - The file system in the external memory is inconsistent.
    - A user has exported the configuration profile and changed the XML file outside the device.
  - For the other configuration profiles the device has not calculated the checksum.

The device verifies the checksum correctly only if the configuration profile has been saved before as follows:

- on an identical device
- with the same software version, which the device is running

**Note:** This function identifies changes to the settings in the configuration profile. The function does not provide protection against operating the device with modified settings.
1.5 **External Memory**

This dialog lets you activate functions that the device automatically executes in combination with the external memory. The dialog also displays the operating state and identifying characteristics of the external memory.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>Type</th>
<th>Displays the type of the external memory.</th>
</tr>
</thead>
<tbody>
<tr>
<td>sd</td>
<td>External SD memory (ACA31)</td>
</tr>
<tr>
<td>usb</td>
<td>External USB memory (ACA21/ACA22)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Status</th>
<th>Displays the operating state of the external memory.</th>
</tr>
</thead>
<tbody>
<tr>
<td>notPresent</td>
<td>No external memory connected.</td>
</tr>
<tr>
<td>removed</td>
<td>Someone has removed the external memory from the device during operation.</td>
</tr>
<tr>
<td>ok</td>
<td>The external memory is connected and ready for operation.</td>
</tr>
<tr>
<td>outOfMemory</td>
<td>The memory space is occupied in the external memory.</td>
</tr>
<tr>
<td>genericErr</td>
<td>The device has detected an error.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Writable</th>
<th>Displays if the device has write access to the external memory.</th>
</tr>
</thead>
<tbody>
<tr>
<td>marked</td>
<td>The device has write access to the external memory.</td>
</tr>
<tr>
<td>unmarked</td>
<td>The device has read-only access to the external memory. Possibly the write protection is activated in the external memory.</td>
</tr>
</tbody>
</table>
Software auto update

Activates/deactivates the automatic device software update during the restart.

Possible values:
- marked (default setting)
  The device updates the device software when the following files are located in the external memory:
  - the image file of the device software
  - a text file `startup.txt` with the content `autoUpdate=<image_file_name>.bin`
- unmarked
  No automatic device software update during the restart.

Config priority

Specifies the memory from which the device loads the configuration profile upon reboot.

Possible values:
- disable
  The device loads the configuration profile from the non-volatile memory (NVM).
- first, second
  The device loads the configuration profile from the external memory designated as first. When the device does not find a configuration profile there, it loads the configuration profile from the external memory designated as second, and so on.
  When the device does not find a configuration profile in the external memory, it loads the configuration profile from the non-volatile memory (NVM).

Note: When loading the configuration profile from the external memory (ENVM), the device overwrites the settings of the Selected configuration profile in the non-volatile memory (NVM).

If the Config priority column has the value first or second and the configuration profile is unencrypted, then the Security status frame in the Basic Settings > System dialog displays an alarm.

In the Diagnostics > Status Configuration > Security Status dialog, Global tab, Monitor column you specify if the device monitors the Load unencrypted config from external memory parameter.

Backup config when saving

Activates/deactivates creating a copy of the configuration profile in the external memory.

Possible values:
- marked (default setting)
  Creating a copy is activated. When you click in the Basic Settings > Load/Save dialog the button, the device generates a copy of the configuration profile on the active external memory.
- unmarked
  Creating a copy is deactivated. The device does not generate a copy of the configuration profile.

Manufacturer ID

Displays the name of the memory manufacturer.

Revision

Displays the revision number specified by the memory manufacturer.
Version

Displays the version number specified by the memory manufacturer.

Name

Displays the product name specified by the memory manufacturer.

Serial number

Displays the serial number specified by the memory manufacturer.
1.6 Port

This dialog lets you specify settings for the individual ports. The dialog also displays the operating mode, connection status, bit rate and duplex mode for every port.

The dialog contains the following tabs:
- [Configuration]
- [Statistics]

[Configuration]

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Port

Displays the port number.

Name

Name of the port.

Possible values:
- Alphanumeric ASCII character string with 0..64 characters

  The device accepts the following characters:
  - <space>
  - 0..9
  - a..z
  - A..Z
  - !#$%&'()*+,-./:;<=>?@[]^_`{}~

Port on

Activates/deactivates the port.

Possible values:
- marked (default setting)
  - The port is active.
- unmarked
  - The port is inactive. The port does not send or receive any data.
State

Displays if the port is currently physically enabled or disabled.

Possible values:
- **marked**
  - The port is physically enabled.
- **unmarked**
  - The port is physically disabled.

Power state (port off)

Specifies if the port is physically switched on or off when you deactivate the port with the *Port on* function.

Possible values:
- **marked**
  - The port remains physically enabled. A connected device receives an active link.
- **unmarked** (default setting)
  - The port is physically disabled.

Auto power down

Specifies how the port behaves when no cable is connected.

Possible values:
- **no-power-save** (default setting)
  - The port remains activated.
- **auto-power-down**
  - The port changes to the energy-saving mode.
- **unsupported**
  - The port does not support this function and remains activated.

Automatic configuration

Activates/deactivates the automatic selection of the operating mode for the port.

Possible values:
- **marked** (default setting)
  - The automatic selection of the operating mode is active.
  - The port negotiates the operating mode independently using autonegotiation and detects the devices connected to the TP port automatically (Auto Cable Crossing). This setting has priority over the manual setting of the port.
  - Elapse several seconds until the port has set the operating mode.
- **unmarked**
  - The automatic selection of the operating mode is inactive.
  - The port operates with the values you specify in the *Manual configuration* column and in the *Manual cable crossing (Auto. conf. off)* column.
- **Grayed-out display**
  - No automatic selection of the operating mode.
Manual configuration

Specifies the operating mode of the ports when the *Automatic configuration* function is disabled.

Possible values:

- **10 Mbit/s HDX**
  Half duplex connection
- **10 Mbit/s FDX**
  Full duplex connection
- **100 Mbit/s HDX**
  Half duplex connection
- **100 Mbit/s FDX**
  Full duplex connection
- **1000 Mbit/s FDX**
  Full duplex connection

**Note:** The operating modes of the port actually available depend on the device configuration.

Link/Current settings

Displays the operating mode which the port currently uses.

Possible values:

- **-**
  No cable connected, no link.
- **10 Mbit/s HDX**
  Half duplex connection
- **10 Mbit/s FDX**
  Full duplex connection
- **100 Mbit/s HDX**
  Half duplex connection
- **100 Mbit/s FDX**
  Full duplex connection
- **1000 Mbit/s FDX**
  Full duplex connection

**Note:** The operating modes of the port actually available depend on the device configuration.

Manual cable crossing (Auto. conf. off)

Specifies the devices connected to a TP port.

The prerequisite is that the *Automatic configuration* function is disabled.

Possible values:

- **mdi**
  The device interchanges the send- and receive-line pairs on the port.
- **mdix** (default setting on TP ports)
  The device helps prevent the interchange of the send- and receive-line pairs on the port.
The device detects the send and receive line pairs of the connected device and automatically adapts to them. Example: When you connect an end device with a crossed cable, the device automatically resets the port from mdix to mdi.

- **auto-mdix**
- **unsupported** (default setting on optical ports or TP-SFP ports)
  - The port does not support this function.

### Flow control

Activates/deactivates the flow control on the port.

**Possible values:**

- **marked** (default setting)
  - The Flow control on the port is active.
  - The sending and evaluating of pause packets (full-duplex operation) or collisions (half-duplex operation) is activated on the port.
  - To enable the flow control in the device, also activate the Flow control function in the Switching > Global dialog.
  - Activate the flow control also on the port of the device that is connected to this port.
  - On an uplink port, activating the flow control can possibly cause undesired sending breaks in the higher-level network segment ("wandering backpressure").

- **unmarked**
  - The Flow control on the port is inactive.

If you are using a redundancy function, then you deactivate the flow control on the participating ports. If the flow control and the redundancy function are active at the same time, it is possible that the redundancy function operates differently than intended.

### Send trap (Link up/down)

Activates/deactivates the sending of SNMP traps when the device detects a change in the link up/down status on the port.

**Possible values:**

- **marked** (default setting)
  - The sending of SNMP traps is active.
  - When the device detects a link up/down status change, the device sends an SNMP trap.

- **unmarked**
  - The sending of SNMP traps is inactive.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.

### Statistics

This tab displays the following overview per port:

- Number of data packets/bytes received in the device
  - **Received packets**
  - **Received octets**
  - **Received unicast packets**
  - **Received multicast packets**
  - **Received broadcast packets**
Basic Settings

[Basic Settings > Port]

- Number of data packets/bytes sent from the device
  - Transmitted packets
  - Transmitted octets
  - Transmitted unicast packets
  - Transmitted multicast packets
  - Transmitted broadcast packets

- Number of errors detected by the device
  - Received fragments
  - Detected CRC errors
  - Detected collisions

- Number of data packets per size category received in the device
  - Packets 64 bytes
  - Packets 65 to 127 bytes
  - Packets 128 to 255 bytes
  - Packets 256 to 511 bytes
  - Packets 512 to 1023 bytes
  - Packets 1024 to 1518 bytes

- Number of data packets discarded by the device
  - Received discards
  - Transmitted discards

To sort the table by a specific criterion click the header of the corresponding column.

For example, to sort the table based on the number of received bytes in ascending order, click the header of the Received octets column once. To sort in descending order, click the header again.

To reset the counter for the port statistics in the table to 0, perform the following steps:

- In the Basic Settings > Port dialog, click the button.
- or
- In the Basic Settings > Restart dialog, click the Clear port statistics button.
1.7 Restart

This dialog lets you restart the device, reset port counters and address tables, and delete log files.

Restart

Cold start...

Opens the Restart dialog to initiate a restart of the device.

If the configuration profile in the volatile memory (RAM) and the "Selected" configuration profile in the non-volatile memory (NVM) differ, then the device displays the Warning dialog.

- To permanently save the changes, click the Yes button in the Warning dialog.
- To discard the changes, click the No button in the Warning dialog.

The device restarts and goes through the following phases:
- The device starts the device software that the Stored version field displays in the Basic Settings > Software dialog.
- The device loads the settings from the "Selected" configuration profile. See the Basic Settings > Load/Save dialog.

Note: During the restart, the device does not transfer any data. During this time, the device cannot be accessed by the Graphical User Interface or other management systems.

Buttons

Reset MAC address table

Removes the MAC addresses from the forwarding table that have in the Switching > Filter for MAC Addresses dialog the value learned in the Status column.

Reset ARP table

Removes the dynamically set up addresses from the ARP table.

See the Diagnostics > System > ARP dialog.

Clear port statistics

Resets the counter for the port statistics to 0.

See the Basic Settings > Port dialog, Statistics tab.

Delete log file

Removes the logged events from the log file.

See the Diagnostics > Report > System Log dialog.
Delete persistent log file

Removes the log files from the external memory.

See the Diagnostics > Report > Persistent Logging dialog.

Clear firewall table

Removes the information about open connections from the state table of the firewall. It is possible, that the device interrupts open communication connections.

Clear ACL hit counts

Resets the counters in the Hits and Timer columns to 0.

See the Network Security > ACL > IPv4 Rule and Network Security > ACL > MAC Rule dialogs.
2 Time

The menu contains the following dialogs:
- Basic Settings
- NTP

2.1 Basic Settings

The device is equipped with a buffered hardware clock. This clock maintains the correct time if the power supply fails or you disconnect the device from the power supply. After the device is started, the current time is available to you, for example for log entries.

The hardware clock bridges a power supply downtime of 3 hours. The prerequisite is that the power supply of the device has been connected continually for at least 5 minutes beforehand.

In this dialog you specify time-related settings independently of the time synchronization protocol specified.

Configuration

System time (UTC)

Displays the current date and time with reference to Universal Time Coordinated (UTC).

Set time from PC

The device uses the time on the PC as the system time.

System time

Displays the current date and time with reference to the local time: System time = System time (UTC) + Local offset [min] + Daylight saving time

Time source

Displays the time source from which the device gets the time information.

The device automatically selects the available time source with the greatest accuracy.

Possible values:
- local
  System clock of the device.
- ntp
  The NTP client is enabled and the device is synchronized by an NTP server.
Local offset [min]

Specifies the difference between the local time and System time (UTC) in minutes: Local offset [min] = System time - System time (UTC)

Possible values:

- 780..840 (default setting: 60)

2.2 NTP

The device lets you synchronize the system time in the device and in the network using the Network Time Protocol (NTP).

The Network Time Protocol (NTP) is a procedure described in RFC 5905 for time synchronization in the network.

On the basis of a reference time source, NTP defines hierarchy levels for time servers and clients. A hierarchy level is known as a "stratum". Devices of the 1st level (stratum 1) synchronize themselves directly with the reference time source and make the time information available to clients of the 2nd level (stratum 2). A GPS receiver or a radio-controlled clock can serve as the reference time source.

The NTP client in the device evaluates the time information of several servers and adjusts its own clock continuously to attain a high level of accuracy. If you also configure the device as an NTP server, then the device distributes time information to the clients in the subordinate network segment.

The menu contains the following dialogs:

- Global
- Server
2.2.1 Global

[Time > NTP > Global]

In this dialog you determine if the device functions as an NTP client and server or only as an NTP client.

- As an NTP client, the device takes the coordinated world time (UTC) from one or more NTP servers in the network.
- As an NTP server, the device distributes the coordinated world time (UTC) to NTP clients in the subordinate network segment. The device takes the coordinated world time from one or more NTP servers in the network, if these were previously specified.

Client only

The device transmits the time information without authentication in the VLAN of the device management as well as in Layer 3 on the IP interfaces set up.

Client

Enables/disables the NTP client in the device.

Possible values:

- **On**
  
  The NTP client is enabled.
  
  The device obtains the time information from one or more NTP servers in the network.

- **Off** (default setting)
  
  The NTP client is disabled.

**Note:** Before you enable the client, disable the **Server** function in the **Client and server** frame.

Mode

Specifies from where the NTP client takes the time information.

Possible values:

- **unicast** (default setting)
  
  The NTP client takes the time information from unicast responses of the servers that are indicated as active in the **Time > NTP > Server** dialog.

- **broadcast**
  
  The NTP client takes the time information from broadcast messages.
Client and server

The device transmits the time information without authentication in the VLAN of the device management as well as in Layer 3 on the IP interfaces set up.

Server

Enables/disables the NTP client and the NTP server in the device.

Possible values:

- **On**
  - The NTP client and the NTP server are enabled.
  - The NTP client obtains the time information from one or more NTP servers in the network. The NTP server distributes the time information to the NTP clients in the subordinate network segment.

- **Off** (default setting)
  - The NTP client and the NTP server are disabled.

**Note:** If you enable the NTP client and the NTP server, then the device disables the function in the Client field in the Client only frame.

Mode

Specifies in which mode the NTP server works.

Possible values:

- **client-server** (default setting)
  - With this setting, the device obtains the time information from NTP servers in the network and distributes it to NTP clients in the subordinate network segment.
    - The NTP client takes the time information from the unicast responses of the servers that are indicated as active in the Time > NTP > Server dialog.
    - The NTP server distributes the time information via unicast to the requesting clients.

- **symmetric**
  - With this setting you integrate the device in a cluster of redundant NTP servers. The device synchronizes the time information with the other NTP servers in the cluster at intervals of 64 seconds.
  - In the Time > NTP > Server dialog, indicate the NTP servers participating in the cluster as active.
  - Specify a uniform value for the stratum for the NTP servers participating in the cluster.

Stratum

Specifies the hierarchical distance of the device to the referent time source.

Possible values:

- **1..16** (default setting: 12)

**Example:** Devices of the first level (Stratum 1) synchronize themselves directly with the reference time source and make the time information available to the clients of the second level (Stratum 2).

The device evaluates this value under the following circumstances:

- The NTP server in the device is working in symmetric mode.
- The device is using the local system clock as the time source. See the Time source field in the Time > Basic Settings dialog.
2.2.2 Server

In this dialog you specify the NTP servers.

- The NTP client of the device obtains the time information from the unicast responses of the servers specified here.
- If the NTP server of the device is working in symmetric mode, then you specify the servers participating in the cluster here.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Index

Displays the index number to which the table row relates.

Possible values:

- 1..4

The device automatically assigns this number.

When you delete a table row, this leaves a gap in the numbering. When you create a new table row, the device fills the first gap.

Address

Specifies the IP address of the NTP server.

Possible values:

- Valid IPv4 address (default setting: 0.0.0.0)

Port

Displays the UDP Port on which the NTP server provides the time information.

Initial burst

Activates/deactivates the Initial burst mode.

During operation, the NTP client of the device only sends single data packets to request the time information. If the NTP server is unreachable (Status column = notResponding), then the NTP client of the device sends several data packets at once (burst) to synchronize as soon as possible.
Possible values:

- **marked**
  The initial burst mode is active.
  - The device sends only once several data packets (burst) when the NTP server is unreachable.
  - Only use this setting if you use a private, non-public NTP server as reference time source.
  - You use this setting with care to speed up the initial synchronization.

- **unmarked** (default setting)
  The initial burst mode is inactive.

**Burst**

Activates/deactivates the burst mode.

During operation, the NTP client of the device only sends single data packets to request the time information. In the burst mode, the NTP client of the device sends several data packets at once (burst) when the NTP server is reachable and ready for synchronization.

Possible values:

- **marked**
  The burst mode is active.
  - For each polling interval, the device sends several data packets (burst) when the NTP server is reachable.
  - Only use this setting if you use a private, non-public NTP server as reference time source.
  - You use this setting with care to improve precision when the connection to the NTP server is unstable.

- **unmarked** (default setting)
  The burst mode is inactive.

**Preferred**

Marks the NTP server as preferred reference time source when multiple NTP servers are specified.

Without marking, the NTP client of the device uses standard algorithms to select the reference time source.

Mark max. 1 sufficiently precise server as **Preferred**.

Possible values:

- **marked**
  The device uses the NTP server as the preferred reference time source. You use this setting to help prevent frequent connection changes between equal NTP servers.

- **unmarked** (default setting)
  No preferred NTP server.

**Status**

Displays the synchronization status.

Possible values:

- **disabled**
  No server available.

- **protocolError**

- **notSynchronized**
  The server is available. The server itself is not synchronized.
> **notResponding**
> The server is available. The device does not receive time information.

> **synchronizing**
> The server is available. The device receives time information.

> **synchronized**
> The server is available. The device has synchronized its clock with the server.

> **genericError**
> Device-internal error.

**Active**

Activates/deactivates the connection to the NTP server.

Possible values:

> **marked**
> The connection to the NTP server is activated.
>  
>  > The NTP client of the device obtains the time information from the unicast responses of this server.
>  
>  > If the NTP server of the device is working in symmetric mode, then this server participates in a cluster.

> **unmarked**
> The connection to the NTP server is deactivated.
3  Device Security

The menu contains the following dialogs:

- User Management
- Authentication List
- LDAP
- Management Access
- Pre-login Banner

3.1 User Management

If users log in with valid login data, then the device lets them have access to its device management.

In this dialog you manage the users of the local user management. You also specify the following settings here:

- Settings for the login
- Settings for saving the passwords
- Specify policy for valid passwords

The methods that the device uses for the authentication you specify in the Device Security > Authentication List dialog.

Configuration

This frame lets you specify settings for the login.

Login attempts

Specifies the number of login attempts possible when the user accesses the device management using the Graphical User Interface and the Command Line Interface.

Note: When accessing the device management using the Command Line Interface through the serial connection, the number of login attempts is unlimited.

Possible values:

- 0..5  (default setting: 0)

If the user makes one more unsuccessful login attempt, then the device locks access for the user.

The device lets only users with the administrator authorization remove the lock.

The value 0 deactivates the lock. The user has unlimited attempts to log in.
Min. password length

The device accepts the password if it contains at least the number of characters specified here.

The device checks the password according to this setting, regardless of the setting for the Policy check checkbox.

Possible values:
- 1..64 (default setting: 6)

Login attempts period (min.)

Displays the time period before the device resets the counter in the Login attempts field.

Possible values:
- 0..60 (default setting: 0)

Password policy

This frame lets you specify the policy for valid passwords. The device checks every new password and password change according to this policy.

The settings effect the Password column. The prerequisite is that you mark the checkbox in the Policy check column.

Upper-case characters (min.)

The device accepts the password if it contains at least as many upper-case letters as specified here.

Possible values:
- 0..16 (default setting: 1)

The value 0 deactivates this setting.

Lower-case characters (min.)

The device accepts the password if it contains at least as many lower-case letters as specified here.

Possible values:
- 0..16 (default setting: 1)

The value 0 deactivates this setting.

Digits (min.)

The device accepts the password if it contains at least as many numbers as specified here.

Possible values:
- 0..16 (default setting: 1)

The value 0 deactivates this setting.
Device Security

[Device Security > User Management]

**Special characters (min.)**

The device accepts the password if it contains at least as many special characters as specified here.

Possible values:

- 0..16 (default setting: 1)

The value 0 deactivates this setting.

**Table**

Every user requires an active user account to gain access to the device management. The table lets you set up and manage user accounts. To change settings, click the desired parameter in the table and modify the value.

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- **Add**
  
  Opens the Create window to add a table row.
  
  - In the User name field, you specify the name of the user account.
    
    Possible values:
    
    - Alphanumeric ASCII character string with 1..32 characters

- **Remove**
  
  Removes the selected table row.

**User name**

Displays the name of the user account.

To create a new user account, click the **Add** button.

**Active**

Activates/deactivates the user account.

Possible values:

- **marked**
  
  The user account is active. The device accepts the login of a user with this user name.

- **unmarked** (default setting)
  
  The user account is inactive. The device rejects the login of a user with this user name.

When one user account exists with the access role **administrator**, this user account is constantly active.
Password

Displays ***** (asterisks) instead of the password with which the user logs in. To change the password, click the relevant field.

Possible values:
- Alphanumeric ASCII character string with 6..64 characters
  The device accepts the following characters:
  - a..z
  - A..Z
  - 0..9
  - !#$%&'()*+,-./:;<=>?@\]^_`{}~

The minimum length of the password is specified in the Configuration frame. The device differentiates between upper and lower case.

If the checkbox in the Policy check column is marked, then the device checks the password according to the policy specified in the Password policy frame.

The device constantly checks the minimum length of the password, even if the checkbox in the Policy check column is unmarked.

Role

Specifies the access role that regulates the access of the user to the individual functions of the device.

Possible values:
- unauthorized
  The user is blocked, and the device rejects the user login.
  Assign this value to temporarily lock the user account. If the device detects an error when another access role is being assigned, then the device assigns this access role to the user account.
- guest (default setting)
  The user is authorized to monitor the device.
- auditor
  The user is authorized to monitor the device and to save the log file in the Diagnostics > Report > Audit Trail dialog.
- operator
  The user is authorized to monitor the device and to change the settings – with the exception of security settings for device access.
- administrator
  The user is authorized to monitor the device and to change the settings.

The device assigns the Service Type transferred in the response of a RADIUS server as follows to an access role:

* Administrative-User: administrator
* Login-User: operator
* NAS-Prompt-User: guest
User locked

Unlocks the user account.

Possible values:

► **marked**
  The user account is locked. The user has no access to the device management. If the user makes too many unsuccessful login attempts, then the device automatically locks the user.

► **unmarked** (grayed out) (default setting)
  The user account is unlocked. The user has access to the device management.

Policy check

Activates/deactivates the password check.

Possible values:

► **marked**
  The password check is activated.
  When you set up or change the password, the device checks the password according to the policy specified in the **Password policy** frame.

► **unmarked** (default setting)
  The password check is deactivated.

SNMP auth type

Specifies the authentication protocol that the device applies for user access via SNMPv3.

Possible values:

► **hmacmd5** (default value)
  For this user account, the device uses protocol HMACMD5.

► **hmacsha**
  For this user account, the device uses protocol HMACSHA.

SNMP encryption type

Specifies the encryption protocol that the device applies for user access via SNMPv3.

Possible values:

► **none**
  No encryption.

► **des** (default value)
  DES encryption

► **aesCfb128**
  AES128 encryption
3.2 Authentication List

In this dialog you manage the authentication lists. In an authentication list you specify which method the device uses for the authentication. You also have the option to assign pre-defined applications to the authentication lists.

If users log in with valid login data, then the device lets them have access to its device management. The device authenticates the users using the following methods:

- User management of the device
- LDAP
- RADIUS

In the default setting the following authentication lists are available:

- defaultLoginAuthList
- defaultV24AuthList

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Note: If the table does not contain a list, then the access to the device management is only possible using the Command Line Interface through the serial interface of the device. In this case, the device authenticates the user by using the local user management. See the Device Security > User Management dialog.

Buttons

Add
Opens the Create window to add a table row.
- In the Name field, you specify the name of the list.
  Possible values:
  - Alphanumeric ASCII character string with 1..32 characters

Remove
Removes the selected table row.

Allocate applications
Opens the Allocate applications window. The window displays the applications that you can designate to the selected list.

- Click and select an entry to designate it to the currently selected list.
  An application that is already designated to a different list the device designates to the currently selected list, after you click the Ok button.

- Click and deselect an entry to undo its designation to the currently selected list.
  If you deselect the application WebInterface, then the connection to the device is lost, after you click the Ok button.
Name

Displays the name of the list.

To create a new list, click the button.

Policy 1  Policy 2  Policy 3  Policy 4  Policy 5

Specifies the authentication policy that the device uses for access using the application specified in the Dedicated applications column.

The device gives you the option of a fall-back solution. For this, you specify another policy in each of the policy fields. If the authentication with the specified policy is unsuccessful, then the device can use the next policy, depending on the order of the values entered in each policy.

Possible values:

- **local** (default setting)
  The device authenticates the users by using the local user management. See the Device Security > User Management dialog. You cannot assign this value to the authentication list defaultDotlx8021AuthList.

- **radius**
  The device authenticates the users with a RADIUS server in the network. You specify the RADIUS server in the Network Security > RADIUS > Authentication Server dialog.

- **reject**
  The device accepts or rejects the authentication depending on which policy you try first. The following list contains authentication scenarios:
  - If the first policy in the authentication list is local and the device accepts the login credentials of the user, then it logs the user in without attempting the other polices.
  - If the first policy in the authentication list is local and the device denies the login credentials of the user, then it attempts to log the user in using the other polices in the order specified.
  - If the first policy in the authentication list is radius or ldap and the device rejects a login, then the login is immediately rejected without attempting to log in the user using another policy.
  - If there is no response from the RADIUS or LDAP server, then the device attempts to authenticate the user with the next policy.
  - If the first policy in the authentication list is reject, then the devices immediately rejects the user login without attempting another policy.
  - Verify that the authentication list defaultV24AuthList contains at least one policy different from reject.

- **ldap**
  The device authenticates the users with authentication data and access role saved in a central location. You specify the Active Directory server that the device uses in the Device Security > LDAP > Configuration dialog.

Dedicated applications

Displays the dedicated applications. When users access the device with the relevant application, the device uses the specified policies for the authentication.

To allocate another application to the list or remove the allocation, click the button. The device lets you assign each application to exactly one list.
Active

Activates/deactivates the list.

Possible values:

- **marked**
  - The list is activated. The device uses the policies in this list when users access the device with the relevant application.

- **unmarked** (default setting)
  - The list is deactivated.

### 3.3 LDAP

The Lightweight Directory Access Protocol (LDAP) lets you authenticate and authorize the users at a central point in the network. A widely used directory service accessible through LDAP is Active Directory®.

The device forwards the login data of the user to the authentication server using the LDAP protocol. The authentication server decides if the login data is valid and transfers the user’s authorizations to the device.

Upon successful login, the device saves the login data temporarily in the cache. This speeds up the login process when users log in again. In this case, no complex LDAP search operation is necessary.

The menu contains the following dialogs:

- LDAP Configuration
- LDAP Role Mapping
3.3.1 LDAP Configuration

This dialog lets you specify up to 4 authentication servers. An authentication server authenticates and authorizes the users when the device forwards the login data to the server.

The device sends the login data to the first authentication server. When no response comes from this server, the device contacts the next server in the table.

**Operation**

Enables/disables the LDAP client.

If in the Device Security > Authentication List dialog you specify the value ldap in one of the columns Policy 1 to Policy 5, then the device uses the LDAP client. Prior to this, specify in the Device Security > LDAP > Role Mapping dialog at least one mapping for this access role administrator. This provides you access to the device as administrator after logging in through LDAP.

Possible values:
- **On**
  - The LDAP client is enabled.
- **Off** (default setting)
  - The LDAP client is disabled.

**Configuration**

**Buttons**

- **Flush cache**

  Removes the cached login data of the successfully logged in users.
Device Security
[Device Security > LDAP > Configuration]

Client cache timeout [min]

Specifies for how many minutes after successfully logging in the login data of a user remain valid. When a user logs in again within this time, no complex LDAP search operation is necessary. The login process is much faster.

Possible values:
- 1..1440 (default setting: 10)

Bind user

Specifies the user ID in the form of the “Distinguished Name” (DN) with which the device logs in to the LDAP server.

If the LDAP server requires a user ID in the form of the “Distinguished Name” (DN) for the login, then this information is necessary. In Active Directory environments, this information is unnecessary.

The device logs in to the LDAP server with the user ID to find the “Distinguished Name” (DN) for the users logging in. The device conducts the search according to the settings in the Base DN and User name attribute fields.

Possible values:
- Alphanumeric ASCII character string with 0..64 characters

Bind user password

Specifies the password which the device uses together with the user ID specified in the Bind user field when logging in to the LDAP server.

Possible values:
- Alphanumeric ASCII character string with 0..64 characters

Base DN

Specifies the starting point for the search in the directory tree in the form of the “Distinguished Name” (DN).

Possible values:
- Alphanumeric ASCII character string with 0..255 characters

User name attribute

Specifies the LDAP attribute which contains a biunique user name. Afterwards, the user uses the user name contained in this attribute to log in.

Often the LDAP attributes userPrincipalName, mail, sAMAccountName and uid contain a unique user name.

The device adds the character string specified in the Default domain field to the user name under the following condition:
- The user name contained in the attribute does not contain the @ character.
- In the Default domain field, a domain name is specified.

Possible values:
- Alphanumeric ASCII character string with 0..64 characters
  (default setting: userPrincipalName)
Default domain

Specifies the character string which the device adds to the user name of the users logging in if the user name does not contain the @ character.

Possible values:
► Alphanumeric ASCII character string with 0..64 characters

CA certificate

URL

Specifies the path and file name of the certificate.

The device accepts certificates with the following properties:
• X.509 format
• .PEM file name extension
• Base64-coded, enclosed by
  -----BEGIN CERTIFICATE-----
  and
  -----END CERTIFICATE-----

For security reasons, we recommend to constantly use a certificate which is signed by a certification authority.

The device gives you the following options for copying the certificate to the device:
► Import from the PC
  When the certificate is located on your PC or on a network drive, drag and drop the certificate in the area. Alternatively click in the area to select the certificate.
  You also have the option of transferring the certificate from your PC to the device through SFTP or SCP. Perform the following steps:
  □ On your PC, open an SFTP or SCP client, for example WinSCP.
  □ Use the SFTP or SCP client to open a connection to the device.
  □ Transfer the certificate file to the directory /upload/ldapcert in the device.
  When the file transfer is complete, the device starts installing the certificate. If the installation was successful, then the device creates an ok file in the directory /upload/ldapcert and deletes the certificate file.

Start

Copies the certificate specified in the URL field to the device.
Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Adds a table row.

Remove

Removes the selected table row.

Index

Displays the index number to which the table row relates.

Description

Specifies the description.

You have the option to describe here the authentication server or note additional information.

Possible values:

- Alphanumeric ASCII character string with 0..255 characters

Address

Specifies the IP address or the DNS name of the server.

Possible values:

- IPv4 address (default setting: 0.0.0.0)
- DNS name in the format <domain>.<tld> or <host>.<domain>.<tld>
- _ldap._tcp.<domain>.<tld>
  Using this DNS name, the device queries the LDAP server list (SRV Resource Record) from the DNS server.

If in the Connection security column a value other than none is specified and the certificate contains only DNS names of the server, then use a DNS name. Enable the Client function in the Advanced > DNS > Client > Global dialog.

Destination TCP port

Specifies the TCP Port on which the server expects the requests.

If you have specified the value _ldap._tcp.domain.tld in the Address column, then the device ignores this value.

Possible values:

- 0..65535 (default setting: 389)
  Exception: Port 2222 is reserved for internal functions.
Frequently used TCP-Ports:

- **LDAP:** 389
- **LDAP over SSL:** 636
- **Active Directory Global Catalogue:** 3268
- **Active Directory Global Catalogue SSL:** 3269

### Connection security

Specifies the protocol which encrypts the communication between the device and the authentication server.

Possible values:

- **none**
  - No encryption.
  - The device establishes an LDAP connection to the server and transmits the communication including the passwords in clear text.

- **ssl**
  - Encryption with SSL.
  - The device establishes a TLS connection to the server and tunnels the LDAP communication over it.

- **startTLS** (default setting)
  - Encryption with startTLS extension.
  - The device establishes an LDAP connection to the server and encrypts the communication.

The prerequisite for encrypted communication is that the device uses the correct time. If the certificate contains only the DNS names, then you specify the DNS name of the server in the Address column. Enable the Client function in the Advanced > DNS > Client > Global dialog.

If the certificate contains the IP address of the server in the “Subject Alternative Name” field, then the device is able to verify the identity of the server without the DNS configuration.

### Server status

Displays the connection status and the authentication with the authentication server.

Possible values:

- **ok**
  - The server is reachable.
  - If in the Connection security column a value other than none is specified, then the device has verified the certificate of the server.

- **unreachable**
  - Server is unreachable.

- **other**
  - The device has not established a connection to the server yet.

### Active

Activates/deactivates the use of the server.

Possible values:

- **marked**
  - The device uses the server.

- **unmarked** (default setting)
  - The device does not use the server.
3.3.2 LDAP Role Mapping

This dialog lets you create up to 64 mappings to assign an access role to users.

In the table you specify if the device assigns an access role to the user based on an attribute with a specific value or based on the group membership.

- The device searches for the attribute and the attribute value within the user object.
- By evaluating the “Distinguished Name” (DN) contained in the member attributes, the device checks group the membership.

When a user logs in, the device searches for the following information on the LDAP server:
- In the related user project, the device searches for attributes specified in the mappings.
- In the group objects of the groups specified in the mappings, the device searches for the member attributes.

On this basis, the device checks any mapping.
- Does the user object contain the required attribute?
- Is the user member of the group?

If the device does not find a match, then the user does not get access to the device.

If the device finds more than one mapping that applies to a user, then the setting in the Matching policy field decides. The user either obtains the access role with the more extensive authorizations or the 1st access role in the table that applies.

Configuration

Matching policy

Specifies which access role the device applies if more than one mapping applies to a user.

Possible values:
- highest  (default setting)
  The device applies the access role with more extensive authorizations.
- first
  The device applies the rule which has the lower value in the Index column to the user.
Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row.

- In the Index field, you specify the index number.
  - Possible values: 1..64

Remove

Removes the selected table row.

Index

Displays the index number to which the table row relates.

Role

Specifies the access role that regulates the access of the user to the individual functions of the device.

Possible values:

- **unauthorized**
  - The user is blocked, and the device rejects the user login.
  - Assign this value to temporarily lock the user account. If an error occurs when another access role is being assigned, then the device assigns this access role to the user account.

- **guest** (default setting)
  - The user is authorized to monitor the device.

- **auditor**
  - The user is authorized to monitor the device and to save the log file in the Diagnostics > Report > Audit Trail dialog.

- **operator**
  - The user is authorized to monitor the device and to change the settings – with the exception of security settings for device access.

- **administrator**
  - The user is authorized to monitor the device and to change the settings.

Type

Specifies if a group or an attribute with an attribute value is specified in the Parameter column.

Possible values:

- **attribute** (default setting)
  - The Parameter column contains an attribute with an attribute value.

- **group**
  - The Parameter column contains the “Distinguished Name” (DN) of a group.
Parameter

Specifies a group or an attribute with an attribute value, depending on the setting in the Type column.

Possible values:

- Alphanumeric ASCII character string with 0..255 characters
  - The device differentiates between upper and lower case.
  - If in the Type column the value attribute is specified, then you specify the attribute in the form of `Attribute_name=Attribute_value`.
  - Example: `l=Germany`
  - If in the Type column the value group is specified, then you specify the “Distinguished Name” (DN) of a group.
  - Example: `CN=admin-users,OU=Groups,DC=example,DC=com`

Active

Activates/deactivates the role mapping.

Possible values:

- marked (default setting)
  - The role mapping is active.
- unmarked
  - The role mapping is inactive.

3.4 Management Access

The menu contains the following dialogs:

- Server
- IP Access Restriction
- Web
- Command Line Interface
- SNMPv1/v2 Community
3.4.1 Server

This dialog lets you set up the server services which enable users or applications to access the management of the device.

The dialog contains the following tabs:
- [Information]
- [SNMP]
- [SSH]
- [HTTP]
- [HTTPS]

[Information]

This tab displays as an overview which server services are enabled.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

SNMPv1

Displays if the server service is active or inactive, which authorizes access to the device using SNMP version 1. See the SNMP tab.

Possible values:
- marked
  - Server service is active.
- unmarked
  - Server service is inactive.

SNMPv2

Displays if the server service is active or inactive, which authorizes access to the device using SNMP version 2. See the SNMP tab.

Possible values:
- marked
  - Server service is active.
- unmarked
  - Server service is inactive.
SNMPv3
Displays if the server service is active or inactive, which authorizes access to the device using SNMP version 3. See the *SNMP* tab.

Possible values:
- **marked**
  - Server service is active.
- **unmarked**
  - Server service is inactive.

SSH server
Displays if the server service is active or inactive, which authorizes access to the device using Secure Shell. See the *SSH* tab.

Possible values:
- **marked**
  - Server service is active.
- **unmarked**
  - Server service is inactive.

HTTP server
Displays if the server service is active or inactive, which authorizes access to the device using the Graphical User Interface through HTTP. See the *HTTP* tab.

Possible values:
- **marked**
  - Server service is active.
- **unmarked**
  - Server service is inactive.

HTTPS server
Displays if the server service is active or inactive, which authorizes access to the device using the Graphical User Interface through HTTPS. See the *HTTPS* tab.

Possible values:
- **marked**
  - Server service is active.
- **unmarked**
  - Server service is inactive.

**[SNMP]**
This tab lets you specify settings for the SNMP agent of the device and to enable/disable access to the device with different SNMP versions.

The SNMP agent enables access to the device management with SNMP-based applications.
Configuration

SNMPv1
Activates/deactivates the access to the device with SNMP version 1.

Possible values:

- **marked**
  Access is activated.
- **unmarked** (default setting)
  Access is deactivated.

You specify the community names in the **Device Security > Management Access > SNMPv1/v2 Community** dialog.

SNMPv2
Activates/deactivates the access to the device with SNMP version 2.

Possible values:

- **marked**
  Access is activated.
- **unmarked** (default setting)
  Access is deactivated.

You specify the community names in the **Device Security > Management Access > SNMPv1/v2 Community** dialog.

SNMPv3
Activates/deactivates the access to the device with SNMP version 3.

Possible values:

- **marked** (default setting)
  Access is activated.
- **unmarked**
  Access is deactivated.

Network management systems like Industrial HiVision use this protocol to communicate with the device.

UDP port
Specifies the number of the UDP port on which the SNMP agent receives requests from clients.

Possible values:

- **1..65535** (default setting: **161**)
  Exception: Port **2222** is reserved for internal functions.

To enable the SNMP agent to use the new port after a change, you proceed as follows:

- Click the ✓ button.
- Select in the **Basic Settings > Load/Save** dialog the active configuration profile.
- Click the  button to save the current changes.
- Restart the device.
This tab lets you enable/disable the SSH server in the device and specify its settings required for SSH. The server works with SSH version 2.

The SSH server enables access to the device management remotely through the Command Line Interface. SSH connections are encrypted.

To access the device and the connected external memory using SFTP or SCP, you also need access to the SSH server. With an SFTP or SCP client, for example WinSCP, you have the option of loading configuration files or a software update to the device.

The SSH server identifies itself to the clients using its public RSA key. When first setting up the connection, the client program displays the user the fingerprint of this key. The fingerprint contains a Base64-coded character sequence that is easy to check. When you make this character sequence available to the users via a reliable channel, they have the option to compare both fingerprints. If the character sequences match, then the client is connected to the correct server.

The device lets you create the private and public keys (host keys) required for RSA directly in the device. Otherwise you have the option to copy your own keys to the device in PEM format.

As an alternative, the device lets you load the RSA key (host key) from an external memory upon restart. You activate this function in the Basic Settings > External Memory dialog, SSH key auto upload column.

**Operation**

**SSH server**

Enables/disables the SSH server.

Possible values:

- **On** (default setting)
  - The SSH server is enabled.
  - The access to the device management is possible through the Command Line Interface using an encrypted SSH connection.
  - You can start the server only if there is an RSA signature in the device.

- **Off**
  - The SSH server is disabled.
  - When you disable the SSH server, the existing connections remain established. However, the device helps prevent new connections from being set up.

**Note:** If you disable the SSH server, then the access to the Command Line Interface is only possible through the serial interface of the device.
Configuration

TCP port

Specifies the number of the TCP port on which the device receives SSH requests from clients.

Possible values:

- 1..65535 (default setting: 22)
  - Exception: Port 2222 is reserved for internal functions.

The server restarts automatically after the port is changed. Existing connections remain in place.

Sessions

Displays how many SSH connections are currently established to the device.

Sessions (max.)

Specifies the maximum number of SSH connections to the device that can be set up simultaneously.

When you access the device using Command Line Interface, SFTP or SCP, each of these applications establishes a separate SSH connection to the device.

Possible values:

- 1..5 (default setting: 5)

Session timeout [min]

Specifies the timeout in minutes. After the user logged in has been inactive for this time, the device ends the connection.

A change in the value takes effect the next time a user logs in.

Possible values:

- 0
  - Deactivates the function. The connection remains established in the case of inactivity.
- 1..160 (default setting: 5)

Signature

RSA present

Displays if an RSA host key is present in the device.

Possible values:

- marked
  - A key is present.
- unmarked
  - No key is present.
Create

Generates a host key in the device. The prerequisite is that the SSH server is disabled.

Length of the key created:
- 2048 bit (RSA)

To get the SSH server to use the generated host key, restart the SSH server.

Alternatively, you have the option to copy your own host key to the device in PEM format. See the Key import frame.

Delete

Removes the host key from the device. The prerequisite is that the SSH server is disabled.

Oper status

Displays if the device currently generates a host key.

It is possible that another user triggered this action.

Possible values:
- rsa
  The device currently generates an RSA host key.
- none
  The device does not generate a host key.

**Fingerprint**

The fingerprint is an easy to verify string that uniquely identifies the host key of the SSH server.

After importing a new host key, the device continues to display the existing fingerprint until you restart the server.

Fingerprint type

Specifies which fingerprint the RSA fingerprint field displays.

Possible values:
- md5
  The RSA fingerprint field displays the fingerprint as hexadecimal MD5 hash.
- sha256 (default setting)
  The device does not support this setting. The RSA fingerprint field retains the previous display.

RSA fingerprint

Displays the fingerprint of the public host key of the SSH server.

When you change the settings in the Fingerprint type field, click afterwards the ✓ button and then the  button to update the display.
Key import

URL

Specifies the path and file name of your own RSA host key.

The device accepts the RSA key if it has the following key length:
• 2048 bit (RSA)

The device gives you the following options for copying the key to the device:
▶ Import from the PC
   When the host key is located on your PC or on a network drive, drag and drop the file that contains the key in the area. Alternatively click in the area to select the file.
   You also have the option of transferring the key from your PC to the device through SFTP or SCP. Perform the following steps:
   □ On your PC, open an SFTP or SCP client, for example WinSCP.
   □ Use the SFTP or SCP client to open a connection to the device.
   □ Transfer the file that contains the key to the directory /upload/ssh-key in the device.
   When the file transfer is complete, the device starts installing the key. If the installation was successful, then the device creates an ok file in directory /upload/ssh-key and deletes the file that contains the key.
   □ To get the server to use this key, you restart the server.

Start

Copies the key specified in the URL field to the device.

[HTTP]

This tab lets you enable/disable the HTTP protocol for the web server and specify the settings required for HTTP.

The web server provides the Graphical User Interface via an unencrypted HTTP connection. For security reasons, disable the HTTP protocol and use the HTTPS protocol instead.

The device supports up to 10 simultaneous connections using HTTP or HTTPS.

Note: If you change the settings in this tab and click the button, then the device ends the session and disconnects every opened connection. To continue working with the Graphical User Interface, log in again.
Device Security

[Device Security > Management Access > Server]

Operation

HTTP server

Enables/disables the HTTP protocol for the web server.

Possible values:

- **On** (default setting)
  - The HTTP protocol is enabled.
  - The access to the device management is possible through an unencrypted HTTP connection. When the HTTPS protocol is also enabled, the device automatically redirects the request for a HTTP connection to an encrypted HTTPS connection.

- **Off**
  - The HTTP protocol is disabled.
  - When the HTTPS protocol is enabled, the access to the device management is possible through an encrypted HTTPS connection.

**Note:** If the HTTP and HTTPS protocols are disabled, then you can enable the HTTP protocol using the Command Line Interface command `http server` to get to the Graphical User Interface.

Configuration

TCP port

Specifies the number of the TCP port on which the web server receives HTTP requests from clients.

Possible values:

- **1..65535** (default setting: 80)
  - Exception: Port 2222 is reserved for internal functions.

HTTPS

This tab lets you enable/disable the HTTPS protocol for the web server and specify the settings required for HTTPS.

The web server provides the Graphical User Interface via an encrypted HTTP connection.

A digital certificate is required for the encryption of the HTTP connection. The device lets you create this certificate yourself or to load an existing certificate onto the device.

The device supports up to 10 simultaneous connections using HTTP or HTTPS.

**Note:** If you change the settings in this tab and click the ✓ button, then the device ends the session and disconnects every opened connection. To continue working with the Graphical User Interface, log in again.
**Operation**

**HTTPS server**

Enables/disables the *HTTPS* protocol for the web server.

Possible values:

- **On** (default setting)
  - The *HTTPS* protocol is enabled.
  - The access to the device management is possible through an encrypted *HTTPS* connection. When there is no digital certificate present, the device generates a digital certificate before it enables the *HTTPS* protocol.

- **Off**
  - The *HTTPS* protocol is disabled.
  - When the *HTTP* protocol is enabled, the access to the device management is possible through an unencrypted *HTTP* connection.

**Note:** If the *HTTP* and *HTTPS* protocols are disabled, then you can enable the *HTTPS* protocol using the Command Line Interface command `https server` to get to the Graphical User Interface.

**Configuration**

**TCP port**

Specifies the number of the TCP port on which the web server receives HTTPS requests from clients.

Possible values:

- 1..65535 (default setting: 443)
  - Exception: Port 2222 is reserved for internal functions.

**Certificate**

**Note:** If the device uses a certificate that is not signed by a certification authority, then the web browser displays a message while loading the Graphical User Interface. To continue, add an exception rule for the certificate in the web browser.

**Present**

Displays if the digital certificate is present in the device.

Possible values:

- **marked**
  - The certificate is present.

- **unmarked**
  - The certificate has been removed.
Create

Generates a digital certificate in the device.

Until restarting the web server uses the previous certificate.

To get the web server to use the newly generated certificate, restart the web server. Restarting the web server is possible only through the Command Line Interface.

Alternatively, you have the option of copying your own certificate to the device. See the Certificate import frame.

Delete

Deletes the digital certificate.

Until restarting the web server uses the previous certificate.

Oper status

Displays if the device currently generates or deletes a digital certificate.

It is possible that another user has triggered the action.

Possible values:

▸ none
  The device does currently not generate or delete a certificate.

▸ delete
  The device currently deletes a certificate.

▸ generate
  The device currently generates a certificate.

Fingerprint

The fingerprint is an easily verified hexadecimal number sequence that uniquely identifies the digital certificate of the HTTPS server.

After importing a new digital certificate, the device displays the current fingerprint until you restart the server.

Fingerprint type

Specifies which fingerprint the Fingerprint field displays.

Possible values:

▸ sha1
  The Fingerprint field displays the SHA1 fingerprint of the certificate.

▸ sha256 (default setting)
  The Fingerprint field displays the SHA256 fingerprint of the certificate.
Fingerprint

Hexadecimal character sequence of the digital certificate used by the server.

When you change the settings in the **Fingerprint type** field, click afterwards the ✔ button and then the ⬇ button to update the display.

Certificate import

URL

Specifies the path and file name of the certificate.

The device accepts certificates with the following properties:

- X.509 format
- .PEM file name extension
- Base64-coded, enclosed by
  - -----BEGIN PRIVATE KEY-----
  - -----END PRIVATE KEY-----
  as well as
  - -----BEGIN CERTIFICATE-----
  - -----END CERTIFICATE-----
- RSA key with 2048 bit length

The device gives you the following options for copying the certificate to the device:

- **Import from the PC**
  When the certificate is located on your PC or on a network drive, drag and drop the certificate onto the area. Alternatively click in the area to select the certificate.
  You also have the option of transferring the certificate from your PC to the device through SFTP or SCP. Perform the following steps:
  - On your PC, open an SFTP or SCP client, for example WinSCP.
  - Use the SFTP or SCP client to open a connection to the device.
  - Transfer the certificate file to the directory /upload/https-cert in the device.
  - When the file transfer is complete, the device starts installing the certificate. If the installation was successful, then the device creates an ok file in the directory /upload/https-cert and deletes the certificate file.
  - To get the web server to use this certificate, restart the web server. Restarting the web server is possible only through the Command Line Interface.

Start

Copies the certificate specified in the **URL** field to the device.
3.4.2 **IP Access Restriction**

This dialog lets you restrict the access to the device management to specific IP address ranges and selected IP-based applications.

- If the function is disabled, then the access to the device management is possible from any IP address and using every application.
- If the function is enabled, then the access is restricted. You have access to the device management only under the following conditions:
  - At least one table row is activated.
  - You are accessing the device with a permitted application from a permitted IP address range.

**Operation**

**Note:** Before you enable the function, verify that at least one active table row in the table lets you access. Otherwise, if you change the settings, then the connection to the device terminates. The access to the device management is possible only using the Command Line Interface through the serial interface.

**Enables/disables the IP Access Restriction function.**

Possible values:

- **On**
  - The IP Access Restriction function is enabled.
  - The access to the device management is restricted.

- **Off** (default setting)
  - The IP Access Restriction function is disabled.

**Table**

You have the option of defining up to 16 table rows and activating them separately.

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- **Add**
  - Adds a table row.

- **Remove**
  - Removes the selected table row.
## Index

Display the index number to which the table row relates.

When you delete a table row, this leaves a gap in the numbering. When you create a new table row, the device fills the first gap.

Possible values:
- 1..16

## Address

Specifies the IP address of the network from which you allow the access to the device management. You specify the network range in the **Netmask** column.

Possible values:
- Valid IPv4 address (default setting: 0.0.0.0)

## Netmask

Specifies the range of the network specified in the **Address** column.

Possible values:
- Valid netmask (default setting: 0.0.0.0)

## HTTP

Activates/deactivates the HTTP access.

Possible values:
- **marked** (default setting)
  - Access is activated for the adjacent IP address range.
- **unmarked**
  - Access is deactivated.

## HTTPS

Activates/deactivates the HTTPS access.

Possible values:
- **marked** (default setting)
  - Access is activated for the adjacent IP address range.
- **unmarked**
  - Access is deactivated.

## SNMP

Activates/deactivates the SNMP access.

Possible values:
- **marked** (default setting)
  - Access is activated for the adjacent IP address range.
- **unmarked**
  - Access is deactivated.
SSH

Activates/deactivates the SSH access.

Possible values:

- **marked** (default setting)
  Access is activated for the adjacent IP address range.

- **unmarked**
  Access is deactivated.

Active

Activates/deactivates the table row.

Possible values:

- **marked** (default setting)
  The table row is activated. The device restricts the access to the device management to the adjacent IP address range and the selected IP-based applications.

- **unmarked**
  The table row is deactivated.
3.4.3 Web

[Device Security > Management Access > Web]

In this dialog you specify settings for the Graphical User Interface.

Configuration

Web interface session timeout [min]

Specifies the timeout in minutes. After the device has been inactive for this time it ends the session for the user logged in.

Possible values:

- 0..160 (default setting: 5)

The value 0 deactivates the function, and the user remains logged in when inactive.
3.4.4 Command Line Interface

In this dialog you specify settings for the Command Line Interface. For further information about the Command Line Interface, see the “Command Line Interface” reference manual.

The dialog contains the following tabs:
- [Global]
- [Login banner]

[Global]

This tab lets you change the prompt in the Command Line Interface and specify the automatic closing of sessions through the serial interface when they have been inactive.

The device has the following serial interfaces.
- V.24 interface

Configuration

Login prompt

Specifies the character string that the device displays in the Command Line Interface at the start of every command line.

Possible values:
- Alphanumeric ASCII character string with 0..128 characters (0x20..0x7E) including space characters
- Wildcards
  - %d date
  - %i IP address
  - %m MAC address
  - %p product name
  - %t time
- Default setting: (EAGLE)

Changes to this setting are immediately effective in the active Command Line Interface session.

Serial interface timeout [min]

Specifies the time in minutes after which the device automatically closes the session of an inactive user logged in with the Command Line Interface through the serial interface.

Possible values:
- 0..160 (default setting: 5)
  - The value 0 deactivates the function, and the user remains logged in when inactive.

A change in the value takes effect the next time a user logs in.

For the SSH server, you specify the timeout in the Device Security > Management Access > Server dialog.
In this tab you replace the start screen of the Command Line Interface with your own text.

In the default setting, the start screen displays information about the device, such as the software version and the device settings. With the function in this tab, you deactivate this information and replace it with an individually specified text.

To display your own text in the Command Line Interface and in the Graphical User Interface before the login, you use the Device Security > Pre-login Banner dialog.

**Operation**

Enables/disables the Login banner function.

Possible values:

- **On**
  - The Login banner function is enabled.
  - The device displays the text information specified in the Banner text field to the users that log in with the Command Line Interface.

- **Off** (default setting)
  - The Login banner function is disabled.
  - The start screen displays information about the device. The text information in the Banner text field is kept.

**Banner text**

Specifies the character string that the device displays in the Command Line Interface at the start of every session.

Possible values:

- Alphanumeric ASCII character string with 0..1024 characters (0x20..0x7E) including space characters
- <Tab>
- <Line break>
3.4.5 **SNMPv1/v2 Community**

In this dialog you specify the community name for SNMPv1/v2 applications.

Applications send requests via SNMPv1/v2 with a community name in the SNMP data packet header. Depending on the community name, the application gets read authorization or read and write authorization for the device.

You activate the access to the device via SNMPv1/v2 in the Device Security > Management Access > Server dialog.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>Community</th>
<th>Displays the authorization for SNMPv1/v2 applications to the device:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write</td>
<td>For requests with the community name entered, the application receives read and write authorization for the device.</td>
</tr>
<tr>
<td>Read</td>
<td>For requests with the community name entered, the application receives read authorization for the device.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Specifies the community name for the adjacent authorization.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Possible values:</td>
</tr>
<tr>
<td></td>
<td>- Alphanumeric ASCII character string with 0..32 characters</td>
</tr>
<tr>
<td></td>
<td>- private (default setting for read and write authorizations)</td>
</tr>
<tr>
<td></td>
<td>- public (default setting for read authorization)</td>
</tr>
</tbody>
</table>
3.5 Pre-login Banner

This dialog lets you display a greeting or information text to users before they log in.

The users see this text in the login dialog of the Graphical User Interface and of the Command Line Interface. Users logging in with SSH see the text - regardless of the client used - before or during the login.

To display the text only in the Command Line Interface, use the settings in the Device Security > Management Access > CLI dialog.

Operation

Enables/disables the Pre-login Banner function.

Using the Pre-login Banner function, the device displays a greeting or information text in the login dialog of the Graphical User Interface and of the Command Line Interface.

Possible values:

- **On**
  The Pre-login Banner function is enabled.
  The device displays the text specified in the Banner text field in the login dialog.

- **Off** (default setting)
  The Pre-login Banner function is disabled.
  The device does not display a text in the login dialog. When you enter a text in the Banner text field, this text is saved in the device.

Banner text

Specifies information text that the device displays in the login dialog of the Graphical User Interface and of the Command Line Interface.

Possible values:

- Alphanumeric ASCII character string with 0..512 characters (0x20..0x7E) including space characters
- `<Tab>`
- `<Line break>`
4 Network Security

The menu contains the following dialogs:

 Network Security Overview
 RADIUS
 Packet Filter
 Deep Packet Inspection
 DoS
 ACL

4.1 Network Security Overview

This dialog displays an overview over the network security rules used in the device.

Overview

The top level displays:
• The ports to which a network security rule is assigned.
• The VLANs to which a network security rule is assigned.

The subordinate levels display:
• The ACL rules specified. See the Network Security > ACL dialog.
• The Packet filter L3 rules specified. See the Network Security > Packet Filter > Routed Firewall Mode dialog.
• The Destination NAT rules specified. See the Routing > NAT > Destination NAT dialog.
• The Double NAT rules specified. See the Routing > NAT > Double NAT dialog.
• The Masquerading NAT rules specified. See the Routing > NAT > Masquerading NAT dialog.
• The 1:1 NAT rules specified. See the Routing > NAT > 1:1 NAT dialog.

Buttons



Displays a text field to search for a keyword. When you enter a character or string, the overview displays only items related to this keyword.



Collapses the levels. The overview then displays only the first level of the items.



Expands the levels. The overview then displays every level of the items.
Expands the current item and displays the items of the next lower level.

Collapses the item and hides the items of the underlying levels.

4.2 RADIUS

With its factory settings, the device authenticates users based on the local user management. However, as the size of a network increases, it becomes more difficult to keep the login data of the users consistent across the devices.

RADIUS (Remote Authentication Dial-In User Service) lets you authenticate and authorize the users at a central point in the network. A RADIUS server performs the following tasks here:

- **Authentication**
  - The authentication server authenticates the users when the RADIUS client at the access point forwards the login data of the users to the server.
- **Authorization**
  - The authentication server authorizes logged in users for selected services by assigning various parameters for the relevant end device to the RADIUS client at the access point.

If you assign the `radius` policy to an application in the Device Security > Authentication List dialog, then the device operates in the role of the RADIUS client. The device forwards the users’ login data to the primary authentication server. The authentication server decides if the login data is valid and transfers the user’s authorizations to the device.

The device assigns the Service Type transferred in the response of a RADIUS server as follows to an access role existing in the device:

- **Administrative-User**: `administrator`
- **Login-User**: `operator`
- **NAS-Prompt-User**: `guest`

The menu contains the following dialogs:

- RADIUS Global
- RADIUS Authentication Server
- RADIUS Authentication Statistics
4.2.1 RADIUS Global

This dialog lets you specify basic settings for RADIUS.

RADIUS configuration

Buttons

- **Reset**

Retransmits (max.)

Specifies how many times the device retransmits an unanswered request to the authentication server before the device sends the request to an alternative authentication server.

Possible values:

- **1..15**  (default setting: 4)

Timeout [s]

Specifies how many seconds the device waits for a response after a request to an authentication server before it retransmits the request.

Possible values:

- **1..30**  (default setting: 5)

NAS IP address (attribute 4)

Specifies the IP address that the device transfers to the authentication server as attribute 4. Specify the IP address of the device or another available address.

**Note:** The device only includes the attribute 4 if the packet was triggered by the 802.1X authentication request of an end device (supplicant).

Possible values:

- **Valid IPv4 address**  (default setting: 0.0.0.0)

In many cases, there is a firewall between the device and the authentication server. In the Network Address Translation (NAT) in the firewall changes the original IP address, and the authentication server receives the translated IP address of the device.

The device transfers the IP address in this field unchanged across the Network Address Translation (NAT).
4.2.2 **RADIUS Authentication Server**

This dialog lets you specify up to 8 authentication servers. An authentication server authenticates and authorizes the users when the device forwards the login data to the server.

The device sends the login data to the specified primary authentication server. When the server does not respond, the device contacts the specified authentication server that is highest in the table. When no response comes from this server either, the device contacts the next server in the table.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

**Add**

Opens the Create window to add a table row.

- In the **Index** field, you specify the index number.
- In the **Address** field, you specify the IP address of the server.

**Remove**

Removes the selected table row.

<table>
<thead>
<tr>
<th>Index</th>
<th>Displays the index number to which the table row relates.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Displays the name of the server. To change the value, click the relevant field. Possible values:</td>
</tr>
<tr>
<td></td>
<td>- Alphanumeric ASCII character string with 1..32 characters (default setting: Default-RADIUS-Server)</td>
</tr>
<tr>
<td></td>
<td>You can specify the same name for several servers. When several servers have the same name, the setting in the <strong>Primary server</strong> column applies.</td>
</tr>
</tbody>
</table>
Address

Specifies the IP address of the server.

Possible values:

- Valid IPv4 address

Destination UDP port

Specifies the number of the UDP port on which the server receives requests.

Possible values:

- 0..65535 (default setting: 1812)

  Exception: Port 2222 is reserved for internal functions.

Secret

Displays ***** (asterisks) when you specify a password with which the device logs in to the server. To change the password, click the relevant field.

Possible values:

- Alphanumeric ASCII character string with 1..16 characters

You get the password from the administrator of the authentication server.

Primary server

Specifies the authentication server as primary or secondary.

Possible values:

- marked

  The server is specified as the primary authentication server. The device sends the login data for authenticating the users to this authentication server. This setting applies only if more than one server in the table has the same value in the Name column.

- unmarked (default setting)

  The server is the secondary authentication server. When the device does not receive a response from the primary authentication server, the device sends the login data to the secondary authentication server.

Active

Activates/deactivates the connection to the server.

The device uses the server, if you specify in the Device Security > Authentication List dialog the value radius in one of the columns Policy 1 to Policy 5.

Possible values:

- marked (default setting)

  The connection is active. The device sends the login data for authenticating the users to this server if the preconditions named above are fulfilled.

- unmarked

  The connection is inactive. The device does not send any login data to this server.
4.2.3 **RADIUS Authentication Statistics**

This dialog displays information about the communication between the device and the authentication server. The table displays the information for each server in a separate table row.

To delete the statistic, click in the Network Security > RADIUS > Global dialog the **button.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Name**

Displays the name of the server.

**Address**

Displays the IP address of the server.

**Round trip time**

Displays the time interval in hundredths of a second between the last response received from the server (Access Reply/Access Challenge) and the corresponding data packet sent (Access Request).

**Access requests**

Displays the number of access data packets that the device sent to the server. This value does not take repetitions into account.

**Retransmitted access-request packets**

Displays the number of access data packets that the device retransmitted to the server.

**Access accepts**

Displays the number of access accept data packets that the device received from the server.

**Access rejects**

Displays the number of access reject data packets that the device received from the server.

**Access challenges**

Displays the number of access challenge data packets that the device received from the server.

**Malformed access responses**

Displays the number of malformed access response data packets that the device received from the server (including data packets with an invalid length).
Bad authenticators

Displays the number of access response data packets with an invalid authenticator that the device received from the server.

Pending requests

Displays the number of access request data packets that the device sent to the server to which it has not yet received a response from the server.

Timeouts

Displays how many times no response to the server was received before the specified waiting time elapsed.

Unknown types

Displays the number of data packets with an unknown data type that the device received from the server on the authentication port.

Packets dropped

Displays the number of data packets that the device received from the server on the authentication port and then discarded them.

4.3 Packet Filter

In this menu, you specify the settings for the Packet Filter functions.

The menu contains the following dialogs:

4.3.1 Routed Firewall Mode

In this menu, you specify the settings for the Routed Firewall Mode packet filter.

The Routed Firewall Mode packet filter contains rules which the device applies successively to the data stream on its router interfaces. The Routed Firewall Mode packet filter evaluates the data stream statefully and filters undesired data packets selectively. The device evaluates the status of the connection, and also determines if the data packets belong to a specific connection (Stateful Packet Inspection).

If a data packet matches the criteria of one or more rules, then the device applies the action specified in the first rule that matches to the data stream. The device ignores the rules that follow the first rule that matches.
If no rule matches, then the device applies the default rule. In the default setting, the default rule has the value `accept`. The device lets you change the default rule in the `Network Security > Packet Filter > Routed Firewall Mode > Global` dialog.

The device provides a multi-step approach to set up and apply the `Packet Filter` rules:
- You create a rule.
- You assign the rule to a router interface.
- Up to this step, changes have no effect on the behavior of the device and the data stream.
- The device applies the rule to the data stream.

In comparison to the `ACL` function, the `Packet Filter` function has the following differences:
- The packet filter has slower data stream processing.
- The packet filter provides refined filtering.
- The packet filter processes the data stream after the ACL has been applied.
- You assign the packet filter to a router interface.

The data packets go through the filter functions of the device in the following sequence:

![Processing sequence of the data packets in the device](image)

The menu contains the following dialogs:
- Global
- Firewall Learning Mode
- Packet Filter Rule
- Packet Filter Assignment
- Packet Filter Overview
4.3.1.1 **Global**

In this dialog you specify the global settings for the *Routed Firewall Mode* packet filter.

**Configuration**

**Buttons**

![Commit changes button](image)

Applies the rules saved in the device to the data stream.

In the process, the device also removes the state information from the packet filter. This includes potential *DCE RPC* information of the *OPC Enforcer* function. In the process, the device interrupts open communication connections.

**Note:** While the device activates the saved rules, you cannot set up any new communication connections.

**Allowed rules for L3 firewalling (max.)**

Displays the maximum number of allowed firewall rules for data packets.

**Default policy**

Specifies how the firewall processes data packets if no rule applies.

Possible values:

- **accept** (default setting)
  
  The device accepts the data packets.

- **drop**
  
  The device discards the data packets.

- **reject**
  
  The device discards the data packet and sends an *ICMP Admin Prohibited* message to the sender.

**Validate checksum**

Specifies how the firewall handles *connection tracking* on the basis of data packet checksum.

Possible values:

- **marked** (default setting)
  
  The device evaluates the *checksum* in the data packet. If the value is invalid, then the device drops the data packet.

- **unmarked**
  
  The device ignores the *checksum*. The device forwards the data packet even if the value is invalid.
Information

Uncommitted changes present

Displays if the Packet Filter rules applied to the data stream differ from the Packet Filter rules saved in the device.

Possible values:

- marked
  At least one of the Packet Filter rules saved in the device contains modified settings. When you click the button, the device applies the Packet Filter rules to the data stream.

- unmarked
  The device applies the saved Packet Filter rules to the data stream.
4.3.1.2 Firewall Learning Mode

This dialog lets you specify the connections which you allow to have access to your network.

The maximum number of rules that you can specify using the FLM function depends on the number of rules already set up in the Packet Filter Rule dialog. The device lets you specify up to 2048 rules.

The FLM function only applies to packets that pass through the device matching the FORWARD chain. The packets that the device receives on the INPUT chain, and those that the device creates on the OUTPUT chain traverse the device unrestricted. During the learning phase the device retains SSH, SNMP, and GUI access.

The FLM function requires you to configure and select at least 2 router interfaces in the device.

The maximum number of connections that the FLM function can learn is 65535.

Note: During the learning phase your network is temporarily exposed, because Firewall Learning Mode configures rules to accept every data packet on the selected ports.

Note: If you enable the VRRP function on a router interface, then the FLM function is ineffective on this router interface.

The dialog contains the following tabs:
- [Configuration]
- [Rules]

[Configuration]

The tab lets you enable the FLM function. The device monitors up to 4 interfaces to discover what type of data traverses the port into your network.

Operation

Enables/disables the FLM function.

Possible values:
- On
  - The FLM function is enabled.
- off (default setting)
  - The FLM function is disabled.
Information

Buttons

▶ Start
Starts the learning phase. The device filters the data packets on the active interfaces.

■ Stop
Stops the learning phase.

-clear
Clears the memory. Learned data can be cleared only when the FLM function is stopped.

Status
Displays the state of the running Firewall Learning Mode application.

Possible values:
▶ off
The function is inactive.
▶ stopped-data-notpresent
▶ stopped-data-present
The device stopped the learning mode. Check the Rule tab for learned data.

▶ learning
The device is learning data.
▶ pending
The device is busy processing learned data.

Information
Displays the status of Firewall Learning Mode application memory.

Interfaces selected for learning
Displays the interfaces that the FLM function actively monitors. The maximum number of interfaces that the device monitors is 4.

Additional information
Displays a special status message.

Learned entries
Displays the number of Layer 3 entries in the connection table.

Free memory for learning data [%]
Displays the percentage of free memory available for learning data.
[Rules]

This tab displays the type of data that is traversing the selected ports. This lets you create rules to manage the data stream traversing the device. Using the data displayed in the Learned entries table you can accept or reject data as required.

The tab is active after the device forwards one data packet and the FLM function is disabled again.

Learned entries table

Buttons

Add

Opens the Create window to add a rule when the Learned entries table displays at least one table row. The Packet filter rules table displays the created rule:

- In the Description field, you specify the name or a description for the rule.
- In the Source address field, you specify the source address of the data packets.
- In the Destination address field, you specify the destination address of the data packets.
- In the Protocol field, you specify protocol type of the data packets.
- In the Destination port field, you specify the destination port of the data packets.
- In the Ingress interface field, you specify if the device applies the rule to data packets received or sent on a router interface.

Source address

Displays the source address of the packets.

Destination address

Displays the destination address of the packet.

Protocol

Displays the IP protocol, based on RFC 791, for protocol filtering.

Destination port

Displays the destination port of the packet.

Ingress interface

Displays the interface that received the packet.

Egress interface

Displays the interface that sent the packet.

First occurrence

Displays the first time that the device has determined the packet.
Network Security
[Network Security > Packet Filter > Routed Firewall Mode > FLM]

Connections by Rule Set

Displays the number of connections that match the rules set in the table below.

Connections by Selection

Displays the number of connections that match the selections in the table below.

Packet filter rules table

Buttons

Remove
Removes the selected table row.

Edit
Opens the Edit window to edit the parameters of the selected table row.

Rule index

Displays the sequential number of the Packet Filter rule. The device automatically assigns the number.

Description

Specifies a name or description for the rule.

Possible values:

- Alphanumeric ASCII character string with 0..32 characters

Source address

Specifies the source address of the data packets to which the device applies the rule.

Possible values:

- any (default setting)
  The device applies the Packet Filter rule to data packets with any source address.
- Valid IPv4 address
  The device applies the rule to data packets with the specified source address.
- Valid IPv4 address and netmask in CIDR notation
  The device applies the rule to data packets with the specified source address in the specified subnet.

Destination address

Specifies the destination address of the data packets to which the device applies the rule.

Possible values:

- any (default setting)
  The device applies the Packet Filter rule to data packets with any destination address.
- Valid IPv4 address
  The device applies the rule to data packets with the specified destination address.
- Valid IPv4 address and netmask in CIDR notation
  The device applies the rule to data packets with the specified destination address in the specified subnet.

Protocol

Specifies the protocol type of the data packets to which the device applies the rule. The device applies the rule only to data packets with a Protocol field of the specified value.

Possible values:
- **any** (default setting)
  The device applies the rule to every data packet without evaluating the protocol.
- **icmp**
  Internet Control Message Protocol (RFC 792)
- **igmp**
  Internet Group Management Protocol
- **ipip**
  IP in IP tunneling (RFC 2003)
- **tcp**
  Transmission Control Protocol (RFC 793)
- **udp**
  User Datagram Protocol (RFC 768)
- **esp**
  IPsec Encapsulated Security Payload (RFC 2406)
- **ah**
  IPsec Authentication Header (RFC 2402)
- **icmpv6**
  Internet Control Message Protocol for IPv6

Destination port

Specifies the destination port of the data packets to which the device applies the rule. The prerequisite is that in the Protocol column the value TCP or UDP is specified.

Possible values:
- **any** (default setting)
  The device applies the Packet Filter rule to every data packet without evaluating the destination port.
- **1..65535**
  The device applies the Packet Filter rule only to data packets containing the specified destination port.

The field lets you specify the following options:
- You specify a port with a single numerical value, for example 21.
- You specify multiple individual ports with numerical values separated by commas, for example 21,80,110.
- You specify a port range with numerical values connected by dashes, for example 2000-3000.
- You can also combine ports and port ranges, for example 21,2000-3000,65535.
  The field lets you specify up to 15 numerical values. When you enter 21,2000-3000,65535, for example, you use 4 of 15 numerical values.
### Action

Specifies how the device handles received data packets when the device applies the rule.

**Possible values:**

- **accept** *(default setting)*
  - The device accepts the data packets according to the ingress rules. Afterwards, the device applies the egress rules before sending the data packets.

- **drop**
  - The device discards the data packet without informing the sender.

- **reject**
  - The device discards the data packet and informs the sender.

- **enforce-modbus**
  - The device applies the rule specified in the DPI profile index column to the data packets.

- **enforce-opc**
  - The device applies the rule specified in the DPI profile index column to the data packets.

- **enforce-dnp3**
  - The device applies the rule specified in the DPI profile index column to the data packets.

- **enforce-iec104**
  - The device applies the rule specified in the DPI profile index column to the data packets.

- **enforce-ethernetip**
  - The device applies the rule specified in the DPI profile index column to the data packets.

### Ingress interface

Displays if the device applies the Packet Filter rule to data packets received or sent on a router interface.

**Possible values:**

- **ingress**
  - The device applies the Packet Filter rule to data packets received on the router interface.

- **egress**
  - The device applies the Packet Filter rule to data packets sent on the router interface.

### Active

Activates/deactivates the rule.

**Possible values:**

- **marked**
  - The rule is active.

- **unmarked** *(default setting)*
  - The rule is inactive.
### 4.3.1.3 Packet Filter Rule

This dialog lets you set up rules for the packet filter. You assign the rules specified here to the desired ports in the Network Security > Packet Filter > Routed Firewall Mode > Assignment dialog.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- **Add**
  Adds a table row.

- **Remove**
  Removes the selected table row.

**Rule index**

Displays the sequential number of the Packet Filter rule. The device automatically assigns this number.

**Description**

Specifies a name or description for the rule.

Possible values:

- Alphanumeric ASCII character string with 0..32 characters

**Source address**

Specifies the source address of the data packets to which the device applies the rule.

Possible values:

- **any** (default setting)
  The device applies the Packet Filter rule to data packets with any source address.
- **Valid IPv4 address**
  The device applies the rule to data packets with the specified source address.
- **Valid IPv4 address and netmask in CIDR notation**
  The device applies the rule to data packets with the specified source address in the specified subnet.
Destination address

Specifies the destination address of the data packets to which the device applies the rule.

Possible values:
- **any** (default setting)
  - The device applies the Packet Filter rule to data packets with any destination address.
- **Valid IPv4 address**
  - The device applies the rule to data packets with the specified destination address.
- **Valid IPv4 address and netmask in CIDR notation**
  - The device applies the rule to data packets with the specified destination address in the specified subnet.

Protocol

Specifies the IP protocol or Layer 4 protocol type of the data packets to which the device applies the rule. The device applies the rule only to data packets with a Protocol field of the specified value.

Possible values:
- **any** (default setting)
  - The device applies the rule to every data packet without evaluating the protocol.
- **icmp**
  - Internet Control Message Protocol (RFC 792)
- **igmp**
  - Internet Group Management Protocol
- **ipip**
  - IP in IP tunneling (RFC 2003)
- **tcp**
  - Transmission Control Protocol (RFC 793)
- **udp**
  - User Datagram Protocol (RFC 768)
- **esp**
  - IPsec Encapsulated Security Payload (RFC 2406)
- **ah**
  - IPsec Authentication Header (RFC 2402)
- **icmpv6**
  - Internet Control Message Protocol for IPv6
Source port

Specifies the source port of the data packets to which the device applies the rule. The prerequisite is that in the Protocol column the value TCP or UDP is specified.

Possible values:

- **any** (default setting)
  The device applies the Packet Filter rule to every data packet without evaluating the source port.

- **1..65535**
  The device applies the Packet Filter rule only to data packets containing the specified source port.
  The field lets you specify the following options:
  - You specify a port with a single numerical value, for example 21.
  - You specify multiple individual ports with numerical values separated by commas, for example 21,80,110.
  - You specify a port range with numerical values connected by dashes, for example 2000-3000.
  - You can also combine ports and port ranges, for example 21,2000-3000,65535.
  The field lets you specify up to 15 numerical values. When you enter 21,2000-3000,65535, for example, you use 4 of 15 numerical values.

Destination port

Specifies the destination port of the data packets to which the device applies the rule. The prerequisite is that in the Protocol column the value TCP or UDP is specified.

Possible values:

- **any** (default setting)
  The device applies the Packet Filter rule to every data packet without evaluating the destination port.

- **1..65535**
  The device applies the Packet Filter rule only to data packets containing the specified destination port.
  The field lets you specify the following options:
  - You specify a port with a single numerical value, for example 21.
  - You specify multiple individual ports with numerical values separated by commas, for example 21,80,110.
  - You specify a port range with numerical values connected by dashes, for example 2000-3000.
  - You can also combine ports and port ranges, for example 21,2000-3000,65535.
  The field lets you specify up to 15 numerical values. When you enter 21,2000-3000,65535, for example, you use 4 of 15 numerical values.

Parameters

Specifies additional parameters for this rule.

Enter parameters in the form `<param>=<val>`. If you enter multiple parameters, then separate them using a comma. If you enter multiple values, then separate them using a vertical bar.

Some parameters are valid when you use a specific protocol. Exception: the value mac is valid independently of the protocol. You also have the option of entering a combination of valid rules and protocol-specific rules.

Possible values:

- **none** (default setting)
  You have not specified any additional parameters for this rule.
This rule applies to packets with the source MAC address `de:ad:ad:be:ef`.

This rule applies to packets with a specific ICMP type. Enter exactly one value (for the meaning of these values see RFC 792).

This rule applies to packets with a specific ICMP code. Enter exactly one value (for the meaning of these values see RFC 792).

When `true`, this rule applies to fragmented packets for which you set specific rules.

This rule applies to packets for which you set specific flags.

This rule applies to packets for which you set the `syn` flag.

This rule applies to packets for which you set the `syn`, `ack`, or `fin` flag.

This rule applies to packets that come from the `de:ad:ad:be:ef` MAC address, are in a new or relative connection, and for which you set the `syn` flag.

Action

Specifies how the device processes received data packets when the device applies the rule.

Possible values:

- **accept** (default setting)
  The device accepts the data packets according to the ingress rules. Afterwards, the device applies the egress rules before transmitting the data packets.

- **drop**
  The device discards the data packet without informing the sender.

- **reject**
  The device discards the data packet and informs the sender.

- **enforce-modbus**
  The device applies the rule specified in the `DPI profile index` column to the data packets. The value is only available in the software level MB/01. Refer to the `Software level` characteristic value in the product code.

- **enforce-opc**
  The device applies the rule specified in the `DPI profile index` column to the data packets. The value is only available in the software level OP/01. Refer to the `Software level` characteristic value in the product code.

- **enforce-dnp3**
  The device applies the rule specified in the `DPI profile index` column to the data packets. The value is only available in the software level SU/UN. Refer to the `Software level` characteristic value in the product code.

- **enforce-iec104**
  The device applies the rule specified in the `DPI profile index` column to the data packets. The value is only available in the software level SU/UN. Refer to the `Software level` characteristic value in the product code.

- **enforce-ethernetip**
  The device applies the rule specified in the `DPI profile index` column to the data packets. The value is only available in the software level IN/UN. Refer to the `Software level` characteristic value in the product code.
Log

Activates/deactivates the logging in the log file.

Possible values:
- **marked**
  - Logging is active.
  - When the device applies the Packet Filter rule to a data packet, the device places an entry in the log file. See the Diagnostics > Report > System Log dialog.
- **unmarked** (default setting)
  - Logging is inactive.

Trap

Activates/deactivates the sending of SNMP traps when the device applies a Packet Filter rule to a data packet.

Possible values:
- **marked**
  - The sending of SNMP traps is active.
  - If the device applies the Packet Filter rule to a data packet, then the device sends an SNMP trap.
- **unmarked** (default setting)
  - The sending of SNMP traps is inactive.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.

DPI profile index

Specifies which rule the device applies to the data packets. The prerequisite for changing the value is that you specify one of the following values in the Action column.

- **enforce-modbus**
- **enforce-opc**
- **enforce-dnp3**
- **enforce-iec104**
- **enforce-ethernetip**

Possible values:
- **0** (default setting)
  - The device does not apply any rule to the data packets.
- **1..32**
  - The device applies the rule with the specified Index number to the data packets.

Active

Activates/deactivates the rule.

To apply the changes to the data stream, perform the following steps:

- Click the **button to save the current changes.
- Open the Network Security > Packet Filter > Routed Firewall Mode > Global dialog, or the Network Security > Packet Filter > Routed Firewall Mode > Assignment dialog.
- Click the **button.
Possible values:

- **marked**
  The rule is active.
- **unmarked** *(default setting)*
  The rule is inactive.
4.3.1.4 Packet Filter Assignment

This dialog lets you assign one or more Packet Filter rules to the router interfaces of the device. You set up router interfaces in the Routing > Interfaces > Configuration dialog.

Information

Assignments
Displays how many rules are active for the ports.

Uncommitted changes present
Displays if the Packet Filter rules applied to the data stream differ from the Packet Filter rules saved in the device.

Possible values:
- marked
  At least one of the Packet Filter rules saved in the device contains modified settings. When you click the button, the device applies the Packet Filter rules to the data stream.
- unmarked
  The device applies the saved Packet Filter rules to the data stream.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add
Opens the Create window to assign a rule to a router interface.

- In the Interface field, you specify the router interface to which the device applies the rule.
- In the Direction field, you specify if the device applies the rule to data packets received or sent.
- In the Rule index field, you specify the rule which you assign to the router interface.
Remove

Removes the selected table row.

Commit changes

Applies the rules saved in the device to the data stream.

In the process, the device also removes the state information from the packet filter. This includes potential DCE RPC information of the OPC Enforcer function. In the process, the device interrupts open communication connections.

Note: While the device activates the saved rules, you cannot set up any new communication connections.

Description

Displays the name or description of the rule. You specify the description in the Network Security > Packet Filter > Routed Firewall Mode > Rule dialog.

Rule index

Displays the sequential number of the Packet Filter rule. To specify this number, click the button.

Interface

 Displays the interface to which the device applies the rule. To specify this interface, click the button. The device displays ports to which you enable the Routing function.

Direction

Displays if the device applies the Packet Filter rule to data packets received or sent.

Possible values:

- **ingress**
  The device applies the Packet Filter rule to data packets received on the router interface.

- **egress**
  The device applies the Packet Filter rule to data packets sent on the router interface.

Priority

Specifies the priority of the Packet Filter rule.

Using the priority, you specify the sequence in which the device applies the rules to the data stream. The device applies the rules in ascending order which starts with priority 0.
Possible values:

- **0..4294967295** (default setting: 1)

**Active**

Activates/deactivates the rule.

To apply the changes to the data stream, perform the following steps:

- Click the **✓** button to save the current changes.
- Open the *Network Security > Packet Filter > Routed Firewall Mode > Global* dialog, or the *Network Security > Packet Filter > Routed Firewall Mode > Assignment* dialog.
- Click the **✓** button.

Possible values:

- **marked**
  - The rule is active.
- **unmarked** (default setting)
  - The rule is inactive.
4.3.1.5 Packet Filter Overview

This dialog gives you an overview of the specified Packet Filter rules.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>Description</th>
<th>Displays the name or description of the rule. You specify the description in the Network Security &gt; Packet Filter &gt; Routed Firewall Mode &gt; Rule dialog.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule index</td>
<td>Displays the sequential number of the Packet Filter rule.</td>
</tr>
<tr>
<td>Interface</td>
<td>Displays the interface to which the device applies the rule.</td>
</tr>
<tr>
<td>Direction</td>
<td>Displays if the device applies the Packet Filter rule to data packets received or sent.</td>
</tr>
<tr>
<td></td>
<td>Possible values:</td>
</tr>
<tr>
<td></td>
<td>▶ ingress</td>
</tr>
<tr>
<td></td>
<td>The device applies the Packet Filter rule to data packets received on the router interface.</td>
</tr>
<tr>
<td></td>
<td>▶ egress</td>
</tr>
<tr>
<td></td>
<td>The device applies the Packet Filter rule to data packets sent on the router interface.</td>
</tr>
<tr>
<td>Priority</td>
<td>Displays the priority of the Packet Filter rule. The device applies the rules in ascending order which starts with priority 0.</td>
</tr>
<tr>
<td>Source address</td>
<td>Displays the source address of the data packets to which the device applies the rule.</td>
</tr>
<tr>
<td>Source port</td>
<td>Displays the source TCP or UDP port of the data packets to which the device applies the rule.</td>
</tr>
<tr>
<td>Destination address</td>
<td>Specifies the destination address of the data packets to which the device applies the rule.</td>
</tr>
</tbody>
</table>
Network Security

Destination port
Displays the destination TCP or UDP port of the data packets to which the device applies the rule.

Protocol
Displays the IP protocol to which the Packet Filter rule is restricted. The device applies the Packet Filter rule only to data packets of the specified IP protocol.

Parameters
Displays additional parameters for this rule.

Action
Displays how the device processes received data packets when the device applies the rule.

DPI profile index

Log
Displays if the device places an entry in the log file when the device applies the rule to a data packet.

Trap
Displays if the device sends an SNMP trap when the device applies the rule to a data packet.

4.4 Deep Packet Inspection

The DPI function lets you monitor and filter data packets. The function supports you in protecting your network from undesirable content, such as spam or viruses.

The DPI function inspects data packets for undesirable characteristics and protocol violations. The protocol inspects the header and the payload of the data packets.

This dialog lets you specify the DPI settings. The device blocks data packets that violate the specified profiles. If an error is detected, then the device terminates the data connection upon user request.

The menu contains the following dialogs:
- Deep Packet Inspection - Modbus Enforcer
- Deep Packet Inspection - OPC Enforcer
- Deep Packet Inspection - DNP3 Enforcer
- Deep Packet Inspection - IEC104 Enforcer
- Deep Packet Inspection - ENIP Enforcer
4.4.1 Deep Packet Inspection - Modbus Enforcer

This dialog lets you specify the Modbus Enforcer settings and define Modbus TCP specific profiles.

The profiles specify function codes and register or coil addresses. The function code in the Modbus TCP protocol specifies the purpose of the data transfer. The device blocks the data packets that violate the specified profiles. If an error is detected, then the device terminates the data connection upon user request. The predefined function code lists and the function code generator support you when specifying the function codes.

When the Modbus Enforcer profile is active (checkbox in the Profile active column is marked), the device applies the profiles to the data stream.
- The device permits data packets containing only the function codes specified in the Function code column.
- The device rejects the data packets containing any other function codes that are not specified in the Function code column.

Information

Uncommitted changes present

Displays if the Modbus Enforcer profiles applied to the data stream differ from the profiles saved in the device.

Possible values:
- marked
  At least one of the active Modbus Enforcer profiles saved in the device contains modified settings.
  When you click the button, the device applies the specified profiles.
- unmarked
  The Modbus Enforcer profiles applied to the data stream match the profiles saved in the device.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row.
- In the Index field, you specify the number of the profile.
  Possible values:
  - 1..32
  When you click the Ok button, the device creates the new table row and assigns the number specified in the Index field to the table row.
Remove

Removes the selected table row.

If you mark the Profile active checkbox for the profile, then the device stops you from removing the profile.

Copy

Opens the Copy window to copy an existing table row. The prerequisite is that the table row for the profile to be copied is selected.

In the Index field, you specify a new number which identifies the copied profile.

Possible values:

- 1..32

The device creates the new table row and assigns the number specified in the Index field to the table row.

Commit changes

The device applies the specified profiles to the data stream.

If you changed the value in the Function type field, then the device applies the change to the Function code list and refreshes the display in the Function code column.

Index

Displays the sequential number of the profile to which the table row relates.

Description

Specifies the name for the profile.

Possible values:

- Alphanumeric ASCII character string with 0..64 characters (default setting: modbus)
  - The device differentiates between upper and lower case.

Function type

Specifies the function type for the Modbus Enforcer profile. After clicking the ✓ button, the device assigns the corresponding type IDs.

Possible values:

- **readOnly** (default setting)
  - Assigns the function codes for the read function of the Modbus TCP protocol.
    - 1,2,3,4,7,11,12,17,20,24
  - **ReadWrite**
    - Assigns the function codes for the read/write functions of the Modbus TCP protocol.
    - 1,2,3,4,5,6,7,11,12,15,16,17,20,21,22,23,24
  - **programming**
    - Assigns the function codes for the programming functions of the Modbus TCP protocol.
    - 1,2,3,4,5,6,7,11,12,15,16,17,20,21,22,23,24,40,42,90, 125,126
Примечание: Если вы указали значение advanced, то для собственной безопасности устройство не допускает последующих изменений. Это помогает избежать перезаписи пользовательских значений, сохраненных в поле Function code. Для указания строки с значением readOnly, readWrite или programming, создайте новую строку.

**Функция кода**

Представляет функции коды для профиля Modbus Enforcer. Устройство разрешает пакеты данных с указанными свойствами.

В столбце функции кода отображаются различные значения в зависимости от значения в столбце Function type:
- Если в столбце Function type значение readOnly, readWrite или programming, устройство автоматически вставляет соответствующие функции коды.
- Если в столбце Function type значение advanced, устройство позволяет указывать пользовательские функции коды. Для этого выполните следующие шаги:
  1. Для соответствующего профиля, щелкните в поле Function code.
  2. В выпадающем списке Function code выберите желаемое значение.
  3. Нажмите кнопку Add.
  4. Для добавления нескольких функций кодов, повторите上述步骤.
  5. Нажмите кнопку Ok.

**Положим значения:**
- FC | AR, FC | AR, ...
  Устройство позволяет указывать несколько функции кодов и дополнительный диапазон адресов. Вы найдете значение чисел в разделе “Meaning of the Function code values” on page 126.
  - Function code <FC> = 1..255
    Вы отделяете каждый функции код от запятой, например, 1,2,3.
    Для некоторых функции коды устройство позволяет указывать дополнительный диапазон адресов. Вы отделяете диапазон адреса от функции кода с помощью вертикальной линии (трубы), например, 1|128-255.
  - Address range <AR> = 0..65535 or 0..65535|0..65535 (for function codes that require read and write address ranges)
    Вы присоединяете начальное и конечное значение диапазона с помощью тире, например, 128-255.

**Идентификатор устройства**

Определяет Modbus TCP идентификационный номер для профиля Modbus Enforcer.

**Положим значения:**
- none (default setting)
  Устройство разрешает пакеты данных без идентификации.
- 0..255
  Устройство разрешает пакеты данных с указанным идентификационным номером.
  Это поле позволяет указать следующие опции:
  - Одинарный Modbus TCP идентификационный номер с одним числовым значением, например, 1.
  - Многомерный Modbus TCP идентификационных номеров с числовыми значениями, разделенными запятой, например, 1,2,3.
Sanity check

Activates/deactivates the plausibility check for the data packets.

Possible values:
- **marked** (default setting)
  - The plausibility check is active.
  - The device checks the plausibility of the data packets in regards to format and specification.
- **unmarked**
  - The plausibility verification is inactive.

Exception

Activates/deactivates the sending of an *exception* response in case of a protocol violation or if the plausibility check identifies errors.

Possible values:
- **marked**
  - The sending of an *exception* response is active.
  - If the device identifies a protocol violation or a plausibility check error, then the device sends an *exception* response to the end points and terminates the Modbus TCP connection.
- **unmarked** (default setting)
  - The sending of an *exception* response is inactive. The Modbus TCP connection remains established.

TCP reset

Activates/deactivates the resetting of the TCP connection in case of a protocol violation or if the plausibility check detects an error.

Possible values:
- **marked** (default setting)
  - The resetting of the TCP connection is active.
  - If the device identifies a protocol violation or detects a plausibility check error, then the device terminates the TCP connection.
- **unmarked**
  - The resetting of the TCP connection is inactive. The TCP connection remains established.

Profile active

Activates/deactivates the profile.

Possible values:
- **marked**
  - The profile is active.
  - The device applies the *Modbus Enforcer* profiles specified in this table row to the data packets.
- **unmarked** (default setting)
  - The profile is inactive.
[**Function code**]

**Function code**

Specifies the *function codes* for the relevant *Modbus Enforcer* profile.

You find the meaning of the numbers in section "Meaning of the Function code values" on page 126.

**Read address range**

Specifies the read address range for certain *function codes*. See section "Meaning of the Function code values" on page 126.

Possible values:

- 0..65535

**Write address range**

Specifies the write address range for certain *function codes*. See section "Meaning of the Function code values" on page 126.

Possible values:

- 0..65535

**Add**

Adds the items you selected in the drop-down list to the *Function code* field.

**Remove**

Removes the item from the *Function code* field.

### Meaning of the Function code values

<table>
<thead>
<tr>
<th>#</th>
<th>Meaning</th>
<th>Address range (read)</th>
<th>Address range (write)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Read Coils</td>
<td>&lt;0..65535&gt;</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Read Discrete Inputs</td>
<td>&lt;0..65535&gt;</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Read Holding Registers</td>
<td>&lt;0..65535&gt;</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Read Input Registers</td>
<td>&lt;0..65535&gt;</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Write Single Coil</td>
<td>&lt;0..65535&gt;</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Write Single Register</td>
<td>&lt;0..65535&gt;</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Read Exception Status</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Diagnostic</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>Get Comm Event Counter</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>Get Comm Event Log</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>Program (584/984)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>Poll (584/984)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>Write Multiple Coils</td>
<td>&lt;0..65535&gt;</td>
<td>-</td>
</tr>
<tr>
<td>#</td>
<td>Meaning</td>
<td>Address range (read)</td>
<td>Address range (write)</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------</td>
<td>----------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>16</td>
<td>Write Multiple Registers</td>
<td>&lt;0..65535&gt;</td>
<td>-</td>
</tr>
<tr>
<td>17</td>
<td>Report Slave ID</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>20</td>
<td>Read File Record</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>21</td>
<td>Write File Record</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>22</td>
<td>Mask Write Register</td>
<td>&lt;0..65535&gt;</td>
<td>-</td>
</tr>
<tr>
<td>23</td>
<td>Read/Write Multiple Registers</td>
<td>&lt;0..65535&gt;</td>
<td>&lt;0..65535&gt;</td>
</tr>
<tr>
<td>24</td>
<td>Read FIFO Queue</td>
<td>&lt;0..65535&gt;</td>
<td>-</td>
</tr>
<tr>
<td>40</td>
<td>Program (Concept)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>42</td>
<td>Concept Symbol Table</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>43</td>
<td>Encapsulated Interface Transport</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>48</td>
<td>Advantech Co. Ltd. - Management Functions</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>66</td>
<td>Scan Data Inc. - Expanded Read Holding Registers</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>67</td>
<td>Scan Data Inc. - Expanded Write Holding Registers</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>90</td>
<td>Unity Programming/OFS</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>100</td>
<td>Scattered Register Read</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>125</td>
<td>Schneider Electric - Firmware</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
4.4.2 Deep Packet Inspection - OPC Enforcer

This dialog lets you specify the OPC Enforcer (OLE for Process Control Enforcer) settings and define the OPC Enforcer specific profiles.

The OPC is an integration protocol for industrial environments. The OPC Enforcer is a function that supports the network security. The device blocks the data packets that violate the specified profiles. Upon user request, the device verifies the data packets for their plausibility and their fragment characteristics. The device verifies and observes OPC data connections and helps protect against invalid or fake data packets. The function dynamically activates TCP ports for each data connection. When requested by an OPC server, the device sets up the data connection only between the OPC server and the related OPC client.

The device removes the state information from the packet filter on the following events:
- When applying the profiles saved in the device to the data stream.
- When activating/deactivating the Routing function on a router interface.

This includes potential DCE RPC information of the OPC Enforcer. In the process, the device interrupts open communication connections.

Operation

Uncommitted changes present

Displays if the OPC Enforcer profiles applied to the data stream differ from the profiles saved in the device. When you click the button, the device applies the specified profiles.

Possible values:
- marked
  At least one of the active OPC Enforcer profiles saved in the device contains modified settings.
- unmarked
  The OPC Enforcer profiles applied to the data stream match the profiles saved in the device.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row.

In the Index field, you specify the number of the profile.

Possible values:

- 1..32

When you click the Ok button, the device creates the new table row and assigns the number specified in the Index field to the table row.
Remove

Removes the selected table row.

If you mark the Profile active checkbox for the profile, then the device stops you from removing the profile.

Copy

Opens the Copy window to copy an existing table row. The prerequisite is that the table row for the profile to be copied is selected.

- In the Index field, you specify the number of the profile.
  Possible values:
  - 1..32
  The device creates the new table row and assigns the number specified in the Index field to the table row.

Commit changes

The device applies the specified profiles to the data stream.

Index

Displays the sequential number of the profile to which the table row relates.

Description

Specifies a name or description for the profile.

Possible values:
- Alphanumeric ASCII character string with 0..64 characters (default setting: opc)

Sanity check

Activates/deactivates the plausibility check for the data packets.

Possible values:
- marked (default setting)
  The plausibility check is active.
  The device checks the plausibility of the data packets regarding format and specification.
  The device blocks data packets that violate the specified profiles.
- unmarked
  The plausibility check is inactive.
Network Security

[Network Security > DPI > DNP3 Enforcer]

Fragment check

Activates/deactivates the fragment check for the data packets.

Possible values:
- **marked** (default setting)
  - The fragment check is active.
  - The device checks the data packets for fragment characteristics.
- **unmarked**
  - The fragment check is inactive.

Timeout at connect

Specifies the period in seconds after which the device terminates the OPC data connection.

Possible values:
- **1..60** (default setting: 5)
- **0**
  - The value 0 deactivates the function. The OPC data connection remains set up without a time limit.

Profile active

Activates/deactivates the profile.

Possible values:
- **marked**
  - The profile is active.
  - The device applies the OPC Enforcer profiles specified in this table row to the data packets.
- **unmarked**
  - The profile is inactive.

4.4.3 Deep Packet Inspection - DNP3 Enforcer

[Network Security > DPI > DNP3 Enforcer]

This dialog lets you specify the DNP3 Enforcer (Distributed Network Protocol v3 Enforcer) settings and define the DNP3 Enforcer specific profiles.

The DNP3 protocol is designed to help ensure reliable communication between components in process automation systems. The protocol provides multiplexing, error checking, link control, prioritization, and layer 2 addressing services for user data. The DNP3 Enforcer function activates the Deep Packet Inspection (DPI) firewall capabilities for the DNP3 data stream. The device blocks the data packets that violate the specified profiles. Upon user request, the device verifies the data packets for their plausibility and their fragment characteristics. The device verifies and monitors DNP3 data connections and helps protect against invalid or falsified data packets.
When the **DNP3 Enforcer** profile is active (checkbox in the **Profile active** column is marked), the device applies the profiles to the data stream.

- The device permits data packets containing only the *function codes* specified in the **Function code list** column.
- The device rejects the data packets containing any other *function codes* that are not specified in the **Function code list** column.

The menu contains the following dialogs:

- DNP3 Profile
- DNP3 Object
4.4.3.1 DNP3 Profile

This dialog lets you set up profiles for the DNP3 Enforcer function. The profile lets you forward or discard data packets based on the specified values.

**Information**

Uncommitted changes present

Displays if the DNP3 Enforcer profiles applied to the data stream differ from the profiles saved in the device.

Possible values:

- **marked**
  At least one of the active DNP3 Enforcer profiles saved in the device contains modified settings.
  To apply the pending profiles to the data stream, click the **button.

- **unmarked**
  The DNP3 Enforcer profiles applied to the data stream match the profiles saved in the device.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- **Add**
  Opens the Create window to add a table row.
  - In the Index field, you specify the number of the profile.
    Possible values:
    - **1**..**32**
      When you click the Ok button, the device creates the new table row and assigns the number specified in the Index field to the table row.

- **Remove**
  Removes the selected table row.
Copy

Opens the Copy window to copy an existing table row. The prerequisite is that the table row for the profile to be copied is selected.

► In the Index field, you specify a new number which identifies the copied profile. Possible values:
  - 1..32
    The device creates the new table row and assigns the number specified in the Index field to the table row.

Commit changes

The device applies the specified profiles to the data stream.

Index

Displays the sequential number of the profile to which the table row relates.

Description

Specifies the name for the profile.

Possible values:

► Alphanumeric ASCII character string with 0..32 characters
  (default setting: dnp3)
  The device differentiates between upper and lower case.

Function code list

Displays the function codes for the DNP3 Enforcer profile. The device permits data packets with the specified properties.

The device lets you specify multiple function codes. To do this, perform the following steps:

- For the relevant profile, click into the Function code list column. The dialog displays the Function code list window. See “[Function code list]” on page 135.
- In the Function code list drop-down list, select the desired function code item.
- Click the Add button.
- To add multiple function codes, repeat the previously described steps.
- Click the Ok button.

Possible values:

► 0..255
  You find the meaning of the numbers in section “Meaning of the Function code list values” on page 135.

Index of Default Object List

Specifies the index numbers used in the default object list.

Possible values:

► all (default setting)
  The device applies the DNP3 Enforcer profile to every data packet regardless of the index number.
The device applies the DNP3 Enforcer profile only to data packets containing the specified index number.

The field lets you specify the following options:
- A single index number with a single numerical value, for example 1.
- Multiple index numbers with numerical values separated by a comma, for example 1,2,3.
- A range with numerical values joined by a dash, for example 7-25.
- You can also combine single numerical values and ranges, for example 2,7-25,56.

None
The device does not apply the index number to the DNP3 Enforcer profile.

CRC check

Activates/deactivates the CRC check for the data packets to validate the checksum contained in the DNP3 data packets.

Possible values:
- marked (default setting)
  The CRC check is active. The device calculates the checksum and compares it with the checksum field in the DNP3 data packets.
- unmarked
  The CRC check is inactive.

Sanity check

Activates/deactivates the plausibility check for the data packets.

Possible values:
- marked (default setting)
  The plausibility check is active. The device checks the plausibility of the data packets regarding format and specification. The device blocks data packets that violate the specified profiles.
- unmarked
  The plausibility verification is inactive.

Check outstation traffic

Activates/deactivates the checking of the data packets that originate at an outstation.

Possible values:
- marked
  The checking of data packets from an outstation is active.
- unmarked
  The checking of data packets from an outstation is inactive.
TCP reset

Activates/deactivates the resetting of the TCP connection in case of a protocol violation or if the plausibility check detects an error.

Possible values:
- **marked** (default setting)
  - The resetting of the TCP connection is active.
  - If the device identifies a protocol violation or detects a plausibility check error, then the device terminates the TCP connection.
- **unmarked**
  - The resetting of the TCP connection is inactive. The TCP connection remains established.

Profile active

Activates/deactivates the profile.

Possible values:
- **marked**
  - The profile is active.
  - The device applies the DNP3 Enforcer profiles specified in this table row to the data packets.
- **unmarked**
  - The profile is inactive.

[Function code list]

Function code list

Specifies the function codes for the relevant DNP3 Enforcer profile.

You find the meaning of the numbers in section “Meaning of the Function code list values” on page 135.

Add

Adds the items you selected in the drop-down list to the Function code list field.

Remove

Removes the item from the Function code list field.

Meaning of the Function code list values

<table>
<thead>
<tr>
<th>#</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Confirm</td>
</tr>
<tr>
<td>1</td>
<td>Read</td>
</tr>
<tr>
<td>2</td>
<td>Write</td>
</tr>
<tr>
<td>3</td>
<td>Select</td>
</tr>
<tr>
<td>4</td>
<td>Operate</td>
</tr>
<tr>
<td>#</td>
<td>Meaning</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>5</td>
<td>Direct Operate</td>
</tr>
<tr>
<td>6</td>
<td>Direct Operate-No Response Required</td>
</tr>
<tr>
<td>7</td>
<td>Freeze</td>
</tr>
<tr>
<td>8</td>
<td>Freeze-No Response Required</td>
</tr>
<tr>
<td>9</td>
<td>Freeze Clear</td>
</tr>
<tr>
<td>10</td>
<td>Freeze Clear-No Response Required</td>
</tr>
<tr>
<td>11</td>
<td>Freeze at Time</td>
</tr>
<tr>
<td>12</td>
<td>Freeze at Time-No Response Required</td>
</tr>
<tr>
<td>13</td>
<td>Cold Restart</td>
</tr>
<tr>
<td>14</td>
<td>Warm Restart</td>
</tr>
<tr>
<td>15</td>
<td>Initialize Data</td>
</tr>
<tr>
<td>16</td>
<td>Initialize Application</td>
</tr>
<tr>
<td>17</td>
<td>Start Application</td>
</tr>
<tr>
<td>18</td>
<td>Stop Application</td>
</tr>
<tr>
<td>19</td>
<td>Save Configuration</td>
</tr>
<tr>
<td>20</td>
<td>Enable Unsolicited Messages</td>
</tr>
<tr>
<td>21</td>
<td>Disable Unsolicited Messages</td>
</tr>
<tr>
<td>22</td>
<td>Assign Class</td>
</tr>
<tr>
<td>23</td>
<td>Delay Measurement</td>
</tr>
<tr>
<td>24</td>
<td>Record Current Time</td>
</tr>
<tr>
<td>25</td>
<td>Open File</td>
</tr>
<tr>
<td>26</td>
<td>Close File</td>
</tr>
<tr>
<td>27</td>
<td>Delete File</td>
</tr>
<tr>
<td>28</td>
<td>Get File Information</td>
</tr>
<tr>
<td>29</td>
<td>Authenticate File</td>
</tr>
<tr>
<td>30</td>
<td>Abort File Transfer</td>
</tr>
<tr>
<td>31</td>
<td>Active Configuration</td>
</tr>
<tr>
<td>32</td>
<td>Authentication Request</td>
</tr>
<tr>
<td>33</td>
<td>Authenticate Request-No Acknowledgment</td>
</tr>
<tr>
<td>129</td>
<td>Response</td>
</tr>
<tr>
<td>130</td>
<td>Unsolicited Response</td>
</tr>
<tr>
<td>131</td>
<td>Authentication Response</td>
</tr>
</tbody>
</table>
4.4.3.2 DNP3 Object

The DNP3 function uses objects to transmit values and information between devices. The DNP3 function uses group numbers to categorize the data type and variation numbers to specify how the data within the group is encoded. Each instance of an encoded information element that defines a unique group and variation in the message, is a DNP3 object.

This window lets you create custom DNP3 objects and also lets you view the previously created custom DNP3 objects. To verify that a created DNP3 object is valid in a particular request message/response message, check the following parameters:

- Type
- Group no.
- Variation
- Function
- Qualifier
- Length
- Function name

Based on the IEEE 1815-2012 standard, the DNP3 Enforcer function permits by default the data stream containing DNP3 objects which are available in the default object list.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row.

- In the Index field, you select the index number of the profile from the drop-down list.
- In the Object index field, you specify the index number of the object. Possible values:
  - 1..256
- In the Type field, you specify the type of the message. Possible values:
  - request
  - response
- In the Group no. field, you specify a means of classifying the type or the types of data packets in a message. The prerequisite is that you have specified a valid value in the Type field. Possible values:
  - 0..255
- In the Variation field, you specify the variation number. The prerequisite is that you have specified a valid value in the Group no. field. Possible values:
  - 0..255
In the *Function* field, you specify the *function code*. The *function code* identifies the purpose of the message. The prerequisite is that you have specified a valid value in the *Variation* field. Possible values:
- 0..128
  *Request messages from masters*. Specify a single numerical value, for example 1.
- 129..255
  *Response messages from outstations*. Specify a single numerical value, for example 254.

In the *Qualifier* field, you specify the *qualifier code* for a pair of each *Group no.*, *Variation*, and *Function* fields. The *qualifier code* is an 8-bit value that defines the *prefix code* and the *range specifier code* for the object in a DNP3 message. The prerequisite is that you have specified a valid value in the *Function* field. Possible values:
- 0x00..0xff
  You specify multiple individual *qualifier codes* using hexadecimal values separated by a comma for a set of each *Group no.*, *Variation*, and *Function* fields.

When you click the *Ok* button, the device creates the new table row. The device assigns the values specified in the *Index*, *Object index*, *Type*, *Group no.*, *Variation*, *Function* and *Qualifier* fields to this table row.

- **Remove**
  Removes the selected table row.

**Index**
Displays the number of the profile to which the table row relates.

**Object index**
Displays the number of the object to which the table row relates.

**Type**
Specifies the type of the message.
Possible values:
- **request**
  Creates a *request message* object in the object list.
- **response**
  Creates a *response message* object in the object list.

**Group no.**
Specifies a means of classifying the type or the types of data packets in a message. The prerequisite is that you have specified a valid value in the *Type* field.
Possible values:
- 0..255
  Each group number shares a common *point type* and *method of data packet creation*. The *point type* defines the machine in an *outstation*. 
Variation

Specifies the variation number. The prerequisite is that you have specified a valid value in the Group no. field. The device applies the DNP3 Enforcer profile only to data packets containing the specified value.

The DNP3 function provides the choice of encoding formats for the type of data packets known as variation number. Every value in the Group no. field has a set of variation numbers.

Possible values:
- 0..255
  - The field lets you specify the following options:
    - You specify a single variation number with a single numerical value, for example 1.
    - You specify a range with numerical values connected by a dash, for example 0-55.

Function

The function code identifies the purpose of the message. The prerequisite is that you have specified a valid value in the Variation field. The device applies the DNP3 Enforcer profile only to data packets containing the specified value.

Possible values:
- 0..128
  - Request messages from masters. Specify a single numerical value, for example 1.
- 129..255
  - Response messages from outstations. Specify a single numerical value, for example 254.

Qualifier

Specifies the qualifier code for a pair of each Group no., Variation, and Function fields. The qualifier code is an 8-bit value that defines the prefix code and the range specifier code for the object in a DNP3 message. The prerequisite is that you have specified a valid value in the Function field. The device applies the DNP3 Enforcer profile only to data packets containing the specified value.

Possible values:
- 0x00..0xff
  - You specify multiple individual qualifier codes using hexadecimal values separated by a comma for a set of each Group no., Variation, and Function fields.

Length

Specifies the optional length for the object. The prerequisite is that you have specified a valid value in the Function field. The device applies the DNP3 Enforcer profile only to data packets containing the specified value.

Possible values:
- 0..255
  - Specify a single numerical value, for example 1.
- byte_2
  - The second byte of the object data contains the length of the remaining portion of the data.
- single_bit_packed
  - If the count of bit values is not a multiple of 8, then the device pads the packed single-bit values up to the next byte boundary.
**double bit packed**

If the count of double bit values is not a multiple of 4, then the device pads the packed double-bit values up to the next byte boundary.

**variation**

Encodes the length of the object.

**Function name**

Specifies the optional name for the *function code*. The prerequisite is that you have specified a valid value in the *Function* field.

Possible values:
- Alphanumeric ASCII character string with 0..32 characters
  
  For example, the device permits data packets with the following *function names*:
  - READ
  - WRITE
  - SELECT

---

### [Index of Default Object List]

**Table 1: Request messages**

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>209-239</td>
<td>2</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>240</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>240</td>
<td>2</td>
<td>WRITE</td>
<td>byte_2</td>
<td>0x00</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>241-243</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>245-247</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>245-247</td>
<td>2</td>
<td>WRITE</td>
<td>byte_2</td>
<td>0x00</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>248-250</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>252</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>254</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>255</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>0-2</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>0</td>
<td>22</td>
<td>ASSIGN CLASS</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>0-3</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td>Index</td>
<td>Group no.</td>
<td>Variation</td>
<td>Function</td>
<td>Function name</td>
<td>Length</td>
<td>Qualifier</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
<td>-----------</td>
<td>----------</td>
<td>--------------------</td>
<td>--------</td>
<td>-----------------</td>
</tr>
<tr>
<td>14</td>
<td>3</td>
<td>0-2</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>0x00 0x01 0x06 0x17 0x28</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>0</td>
<td>22</td>
<td>ASSIGN CLASS</td>
<td></td>
<td>0x00 0x01 0x06 0x17 0x28</td>
</tr>
<tr>
<td>16</td>
<td>4</td>
<td>0-3</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>0x06 0x07 0x08</td>
</tr>
<tr>
<td>17</td>
<td>10</td>
<td>0</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>0x00 0x01 0x06 0x17 0x28</td>
</tr>
<tr>
<td>18</td>
<td>10</td>
<td>0</td>
<td>22</td>
<td>ASSIGN CLASS</td>
<td></td>
<td>0x00 0x01 0x06 0x17 0x28</td>
</tr>
<tr>
<td>19</td>
<td>10</td>
<td>1</td>
<td>2</td>
<td>WRITE</td>
<td>single_bitpacked</td>
<td>0x00 0x01</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
<td>2</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>0x00 0x01 0x06 0x17 0x28</td>
</tr>
<tr>
<td>21</td>
<td>11</td>
<td>0-2</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>0x06 0x07 0x08</td>
</tr>
<tr>
<td>22</td>
<td>12</td>
<td>0</td>
<td>22</td>
<td>ASSIGN_CLASS</td>
<td></td>
<td>0x00 0x01 0x06 0x17 0x28</td>
</tr>
<tr>
<td>23</td>
<td>12</td>
<td>1</td>
<td>3</td>
<td>SELECT</td>
<td>11</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>24</td>
<td>12</td>
<td>1</td>
<td>4</td>
<td>OPERATE</td>
<td>11</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>25</td>
<td>12</td>
<td>1</td>
<td>5</td>
<td>DIRECT_OPERATE</td>
<td>11</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
</tbody>
</table>
Table 1: Request messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>12</td>
<td>1</td>
<td>6</td>
<td>DIRECT_OPERATE_NR</td>
<td>11</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>27</td>
<td>12</td>
<td>2</td>
<td>3</td>
<td>SELECT</td>
<td>11</td>
<td>0x07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x08</td>
</tr>
<tr>
<td>28</td>
<td>12</td>
<td>2</td>
<td>4</td>
<td>OPERATE</td>
<td>11</td>
<td>0x07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x08</td>
</tr>
<tr>
<td>29</td>
<td>12</td>
<td>2</td>
<td>5</td>
<td>DIRECT_OPERATE</td>
<td>11</td>
<td>0x07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x08</td>
</tr>
<tr>
<td>30</td>
<td>12</td>
<td>2</td>
<td>6</td>
<td>DIRECT_OPERATE_NR</td>
<td>11</td>
<td>0x07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x08</td>
</tr>
<tr>
<td>31</td>
<td>12</td>
<td>3</td>
<td>3</td>
<td>SELECT</td>
<td>single_bit_packed</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td>32</td>
<td>12</td>
<td>3</td>
<td>4</td>
<td>OPERATE</td>
<td>single_bit_packed</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td>33</td>
<td>12</td>
<td>3</td>
<td>5</td>
<td>DIRECT_OPERATE</td>
<td>single_bit_packed</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td>34</td>
<td>12</td>
<td>3</td>
<td>6</td>
<td>DIRECT_OPERATE_NR</td>
<td>single_bit_packed</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td>35</td>
<td>13</td>
<td>0-2</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x08</td>
</tr>
<tr>
<td>36</td>
<td>20</td>
<td>0-2</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>37</td>
<td>20</td>
<td>5-6</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>38</td>
<td>20</td>
<td>0</td>
<td>7</td>
<td>IMMEDIATE_FREEZE</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>39</td>
<td>20</td>
<td>0</td>
<td>8</td>
<td>IMMEDIATE_FREEZE_NR</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>40</td>
<td>20</td>
<td>0</td>
<td>9</td>
<td>FREEZE_CLEAR</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
</tbody>
</table>
### Table 1: Request messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>20</td>
<td>0</td>
<td>10</td>
<td>FREEZE_CLEAR_NR</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>42</td>
<td>20</td>
<td>0</td>
<td>11</td>
<td>FREEZE_AT_TIME</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>43</td>
<td>20</td>
<td>0</td>
<td>12</td>
<td>FREEZE_AT_TIME_NR</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>44</td>
<td>20</td>
<td>0</td>
<td>22</td>
<td>ASSIGN_CLASS</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>45</td>
<td>21</td>
<td>0-2</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>46</td>
<td>21</td>
<td>5-6</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>47</td>
<td>21</td>
<td>9-10</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>48</td>
<td>21</td>
<td>0</td>
<td>22</td>
<td>ASSIGN_CLASS</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>49</td>
<td>22</td>
<td>0-2</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x08</td>
</tr>
<tr>
<td>50</td>
<td>22</td>
<td>5-6</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x08</td>
</tr>
<tr>
<td>51</td>
<td>23</td>
<td>0-2</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x08</td>
</tr>
<tr>
<td>Index</td>
<td>Group no.</td>
<td>Variation</td>
<td>Function</td>
<td>Function name</td>
<td>Length</td>
<td>Qualifier</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
<td>-----------</td>
<td>----------</td>
<td>---------------</td>
<td>--------</td>
<td>-----------</td>
</tr>
<tr>
<td>52</td>
<td>23</td>
<td>5-6</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x08</td>
</tr>
<tr>
<td>53</td>
<td>30</td>
<td>0-6</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>54</td>
<td>30</td>
<td>0</td>
<td>7</td>
<td>IMMEDIATE_FREEZE</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>55</td>
<td>30</td>
<td>0</td>
<td>8</td>
<td>IMMEDIATE_FREEZE_NR</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>56</td>
<td>30</td>
<td>0</td>
<td>11</td>
<td>FREEZE_AT_TIME</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>57</td>
<td>30</td>
<td>0</td>
<td>12</td>
<td>FREEZE_AT_TIME_NR</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>58</td>
<td>30</td>
<td>0</td>
<td>22</td>
<td>ASSIGN_CLASS</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>59</td>
<td>31</td>
<td>0-8</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>60</td>
<td>31</td>
<td>0</td>
<td>22</td>
<td>ASSIGN_CLASS</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>61</td>
<td>32</td>
<td>0-8</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x08</td>
</tr>
<tr>
<td>62</td>
<td>33</td>
<td>0-8</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x08</td>
</tr>
</tbody>
</table>

Table 1: Request messages (cont.)
<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>34</td>
<td>0-3</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>0x00 0x01 0x06</td>
</tr>
<tr>
<td>64</td>
<td>34</td>
<td>1</td>
<td>2</td>
<td>WRITE</td>
<td>2</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>65</td>
<td>34</td>
<td>2</td>
<td>2</td>
<td>WRITE</td>
<td>4</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>66</td>
<td>34</td>
<td>3</td>
<td>2</td>
<td>WRITE</td>
<td>4</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>67</td>
<td>40</td>
<td>0</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>0x00 0x01 0x06</td>
</tr>
<tr>
<td>68</td>
<td>40</td>
<td>0</td>
<td>22</td>
<td>ASSIGN_CLASS</td>
<td></td>
<td>0x00 0x01 0x06 0x17 0x28</td>
</tr>
<tr>
<td>69</td>
<td>40</td>
<td>1-4</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>0x00 0x01 0x06 0x17 0x28</td>
</tr>
<tr>
<td>70</td>
<td>41</td>
<td>0</td>
<td>22</td>
<td>ASSIGN_CLASS</td>
<td></td>
<td>0x00 0x01 0x06 0x17 0x28</td>
</tr>
<tr>
<td>71</td>
<td>41</td>
<td>1</td>
<td>3</td>
<td>SELECT</td>
<td>5</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>72</td>
<td>41</td>
<td>2</td>
<td>3</td>
<td>SELECT</td>
<td>3</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>73</td>
<td>41</td>
<td>3</td>
<td>3</td>
<td>SELECT</td>
<td>5</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>74</td>
<td>41</td>
<td>1</td>
<td>4</td>
<td>OPERATE</td>
<td>5</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
</tbody>
</table>
Table 1: Request messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>41</td>
<td>2</td>
<td>4</td>
<td>OPERATE</td>
<td>3</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>76</td>
<td>41</td>
<td>3</td>
<td>4</td>
<td>OPERATE</td>
<td>5</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>77</td>
<td>41</td>
<td>1</td>
<td>5</td>
<td>DIRECT_OPERATE</td>
<td>5</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>78</td>
<td>41</td>
<td>2</td>
<td>5</td>
<td>DIRECT_OPERATE</td>
<td>3</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>79</td>
<td>41</td>
<td>3</td>
<td>5</td>
<td>DIRECT_OPERATE</td>
<td>5</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>80</td>
<td>41</td>
<td>1</td>
<td>6</td>
<td>DIRECT_OPERATE_NR</td>
<td>5</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>81</td>
<td>41</td>
<td>2</td>
<td>6</td>
<td>DIRECT_OPERATE_NR</td>
<td>3</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>82</td>
<td>41</td>
<td>3</td>
<td>6</td>
<td>DIRECT_OPERATE_NR</td>
<td>5</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>83</td>
<td>42</td>
<td>0-8</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>84</td>
<td>43</td>
<td>0-8</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>85</td>
<td>50</td>
<td>1</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td>86</td>
<td>50</td>
<td>1</td>
<td>2</td>
<td>WRITE</td>
<td>6</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td>87</td>
<td>50</td>
<td>2</td>
<td>11</td>
<td>FREEZE_AT_TIME</td>
<td>10</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td>88</td>
<td>50</td>
<td>2</td>
<td>12</td>
<td>FREEZE_AT_TIME_NR</td>
<td>10</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td>89</td>
<td>50</td>
<td>3</td>
<td>2</td>
<td>WRITE</td>
<td>10</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td>90</td>
<td>50</td>
<td>4</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
</tbody>
</table>
### Table 1: Request messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>50</td>
<td>4</td>
<td>WRITE</td>
<td></td>
<td>11</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>92</td>
<td>60</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td>93</td>
<td>60</td>
<td>2-4</td>
<td>READ</td>
<td></td>
<td>-</td>
<td>0x06 0x07 0x08</td>
</tr>
<tr>
<td>94</td>
<td>60</td>
<td>1-4</td>
<td>ASSIGN_CLASS</td>
<td></td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td>95</td>
<td>60</td>
<td>2-4</td>
<td>ENABLE_UNSOLICITED</td>
<td></td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td>96</td>
<td>60</td>
<td>2-4</td>
<td>DISABLE_UNSOLICITED</td>
<td></td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td>97</td>
<td>70</td>
<td>2</td>
<td>FILE_AUTHENTICATE</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>98</td>
<td>70</td>
<td>3</td>
<td>OPEN_FILE</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>99</td>
<td>70</td>
<td>3</td>
<td>DELETE_FILE</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>70</td>
<td>4</td>
<td>CLOSE_FILE</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>101</td>
<td>70</td>
<td>4</td>
<td>FILE_ABORT</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>102</td>
<td>70</td>
<td>5-6</td>
<td>READ</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>103</td>
<td>70</td>
<td>5</td>
<td>WRITE</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>104</td>
<td>70</td>
<td>7</td>
<td>GET_FILE_INFORMATION</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>105</td>
<td>70</td>
<td>8</td>
<td>ACTIVATE_CONFIGURATION</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>106</td>
<td>80</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>-</td>
<td>0x00 0x01</td>
</tr>
<tr>
<td>107</td>
<td>80</td>
<td>1</td>
<td>WRITE</td>
<td>single_bit_packed</td>
<td>0x00 0x01</td>
<td></td>
</tr>
<tr>
<td>108</td>
<td>81</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>-</td>
<td>0x00 0x01</td>
</tr>
<tr>
<td>109</td>
<td>82</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>-</td>
<td>0x00 0x01</td>
</tr>
<tr>
<td>110</td>
<td>83</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>-</td>
<td>0x00 0x01</td>
</tr>
<tr>
<td>111</td>
<td>85</td>
<td>0</td>
<td>READ</td>
<td></td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td>112</td>
<td>85</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>-</td>
<td>0x00 0x01 0x06 0x17 0x28</td>
</tr>
<tr>
<td>113</td>
<td>85</td>
<td>1</td>
<td>WRITE</td>
<td>QC_5B</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>114</td>
<td>86</td>
<td>0</td>
<td>ASSIGN_CLASS</td>
<td></td>
<td>-</td>
<td>0x00 0x01 0x06 0x17 0x28</td>
</tr>
<tr>
<td>115</td>
<td>86</td>
<td>1-3</td>
<td>READ</td>
<td></td>
<td>-</td>
<td>0x00 0x01 0x06 0x17 0x28</td>
</tr>
</tbody>
</table>
## Table 1: Request messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>116</td>
<td>86</td>
<td>1</td>
<td>WRITE</td>
<td>QC_5B</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>117</td>
<td>86</td>
<td>3</td>
<td>WRITE</td>
<td>QC_5B</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>118</td>
<td>87</td>
<td>0</td>
<td>READ</td>
<td></td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td>119</td>
<td>87</td>
<td>1</td>
<td>READ</td>
<td></td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>120</td>
<td>87</td>
<td>1</td>
<td>WRITE</td>
<td>QC_5B</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>121</td>
<td>87</td>
<td>1</td>
<td>SELECT</td>
<td>QC_5B</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>122</td>
<td>87</td>
<td>1</td>
<td>OPERATE</td>
<td>QC_5B</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>123</td>
<td>87</td>
<td>1</td>
<td>DIRECT_OPERATE</td>
<td>QC_5B</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>124</td>
<td>87</td>
<td>1</td>
<td>DIRECT_OPERATE_NR</td>
<td>QC_5B</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>88</td>
<td>0-1</td>
<td>READ</td>
<td></td>
<td>-</td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x08</td>
</tr>
<tr>
<td>126</td>
<td>90</td>
<td>1</td>
<td>16</td>
<td>INITIALIZE_APPLICATION QC_5B</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>127</td>
<td>90</td>
<td>1</td>
<td>17</td>
<td>START_APPLICATION QC_5B</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>128</td>
<td>90</td>
<td>1</td>
<td>18</td>
<td>STOP_APPLICATION QC_5B</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>129</td>
<td>101</td>
<td>1-3</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>130</td>
<td>102</td>
<td>1</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x03</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x04</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>131</td>
<td>102</td>
<td>1</td>
<td>2</td>
<td>WRITE</td>
<td>1</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x03</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x04</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>132</td>
<td>110</td>
<td>128</td>
<td>1</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x03</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x04</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
</tbody>
</table>
### Table 1: Request messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>133</td>
<td>110</td>
<td>128</td>
<td>WRITE</td>
<td>variation</td>
<td>0x00</td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x03</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x04</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>134</td>
<td>110</td>
<td>128</td>
<td>ACTIVATE_CONFIGURATION</td>
<td>variation</td>
<td>0x5B</td>
<td></td>
</tr>
<tr>
<td>135</td>
<td>111</td>
<td>128</td>
<td>READ</td>
<td>-</td>
<td>0x06</td>
<td></td>
</tr>
<tr>
<td>136</td>
<td>112</td>
<td>128</td>
<td>WRITE</td>
<td>variation</td>
<td>0x00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x03</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x04</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x05</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
<td></td>
</tr>
<tr>
<td>137</td>
<td>113</td>
<td>0</td>
<td>READ</td>
<td>-</td>
<td>0x00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
<td></td>
</tr>
<tr>
<td>138</td>
<td>113</td>
<td>0</td>
<td>ASSIGN_CLASS</td>
<td>-</td>
<td>0x00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x06</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2: Response messages

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>139</td>
<td>0</td>
<td>209-239</td>
<td>RESPONSE</td>
<td>byte_2</td>
<td>0x00</td>
<td>0x17</td>
</tr>
<tr>
<td>140</td>
<td>0</td>
<td>240</td>
<td>RESPONSE</td>
<td>byte_2</td>
<td>0x00</td>
<td>0x17</td>
</tr>
<tr>
<td>141</td>
<td>0</td>
<td>241-243</td>
<td>RESPONSE</td>
<td>byte_2</td>
<td>0x00</td>
<td>0x17</td>
</tr>
<tr>
<td>142</td>
<td>0</td>
<td>245-247</td>
<td>RESPONSE</td>
<td>byte_2</td>
<td>0x00</td>
<td>0x17</td>
</tr>
<tr>
<td>143</td>
<td>0</td>
<td>248-250</td>
<td>RESPONSE</td>
<td>byte_2</td>
<td>0x00</td>
<td>0x17</td>
</tr>
<tr>
<td>144</td>
<td>0</td>
<td>252</td>
<td>RESPONSE</td>
<td>byte_2</td>
<td>0x00</td>
<td>0x17</td>
</tr>
<tr>
<td>145</td>
<td>0</td>
<td>255</td>
<td>RESPONSE</td>
<td>byte_2</td>
<td>0x00</td>
<td>0x17</td>
</tr>
<tr>
<td>146</td>
<td>1</td>
<td>1</td>
<td>RESPONSE</td>
<td>single_bit_packed</td>
<td>0x00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
<td></td>
</tr>
<tr>
<td>147</td>
<td>1</td>
<td>2</td>
<td>RESPONSE</td>
<td>1</td>
<td>0x00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2: Response messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>148</td>
<td>2</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>1</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>149</td>
<td>2</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>7</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>150</td>
<td>2</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>151</td>
<td>2</td>
<td>1</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>1</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>152</td>
<td>2</td>
<td>2</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>7</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>153</td>
<td>2</td>
<td>3</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>154</td>
<td>3</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>double_bit_packed</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>155</td>
<td>3</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>1</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>156</td>
<td>4</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>1</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>157</td>
<td>4</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>7</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>158</td>
<td>4</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>159</td>
<td>4</td>
<td>1</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>1</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>160</td>
<td>4</td>
<td>2</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>7</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>161</td>
<td>4</td>
<td>3</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>162</td>
<td>10</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>1</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>163</td>
<td>11</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>1</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>164</td>
<td>11</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>7</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>165</td>
<td>11</td>
<td>1</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>1</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>166</td>
<td>11</td>
<td>2</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>7</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>167</td>
<td>12</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
</tbody>
</table>
### Table 2: Response messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>168</td>
<td>12</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x07 0x08</td>
</tr>
<tr>
<td>169</td>
<td>12</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td></td>
<td>single_bit_packed 0x00 0x01</td>
</tr>
<tr>
<td>170</td>
<td>13</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>1</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>171</td>
<td>13</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>7</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>172</td>
<td>13</td>
<td>1</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>1</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>173</td>
<td>13</td>
<td>2</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>7</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>174</td>
<td>20</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>175</td>
<td>20</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>176</td>
<td>20</td>
<td>5</td>
<td>129</td>
<td>RESPONSE</td>
<td>4</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>177</td>
<td>20</td>
<td>6</td>
<td>129</td>
<td>RESPONSE</td>
<td>2</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>178</td>
<td>21</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>179</td>
<td>21</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>180</td>
<td>21</td>
<td>5</td>
<td>129</td>
<td>RESPONSE</td>
<td>4</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>181</td>
<td>21</td>
<td>6</td>
<td>129</td>
<td>RESPONSE</td>
<td>2</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>182</td>
<td>21</td>
<td>9</td>
<td>129</td>
<td>RESPONSE</td>
<td>4</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
</tbody>
</table>
Table 2: Response messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>183</td>
<td>21</td>
<td>10</td>
<td>129</td>
<td>RESPONSE</td>
<td>2</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>184</td>
<td>22</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>185</td>
<td>22</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>186</td>
<td>22</td>
<td>1</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>187</td>
<td>22</td>
<td>2</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>188</td>
<td>22</td>
<td>5</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>189</td>
<td>22</td>
<td>6</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>190</td>
<td>22</td>
<td>5</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>191</td>
<td>22</td>
<td>6</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>192</td>
<td>23</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>193</td>
<td>23</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>194</td>
<td>23</td>
<td>1</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>195</td>
<td>23</td>
<td>2</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>196</td>
<td>23</td>
<td>5</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>197</td>
<td>23</td>
<td>6</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>198</td>
<td>23</td>
<td>5</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>199</td>
<td>23</td>
<td>6</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>200</td>
<td>30</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>201</td>
<td>30</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>202</td>
<td>30</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td>4</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
</tbody>
</table>
### Table 2: Response messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>203</td>
<td>30</td>
<td>4</td>
<td>129</td>
<td>RESPONSE</td>
<td>2</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>204</td>
<td>30</td>
<td>5</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>205</td>
<td>30</td>
<td>6</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>206</td>
<td>31</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>207</td>
<td>31</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>208</td>
<td>31</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>209</td>
<td>31</td>
<td>4</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>210</td>
<td>31</td>
<td>5</td>
<td>129</td>
<td>RESPONSE</td>
<td>4</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>211</td>
<td>31</td>
<td>6</td>
<td>129</td>
<td>RESPONSE</td>
<td>2</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>212</td>
<td>31</td>
<td>7</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>213</td>
<td>31</td>
<td>8</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>214</td>
<td>32</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>215</td>
<td>32</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>216</td>
<td>32</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
</tbody>
</table>
### Table 2: Response messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>217</td>
<td>32</td>
<td>4</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>218</td>
<td>32</td>
<td>5</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>219</td>
<td>32</td>
<td>6</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>220</td>
<td>32</td>
<td>7</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>221</td>
<td>32</td>
<td>8</td>
<td>129</td>
<td>RESPONSE</td>
<td>15</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>222</td>
<td>32</td>
<td>1</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>223</td>
<td>32</td>
<td>2</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>224</td>
<td>32</td>
<td>3</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>225</td>
<td>32</td>
<td>4</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>226</td>
<td>32</td>
<td>5</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>227</td>
<td>32</td>
<td>6</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>228</td>
<td>32</td>
<td>7</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>229</td>
<td>32</td>
<td>8</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>15</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>230</td>
<td>33</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x17 0x18</td>
</tr>
<tr>
<td>231</td>
<td>33</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>232</td>
<td>33</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>233</td>
<td>33</td>
<td>4</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>234</td>
<td>33</td>
<td>5</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>235</td>
<td>33</td>
<td>6</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>236</td>
<td>33</td>
<td>7</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>237</td>
<td>33</td>
<td>8</td>
<td>129</td>
<td>RESPONSE</td>
<td>15</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>238</td>
<td>33</td>
<td>1</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>239</td>
<td>33</td>
<td>2</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>Index</td>
<td>Group no.</td>
<td>Variation</td>
<td>Function</td>
<td>Function name</td>
<td>Length</td>
<td>Qualifier</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
<td>-----------</td>
<td>----------</td>
<td>--------------------------</td>
<td>--------</td>
<td>-----------</td>
</tr>
<tr>
<td>240</td>
<td>33</td>
<td>3</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>11</td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>241</td>
<td>33</td>
<td>4</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>9</td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>242</td>
<td>33</td>
<td>5</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>5</td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>243</td>
<td>33</td>
<td>6</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>9</td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>244</td>
<td>33</td>
<td>7</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>11</td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>245</td>
<td>33</td>
<td>8</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>15</td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>246</td>
<td>34</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>2</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td>247</td>
<td>34</td>
<td>2-3</td>
<td>129</td>
<td>RESPONSE</td>
<td>4</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td>248</td>
<td>40</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>249</td>
<td>40</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>250</td>
<td>40</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>251</td>
<td>40</td>
<td>4</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>252</td>
<td>41</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>253</td>
<td>41</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>254</td>
<td>41</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>255</td>
<td>42</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
<tr>
<td>256</td>
<td>42</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x28</td>
</tr>
</tbody>
</table>
### Table 2: Response messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>257</td>
<td>42</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>258</td>
<td>42</td>
<td>4</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>259</td>
<td>42</td>
<td>5</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>260</td>
<td>42</td>
<td>6</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>261</td>
<td>42</td>
<td>7</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>262</td>
<td>42</td>
<td>8</td>
<td>129</td>
<td>RESPONSE</td>
<td>15</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>263</td>
<td>42</td>
<td>1</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>264</td>
<td>42</td>
<td>2</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>265</td>
<td>42</td>
<td>3</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>266</td>
<td>42</td>
<td>4</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>267</td>
<td>42</td>
<td>5</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>268</td>
<td>42</td>
<td>6</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>269</td>
<td>42</td>
<td>7</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>270</td>
<td>42</td>
<td>8</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>15</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>271</td>
<td>43</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>272</td>
<td>43</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>273</td>
<td>43</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>274</td>
<td>43</td>
<td>4</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>275</td>
<td>43</td>
<td>5</td>
<td>129</td>
<td>RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>276</td>
<td>43</td>
<td>6</td>
<td>129</td>
<td>RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>277</td>
<td>43</td>
<td>7</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>278</td>
<td>43</td>
<td>8</td>
<td>129</td>
<td>RESPONSE</td>
<td>15</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>279</td>
<td>43</td>
<td>1</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>Index</td>
<td>Group no.</td>
<td>Variation</td>
<td>Function</td>
<td>Function name</td>
<td>Length</td>
<td>Qualifier</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
<td>-----------</td>
<td>----------</td>
<td>------------------------</td>
<td>--------</td>
<td>-----------</td>
</tr>
<tr>
<td>280</td>
<td>43</td>
<td>2</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>3</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>281</td>
<td>43</td>
<td>3</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>282</td>
<td>43</td>
<td>4</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>283</td>
<td>43</td>
<td>5</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>5</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>284</td>
<td>43</td>
<td>6</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>9</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>285</td>
<td>43</td>
<td>7</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>11</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>286</td>
<td>43</td>
<td>8</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>15</td>
<td>0x17 0x28</td>
</tr>
<tr>
<td>287</td>
<td>50</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>6</td>
<td>0x07</td>
</tr>
<tr>
<td>288</td>
<td>50</td>
<td>4</td>
<td>129</td>
<td>RESPONSE</td>
<td>11</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>289</td>
<td>51</td>
<td>1-2</td>
<td>129</td>
<td>RESPONSE</td>
<td>6</td>
<td>0x07</td>
</tr>
<tr>
<td>290</td>
<td>51</td>
<td>1-2</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>6</td>
<td>0x07</td>
</tr>
<tr>
<td>291</td>
<td>52</td>
<td>1-2</td>
<td>129</td>
<td>RESPONSE</td>
<td>2</td>
<td>0x07</td>
</tr>
<tr>
<td>292</td>
<td>70</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
</tr>
<tr>
<td>293</td>
<td>70</td>
<td>4-7</td>
<td>129</td>
<td>RESPONSE</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
</tr>
<tr>
<td>294</td>
<td>70</td>
<td>4-7</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
</tr>
<tr>
<td>295</td>
<td>80</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>2</td>
<td>0x00 0x01</td>
</tr>
<tr>
<td>296</td>
<td>81</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>3</td>
<td>0x07</td>
</tr>
<tr>
<td>297</td>
<td>82</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
</tr>
<tr>
<td>298</td>
<td>82</td>
<td>1</td>
<td>130</td>
<td>RESPONSE</td>
<td>QC_5B_count_1</td>
<td>0x5B</td>
</tr>
<tr>
<td>299</td>
<td>83</td>
<td>1-2</td>
<td>129</td>
<td>RESPONSE</td>
<td>QC_5B</td>
<td>0x5B</td>
</tr>
<tr>
<td>300</td>
<td>83</td>
<td>1</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>QC_5B</td>
<td>0x5B</td>
</tr>
<tr>
<td>301</td>
<td>85</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>QC_5B</td>
<td>0x5B</td>
</tr>
<tr>
<td>302</td>
<td>86</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>QC_5B</td>
<td>0x5B</td>
</tr>
<tr>
<td>303</td>
<td>86</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>1</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>304</td>
<td>86</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td>QC_5B</td>
<td>0x5B</td>
</tr>
<tr>
<td>305</td>
<td>87</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>QC_5B</td>
<td>0x5B</td>
</tr>
<tr>
<td>306</td>
<td>88</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>QC_5B</td>
<td>0x5B</td>
</tr>
<tr>
<td>307</td>
<td>88</td>
<td>1</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE</td>
<td>QC_5B</td>
<td>0x5B</td>
</tr>
<tr>
<td>308</td>
<td>91</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>QC_5B</td>
<td>0x5B</td>
</tr>
</tbody>
</table>
Table 2: Response messages (cont.)

<table>
<thead>
<tr>
<th>Index</th>
<th>Group no.</th>
<th>Variation</th>
<th>Function</th>
<th>Function name</th>
<th>Length</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>309</td>
<td>101</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>2</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>310</td>
<td>101</td>
<td>2</td>
<td>129</td>
<td>RESPONSE</td>
<td>4</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>311</td>
<td>101</td>
<td>3</td>
<td>129</td>
<td>RESPONSE</td>
<td>8</td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>312</td>
<td>102</td>
<td>1</td>
<td>129</td>
<td>RESPONSE</td>
<td>1</td>
<td>0x00 0x01 0x03 0x04 0x05 0x17 0x28</td>
</tr>
<tr>
<td>313</td>
<td>110</td>
<td>128</td>
<td>129</td>
<td>RESPONSE variation</td>
<td></td>
<td>0x00 0x01 0x03 0x04 0x05 0x17 0x28</td>
</tr>
<tr>
<td>314</td>
<td>111</td>
<td>128</td>
<td>129</td>
<td>RESPONSE variation</td>
<td></td>
<td>0x00 0x01 0x03 0x04 0x05 0x17 0x28</td>
</tr>
<tr>
<td>315</td>
<td>111</td>
<td>128</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE variation</td>
<td></td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>316</td>
<td>113</td>
<td>128</td>
<td>129</td>
<td>RESPONSE</td>
<td></td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
<tr>
<td>317</td>
<td>113</td>
<td>128</td>
<td>130</td>
<td>UNSOLICITED_RESPONSE variation</td>
<td></td>
<td>0x00 0x01 0x17 0x28</td>
</tr>
</tbody>
</table>
4.4.4 Deep Packet Inspection - IEC104 Enforcer

This dialog lets you specify the IEC104 Enforcer settings and define the IEC104 Enforcer specific profiles.

The IEC104 protocol is a communication protocol used in the automation sector. The IEC104 protocol helps to transfer the IEC104 data packets between a control station (client) and a substation (server) using a TCP/IP network. The IEC104 Enforcer function activates the Deep Packet Inspection (DPI) firewall capabilities for the IEC104 data stream. The type IDs in the IEC104 protocol specify the purpose of the data transfer. The device blocks data packets that violate the specified profiles.

When a IEC104 Enforcer profile is active, the device applies the profile to the data stream.

The device permits only data packets containing the values specified in the following columns:

- Function type
- Advanced type ID list
- Originator address list
- Common address list

**Operation**

Uncommitted changes present

Displays if the IEC104 Enforcer profiles applied to the data stream differ from the profiles saved in the device.

When you click the button, the device applies the specified profiles.

Possible values:

- marked
  At least one of the active IEC104 Enforcer profiles saved in the device contains modified settings.
- unmarked
  The IEC104 Enforcer profiles applied to the data stream match the profiles saved in the device.
### Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

### Buttons

**Add**

Opens the Create window to add a table row.

- In the Index field, you specify the number of the profile.
  - Possible values: 1..32
  - When you click the Ok button, the device creates the new table row and assigns the number specified in the Index field to the table row.

**Remove**

Removes the selected table row.

If you mark the Profile active checkbox for the profile, then the device stops you from removing the profile.

**Copy**

Opens the Copy window to copy an existing table row. The prerequisite is that the table row for the profile to be copied is selected.

- In the Index field, you specify the new number of the copied profile.
  - Possible values: 1..32
  - The device creates the new table row and assigns the number specified in the Index field to the table row.

**Commit changes**

The device applies the specified profiles to the data stream.

If you changed the values in the Function type field, then the device assigns the specific values to the related profile.

### Index

Displays the sequential number of the profile to which the table row relates.

### Description

Specifies a name or description for the profile.

Possible values:

- Alphanumeric ASCII character string with 0..128 characters
  (default setting: `iec104`)
Function type

Specifies the function type for the IEC104 Enforcer profile. After clicking the ✓ button, the device assigns the corresponding type IDs.

Possible values:

- readOnly
  Assigns the type IDs for the read function.
  1,3,5,7,9,11,13,15,20,21,30-40,70,100-102

- readWrite
  Assigns the type IDs for the read/write functions.
  1,3,5,7,9,11,13,15,20,21,30-40,45-51,58-64,70,100-102

- common
  Assigns the type IDs for the common functions.
  1,3,5,7,9,11,13,15,20,21,30-40,45-51,58-64,70,100-102,110-113,120-127

- any (default setting)
  Assigns the type IDs for every function.
  1,2,..,254,255
  The device does not permit any subsequent changes in the Advanced type ID list column.

- advanced
  Lets you specify user-defined values in the Advanced type ID list column.

Advanced type ID list

Displays the advanced type IDs for the IEC104 Enforcer profile. The device permits data packets with the specified properties. The prerequisite is that you specify in the Function type column a value other than any.

The device lets you specify multiple Advanced type IDs. To do this, perform the following steps:

- For the relevant profile, click into the Advanced type ID list column.
  The dialog displays the Advanced type ID list window.
- In the Advanced type ID list drop-down list, select the desired type ID item.
- Click the Add button.
- To add multiple type IDs, repeat the previously described steps.
- Click the Ok button.

Possible values:

- 0..255
  You find the meaning of the numbers in section “Meaning of the Advanced type ID list values” on page 164.

Originator address list

Specifies the addresses from which data packets originated. The prerequisite is that you specify in the Cause of transmission size column the value 2.

Possible values:

- <empty> (default setting)
  The device permits data packets from any originator address.
- 0..255
  The device permits data packets with the specified originator address.
Common address list

Specifies the addresses to which the device forwards the IEC104 data packets.

Possible values:
- **0..255**
  The device permits data packets with the specified common address. The prerequisite is that you specify in the Common address size column the value 1.
- **0..65535**
  The device permits data packets with the specified common address. The prerequisite is that you specify in the Common address size column the value 2.

Cause of transmission size

Specifies the size in octets that defines the variation of the respective fields in the data packets. The device performs the DPI function based on these settings.

Possible values:
- **1**
  The data packets do not contain an originator address.
- **2** (default setting)
  The data packets contain an originator address.

Common address size

Specifies the size in octets of the common address to which the device forwards the IEC104 data packets. This setting affects the setting in the Common address list column.

Possible values:
- **1**
- **2** (default setting)

IO address size

Specifies the size in octets of the information object address.

Possible values:
- **1**
- **2**
- **3** (default setting)

Allow IEC_60870_5_101

Activates/deactivates the type IDs defined in the IEC101 specification.

Possible values:
- **marked**
  The type IDs defined in the IEC101 specification are active. The device permits the type ID values 2, 4, 6, 8, 10, 12, 14, 16, 17, 18, 19, 103, 104, 105, 106 along with the type IDs based on the values specified in the Function type column or Advanced type ID list column.
- **unmarked** (default setting)
  The type IDs defined in the IEC101 specification are inactive. The device permits only the type ID values based on the values specified in the Function type or Advanced type ID list column.
### Sanity check

Activates/deactivates the plausibility check for the data packets.

**Possible values:**
- **marked** (default setting)
  - The plausibility check is active.
  - The device checks the plausibility of the data packets regarding format and specification. The device blocks data packets that violate the specified profiles.
- **unmarked**
  - The plausibility verification is inactive.

### TCP reset

Activates/deactivates the resetting of the TCP connection in case of a protocol violation or if the plausibility check detects an error.

**Possible values:**
- **marked** (default setting)
  - The resetting of the TCP connection is active.
  - If the device identifies a protocol violation or detects a plausibility check error, then the device terminates the TCP connection. The device establishes the TCP connection again on receiving a new request.
- **unmarked**
  - The resetting of the TCP connection is inactive.

### Debug

Activates/deactivates the debugging of the profiles.

**Possible values:**
- **marked**
  - Debugging is active.
  - The device sends the reset packet along with the information related to the termination of TCP connection. The prerequisite is that you mark the checkbox in the **TCP reset** column.
- **unmarked** (default setting)
  - Debugging is inactive.

### Profile active

Activates/deactivates the profile.

**Possible values:**
- **marked**
  - The profile is active.
  - The device applies the **IEC104 Enforcer** profiles specified in this table row to the data packets.
- **unmarked**
  - The profile is inactive.
[Advanced type ID list]

Advanced type ID list

Specifies the Advanced type IDs for the relevant IEC104 Enforcer profile.

You find the meaning of the numbers in section "Meaning of the Advanced type ID list values" on page 164.

Add

Adds the items you selected in the drop-down list to the Advanced type ID list field.

Removes the item from the Advanced type ID list field.

Meaning of the Advanced type ID list values

<table>
<thead>
<tr>
<th>#</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single point information M_SP NA_1</td>
</tr>
<tr>
<td>2</td>
<td>Single point information with time tag M_SP TA_1</td>
</tr>
<tr>
<td>3</td>
<td>Double point information M_DP NA_1</td>
</tr>
<tr>
<td>4</td>
<td>Double point information with time tag M_DP TA_1</td>
</tr>
<tr>
<td>5</td>
<td>Step position information M_ST NA_1</td>
</tr>
<tr>
<td>6</td>
<td>Step position information with time tag M_ST TA_1</td>
</tr>
<tr>
<td>7</td>
<td>Bit string of 32 bit M_BO NA_1</td>
</tr>
<tr>
<td>8</td>
<td>Bit string of 32 bit with time tag M_BO TA_1</td>
</tr>
<tr>
<td>9</td>
<td>Measured value, normalized value M_ME NA_1</td>
</tr>
<tr>
<td>10</td>
<td>Measured value, normalized value with time tag M_ME TA_1</td>
</tr>
<tr>
<td>11</td>
<td>Measured value, scaled value M_ME NB_1</td>
</tr>
<tr>
<td>12</td>
<td>Measured value, scaled value with time tag M_ME TB_1</td>
</tr>
<tr>
<td>13</td>
<td>Measured value, short floating point value M_ME NC_1</td>
</tr>
<tr>
<td>14</td>
<td>Measured value, short floating point value with time tag M_ME TC_1</td>
</tr>
<tr>
<td>15</td>
<td>Integrated totals M_IT NA_1</td>
</tr>
<tr>
<td>16</td>
<td>Integrated totals with time tag M_IT TA_1</td>
</tr>
<tr>
<td>17</td>
<td>Event of protection equipment with time tag M_EP TA_1</td>
</tr>
<tr>
<td>18</td>
<td>Packed start events of protection equipment with time tag M_EP TB_1</td>
</tr>
<tr>
<td>19</td>
<td>Packed output circuit information of protection equipment with time tag M_EP TC_1</td>
</tr>
<tr>
<td>20</td>
<td>Packed single-point information with status change detection M_PS NA_1</td>
</tr>
<tr>
<td>21</td>
<td>Measured value, normalized value without quality descriptor M_ME ND_1</td>
</tr>
<tr>
<td>30</td>
<td>Single point information with time tag CP56Time2a M_SP TB_1</td>
</tr>
<tr>
<td>31</td>
<td>Double point information with time tag CP56Time2a M_DP TB_1</td>
</tr>
<tr>
<td>32</td>
<td>Step position information with time tag CP56Time2a M_ST TB_1</td>
</tr>
<tr>
<td>33</td>
<td>Bit string of 32 bit with time tag CP56Time2a M_BO TB_1</td>
</tr>
<tr>
<td>34</td>
<td>Measured value, normalized value with time tag CP56Time2a M_ME TD_1</td>
</tr>
<tr>
<td>35</td>
<td>Measured value, scaled value with time tag CP56Time2a M_ME TE_1</td>
</tr>
<tr>
<td>#</td>
<td>Meaning</td>
</tr>
<tr>
<td>----</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>36</td>
<td>Measured value, short floating point value with time tag CP56Time2a</td>
</tr>
<tr>
<td></td>
<td>M_NE_TF_1</td>
</tr>
<tr>
<td>37</td>
<td>Integrated totals with time tag CP56Time2a M_IT_TB_1</td>
</tr>
<tr>
<td>38</td>
<td>Event of protection equipment with time tag CP56Time2a M_EP_TD_1</td>
</tr>
<tr>
<td>39</td>
<td>Packed start events of protection equipment with time tag CP56time2a</td>
</tr>
<tr>
<td></td>
<td>M_EP_TE_1</td>
</tr>
<tr>
<td>40</td>
<td>Packed output circuit information of protection equipment with time tag</td>
</tr>
<tr>
<td></td>
<td>CP56Time2a M_EP_TF_1</td>
</tr>
<tr>
<td>45</td>
<td>Single command C_SC_NA_1</td>
</tr>
<tr>
<td>46</td>
<td>Double command C_DC_NA_1</td>
</tr>
<tr>
<td>47</td>
<td>Regulating step command C_RC_NA_1</td>
</tr>
<tr>
<td>48</td>
<td>Setpoint command, normalized value C_SE_NA_1</td>
</tr>
<tr>
<td>49</td>
<td>Setpoint command, scaled value C_SE_NB_1</td>
</tr>
<tr>
<td>50</td>
<td>Setpoint command, short floating point value C_SE_NC_1e</td>
</tr>
<tr>
<td>51</td>
<td>Bit string 32 bit C_BO_NA_1</td>
</tr>
<tr>
<td>52</td>
<td>Single command with time tag CP56Time2a C_SC_TA_1</td>
</tr>
<tr>
<td>53</td>
<td>Double command with time tag CP56Time2a C_DC_TA_1</td>
</tr>
<tr>
<td>54</td>
<td>Regulating step command with time tag CP56Time2a C_RC_TA_1</td>
</tr>
<tr>
<td>55</td>
<td>Setpoint command, normalized value with time tag CP56Time2a C_SE_TA_1</td>
</tr>
<tr>
<td>56</td>
<td>Setpoint command, scaled value with time tag CP56Time2a C_SE_TB_1</td>
</tr>
<tr>
<td>57</td>
<td>Setpoint command, short floating point value with time tag CP56Time2a</td>
</tr>
<tr>
<td></td>
<td>C_SE_TC_1</td>
</tr>
<tr>
<td>58</td>
<td>Bit string 32 bit with time tag CP56Time2a C_BO_TA_1</td>
</tr>
<tr>
<td>59</td>
<td>End of initialization M_EI_NA_1</td>
</tr>
<tr>
<td>60</td>
<td>(General-) Interrogation command C_IC_NA_1</td>
</tr>
<tr>
<td>61</td>
<td>Counter interrogation command C_CI_NA_1</td>
</tr>
<tr>
<td>62</td>
<td>Read command C_RD_NA_1</td>
</tr>
<tr>
<td>63</td>
<td>Clock synchronization command C_CS_NA_1</td>
</tr>
<tr>
<td>64</td>
<td>( IEC 101 ) Test command C_TS_NB_1</td>
</tr>
<tr>
<td>65</td>
<td>Reset process command C_RP_NC_1</td>
</tr>
<tr>
<td>66</td>
<td>( IEC 101 ) Delay acquisition command C_CD_NA_1</td>
</tr>
<tr>
<td>67</td>
<td>Test command with time tag CP56Time2a C_TS_TA_1</td>
</tr>
<tr>
<td>68</td>
<td>Parameter of measured value, normalized value P_ME_NA_1</td>
</tr>
<tr>
<td>69</td>
<td>Parameter of measured value, scaled value P_ME_NB_1</td>
</tr>
<tr>
<td>70</td>
<td>Parameter of measured value, short floating point value P_ME_NC_1</td>
</tr>
<tr>
<td>71</td>
<td>Parameter activation P_AC_NA_1</td>
</tr>
<tr>
<td>72</td>
<td>File ready F_FR_NA_1</td>
</tr>
<tr>
<td>73</td>
<td>Section ready F_SR_NA_1</td>
</tr>
<tr>
<td>74</td>
<td>Call directory, select file, call file, call section F_SC_NA_1</td>
</tr>
<tr>
<td>75</td>
<td>Last section, last segment F_LS_NA_1</td>
</tr>
<tr>
<td>76</td>
<td>Ack file, Ack section F_AP_NA_1</td>
</tr>
<tr>
<td>77</td>
<td>Segment F_SG_NA_1</td>
</tr>
<tr>
<td>78</td>
<td>F_DR_TA_1</td>
</tr>
<tr>
<td>79</td>
<td>QueryLog – Request archive file F_SC_NB_1</td>
</tr>
</tbody>
</table>
4.4.5 Deep Packet Inspection - ENIP Enforcer

This dialog lets you specify the ENIP Enforcer (Ethernet Industrial Protocol Enforcer) settings and define the ENIP Enforcer specific profiles.

The ENIP protocol is part of the CIP protocol (Common Industrial Protocol). The CIP protocol defines the object structure and specifies the message transfer. The ENIP Enforcer function applies the Deep Packet Inspection (DPI) function to the ENIP and CIP data stream. The ENIP protocol is used to monitor and control industrial automation equipment such as PLCs (Programmable Logic Controllers), sensors, and meters.

The device uses the ENIP Enforcer function to perform the DPI function on the data stream. The device performs the DPI function based on the values defined in the specified profiles. The device blocks data packets that violate the specified profiles.

When the ENIP Enforcer profile is active, the device applies the profile to the data stream. The device permits only data packets containing the values specified in the following columns:

- Function type
- Sanity check
- Default object list
- Wildcard service codes
- Allow embedded PCCC (Programmable Controller Communication Commands)

The menu contains the following dialogs:
- ENIP Profile
- ENIP Object
4.4.5.1 ENIP Profile

In this dialog you specify the global settings for the ENIP Enforcer profile.

**Operation**

**Uncommitted changes present**

Displays if the ENIP Enforcer profiles applied to the data stream differ from the profiles saved in the device.

Possible values:

- **marked**
  At least one of the active ENIP Enforcer profiles saved in the device contains modified settings.
  When you click the button, the device applies the specified profiles.

- **unmarked**
  The ENIP Enforcer profiles applied to the data stream match the profiles saved in the device.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- **Add**
  Opens the Create window to add a table row.
  In the Index field, you specify the number of the profile.
  Possible values:
  - 1..32
  When you click the Ok button, the device creates the new table row and assigns the number specified in the Index field to the table row.

- **Remove**
  Removes the selected table row.

If you mark the Profile active checkbox for the profile, then the device stops you from removing the profile.
Copy

Opens the Copy window to copy an existing table row. The prerequisite is that the table row for the profile to be copied is selected.

- In the Index field, you specify the new number of the copied profile.
  Possible values:
  - 1..32
    The device creates the new table row and assigns the number specified in the Index field to the table row.

Commit changes

The device applies the specified profiles to the data stream.

If you changed the values in the Function type field, then the device assigns the specific values to the related profile.

Index

Displays the sequential number of the profile to which the table row relates.

Description

Specifies a name or description for the profile.

Possible values:
- Alphanumeric ASCII character string with 0..32 characters
  (default setting: enip)

Function type

Specifies the function type for the ENIP Enforcer profile. After clicking the button, the device assigns the corresponding class IDs and service codes.

Possible values:
- readonly
  Assigns the class IDs for the read function.
  You find the list of the readonly class IDs in section "[List of the class IDs for function type readonly]" on page 181.
- readwrite
  Assigns the class IDs for the read/write functions.
  You find the list of the read/write class IDs in section "[List of the class IDs for function type readwrite]" on page 186.
- any (default setting)
  Assigns the class IDs for every function. You cannot specify user-defined class IDs through the ENIP Object value if the function type is any.
- advanced
  Lets you specify user-defined class IDs.
Allow embedded PCCC

Activates/deactivates DPI for PCCC messages encapsulated in data packets. PCCC messages are embedded within the ENIP protocol. Activating this setting is useful when securing network traffic to and from PLC-5 and MicroLogix controllers.

Possible values:
- **marked**: DPI for PCCC messages is active.
- **unmarked**: (default setting) DPI for PCCC messages is inactive.

Sanity check

Activates/deactivates the plausibility check for the data packets.

Possible values:
- **marked**: (default setting) The plausibility check is active. The device checks the plausibility of the data packets with regards to format and specification. The device blocks data packets that violate the specified profiles.
- **unmarked**: The plausibility check is inactive.

TCP reset

Activates/deactivates the resetting of the TCP connection in case of a protocol violation or if the plausibility check detects an error.

Possible values:
- **marked**: (default setting) The resetting of the TCP connection is active. If the device identifies a protocol violation or detects a plausibility check error, then the device terminates the TCP connection. The device establishes the TCP connection again on receiving a new connection request.
- **unmarked**: The resetting of the TCP connection is inactive.

Debug

Activates/deactivates the debugging of the profiles.

Possible values:
- **marked**: Debugging is active. The device sends the reset packet along with the information related to the termination of TCP connection. The prerequisite is that you mark the checkbox in the TCP reset column.
- **unmarked**: (default setting) Debugging is inactive.
Default object list

Specifies the index numbers used in the default object list.

Possible values:

- **all**
  The device applies the ENIP Enforcer profile to every data packet regardless of the index number.

- **1..347**
  The device applies the ENIP Enforcer profile only to data packets containing class IDs and service codes in the specified index number.

  The field lets you specify the following options:
  - You specify a single index number with a single numerical value. Example: 1.
  - You specify multiple index numbers with numerical values separated by a comma. Example: 1, 2, 3.
  - You specify an index number range with numerical values connected by a dash. Example: 7-25.
  - You can also combine index numbers and index number ranges. Example: 2, 7-25, 56.

  The field lets you specify up to 347 numerical values. When you enter 2, 7-25, 56, for example, you use 4 of 347 numerical values.

  You find the list of the class IDs and corresponding service codes in section “[Default object list]” on page 172.

- **none** (default setting)
  The device does not apply the index number to the ENIP Enforcer profile.

Wildcard service codes

Specifies the service codes which device permits with any valid class IDs.

Possible values:

- **0x00..0x7F**
  The device applies the profile only to data packets that contain the specified service codes.

  The field lets you specify the following options:
  - You specify a service list with a single hexadecimal value. Example: 0x00.
  - You specify multiple individual service codes with comma-separated hexadecimal values.
    Example: 0x02, 0x03, 0x04, 0x05.

  The field lets you specify up to 128 hexadecimal values. When you enter 0x02, 0x03, 0x04, 0x05, for example, you use 4 of 128 hexadecimal values.

Profile active

Activates/deactivates the profile.

Possible values:

- **marked**
  The profile is active.

  The device applies the ENIP Enforcer profiles specified in this table row to the data packets.

- **unmarked** (default setting)
  The profile is inactive.
4.4.5.2 ENIP Object

The ENIP function uses objects to transmit values and information between devices. The ENIP function uses class IDs and service codes to specify how the data within the object is encoded. Each instance of an encoded information element that defines a unique class ID and a unique service code in a message, is an ENIP object.

This window lets you create custom ENIP objects and also lets you view the previously created custom ENIP objects. To verify that a created ENIP object is valid, check the following parameters:

- Class ID
- Service codes

**Table**

For information on how to customize the appearance of the table, see "Working with tables" on page 16.

**Buttons**

**Add**

Opens the Create window to add a table row.

- In the Index field, you select the index number of the profile from the drop-down list.
- In the Class ID field, you specify the user-defined class IDs.
  Possible values:
  - 0x00..0xFFFFFFFF
- In the Service codes field, you specify the service codes.
  Possible values:
  - 0x00..0x7f

When you click the Ok button, the device creates the new table row. The device assigns the values specified in the Index, Class ID and Service codes fields to this table row.

**Remove**

Removes the selected table row.

**Index**

Displays the number of the profile to which the table row relates.
**Class ID**

Specifies the user-defined *class IDs* for the *ENIP Enforcer* profile.

Possible values:
- 0x00..0xFFFFFFFF

**Service codes**

Specifies the *service codes*.

Possible values:
- 0x00..0x7F
  
  The device applies the profile only to data packets that contain the specified *service codes*. The field lets you specify the following options:
  - You specify a service list with a single hexadecimal value. Example: 0x00.
  - You specify multiple individual *service codes* with comma-separated hexadecimal values. Example: 0x02,0x03,0x04,0x05.
  
  The field lets you specify up to 128 hexadecimal values. When you enter 0x02,0x03,0x04,0x05, for example, you use 4 of 128 hexadecimal values.

**Description**

Displays the name of the object.

### [Default object list]

<table>
<thead>
<tr>
<th>Index</th>
<th>Class ID</th>
<th>Service codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0x01</td>
<td>0x01=Get Attributes All</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>0x05=Reset</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0x0E=Get Attribute Signal</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0x10=Set Attribute Signal</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>0x11=Find Next Object Instance</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>0x18=Get Member</td>
</tr>
<tr>
<td>7</td>
<td>0x02</td>
<td>0x01=Get Attributes All</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>0x0E=Get Attribute Single</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>0x4B=Write Data Table (Rockwell)</td>
</tr>
<tr>
<td>10</td>
<td>0x04</td>
<td>0x08=Create</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>0x09=Delete</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>0x0E=Get Attribute Single</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>0x10=Set Attribute Single</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>0x18=Get Member</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>0x19=Set Member</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>0x1A=Insert Member</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>0x1B=Remove Member</td>
</tr>
<tr>
<td>Index</td>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>18</td>
<td>0x05 = Connection</td>
<td>0x05 = Reset</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>0x08 = Create</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>0x09 = Delete</td>
</tr>
<tr>
<td>21</td>
<td></td>
<td>0x0D = Apply Attributes</td>
</tr>
<tr>
<td>22</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>23</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>0x11 = Find Next Object Instance</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>0x4B = Connection Bind</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>0x4C = Production Application Lookup</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>0x4E = Safety Close</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>0x54 = Safety Open</td>
</tr>
<tr>
<td>29</td>
<td>0x06 = Off-Link Connection Manager</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>0x02 = Set Attributes All</td>
</tr>
<tr>
<td>31</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>33</td>
<td></td>
<td>0x4E = Forward Close</td>
</tr>
<tr>
<td>34</td>
<td></td>
<td>0x52 = Unconnected Send</td>
</tr>
<tr>
<td>35</td>
<td></td>
<td>0x54 = Forward Open</td>
</tr>
<tr>
<td>36</td>
<td></td>
<td>0x56 = Get Connection Data</td>
</tr>
<tr>
<td>37</td>
<td></td>
<td>0x57 = Search Connection Data</td>
</tr>
<tr>
<td>38</td>
<td></td>
<td>0x5A = Get Connection Owner</td>
</tr>
<tr>
<td>39</td>
<td></td>
<td>0x5B = Large Forward Open</td>
</tr>
<tr>
<td>40</td>
<td>0x07 = Register</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>41</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>42</td>
<td>0x08 = Discrete Input Point</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>43</td>
<td></td>
<td>0x02 = Set Attributes All</td>
</tr>
<tr>
<td>44</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>46</td>
<td>0x09 = Discrete Output Point</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>47</td>
<td></td>
<td>0x02 = Set Attributes All</td>
</tr>
<tr>
<td>48</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>49</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>50</td>
<td>0x0A = Analog Input Point</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>51</td>
<td></td>
<td>0x02 = Set Attributes All</td>
</tr>
<tr>
<td>52</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>53</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>54</td>
<td>0x0B = Analog Output Point</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>55</td>
<td></td>
<td>0x02 = Set Attributes All</td>
</tr>
<tr>
<td>56</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>57</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>58</td>
<td>0x0E = Presence Sensing</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>59</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>Index</td>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>60</td>
<td>0x0F = Parameter</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x05 = Reset</td>
</tr>
<tr>
<td>62</td>
<td>0x10 = Parameter Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>63</td>
<td>0x11 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>64</td>
<td>0x12 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>65</td>
<td>0x13 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>66</td>
<td>0x14 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>67</td>
<td>0x15 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>68</td>
<td>0x16 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>69</td>
<td>0x17 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>70</td>
<td>0x18 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>71</td>
<td>0x19 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>72</td>
<td>0x1A = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>73</td>
<td>0x1B = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>74</td>
<td>0x1C = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>75</td>
<td>0x1D = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>76</td>
<td>0x1E = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>77</td>
<td>0x1F = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>78</td>
<td>0x20 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>79</td>
<td>0x21 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>80</td>
<td>0x22 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>81</td>
<td>0x23 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>82</td>
<td>0x24 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>83</td>
<td>0x25 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>84</td>
<td>0x26 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>85</td>
<td>0x27 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>86</td>
<td>0x28 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>87</td>
<td>0x29 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>88</td>
<td>0x2A = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>89</td>
<td>0x2B = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>90</td>
<td>0x2C = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>91</td>
<td>0x2D = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>92</td>
<td>0x2E = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>93</td>
<td>0x2F = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>94</td>
<td>0x30 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>95</td>
<td>0x31 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>96</td>
<td>0x32 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>97</td>
<td>0x33 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>98</td>
<td>0x34 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>99</td>
<td>0x35 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>100</td>
<td>0x36 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>101</td>
<td>0x37 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>102</td>
<td>0x38 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x06 = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x07 = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x08 = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x09 = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x0A = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x0B = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x0C = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x0D = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x0F = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x11 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x12 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x13 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x14 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x15 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x16 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x17 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x18 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x19 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x1A = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x1B = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x1C = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x1D = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x1E = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x1F = Set Attribute Single</td>
</tr>
</tbody>
</table>

Note: The table lists the Class ID and Service codes for various objects and groups in the RM GUI EAGLE20/30 Release 4.3 03/2022.
<table>
<thead>
<tr>
<th>Index</th>
<th>Class ID</th>
<th>Service codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>0x24 = Position Controller Supervisor Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>104</td>
<td>0x25 = Position Controller Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>105</td>
<td>0x26 = Block Sequencer Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>106</td>
<td>0x27 = Command Block Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>107</td>
<td>0x28 = Motor Data Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>108</td>
<td>0x29 = Control Supervisor Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>109</td>
<td>0x30 = AC/DC Drive Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>110</td>
<td>0x31 = Motor Control Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>111</td>
<td>0x32 = Motor Data Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>112</td>
<td>0x33 = Control Supervisor Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>113</td>
<td>0x34 = Softstart Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>114</td>
<td>0x35 = Softstart Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>115</td>
<td>0x36 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>116</td>
<td>0x37 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>117</td>
<td>0x38 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>118</td>
<td>0x39 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>119</td>
<td>0x3A = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>120</td>
<td>0x3B = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>121</td>
<td>0x3C = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>122</td>
<td>0x3D = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>123</td>
<td>0x3E = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>124</td>
<td>0x3F = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>125</td>
<td>0x40 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>126</td>
<td>0x41 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>127</td>
<td>0x42 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>128</td>
<td>0x43 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>129</td>
<td>0x44 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>130</td>
<td>0x45 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>131</td>
<td>0x46 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>132</td>
<td>0x47 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>133</td>
<td>0x48 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>134</td>
<td>0x49 = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>135</td>
<td>0x4A = Overload Object</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>Index</td>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>136</td>
<td>0x2E = Selection Object</td>
<td>0x05 = Reset 0x06 = Start 0x07 = Stop 0x08 = Create 0x09 = Delete</td>
</tr>
<tr>
<td>137</td>
<td></td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>140</td>
<td>0x18 = Get Member</td>
<td>0x19 = Set Member 0x1A = Insert Member 0x1B = Remove Member</td>
</tr>
<tr>
<td>141</td>
<td></td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>142</td>
<td>0x18 = Get Member</td>
<td>0x19 = Set Member 0x1A = Insert Member 0x1B = Remove Member</td>
</tr>
<tr>
<td>144</td>
<td></td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>145</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>146</td>
<td>0x18 = Get Member</td>
<td>0x19 = Set Member 0x1A = Insert Member 0x1B = Remove Member</td>
</tr>
<tr>
<td>147</td>
<td>0x05 = Reset 0x06 = Start 0x07 = Stop 0x08 = Create 0x09 = Delete</td>
<td></td>
</tr>
<tr>
<td>148</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>149</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>151</td>
<td>0x4B = Abort 0x4C = Recover 0x4E = Perform Diagnostics</td>
<td></td>
</tr>
<tr>
<td>152</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>153</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>154</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>155</td>
<td>0x01 = Get Attributes All 0x0E = Get Attribute Single 0x4B = Zero Adjust 0x4C = Gain Adjust</td>
<td></td>
</tr>
<tr>
<td>156</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>157</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>158</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>159</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>160</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>161</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>162</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>163</td>
<td>0x63 = Calibrate</td>
<td>0x4B = Get All Instances</td>
</tr>
<tr>
<td>164</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>165</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>166</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>167</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>168</td>
<td>0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
<td></td>
</tr>
<tr>
<td>Index</td>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>169</td>
<td>0x37 = File Object</td>
<td>0x06 = Start</td>
</tr>
<tr>
<td>170</td>
<td></td>
<td>0x07 = Stop</td>
</tr>
<tr>
<td>171</td>
<td></td>
<td>0x08 = Create</td>
</tr>
<tr>
<td>172</td>
<td></td>
<td>0x09 = Delete</td>
</tr>
<tr>
<td>173</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>174</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>175</td>
<td></td>
<td>0x15 = Restore</td>
</tr>
<tr>
<td>176</td>
<td></td>
<td>0x16 = Save</td>
</tr>
<tr>
<td>177</td>
<td></td>
<td>0x18 = Get Member</td>
</tr>
<tr>
<td>178</td>
<td></td>
<td>0x4B = Initiate Upload</td>
</tr>
<tr>
<td>179</td>
<td></td>
<td>0x4C = Initiate Download</td>
</tr>
<tr>
<td>180</td>
<td></td>
<td>0x4D = Initiate Partial Read</td>
</tr>
<tr>
<td>181</td>
<td></td>
<td>0x4E = Initiate Partial Write</td>
</tr>
<tr>
<td>182</td>
<td></td>
<td>0x4F = Upload Transfer</td>
</tr>
<tr>
<td>183</td>
<td></td>
<td>0x50 = Download Transfer</td>
</tr>
<tr>
<td>184</td>
<td></td>
<td>0x51 = Clear File</td>
</tr>
<tr>
<td>185</td>
<td>0x38 = S-Partial Pressure Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>186</td>
<td></td>
<td>0x08 = Create</td>
</tr>
<tr>
<td>187</td>
<td></td>
<td>0x09 = Delete</td>
</tr>
<tr>
<td>188</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>189</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>190</td>
<td></td>
<td>0x4B = Create Range</td>
</tr>
<tr>
<td>191</td>
<td></td>
<td>0x4C = Get Instance List</td>
</tr>
<tr>
<td>192</td>
<td></td>
<td>0x4D = Get Pressures</td>
</tr>
<tr>
<td>193</td>
<td></td>
<td>0x4E = Get All Pressures</td>
</tr>
<tr>
<td>194</td>
<td></td>
<td>0x4F = Group Enable</td>
</tr>
<tr>
<td>195</td>
<td>0x40 = S-Sensor Calibration Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>196</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>197</td>
<td></td>
<td>0x4B = Get all Instances</td>
</tr>
<tr>
<td>198</td>
<td>0x41 = Event Log Object</td>
<td>0x05 = Reset</td>
</tr>
<tr>
<td>199</td>
<td></td>
<td>0x06 = Start</td>
</tr>
<tr>
<td>200</td>
<td></td>
<td>0x07 = Stop</td>
</tr>
<tr>
<td>201</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>202</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>203</td>
<td></td>
<td>0x18 = Get Member</td>
</tr>
<tr>
<td>204</td>
<td></td>
<td>0x19 = Set Member</td>
</tr>
<tr>
<td>205</td>
<td></td>
<td>0x1A = Insert Member</td>
</tr>
<tr>
<td>206</td>
<td></td>
<td>0x1B = Remove Member</td>
</tr>
<tr>
<td>Index</td>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>207</td>
<td>0x42</td>
<td>0x03 = Get Attribute List</td>
</tr>
<tr>
<td>208</td>
<td>0x03</td>
<td>0x04 = Set Attribute List</td>
</tr>
<tr>
<td>209</td>
<td>0x0E</td>
<td>0x10 = Get Attribute Single</td>
</tr>
<tr>
<td>210</td>
<td>0x10</td>
<td>0x1C = GroupSync</td>
</tr>
<tr>
<td>211</td>
<td>0x4B</td>
<td>0x4C = Set Attribute List</td>
</tr>
<tr>
<td>212</td>
<td>0x4C</td>
<td>0x4D = Set Cyclic Write List</td>
</tr>
<tr>
<td>213</td>
<td>0x4E</td>
<td>0x4F = Set Cyclic Read List</td>
</tr>
<tr>
<td>214</td>
<td>0x50</td>
<td>0x51 = Run Motor Test</td>
</tr>
<tr>
<td>215</td>
<td>0x51</td>
<td>0x52 = Get Motor Test Data</td>
</tr>
<tr>
<td>216</td>
<td>0x52</td>
<td>0x53 = Run Inertia Test</td>
</tr>
<tr>
<td>217</td>
<td>0x53</td>
<td>0x54 = Get Inertia Test Data</td>
</tr>
<tr>
<td>218</td>
<td>0x54</td>
<td>0x55 = Run Hookup Test</td>
</tr>
<tr>
<td>219</td>
<td>0x55</td>
<td>0x56 = Get Hookup Test Data</td>
</tr>
<tr>
<td>220</td>
<td>0x56</td>
<td>0x57 = Get Attributes All</td>
</tr>
<tr>
<td>221</td>
<td>0x57</td>
<td>0x58 = Get Attribute List</td>
</tr>
<tr>
<td>222</td>
<td>0x58</td>
<td>0x59 = Set Attribute List</td>
</tr>
<tr>
<td>223</td>
<td>0x59</td>
<td>0x5E = Get Attribute Single</td>
</tr>
<tr>
<td>224</td>
<td>0x5E</td>
<td>0x60 = Set Attribute Single</td>
</tr>
<tr>
<td>225</td>
<td>0x60</td>
<td>0x61 = GroupSync</td>
</tr>
<tr>
<td>226</td>
<td>0x61</td>
<td>0x62 = Get Attribute List</td>
</tr>
<tr>
<td>227</td>
<td>0x62</td>
<td>0x63 = Set Attribute List</td>
</tr>
<tr>
<td>228</td>
<td>0x63</td>
<td>0x64 = Get Attribute Single</td>
</tr>
<tr>
<td>229</td>
<td>0x64</td>
<td>0x65 = Set Attribute List</td>
</tr>
<tr>
<td>230</td>
<td>0x65</td>
<td>0x66 = Get Attribute Single</td>
</tr>
<tr>
<td>231</td>
<td>0x66</td>
<td>0x67 = Set Attribute List</td>
</tr>
<tr>
<td>232</td>
<td>0x67</td>
<td>0x68 = Get Attribute Single</td>
</tr>
<tr>
<td>233</td>
<td>0x68</td>
<td>0x69 = Set Attribute List</td>
</tr>
<tr>
<td>234</td>
<td>0x69</td>
<td>0x6A = Get Attribute Single</td>
</tr>
<tr>
<td>235</td>
<td>0x6A</td>
<td>0x6B = Get Attribute Single</td>
</tr>
<tr>
<td>236</td>
<td>0x6B</td>
<td>0x6C = Get Attribute Single</td>
</tr>
<tr>
<td>237</td>
<td>0x6C</td>
<td>0x6D = Get Attribute Single</td>
</tr>
<tr>
<td>238</td>
<td>0x6D</td>
<td>0x6E = Get Attribute Single</td>
</tr>
<tr>
<td>239</td>
<td>0x6E</td>
<td>0x6F = Get Attribute Single</td>
</tr>
<tr>
<td>240</td>
<td>0x6F</td>
<td>0x70 = Get Attribute Single</td>
</tr>
<tr>
<td>241</td>
<td>0x70</td>
<td>0x71 = Get Attribute Single</td>
</tr>
<tr>
<td>242</td>
<td>0x71</td>
<td>0x72 = Get Attribute Single</td>
</tr>
<tr>
<td>Index</td>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>243</td>
<td>0x47 = Device Level Ring (DLR) Object</td>
<td>0x01 = Get Attributes All, 0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>244</td>
<td></td>
<td>0x10 = Set Attribute Single, 0x18 = Get Member</td>
</tr>
<tr>
<td>245</td>
<td></td>
<td>0x44 = Verify Fault Location</td>
</tr>
<tr>
<td>246</td>
<td></td>
<td>0x4C = Clear Rapid Faults</td>
</tr>
<tr>
<td>247</td>
<td></td>
<td>0x4D = Restart Sign On</td>
</tr>
<tr>
<td>248</td>
<td></td>
<td>0x4E = Clear Gateway Partial Fault</td>
</tr>
<tr>
<td>249</td>
<td></td>
<td>0x4F = Device Level Ring (DLR) Object</td>
</tr>
<tr>
<td>250</td>
<td></td>
<td>0x01 = Get Attributes All, 0x02 = Get Attribute Single</td>
</tr>
<tr>
<td>251</td>
<td>0x48 = QoS Object</td>
<td>0x01 = Get Attributes All, 0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>252</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>253</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>254</td>
<td>0x4D = Target Connection List Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>255</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>256</td>
<td></td>
<td>0x4C = Connection Read</td>
</tr>
<tr>
<td>257</td>
<td>0x4E = Base Energy Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>258</td>
<td></td>
<td>0x03 = Get Attribute List</td>
</tr>
<tr>
<td>259</td>
<td></td>
<td>0x04 = Get Attribute List</td>
</tr>
<tr>
<td>260</td>
<td></td>
<td>0x05 = Reset</td>
</tr>
<tr>
<td>261</td>
<td></td>
<td>0x08 = Create</td>
</tr>
<tr>
<td>262</td>
<td></td>
<td>0x09 = Delete</td>
</tr>
<tr>
<td>263</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>264</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>265</td>
<td></td>
<td>0x18 = Get Member</td>
</tr>
<tr>
<td>266</td>
<td></td>
<td>0x19 = Set Member</td>
</tr>
<tr>
<td>267</td>
<td></td>
<td>0x1A = Insert Member</td>
</tr>
<tr>
<td>268</td>
<td></td>
<td>0x1B = Remove Member</td>
</tr>
<tr>
<td>269</td>
<td></td>
<td>0x4B = Start Metering</td>
</tr>
<tr>
<td>270</td>
<td></td>
<td>0x4C = Stop Metering</td>
</tr>
<tr>
<td>271</td>
<td>0x4F = Electrical Energy Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>272</td>
<td></td>
<td>0x03 = Get Attribute List</td>
</tr>
<tr>
<td>273</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>274</td>
<td>0x50 = Non-Electrical Energy Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>275</td>
<td></td>
<td>0x03 = Get Attribute List</td>
</tr>
<tr>
<td>276</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>277</td>
<td>0x51 = Base Switch Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>278</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>279</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>280</td>
<td>0x52 = SNMP Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>281</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>282</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>Index</td>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>-------</td>
<td>----------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>283</td>
<td>0x53 = Power Management Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x03 = Get Attribute List</td>
</tr>
<tr>
<td>284</td>
<td></td>
<td>0x04 = Set Attribute List</td>
</tr>
<tr>
<td>285</td>
<td></td>
<td>0x05 = Get Attribute Single</td>
</tr>
<tr>
<td>286</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>287</td>
<td></td>
<td>0x18 = Get Member</td>
</tr>
<tr>
<td>288</td>
<td></td>
<td>0x19 = Set Member</td>
</tr>
<tr>
<td>289</td>
<td></td>
<td>0x4D = Power Management</td>
</tr>
<tr>
<td>290</td>
<td></td>
<td>0x4E = Set Pass Code</td>
</tr>
<tr>
<td>291</td>
<td></td>
<td>0x4F = Clear Pass Code</td>
</tr>
<tr>
<td>292</td>
<td></td>
<td></td>
</tr>
<tr>
<td>293</td>
<td>0x54 = RSTP Bridge Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>294</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>295</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>296</td>
<td>0x55 = RSTP Port Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>297</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>298</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>299</td>
<td>0xF3 = Connection Configuration Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>300</td>
<td></td>
<td>0x02 = Set Attributes All</td>
</tr>
<tr>
<td>301</td>
<td></td>
<td>0x08 = Create</td>
</tr>
<tr>
<td>302</td>
<td></td>
<td>0x09 = Delete</td>
</tr>
<tr>
<td>303</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>304</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>305</td>
<td></td>
<td>0x15 = Restore</td>
</tr>
<tr>
<td>306</td>
<td></td>
<td>0x4B = Kick Timer</td>
</tr>
<tr>
<td>307</td>
<td></td>
<td>0x4C = Open Connection</td>
</tr>
<tr>
<td>308</td>
<td></td>
<td>0x4D = Close Connection</td>
</tr>
<tr>
<td>309</td>
<td></td>
<td>0x4E = Stop Connection</td>
</tr>
<tr>
<td>310</td>
<td></td>
<td>0x4F = Change Start</td>
</tr>
<tr>
<td>311</td>
<td></td>
<td>0x50 = Get Status</td>
</tr>
<tr>
<td>312</td>
<td></td>
<td>0x51 = Change Complete</td>
</tr>
<tr>
<td>313</td>
<td></td>
<td>0x52 = Audit Changes</td>
</tr>
<tr>
<td>314</td>
<td>0xF4 = Port Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>315</td>
<td></td>
<td>0x05 = Reset</td>
</tr>
<tr>
<td>316</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>317</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>318</td>
<td>0xF5 = TCP/IP Interface Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>319</td>
<td></td>
<td>0x02 = Set Attributes All</td>
</tr>
<tr>
<td>320</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>321</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>322</td>
<td>0xF6 = EtherNet Link Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>323</td>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>324</td>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>325</td>
<td></td>
<td>0x4C = Get And Clear</td>
</tr>
</tbody>
</table>
### List of the class IDs for function type *readonly*

<table>
<thead>
<tr>
<th>Class ID</th>
<th>Service codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x01 = Identity</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Signal</td>
</tr>
<tr>
<td></td>
<td>0x11 = Find Next Object Instance</td>
</tr>
<tr>
<td></td>
<td>0x18 = Get Member</td>
</tr>
<tr>
<td>0x02 = Message Router</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x4B = Write Data Table (Rockwell)</td>
</tr>
<tr>
<td></td>
<td>0x54</td>
</tr>
<tr>
<td>0x04 = Assembly</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x18 = Get Member</td>
</tr>
<tr>
<td>0x05 = Connection</td>
<td>0x08 = Create</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x11 = Find Next Object Instance</td>
</tr>
<tr>
<td></td>
<td>0x4C = Production Application Lookup</td>
</tr>
</tbody>
</table>

**Network Security**

[Network Security > DPI > ENIP Enforcer > Object]
<table>
<thead>
<tr>
<th>Class ID</th>
<th>Service codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x06 = Off-Link Connection Manager</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x4C</td>
</tr>
<tr>
<td></td>
<td>0x4E = Forward Close</td>
</tr>
<tr>
<td></td>
<td>0x52 = Unconnected Send</td>
</tr>
<tr>
<td></td>
<td>0x54 = Forward Open</td>
</tr>
<tr>
<td></td>
<td>0x56 = Get Connection Data</td>
</tr>
<tr>
<td></td>
<td>0x57 = Search Connection Data</td>
</tr>
<tr>
<td></td>
<td>0x59</td>
</tr>
<tr>
<td></td>
<td>0x5A = Get Connection Owner</td>
</tr>
<tr>
<td></td>
<td>0x5B = Large Forward Open</td>
</tr>
<tr>
<td>0x07 = Register</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x08 = Discrete Input Point</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x09 = Discrete Output Point</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x0A = Analog Input Point</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x0B = Analog Output Point</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x0E = Presence Sensing</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x0F = Parameter</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x18 = Get Member</td>
</tr>
<tr>
<td></td>
<td>0x4B = Get Enum String</td>
</tr>
<tr>
<td>0x10 = Parameter Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x12 = Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x1D = Discrete Input Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x1E = Discrete Output Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x1F = Discrete Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x20 = Analog Input Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x21 = Analog Output Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x22 = Analog Group</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x23 = Position Sensor Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x18 = Get Member</td>
</tr>
<tr>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>0x24 = Position Controller Supervisor Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x25 = Position Controller Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x26 = Block Sequencer Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x27 = Command Block Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x28 = Motor Data Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x29 = Control Supervisor Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x2A = AC/DC Drive Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x2B = Acknowledge Handler Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x2C = Overload Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x2D = Softstart Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x2E = Selection Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x30 = S-Device Supervisor Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x31 = S-Analog Sensor Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>0x32 = S-Analog Actuator Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x33 = S-Single Stage Controller Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x34 = S-Gas Calibration Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x35 = Trip Point Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x37 = File Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x38 = S-Partial Pressure Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td>0x39 = S-Partial Pressure Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x40 = S-Sensor Calibration Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x41 = Event Log Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x4B = Initiate Upload</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x4D = Initiate Partial Read</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x4F = Upload Transfer</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x18 = Get Member</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x30 = S-Device Supervisor Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x4B = Initiate Upload</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x4D = Initiate Partial Read</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x4F = Upload Transfer</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>0x42 = Motion Device Axis Object</td>
<td>0x03 = Get Attribute List 0x0E = Get Attribute Single 0x4E = Get Axis Attributes List 0x50 = Get Motor Test Data 0x52 = Get Inertia Test Data 0x54 = Get Hookup Test Data</td>
</tr>
<tr>
<td>0x43 = Time Sync Object</td>
<td>0x01 = Get Attributes All 0x03 = Get Attribute List 0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x44 = Modbus Object</td>
<td>0x0E = Get Attribute Single 0x4B = Read Discrete Inputs 0x4C = Read Coils 0x4D = Read Input Registers 0x4E = Read Holding Registers</td>
</tr>
<tr>
<td>0x45 = Originator Connection List Object</td>
<td>0x4C = Connection Read</td>
</tr>
<tr>
<td>0x46 = Modbus Serial Link Object</td>
<td>0x01 = Get Attributes All 0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x47 = Device Level Ring (DLR) Object</td>
<td>0x01 = Get Attributes All 0x0E = Get Attribute Single 0x18 = Get Member</td>
</tr>
<tr>
<td>0x48 = QoS Object</td>
<td>0x01 = Get Attributes All 0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x4D = Target Connection List Object</td>
<td>0x01 = Get Attributes All 0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x4E = Base Energy Object</td>
<td>0x01 = Get Attributes All 0x03 = Get Attribute List 0x0E = Get Attribute Single 0x18 = Get Member</td>
</tr>
<tr>
<td>0x4F = Electrical Energy Object</td>
<td>0x01 = Get Attributes All 0x03 = Get Attribute List 0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x50 = Non-Electrical Energy Object</td>
<td>0x01 = Get Attributes All 0x03 = Get Attribute List 0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x51 = Base Switch Object</td>
<td>0x01 = Get Attributes All 0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x52 = SNMP Object</td>
<td>0x01 = Get Attributes All 0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x53 = Power Management Object</td>
<td>0x01 = Get Attributes All 0x03 = Get Attribute List 0x0E = Get Attribute Single 0x18 = Get Member</td>
</tr>
<tr>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>----------</td>
<td>--------------------------------------</td>
</tr>
</tbody>
</table>
| 0x54 = RSTP Bridge Object | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
| 0x55 = RSTP Port Object | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
| 0x91 = ANSI Extended Symbol Segment | 0x03  
| | 0x55  |
| 0x6B | 0x55  |
| 0x6C | 0x01  |
| 0xAC | 0x01  
| | 0x4C  |
| 0xB2 | 0x08  
| | 0x4E  
| | 0x4F  |
| 0xF3 = Connection Configuration Object | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  
| | 0x4C = Open Connection  
| | 0x4D = Close Connection  
| | 0x4E = Stop Connection  
| | 0x50 = Get Status  |
| 0xF4 = Port Object | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
| 0xF5 = TCP/IP Interface Object | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
| 0xF6 = EtherNet Link Object | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
| 0x300 = Module Diagnostics | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
| 0x301 = InputIOCnx | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
| 0x302 = Local Slaves | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
| 0x400 = Service Port Control Object | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
| 0x401 = Dynamic IO Control Object | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
| 0x402 = Router Diagnostics Object | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
| 0x403 = Router Routing Table Object | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
| 0x404 = SMTP | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Single  |
### List of the class IDs for function type *readwrite*:

<table>
<thead>
<tr>
<th>Class ID</th>
<th>Service codes</th>
</tr>
</thead>
</table>
| 0x01 = Identity | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Signal  
| | 0x10 = Set Attribute Signal  
| | 0x11 = Find Next Object Instance  
| | 0x18 = Get Member  
| 0x02 = Message Router | 0x01 = Get Attributes All  
| | 0x0E = Get Attribute Signal  
| | 0x4B = Write Data Table (Rockwell)  
| | 0x54  
| 0x04 = Assembly | 0x08 = Create  
| | 0x09 = Delete  
| | 0x0E = Get Attribute Single  
| | 0x10 = Set Attribute Single  
| | 0x18 = Get Member  
| | 0x19 = Set Member  
| | 0x1A = Insert Member  
| | 0x1B = Remove Member  
| | 0x4B  
| | 0x4C  
| 0x05 = Connection | 0x05 = Reset  
| | 0x08 = Create  
| | 0x09 = Delete  
| | 0x0D = Apply Attributes  
| | 0x0E = Get Attribute Single  
| | 0x10 = Set Attribute Single  
| | 0x11 = Find Next Object Instance  
| | 0x4B = Connection Bind  
| | 0x4C = Production Application Lookup  
| | 0x4E = Safety Close  
| | 0x54 = Safety Open  

---

[Network Security > DPI > ENIP Enforcer > Object]
<table>
<thead>
<tr>
<th>Class ID</th>
<th>Service codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x06 = Off-Link Connection Manager</td>
<td>0x01 = Get Attributes All, 0x02 = Set Attributes All, 0x0E = Get Attribute Single, 0x10 = Set Attribute Single, 0x4C, 0x4E = Forward Close, 0x52 = Unconnected Send, 0x54 = Forward Open, 0x56 = Get Connection Data, 0x57 = Search Connection Data, 0x59, 0x5A = Get Connection Owner, 0x5B = Large Forward Open</td>
</tr>
<tr>
<td>0x07 = Register</td>
<td>0x0E = Get Attribute Single, 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>0x08 = Discrete Input Point</td>
<td>0x01 = Get Attributes All, 0x02 = Set Attributes All, 0x0E = Get Attribute Single, 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>0x09 = Discrete Output Point</td>
<td>0x01 = Get Attributes All, 0x02 = Set Attributes All, 0x0E = Get Attribute Single, 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>0x0A = Analog Input Point</td>
<td>0x01 = Get Attributes All, 0x02 = Set Attributes All, 0x0E = Get Attribute Single, 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>0x0B = Analog Output Point</td>
<td>0x01 = Get Attributes All, 0x02 = Set Attributes All, 0x0E = Get Attribute Single, 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>0x0E = Presence Sensing</td>
<td>0x0E = Get Attribute Single, 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>0x0F = Parameter</td>
<td>0x01 = Get Attributes All, 0x05 = Reset, 0x0D = Apply Attributes, 0x0E = Get Attribute Single, 0x10 = Set Attribute Single, 0x15 = Restore, 0x16 = Save, 0x18 = Get Member, 0x4B = Get Enum String</td>
</tr>
<tr>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------------</td>
</tr>
</tbody>
</table>
| 0x10 = Parameter Group | 0x01 = Get Attributes All  
|                   | 0x0E = Get Attribute Single  
|                   | 0x10 = Set Attribute Single  |
| 0x12 = Group      | 0x01 = Get Attributes All  
|                   | 0x0E = Get Attribute Single  |
| 0x1D = Discrete Input Group | 0x01 = Get Attributes All  
|                   | 0x02 = Set Attributes All  
|                   | 0x0E = Get Attribute Single  
|                   | 0x10 = Set Attribute Single  |
| 0x1E = Discrete Output Group | 0x01 = Get Attributes All  
|                    | 0x02 = Set Attributes All  
|                    | 0x0E = Get Attribute Single  
|                    | 0x10 = Set Attribute Single  |
| 0x1F = Discrete Group | 0x01 = Get Attributes All  
|                   | 0x0E = Get Attribute Single  |
| 0x20 = Analog Input Group | 0x01 = Get Attributes All  
|                   | 0x02 = Set Attributes All  
|                   | 0x0E = Get Attribute Single  
|                   | 0x10 = Set Attribute Single  |
| 0x21 = Analog Output Group | 0x01 = Get Attributes All  
|                   | 0x02 = Set Attributes All  
|                   | 0x0E = Get Attribute Single  
|                   | 0x10 = Set Attribute Single  |
| 0x22 = Analog Group | 0x01 = Get Attributes All  
|                   | 0x0E = Get Attribute Single  
|                   | 0x10 = Set Attribute Single  |
| 0x23 = Position Sensor Object | 0x05 = Reset  
|                   | 0x0D = Apply Attributes  
|                   | 0x0E = Get Attribute Single  
|                   | 0x10 = Set Attribute Single  
|                   | 0x15 = Restore  
|                   | 0x16 = Save  
|                   | 0x18 = Get Member  
|                   | 0x19 = Set Member  
| 0x24 = Position Controller Supervisor Object | 0x0E = Get Attribute Single  
|                   | 0x10 = Set Attribute Single  |
| 0x25 = Position Controller Object | 0x0E = Get Attribute Single  
|                   | 0x10 = Set Attribute Single  |
| 0x26 = Block Sequencer Object | 0x0E = Get Attribute Single  
|                   | 0x10 = Set Attribute Single  |
| 0x27 = Command Block Object | 0x0E = Get Attribute Single  
<p>|                   | 0x10 = Set Attribute Single  |</p>
<table>
<thead>
<tr>
<th>Class ID</th>
<th>Service codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x28 = Motor Data Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x15 = Restore</td>
</tr>
<tr>
<td></td>
<td>0x16 = Save</td>
</tr>
<tr>
<td>0x29 = Control Supervisor Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x05 = Reset</td>
</tr>
<tr>
<td>0x2A = AC/DC Drive Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x15 = Restore</td>
</tr>
<tr>
<td></td>
<td>0x16 = Save</td>
</tr>
<tr>
<td>0x2B = Acknowledge Handler Object</td>
<td>0x08 = Create</td>
</tr>
<tr>
<td></td>
<td>0x09 = Delete</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x4B = Add AckData Path</td>
</tr>
<tr>
<td></td>
<td>0x4C = Remove AckData Path</td>
</tr>
<tr>
<td>0x2C = Overload Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x15 = Restore</td>
</tr>
<tr>
<td></td>
<td>0x16 = Save</td>
</tr>
<tr>
<td>0x2D = Softstart Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x15 = Restore</td>
</tr>
<tr>
<td></td>
<td>0x16 = Save</td>
</tr>
<tr>
<td>0x2E = Selection Object</td>
<td>0x05 = Reset</td>
</tr>
<tr>
<td></td>
<td>0x06 = Start</td>
</tr>
<tr>
<td></td>
<td>0x07 = Stop</td>
</tr>
<tr>
<td></td>
<td>0x08 = Create</td>
</tr>
<tr>
<td></td>
<td>0x09 = Delete</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x18 = Get Member</td>
</tr>
<tr>
<td></td>
<td>0x19 = Set Member</td>
</tr>
<tr>
<td></td>
<td>0x1A = Insert Member</td>
</tr>
<tr>
<td></td>
<td>0x1B = Remove Member</td>
</tr>
<tr>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>----------</td>
<td>---------------</td>
</tr>
</tbody>
</table>
| 0x30 = S-Device Supervisor Object | 0x05 = Reset  
0x06 = Start  
0x07 = Stop  
0x0E = Get Attribute Single  
0x10 = Set Attribute Single  
0x4B = Abort  
0x4C = Recover  
0x4E = Perform Diagnostics |
| 0x31 = S-Analog Sensor Object | 0x01 = Get Attributes All  
0x0E = Get Attribute Single  
0x4B = Zero Adjust  
0x4C = Gain Adjust |
| 0x32 = S-Analog Actuator Object | 0x0E = Get Attribute Single  
0x10 = Set Attribute Single |
| 0x33 = S-Single Stage Controller Object | 0x0E = Get Attribute Single  
0x10 = Set Attribute Single  
0x63 = Calibrate |
| 0x34 = S-Gas Calibration Object | 0x0E = Get Attribute Single  
0x10 = Set Attribute Single  
0x4B = Get All Instances |
| 0x35 = Trip Point Object | 0x0E = Get Attribute Single  
0x10 = Set Attribute Single |
| 0x37 = File Object | 0x06 = Start  
0x07 = Stop  
0x08 = Create  
0x09 = Delete  
0x0E = Get Attribute Single  
0x10 = Set Attribute Single  
0x15 = Restore  
0x16 = Save  
0x18 = Get Member  
0x4B = Initiate Upload  
0x4C = Initiate Download  
0x4D = Initiate Partial Read  
0x4E = Initiate Partial Write  
0x50 = Download Transfer  
0x51 = Clear File |
<table>
<thead>
<tr>
<th>Class ID</th>
<th>Service codes</th>
</tr>
</thead>
</table>
| 0x38 = S-Partial Pressure Object | 0x01 = Get Attributes All  
0x08 = Create  
0x09 = Delete  
0x0E = Get Attribute Single  
0x10 = Set Attribute Single  
0x4B = Create Range  
0x4C = Get Instance List  
0x4D = Get Pressures  
0x4E = Get All Pressures  
0x4F = Group Enable |
| 0x40 = S-Sensor Calibration Object | 0x0E = Get Attribute Single  
0x10 = Set Attribute Single  
0x4B = Get all Instances |
| 0x41 = Event Log Object | 0x05 = Reset  
0x06 = Start  
0x07 = Stop  
0x0E = Get Attribute Single  
0x10 = Set Attribute Single  
0x18 = Get Member  
0x19 = Set Member  
0x1A = Insert Member  
0x1B = Remove Member |
| 0x42 = Motion Device Axis Object | 0x03 = Get Attribute List  
0x04 = Set Attribute List  
0x0E = Get Attribute Single  
0x10 = Set Attribute Single  
0x1C = GroupSync  
0x4B = Get Axis Attributes List  
0x4C = Set Axis Attributes List  
0x4D = Set Cyclic Write List  
0x4E = Set Cyclic Read List  
0x4F = Run Motor Test  
0x50 = Get Motor Test Data  
0x51 = Run Inertia Test  
0x52 = Get Inertia Test Data  
0x53 = Run Hookup Test  
0x54 = Get Hookup Test Data |
| 0x43 = Time Sync Object | 0x01 = Get Attributes All  
0x03 = Get Attribute List  
0x04 = Set Attribute List  
0x0E = Get Attribute Single  
0x10 = Set Attribute Single |
<table>
<thead>
<tr>
<th>Class ID</th>
<th>Service codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x44 = Modbus Object</td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x4B = Read Discrete Inputs</td>
</tr>
<tr>
<td></td>
<td>0x4C = Read Coils</td>
</tr>
<tr>
<td></td>
<td>0x4D = Read Input Registers</td>
</tr>
<tr>
<td></td>
<td>0x4E = Read Holding Registers</td>
</tr>
<tr>
<td></td>
<td>0x4F = Write Coils</td>
</tr>
<tr>
<td></td>
<td>0x50 = Write Holding Registers</td>
</tr>
<tr>
<td></td>
<td>0x51 = Modbus Passthrough</td>
</tr>
<tr>
<td>0x45 = Originator Connection List Object</td>
<td>0x08 = Create</td>
</tr>
<tr>
<td></td>
<td>0x09 = Delete</td>
</tr>
<tr>
<td></td>
<td>0x4C = Connection Read</td>
</tr>
<tr>
<td>0x46 = Modbus Serial Link Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x05 = Reset</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x4B = Get And Clear</td>
</tr>
<tr>
<td>0x47 = Device Level Ring (DLR) Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x18 = Get Member</td>
</tr>
<tr>
<td></td>
<td>0x4B = Verify Fault Location</td>
</tr>
<tr>
<td></td>
<td>0x4C = Clear Rapid Faults</td>
</tr>
<tr>
<td></td>
<td>0x4D = Restart Sign On</td>
</tr>
<tr>
<td></td>
<td>0x4E = Clear Gateway Partial Fault</td>
</tr>
<tr>
<td>0x48 = QoS Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>0x4D = Target Connection List Object</td>
<td>0x01 = Get Attributes All</td>
</tr>
<tr>
<td></td>
<td>0x0E = Get Attribute Single</td>
</tr>
<tr>
<td></td>
<td>0x4C = Connection Read</td>
</tr>
<tr>
<td>Class ID</td>
<td>Service codes</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------------------</td>
</tr>
</tbody>
</table>
| 0x4E = Base Energy Object | 0x01 = Get Attributes All  
                      | 0x03 = Get Attribute List  
                      | 0x04 = Set Attribute List  
                      | 0x05 = Reset  
                      | 0x08 = Create  
                      | 0x09 = Delete  
                      | 0x0E = Get Attribute Single  
                      | 0x10 = Set Attribute Single  
                      | 0x18 = Get Member  
                      | 0x19 = Set Member  
                      | 0x1A = Insert Member  
                      | 0x1B = Remove Member  
                      | 0x4B = Start Metering  
                      | 0x4C = Stop Metering  |
| 0x4F = Electrical Energy Object | 0x01 = Get Attributes All  
                  | 0x03 = Get Attribute List  
                  | 0x0E = Get Attribute Single  |
| 0x50 = Non-Electrical Energy Object | 0x01 = Get Attributes All  
                  | 0x03 = Get Attribute List  
                  | 0x0E = Get Attribute Single  |
| 0x51 = Base Switch Object | 0x01 = Get Attributes All  
                      | 0x0E = Get Attribute Single  
                      | 0x10 = Set Attribute Single  |
| 0x52 = SNMP Object | 0x01 = Get Attributes All  
                      | 0x0E = Get Attribute Single  
                      | 0x10 = Set Attribute Single  |
| 0x53 = Power Management Object | 0x01 = Get Attributes All  
                      | 0x03 = Get Attribute List  
                      | 0x04 = Set Attribute List  
                      | 0x0E = Get Attribute Single  
                      | 0x10 = Set Attribute Single  
                      | 0x18 = Get Member  
                      | 0x19 = Set Member  
                      | 0x4D = Power Management  
                      | 0x4E = Set Pass Code  
                      | 0x4F = Clear Pass Code  |
| 0x54 = RSTP Bridge Object | 0x01 = Get Attributes All  
                      | 0x0E = Get Attribute Single  
                      | 0x10 = Set Attribute Single  |
| 0x55 = RSTP Port Object | 0x01 = Get Attributes All  
                      | 0x0E = Get Attribute Single  
<pre><code>                  | 0x10 = Set Attribute Single  |
</code></pre>
<table>
<thead>
<tr>
<th>Class ID</th>
<th>Service codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x91 = ANSI Extended Symbol Segment</td>
<td>0x03 0x55</td>
</tr>
<tr>
<td>0x6B</td>
<td>0x55</td>
</tr>
<tr>
<td>0x6C</td>
<td>0x01</td>
</tr>
<tr>
<td>0xAC</td>
<td>0x01 0x4C</td>
</tr>
<tr>
<td>0xB2</td>
<td>0x00 0x4E 0x4F</td>
</tr>
<tr>
<td>0xF3 = Connection Configuration Object</td>
<td>0x01 = Get Attributes All 0x02 = Set Attributes All 0x08 = Create 0x09 = Delete 0x0E = Get Attribute Single 0x10 = Set Attribute Single 0x15 = Restore 0x4B = Kick Timer 0x4C = Open Connection 0x4D = Close Connection 0x4E = Stop Connection 0x4F = Change Start 0x50 = Get Status 0x51 = Change Complete 0x52 = Audit Changes</td>
</tr>
<tr>
<td>0xF4 = Port Object</td>
<td>0x01 = Get Attributes All 0x05 = Reset 0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>0xF5 = TCP/IP Interface Object</td>
<td>0x01 = Get Attributes All 0x02 = Set Attributes All 0x0E = Get Attribute Single 0x10 = Set Attribute Single</td>
</tr>
<tr>
<td>0xF6 = EtherNet Link Object</td>
<td>0x01 = Get Attributes All 0x0E = Get Attribute Single 0x10 = Set Attribute Single 0x4C = Get And Clear</td>
</tr>
<tr>
<td>0x300 = Module Diagnostics</td>
<td>0x01 = Get Attributes All 0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x301 = InputIOCnx</td>
<td>0x01 = Get Attributes All 0x0E = Get Attribute Single</td>
</tr>
<tr>
<td>0x302 = Local Slaves</td>
<td>0x01 = Get Attributes All 0x0E = Get Attribute Single</td>
</tr>
</tbody>
</table>
### 4.5 DoS

Denial of Service (DoS) is a cyber-attack that aims to bring down specific services or devices. In this dialog you can set up several filters to help protect the device itself and other devices in the network from DoS attacks.

The menu contains the following dialogs:

- **DoS Global**

<table>
<thead>
<tr>
<th>Class ID</th>
<th>Service codes</th>
</tr>
</thead>
</table>
| 0x400 = Service Port Control Object | 0x01 = Get Attributes All  
|                                  | 0x0E = Get Attribute Single |
| 0x401 = Dynamic IO Control Object | 0x01 = Get Attributes All  
|                                  | 0x0E = Get Attribute Single |
| 0x402 = Router Diagnostics Object | 0x01 = Get Attributes All  
|                                  | 0x0E = Get Attribute Single |
| 0x403 = Router Routing Table Object | 0x01 = Get Attributes All  
|                                  | 0x0E = Get Attribute Single |
| 0x404 = SMTP                     | 0x01 = Get Attributes All  
|                                  | 0x0E = Get Attribute Single  
|                                  | 0x32 = Clear All |
| 0x405 = SNTP                     | 0x01 = Get Attributes All  
|                                  | 0x0E = Get Attribute Single  
|                                  | 0x32 = Clear All |
| 0x406 = HSBY                     | 0x01 = Get Attributes All  
|                                  | 0x0E = Get Attribute Single |
4.5.1 DoS Global

In this dialog you specify the DoS settings for the TCP/UDP, IP and ICMP protocols.

TCP/UDP

A scanner uses port scans to prepare network attacks. The scanner uses different techniques to determine running devices and open ports. This frame lets you activate filters for specific scanning techniques.

The device supports the detection of the following scan types:
- Null scans
- Xmas scans
- SYN/FIN scans
- TCP Offset attacks
- TCP SYN attacks
- L4 Port attacks
- Minimal Header scans

Null Scan filter

Activates/deactivates the Null Scan filter.

The device detects and discards incoming TCP packets with the following properties:
- No TCP flags are set.
- The TCP sequence number is 0.

Possible values:
- marked
  The filter is active.
- unmarked (default setting)
  The filter is inactive.

Xmas filter

Activates/deactivates the Xmas filter.

The device detects and discards incoming TCP packets with the following properties:
- The TCP flags FIN, URG and PSH are simultaneously set.
- The TCP sequence number is 0.

Possible values:
- marked
  The filter is active.
- unmarked (default setting)
  The filter is inactive.
SYN/FIN filter

Activates/deactivates the SYN/FIN filter.

The device detects incoming data packets with the TCP flags SYN and FIN set simultaneously and discards them.

Possible values:
- **marked**
  - The filter is active.
- **unmarked** (default setting)
  - The filter is inactive.

TCP Offset protection

Activates/deactivates the TCP Offset protection.

The TCP Offset protection detects incoming TCP data packets whose fragment offset field of the IP header is equal to 1 and discards them.

The TCP Offset protection accepts UDP and ICMP packets whose fragment offset field of the IP header is equal to 1.

Possible values:
- **marked**
  - The protection is active.
- **unmarked** (default setting)
  - The protection is inactive.

TCP SYN protection

Activates/deactivates the TCP SYN protection.

The TCP SYN protection detects incoming data packets with the TCP flag SYN set and a L4 source port < 1024 and discards them.

Possible values:
- **marked**
  - The protection is active.
- **unmarked** (default setting)
  - The protection is inactive.

L4 Port protection

Activates/deactivates the L4 Port protection.

The L4 Port protection detects incoming TCP and UDP data packets whose source port number and destination port number are identical and discards them.

Possible values:
- **marked**
  - The protection is active.
- **unmarked** (default setting)
  - The protection is inactive.
Min. Header Size filter

Activates/deactivates the Minimal Header filter.

The Minimal Header filter compares the TCP header of incoming data packets. If the data offset value multiplied by 4 is smaller than the minimum TCP header size, then the filter discards the data packet.

Possible values:

- **marked**
  The filter is active.
- **unmarked** (default setting)
  The filter is inactive.

Min. TCP header size

Displays the minimum size of a valid TCP header.

**IP**

Land Attack filter

Activates/deactivates the Land Attack filter. With the Land Attack method, the attacking station sends data packets whose source and destination addresses are identical to the IP address of the recipient.

Possible values:

- **marked**
  The filter is active. The device discards data packets whose source and destination addresses are identical.
- **unmarked** (default setting)
  The filter is inactive.

Drop IP Source Route

Activates/deactivates filtering of the received IP data packets with Strict Source Routing or Loose Source Routing. The Strict Source Routing or Loose Source Routing is an option in the IP header where the sender specifies the routing path. The data packets follow this routing path to reach the destination.

Possible values:

- **marked** (default setting)
  The filter is active. The device discards IP data packets with a specified routing path in the IP header.
- **unmarked**
  The filter is inactive.

**ICMP**

This dialog provides you with filter options for the following ICMP parameters:

- Fragmented data packets
- ICMP packets from a specific size upwards
Fragmented packets filter

Activates/deactivates the filter for fragmented ICMP packets.

The filter detects fragmented ICMP packets and discards them.

Possible values:
- **marked**: The filter is active.
- **unmarked** *(default setting)*: The filter is inactive.

Packet size filter

Activates/deactivates the filter for incoming ICMP packets.

The filter detects ICMP packets whose payload size exceeds the size specified in the *Allowed payload size [byte]* field and discards them.

Possible values:
- **marked**: The filter is active.
- **unmarked** *(default setting)*: The filter is inactive.

**Allowed payload size [byte]**

Specifies the maximum allowed payload size of ICMP packets in bytes.

Possible values:
- 0..1472 *(default setting: 512)*

**4.6 ACL**

In this menu, you specify the settings for the Access Control Lists (ACL). Access Control Lists contain rules which the device applies successively to the data stream on its ports or VLANs.

If a data packet matches the criteria of one or more rules, then the device applies the action specified in the first rule that matches to the data stream. The device ignores the rules that follow the first rule that matches. Possible actions include:
- **permit**: The device transmits the data packet to a port or to a VLAN. When necessary, the device transmits a copy of the data packets to a further port.
- **deny**: The device drops the data packet.

In the default setting, the device forwards every data packet. Once you assign an Access Control List to a port or VLAN, then this behavior changes. The device enters at the end of an Access Control List an implicit Deny-All rule. Consequently, the device discards data packets that do not match the criteria of any rules. If you want a different behavior, then add a Permit-All rule at the end of your Access Control Lists.
Proceed as follows to set up Access Control Lists and rules:

- Make a rule and specify the rule settings. See the Network Security > ACL > IPv4 Rule dialog, or the Network Security > ACL > MAC Rule dialog.
- Assign the Access Control List to the ports and VLANs of the device. See the Network Security > ACL > Assignment dialog.

In comparison to the Packet Filter function, the ACL function has the following differences:

- The ACL has the faster data stream processing.
- ACLs provide coarse filtering.
- ACLs process data stream before the device applies the Packet Filter function.
- ACLs use the IP or MAC address for filtering.

The device processes data packets in the following sequence:

![Processing sequence of the data packets in the device](image)

The menu contains the following dialogs:

- ACL IPv4 Rule
- ACL MAC Rule
- ACL Assignment
4.6.1 **ACL IPv4 Rule**

In this dialog you specify the rules that the device applies to the IP data packets.

An Access Control List (group) contains one or more rules. The device applies the rules of an Access Control List successively, beginning with the rule with the lowest value in the Index column.

The device lets you filter according to the following criteria:
- Source or destination IP address of a data packet
- Type of the transmitting protocol
- Source or destination port of a data packet
- Classification according to DSCP
- Classification according to ToS

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

**Add**

Opens the Create window to add a table row.
- In the Group name field, you specify the name of the Access Control List to which the rule belongs. When you add a new name, click the icon.
- In the Index field, you specify the number of the rule within the Access Control List. If the Access Control List contains multiple rules, then the device processes the rule with the lowest index value first.

**Remove**

Removes the selected table row.

**Clear ACL hit counts**

Resets the counters in the Hits and Timer columns to 0.
- When you select the table row of a rule within an Access Control List, the device resets the counter of this rule to 0.
- When you select the table row of an Access Control List, the device resets the counter in the associated rules to 0.
- When you select the table row of multiple Access Control Lists, the device resets the counter in every associated rule to 0.

**Group name**

Displays the name of the Access Control List. The Access Control List contains the rules.
Index

Displays the number of the rule within the Access Control List.

If the Access Control List contains multiple rules, then the device processes the rule with the lowest value first.

Active

Activates/deactivates the Access Control List or the rule within an Access Control List.

Possible values (for an Access Control List):
- marked (default setting)
  The Access Control List is active. The device applies the associated active rules to the data stream.
- unmarked
  The Access Control List is inactive.

Possible values (for rules within an Access Control List):
- marked (default setting)
  The rule is active. The device applies the rule to the data stream if the associated Access Control List is also active.
- unmarked
  The rule is inactive.

Match every packet

Specifies to which IP data packets the device applies the rule.

Possible values:
- marked (default setting)
  The device applies the rule to every IP data packet.
- unmarked
  The device applies the rule to IP data packets depending on the value in the following fields:
  - Source IP address, Destination IP address, Protocol
  - DSCP, TOS priority, TOS mask
  - Packet fragmented

Source IP address

Specifies the source address of the IP data packets to which the device applies the rule.

Possible values:
- ?.?.?.? (default setting)
  The device applies the rule to IP data packets with any source address.
- Valid IPv4 address
  The device applies the rule to IP data packets with the specified source address.
  You use the ? character as a wild card.
  Example 192.?.?.32: The device applies the rule to IP data packets whose source address begins with 192. and ends with .32.
- Valid IPv4 address/bit mask
  The device applies the rule to IP data packets with the specified source address. The inverse bit mask lets you specify the address range with bit-level accuracy.
  Example 192.168.1.0/0.0.0.127: The device applies the rule to IP data packets with a source address in the range from 192.168.1.0 to ...127.
Destination IP address

Specifies the destination address of the IP data packets to which the device applies the rule.

Possible values:

- ?.?.?.?  (default setting)
  The device applies the rule to IP data packets with any destination address.

- Valid IPv4 address
  The device applies the rule to data packets with the specified destination address.
  You use the ? character as a wild card.
  Example 192.??.32: The device applies the rule to IP data packets whose source address
  begins with 192. and ends with .32.

- Valid IPv4 address/bit mask
  The device applies the rule to data packets with the specified destination address. The inverse
  bit mask lets you specify the address range with bit-level accuracy.
  Example 192.168.1.0/0.0.0.127: The device applies the rule to IP data packets with a
  destination address in the range from 192.168.1.0 to ….127.

Protocol

Specifies the IP protocol or Layer 4 protocol type of the data packets to which the device applies
the rule. The device applies the rule only to data packets with a Protocol field of the specified value.

Possible values:

- any  (default setting)
  The device applies the rule to every IP data packet without evaluating the protocol type.

- icmp
  Internet Control Message Protocol (RFC 792)

- igmp
  Internet Group Management Protocol

- ip-in-ip
  IP in IP tunneling (RFC 2003)

- tcp
  Transmission Control Protocol (RFC 793)

- udp
  User Datagram Protocol (RFC 768)

- ip
  Internet Protocol

Source TCP/UDP port

Specifies the source port of the IP data packets to which the device applies the rule. The
prerequisite is that you specify in the Protocol column the value TCP or UDP.

Possible values:

- any  (default setting)
  The device applies the rule to every IP data packet without evaluating the source port.

- 1..65535
  The device applies the rule only to IP data packets containing the specified source port.
Destination TCP/UDP port

Specifies the destination port of the IP data packets to which the device applies the rule. The prerequisite is that you specify in the Protocol column the value TCP or UDP.

Possible values:
- any (default setting)
  The device applies the rule to every IP data packet without evaluating the destination port.
- 1..65535
  The device applies the rule only to IP data packets containing the specified destination port.

DSCP

Specifies the Differentiated Service Code Point (DSCP value) in the header of the IP data packets to which the device applies the rule.

Possible values:
- – (default setting)
  The device applies the rule to every IP data packet without evaluating the DSCP value.
- 0..63
  The device applies the rule only to IP data packets containing the specified DSCP value.

TOS priority

Specifies the IP precedence (ToS value) in the header of the IP data packets to which the device applies the rule.

Possible values:
- any (default setting)
  The device applies the rule to every IP data packet without evaluating the ToS value.
- 0..7
  The device applies the rule only to IP data packets containing the specified ToS value.

TOS mask

Specifies the bit mask for the ToS value in the header of the IP data packets to which the device applies the rule. The prerequisite is that you specify in the TOS priority column a ToS value.

Possible values:
- any (default setting)
  The device applies the rule to IP data packets and evaluates the ToS value completely.
- 1..1f
  The device applies the rule to IP data packets and evaluates the bits of the ToS value specified in the bit mask.

Packet fragmented

Activates/deactivates applying the ACL rule to the packet fragments.

To filter the complete data packet including its subsequent fragments, create 2 ACL rules.
- Create an ACL rule for the initial data packet to filter on both at the protocol level and at the TCP/UDP ports.
- Create a second ACL rule for the fragments to filter only at the protocol level.
Possible values:

- **marked**
  The device applies the ACL rule to the fragments. Use this setting in the second ACL rule for the fragments.

- **unmarked**  (default setting)
  The device does not apply the ACL rule to the fragments.

**Action**

Specifies how the device processes received IP data packets when the device applies the rule.

Possible values:

- **permit**  (default setting)
  The device transmits the IP data packets.

- **deny**
  The device drops the IP data packets.

**Redirection port**

Specifies the port on which the device transmits the IP data packets. The prerequisite is that you specify in the **Action** column the value **permit**. The device does not provide the option of mirroring IP data packets across VLAN boundaries or to router interfaces.

Possible values:

- **–**  (default setting)
  The **Redirection port** function is inactive.

- **<Port number>**
  The device transmits the IP data packets on the specified port.

**Mirror port**

Specifies the port on which the device transmits a copy of the IP data packets. The prerequisite is that you specify in the **Action** column the value **permit**. The device does not provide the option of mirroring IP data packets across VLAN boundaries or to router interfaces.

Possible values:

- **–**  (default setting)
  The **Mirror port** function is inactive.

- **<Port number>**
  The device transmits a copy of the IP data packets on the specified port.
Assigned queue ID

Specifies the priority queue to which the device assigns the IP data packets.

Possible values:
- 0..7 (default setting: 0)

Log

Activates/deactivates the logging in the log file. See the Diagnostics > Report > System Log dialog.

Possible values:
- marked
  - Logging is active.
  - The prerequisite is that you assign the Access Control List in the Network Security > ACL > Assignment dialog to a VLAN or port.
  - The device registers in the log file, in an interval of 30 s, how many times it applied the deny rule to IP data packets.
- unmarked (default setting)
  - Logging is inactive.

Rate limit

Specifies the limit for the data transfer rate for the port specified in the Redirection port column. The limit applies to the summary of the data sent and received.

This function limits the data stream on the port or in the VLAN:

Possible values:
- 0 (default setting)
  - No limitation of the data transfer rate.
- 1..4294967295
  - If the data transfer rate on the port exceeds the value specified, then the device discards surplus IP data packets. The prerequisite is that you specify in the Burst size column a value > 0. You specify the measurement unit of the limit in the Unit column.

Unit

Specifies the measurement unit for the data transfer rate specified in the Rate limit column.

Possible values:
- kbps
  - kBytes per second
- pps
  - Data packets per second
Burst size

Specifies the limit in KByte for the data volume during temporary bursts.

Possible values:
- **0** (default setting)
  
  No limitation of the data volume.
- **1..128**
  
  If during temporary bursts on the port the data volume exceeds the value specified, then the device discards surplus MAC data packets. The prerequisite is that you specify in the Rate limit column a value > 0.

Recommendation:
- If the bandwidth is known:
  \[ \text{Burst size} = \text{bandwidth} \times \text{allowed duration of a burst} / 8. \]
- If the bandwidth is unknown:
  \[ \text{Burst size} = 10 \times \text{MTU (Maximum Transmission Unit)} \text{ of the port.} \]

Hits

Displays the number of IP data packets to which the device has applied the rule.

Possible values:
- **0..18446744073709551615**

Timer

Indicates the time when the value in the Hits column last exceeded the maximum value. At this time, the device resets the value to 0 in the Hits column.
4.6.2 ACL MAC Rule

In this dialog you specify the rules that the device applies to the MAC data packets.

An Access Control List (group) contains one or more rules. The device applies the rules of an Access Control List successively, beginning with the rule with the lowest value in the Index column.

The device lets you filter according to the following criteria:
- Source or destination MAC address of a data packet
- Type of the transmitting protocol
- Membership of a specific VLAN
- Service class of a data packet

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row.

- In the Group name field, you specify the name of the Access Control List to which the rule belongs. When you add a new name, click the icon.
- In the Index field, you specify the number of the rule within the Access Control List. If the Access Control List contains multiple rules, then the device processes the rule with the lowest index value first.

Remove

Removes the selected table row.

Clear ACL hit counts

Resets the counters in the Hits and Timer columns to 0.

- When you select the table row of a rule within an Access Control List, the device resets the counter of this rule to 0.
- When you select the table row of an Access Control List, the device resets the counter in the associated rules to 0.
- When you select the table row of multiple Access Control Lists, the device resets the counter in every associated rule to 0.

Group name

Displays the name of the Access Control List. The Access Control List contains the rules.
Index

Displays the number of the rule within the Access Control List.

If the Access Control List contains multiple rules, then the device processes the rule with the lowest value first.

Active

Activates/deactivates the Access Control List or the rule within an Access Control List.

Possible values (for an Access Control List):

- **marked** (default setting)
  The Access Control List is active. The device applies the associated active rules to the data stream.
- **unmarked**
  The Access Control List is inactive.

Possible values (for rules within an Access Control List):

- **marked** (default setting)
  The rule is active. The device applies the rule to the data stream if the associated Access Control List is also active.
- **unmarked**
  The rule is inactive.

Match every packet

Specifies to which MAC data packets the device applies the rule.

Possible values:

- **marked** (default setting)
  The device applies the rule to every MAC data packet.
- **unmarked**
  The device applies the rule to MAC data packets depending on the value in the following fields:
    - Source MAC address
    - Destination MAC address
    - Ethertype
    - Ethertype custom value
    - VLAN ID
    - COS

Source MAC address

Specifies the source address of the MAC data packets to which the device applies the rule.

Possible values:

- **??:??:??:??:??:??:?? (default setting)**
  The device applies the rule to MAC data packets with any source address.
Valid MAC address
The device applies the rule to MAC data packets with the specified source address. You use the ? character as a wild card.
Example: 00:11::??::??::?? The device applies the rule to MAC data packets whose source address begins with 00:11.

Valid MAC address/bit mask
The device applies the rule to MAC data packets with the specified source address. The bit mask lets you specify the address range with bit-level accuracy.
Example: 00:11:22:33:44:54/FF:FF:FF:FF:FF:FC The device applies the rule to MAC data packets with a source address in the range from 00:11:22:33:44:54 to ...:57.

Destination MAC address
Specifies the destination address of the MAC data packets to which the device applies the rule.
Possible values:
- ??::??::??::??::?? (default setting) The device applies the rule to MAC data packets with any destination address.
- Valid MAC address The device applies the rule to MAC data packets with the specified destination address. You use the ? character as a wild card.
Example: 00:11::??::??::?? The device applies the rule to MAC data packets whose destination address begins with 00:11.
- Valid MAC address/bit mask The device applies the rule to MAC data packets with the specified source address. The bit mask lets you specify the address range with bit-level accuracy.
Example: 00:11:22:33:44:54/FF:FF:FF:FF:FF:FC The device applies the rule to MAC data packets with a destination address in the range from 00:11:22:33:44:54 to ...:57.

Ethertype
Specifies the Ethertype keyword of the MAC data packets to which the device applies the rule.
Possible values:
- custom (default setting) The device applies the value specified in the Ethertype custom value column.
- appletalk
- arp
- ibmsna
- ipv4
- ipv6
- ipxold
- mplsmdcast
- mplsucast
- netbios
- novell
- rarp
- pppoedic
- pppoessess
- ipxnew
- profinet
- powerlink
- ethercat
Ethertype custom value

Specifies the Ethertype value of the MAC data packets to which the device applies the rule. The prerequisite is that in the Ethertype column the value custom is specified.

Possible values:
- **1..5ff**
  The device applies the rule to Logical Link Control (LLC) data packets whose length field contains the specified value. These values are available only for port-based rules.
- **600..ffff**
  The device applies the rule only to MAC data packets containing the Ethertype value specified here.

VLAN ID

Specifies the VLAN ID of the MAC data packets to which the device applies the rule.

Possible values:
- **any** (default setting)
  The device applies the rule to every MAC data packet without evaluating the VLAN ID.
- **1..4042**

COS

Specifies the Class of Service (COS) value of the MAC data packets to which the device applies the rule.

Possible values:
- **0..7**
- **any** (default setting)
  The device applies the rule to every MAC data packet without evaluating the Class of Service value.

**Note:** For data packets without a VLAN tag, the device uses the port priority instead of the COS value.

Action

Specifies how the device processes received MAC data packets when the device applies the rule.

Possible values:
- **permit** (default setting)
  The device transmits the MAC data packets.
- **deny**
  The device discards the MAC data packets.
Redirection port

Specifies the port on which the device transmits the MAC data packets. The prerequisite is that in the Action column the value **permit** is specified. The device does not provide the option of mirroring IP data packets across VLAN boundaries or to router interfaces.

Possible values:
- (default setting) The Redirection port function is inactive.
- <Port number> The device transmits the MAC data packets on the specified port.

Mirror port

Specifies the port on which the device transmits a copy of the MAC data packets. The prerequisite is that in the Action column the value **permit** is specified. The device does not provide the option of mirroring IP data packets across VLAN boundaries or to router interfaces.

Possible values:
- (default setting) The Mirror port function is disabled.
- <Port number> The device transmits a copy of the MAC data packets on the specified port.

Assigned queue ID

Specifies the ID of the priority queue on which the device transmits the MAC data packets.

Possible values:
- 0..7 (default setting: 0)

Log

Activates/deactivates the logging in the log file. See the Diagnostics > Report > System Log dialog.

Possible values:
- marked Logging is active.
  - The prerequisite is that you assign the Access Control List in the Network Security > ACL > Assignment dialog to a VLAN or port.
  - The device registers in the log file, in an interval of 30 s, how many times it applied the deny rule to MAC data packets.
- unmarked (default setting) Logging is inactive.

Rate limit

Specifies the limit for the data transfer rate for the port specified in the Redirection port column. The limit applies to the summary of the data sent and received.

This function limits the data stream on the port or in the VLAN:
Possible values:

- **0** (default setting)
  - No limitation of the data transfer rate.
- **1..4294967295**
  - If the data transfer rate on the port exceeds the value specified, then the device discards surplus MAC data packets. The prerequisite is that you specify in the *Burst size* column a value > 0. You specify the measurement unit of the limit in the *Unit* column.

**Unit**

Specifies the unit of measurement for the data transfer rate specified in the *Rate limit* column.

Possible values:

- **kbps**
  - kBytes per second
- **pps**
  - Data packets per second

**Burst size**

Specifies the limit in KByte for the data volume during temporary bursts.

Possible values:

- **0** (default setting)
  - No limitation of the data volume.
- **1..128**
  - If during temporary bursts on the port the data volume exceeds the value specified, then the device discards surplus MAC data packets. The prerequisite is that you specify in the *Rate limit* column a value > 0.

Recommendation:

- **If the bandwidth is known:**
  
  \[ \text{Burst size} = \text{bandwidth} \times \text{allowed duration of a burst} / 8. \]

- **If the bandwidth is unknown:**
  
  \[ \text{Burst size} = 10 \times \text{MTU (Maximum Transmission Unit)} \] of the port.

**Hits**

Displays the number of MAC data packets to which the device has applied the rule.

Possible values:

- **0..18446744073709551615**

**Timer**

Displays when the value in the *Hits* column exceeded the maximum value. At this time, the device has reset the value in the *Hits* column to 0.
4.6.3 **ACL Assignment**

This dialog lets you assign one or more Access Control Lists to the ports and VLANs of the device. By assigning a priority you specify the processing sequence, provided you assign one or more Access Control Lists to a port or VLAN.

The device applies rules successively, namely in the sequence specified by the rule index. You specify the priority of a group in the *Priority* column. The lower the number, the higher the priority. In this process, the device applies the rules with a high priority before the rules with a low priority.

The assignment of Access Control Lists to ports and VLANs results in the following different types of ACLs:
- Port-based IPv4 ACLs
- Port-based MAC ACLs
- VLAN-based IPv4 ACLs
- VLAN-based MAC ACLs

The device lets you apply the Access Control Lists to data packets received (*inbound*).

**Note:** Before you enable the function, verify that at least one active table row in the table lets you access. Otherwise, the connection to the device terminates if you change the settings. To access the device management is possible only using the CLI through the serial interface of the device.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

**Add**

Opens the *Create* window to assign a rule to a port or a VLAN.
- In the *Port/VLAN* field, you specify the number of the port or the VLAN ID to which the device applies the rule.
- In the *Priority* field, you specify the sequence in which the device applies the rules to the data stream.
- In the *Direction* field, you specify if the device applies the rule to data packets received or sent.
- In the *Group name* field, you specify which rule the device assigns to the port or VLAN.

**Remove**

Removes the selected table row.

**Group name**

Displays the name of the Access Control List. The Access Control List contains the rules.
Type

Displays if the Access Control List contains MAC rules or IPv4 rules.

Possible values:

- **mac**
  - The Access Control List contains MAC rules.

- **ip**
  - The Access Control List contains IPv4 rules.


Port

Displays the port to which the Access Control List is assigned. The field remains empty when the Access Control List is assigned to a VLAN.

VLAN ID

Displays the VLAN to which the Access Control List is assigned. The field remains empty when the Access Control List is assigned to a port.

Direction

Displays that the device applies the Access Control List to received data packets.

Priority

Displays the priority of the Access Control List.

Using the priority, you specify the sequence in which the device applies the Access Control Lists to the data stream. The device applies the rules in ascending order which starts with priority 1. If an Access Control List is assigned to a port and to a VLAN with the same priority, then the device applies the rules to the port first.

Possible values:

- **1..4294967295**

Active

Displays if the Access Control List on the port or in the VLAN is active.

Possible values:

- **marked** (default setting)
  - The Access Control List is active.

- **unmarked**
  - The Access Control List is inactive.
5 Virtual Private Network

The menu contains the following dialogs:
- VPN Overview
- VPN Certificates
- VPN Connections

5.1 VPN Overview

Virtual Private Networks (VPN) provide secure communications for remote users or branch offices, allowing them to connect to servers within other branch offices, or even other companies using public networks. Even though the VPN tunnel uses a public network, it has the same behavior as a private network.

VPN tunnels provide secure communications to support the current trend of increased telecommuting and global business operations. In such cases, remote users or branch offices are able to connect to each other and central resources.

To provide secure communications, VPNs use IP Security (IPSec). IPSec has 2 functions for providing confidentiality namely, data encryption and data integrity. To provide authentication and integrity of the source with encryption, the device uses the IPSec Encapsulating Security Payload (ESP). Only the sender and receiver know the security key.

The device also uses the Negotiated Security Association method. The first packet received initiates a negotiation, between the sender and receiver, for which security association (SA) parameters the devices are going to use. The devices use the Internet Key Exchange (IKE) for the negotiation process. When negotiating the parameters, the sending and receiving devices agree on the authentication and data-security methods. The devices also perform mutual authentication, and then generate a shared key. The devices use the shared key to encrypt the data contained in each packet.

The VPN LED is green if at least one VPN tunnel is active and established. The LED is a separate LED for VPN and as such is non-configurable for this device. The VPN LED only displays the status of the VPN tunnels.

The dialog contains tabs which display the current VPN tunnels and statuses.

The Connection errors tab displays detected errors that are helpful when troubleshooting a VPN tunnel.

The dialog contains the following tabs:
- [Overview]
- [Diagnostics]
- [Connection errors]
Connection

Connections (max.)

Displays the maximum number of VPN tunnels supported. The device limits maximum number of active VPN tunnels to the amount set in Max. active connections.

Max. active connections

Displays the maximum number of active VPN tunnels supported.

[Overview]

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

VPN index

Displays the table row index for unique identification of a VPN tunnel.

VPN description

Displays the user-defined name for the VPN tunnel.

VPN active

Displays if the VPN tunnel is active/inactive.

The device limits the maximum number of configured VPN tunnels to the value displayed in Connections (max.). The device also limits the maximum number of active VPN tunnels to the value specified in the Max. active connections column.

Possible values:

- **marked**
  - The VPN tunnel is active.
- **unmarked**
  - The VPN tunnel is inactive.

Used IKE version

Displays the version of the IKE protocol that the VPN tunnel uses.

Possible values:

- **ikev1**
  - The device uses the IKE version 1 (ISAKMP) protocol.
- **ikev2**
  - The device uses the IKE version 2 protocol.
Virtual Private Network

Startup

Displays the starting role for mediating the key exchange for VPN tunnel.

Possible values:

- **initiator**
  If you specify the role of the device as an *Initiator* for the VPN tunnel, then the device actively initiates the Internet Key Exchange (IKE) and parameter negotiation.

- **responder**
  If you specify the role of the device as a *Responder* for the VPN tunnel, then the device waits for the *Initiator* to begin a key exchange (IKE) and connection parameter negotiation.

Operational status

Displays the current status of the VPN tunnel.

Possible values:

- **up**
  The Internet Key Exchange-Security Association (IKE-SA) and every Internet Protocol Security-Security Association (IPsec-SA) is up.

- **down**
  The IKE-SA and IPsec-SAs are down.

- **negotiation**
  If you specify the VPN tunnel for this device as the *Initiator*, then the value indicates that the key exchange and negotiation algorithm is in progress. If the VPN tunnel for this device is the *Responder*, then the value indicates that the VPN tunnel is waiting for the process to begin.

- **constructing**
  The IKE-SA is up. However, the device has detected at least one unestablished IPsec-SA for this instance.

- **dormant**
  The device is waiting for you to complete the configuration before starting the VPN tunnel setup. For example, the device has an unsuccessful hostname resolution.

- **re-keying**
  The key exchange is in progress. The device displays the value after the expiration of either the IKE or the IPSEC lifetime timer.

Connection established [s]

Displays the time, in seconds, since the device established the VPN tunnel for this device. The device updates the value after every IKE re-authentication.
Local host

Displays the name and/or IP address of the local host that the device detected using IKE.

Possible values:
- Alphanumeric ASCII character string with 1..128 characters

Remote host

Displays the name and/or IP address of the remote host that the device detected using IKE.

Possible values:
- Alphanumeric ASCII character string with 1..128 characters

IKE proposal

Displays the algorithms that IKE uses for the key exchange.

The device displays a combination of the IKE key agreement, IKE integrity (MAC) and IKE encryption parameters.

If you configure an IKE algorithm for the device in the VPN Connections dialog, and the remote endpoint has a more secure algorithm configured, then it is possible that both the local and remote devices use the remote algorithm.

The device displays the current cipher suite used for the connection.

IPsec proposal

Displays the algorithms that IPsec uses for data communication.

The device displays a combination of the IPsec key agreement, IPsec integrity (MAC) and IPsec encryption parameters.

If you configure an IPsec algorithm for the instance in the VPN Connections dialog, and the remote endpoint has a better, more secure algorithm configured, then it is possible that both the local and remote devices use the better algorithm.

The device displays the current cipher suite used for the connection.

Tunnels

Displays the number of IPsec tunnels within the VPN network.
[Diagnostics]

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

VPN index

Displays the table row index for unique identification of a VPN tunnel.

VPN description

Displays the user-defined name for the VPN tunnel.

VPN active

Displays if the VPN tunnel is active/inactive.

The device limits the maximum number of configured VPN tunnels to the value displayed in Connections (max.). The device also limits the maximum number of active VPN tunnels to the value specified in the Max. active connections column.

Possible values:

- marked
  - The VPN tunnel is active.
- unmarked
  - The VPN tunnel is inactive.

Tunnel index

Displays the index value that, together with the value in the VPN index column, identifies the entry in the connection tunnel info table.

Traffic selector index

Displays the index value that, together with the value in the VPN index column, identifies the entry in the traffic selector table which is mapped into the IPsec tunnel.

Possible values:

- 0
  - The traffic selector index is unknown.
- 1..16

Operational status

Displays the current status of the VPN tunnel.

Possible values:

- up
  - The Internet Key Exchange-Security Association (IKE-SA) and every Internet Protocol Security-Security Association (IPsec-SA) is up.
- down
  - The IKE-SA and IPsec-SAs are down.
▲ negotiation
If you specify the VPN tunnel for this instance as the Initiator, then the value indicates that the key exchange and negotiation algorithm is in progress. If the VPN tunnel for this instance is the Responder, then the value indicates that the VPN tunnel is waiting for the process to begin.

▲ constructing
The IKE-SA is up. However, the device has detected at least one unestablished IPsec-SA for this instance.

▲ dormant
The device is waiting for you to complete the configuration before starting the VPN tunnel setup. For example, the device has an unsuccessful hostname resolution.

▲ re-keying
The key exchange is in progress. The device displays the value after the expiration of either the IKE or the IPSEC lifetime timer.

IKE re-authentication [s]
Displays the remaining time, in seconds, before the next IKE re-authentication. The value 0 indicates that re-authentication is unconfigured.

Next IKE re-keying [s]
Displays the remaining time, in seconds, before the next IKE re-key. The value 0 indicates that re-keying is unconfigured.

IKE initiator SPI
Displays the Security Parameter Index (SPI) of the Initiator, depending which device you specify as the Initiator. For example, when you specify this device as the Initiator, then this value is the SPI of the local device.

IKE responder SPI
Displays the SPI of the Responder, depending which device you specify as the Initiator. For example, when you specify this device as the Initiator, then this value is the SPI of the remote device.

Local traffic selector
Displays the local traffic selector for this IPsec tunnel. As a result of the negotiation process between the peers, the local traffic selector can be different from the configured traffic selector.

Remote traffic selector
Displays the remote traffic selector for this IPsec tunnel. As a result of the negotiation process between the peers, the traffic selector can be different from the configured traffic selector.

Tunnel status
Displays the current operational status of the IPsec tunnel.

Possible values:
▲ unknown
The IPsec proposal is in progress. No traffic selectors or security parameters have been negotiated for this IPsec-SA.
created
The key exchange and the negotiation algorithm is finished for this IPsec-SA, but the tunnel is inactive.

routed
The encryption policies for the data stream are established, but the negotiation process has not started.

installing
The peer authentication is established, but the IPsec proposal for this tunnel is still in progress.

installed
The IPsec-SA is installed.

updating
The device updates the security associations.

re-keying
The key exchange is in progress for this IPsec-SA. The device displays the value after the expiration of the IPsec lifetime timer.

re-keyed
The key exchange for this IPsec-SA is finished and the device creates a new tunnel. The tunnel is active after the expiration of the previous IPsec proposal.

re-trying
The key exchange for this IPsec-SA failed. The device will automatically try to initiate a new key exchange.

deleting
The device replaces the IPsec tunnel during re-keying. The device keeps the tunnel open till the processing of delayed packets, which is default set to 5 seconds. After the IPsec lifetime timer has expired, the device deletes the tunnel.

destroying
The IPsec lifetime timer has expired. The device deletes the tunnel.

IPsec input SPI
Displays IPSec Security Parameter Index (SPI) that the device applies to the data it receives from the VPN tunnel. The SPI lets the device select the SA under which it processes a received packet.

IPsec output SPI
Displays IPSec Security Parameter Index (SPI) that the device applies to the data it transmits to the VPN tunnel.

Next IPsec re-keying [s]
Displays the remaining time, in seconds, before the next re-keying starts for this IPsec tunnel.

IPsec tunnel input [byte]
Displays the number of bytes received into this VPN tunnel.

IPsec-tunnel input [packets]
Displays the number of packets received into this VPN tunnel.

Last IPsec data received [s]
Displays the time, in seconds, since the VPN tunnel has received the last time data.
IPsec tunnel output [byte]

Displays the number of bytes sent into this VPN tunnel.

IPsec tunnel output [packets]

Displays the number of packets sent into this VPN tunnel.

Last IPsec data transmitted [s]

Displays the time, in seconds, since the VPN tunnel has sent the last time data.

[Introduction to Connection errors]

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

VPN index

Displays the table row index for unique identification of a VPN tunnel.

VPN description

Displays the user-defined name for the VPN tunnel.

VPN active

Displays if the VPN tunnel is active/inactive.

The device limits the maximum number of configured VPN tunnels to the value displayed in Connections (max.). The device also limits the maximum number of active VPN tunnels to the value specified in the Max. active connections column.

Possible values:

- marked
  - The VPN tunnel is active.
- unmarked
  - The VPN tunnel is inactive.

Last connection error

Displays the last error notification that occurred for this VPN tunnel.

When the connection remains in the down state, this value is useful to help you isolate detected errors. This value helps you determine if a detected error occurred in the proposal exchange or during tunnel establishment.

Possible values:

- Alphanumeric ASCII character string with 1..512 characters
5.2 VPN Certificates

A Certificate Authority (CA) issues certificates to authenticate the identity of devices requesting a VPN tunnel. You configure the devices that form a VPN tunnel to trust the CA that signed the certificate. When a trusted CA issues a certificate, the device considers it to be valid. Using a trusted CA, lets you add, renew, and change the certificates loaded in the device without affecting the VPN. The prerequisite is, that the actual identity information is correct.

Using certificates also lets you reduce the required maintenance work. The reason for this is because you change certificates less often as you change pre-shared keys. The CA creates certificates with commence and expiration date. The certificate is only valid during this time. When a certificate expires, the device requires a new certificate.

You create a self signed certificate using the strongSwan application in conjunction with the Linux Operating System.

**Note:** RC2 certificate encryption algorithms are unsupported, for example PKCS12 containers with RC2 encryption or passphrase protection.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- **Remove**
  Removes the selected table row.

- **Upload**
  Opens the *Upload certificate* window to add a certificate to the table.
  - In the *Passphrase (private key)* field, you enter the passphrase used with this certificate.
    Possible values:
    - Alphanumeric ASCII character string with 0..128 characters
  - In the *URL* field, you enter the certificate file path.
  - When the certificate is located on your PC or on a network drive, click the area to select the file that contains the certificate.
Virtual Private Network

[Virtual Private Network > Certificates]

Index

Displays the table row index of the certificate entry.

Possible values:

► 1..100

File name

Displays the name of the file uploaded to the device.

Possible values:

► Alphanumeric ASCII character string with 1..64 characters

Subject

Displays the subject field of certificate.

The subject field of the certificate is a combination of the following items the country (C), state (ST), organization (O), organizational unit (OU), common name (CN), and email address of the recipient (emailAddress).

Possible values:

► Alphanumeric ASCII character string with 0..64 characters

Issuer

Displays the issuer of the certificate.

Possible values:

► Alphanumeric ASCII character string with 0..64 characters

Valid from

Displays the certificate commencement time and date.

Possible values:

► Date and time stamp

Valid until

Displays the certificate expiration time and date.

Possible values:

► Date and time stamp

Type

Displays the type of the container file used.

Possible values:

► ca
  The value indicates that the uploaded file is a certificate authority.

► peer
  The value indicates that the uploaded file is a peer certificate.
pkcs12
The value indicates that the uploaded file is a p12 bundle.

encryptedkey
The value indicates that the uploaded file is a key file with password encryption.

encryptedpkcs12
The value indicates that the uploaded file is a p12 bundle with password encryption.

Upload date
Displays the time and date of the last certificate upload.
Possible values:
► Date and time stamp

Private key status
Displays the status of the private key in the peer certificate. Use a peer certificate with a private key.
Possible values:
► none
The peer certificate does not contain a private key.
► present
The device has located and extracted the private key from the peer certificate.
► notFound
The device has located a private key. However, the key is missing the passphrase and the device has suspended the transfer.

Private key file
Displays the name of the private key file.
The device lets you enter alphanumeric characters plus hyphens, underscores and dots.
Possible values:
► Alphanumeric ASCII character string with 0..64 characters

Active connections
Displays the number of active connections that are using this certificate.
The device lets you delete the certificate only when the value is 0.
Possible values:
► 0..256
5.3 **VPN Connections**

This dialog lets you create, delete and edit VPN tunnels.

**Note:** The device uses software for DES and AES-Galois/Counter Mode (GCM) encryption.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- **Add**
  
  Opens the *Create* window to add a table row.
  
  In the *VPN description* field, you specify the user-defined description. To enter a new description, click the icon.
  
  Possible values:
  
  - Alphanumeric ASCII character string with 0..128 characters

- **Remove**
  
  Removes the selected table row.

- **Wizard**
  
  Opens the *Wizard* window that helps you associate the ports with the address of one or more desired senders. See “[Wizard: VPN configuration]” on page 239.

**VPN description**

Specifies the user-defined name for the VPN tunnel.

Possible values:

- Alphanumeric ASCII character string with 1..128 characters

**Traffic selector index**

Displays the index value that, together with the value in the *VPN index* column, identifies the entry in the traffic selector table.

Possible values:

- 1..16
  
  The device lets you specify any available value within the given range.
Status

Displays if the VPN tunnel is active/inactive.

The device limits the maximum number of configured VPN tunnels to the value displayed in Connections (max.). The device also limits the maximum number of active VPN tunnels to the value displayed in Max. active connections.

Possible values:

- **marked**
  The VPN tunnel is active.
- **unmarked** (default setting)
  The VPN tunnel is inactive.

Traffic selector description

Specifies the name of the traffic selector.

Possible values:

- Alphanumeric ASCII character string with 1..128 characters

Source address (CIDR)

Specifies the IP address and netmask of the source host. When the device forwards packets containing this source IP address over a VPN tunnel, the device applies the settings specified in this table row. Furthermore, the device applies the associated IPsec and IKE-SA settings, to every IP packet it forwards containing this address.

Possible values:

- Valid IPv4 address and netmask in CIDR notation
- **any** (default setting)
  The device applies the settings in this table row to every packet it forwards.

Source restrictions

Specifies the optional source restrictions using names or numbers entered as <protocol/port>. The device sends only the type of data specified through the VPN tunnel.

Examples:

- tcp/http is equal to 6/80
- udp is equal to udp/any
- /53 is equal to any/53

Possible values:

- Alphanumeric ASCII character string with 1..32 characters
- **<empty>** (default setting)
  The device uses any/any as the restriction.
Destination address (CIDR)

Specifies the IP address and netmask of the destination. When the device forwards packets containing this destination IP address over a VPN tunnel, the device applies the settings specified in this table row. Furthermore, for every IP packet the device forwards containing this address, it applies the associated IPsec and IKE-SA settings.

Possible values:
- Valid IPv4 address and netmask in CIDR notation
- any (default setting)
  The device applies the settings in this table row to every packet it forwards.

Destination restrictions

Specifies the optional destination restrictions using names or numbers entered as `<protocol/port>`. The device accepts only the type of data specified from the VPN tunnel.

Examples:
- tcp/http is equal to 6/80
- udp is equal to udp/any
- /53 is equal to any/53

Possible values:
- Alphanumeric ASCII character string with 1..32 characters
- <empty> (default setting)
  The device uses any/any as the restriction.

Version

Specifies the version of the IKE protocol for the VPN connection.

Possible values:
- auto (default setting)
  The VPN starts with protocol IKEv2 as the Initiator and accepts IKEv1/v2 as the Responder.
- ikev1
  The VPN starts with the IKEv1 (ISAKMP) protocol.
- ikev2
  The VPN starts with the IKEv2 protocol.

Startup

Specifies if the device starts this instance as a Responder or Initiator.

If you specify the local peer as the Responder, and the remote peer sends traffic to a specific selector, then the device attempts to establish the connection as the Responder. Establishing a connection as a Responder depends upon other settings for this connection. For example, if you specify in the Remote endpoint field the value any, then the device cannot initiate the connection.

Possible values:
- initiator
  If you specify that the device starts as an Initiator, then the device starts an key exchange with the Responder.
- responder (default setting)
  If you specify that the device starts as a Responder, then the device waits for the Initiator to start the key exchange and parameter negotiation.
DPD timeout [s]

Specifies the timeout, in seconds, before the local peer declares the remote peer dead, if the remote peer is unresponsive.

Possible values:

- 0..86400  (default setting: 120)
  
The value 0 disables this feature. The default setting is 2 minutes. The maximum setting is 24 hours.

IKE lifetime [s]

Specifies the lifetime, in seconds, of the IKE security association between two network devices to support secure communication. The devices establish a security association after exchanging a set of pre-defined keys.

Possible values:

- 300..86400  (default setting: 28800)
  
The default setting is 8 hours. The maximum setting is 24 hours.

IKE exchange mode

Specifies the use of the phase 1 exchange mode for IKEv1.

The purpose of IKE phase 1 is to establish a secure authenticated communication channel. The device uses the Diffie-Hellman key exchange algorithm to generate a shared secret key. The device then uses the shared secret key to further encrypt IKE communications.

Possible values:

- main  (default setting)
  
The main mode for phase 1 provides identity protection.
- aggressive
  
  You use the aggressive mode to reduce round trips.

Authentication type

Specifies the type of authentication that the device uses.

Possible values:

- psk  (default setting)
  
  Select this value for the device to use a key that was previously created and saved on both the remote and local devices.
- individualx509
  
  Select this value for the device to use an X509 certificate. Use a separate certificate for CA and local identification.
- pkcs12
  
  Select this value for the device to use a PKCS12 container with the needed certificates, which also includes the CA.
Pre-shared key

Specifies the pre-shared key. The prerequisite to use this parameter is that, in the **Authentication type** column, you specify the value `psk`.

Possible values:
- Alphanumeric ASCII character string with 0..128 characters excluding double-quote and newline characters
  
  The device also lets you create pre-shared secrets as hexadecimal or Base64 encoded binary values. The device interprets a character sequence starting with `0x` as a sequence with hexadecimal digits. Similarly, the device also interprets a character sequence starting with multiple zeros as Base64 encoded binary data.

IKE auth. cert. CA

Specifies the name of the certificate authority (CA) which issued the certificate. The device uses this certificate for signature verification of the local and remote certificates. The prerequisite to use this parameter is that, in the **Authentication type** column, you specify the value `individualx509`.

Possible values:
- Alphanumeric ASCII character string with 1..128 characters

IKE auth. cert. local

Specifies the file name of the certificate the local device uses. The device uses this certificate for authentication of the local peer on the remote side.

Possible values:
- Alphanumeric ASCII character string with 1..128 characters
  
  The behavior depends on the value you specify in the **Authentication type** column:
  - `individualx509`
    
    The certificate binds the identity of the local peer to the specified public key signed by the certification authority (CA) specified in the `IKE auth. cert. CA` column.
  - `pkcs12`
    
    The certificate in the PKCS bundle binds the identity of the local peer to the specified public key. The device performs this check independently of the certificate displayed in the `IKE auth. cert. CA` column.

IKE auth. cert. remote

Specifies the file name of the certificate the remote device uses. The device uses this certificate for authentication of the remote peer on the local side. This certificate binds the identity of the remote peer to the specified public key. The prerequisite to use this parameter is that, in the **Authentication type** column, you specify the value `individualx509`.

Possible values:
- Alphanumeric ASCII character string with 0..128 characters
  
  The value is optional, because the remote peer typically sends the certificate and the device only checks the validity of the certificate.

Encrypted private key

Specifies the file name for the private key.

Prerequisites:
- In the **Authentication type** column, specify the `individualx509` value.
- Encrypt the key saved in the device with a passphrase.
The key requires that, in the **Encrypted key/PKCS12 passphrase** column, you specify the passphrase. The device considers the key and the certificate unmatched until the key is decrypted.

Possible values:
- Alphanumeric ASCII character string with 0..128 characters

**Encrypted key/PKCS12 passphrase**

Specifies the passphrase that the device uses for decryption of the private key specified in the **Encrypted private key** column or **pkcs12** certificate container.

Possible values:
- Alphanumeric ASCII character string with 0..128 characters

**IKE local identifier type**

Specifies the type of local peer identifier that the device uses for the **IKE local ID** parameter.

Possible values:
- `default` (default setting)
  - The behavior depends on the value you specify in the **Authentication type** column:
    - `psk`
      - The device uses the IP address specified in the **Local endpoint** column as the local identifier.
    - `individualx509` or `pkcs12`
      - The device uses the distinguished name (DN) contained in the local **IKE auth. cert. local** certificate.
- `address`
  - In the **IKE local ID** column, the device uses the IP address or the DNS hostname specified in the **Local endpoint** column.
- `id`
  - The device identifies the value specified in the **IKE local ID** column as one of the following types:
    - An IPv4 address or a DNS hostname
    - A key identifier which specifies the data that the device uses to pass vendor-specific information. The device uses the information to identify which pre-shared key it uses for aggressive mode authentication during negotiations.
    - A FQDN (Fully Qualified Domain Name) web address, for example, `foo.bar.com`
    - An email address
    - The **ASN.1 X.500 Distinguished Name (DN)** contained within the **IKE auth. cert. remote** column. The local and remote devices exchange their certificates to establish the **security association (SA)**.

**IKE local ID**

Specifies the local peer identifier that the device sends to the remote device in the ID payload during phase 1 negotiations. The device uses the ID payload to identify the **Initiator** of the security association (SA). The **Responder** uses the identity to determine the correct host system policy requirement for the SA.

The formats for this parameter depend on the type specified in the **IKE local identifier type** column.
Possible values:
- <empty> (default setting)
  If in the IKE local identifier type column, you specify the value `id`, then specify the value using one of the following options:
  - An IPv4 address or a DNS hostname
  - A previously specified key identifier, specifying data that the device uses to pass vendor-specific information.
  - A FQDN web address, for example, `foo.bar.com`
  - An email address
  - An X.500 distinguished name

Remote identifier type

Specifies the type of remote peer identifier that the device uses for the Remote ID parameter.

Possible values:
- any (default setting)
  The device accepts each received remote identifier without further verification.
- address
  In the Remote ID column, the device uses the IP address or the DNS hostname specified in the Remote endpoint column.
- id
  The device identifies the value specified in the Remote ID column as one of the following types:
  - An IPv4 address or a DNS hostname
  - A key identifier which specifies the data that the device uses to pass vendor-specific information. The device uses the information to identify which pre-shared key it uses for aggressive mode authentication during phase 1 negotiations.
  - A FQDN web address, for example, `foo.bar.com`
  - An email address
  - The ASN.1 X.500 Distinguished Name (DN) contained within the IKE auth. cert. remote column. The local and remote devices exchange their certificates to establish the SA.

Remote ID

Specifies the remote peer identifier which the device compares with the value in the ID payload during phase 1 negotiations. The device uses the ID payload to identify the Initiator of the SA. The Responder uses the identity to determine the correct host system policy requirement for the SA.

The formats for this parameter depend on the type specified in the Remote identifier type column.

Possible values:
- <empty> (default setting)
  If in the Remote identifier type column, you specify the value `id`, then specify the value using one of the following options:
  - An IPv4 address or a DNS hostname
  - A previously specified key identifier, specifying data that the device uses to pass vendor-specific information.
  - A FQDN web address, for example, `foo.bar.com`
  - An email address
  - An X.500 distinguished name
IKE key agreement

Specifies which Diffie-Hellman (DH) key agreement algorithm the device uses for establishing the IKE-SA session key.

Possible values:

- **any**
  - The device accepts every algorithm when specified as the **Responder**.

- **modp1024** (default setting)
  - The value represents an RSA algorithm with 1024 bits modulus which is DH Group 2.

- **modp1536**
  - The value represents an RSA algorithm with 1536 bits modulus which is DH Group 5.

- **modp2048**
  - The value represents an RSA algorithm with 2048 bits modulus which is DH Group 14.

- **modp3072**
  - The value represents an RSA algorithm with 3072 bits modulus which is DH Group 15.

- **modp4096**
  - The value represents an RSA algorithm with 4096 bits modulus which is DH Group 16.

IKE integrity (MAC)

Specifies which IKE Integrity Message Authentication Code (MAC) algorithm the device uses. To help keep the information on the VPN secure, the Hash-based Message Authentication Code (HMAC) process in the sending device mixes (hashes) the message data with a shared secret key. The receiving device mixes the results (hash value) with the secret key again, and then applies the hash function a second time.

Possible values:

- **any**
  - When you specify the device as the **Responder**, the device accepts any algorithm. When you specify the device as the **Initiator**, the device uses various pre-defined algorithms.

- **hmacmd5**
  - The device uses the Message Digest algorithm 5 (MD5) for the hash function calculation.

- **hmacsha1** (default setting)
  - The device uses the Secure Hash Algorithm version 1 (SHA-1) for the hash function calculation.

- **hmacsha256**
  - The device uses SHA-256 (part of the version 2 family) for the hash function calculation which the device computes with 32 bit words.

- **hmacsha384**
  - The device uses SHA-384 (part of the version 2 family) for hash function calculation which the device computes using a shorter version of SHA-512.

- **hmacsha512**
  - The device uses SHA-512 (part of the version 2 family) for hash function calculation which the device computes with 64 bit words.

**Note:** We recommend to use the setting **hmacsha256** or higher.

IKE encryption

Specifies the IKE encryption algorithm that the device uses.

Possible values:

- **any**
  - When you specify the device as the **Responder**, the device accepts any algorithm. When you specify the device as the **Initiator**, the device uses various pre-defined algorithms.
Virtual Private Network
[Virtual Private Network > Connections]

- **des**
  The device uses the Data Encryption Standard (DES) block cipher for encryption of message data with a 56 bit key.

- **des3**
  The device uses the Triple DES block cipher for encryption of message data which applies the 56 bit key, from DES, 3 times to each block.

- **aes128** (default setting)
  The device uses the Advanced Encryption Standard (AES) with a block size of 128 bits, and a key length of 128 key bits.

- **aes192**
  The device uses the AES with a block size of 128 bits, and a key length of 192 key bits.

- **aes256**
  The device uses the AES with a block size of 128 bits, and a key length of 256 key bits.

**Note:** We recommend to use the setting **aes128** or higher.

### Local endpoint

Specifies the hostname or IP address of the local IPsec VPN tunnel endpoint.

Possible values:
- **any** (default setting)
  The device uses the IP address of the interface the device uses to forward data to the remote endpoint.
- Valid IPv4 address and netmask in CIDR notation
- hostname
  Alphanumeric ASCII character string with 1..128 characters

### Remote endpoint

Specifies the hostname or IP address of the remote IPsec VPN tunnel endpoint.

Possible values:
- **any** (default setting)
  The device accepts any IP address when establishing an IKE-SA as a VPN **Responder**.
- Valid IPv4 address and netmask in CIDR notation
  If you specify that the device is a **Responder** for this VPN tunnel, then the device accepts a network in CIDR notation, during IKE-SA establishment.
- hostname
  Alphanumeric ASCII character string with 1..128 characters

### Re-authentication

Activates/deactivates peer re-authentication after an IKE-SA re-key. If in the **Version** column, you specify the value **ikev1**, then the device constantly re-authenticates the VPN tunnel, even when you unmark the checkbox.

Possible values:
- **marked**
  The device creates a new IKE-SA and attempts to recreate the IPsec SAs.
- **unmarked** (default setting)
  When you use the IKEv2 protocol, the device re-keys the VPN tunnel and retains the IPsec SAs.
IPsec key agreement

Specifies which Diffie-Hellman key agreement algorithm the device uses for establishing the IPsec-SA session key. If the Perfect Forward Secrecy (PFS) function is enabled and a compromise of a single key occurs, then the integrity remains for subsequently generated keys.

Possible values:
- any
  - When you specify the device as the Responder, the device accepts every algorithm. When you specify the device as the Initiator, the device uses various pre-defined algorithms.
- modp1024 (default setting)
  - The value represents an Rivest, Shamir, and Adleman (RSA) algorithm with 1024 bits modulus. This value is Diffie-Hellman (DH) Group 2.
- modp1536
  - The value represents an RSA algorithm with 1536 bits modulus which is DH Group 5.
- modp2048
  - The value represents an RSA algorithm with 2048 bits modulus which is DH Group 14.
- modp3072
  - The value represents an RSA algorithm with 3072 bits modulus which is DH Group 15.
- modp4096
  - The value represents an RSA algorithm with 4096 bits modulus which is DH Group 16.
- none
  - The device disables the PFS function. Disabling the PFS function is considered a confidentiality violation and therefore a security risk.

IPsec integrity (MAC)

Specifies which IPsec Integrity MAC algorithm the device uses for the instance. To help keep the information on the VPN secure, the Hash-based Message Authentication Code (HMAC) process in the sending device mixes (hashes) the message data with a shared secret key. The receiving device mixes the results (hash value) with the secret key again, and then applies the hash function a second time.

Possible values:
- any
  - When you specify the device as the Responder, the device accepts every algorithm. When you specify the device as the Initiator, the device uses various pre-defined algorithms.
- hmacmd5
  - The device uses the Message Digest algorithm 5 (MD5) for the hash function calculation.
- hmacsha1 (default setting)
  - The device uses the Secure Hash Algorithm version 1 (SHA-1) for the hash function calculation.
- hmacsha256
  - The device uses SHA-256 (part of the version 2 family) for the hash function calculation which the device computes with 32 bit words.
- hmacsha384
  - The device uses SHA-384 (part of the version 2 family) for hash function calculation which the device computes using a shorter version of SHA-512.
- hmacsha512
  - The device uses SHA-512 (part of the version 2 family) for hash function calculation which the device computes with 64 bit words.

Note: We recommend to use the setting hmacsha256 or higher.
IPsec encryption

Specifies the IPsec encryption algorithm that the device uses.

Possible values:
- **any**
  - When you specify the device as the *Responder*, the device accepts any algorithm. When you specify the device as the *Initiator*, the device uses various pre-defined algorithms.
- **des**
  - The device uses the Data Encryption Standard (DES) block cipher for encryption of message data with a 56 bit key.
- **des3**
  - The device uses the Triple DES block cipher for encryption of message data which applies the 56 bit key, from DES, 3 times to each block.
- **aes128** (default setting)
  - The device uses the Advanced Encryption Standard (AES) with a block size of 128 bits, and a key length of 128 key bits.
- **aes192**
  - The device uses the AES with a block size of 128 bits, and a key length of 192 key bits.
- **aes256**
  - The device uses the AES with a block size of 128 bits, and a key length of 256 key bits.
- **aes128ctr**
  - AES-CTR with 128 key bits.
- **aes192ctr**
  - AES-CTR with 192 key bits.
- **aes256ctr**
  - AES-CTR with 256 key bits.
- **aes128gcm64**
  - The device uses the AES-Galois/Counter Mode (GCM) with a 64 bit Integrity Check Value (ICV) and 128 key bits.
- **aes128gcm96**
  - AES-GCM with a 96 bit ICV and 128 key bits.
- **aes128gcm128**
  - AES-GCM with a 128 bit ICV and 128 key bits.
- **aes192gcm64**
  - AES-GCM with a 64 bit ICV and 192 key bits.
- **aes192gcm96**
  - AES-GCM with a 96 bit ICV and 192 key bits.
- **aes192gcm128**
  - AES-GCM with a 128 bit ICV and 192 key bits.
- **aes256gcm64**
  - AES-GCM with a 64 bit ICV and 256 key bits.
- **aes256gcm96**
  - AES-GCM with a 96 bit ICV and 256 key bits.
- **aes256gcm128**
  - AES-GCM with a 128 bit ICV and 256 key bits.

**Note:** We recommend to use the setting **aes128** or higher.
IPsec lifetime [s]

Specifies the lifetime, in seconds, of the IPsec security association between 2 network devices to support secure communication. The devices establish a security association after exchanging a set of pre-defined keys.

Possible values:
- 300..28800 (default setting: 3600)
  The default setting is 1 hour. The maximum setting is 8 hours.

Margin time [s]

Specifies the period in seconds, beforeIKE lifetime [s] and IPsec lifetime [s] expire, after which the device attempts to negotiate a new key.

Possible values:
- 1..1800 (default setting: 150)
  The default setting is equal to 2.5 minutes. The maximum value is half an hour.

Log informational entries

Activates/deactivates event log entries for debugging proposes only.

Possible values:
- marked
  The device receives and processes the informational messages for this VPN tunnel, and enters the message in the event log.
- unmarked (default setting)
  The device receives and processes the informational messages for this connection, without an event log entry.

Log unhandled messages

Activates/deactivates message handling for messages unknown to strongSwan for debugging proposes only.

Possible values:
- marked
  The device enters the non-strongSwan messages received for this connection, in the event log.
- unmarked (default setting)
  The device ignores the non-strongSwan messages received for this connection.

[Wizard: VPN configuration]

The Wizard window lets you set up a VPN tunnel. The device also lets you create or change a VPN tunnel directly in the dialog.

The Wizard window guides you through the following steps:
- Create or select entry
- Authentication
- Endpoint and traffic selectors
- Advanced configuration
Create or select entry

VPN

Displays the existing VPN tunnels setup in the device. Select an entry to continue. Alternatively, specify a VPN tunnel in the **VPN index** and **VPN description** fields.

VPN index

Specifies the index number of the VPN tunnel.

Displays the index number to which the table row relates.

Possible values:

- 1..256

VPN description

Specifies the user-defined description for the VPN tunnel.

Possible values:

- Alphanumeric ASCII character string with 1..128 characters

Authentication

For each VPN tunnel you can specify the authentication methods using the following tabs:

- **Authentication - Pre-shared key**

Authentication - Pre-shared key

Pre-shared key

Specifies the pre-shared key. You can view the specified values by clicking the icon.

Possible values:

- Alphanumeric ASCII character string with 0..128 characters excluding double-quote and new line characters
  
  The device also lets you create pre-shared secrets as hexadecimal or Base64 encoded binary values. The device interprets a character sequence starting with 0x as sequence with hexadecimal digits. Similarly, the device also interprets a character sequence starting with multiple zeros as Base64 encoded binary data.
Authentication - X.509

IKE auth. cert. local

Specifies the name of the local peer identified in the certificate. The device uses this certificate for authentication of the local peer on the remote side. The certificate binds the identity of the local peer to the specified public key signed by the certification authority (CA) specified in the IKE auth. cert. CA field.

Possible values:
- Alphanumeric ASCII character string with 1..128 characters

IKE auth. cert. CA

Specifies the name of the certificate authority (CA) which issued the certificate. The device uses this certificate for signature verification of the local and remote certificates.

Possible values:
- Alphanumeric ASCII character string with 1..128 characters

Encrypted private key

Specifies the file name for the private key. The prerequisite is that you encrypt the key saved in the device with a passphrase. The key requires that, in the Encrypted key/PKCS12 passphrase field, you specify the passphrase. The device considers the key and the certificate unmatched until the key is decrypted.

Possible values:
- Alphanumeric ASCII character string with 0..128 characters

Encrypted key/PKCS12 passphrase

Specifies the passphrase that the device uses for decryption of the private key specified in the Encrypted private key field. You can view the passphrase by clicking the icon.

Possible values:
- Alphanumeric ASCII character string with 0..128 characters

Authentication - PKCS 12

IKE auth. cert. local

Specifies the name of the local peer identified in the certificate. The device uses this certificate for authentication of the local peer on the remote side.

Possible values:
- Alphanumeric ASCII character string with 1..128 characters

Encrypted key/PKCS12 passphrase

Specifies the passphrase that the device uses for decryption of the private key specified in the Encrypted private key field. You can view the passphrase by clicking the icon.
Possible values:
- Alphanumeric ASCII character string with 0..128 characters

**Endpoint and traffic selectors**

**Local endpoint**

Specifies the hostname or IP address of the local IPsec VPN tunnel endpoint.

Possible values:
- **any** (default setting)
  - The device uses the IP address of the interface the device uses to forward data to the remote endpoint.
- Valid IPv4 address and netmask in CIDR notation
- hostname
  - Alphanumeric ASCII character string with 1..128 characters

**Remote endpoint**

Specifies the hostname or IP address of the remote IPsec VPN tunnel endpoint.

Possible values:
- **any** (default setting)
  - The device accepts any IP address when establishing an IKE-SA as a VPN Responder.
- Valid IPv4 address and netmask in CIDR notation
  - If you specify that the device is a Responder for this VPN tunnel, then the device accepts a network in CIDR notation, during IKE-SA establishment.
- hostname
  - Alphanumeric ASCII character string with 1..128 characters

**Add traffic selector**

Traffic selector description

Specifies the user-defined description for the traffic selector.

Possible values:
- Alphanumeric ASCII character string with 1..128 characters

**Source address (CIDR)**

Specifies the IP address and netmask of the source host. When the device forwards packets containing this source IP address over a VPN tunnel, the device applies the settings specified in this field. Furthermore, the device applies the associated IPsec and IKE-SA settings, to every IP packet that the device forwards containing the source IP address in the range specified by the source IP and netmask.

Possible values:
- Valid IPv4 address and netmask in CIDR notation
- **any** (default setting)
  - The device applies the settings to every packet that the device forwards.
Source restrictions

Specifies the optional source restrictions using names or numbers entered as `<protocol/port>`. The device sends only the type of data specified through the VPN tunnel.

Examples:
- `tcp/http` is equal to `6/80`
- `udp` is equal to `udp/any`
- `/53` is equal to `any/53`

Possible values:
- Alphanumeric ASCII character string with 1..32 characters
- `<empty>` (default setting)
  - The device uses `any/any` as the restriction.

Destination address (CIDR)

Specifies the IP address and netmask of the destination. When the device forwards packets containing this destination IP address over a VPN tunnel, the device applies the settings specified in this field. Furthermore, the device applies the associated IPsec and IKE-SA settings to every IP packet that the device forwards containing the destination IP address in the range specified by the destination IP and netmask.

Possible values:
- Valid IPv4 address and netmask in CIDR notation
- `any` (default setting)
  - The device applies the settings to every packet that the device forwards.

Destination restrictions

Specifies the optional destination restrictions using names or numbers entered as `<protocol/port>`. The device accepts only the type of data specified from the VPN tunnel.

Examples:
- `tcp/http` is equal to `6/80`
- `udp` is equal to `udp/any`
- `/53` is equal to `any/53`

Possible values:
- Alphanumeric ASCII character string with 1..32 characters
- `<empty>` (default setting)
  - The device uses `any/any` as the restriction.

Removes the corresponding table row.

Add

Adds a table row to the Add traffic selector table.
Advanced configuration

For each VPN tunnel you can specify the parameters using the following tabs:

► Advanced configuration - General

Advanced configuration - General

Margin time [s]

Specifies the time in seconds before the connection or the keying channel expires. Afterwards, the device attempts to negotiate a replacement.

Possible values:

► 1..1800  (default setting: 150)
  The default setting is equal to 2.5 minutes. The maximum value is half an hour.

Advanced configuration - IKE/Key-exchange

Version

Specifies the version of the IKE protocol for the VPN connection.

Possible values:

► auto  (default setting)
  The VPN starts with protocol IKEv2 as the Initiator and accepts IKEv1/v2 as the Responder.
► ikev1
  The VPN starts with the IKEv1 (ISAKMP) protocol.
► ikev2
  The VPN starts with the IKEv2 protocol.

Startup

Specifies if the device starts this instance as a Responder or Initiator.

Possible values:

► initiator
  The device starts a key exchange with the Responder.
► responder  (default setting)
  The device waits for the Initiator to start the key exchange and parameter negotiation.
  If the remote peer sends traffic to a specific selector, then the device attempts to establish the connection as the Responder. Establishing a connection as a Responder depends upon other settings for this connection. For example, if you specify in the Remote endpoint field the value any, then the device prevents the remote device from initiating the connection.
DPD timeout [s]

Specifies the timeout, in seconds, before the local peer declares the remote peer dead, if the remote peer is unresponsive.

Possible values:
- 0
  Disables the timeout.
- 1..86400 (default setting: 120)
  The default setting is 2 minutes. The maximum setting is 24 hours.

IKE lifetime [s]

Specifies the lifetime, in seconds, of the IKE security association between two network devices to support secure communication. The devices establish a security association after exchanging a set of pre-defined keys.

Possible values:
- 300..86400 (default setting: 28800)
  The default setting is 8 hours. The maximum setting is 24 hours.

IKE local identifier type

Specifies the type of local peer identifier that the device uses for the IKE local ID parameter.

Possible values:
- default (default setting)
  The behavior depends on the value you specify in the following authentication methods:
  - Pre-shared key
    The device uses the IP address specified in the Local endpoint field as the local identifier. You find the Local endpoint field in section “Endpoint and traffic selectors” on page 242.
  - X.509 or PKCS 12
    The device uses the distinguished name (DN) contained in the local IKE auth. cert. local certificate.
- address
  In the IKE local ID field, the device uses the IP address or the DNS hostname specified in the Local endpoint field. You find the Local endpoint field in section “Endpoint and traffic selectors” on page 242.
- id
  The device identifies the value specified in the IKE local ID field as one of the following types:
  - An IPv4 address or a DNS hostname
  - A key identifier which specifies the data that the device uses to pass vendor-specific information. The device uses the information to identify which pre-shared key it uses for aggressive mode authentication during negotiations.
  - An FQDN (Fully Qualified Domain Name) web address, for example, foo.bar.com
  - An email address
  - The ASN.1 X.500 Distinguished Name (DN) contained within the IKE auth. cert. remote field. The local and remote devices exchange their certificates to establish the security association (SA).
Virtual Private Network
[Virtual Private Network > Connections]

IKE local ID

Specifies the local peer identifier that the device sends to the remote device in the ID payload during phase 1 negotiations. The device uses the ID payload to identify the Initiator of the security association (SA). The Responder uses the identity to determine the correct host system policy requirement for the security association (SA).

The formats for this parameter depend on the type specified in the IKE local identifier type field.

Possible values:
- <empty> (default setting)
- If in the IKE local identifier type field, you specify the value id, then specify the value using one of the following options:
  - An IPv4 address or a DNS hostname
  - A previously specified key identifier, specifying data that the device uses to pass vendor-specific information.
  - A FQDN web address, for example, foo.bar.com
  - An email address
  - An X.500 distinguished name

Remote identifier type

Specifies the type of remote peer identifier that the device uses for the Remote ID parameter.

Possible values:
- any (default setting)
- The device accepts each received remote identifier without further verification.
- address
  - In the Remote ID field, the device uses the IP address or the DNS hostname specified in the Remote endpoint field. You find the Remote endpoint field in section "Endpoint and traffic selectors" on page 242.
- id
  - The device identifies the value specified in the Remote ID field as one of the following types:
    - An IPv4 address or a DNS hostname
    - A key identifier which specifies the data that the device uses to pass vendor-specific information. The device uses the information to identify which pre-shared key it uses for aggressive mode authentication during negotiations.
    - A FQDN web address, for example, foo.bar.com
    - An email address
    - The ASN.1 X.500 Distinguished Name (DN) contained within the IKE auth. cert. remote field. The local and remote devices exchange their certificates to establish the SA.

Remote ID

Specifies the remote peer identifier which the device compares with the value in the ID payload during phase 1 negotiations. The device uses the ID payload to identify the Initiator of the SA. The Responder uses the identity to determine the correct host system policy requirement for the SA.

The formats for this parameter depend on the type specified in the Remote identifier type field.
Possible values:

- `<empty>` (default setting)
- If in the Remote identifier type field, you specify the value `id`, then specify the value using one of the following options:
  - An IPv4 address or a DNS hostname
  - A previously specified key identifier, specifying data that the device uses to pass vendor-specific information.
  - A FQDN web address, for example, `foo.bar.com`
  - An email address
  - An X.500 distinguished name

IKE exchange mode

Specifies the use of the phase 1 exchange mode for IKEv1.

The purpose of IKE phase 1 is to establish a secure authenticated communication channel. The device uses the Diffie-Hellman (DH) key exchange algorithm to generate a shared secret key. The device then uses the shared secret key to further encrypt IKE communications.

Possible values:

- `main` (default setting)
  The main mode for phase 1 provides identity protection.
- `aggressive`
  You use the aggressive mode to reduce round trips.

IKE key agreement

Specifies which Diffie-Hellman (DH) key agreement algorithm the device uses for establishing the IKE-SA session key.

Possible values:

- `any`
  The device accepts every algorithm when specified as the Responder.
- `modp1024` (default setting)
  The value represents an RSA algorithm with 1024 bits modulus which is DH Group 2.
- `modp1536`
  The value represents an RSA algorithm with 1536 bits modulus which is DH Group 5.
- `modp2048`
  The value represents an RSA algorithm with 2048 bits modulus which is DH Group 14.
- `modp3072`
  The value represents an RSA algorithm with 3072 bits modulus which is DH Group 15.
- `modp4096`
  The value represents an RSA algorithm with 4096 bits modulus which is DH Group 16.
IEEE integrity (MAC)

Specifies which IKE Integrity Message Authentication Code (MAC) algorithm the device uses. To help keep the information on the VPN secure, the Hash-based Message Authentication Code (HMAC) process in the sending device mixes (hashes) the message data with a shared secret key. The receiving device mixes the results (hash value) with the secret key again, and then applies the hash function a second time.

Possible values:

- **any**
  When you specify the device as the **Responder**, the device accepts every algorithm. When you specify the device as the **Initiator**, the device uses various pre-defined algorithms.

- **hmacmd5**
  The device uses the Message Digest algorithm 5 (MD5) for the hash function calculation.

- **hmacsha1** (default setting)
  The device uses the Secure Hash Algorithm version 1 (SHA-1) for the hash function calculation.

- **hmacsha256**
  The device uses SHA-256 (part of the version 2 family) for the hash function calculation which the device computes with 32 bit words.

- **hmacsha384**
  The device uses SHA-384 (part of the version 2 family) for hash function calculation which the device computes using a shorter version of SHA-512.

- **hmacsha512**
  The device uses SHA-512 (part of the version 2 family) for hash function calculation which the device computes with 64 bit words.

**Note:** We recommend to use the setting **hmacsha256** or higher.

IEEE encryption

Specifies the IKE encryption algorithm that the device uses.

Possible values:

- **any**
  When you specify the device as the **Responder**, the device accepts every algorithm. When you specify the device as the **Initiator**, the device uses various pre-defined algorithms.

- **des**
  The device uses the Data Encryption Standard (DES) block cipher for encryption of message data with a 56 bit key.

- **des3**
  The device uses the Triple DES block cipher for encryption of message data which applies the 56 bit key, from DES, 3 times to each block.

- **aes128** (default setting)
  The device uses the Advanced Encryption Standard (AES) with a block size of 128 bits, and a key length of 128 key bits.

- **aes192**
  The device uses the AES with a block size of 128 bits, and a key length of 192 key bits.

- **aes256**
  The device uses the AES with a block size of 128 bits, and a key length of 256 key bits.

**Note:** We recommend to use the setting **aes128** or higher.
**Advanced configuration - IPSec/Data-exchange**

**IPsec lifetime [s]**

Specifies the lifetime, in seconds, of the IPsec security association between 2 network devices to support secure communication. The devices establish a security association after exchanging a set of pre-defined keys.

Possible values:

- **300..28800** (default setting: **3600**)
  The default setting is 1 hour. The maximum setting is 8 hours.

**IPsec integrity (MAC)**

Specifies which IPsec Integrity MAC algorithm the device uses for the instance. To help keep the information on the VPN secure, the Hash-based Message Authentication Code (HMAC) process in the sending device mixes (hashes) the message data with a shared secret key. The receiving device mixes the results (hash value) with the secret key again, and then applies the hash function a second time.

Possible values:

- **any**
  When you specify the device as the Responder, the device accepts every algorithm. When you specify the device as the Initiator, the device uses various pre-defined algorithms.

- **hmacmd5**
  The device uses the Message Digest algorithm 5 (MD5) for the hash function calculation.

- **hmacsha1** (default setting)
  The device uses the Secure Hash Algorithm version 1 (SHA-1) for the hash function calculation.

- **hmacsha256**
  The device uses SHA-256 (part of the version 2 family) for the hash function calculation which the device computes with 32 bit words.

- **hmacsha384**
  The device uses SHA-384 (part of the version 2 family) for hash function calculation which the device computes using a shorter version of SHA-512.

- **hmacsha512**
  The device uses SHA-512 (part of the version 2 family) for hash function calculation which the device computes with 64 bit words.

**Note:** We recommend to use the setting **hmacsha256** or higher.

**IPsec encryption**

Specifies the IPsec encryption algorithm that the device uses.

Possible values:

- **any**
  When you specify the device as the Responder, the device accepts every algorithm. When you specify the device as the Initiator, the device uses various pre-defined algorithms.

- **des**
  The device uses the Data Encryption Standard (DES) block cipher for encryption of message data with a 56 bit key.

- **des3**
  The device uses the Triple DES block cipher for encryption of message data which applies the 56 bit key from DES, 3 times to each block.
The device uses the Advanced Encryption Standard (AES) with a block size of 128 bits, and a key length of 128 key bits.

- **aes192**
The device uses the AES with a block size of 128 bits, and a key length of 192 key bits.

- **aes256**
The device uses the AES with a block size of 128 bits, and a key length of 256 key bits.

- **aes128ctr**
  AES-CTR with 128 key bits.

- **aes192ctr**
  AES-CTR with 192 key bits.

- **aes256ctr**
  AES-CTR with 256 key bits.

- **aes128gcm64**
  AES-GCM with a 64 bit ICV and 128 key bits.

- **aes128gcm96**
  AES-GCM with a 96 bit ICV and 128 key bits.

- **aes128gcm128**
  AES-GCM with a 128 bit ICV and 128 key bits.

- **aes192gcm64**
  AES-GCM with a 64 bit ICV and 192 key bits.

- **aes192gcm96**
  AES-GCM with a 96 bit ICV and 192 key bits.

- **aes192gcm128**
  AES-GCM with a 128 bit ICV and 192 key bits.

- **aes256gcm64**
  AES-GCM with a 64 bit ICV and 256 key bits.

- **aes256gcm96**
  AES-GCM with a 96 bit ICV and 256 key bits.

- **aes256gcm128**
  AES-GCM with a 128 bit ICV and 256 key bits.

**Note:** We recommend to use the setting **aes128** or higher.

### IPsec key agreement

Specifies which Diffie-Hellman key agreement algorithm the device uses for establishing the IPsec-SA session key. If the **Perfect Forward Secrecy (PFS)** function is enabled and a compromise of a single key occurs, then the integrity remains for subsequently generated keys.

Possible values:

- **any**
  When you specify the device as the **Responder**, the device accepts every algorithm. When you specify the device as the **Initiator**, the device uses various pre-defined algorithms.

- **modp1024** (default setting)
  The value represents an Rivest-Shamir-Adleman (RSA) algorithm with 1024 bits modulus. This value is Diffie Hellman (DH) Group 2.

- **modp1536**
  The value represents an RSA algorithm with 1536 bits modulus which is DH Group 5.

- **modp2048**
  The value represents an RSA algorithm with 2048 bits modulus which is DH Group 14.

- **modp3072**
  The value represents an RSA algorithm with 3072 bits modulus which is DH Group 15.
- **modp4096**
  The value represents an RSA algorithm with 4096 bits modulus which is DH Group 16.

- **none**
  The device disables the PFS function. Disabling the PFS function is considered a confidentiality violation and therefore a security risk.
6 Switching

The menu contains the following dialogs:

- Switching Global
- Rate Limiter
- Filter for MAC Addresses
- QoS/Priority
- VLAN

6.1 Switching Global

This dialog lets you specify the following settings:

- Change the Aging time of the address table
- Enable the flow control in the device

If a large number of data packets are received in the priority queue of a port at the same time, then this can cause the port memory to overflow. This happens, for example, when the device receives data on a Gigabit port and forwards it to a port with a lower bandwidth. The device discards surplus data packets.

The flow control mechanism described in standard IEEE 802.3 helps ensure that no data packets are lost due to a port memory overflowing. Shortly before a port memory is completely full, the device signals to the connected devices that it is not accepting any more data packets from them.

- In full-duplex mode, the device sends a pause data packet.
- In half-duplex mode, the device simulates a collision.

Then the connected devices do not send any more data packets for as long as the signaling takes. On uplink ports, this can possibly cause undesired sending breaks in the higher-level network segment (“wandering backpressure”).

Configuration

**MAC address**

Displays the MAC address of the device.

**Aging time [s]**

Specifies the aging time in seconds.

Possible values:

- **10..500000** (default setting: 30)

The device monitors the age of the learned unicast MAC addresses. The device deletes address entries that exceed a particular age (aging time) from its address table.

You find the address table in the **Switching > Filter for MAC Addresses** dialog.

In connection with the router redundancy, specify a time ≥ 30 s.
Flow control

Activates/deactivates the flow control in the device.

Possible values:

- **marked**
  The flow control is active in the device.
  Additionally activate the flow control on the required ports. See the Basic Settings > Port dialog, Configuration tab, checkbox in the Flow control column.

- **unmarked**  (default setting)
  The flow control is inactive in the device.
6.2 Rate Limiter

The device lets you limit the traffic on the ports in order to help provide stable operation even with a large traffic volume. If the traffic on a port exceeds the traffic value entered, then the device discards the excess traffic on this port.

The rate limiter function operates only on Layer 2, and is used to limit the effects of storms of data packets that flood the device (typically Broadcasts).

The rate limiter function ignores protocol information on higher layers, such as IP or TCP.

The dialog contains the following tabs:

Ingress

In this tab you enable the Rate Limiter function. The threshold value specifies the maximum amount of traffic the port receives. If the traffic on this port exceeds the threshold value, then the device discards the excess traffic on this port.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Port

Displays the port number.

Threshold unit

Specifies the unit for the threshold value:

Possible values:

- \texttt{percent} (default setting)
  Specifies the threshold value as a percentage of the data rate of the port.

- \texttt{pps}
  Specifies the threshold value in data packets per second.

Broadcast mode

Activates/deactivates the rate limiter function for received broadcast data packets.

Possible values:

- \texttt{marked}
- \texttt{unmarked} (default setting)

If the threshold value is exceeded, then the device discards the excess broadcast data packets on this port.
Broadcast threshold

Specifies the threshold value for received broadcasts on this port.

Possible values:

▸ 0..14880000 (default setting: 0)
  
The value 0 deactivates the rate limiter function on this port.
  □ If you select the value percent in the Threshold unit column, then enter a percentage value from 1 to 100.
  □ If you select the value pps in the Threshold unit column, then enter an absolute value for the data rate.

Multicast mode

Activates/deactivates the rate limiter function for received multicast data packets.

Possible values:

▸ marked
▸ unmarked (default setting)

If the threshold value is exceeded, then the device discards the excess multicast data packets on this port.

Multicast threshold

Specifies the threshold value for received multicasts on this port.

Possible values:

▸ 0..14880000 (default setting: 0)
  
The value 0 deactivates the rate limiter function on this port.
  □ If you select the value percent in the Threshold unit column, then enter a percentage value from 0 to 100.
  □ If you select the value pps in the Threshold unit column, then enter an absolute value for the data rate.

Unknown unicast mode

Activates/deactivates the rate limiter function for received unicast data packets with an unknown destination address.

Possible values:

▸ marked
▸ unmarked (default setting)

If the threshold value is exceeded, then the device discards the excess unicast data packets on this port.
Unicast threshold

Specifies the threshold value for received unicasts with an unknown destination address on this port.

Possible values:

- $0..14880000$ (default setting: $0$)
  - The value $0$ deactivates the rate limiter function on this port.
  - If you select the value $\text{percent}$ in the Threshold unit, then enter a percentage value from $0$ to $100$.
  - If you select the value $\text{pps}$ in the Threshold unit column, then enter an absolute value for the data rate.
6.3 Filter for MAC Addresses

This dialog lets you display and edit address filters for the address table. Address filters specify the way the data packets are forwarded in the device based on the destination MAC address.

Each table row represents one filter. The device automatically sets up the filters. The device lets you set up additional filters manually.

The device transmits the data packets as follows:
- When the table contains the destination address of a data packet, the device transmits the data packet from the receiving port to the port specified in the table row.
- When there is no table entry for the destination address, the device transmits the data packet from the receiving port to every other port.

Table

To delete the learned MAC addresses from the address table, click in the Basic Settings > Restart dialog the Reset MAC address table button.

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row.
- In the Address field, you specify the destination MAC address.
- In the VLAN ID field, you specify the ID of the VLAN.
- In the Port field, you specify the port.
  - Select one port if the destination MAC address is a unicast address.
  - Select one or more ports if the destination MAC address is a multicast address.
  - Select no port to create a discard filter. The device discards data packets with the destination MAC address specified in the table entry.

Remove

Removes the selected table row.

Reset MAC address table

Removes the MAC addresses from the forwarding table that have the value learned in the Status column.

Address

Displays the destination MAC address to which the table row applies.
VLAN ID

Displays the ID of the VLAN to which the table row applies.

The device learns the MAC addresses for every VLAN separately (independent VLAN learning).

Status

Displays how the device has set up the address filter.

Possible values:
- **learned**: Address filter set up automatically by the device based on received data packets.
- **permanent**: Address filter set up manually. The address filter stays set up permanently.
- **mgmt**: MAC address of the device. The address filter is protected against changes.

<Port number>

Displays how the corresponding port transmits data packets which it directs to the adjacent destination address.

Possible values:
- **-**: The port does not transmit any data packets to the destination address.
- **learned**: The port transmits data packets to the destination address. The device created the filter automatically based on received data packets.
- **unicast static**: The port transmits data packets to the destination address. A user created the filter.
- **multicast static**: The port transmits data packets to the destination address. A user created the filter.

### 6.4 QoS/Priority

Communication networks transmit a number of applications at the same time that have different requirements as regards availability, bandwidth and latency periods.

QoS (Quality of Service) is a procedure defined in IEEE 802.1D. It is used to distribute resources in the network. You therefore have the possibility of providing minimum bandwidth for necessary applications. The prerequisite is that the end devices and the devices in the network support prioritized data transmission. Data packets with high priority are given preference when transmitted by devices in the network. You transfer data packets with lower priority when there are no data packets with a higher priority to be transmitted.

The device provides the following setting options:
- You specify how the device evaluates QoS/prioritization information for inbound data packets.
- For outbound packets, you specify which QoS/prioritization information the device writes in the data packet (for example priority for management packets, port priority).
**Note:** If you use the functions in this menu, then disable the flow control. The flow control is inactive if in the *Switching > Global* dialog, *Configuration* frame the *Flow control* checkbox is unmarked.

The menu contains the following dialogs:

- QoS/Priority Global
- QoS/Priority Port Configuration
- 802.1D/p Mapping
6.4.1 QoS/Priority Global

The device lets you maintain access to the device management, even in situations with heavy utilization. In this dialog you specify the required QoS/priority settings.

Configuration

VLAN priority for management packets

Specifies the VLAN priority for sending management data packets. Depending on the VLAN priority, the device assigns the data packet to a specific traffic class and thus to a specific priority queue of the port.

Possible values:

- 0..7 (default setting: 0)

In the Switching > QoS/Priority > 802.1D/p Mapping dialog, you assign a traffic class to every VLAN priority.

IP DSCP value for management packets

Specifies the IP DSCP value for sending management data packets. Depending on the IP DSCP value, the device assigns the data packet to a specific traffic class and thus to a specific priority queue of the port.

Possible values:

- 0 (be/cs0)..63 (default setting: 0 (be/cs0))

Some values in the list also have a DSCP keyword, for example 0 (be/cs0), 10 (af11) and 46 (ef). These values are compatible with the IP precedence model.

Queues per port

Displays the number of priority queues per port.

The device has 8 priority queues per port. You assign every priority queue to a specific traffic class (traffic class according to IEEE 802.1D).
## 6.4.2 QoS/Priority Port Configuration

In this dialog you specify for every port how the device processes received data packets based on their QoS/priority information.

### Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>Port</th>
<th>Displays the port number.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port priority</td>
<td>Specifies what VLAN priority information the device writes into a data packet if the data packet contains no priority information. After this, the device transmits the data packet depending on the value specified in the Trust mode column.</td>
</tr>
</tbody>
</table>

Possible values:
- 0..7 (default setting: 0)
6.4.3 **802.1D/p Mapping**

The device transmits data packets with a VLAN tag according to the contained QoS/priority information with a higher or lower priority.

In this dialog you see which VLAN priority is assigned to which traffic class. You assign the traffic classes to the priority queues of the ports.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>VLAN priority</th>
<th>Displays the VLAN priority.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic class</td>
<td>Displays the traffic class assigned to the VLAN priority.</td>
</tr>
</tbody>
</table>

Possible values:

- **0..7**
  - 0 assigned to the priority queue with the lowest priority.
  - 7 assigned to the priority queue with the highest priority.

**Note:** Among other things redundancy mechanisms use the highest traffic class. Therefore, select another traffic class for application data.

### Default assignment of the VLAN priority to traffic classes

<table>
<thead>
<tr>
<th>VLAN Priority</th>
<th>Traffic class</th>
<th>Content description according to IEEE 802.1D</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>Best Effort</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Normal data without prioritizing</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>Background</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-time-sensitive data and background services</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Normal data</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Excellent Effort</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crucial data</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Controlled Load</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time-sensitive data with a high priority</td>
</tr>
</tbody>
</table>
With VLAN (Virtual Local Area Network) you distribute the data traffic in the physical network to logical subnetworks. This provides you with the following advantages:

- **High flexibility**
  - With VLAN you distribute the data traffic to logical networks in the existing infrastructure. Without VLAN, it would be necessary to have additional devices and complicated cabling.
  - With VLAN you specify network segments independently of the location of the individual end devices.

- **Improved throughput**
  - In VLANs data packets can be transferred by priority. When the priority is high, the device transfers the data of a VLAN preferentially, for example for time-sensitive applications such as VoIP phone calls.
  - When the data packets and Broadcasts are distributed in small network segments instead of in the entire network, the network load is considerably reduced.

- **Increased security**
  The distribution of the data traffic among individual logical networks makes unwanted accessing more difficult and strengthens the system against attacks such as MAC Flooding or MAC Spoofing.

The device supports packet-based “tagged” VLANs according to the IEEE 802.1Q standard. The VLAN tagging in the data packet indicates the VLAN to which the data packet belongs.

The device transmits the tagged data packets of a VLAN only on ports that are assigned to the same VLAN. This reduces the network load.

The device learns the MAC addresses for every VLAN separately (independent VLAN learning).

The menu contains the following dialogs:

- VLAN Global
- VLAN Configuration
- VLAN Port

### VLAN Priority Traffic class Content description according to IEEE 802.1D

<table>
<thead>
<tr>
<th>VLAN Priority</th>
<th>Traffic class</th>
<th>Content description according to IEEE 802.1D</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>5</td>
<td>Video</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Video transmission with delays and jitter &lt; 100 ms</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>Voice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Voice transmission with delays and jitter &lt; 10 ms</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>Network Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Data for network management and redundancy mechanisms</td>
</tr>
</tbody>
</table>
6.5.1 VLAN Global

This dialog lets you view general VLAN parameters for the device.

**Configuration**

**Buttons**

- **Reset VLAN settings**

  Resets the VLAN settings of the device to the default setting.

  Note that you lose your connection to the device if you have changed the VLAN ID for the device management in the *Basic Settings > Network > Global* dialog.

**Max. VLAN ID**

Highest ID assignable to a VLAN.

See the *Switching > VLAN > Configuration* dialog.

**VLANs (max.)**

Displays the maximum number of VLANs possible.

See the *Switching > VLAN > Configuration* dialog.

**VLANs**

Number of VLANs currently configured in the device.

See the *Switching > VLAN > Configuration* dialog.

The VLAN ID 1 is constantly present in the device.
6.5.2 VLAN Configuration

In this dialog you manage the VLANs. To set up a VLAN, create a further table row. There you specify for each port if it transmits data packets of the respective VLAN and if the data packets contain a VLAN tag.

You distinguish between the following VLANs:

- The user sets up static VLANs.
- The device sets up dynamic VLANs automatically and removes them if the prerequisites cease to apply.

For the following functions the device creates dynamic VLANs:
- **Routing**: The device creates a VLAN for every router interface.

**Table**

For information on how to customize the appearance of the table, see "Working with tables" on page 16.

**Buttons**

- **Add**
  Opens the Create window to add a table row.

  In the **VLAN ID** field, you specify the ID of the VLAN.

- **Remove**
  Removes the selected table entry.

**VLAN ID**

ID of the VLAN.

The device supports up to 64 VLANs simultaneously set up.

Possible values:

- **1..4042**

**Status**

Displays how the VLAN is set up.

Possible values:

- **other**
  VLAN set up by the user.
  If you save the changes in the non-volatile memory, then the VLANs with this setting remain set up after a restart.
Creation time

Displays the time of VLAN creation.

The field displays the time stamp for the operating time (system uptime).

Name

Specifies the name of the VLAN.

Possible values:
- Alphanumeric ASCII character string with 1..32 characters

<Port number>

Specifies if the respective port transmits data packets of the VLAN and if the data packets contain a VLAN tag.

Possible values:
- - (default setting)
  The port is not a member of the VLAN and does not transmit data packets of the VLAN.
- T = Tagged
  The port is a member of the VLAN and transmits the data packets with a VLAN tag. You use this setting for uplink ports, for example.
- LT = Tagged Learned
  The port is a member of the VLAN and transmits the data packets with a VLAN tag. The device created the entry automatically based on the GVRP or MVRP function.
- F = Forbidden
  The port is not a member of the VLAN and does not transmit data packets of this VLAN.
- U = Untagged (default setting for VLAN 1)
  The port is a member of the VLAN and transmits the data packets without a VLAN tag. Use this setting if the connected device does not evaluate any VLAN tags, for example on end ports.
- LU = Untagged Learned
  The port is a member of the VLAN and transmits the data packets without a VLAN tag. The device created the entry automatically based on the GVRP or MVRP function.

Note: Verify that the port on which the network management station is connected is a member of the VLAN in which the device transmits the management data. In the default setting, the device transmits the management data on VLAN 1. Otherwise, the connection to the device terminates when you transfer the changes to the device. The access to the device management is possible only using the Command Line Interface through the serial interface.
6.5.3 VLAN Port

In this dialog you specify how the device handles received data packets that have no VLAN tag, or whose VLAN tag differs from the VLAN ID of the port.

This dialog lets you assign a VLAN to the ports and thus specify the port VLAN ID.

Additionally, you also specify for each port how the device transmits data packets and one of the following situations occurs:

- The port receives data packets without a VLAN tagging.
- The port receives data packets with VLAN priority information (VLAN ID 0, priority tagged).
- The VLAN tagging of the data packet differs from the VLAN ID of the port.

**Table**

For information on how to customize the appearance of the table, see "Working with tables" on page 16.

<table>
<thead>
<tr>
<th>Port</th>
<th>Displays the port number.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port-VLAN ID</td>
<td>Specifies the ID of the VLAN which the device assigns to data packets without a VLAN tag.</td>
</tr>
<tr>
<td>Prerequisites:</td>
<td>In the Acceptable packet types column, you specify the value admitAll.</td>
</tr>
<tr>
<td>Possible values:</td>
<td>ID of a VLAN you set up (default setting: 1)</td>
</tr>
<tr>
<td>Possible values:</td>
<td>4043..</td>
</tr>
<tr>
<td>Possible values:</td>
<td>The device assigns values &gt; 4042 for internal functions for example, for port-based router interfaces.</td>
</tr>
</tbody>
</table>

**Acceptable packet types**

Specifies if the port transmits or discards received data packets without a VLAN tag.

**Possible values:**

- admitAll (default setting)
  - The port accepts data packets both with and without a VLAN tag.
- admitOnlyVlanTagged
  - The port accepts only data packets tagged with a VLAN ID ≥ 1.
Ingress filtering

Activates/deactivates the ingress filtering.

Possible values:

- **marked** (default setting)
  The ingress filtering is active.
  The device compares the VLAN ID in the data packet with the VLANs of which the device is a member. See the *Switching > VLAN > Configuration* dialog. If the VLAN ID in the data packet matches one of these VLANs, then the port transmits the data packet. Otherwise, the device discards the data packet.

- **unmarked**
  The ingress filtering is inactive.
  The device transmits received data packets without comparing the VLAN ID. Thus the port also transmits data packets with a VLAN ID of which the port is not a member.
Switching
6.5.3 VLAN Port
7  **WAN**  (depends on hardware)

The menu contains the following dialogs:
- SHDSL/EFM  (depends on hardware)

### 7.1  **SHDSL/EFM**  (depends on hardware)

[**WAN > SHDSL/EFM**]

Single-Pair Highspeed Digital Subscriber Line (SHDSL) enables data transmission over copper pairs with symmetric upstream and downstream.

The device supports only the EFM interface of SHDSL (2BASE-TL). This lets you connect 2 EAGLE20/30 devices over existing telephone lines using Ethernet in full-duplex mode. Depending on interference, line quality, and speed, the devices can be several kilometers apart.

The device aggregates 2 pairs to a connection on the port only if they are present and correctly wired. This enables bandwidths according to IEEE 802.3-2008, Clause 63 (Section 5), of up to 2 × 5696 MBit/s per port.

The menu contains the following dialogs:
- SHDSL/EFM Configuration  (depends on hardware)
- SHDSL/EFM Statistics  (depends on hardware)
7.1.1 **SHDSL/EFM Configuration** (depends on hardware)

This dialog lets you specify the settings for the SHDSL ports.

**Note:** Use the SHDSL ports only for the purpose of connecting 2 EAGLE20/30 devices with each other. For data connections to public networks, you need an EFM connection on the provider side. Data connections between 2 devices are permitted only on one port. The device does not support link aggregation.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>Profile</th>
<th>Min data rate (kbit/s)</th>
<th>Max data rate (kbit/s)</th>
<th>Power (dBm)</th>
<th>Region</th>
<th>Constellation</th>
<th>Standard/Custom</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5696</td>
<td>5696</td>
<td>13.5</td>
<td>North America (Annex A sec. A.4.1)</td>
<td>32-TCPAM</td>
<td>Standard</td>
</tr>
<tr>
<td>2</td>
<td>3072</td>
<td>3072</td>
<td>13.5</td>
<td>North America (Annex A sec. A.4.1)</td>
<td>32-TCPAM</td>
<td>Standard</td>
</tr>
<tr>
<td>3</td>
<td>2048</td>
<td>2048</td>
<td>13.5</td>
<td>North America (Annex A sec. A.4.1)</td>
<td>16-TCPAM</td>
<td>Standard</td>
</tr>
<tr>
<td>4</td>
<td>1024</td>
<td>1024</td>
<td>13.5</td>
<td>North America (Annex A sec. A.4.1)</td>
<td>16-TCPAM</td>
<td>Standard</td>
</tr>
<tr>
<td>5</td>
<td>704</td>
<td>704</td>
<td>13.5</td>
<td>North America (Annex A sec. A.4.1)</td>
<td>16-TCPAM</td>
<td>Standard</td>
</tr>
<tr>
<td>6</td>
<td>512</td>
<td>512</td>
<td>13.5</td>
<td>North America (Annex A sec. A.4.1)</td>
<td>16-TCPAM</td>
<td>Standard</td>
</tr>
<tr>
<td>7</td>
<td>5696</td>
<td>5696</td>
<td>14.5</td>
<td>Europe (Annex B sec. A.4.1)</td>
<td>32-TCPAM</td>
<td>Standard</td>
</tr>
<tr>
<td>8</td>
<td>3072</td>
<td>3072</td>
<td>14.5</td>
<td>Europe (Annex B sec. A.4.1)</td>
<td>32-TCPAM</td>
<td>Standard</td>
</tr>
<tr>
<td>9</td>
<td>2048</td>
<td>2048</td>
<td>14.5</td>
<td>Europe (Annex B sec. A.4.1)</td>
<td>16-TCPAM</td>
<td>Standard</td>
</tr>
<tr>
<td>10</td>
<td>1024</td>
<td>1024</td>
<td>13.5</td>
<td>Europe (Annex B sec. A.4.1)</td>
<td>16-TCPAM</td>
<td>Standard</td>
</tr>
<tr>
<td>11</td>
<td>704</td>
<td>704</td>
<td>13.5</td>
<td>Europe (Annex B sec. A.4.1)</td>
<td>16-TCPAM</td>
<td>Standard</td>
</tr>
<tr>
<td>12</td>
<td>512</td>
<td>512</td>
<td>13.5</td>
<td>Europe (Annex B sec. A.4.1)</td>
<td>16-TCPAM</td>
<td>Standard</td>
</tr>
<tr>
<td>13</td>
<td>512</td>
<td>5696</td>
<td>0</td>
<td>North America (Annex A sec. A.4.1)</td>
<td>0</td>
<td>Custom</td>
</tr>
<tr>
<td>14</td>
<td>512</td>
<td>5696</td>
<td>0</td>
<td>Europe (Annex B sec. A.4.1)</td>
<td>0</td>
<td>Custom</td>
</tr>
<tr>
<td>15</td>
<td>192</td>
<td>192</td>
<td>0</td>
<td>North America (Annex A sec. A.4.1)</td>
<td>16-TCPAM</td>
<td>Custom</td>
</tr>
</tbody>
</table>
### WAN (depends on hardware)

#### [WAN > SHDSL/EFM > Configuration]

**Port**

Displays the port number.

**Operation mode**

Specifies the operating mode that the device applies to the pair.

Change the operating mode only if no connection through the port has been established. For the 2 pairs of a port, use the same operating mode.

Possible values:
- `ieee2BaseTLO` Operating mode “Office”
- `ieee2BaseTLR` Operating mode “Remote”

#### Admin profile

Specifies the SHDSL profile that the device applies to the pair. The prerequisite is that the device is operating in the operating mode “Office” (*Operation mode* column = `ieee2BaseTLO`).

A profile contains special settings for the data rate, annex, and modulation type.

Possible values:
- `efmCuFme2BProfile[1..20]`
  A profile containing special settings is assigned. See the following table.

---

### Table 3: Profiles with settings (cont.)

<table>
<thead>
<tr>
<th>Profile</th>
<th>Min data rate (kbit/s)</th>
<th>Max data rate (kbit/s)</th>
<th>Power (dBm)</th>
<th>Region</th>
<th>Constellation</th>
<th>Standard/Custom</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>256</td>
<td>256</td>
<td>0</td>
<td>North America (Annex A sec. A.4.1)</td>
<td>16-TCPAM</td>
<td>Custom</td>
</tr>
<tr>
<td>17</td>
<td>192</td>
<td>512</td>
<td>0</td>
<td>North America (Annex A sec. A.4.1)</td>
<td>16-TCPAM</td>
<td>Custom</td>
</tr>
<tr>
<td>18</td>
<td>192</td>
<td>192</td>
<td>0</td>
<td>Europe (Annex B sec. B.4.1)</td>
<td>16-TCPAM</td>
<td>Custom</td>
</tr>
<tr>
<td>19</td>
<td>256</td>
<td>256</td>
<td>0</td>
<td>Europe (Annex B sec. B.4.1)</td>
<td>16-TCPAM</td>
<td>Custom</td>
</tr>
<tr>
<td>20</td>
<td>192</td>
<td>512</td>
<td>0</td>
<td>Europe (Annex B sec. B.4.1)</td>
<td>16-TCPAM</td>
<td>Custom</td>
</tr>
</tbody>
</table>
(Grayed-out display)
You cannot specify a profile. The device is operating in the operating mode “Remote” (Operation mode column = ieee2BaseTLR).

- none-
No matching profile available.
7.1.2 **SHDSL/EFM Statistics** *(depends on hardware)*

This dialog displays information about the connection parameters.

- PAF (PME Aggregation Function) displays the parameters of the pairs of SHDSL ports aggregated into a connection.
- PME (Physical Medium Entity) displays the parameters of the individual pairs.

The dialog contains the following tabs:
- **[Port]**
- **[PME]**

**[Port]**

This tab displays the connection parameters of the SHDSL ports.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Port**

Displays the port number.

**Fault status**

Displays the possible cause for connection errors on the port. If the device does not detect a connection error, then the field remains empty.

Possible values:
- **noPeer**
  - No remote device accessible.
- **peerPowerLoss**
  - The power supply of the remote device has failed.
- **pmeSubTypeMismatch**
  - Contradictory operating modes are assigned to the pairs. See the **WAN > SHDSL/EFM > Configuration** dialog, **Operation mode** column.
- **lowRate**
  - The bandwidth falls below the threshold specified in the **efmCuThreshLowRate** MIB variable.
  - Default setting: 192 kbit/s.

**Port side**

Displays the operating mode that the device applies to the pairs.

Possible values:
- **office**
  - The port is operating in the operating mode “Office”.
The port is operating in the operating mode “Remote”.

No operating mode is assigned to the pairs.

Contradictory operating modes are assigned to the pairs. See the WAN > SHDSL/EFM > Configuration dialog, Operation mode column.

PMEs

Displays the number of pairs that the port currently uses.

PAF in errors

Displays the number of received erroneous packets that the device has discarded on the port.

PAF in small fragments

Displays the number of received fragments smaller than 64 bytes that the device has discarded on the port.

PAF in large fragments

Displays the number of received fragments larger than 512 bytes that the device has discarded on the port.

PAF in bad fragments

Displays the number of received fragments that the device discarded on the port because they do not fit into the sequence expected by the defragmentation function.

PAF in lost fragments

Displays the number of fragment gaps that the device received on the port.

PAF in lost starts

Displays the number of missing StartOfPacket indicators expected by the defragmentation function which the device has detected on the port.

PAF in lost ends

Displays the number of missing EndOfPacket indicators expected by the defragmentation function which the device has detected on the port.

PAF in overflows

Displays the number of received fragments that the device has discarded on the port, because this would have led to a buffer overflow of the defragmentation function.

This tab displays the connection parameters of the individual pairs.
Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Port

Displays the number of ports to which the pair belongs.

PME oper status

Displays the current operating status of the pair.

Possible values:
- **up**
  Connection established and operational.
- **downNotReady**
  No connection has been established. No handshake signals from the remote site can be detected.
- **downReady**
  No connection has been established. Handshake signals from the remote site can be detected.
- **init**
  The connection is being initialized.

Fault status

Displays the possible cause for connection errors on the pair. If the device does not detect a connection error, then the field remains empty.

Possible values:
- **lossOfFraming**
  Interruption of synchronization.
- **snrMgnDefect**
  The signal-to-noise ratio falls below the threshold.
- **lineAtnDefect**
  The line attenuation exceeds the threshold.
- **deviceFault**
  The device has detected a self-test error.
- **configInitFailure**
  Initialization error. The connection on the pair does not support the requested profile.
- **protocolInitFailure**
  Initialization error. The remote device is using an incompatible protocol.

Operation mode

Displays the operating mode that the device applies to the pair.

Possible values:
- **ieee2BaseTLO**
  Operating mode “Office”
- **ieee2BaseTLR**
  Operating mode “Remote”
Oper profile

Displays the SHDSL profile that the device applies to the pair.

Possible values:

► 1..20
   A profile containing special settings for the data rate, annex, and modulation type is assigned.

► 0
   The connection is being initialized.
   or
   The device is operating in the operating mode “Remote” (see the WAN > SHDSL/EFM > Configuration dialog, Operation mode column = ieee2BaseTLR).

SNR [dB]

Displays the current signal-to-noise ratio in dB on the pair (determined by the local device).

Possible values:

► -127..128
► 65535
   No connection has been established.
   or
   The connection is being initialized.

SNR remote [dB]

Currently the device does not support this function.

Line attenuation [dB]

Displays the current line attenuation in dB on the pair (determined by the local device).

Possible values:

► -127..128
► 65535
   No connection has been established.
   or
   The connection is being initialized.

Line attenuation remote [dB]

Currently the device does not support this function.

TC coding errors

Displays the number of 64/65 octet encapsulation errors the device has detected in the received data stream.

TC CRC errors

Displays the number of CRC errors the device has detected in the received data stream.
8 Routing

The menu contains the following dialogs:
- Routing Global
- Routing Interfaces
- ARP
- Open Shortest Path First
- Routing Table
- Tracking
- L3 Relay
- Loopback Interface
- L3-Redundancy
- NAT

8.1 Routing Global

The Routing menu lets you specify the Routing functions settings for transmitting data on Layer 3 of the ISO/OSI layer model.

For security reasons, the following functions are permanently disabled in the device:
- Source Routing
  With source routing, the data packet contains the routing information and overwrites the settings in the router with it.
- ICMP Redirects
  ICMP redirect data packets are able to modify the routing table. The device generally ignores received ICMP redirect data packets. The settings in the Routing > Interfaces > Configuration dialog, column ICMP redirects, have an effect only on the sending of ICMP redirect data packets.

In accordance with RFC 2644, the device does not exchange any broadcast data packets from external networks in a local network. This behavior supports you in protecting the devices in the local network against overloading, for example due to so-called smurf attacks.

This dialog lets you enable the routing function in the device and to specify further settings.

Operation

Enables/disables the Routing function in the device.

Possible values:
- **On**
  The Routing function is enabled.
  Also activate the routing function on the router interfaces. See the Routing > Interfaces > Configuration dialog.
- **Off** (default setting)
  The Routing function is disabled.
ICMP filter

In the ICMP filter frame, you have the option of limiting the transmission of ICMP messages on the set up router interfaces. A limitation is meaningful for several reasons:

- A large number of "ICMP Error" messages influences the router performance and reduces the available network bandwidth.
- Malicious senders use "ICMP Redirect" messages to perform man-in-the-middle attacks or to divert data packets through "black hole" for the purpose of supervision or denial-of-service (DoS).
- "ICMP Echo Reply" messages are ping responses which can be misused to discover vulnerable devices and routers in the network.

Send echo reply

Activates/deactivates the responding to pings on the router interfaces.

Possible values:

- marked (default setting)
  Responding to pings is active. The device reacts to received "IPv4 Echo Requests" and responds with an "ICMP Echo Reply" message.
- unmarked
  Responding to pings is inactive.

Send redirects

Activates/deactivates the sending of "ICMP Redirect" messages on the router interfaces.

Possible values:

- marked (default setting)
  The sending of "ICMP Redirect" messages is active. In the Routing > Interfaces > Configuration dialog, you have the option of individually activating the sending on every router interface. See the ICMP redirects function.
- unmarked
  The sending of "ICMP Redirect" messages is inactive. This setting helps prevent the multiplication of data packets, if both hardware and software functions of the device forward a copy of the same data packet.

Rate limit interval [ms]

Specifies the average minimum time in milliseconds between sending ICMP packets. The device sends existing ICMP packets to each receiver using a token bucket algorithm.

- In periods without sending ICMP packets, the device accumulates tokens to allow bursts.
- In the case of bursts, the interval is shorter than specified here.
Possible values:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0..2147483647</td>
<td>(default setting: 1000)</td>
</tr>
</tbody>
</table>

**Rate limit burst size**

Displays the maximum number of ICMP packets, the device sends during a burst to each receiver.

Possible values:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

**Information**

**Default TTL**

Displays the fixed TTL value 64 which the device adds to IP packets that the device management sends.

TTL (Time To Live, also known as “Hop Count”) identifies the maximum number of steps an IP packet is allowed to perform on the way from the sender to the receiver. Every router on the transmission path reduces the value in the IP packet by 1. If a router receives a data packet with the TTL value 1, then the router discards the IP packet. The router reports to the source that it has discarded the IP packet.

**8.2 Routing Interfaces**

This menu lets you specify the settings for the router interfaces.

The menu contains the following dialogs:

- Routing Interfaces Configuration
- Routing Interfaces Secondary Interface Addresses
8.2.1 Routing Interfaces Configuration

This dialog lets you specify the settings for the router interfaces.

To set up a port-based router interface, edit the table rows. To set up a VLAN-based router interface, use the Wizard window.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row. In the VLAN ID field, you specify the ID of the VLAN.

Remove

Removes the selected table row.

Wizard

Opens the Wizard window that helps you associate the ports with the address of one or more desired senders. See [Wizard: Configure VLAN router interface] on page 285.

Port

Displays the number of the port or VLAN belonging to the router interface.

Name

Name of the port.

Possible values:

- Alphanumeric ASCII character string with 0..64 characters
  - The device accepts the following characters:
    - <space>
    - 0..9
    - a..z
    - A..Z
    - !#$%&'()*+,-./:;<=>?@[\]^_`{}~
Port on

Activates/deactivates the port.

Possible values:

- **marked**  (default setting)
  The port is active.
- **unmarked**
  The port is inactive. The port does not send or receive any data.

Port status

Displays the operating state of the port.

Possible values:

- **up**
  The port is enabled.
- **down**
  The port is disabled.

IP address

Specifies the IP address for the router interface.

Possible values:

- **Valid IPv4 address**  (default setting: 0.0.0.0)

Verify that the IP subnet of the router interface is not overlapping with any subnet connected to another interface of the device:
- management port
- router interface
- loopback interface

Netmask

Specifies the netmask for the router interface.

Possible values:

- **Valid IPv4 netmask**  (default setting: 0.0.0.0)

Routing

Activates/deactivates the *Routing* function on the router interface.

In the process, the device removes the state information from the packet filter. This includes potential DCE RPC information of the OPC enforcer. In the process, the device interrupts open communication connections.
Routing

Routing > Interfaces > Configuration

Possible values:

- **marked**
  - The *Routing* function is active.
  - With port-based routing, the device transforms the port into a router interface.
  - Enabling the *Routing* function removes the port from the VLANs in which it was previously a member. Disabling the *Routing* function does not re-establish the assignment; the port is not a member of any VLAN.
  - With VLAN-based routing, the device forwards the data packets in the related VLAN.

- **unmarked** (default setting)
  - The *Routing* function is inactive.
  - With VLAN-based routing, the device is still reachable through the router interface if the IP address and netmask have been configured for the router interface.

### Proxy ARP

Activates/deactivates the *Proxy ARP* function on the router interface. This feature lets you connect devices from other networks as if these devices could be reached in the same network.

Possible values:

- **marked**
  - The *Proxy ARP* function is active.
  - The device responds to ARP requests from end devices that are located in other networks.

- **unmarked** (default setting)
  - The *Proxy ARP* function is inactive.

### MTU value

Specifies the maximum allowed size of IP packets on the router interface in bytes.

Possible values:

- **0**
  - Restores the default value (1500).

- **68..1500** (default setting: 1500)
  - The prerequisite is that on the ports belonging to the router interface you specify the maximum allowed size of Ethernet packets at least 18 bytes larger than specified here. See the Basic Settings > Port dialog, MTU column.

### ICMP unreachables

Displays if the sending of *ICMP Destination Unreachable* messages is active on the router interface.

Possible values:

- **marked**
  - The router interface sends *ICMP Destination Unreachable* messages.

### ICMP redirects

Displays if the sending of “ICMP Redirect” messages is active on the router interface.

Possible values:

- **marked**
  - The router interface sends “ICMP Redirect” messages.

- **unmarked** (default setting)
  - The router interface does not send “ICMP Redirect” messages.
[Wizard: Configure VLAN router interface]

This Wizard window lets you set up VLAN-based router interfaces.

The Wizard window guides you through the following steps:
- Create or select VLAN
- Setup VLAN

Create or select VLAN

VLAN ID

Displays the VLANs set up in the device. To continue, select an entry. Alternatively, specify a value in the VLAN ID field below.

VLAN ID

Specify the ID of a VLAN. Alternatively, select an entry in the VLAN ID overview above. You can also create a VLAN ID in the Switching > VLAN > Configuration dialog.

Possible values:
- 1..4042

Setup VLAN

VLAN ID

Displays the ID of the VLAN that you have specified in the preceding Wizard step.

Name

Specifies the name of the VLAN. This setting overwrites the setting specified for the port in the Switching > VLAN > Configuration dialog.

Possible values:
- Alphanumeric ASCII character string with 1..32 characters (hexadecimal ASCII code 0x20..0x7E) including space characters
<Port number>

Displays the port number.

Member

Activates/deactivates the VLAN membership of the port. As a VLAN member the port belongs to the router interface to be set up. This setting overwrites the setting for the port specified in the Switching > VLAN > Configuration dialog.

Possible values:
- marked
  The port is a member of the VLAN.
- unmarked
  The port is not a member of the VLAN.

Untagged

Activates/deactivates the transmission of data packets with a VLAN tag on the port. This setting overwrites the setting for the port specified in the Switching > VLAN > Configuration dialog.

Possible values:
- marked
  The port transmits the data packets without a VLAN tag.
  Use this setting if the connected device does not evaluate any VLAN tags, for example on ports to which an end device is directly connected.
- unmarked
  The port transmits the data packets with a VLAN tag.

Port-VLAN ID

Specifies the ID of the VLAN which the device assigns to data packets received without a VLAN tag. This setting overwrites the setting for the port specified in the Switching > VLAN > Port dialog, column Port-VLAN ID.

Possible values:
- ID of a VLAN you set up (default setting: 1)

Setup virtual router port

The device lets you specify up to 2 IP addresses (1 primary, 1 secondary) for a router interface and a total of up to 64 IP addresses.

When you assign ports to the router interface that already transmit data packets in other VLANs, the device displays a message upon closing the Wizard window:
- If you click the Yes button, then the related ports transmit the data packets from now on only in the router VLAN.
  In the Switching > VLAN > Configuration dialog, the related ports in the table row of the router VLAN have the value 0 or 1, in the table rows of other VLANs the value –.
- If you click the No button, then the related ports transmit the data packets in the router VLAN and in other VLANs. This setting possibly causes undesired behavior and may also pose a security risk.
Primary address

Address
Specifies the primary IP address for the router interface.
Possible values:
▶ Valid IPv4 address (default setting: 0.0.0.0)

Netmask
Specifies the primary netmask for the router interface.
Possible values:
▶ Valid IPv4 netmask (default setting: 0.0.0.0)

Secondary addresses

Address
Specifies a further IP address for the router interface (Multinetting).
Possible values:
▶ Valid IPv4 address (default setting: 0.0.0.0)

Note: Specify an IP address which is different from the primary IP address of the router interface.

Netmask
Specifies the netmask for the secondary IP address.
Possible values:
▶ Valid IPv4 netmask (default setting: 0.0.0.0)

Add
Creates a VLAN-based router interface.
8.2.2 Routing Interfaces Secondary Interface Addresses

This dialog lets you assign further IP addresses to the router interfaces. You use this function to connect a router interface to several subnets.

The device lets you specify up to 2 IP addresses (1 primary, 1 secondary) for a router interface and a total of up to 64 IP addresses.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add another IP address to the router interface selected in the table.

- In the Port drop-down list, you select the port number or VLAN ID belonging to the router interface.
- In the Additional IP address field, you specify the IP address.
  Possible values:
  - Valid IPv4 address
- In the Additional netmask field, you specify the netmask.
  Possible values:
  - Valid IPv4 netmask

Remove

Removes the selected table row.

Port

Displays the number of the port or VLAN belonging to the router interface.

IP address

Displays the primary IP address of the router interface. See the Routing > Interfaces > Configuration dialog.
Netmask

Displays the primary netmask of the router interface. See the Routing > Interfaces > Configuration dialog.

Additional IP address

Displays further IP addresses assigned to the router interface.

Additional netmask

Displays further netmasks assigned to the router interface.

8.3 ARP

The Address Resolution Protocol (ARP) learns the MAC address that belongs to an IP address.

The menu contains the following dialogs:

- ARP Global
- ARP Current
- ARP Static
8.3.1 ARP Global

This dialog lets you set the ARP parameters and view statistical values.

**Configuration**

Aging time [s]

Specifies the average time in seconds, after which the device removes an entry from the ARP table. The device actually removes an entry after a randomly determined time in the range (0.5 to 1.5)× of the value defined here.

When there is data exchange with the associated device within this time period, the time measuring begins from the start again.

Possible values:

- 15..21600 (default setting: 1200)

Response timeout [s]

Specifies the time in seconds, that the device waits for a response before the query is seen as a failure.

Possible values:

- 1..10 (default setting: 1)

Retries

Specifies how many times the device repeats a failed query before it discards the query to this address.

Possible values:

- 0..10 (default setting: 4)

**Information**

Current entries total

Displays the number of entries that the ARP table currently contains.

This includes:

- Addresses of the devices which are connected to the router interfaces. See the Routing > ARP > Current dialog.
- Addresses of the devices which are connected to the device management. See the Diagnostics > System > ARP dialog.

Entries (max.)

Displays how many entries the ARP table can contain at a maximum.
Total entry peaks

Displays how many entries the ARP table has already contained at a maximum.

To reset the counter to the value 0, in the Routing > ARP > Current dialog, click the 🗑 button.

Current static entries

Displays the number of statically configured entries the ARP table currently contains. See the Routing > ARP > Static dialog.

Static entries (max.)

Displays the number of statically configured entries the ARP table can contain at a maximum.
8.3.2 ARP Current

This dialog lets you view the ARP table and delete the dynamically configured entries.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- **Remove**
  Removes the selected table row.

- **Reset ARP table**
  Removes the dynamically set up addresses from the ARP table.

**Port**

Displays the router interface on which the device has learned the IP/MAC address assignment.

**IP address**

Displays the IP address of the device that responded to an ARP query on this router interface.

**MAC address**

Displays the MAC address of the device that responded to an ARP query on this router interface.

**Last updated**

Displays the time in seconds since the current settings of the entry were registered in the ARP table.

**Type**

Displays the way in which the ARP entry was set up.

**Possible values:**

- **dynamic**
  Dynamically configured entry.
  When no traffic with the associated device takes place by the end of the aging time, the device removes this entry from the ARP table.
  You specify the aging time in the Routing > ARP > Global dialog, field Aging time [s].
- **static**
  Statically configured entry.
  When you remove the dynamically configured addresses from the ARP table using the button, the entry remains.

- **local**
  Identifies the IP/MAC address assignment of the router interface.

- **invalid**
  Invalid entry.
8.3.3 **ARP Static**

This dialog lets you add to the ARP table IP/MAC address assignments that you have specified yourself.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- **Remove**
  Removes the selected table row.

- **Wizard**
  Opens the *Wizard* window that helps you associate the ports with the address of one or more desired senders. See “[Wizard: ARP]” on page 295.

**IP address**

Displays the IP address of the static ARP entry.

**MAC address**

Displays the MAC address that the device assigns to the IP address when answering an ARP request.

**Port**

Displays the router interface to which the device applies the IP/MAC address assignment.

**Possible values:**

- `<Router interface>`
  The device applies the IP/MAC address assignment to this router interface.
- `no port`
  The IP/MAC address assignment is currently not assigned to a router interface.

**Active**

Displays if the IP/MAC address assignment is active or inactive.

**Possible values:**

- `marked`
  The IP/MAC address assignment is active. The ARP table of the device contains the IP/MAC address assignment as a static entry.
- `unmarked` *(default setting)*
  The IP/MAC address assignment is inactive.
**Wizard: ARP**

The *Wizard* window lets you add the IP/MAC address assignments in the ARP table. The prerequisite is that at least one router interface is set up.

**Edit ARP table**

Perform the following steps:

- Specify the IP address and the associated MAC address.

**Note:** Verify the MAC address carefully. Doing so can help protect your network against unauthorized devices that might perform a Man-in-the-Middle (MITM) attack.

- Insert the IP/MAC address assignment in the _Static entries_ field. To do this, click the _Add_ button.
- Close the *Wizard* window. To do this, click the _Finish_ button.
- Specify the router interface in the _Port_ column.
- Enable the IP/MAC address assignment. To do this, mark the checkbox in the _Active_ column.

**Static entries**

Displays the created static entries. You can remove a static entry by clicking the ** icon.

**IP address**

Specifies the IP address of the static ARP entry.

Possible values:

- Valid IPv4 address

**MAC address**

Specifies the MAC address that the device assigns to the IP address when answering an ARP request.

Possible values:

- Valid MAC address

### 8.4 Open Shortest Path First

Open Shortest Path First (OSPF) version 2 is a routing protocol described in RFC 2328, which is applicable to networks with many routers.

In contrast to the hop count based distance-vector routing protocols such as RIP, OSPF provides a link state algorithm. OSPF bases its link state algorithm on link cost meaning that the criteria for the routing decisions are the path costs instead of hop counts. The path cost is calculated as \((100 \text{ Mbit/s}) / (\text{bandwidth in Mbit/s})\). OSPF also supports Variable Length Subnet Masking (VLSM) or Classless Inter-Domain Routing (CIDR) networks.
OSPF convergence of the entire network is slow. However, after initialization the protocol is quick in reacting to topology changes. The convergence time for OSPF is 5 to 15 seconds, depending on the size of the network.

OSPF supports networks grouped to "Areas" and thus reduces the administrative effort when maintaining the overall network (OSPF domain). The routers participating in the network know and only manage their own "Area" by flooding Link State Advertisements (LSAs) into the area. Using the LSAs each router builds its own topology database.

- The Area Border Routers (ABR) flood LSAs in an "Area" informing the local networks about destinations in other areas within the OSPF domain. The Designated Routers (DR) transmit LSAs informing about destinations in other areas.
- With Hello packets, neighboring routers periodically identify themselves and signal their availability. If a router misses the Hello packets of another router, then after the expiration of the dead-interval timer, the router considers this router as unreachable.

The device lets you use the md5 algorithm for data transmission. If you use the md5 mode, then specify the same values in the devices in the same area. Specify the area relevant values connected to the ABRs and ASBRs.

OSPF divides routers into the following roles:
- Designated Router (DR)
- Backup Designated Router (BDR)
- Area Border Router (ABR)
- Autonomous System Boundary Router (ASBR)

The menu contains the following dialogs:
- OSPF Global
- OSPF Areas
- OSPF Stub Areas
- OSPF Not So Stubby Areas
- OSPF Interfaces
- OSPF Virtual Links
- OSPF Ranges
- OSPF Diagnostics
### 8.4.1 OSPF Global

This dialog lets you specify the basic OSPF settings.

The menu contains the following dialogs:
- [General]
- [Configuration]
- [Redistribution]

#### [General]

This tab lets you enable the OSPF function in the device and to specify network parameters.

**Operation**

Enables/disables the OSPF function in the device.

Possible values:
- **On** (default setting)
  The OSPF function is enabled.
- **Off**
  The OSPF function is disabled.

**Configuration**

**Router ID**

Specifies the unique identifier for the router in the Autonomous System (AS). It influences the election of the Designated Router (DR) and the Backup Designated Router (BDR). Ideally, you use the IP address of a router interface in the device.

Possible values:
- `<IP address of an interface>` (default setting: 0.0.0.0)

**External LSDB limit**

Specifies the maximum number of entries, non-default AS-external-LSAs, that the device saves in the link state database. When this limit is reached, the router enters the overflow state.

Possible values:
- **-1** (default setting)
  The router continues to save entries until the memory is full.
- **0..2147483647**
  The device saves up to the specified number of entries.

Specify the same value in the routers on the OSPF backbone and in any regular OSPF area.
Routing
(Route > OSPF > Global)

External LSAs
Displays the current number of entries, non-default AS-external-LSAs, that the device currently holds in the link state database.

Autocost reference bandwidth
Specifies a reference for router interface bandwidth calculations, in Mbps. You use this value for metric calculations.

Possible values:
- 1..4294967 (default setting: 100)

Paths (max.)
Specifies the maximum number of ECMP routes that the OSPF function adds to the routing table when multiple routes exist for a subnet with same path costs, but different next hops.

Possible values:
- 1..4 (default setting: 4)
- 5..16
  Available when the ipv4DataCenter routing profile is currently applied. See the Routing profile frame in the Routing > Global dialog.

Default metric
Specifies the default metric value for the OSPF function.

Possible values:
- 0 (default setting)
  The OSPF function automatically assigns a cost of 20 for routes learned from external sources (static or directly connected).
- 1..16777214

Send trap
Activates/deactivates the sending of SNMP traps when the device detects a change in an OSPF parameter.

Possible values:
- marked
  The sending of SNMP traps is active.
  If the device detects changes in the OSPF parameters, then the device sends an SNMP trap.
- unmarked (default setting)
  The sending of SNMP traps is inactive.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.
**Shortest path first**

**Delay time [s]**

Specifies the delay time, in seconds, between when the router receives a topology change and when it starts an SPF calculation.

Possible values:
- \(0 \ldots 65535\) (default setting: 5)
  - The value 0 means that the router immediately begins the SPF calculation after receiving the topology change.

**Hold time [s]**

Specifies the minimum time, in seconds, between consecutive SPF calculations.

Possible values:
- \(0 \ldots 65535\) (default setting: 10)
  - The value 0 means that after the router completes an SPF calculation it immediately begins the next consecutive SPF calculation.

**Exit overflow interval [s]**

Specifies the number of seconds, after entering the overflow state, that a router attempts to leave the overflow state. When the router leaves the overflow state, the router transmits new non-default AS-external-LSAs.

Possible values:
- \(0 \ldots 2147483647\) (default setting: 0)
  - The value 0 means that the router remains in the Overflow-State until restarted.

**Information**

**ASBR status**

Displays if the device operates as an Autonomous System Boundary Router (ASBR).

Possible values:
- marked
  - The router is an ASBR.
- unmarked
  - The router functions in a role other than the role of an ASBR.

**ABR status**

Displays if the device operates as an Area Border Router (ABR).

Possible values:
- marked
  - The router is an ABR.
- unmarked
  - The router functions in a role other than the role of an ABR.
External LSA checksum

Displays the link state checksums of the external LSAs contained in the link state database. This value helps to determine when changes occur in a link state database of the router, and to compare the link state database to other routers.

New LSA originated

Displays the number of new link state advertisements originated on this router. The router increments this number each time it originates a new Link State Advertisement (LSA).

LSAs received

Displays the number of LSAs received that the router determined to be new instances. This number also excludes newer instances of self-originated LSAs.

[Configuration]

This dialog lets you specify the following settings:
- the manner in which the device calculates the path costs
- how the OSPF function handles default routes
- the type of route the OSPF function uses for the path-cost calculation

RFC 1583 compatibility

The Network Working Group is continually developing the OSPF function improving and adding parameters. This router provides parameters in accordance with RFC 2328. With parameters in this dialog, you make the router compatible with routers developed under RFC 1583. Activating the compatibility function lets you install this device in a network containing routers developed under RFC 1583.

RFC 1583 compatibility

Enables/disabled the device to be compatible with routers developed under RFC 1583.

In order to minimize the chance of routing loops, set this function to the same value on the OSPF enabled routers in an OSPF domain.

Possible values:
- **On** (default setting)  
  Enable the function when routers are present in the domain without software containing the external path preference functionality described in RFC 2328.
- **Off**  
  Disable the function when every router present in the domain has software containing the external path preference functionality described in RFC 2328.
**Preferences**

The preferences in this dialog are metrics values which the device uses as a tie breaker between identical routes with different distance types. For example, when a route is inside the local area (intra-area) and the other is outside the local area (inter-area or external). If the metric values are the same for intra, inter and external, then the order of preference is intra, inter then external.

The **OSPF** function considers routes specified with a preference value of 255 as unreachable.

**Preference (intra)**

Specifies the "administrative distance" between routers within the same area (intra-area OSPF routes).

Possible values:

- 1..255 (default setting: 110)

**Preference (inter)**

Specifies the "administrative distance" between routers in different areas (inter-area OSPF routes).

Possible values:

- 1..255 (default setting: 110)

**Preference (external)**

Specifies the "administrative distance" between routers external to the areas (external OSPF routes).

Possible values:

- 1..255 (default setting: 110)

**Default route**

**Advertise**

Activates/deactivates OSPF advertisements of default routes learned from other protocols.

For example, area border routers of stub areas advertise a default route into the stub area through summary link advertisements. When you configure the router as an AS boundary router, it advertises the default route in AS external link advertisements.

Possible values:

- **marked**
  - The router advertises default routes.
- **unmarked** (default setting)
  - The router suppresses advertisements of default routes.
Routing
[Routing > OSPF > Global]

Advertise always

Displays if the router constantly advertises 0.0.0.0/0 as the default route.

When routers forward an IP packet, the router constantly forwards the packet to the best matching destination address. A default route with a destination address of 0.0.0.0 and a mask of 0.0.0.0 is a match for every IP destination address. Matching every IP destination address lets an AS boundary router operate as a gateway for destinations outside of the AS.

Possible values:
- marked
  - The router constantly advertises 0.0.0.0/0 as the default route.
- unmarked (default setting)
  - The device uses the settings specified in the Advertise parameter.

Metric

Specifies the metric of the default route, which the OSPF function advertises when learned from other protocols.

Possible values:
- 0
  - The device uses the value specified in the Default metric field.
- 1..16777214

Metric type

Displays the metric type of the default route which the OSPF function advertises when learned from another protocol.

Possible values:
- externalType1
  - Includes both the external path cost from the ABR to the ASBR that originated the route plus the internal path cost to the ABR that advertised the route in the local area.
- externalType2 (default setting)
  - Includes only the external path cost.

[Redistribution]

A router with a disabled OSPF function on a routed interface does not propagate the network of this interface on its other interfaces. Thus, the network cannot be reached. To propagate such networks, enable the Redistribution for "connected" networks.

Redistribution is helpful in cases where multiple network administrators manage different departments, or in multi-vendor networks with multiple protocols. OSPF redistribution lets you convert route information such as cost and distance to a destination from other protocols into OSPF.

To help prevent routes from double redistribution and thus preventing a possible loop, use the Tag function. This function marks the routes redistributed from other protocols into OSPF. Then on the other routers in the network, create an ACL active to deny the tagged number. To specify exactly which routes the device distributes in OSPF, create ACL permit rules.

The number of routes that the device learns through the OSPF function is limited to the size of the routing table.
**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Source**

Displays the source protocol, from which the OSPF function redistributes routes. This object also acts as the identifier for the table row.

Activating a table row lets the device redistribute routes from the specific source protocol into OSPF.

**Possible values:**
- **connected**
  - The router is directly connected to the route.
- **static**
  - A network administrator has specified the route in the router.

**Active**

Activates/deactivates route redistribution from the source protocol into OSPF.

**Possible values:**
- **marked**
  - Redistribution of routes learned from the source protocol is active.
- **unmarked** (default setting)
  - OSPF route redistribution is inactive.

**Metric**

Specifies the metric value for routes redistributed from this protocol.

**Possible values:**
- **0** (default setting)
  - The device uses the value specified in the Default metric field.
- **1..16777214**

**Metric type**

Specifies the route metric type which the OSPF function redistributes from other source protocols.

**Possible values:**
- **externalType1**
  - This metric type includes both the external path cost from the ABR to the ASBR that originated the route plus the internal path cost to the ABR that advertised the route in the local area.
- **externalType2** (default setting)
  - This metric type is only that of the external path cost.
Tag

Specifies a tag for routes redistributed into the OSPF function.

When you set a route tag, the OSPF function assigns the value to every redistributed route from this source protocol. This function is useful when 2 or more border routers connect an autonomous system to an external network. To help prevent double redistribution, specify the same value in every border router when redistributing the same protocol.

Possible values:
- 0..4294967295 (default setting: 0)

Subnets

Activates/deactivates subnet route redistribution into the OSPF function.

The OSPF function only redistributes classful routes into the OSPF domain. In order to redistribute subnet routes into OSPF, activate the subnet parameter.

Possible values:
- marked (default setting)
  - The router redistributes classful and subnet routes into OSPF.
- unmarked
  - The router redistributes only classful routes into OSPF.

ACL group name

Specifies the name of the Access Control List created to filter routes received from the specified source protocol.

To help prevent double redistribution and eventual loops, create an access list denying redistribution of routes originating in another protocol. Specify the access list ID, then activate the function in the ACL active column. When filtering redistributed routes, the device uses the source address.

Possible values:
- - (default setting)
  - No Access Control List assigned.
- <Group name> (IPv4)

ACL active

Activates/deactivates Access Control List filtering for this source protocol.

Possible values:
- marked
  - The router filters redistribution of routes according to the specified Access Control List.
- unmarked (default setting)
  - The router ignores Access Control List filtering for this source protocol.
8.4.2 **OSPF Areas**

OSPF supports networks divided into "Areas" and thus reduces the administrative effort when maintaining the network. The routers participating in the network know and only manage their own "Area" by flooding Link State Advertisements (LSAs) into the area. Using the LSAs, each router builds its own topology database.

The device lets you specify up to a total of 64 OSPF Areas.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

**Add**

Opens the *Create* window to add a table row.

- In the *Area ID* field you specify the area ID for the new table row.
  - Possible values:
    - Octet value displayed like an IPv4 address

**Remove**

Removes the selected table row.

**Area ID**

Displays the area ID.

**Area type**

Specifies the import policy of AS external LSAs for the area which determines the Area Type.

OSPF import policies apply to external routes only. An external route is a route that is outside the OSPF autonomous system.

**Possible values:**

- *area* (default setting)
  - The router imports type 5 AS external LSAs into the area.
- *stub area*
  - The router ignores type 5 AS external LSAs.
- *nssa*
  - The router translates type 7AS external LSAs into type 5 NSSA summary LSAs and imports them into the area.
Routing
[Routing > OSPF > Areas]

SPF runs
Displays the number of times that the router calculated the intra-area routing table using the link state database of this area. The router uses Dijkstra's algorithm for route calculation.

Area border router
Displays the total number of ABRs reachable within this area. The number of reachable routers is initially 0. The OSPF function calculates the number in each SPF Pass.

AS boundary router
Displays the total number of ASBRs reachable within this area. The number of reachable ASBRs is initially 0. The OSPF function calculates the number in each SPF Pass.

Area LSAs
Displays the total number of link state advertisements in the link state database of this area, excluding AS External LSAs.

Area LSA checksum
Displays the total number of LS checksums contained in the LS database of this area. This sum excludes type 5 external LSAs. You use the sum to determine if there has been a change in an LS database of a router, and to compare the LS database to other routers.
8.4.3 OSPF Stub Areas

OSPF lets you specify certain areas as stub areas. The Area Border Router (ABR) of a stub area enters the information learned from AS external LSAs in its database without flooding the AS external LSAs across the stub area. The ABR instead sends a summary LSA into the stub area advertising a default route. The default route advertised in the summary LSA pertains only to the particular stub area. When forwarding data to AS external destinations, the routers in a stub area use the default ABR only. Sending a summary LSA containing the default route instead of AS external LSAs reduces the link state database size, and therefore the memory requirements for an internal router of a stub area.

The device gives you the following options for creating a Stub Area:

- **Convert an Area into a Stub Area.** To do this, perform the following step:
  - In the *Routing > OSPF > Areas* dialog, change the value in the *Area type* column to *Stub Area*.

- **Create a new Stub Area.** To do this, perform the following steps:
  - In the *Routing > OSPF > Areas* dialog, create a table row.
  - Change the value in the *Area type* column to *stub area*.

### Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>Area ID</th>
<th>Displays the area ID for the stub area.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default cost</td>
<td>Specifies the external metric value for the metric type.</td>
</tr>
</tbody>
</table>
| Possible values: | 0..16777215  
The router sets the default value to equal the lower cost within the area for the metric type. |
| Metric type | Specifies the type of metric used for the default route advertised into the area. |
| The border router of a stub area advertises a default route as a network summary LSA. |
| Possible values: | OSPF metric  (default setting)  
The ABR advertises the metric as OSPF internal, which is the cost of an intra-area route to the ABR.  
External type 1  
The ABR advertises the metric as External type 1, which is the cost of the OSPF internal metric plus external metric to the ASBR.  
External type 2  
The ABR advertises the metric as External type 2, which is the cost of the external metric to the ASBR. You use this value for NSSAs. |
Totally stub

Activates/deactivates the import of summary LSAs into stub areas.

Possible values:

- **marked**
  The router does not import area summaries. The stub area relies entirely on the default route. This makes the default route a Totally Stub Area.

- **unmarked** (default setting)
  The router both summarizes and propagates summary LSAs into the stub area.
8.4.4 OSPF Not So Stubby Areas

NSSAs are similar to the OSPF stub area. However, NSSAs have the additional capability of importing limited AS external routes. The ABR sends external routes out of the NSSA by converting type 7 AS external LSAs into type 5 AS external LSAs. The ASBR in an NSSA originates type 7 LSAs. The only difference between the type 5 and type 7 LSAs is that the router sets the "N" bit for NSSAs. Both NSSA neighbors have the "N" bit set. This forms the OSPF neighbor adjacency.

Beside the internal data traffic, NSSAs act like transit areas by transport data coming from external sources to other areas within the OSPF domain.

The device gives you the following options for creating an NSSA:

- Convert an Area into an NSSA. To do this, perform the following step:
  - In the Routing > OSPF > Areas dialog, change the value in the Area type column to nssa.

- Create a new NSSA. To do this, perform the following steps:
  - In the Routing > OSPF > Areas dialog, create a table row.
  - Change the value in the Area type column to nssa.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>Area ID</th>
<th>Displays the area ID to which the table entries apply.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redistribute</td>
<td>Activates/deactivates external route redistribution into the NSSA.</td>
</tr>
<tr>
<td>Possible values:</td>
<td></td>
</tr>
<tr>
<td>marked (default setting)</td>
<td></td>
</tr>
<tr>
<td>The NSSA ASBRs suppress external route redistribution into the NSSA. Furthermore, the ASBR stops to create type 7 external LSAs for external routes.</td>
<td></td>
</tr>
<tr>
<td>unmarked</td>
<td></td>
</tr>
<tr>
<td>The NSSA ASBRs redistribute external routes into the NSSA.</td>
<td></td>
</tr>
<tr>
<td>Originate default info</td>
<td>Activates/deactivates the creation of type 7 default LSAs.</td>
</tr>
<tr>
<td>The prerequisite for the creation of type 7 default LSAs is that the router is an NSSA ABR or ASBR.</td>
<td></td>
</tr>
<tr>
<td>Possible values:</td>
<td></td>
</tr>
<tr>
<td>marked</td>
<td></td>
</tr>
<tr>
<td>The router creates type 7 default LSAs and sends then into the NSSA.</td>
<td></td>
</tr>
<tr>
<td>unmarked (default setting)</td>
<td></td>
</tr>
<tr>
<td>The router suppresses type 7 default LSAs.</td>
<td></td>
</tr>
</tbody>
</table>
Default metric

Specifies the metric value advertised in the type 7 default LSA.

Possible values:
- **1..16777214** (default setting: 10)

Default metric type

Specifies the metric type advertised in the type 7 default LSA.

Possible values:
- **ospfMetric**
  - The router advertises the metric as OSPF internal, which is the cost of an intra-area route to the ABR.
- **comparable**
  - The router advertises the metric as external type 1, which is the cost of the OSPF internal metric plus external metric to the ASBR.
- **nonComparable**
  - The router advertises the metric as external type 2, which is the cost of the external metric to the ASBR.

Translator role

Specifies the ability of an NSSA border router to perform translation of type-7 LSAs into type-5 LSAs.

NSSA Area Border Routers receive type-5 LSAs containing information about external routes. The NSSA border routers block the type-5 LSAs from entering into the NSSA. However, using type-7 LSAs the border routers inform each other about external routes. The ABRs then translate the type-7 LSAs to type-5 external LSAs and flood the information to the rest of the OSPF network.

Possible values:
- **always**
  - The router translates type-7 LSAs to type-5 LSAs.
  - When the router receives a type-5 LSAs from another router with a router ID higher then its own, it flushes its type-5 LSAs.
- **candidate** (default setting)
  - The router translates type-7 LSAs to type-5 LSAs.
  - To help prevent routing loops, the OSPF function performs a translator election. When multiple candidates exist, the OSPF function elects the router with the higher router ID as the translator.

Translator status

Displays if and how the router is translating type-7 LSAs into type-5 LSAs.

Possible values:
- **enabled**
  - The Translator role of the router is set to always.
- **elected**
  - As a candidate, the NSSA Border router is translating type-7 LSAs into type-5.
- **disabled**
  - Another NSSA border router is translating type-7 LSAs into type-5 LSAs.
Translator stability interval [s]

Specifies the number of seconds after the router loses a translation election that it continues to translate type-7 LSAs into type-5 LSAs.

Possible values:

- **0..65535** (default setting: 40)

Translator events

Displays the number of translator status changes that have occurred since the last boot-up.

Discontinuities in the value of this counter occur while the OSPF function is disabled and can occur during re-initialization of the management system.

Totally NSSA

Activates/deactivates importation of summary routes into the NSSA as type 3 summary LSAs.

Possible values:

- **marked**
  
  The router suppresses summary route importation making the area a Totally NSSA.

- **unmarked** (default setting)
  
  The router imports summary routes into the NSSA as type 3 summary LSAs.
8.4.5 OSPF Interfaces

This dialog lets you specify, activate, and display OSPF parameters on the router interfaces.

The device lets you activate up to 64 OSPF router interfaces.

The device uses the OSPF routing protocol to exchange reachability information between the routers. The device uses routing information learned from peers to determine the next hop towards the destination. To route traffic correctly, the router authenticates OSPF protocol exchanges to help prevent malicious or incorrect routing information from getting introduced into the routing table.

The OSPF function supports multiple types of authentication. You configure the type of authentication in use on a per interface basis. The cryptographic authentication option \texttt{md5}, helps protect your network against passive attacks and helps provide significant protection against active attacks. When using the cryptographic authentication option, each router appends a "message digest" to its transmitted OSPF packets. Receivers then use the shared secret key and received digest to verify that each received OSPF packet is authentic.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Port

Displays the interface to which the table row applies.

IP address

Displays the IP address of this OSPF interface.

Active

Activates/deactivates the OSPF administrative status of the interface.

Possible values:

- marked
  The router advertises the values specified on the interface, and the interface as an OSPF internal route.

- unmarked (default setting)
  The interface is external to the OSPF function.

Area ID

Specifies the area ID of the domain to which the interface connects.

Possible values:

- <Area ID>
  You specify the area IDs in the Routing > OSPF > Areas dialog.
Priority

Specifies the priority of this interface.

In multi-access networks, the router uses the value in the Designated Router election algorithm. When a tie occurs, the routers use their router ID as a tie breaker. The highest router ID wins.

Possible values:

- **0**
  - The router is unable to become the Designated Router on this particular network.
- **1..255** (default setting: 1)

Transmit delay [s]

Specifies the estimated number of seconds it takes to transmit a link state update packet over this interface.

This setting is useful for low speed links. The timer increases the age of the LS updates to compensate for estimated delays on the interface. Increasing the packet age too much results in a reply that is younger than the original packet.

Possible values:

- **0..3600** (default setting: 1)

Retrans interval [s]

Specifies the number of seconds between link state advertisement retransmissions for adjacencies belonging to this interface.

You also use this value when retransmitting database description and link state request packets.

Possible values:

- **0..3600** (default setting: 5)

Hello interval [s]

Specifies the number of seconds between Hello packet transmissions on the interface.

Set this value the same for the routers attached to a common network. Verify that every router in an area has the same value.

Possible values:

- **1..65535** (default setting: 10)

Dead interval [s]

Specifies the number of seconds between received Hello packets before a router declares the neighbor router down.

Specify the value to a multiple of the Hello interval [s]. Specify the same value for the router interfaces within the same area.

Possible values:

- **1..65535** (default setting: 40)
  - Specify a lower value to get a faster detection of a neighbor in a down state.

Note: Lower values are prone to interoperability issues.
Routing

[Routing > OSPF > Interfaces]

Status

Displays the OSPF interface state.

Possible values:

- **down** (default setting)
  The interface is in the initial state and is blocking traffic.

- **loopback**
  The interface is a loopback interface of the device. Although packets are not sent out on the loopback interface, the router LSAs continue to advertise the interface address.

- **waiting**
  Applies only to interfaces connected to broadcast and Non-broadcast Multi-access (NBMA) network types. While in this state, the router attempts to identify the state of the network DR and BDR by sending and receiving Hello packets. The wait timer causes the interface to exit the waiting state and select a DR. The period of this timer is the same as the value in the *Dead interval [s]* field.

- **pointToPoint**
  Applies only to interfaces connected to point-to-point, point-to-multipoint, and virtual link network types. While in this state the interface sends Hello packets every *Hello interval [s]* and establishes an adjacency with its neighbor.

- **designatedRouter**
  The router is the DR for the multi-access network and establishes adjacencies with the other network routers.

- **backupDesignatedRouter**
  The router is the BDR for the multi-access network and establishes adjacencies with the other network routers.

- **otherDesignatedRouter**
  The router is only a network participant. The router establishes adjacencies only with the DR and BDR and tracks its network neighbors.

Designated router

Displays the IP address of the Designated Router.

Possible values:

- Valid IPv4 address (default setting: 0.0.0.0)

Backup designated router

Displays the IP address of the Backup Designated Router.

Possible values:

- Valid IPv4 address (default setting: 0.0.0.0)

Events

Displays the number of times this OSPF interface changed its state, or the router detected an error.

Network type

Specifies the OSPF network type of the autonomous system.

Possible values:

- **broadcast**
  Use this value for broadcast networks, such as Ethernet and IEEE 802.5. The OSPF function performs a DR and BDR election with which the non-designated routers form an adjacency.
nbma
Use this value for non-broadcast multi-access networks such as X.25 and similar technologies. The OSPF function performs a DR and BDR election to limit the number of adjacencies formed.

pointToPoint
Use this value for networks that link only 2 interfaces.

pointToMultipoint
Use this value when you collect several point-to-point links into a non-broadcast network. Every router in the network transmits Hello packets to other routers in the network, but without having a DR and BDR election.

Auth type
Specifies the authentication type for an interface.

If you specify simple or MD5, then this router requires other routers to pass an authentication process before this router accepts the other routers as neighbors.

If you use authentication to help protect your network, then use the same type and key for every router in your autonomous system.

Possible values:
- none (default setting)
  Network authentication is inactive.
- simple
  The router uses clear text authentication. In this case, routers transmit the passwords as clear text.
- MD5
  The router uses the message-digest algorithm MD5 authentication. This type of authentication helps make your network more secure.

Auth key
Specifies the authentication key.

After entering the field displays ***** (asterisk) instead of the authentication key.

Possible values:
- Alphanumeric ASCII character string with 16 characters
  - with 8 characters if in the Auth type drop-down list the simple item is selected
  - with 16 characters if in the Auth type drop-down list the MD5 item is selected
  If you specify a shorter authentication key, then the device fills in the remaining characters with 0.

Auth key ID
Specifies the MD5 authentication key ID value.

The cryptographic authentication option MD5, helps protect your network against passive attacks and helps provide significant protection against active attacks.

The prerequisite for changing the value is that, in the Auth type column, you specify the value MD5.
Routing

[Routing > OSPF > Interfaces]

Cost

Specifies the internal metric.

The OSPF function uses link cost as the metric. The OSPF function also uses the cost of a link to calculate the SPF routes. The OSPF function prefers the route with the smaller value.

The formula to calculate cost is reference bandwidth divided by interface bandwidth. Reference bandwidth is specified in the Autocost reference bandwidth field and is set to 100 Mbit/s by default. See the Routing > OSPF > Global dialog, General tab.

Example:

The interface bandwidth is 10 Mbit/s.

The metric is \( \frac{100 \text{ Mbit/s}}{10 \text{ Mbit/s}} = 10 \).

Possible values:

- **0..255** (default setting: 0)
  - The device calculates the metric and automatically adjusts the value when the interface bandwidth changes.

**Calculated cost**

Displays the metric value which the OSPF function currently uses for this interface.

**MTU ignore**

Activates/deactivates the IP MTU (Maximum Transmission Unit) mismatch detection on this OSPF interface.

Possible values:

- **marked**
  - Disables the IP MTU check and makes adjacencies possible when the MTU value differs on the interfaces.

- **unmarked** (default setting)
  - The router checks if neighbors are using the same MTU value on the interfaces.
8.4.6 OSPF Virtual Links

The OSPF function requires that you link every area to the backbone area. The physical location of routers often prohibits a direct link to the backbone. Virtual links allow you to connect physically separated areas to the backbone through a transit area. You specify both routers on the endpoints of a virtual link as ABRs on a point-to-point link.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row.

- In the Area ID drop-down list you select the area ID for the new table row.
- In the Neighbor ID field you specify the router ID of the virtual neighbor.

Remove

Removes the selected table row.

Area ID

Displays the area ID for the transit area that the virtual link traverses.

Neighbor ID

Displays the router ID of the virtual neighbor.

The router learns this value from Hello packets received from the virtual neighbor. The value is a static value for virtual adjacencies.

Transmit delay [s]

Specifies the estimated number of seconds it takes to transmit an LS update packet over this interface.

This setting is useful for low speed links. The timer increases the age of the LS updates to compensate for estimated delays on the interface. Increasing the packet age too much results in a reply that is younger than the original packet.
Routing

[Routing > OSPF > Virtual Links]

Possible values:
- 0..3600  (default setting: 1)

Retrans interval [s]

Specifies the number of seconds between the LS advertisement retransmissions for adjacencies belonging to this interface.

You also use this value when retransmitting Database Description (DD) and LS Request packets.

Possible values:
- 0..3600  (default setting: 5)

Dead interval [s]

Specifies the number of seconds between received Hello packets before a router declares the neighbor router down.

Specify the value to a multiple of the Hello interval [s]. Specify the same value for the router interfaces within the same area.

Possible values:
- 1..65535  (default setting: 40)
  Specify a lower value to get a faster detection of a neighbor in a down state.

Note: Lower values are prone to interoperability issues.

Hello interval [s]

Specifies the number of seconds between Hello packet transmissions on the interface.

Set this value the same for the routers attached to a common network.

Possible values:
- 1..65535  (default setting: 10)

Status

Displays the OSPF virtual interface state.

Possible values:
- down  (default setting)
  The interface is in the initial state and is blocking traffic.
- pointToPoint
  Applies only to interfaces connected to point-to-point, point-to-multipoint, and virtual link network types. While in this state the interface sends Hello packets every Hello interval [s] and establishes an adjacency with its neighbor.

Events

Displays the number of times this interface changed its state due to a received event.
Auth type

Specifies the authentication type for a virtual link.

If you specify simple or MD5, then this router requires other routers to pass an authentication process before this router accepts the other routers as neighbors.

If you use authentication to help protect your network, then use the same type and key for every router in your autonomous system.

Possible values:
- none (default setting)  
  Network authentication is inactive.
- simple  
  The router uses clear text authentication. In this case, routers transmit the passwords as clear text.
- MD5  
  The router uses the message-digest algorithm MD5 authentication. This type of authentication helps make your network more secure.

Auth key

Specifies the authentication key.

After entering the field displays ***** (asterisk) instead of the authentication key.

Possible values:
- Alphanumeric ASCII character string with 16 characters
  - with 8 characters if in the Auth type drop-down list the simple item is selected
  - with 16 characters if in the Auth type drop-down list the MD5 item is selected
  If you specify a shorter authentication key, then the device fills in the remaining characters with 0.

Auth key ID

Specifies the MD5 authentication key ID value.

The cryptographic authentication option md5, helps protect your network against passive attacks and helps provide significant protection against active attacks.

The prerequisite for specifying this value is that you specify in the Auth type column the value MD5.

Possible values:
- 0..255 (default setting: 0)
8.4.7 OSPF Ranges

In large areas, OSPF messages flooded across the network reduce available bandwidth and increase the size of the routing table. A large routing table increases the amount of CPU processing that the router requires to enter the information into the routing table. A large routing table also reduces available memory. To decrease the number of OSPF messages flooded across the network, the OSPF function lets you create several smaller subnets within a large area.

In order to summarize routing information into and out of a subnet, the Area Border Router (ABR) specifies the subnet as a single address range. The ABR advertises each address range as a single route to the external area. The IP address that the ABR advertises for the subnet is an address and mask pair. Unadvertised ranges allow you to hide the existence of subnets from other areas.

The router specifies cost of the advertised route as the greater cost in the set component subnets.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- **Add**
  
  Opens the Create window to add a table row.
  
  - In the **Area ID** drop-down list you select the area ID of the address range.
  
  - In the **LSDB type** drop-down list you select the route information aggregated by the address range.
    
    Possible values:
    
    - **summaryLink**
      
      The area range aggregates type 5 route information.
    
    - **nssaExternalLink**
      
      The area range aggregates type 7 route information.
  
  - In the **Network** field you specify the IP address for the area subnet.
  
  - In the **Netmask** field you specify the netmask for the area subnet.

- **Remove**
  
  Removes the selected table row.

**Area ID**

Displays the area ID of the address range.
LSDB type

Displays the route information aggregated by the address range.

Possible values:
- `summaryLink`
  - The area range aggregates type 5 route information.
- `nssaExternalLink`
  - The area range aggregates type 7 route information.

Network

Displays the IP address of the subnet of the range.

Netmask

Displays the netmask of the subnet of the range.

Effect

Specifies the external advertisement of the subnet ranges.

Possible values:
- `advertiseMatching` (default setting)
  - The router advertises the range in other areas.
- `doNotAdvertiseMatching`
  - The router withholds range advertisement to other external areas.
8.4.8 **OSPF Diagnostics**

To function properly, the **OSPF** function relies on 2 basic processes.

- forming adjacencies
- after forming adjacencies, the neighboring routers exchange information and update their routing table

The statistics displayed in the tabs help you to analyze the OSPF processes.

The dialog contains the following tabs:

- [Statistics]
- [Link state database]
- [Neighbors]
- [Virtual neighbors]
- [External link state database]
- [Route]

### [Statistics]

In order to accomplish the 2 basic processes, OSPF routers send and receive various messages containing information to form adjacencies, and update routing tables. The counters in the tab indicate the amount of message traffic transmitted and received on the OSPF interfaces.

- Link State Acknowledgments (LSAcks) provide a response to a Link State Update (LS update) request as part of the link state exchange process.
- The Hello messages allow a router to discover other OSPF routers in the area and to establish adjacencies between the neighboring devices. After establishing adjacencies, the routers advertise their credentials for establishing a role as either a Designated Router (DR), a Backup Designated Router (BDR), or only as a participant in the OSPF network. The routers then use the Hello messages to exchange information about the OSPF configuration in the Autonomous System (AS).
- Database Description (DD) messages contain descriptions of the AS or area topology. The messages also propagate the contents of the link state database for the AS or area from a router to other routers in the area.
- Link State Requests (LS Request) messages provide a means of requesting updated information about a portion of the Link State Database (LSDB). The message specifies the link or links for which the requesting router requires current information.
- LS Update messages contain updated information about the state of certain links on the LSDB. The router sends the updates as a response to an LS Request message. The router also broadcast or multicast messages periodically. The router uses the message contents to update the information in the LSDBs of routers that receive them.
- LSAs contain the local routing information for the OSPF area. The router transmits the LSAs to other routers in an OSPF area and only on interfaces connecting the router to the specific OSPF area.
- Type 1 LSAs are router LSAs. Each router in an area originates a router-LSA. A single router LSA describes the state and cost of every link in the area. The router floods type 1 LSAs only across its own area.
- Type 2 LSAs are network LSAs. The DR creates a network LSA from information received in the type 1 LSAs. The DR originates in its own area a network LSA for each broadcast and NBMA network it is connected to. The LSA describes every router attached to the network, including the DR itself. The router floods type 2 LSAs only across its own area.
Type 3 LSAs are network summary LSAs. An Area Border Router (ABR) creates a single network summary LSA from information contained in the type 1 and type 2 LSAs received from the DRs. The ABR transmits network summary LSAs describing inter-area destinations. The router floods type 3 LSAs across every area connected to it. Except this is the area for which it generated the Type 3 LSA.

Type 4 LSAs are Autonomous System Boundary Router (ASBR) summary LSAs. An ABR creates a single ASBR summary LSA from information contained in the type 1 and type 2 LSAs received from the DRs. The ABR transmits type 4 LSAs to areas different than the area it resides in, to describe the ASBRs from which the ABR received type 5 LSAs. The router floods type 4 LSAs across every area connected to it. Except this is the area for which it generated the Type 4 LSA.

Type 5 LSAs are AS external LSAs. The AS boundary routers create the AS external LSAs describing destinations external to the AS. The type 5 LSAs contain information redistributed into the OSPF function from other routing processes. The router floods type 5 LSAs to every area except stub and NSSA areas.

**Function**

- **LSA retransmitted**
  Displays the total number of LSAs retransmitted since resetting the counters. When the router transmits the same LSA to multiple neighbors, the router increments the count for each neighbor.

- **Hello packets received**
  Displays the total number of OSPFv2 Hello packets received since resetting the counters.

- **Hello packets transmitted**
  Displays the total number of OSPFv2 Hello packets transmitted since resetting the counters.

- **DB description packets received**
  Displays the total number of OSPFv2 Database Description packets received since resetting the counters.

- **DB description packets transmitted**
  Displays the total number of OSPFv2 Database Description packets transmitted since resetting the counters.

- **LS request packets received**
  Displays the total number of OSPFv2 Link State Request packets received since resetting the counters.

- **LS request packets transmitted**
  Displays the total number of OSPFv2 Link State Request packets transmitted since resetting the counters.

- **LS update packets received**
  Displays the total number of OSPFv2 LS Update packets received since resetting the counters.
Routing

[Routing > OSPF > Diagnostics]

LS update packets transmitted
Displays the total number of OSPFv2 LS Update packets transmitted since resetting the counters.

LS ack update packets received
Displays the total number of OSPFv2 LS Acknowledgement packets received since resetting the counters.

LS ack update packets transmitted
Displays the total number of OSPFv2 LS Acknowledgement packets transmitted since resetting the counters.

Max. rate of LSU received in any 5sec
Displays the maximum rate of OSPFv2 LS Update packets received over any 5-second interval since resetting the counters. The field displays the rate in packets per second. For example, the number of packets received during the 5-second interval, divided by 5.

Max. rate of LSU transmitted in any 5sec
Displays the maximum rate of OSPFv2 LS Update packets transmitted over any 5-second interval since resetting the counters. The field displays the rate in packets per second. For example, the number of packets transmitted during the 5-second interval, divided by 5.

Type-1 (Router) LSAs received
Displays the number of type 1 router LSAs received since resetting the counters.

Type-2 (Network) LSAs received
Displays the number of type 2 network LSAs received since resetting the counters.

Type-3 (Summary) LSAs received
Displays the number of type 3 network summary LSAs received since resetting the counters.

Type-4 (ASBR) LSAs received
Displays the number of type 4 ASBR summary LSAs received since resetting the counters.

Type-5 (External) LSAs received
Displays the number of type 5 external LSAs received since resetting the counters.

[Link state database]
A router maintains a separate link state database for every area to which it belongs.

The router adds LSAs to the database in the following cases:
- When the router receives an LSA, for example during the flooding process.
- When the router originates the LSA.
When a router deletes an LSA from the database, it also removes the LSA from the link state retransmission lists of the other routers in the network. A router deletes an LSA from its database in the following cases:

- A newer instance overwrites the LSA during the flooding process.
- The router originates a newer instance of a self-originated LSA.
- The LSA ages out and the router flushes the LSA from the routing domain.

### Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>Area ID</th>
<th>Displays the area ID from which router received the LSA.</th>
</tr>
</thead>
</table>
| Type    | Displays the type of the LSAs received. Each LSA type has a separate advertisement format. Possible values: 

- **routerLink**  
  The router received the information from another router in the same area. Routers announce their existence and list the links to other routers within the same area using a type 1 LSA. The link state ID is the originating router ID.

- **networkLink**  
  The router received the information from a DR on a broadcast segment using a type 2 LSA. The DR compiles the information received in type 1 LSAs and lists the routers linked together by the segment. The link state ID is the IP interface address of the DR.

- **summaryLink**  
  The router received the information from an ABR using a type 3 LSA describing routes to networks. ABRs compile information learned from type 1 and type 2 LSAs received from the attached areas before sending the routing information to the other areas. The link state ID is the destination network number which is the results of the summarization process.

- **asSummaryLink**  
  The router received the information from an ABR using a type 4 LSA describing routes to ASBRs. ABRs compile information learned from type 1 and type 2 LSAs received from the attached areas before sending the routing information to the other areas. The link state ID is the destination network number.

- **asExternalLink**  
  The router received the information from an ASBR using a type 5 LSA describing routes to another AS. The link state ID is the router id of the ASBR.

- **nssaExternalLink**  
  The router received the information from a router in a NSSA using a type 7 LSA.

| LSID | Displays the Link State ID (LSID) value received in the LSA. The LSID is a field located in the LSA header. The field contains either a router ID or an IP address according to the LSA type. |
Possible values:

- `<Router ID>`
- Valid IPv4 address

**Router ID**

Displays the router ID uniquely identifying the originating router.

**Sequence**

Displays the value of the sequence field in an LSA.

The router examines the contents or the LS checksum field whenever the LS sequence number field indicates that 2 instances of an LSA are the same. When there is a difference, the router considers the instance with the larger LS checksum to be most recent.

**Age**

Displays the age of the link state advertisement in seconds.

When the router creates the LSA, the router sets the LS age to the value 0. As the routers transmit the LSA across the network they increment the value by the value specified in the `Transmit delay [s]` column.

If a router receives 2 LSAs for the same segment having identical LS sequence numbers and LS checksums, then the router examines the age of the LSAs.

- The router immediately accepts LSA with MaxAge.
- Otherwise, the router accepts the LSA with the smaller age.

**Checksum**

Displays the contents of the checksum.

The field is a checksum of the complete contents of the LSA, except for the age field. The age field of the advertisement increases as the routers transmit the message across the network. Excluding the age field lets routers transmit the message without needing to update the checksum field.

**Neighbors**

The Hello Protocol is responsible for neighbor acquisition, maintenance, and for 2-way communication between neighbors.

During the acquisition process, the routers on a segment compare their configurations for compatibility. If the routers are compatible, then the routers form adjacencies. The routers discover their master or slave status using information provided in the Hello packets.

After the routers discover their roles, they exchange routing information to synchronize their routing databases. When the routers finish updating their databases, the neighbors are fully adjacent and the LSA lists the adjacency.
Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Neighbor ID

Displays the router ID of the neighboring router.

The router learns this value from Hello packets received from the neighbor. The value is a static value for virtual adjacencies.

IP address

Displays the IP address of the neighboring router interface attached to the port.

When sending unicast protocol packets on this adjacency, the router uses the value as the destination IP address. When the neighboring router is the DR, the router is also used in router LSAs as the link ID for the attached network. The router learns the neighbor IP address when it receives Hello packets from the neighbor. For virtual links, the router learns the neighbor IP address while building the routing table.

Interface

Displays the interface to which the table row applies.

Status

Displays the state of the relationship with the neighbor listed in this instance.

An event invokes each state change, such as a received Hello packet. This event produces different effects, depending on the current state of the neighbor. Also, depending on the state of neighbor change, the routers initiate a DR election.

Possible values:

- **down** (default setting)
  The initial state of a neighbor conversation or a router terminated the conversation due to expiration of the Dead interval [s] timer.

- **attempt**
  The state is only valid for neighbors attached to NBMA networks. The information from the neighbor remains unresolved. The router actively attempts to contact the neighbor by sending the neighbor Hello packets in the interval specified in the Hello interval [s] column.

- **init**
  The router has recently seen a Hello packet from the neighbor. However, the router has only established uni-directional communication with the neighbor. For example, the router ID of this router is missing from the Hello packet of the neighbor. When sending Hello packets, the associated interface lists neighbors in this state or higher.

- **twoWay**
  Communication between the 2 routers is bidirectional. The router verifies the operation by examining the contents of the Hello packet. The routers elect a DR and BDR from the set of neighbors while in or after the 2-way state.

- **exchangeStart**
  The first step in creating an adjacency between the 2 neighboring routers. The goal of this step is to decide which router is the master and to decide upon the initial Sequence number.
Routing

[Routing > OSPF > Diagnostics]

- **exchange**
  The router is announcing its entire link state database by sending Database Description (DD) packets to the neighbor. The router explicitly acknowledges each DD packet. Each packet has a sequence number. The adjacencies only allow one DD packet to be outstanding at any time. In this state, the router sends LS Request packets asking for up-to-date database information. The adjacencies are fully capable of transmitting and receiving OSPF routing protocol packets.

- **loading**
  The router sends LS Request packets to the neighbor inquiring about the outstanding database updates sent in the exchange state.

- **full**
  The neighboring routers are fully adjacent. The adjacencies now appear in router LSAs and network LSAs.

**Dead time**

Displays the amount of time remaining before the router declares the neighbor status as down. The timer initiates the count down after the router receives a Hello packet.

[**Virtual neighbors**]

The OSPF function requires a continuous connection of the Autonomous System backbone area. The OSPF function also requires that every area has a connection to the backbone area. The physical location of routers often prohibits an area from directly connecting to the backbone area. Virtual links allow you to connect physically separated areas to the backbone area.

The ABRs of the backbone area and the physically separated area form a point-to-point link through a transit area. When the ABRs establish an adjacency, the backbone router LSAs include the link and OSPF packets flow over the virtual link. Furthermore, the routing database of each endpoint router includes the link state information of the other endpoint router.

**Note:** The OSPF function lets you specify virtual links through every type of area except for stub areas.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>Area ID</th>
<th>Displays the transit area ID of the virtual link.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router ID</td>
<td>Displays the router ID of the other virtual endpoint ABR.</td>
</tr>
</tbody>
</table>

After virtual adjacencies form, the virtual link carries OSPF packets such as Hello packets and LS update packets containing database information. The prerequisite is that the LSAs of the neighbor router contain the router ID of the local router.
IP address

Displays the IP address of the virtual neighbor.

The router uses the IP address to send OSPF packets across the transit network to the virtual neighbor.

Options

Displays the information contained in the options field of the LSA. This value indicates the capabilities of virtual neighbor.

The options field used in the Hello packets allow routers to identify their optional capabilities, and to communicate the capabilities to other routers. This mechanism lets you mix routers of different capabilities within a routing domain.

The router supports 4 options by setting the following bits in the options field either high or low depending on the capabilities of the router. The field displays the value by adding the following option bits together. You read the fields from least significant bit to most significant bit.

- The routers advertise the ability to process TOS 0 in AS external routes when it sets the E-bit high. The E-bit is the second bit in the options field and represents the value $2^1$ or 2.
- The routers advertise the ability to process multicast routes when it sets the MC-bit high. The MC-bit is the third bit in the options field and represents the value $2^2$ or 4.
- The routers advertise the ability to process AS external routes in an NSSA summary with type 7 LSAs when it sets the N/P-bit high. The N/P-bit is the fourth bit in the options field and represents the value $2^3$ or 8.
- The routers advertise the ability to process demand circuits when it sets the DC-bit high. The DC-bit is the sixth bit in the options field and represents the value $2^5$ or 32.

In a special case, the router sets the E-bit low.

- The routers advertise the ability to process TOS metrics other than TOS 0 when it sets the E-bit low. The E-bit is the second bit in the options field and when set low, the bit represents the value 0.

Possible values:

- $2, 6, 10, 14, 34, 38, 42, 46$
  The values indicate that the virtual neighbor supports Type of Service metric (TOS) 0 in AS external LSAs.
- $0, 4, 8, 12, 32, 36, 40, 44$
  The values indicate that the virtual neighbor supports TOS metrics other than TOS 0.
- $4, 6, 12, 14, 36, 38, 44, 46$
  The values indicate that the virtual neighbor supports multicast routing.
- $8, 10, 12, 14, 40, 42, 44, 46$
  The values indicate that the virtual neighbor supports type 7 LSAs.
- $32, 34, 36, 38, 40, 42, 44, 46$
  The values indicate that the virtual neighbor supports demand circuits.

Status

Displays the state of the relationship with the neighbor listed in this instance.

An event invokes each state change, such as a received Hello packet. This event produces different effects, depending on the current state of the neighbor. Also, depending on the state of neighbor change, the routers initiate a DR election.
Possible values:

- **down** (default setting)
  The initial state of a neighbor conversation or a router terminated the conversation due to expiration of the **Dead interval [s]** timer.

- **attempt**
  The state is only valid for neighbors attached to NBMA networks. Information from the neighbor remains unresolved. The router actively attempts to contact the neighbor by sending the neighbor Hello packets in the interval specified in the **Hello interval [s]** column.

- **init**
  The router has recently seen a Hello packet from the neighbor. However, the router has only established uni-directional communication with the neighbor. For example, the router ID of this router is missing from the Hello packet of the neighbor. When sending Hello packets, the associated interface lists neighbors in this state or higher.

- **twoWay**
  Communication between the 2 routers is bidirectional. The router verifies the operation by examining the contents of the Hello packet. The routers elect a DR and BDR from the set of neighbors while in or after the 2-way state.

- **exchangeStart**
  The first step in creating an adjacency between the 2 neighboring routers. The goal of this step is to decide which router is the master and to decide upon the initial **Sequence** number.

- **exchange**
  The router is announcing its entire link state database by sending Database Description (DD) packets to the neighbor. The router explicitly acknowledges each DD packet. Each packet has a sequence number. The adjacencies only allow one DD packet to be outstanding at any time. In this state, the router sends LS Request packets asking for up-to-date database information. The adjacencies are fully capable of transmitting and receiving OSPF routing protocol packets.

- **loading**
  The router sends LS Request packets to the neighbor inquiring about the outstanding database updates sent in the exchange state.

- **full**
  The neighboring routers are fully adjacent. The adjacencies now appear in router LSAs and network LSAs.

Events

- Displays the number of times this interface changed its state due to a received event such as HelloReceived or 2-way.

Length of retransmission queue

- Displays the length of the retransmission list.

  In order to flood LSAs out of an interface to the neighbor, the router places the LSAs on the link state retransmission list of the adjacency. To validate LSA flooding, the router retransmits the LSAs until the neighbor acknowledges the LSA reception. You configure the length of time between retransmissions in the **Routing > OSPF > Interfaces** dialog in the **Retrans interval [s]** column.

Suppressed Hellos

- Displays if the router is suppressing Hello packets to the neighbor.

  Suppressing Hello packet transmission to the neighbor lets demand circuits close, on point-to-point links, during periods of inactivity. In NBMA networks, the periodic transmission of LSAs causes the circuit to remain open.
Possible values:

- **marked**
  The router suppresses Hello packets.

- **unmarked**
  The router transmits Hello packets.

### External link state database

The table displays the contents of the external link state database, with an entry for each unique link state ID. External links allow the area to connect to destinations outside of the autonomous system. Routers pass information about the external links throughout the network as link state updates.

### Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Type**

Displays the type of the link state advertisement. When the router detects an external link state advertisement, the router enters the information in the table.

Possible values:

- `asExternalLink`

**LSID**

Displays the Link State ID is an LS type-specific field containing either a router ID or an IP address. The value identifies the routing domain described in the advertisement.

**Router ID**

Displays the router ID uniquely identifying the originating router.

**Sequence**

Displays the value of the sequence field in an LSA.

The router examines the contents or the LS checksum field whenever the LS sequence number field indicates that 2 instances of an LSA are the same. When there is a difference, the router considers the instance with the larger LS checksum to be most recent.

**Age**

Displays the age of the link state advertisement in seconds.

When the router creates the LSA, the router sets the LS age to the value 0. As the routers transmit the LSA across the network they increment the value by the value specified in the *Transmit delay [s]* column.
If a router receives 2 LSAs for the same segment having identical LS sequence numbers and LS checksums, then the router examines the age of the LSAs.

- The router immediately discards LSA with MaxAge.
- Otherwise, the router discards the LSA with the smaller age.

Checksum

Displays the contents of the checksum.

The field is a checksum of the complete contents of the LSA, except for the age field. The age field of the advertisement increases as the routers transmit the message across the network. Excluding the age field lets routers transmit the message without needing to update the checksum field.

[Route]

The dialog displays the OSPF route information learned from the Link State Advertisements (LSA).

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

IP address

Displays the IP address of the network or subnet for the route.

Netmask

Displays the netmask for the network or subnet.

Metric

Displays the route cost, calculated in the SPF algorithm, to reach the network.

Type

Displays the type of route that was learned from OSPF.

Possible values:

- **intra**
  Entry for routes from OSPF within an area.

- **inter**
  Entry for routes from OSPF between areas.

- **ext-type1**
  These routes were imported from an Autonomous System Boundary Router (ASBR) into the OSPF area. These routes use the costs relating to the connection between the ASBR and the route costs includes this device.

- **ext-type2**
  These routes were imported from an Autonomous System Boundary Router (ASBR) into the OSPF area. These routes do not use the costs relating to the connection between the ASBR and the route costs includes this device.
Routing

These routes were imported from an Autonomous System Boundary Router (ASBR) into the Not-So-Stub Area. These routes use the costs relating to the connection between the ASBR and the route costs includes this device.

These routes were imported from an Autonomous System Boundary Router (ASBR) into the Not-So-Stub Area. These routes do not use the costs relating to the connection between the ASBR and the route costs includes this device.

8.5 Routing Table

This dialog displays the routing table with the routes configured in the device. Using the routing table, the device learns the router interface through which it transfers IP packets that are addressed to recipients in a different network.

Configuration

Preference

Specifies the preference number that the device assigns by default to the newly configured, static routes.

Possible values:

1..255 (default setting: 1)

Routes with a value of 255 will be ignored by the device in the routing decision.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create dialog to create a static route.

In the Network address field, you specify the address of the destination network.

Possible values:

Valid IPv4 address

If you specify a default route (0.0.0.0), then you specify a default gateway in the Next hop IP address field. This setting takes precedence over the setting in the following dialog:

Basic Settings > Network > IPv4 dialog, Gateway address field
In the **Netmask** field, you specify the netmask that identifies the network prefix in the address of the destination network.
Possible values:
- Valid IPv4 netmask

In the **Next hop IP address** field, you specify the IP address of the next router on the path to the destination network.
Possible values:
- Valid IPv4 address
  
  To make a *reject* type route, specify the value `0.0.0.0` in this field. With this route, the device discards IP packets addressed to the destination network and informs the sender.

In the **Preference** field, you specify the preference number that the device uses to decide which of several existing routes to the destination network it will use.
Possible values:
- 1..255
  
  In routing decisions, the device gives preference to the route with the smallest value. The default setting is the value specified in the *Configuration* frame, field *Preference*.

In the **Track name** field, you specify the tracking object with which the device links the route.
Possible values:
- –
  
  No tracking object selected.
- Name of the tracking object, made up of *Type* and *Track ID*.

**Remove**

Removes the selected table row.

**Port**

Displays the router interface through which the device is currently transmitting IP packets addressed to the destination network.

Possible values:
- `<Router interface>`
  
  The device uses this router interface to transfer IP packets addressed to the destination network.
- no port
  
  The static route is currently not assigned to a router interface.

**Network address**

Displays the address of the destination network.

**Netmask**

Displays the netmask.

**Next hop IP address**

Displays the IP address of the next router on the path to the destination network.
Routing Table

Type

Displays the type of the route.

Possible values:

- **local**
  The router interface is directly connected to the destination network.

- **remote**
  The router interface is connected to the destination network through a router (**Next hop IP address**).

- **reject**
  The device discards IP packets addressed to the destination network and informs the sender.

- **other**
  The route is inactive. See the **Active** checkbox.

Protocol

Displays the origin of this route.

Possible values:

- **local**
  The device created this route when setting up the router interface. See the **Routing > Interfaces > Configuration** dialog.

- **netmgmt**
  A user created this static route with the **** button.

**Note:** You can make static routes with the same destination and preference, but with different next hops. The device uses Equal Cost Multi Path (ECMP) forwarding mechanism to help ensure load sharing and redundancy over the network. Depending on the selected routing profile in the **Routing > Global** dialog, ECMP can use up to 4 routes. If you select the **ipv4DataCenter** routing profile, then ECMP can use up to 16 routes.

- **ospf**
  The **OSPF** function created this route. See the **Routing > OSPF** dialog.

Preference

Specifies the "administrative distance" of the route.

The device uses this value instead of the metric, when the metric of the routes is incomparable.

Possible values:

- **0**
  Reserved for routes that the device creates when setting up the router interfaces. These routes have the value **local** in the **Protocol** column.

- **1..254**
  In routing decisions, the device gives preference to the route with the smallest value.

- **255**
  In routing decisions, the device ignores the route.

The "administrative distance" can be set for static routes created using the **** button.
Routing
[Routing > Tracking]

Metric
Displays the metric of the route.
The device transmits the data packets using the route with the smallest value.

Last update [s]
Displays the time in seconds, since the current settings of the route were entered in the routing table.

Track name
Specifies the tracking object with which the device links the route.
The device automatically activates or deactivates static routes – depending on the link status of an interface or the reachability of a remote router or end device.
You set up tracking objects in the Routing > Tracking > Configuration dialog.
Possible values:
► Name of the tracking object, made up of Type and Track ID.
► –
  No tracking object selected.
This function is used only for static routes. (Column Protocol = netmgmt)

Active
Displays if the route is active or inactive.
Possible values:
► marked
  The route is active; the device uses the route.
► unmarked
  The route is inactive.

8.6 Tracking
[Routing > Tracking]
The tracking function lets you monitor what are known as tracking objects. Examples of monitored tracking objects are the link status of an interface or the reachability of a remote router or end device.
The device forwards status changes of the tracking objects to the registered applications, for example to the routing table or to a VRRP instance. The applications then react to the status changes:
• In the routing table, the device activates/deactivates the route linked to the tracking object.
• The VRRP instance linked to the tracking object reduces the priority of the virtual router so that a backup router takes over the role of the master.
If you set up the tracking objects in the **Tracking Configuration** dialog, then you can link applications with the tracking objects:

- You link static routes with a tracking object in the **Routing > Routing Table** dialog, **Track name** column.
- You link virtual routers with a tracking object in the **Routing > L3-Redundancy > VRRP > Tracking** dialog. Click the button to open the **Create** window and select the tracking object in the **Track name** drop-down list.

The menu contains the following dialogs:

- Tracking Configuration
- Tracking Applications
8.6.1 Tracking Configuration

In this dialog you set up the tracking objects.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row.

- In the Type field, you specify the type of the tracking object.
  Possible values:
  - interface
    The device monitors the link status of its physical ports or of its link aggregation, LRE or VLAN router interface.
  - ping
    The device monitors the route to a remote router or end device by means of periodic ping requests.
  - logical
    The device monitors tracking objects logically linked to each other and thus enables complex monitoring tasks.

- In the Track ID field, you specify the identification number of the tracking object.
  Possible values:
  - 1..256

Remove

Removes the selected table row.

Type

Specifies the type of the tracking object.

Possible values:

- interface
  The device monitors the link status of its physical ports or of its link aggregation, LRE or VLAN router interface.
- ping
  The device monitors the route to a remote router or end device by means of periodic ping requests.
- logical
  The device monitors tracking objects logically linked to each other and thus enables complex monitoring tasks.
**Track ID**

Specifies the identification number of the tracking object.

Possible values:
- **1..256**
  This range is available to every type (*interface*, *ping* and *logical*).

**Track name**

Displays the name of the tracking object made up of *Type* and *Track ID*.

**Active**

Activates/deactivates the monitoring of the tracking object.

Possible values:
- **marked**
  Monitoring is active. The device monitors the tracking object.
- **unmarked** (default setting)
  Monitoring is inactive.

**Description**

Specifies the description.

Here you describe what the device uses the tracking object for.

Possible values:
- Alphanumeric ASCII character string with 0..255 characters

**Status**

Displays the monitoring result of the tracking object.

Possible values:
- **up**
  The monitoring result is positive:
  - The link status is active.
    - The remote router or end device is reachable.
      - The result of the logical link is TRUE.
- **down**
  The monitoring result is negative:
  - The link status is inactive.
    - The remote router or end device is not reachable.
      - The result of the logical link is FALSE.
- **notReady**
  The monitoring of the tracking object is inactive. You activate the monitoring in the *Active* column.
Changes

Displays the number of status changes since the tracking object has been activated.

Last changed

Displays the time of the last status change.

Send trap

Activates/deactivates the sending of an SNMP trap when someone activates or deactivates the tracking object.

Possible values:

- **marked**
  - If someone activates or deactivates the tracking object in the Active column, then the device sends an SNMP trap.
- **unmarked** (default setting)
  - The device does not send an SNMP trap.

Port

Specifies the interface to be monitored for tracking objects of the *interface* type.

Possible values:

- **<Interface number>**
  - Number of the physical ports or of the link aggregation, LRE or VLAN router interface.
- **no Port**
  - No tracking object of the *interface* type.

Link up delay [s]

Specifies the period in seconds after which the device evaluates the monitoring result as positive. If the link has been active on the interface for longer than the period specified here, then the Status column displays the value *up*.

Possible values:

- **0..255**
- **–**
  - No tracking object of the *logical* type.

Link down delay [s]

Specifies the period in seconds after which the device evaluates the monitoring result as negative. If the link has been inactive on the interface for longer than the period specified here, then the Status column displays the value *down*.

Possible values:

- **0..255**
- **–**
  - No tracking object of the *interface* type.
If the link to every aggregated port is interrupted, then Link aggregation, LRE and VLAN router interfaces have a negative monitoring result.

If the link to every physical port and link-aggregation interface which is a member of the VLAN is interrupted, then a VLAN router interface has a negative monitoring result.

Ping port

Specifies the router interface for tracking objects of the ping type through which the device sends the ping request packets.

Possible values:
- `<Interface number>`
  Number of the router interface.
- `noName`
  No router interface assigned.
- `-`
  No tracking object of the ping type.

IP address

Specifies the IP address of the remote router or end device to be monitored.

Possible values:
- Valid IPv4 address
- `-`
  No tracking object of the ping type.

Ping interval [ms]

Specifies the interval in milliseconds at which the device periodically sends ping request packets.

Possible values:
- `100..20000` (default setting: `1000`)
  If you specify a value `<1000`, then you can set up a maximum of 16 tracking objects of the ping type.
- `-`
  No tracking object of the ping type.

Ping replies to lose

Specifies the number of missed responses from the device after which the device evaluates the monitoring result as negative. If the device does not receive a response to its sent ping request packets for the number of times specified here, then the Status column displays the value `down`.

Possible values:
- `1..10` (default setting: `3`)
- `-`
  No tracking object of the ping type.
Routing
[Routing > Tracking > Configuration]

Ping replies to receive

Specifies the number of received responses from the device after which the device evaluates the monitoring result as positive. If the device receives a response to its sent ping request packets for the number of times specified here, then the Status column displays the value up.

Possible values:

- 1..10  (default setting: 2)
- –

No tracking object of the ping type.

Ping timeout [ms]

Specifies the period in milliseconds for which the device waits for a response. If the device does not receive a response within this period, then the device evaluates this as a missed response. See the Ping replies to lose column.

Possible values:

- 10..10000  (default setting: 100)
  - If a large number of ping tracking objects is set up in the device, then specify a sufficiently large value. If more than 100 instances are present, then specify at least 200 ms.
- –

No tracking object of the ping type.

Ping TTL

Specifies the TTL value in the IP header with which the device sends the ping request packets.

TTL (Time To Live, also known as “Hop Count”) identifies the maximum number of steps an IP packet is allowed to perform on the way from the sender to the receiver.

Possible values:

- –

No tracking object of the ping type.

- 1..255  (default setting: 128)

Best route

Displays the number of the router interface through which the best route leads to the monitoring router or end device.

Possible values:

- <Port number>
  - Number of the router interface.
- no Port
  - No route exists.
- –

No tracking object of the ping type.
Logical operand A

Specifies the first operand of the logical link for tracking objects of the *logical* type.

Possible values:
- Tracking objects set up
- – No tracking object of the *logical* type.

Logical operand B

Specifies the second operand of the logical link for tracking objects of the *logical* type.

Possible values:
- Tracking objects set up
- – No tracking object of the *logical* type.

Operator

Links the tracking objects specified in the *Logical operand A* and *Logical operand B* fields.

Possible values:
- *and* Logical AND link
- *or* Logical OR link
- – No tracking object of the *logical* type.
8.6.2 Tracking Applications

In this dialog you see which applications are linked with the tracking objects.

The following applications can be linked with tracking objects:
- You link static routes with a tracking object in the Routing > Routing Table dialog, Track name column.
- You link virtual routers with a tracking object in the Routing > L3-Redundancy > VRRP > Tracking dialog. Click the button to open the Create window and select the tracking object in the Track name drop-down list.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>Type</th>
<th>Displays the type of the tracking object.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track ID</td>
<td>Displays the identification number of the tracking object.</td>
</tr>
<tr>
<td>Application</td>
<td>Displays the name of the application that is linked with the tracking object.</td>
</tr>
<tr>
<td>Possible values:</td>
<td></td>
</tr>
<tr>
<td>➤ Tracking objects of the logical type</td>
<td></td>
</tr>
<tr>
<td>➤ Static routes</td>
<td></td>
</tr>
<tr>
<td>➤ Virtual router of a VRRP instance</td>
<td></td>
</tr>
<tr>
<td>Track name</td>
<td>Displays the name of the tracking object made up of Type and Track ID.</td>
</tr>
</tbody>
</table>
8.7 L3 Relay

Clients in a subnet send BOOTP/DHCP broadcasts messages to DHCP servers requesting configuration information such as IP addresses. Routers provide a border for broadcast domains so that BOOTP/DHCP requests remain in the local subnet. The Layer 3 Relay (L3 Relay) function acts as a proxy for clients that require information from a BOOTP/DHCP server in another network.

When you configure this device to retrieve IP addresses from a DHCP server located in another subnet, the L3 Relay function lets you forward requests across multiple hops to a server located in another network.

Using IP helper addresses and UDP helper ports the L3 Relay forwards DHCP packets between the clients and servers. The IP helper address is the DHCP server IP address. Clients use the UDP helper port to request a type of information such as DNS information on UDP port 53, or DHCP information on UDP port 67.

The L3 Relay function provides you the follow advantages over the standard BOOTP/DHCP function:

- **redundancy**, when you specify multiple servers to process client requests.
- **load balancing**, when you specify multiple interfaces to relay broadcast packets from the client to the servers.
- **central management**, useful in large networks. The administrator saves the device configurations on a centrally located server which responds to client requests in multiple subnets.
- **diversity**, this function lets you specify up to 512 entries.

**Operation**

Enables/disables the **L3 Relay** function.

Possible values:

- **On**: The **L3 Relay** function is globally enabled.
- **Off** (default setting): The **L3 Relay** function is globally disabled.

**Configuration**

Activates/deactivates the BOOTP/DHCP Circuit ID Option Mode.

The device sends circuit ID suboption information, identifying the local agent, to the DHCP server. The DHCP server uses the suboption information to send responses back to the proper agent.
Routing

[Routing > L3 Relay]

Possible values:

- **marked**
  The device adds the circuit ID of the DHCP relay agent to the suboptions for client requests.

- **unmarked**  (default setting)
  The device removes the DHCP relay agent circuit ID suboptions from client requests.

**BOOTP/DHCP wait time (min.)**

Specifies the minimum amount of time that the device delays forwarding the BOOTP/DHCP request.

The end devices send broadcast request on the local network. This setting lets a local server respond to the client request before the router forwards the client request through the interfaces.

Possible values:

- **0..100**  (default setting: 0)
  If a local server is absent from the network, then set the value to 0.

**BOOTP/DHCP hops (max.)**

Specifies the maximum number of cascaded devices allowed to forward the BOOTP/DHCP request.

If the hop count exceeds the maximum number of hops specified in this field, then the device drops BOOTP requests.

Possible values:

- **0..16**  (default setting: 4)

**Information**

**DHCP client messages received**

Displays the number of DHCP requests received from the clients.

**DHCP client messages relayed**

Displays the number of DHCP requests forwarded to the servers specified in the table.

**DHCP server messages received**

Displays the number of DHCP offers received from the servers specified in the table.

**DHCP server messages relayed**

Displays the number of DHCP offers forwarded to the clients from the servers specified in the table.

**UDP messages received**

Displays the number of UDP requests received from the clients.
UDP messages relayed

Displays the number of UDP requests forwarded to the servers specified in the table.

Packets with expired TTL

Displays the number of UDP packets received with an expired TTL value.

Discarded packets

Displays the number of UDP packets that device discarded, because the packet matched an active table row.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row. For further information, see “Create” on page 348.

Remove

Removes the selected table row.

Reset statistics

Resets the table statistics.

Port

Displays the interface to which the table row applies.

UDP port

Displays the UDP port for client messages received on this interface. The device forwards client DHCP messages matching the UDP port criteria to the IP helper address specified in this table row.

IP address

Displays the IP helper address associated with this table row.

Hits

Displays the current number of packets that the interface forwards for the specified UDP port.

Status

Displays if the IP helper address and UDP port entry added to the respective port is active.
Create

**Port**

Specifies the interface to which the table row applies.

Interface configurations take priority over global configurations. If the destination UDP port for a packet matches any entry on an ingress interface, then the device handles the packet according to the interface configuration. If none of the interface entries match the packet, then the device handles the packet according to the global configuration.

Possible values:
- **All** (default setting)
  Relay entries with this port value specify a global configuration.
- **<available interfaces>**
  Used to specify interface configurations.

**UDP port**

Specifies the helper UDP port criteria for packets received on this interface. When active, the device forwards packets received with this destination UDP port value to the IP address specified in this table row.

Possible values:
- **default** (default setting)
  Equal to UDP port 0. An entry with a UDP port specified as 0 enables the dhcp, time, nameserver, tacacs, dns, tftp, netbios-ns, and netbios-dgm entries.
- **dhcp**
  Equal to UDP port 67. The device forwards DHCP requests for IP address assignment and networking parameters.
- **domain**
  Equal to UDP port 53. The device forwards DNS requests for host name to IP address conversion.
- **isakmp**
  Equal to UDP port 500. The device forwards Internet Security Association and Key Management Protocol requests. The requests specifies procedures and packet formats which establish, negotiate, modify and delete Security Associations.
- **mobile-ip**
  Equal to UDP port 434. The device forwards Home Agent Registration requests. Use this value when you install the device in a network other than the home network.
- **nameserver**
  Equal to UDP port 42. The device forwards Windows Internet Name Service requests. You use the port to copy the NetBIOS name table from one Windows server to another.
- **netbios-dgm**
  Equal to UDP port 138. The device forwards NetBIOS Datagram Service requests. The datagram service provides the ability to send a message to a unique name or to a group name.
- **netbios-ns**
  Equal to UDP port 137. The device forwards NetBIOS Name Service requests for name registration and resolution.
- **ntp**
  Equal to UDP port 123.
  The device forwards Network Time Protocol requests. Use this value for peer-to-peer synchronization where both peers consider the other to be a time source.

- **pim-auto-rp**
  Equal to UDP port 496.
  The device forwards Protocol Independent Multicast-Automatic-Rendezvous Point requests. The Rendezvous Point (RP) serves as the root of the shared multicast delivery tree and is responsible for gathering multicast data from different sources, then forwarding the data to the clients.

- **rip**
  Equal to UDP port 520.
  The device forwards RIP request and RIP response messages.

- **tacacs**
  Equal to UDP port 49.
  The device forwards TACACS Login Host Protocol requests for remote authentication and related services for networked access control through a centralized server.

- **tftp**
  Equal to UDP port 69.
  The device forwards Trivial File Transfer Protocol requests and responses.

- **time**
  Equal to UDP port 37.
  The device forwards Time Protocol requests. The device forwards client requests to a server that supports the time protocol. The server then responds with a message containing an integer representing the number of seconds since 00:00 1 January, 1900 GMT, and closes the data link.

- **0..65535**
  When you know the UDP port number, the device lets you specify the port number directly.

**IP address**

Specifies the IP helper address for packets received on this interface.

**Possible values:**

- **Valid IP address**
  An address of 0.0.0.0 identifies the entry as a discard entry. The device drops packets that match a discard entry. You specify discard entries only on the interfaces.
8.8 **Loopback Interface**

A loopback interface is a virtual network interface without reference to a physical port. Loopback interfaces are constantly available while the device is in operation.

The device lets you create router interfaces on the basis of loopback interfaces. Using such a router interface, the device is constantly available, even during periods of inactivity of individual router interfaces.

Up to 8 loopback interfaces can be set up in the device.

**Table**

For information on how to customize the appearance of the table, see "Working with tables" on page 16.

**Buttons**

![Add](add_icon) **Add**

Opens the *Create* window to create a loopback interface.

- In the **Index** field, you specify the number that uniquely identifies the loopback interface.
  - Possible values: 1..8

![Remove](remove_icon) **Remove**

Removes the selected table row.

**Index**

Displays the number that uniquely identifies the loopback interface.

**Port**

Displays the name of the loopback interface.
### IP address

Specifies the IP address for the loopback interface.

Possible values:
- Valid IPv4 address (default setting: 0.0.0.0)

### Subnet mask

Specifies the netmask for the loopback interface.

Possible values:
- Valid IPv4 netmask (default setting: 0.0.0.0)
  
  **Example:** 255.255.255.255

### Active

Displays if the loopback interface is active or inactive.

Possible values:
- **marked** (default setting)
  
  The loopback interface is active.
  
  When sending SNMP traps, the device uses the IP address of the first loopback interface as the sender.
  
  **unmarked**
  
  The loopback interface is inactive.
8.9 L3-Redundancy

The menu contains the following dialogs:
► VRRP

8.9.1 VRRP

[Routing > L3-Redundancy > VRRP]

The Virtual Router Redundancy Protocol (VRRP) is a procedure that lets the system react to the failure of a router.

You use VRRP in networks with end devices that support one entry for the default gateway. If the default gateway fails, then VRRP helps ensure that the end devices find a redundant gateway.

Note: For further information on the VRRP function, see the “Configuration” user manual.

The menu contains the following dialogs:
► VRRP Configuration
► VRRP Statistics
► VRRP Tracking
8.9.1.1 VRRP Configuration

This dialog lets you specify the following settings:
- up to 16 virtual routers per router interface
- up to 2 addresses per virtual router

**Operation**

Enables/disables the VRRP redundancy in the device.

Possible values:
- **On**: The VRRP function is enabled.
- **Off** (default setting): The VRRP function is disabled.

**Configuration**

Send trap (VRRP master)

Activates/deactivates the sending of SNMP traps when the device is the VRRP master.

Possible values:
- **marked**: The sending of SNMP traps is active. If the device is the VRRP master, then the device sends an SNMP trap.
- **unmarked** (default setting): The sending of SNMP traps is inactive.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.

Send trap (VRRP authentication failure)

Activates/deactivates the sending of SNMP traps when the device receives a VRRP packet including authentication information.

**Note:** The device supports only VRRP packets without authentication information. In order for the device to operate in conjunction with other devices that support VRRP authentication, verify that on those devices the VRRP authentication is not applied.
Routing
[Routing > L3-Redundancy > VRRP > Configuration]

Possible values:

- **marked**
  The sending of SNMP traps is active. If the device receives a VRRP packet including authentication information, then the device sends an SNMP trap.

- **unmarked** (default setting)
  The sending of SNMP traps is inactive.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.

**Information**

**Version**

Specifies the VRRP version.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- **Add**
  Opens the Create window to add a table row.
  - In the Port field, you specify the router interface.
  - In the VRID field, you specify the Virtual Route Identifier (VRID).

- **Remove**
  Removes the selected table row.

- **Wizard**
  Opens the Wizard window that helps you associate the ports with the address of one or more desired senders. See “[Wizard: VRRP configuration]” on page 358.

**Port**

Displays the port number to which the table row relates.

**VRID**

Displays the Virtual Router Identifier.
Active

Activates/deactivates the VRRP instance specified in this table row.

Possible values:
- **marked**: The VRRP instance is active.
- **unmarked** (default setting): The VRRP instance is inactive.

Oper status

Displays the table row status. The operational state of the related virtual router controls the row status of a currently active table row.

Possible values:
- **active**: The instance is available for use.
- **notInService**: The instance exists in the device, but necessary information is missing and it is unavailable for use.
- **notReady**: The instance exists in the device, but necessary information is missing and it is unavailable for use.

State

Displays the VRRP state.

Possible values:
- **initialize**: VRRP is in the initialization phase, the function is inactive, or the master router is still unnamed.
- **backup**: The router sees the possibility of becoming the master router.
- **master**: The router is the master router.

Base priority

Specifies the priority of the virtual router. If the value differs from the value in the **Priority** field, then the tracked object is down or the virtual router is the IP address owner.

Possible values:
- 1..254 (default setting: 100): The higher the number, the higher the priority. When you set up multiple VRRP routers in a single instance, distribute the priority values uniformly on the routers. For example, assign the priority value of 50 to the primary router, the value of 100 to the next router. Repeat the steps with the value 150, and so on. This distribution simplifies adding another router later with a priority between the existing values, for example with the value 75.
Routing
[Routing > L3-Redundancy > VRRP > Configuration]

Priority
Displays the VRRP priority value. You specify the priority in the Routing > OSPF > Interfaces dialog. The router with the higher priority value takes over the master router role. If the virtual router IP address is the same as the IP address of a router interface, then the router is the IP address owner. If an IP address owner exists, then the VRRP function lets the device assign the IP address owner the priority value 255 and declares the router as the master router.

Possible values:
- 0
  The higher the number, the higher the priority. When you disable or remove a VRRP router, which is in the master role, you force the instance to send an advertisement with priority value 0. This lets the other backup routers know that the master does not participate. Sending a priority value 0 forces a new election.
- 1..255
  The value 255 means that the virtual router is the IP address owner.

Virtual IP address
Displays the virtual IP address in the subnet of the primary IP address on the interface. If no match is found, then the device returns an unspecified virtual address. If no virtual address is configured, then the device returns 0.0.0.0.

Possible values:
- Valid IPv4 address

Preempt mode
Activates/deactivates the preempt mode. This setting specifies if this router, as a backup router, takes over the master router role when the master router has a lower VRRP priority.

Possible values:
- marked (default setting)
  The Preempt mode is active. The router takes the master router role from a router with a lower VRRP priority without an election.
- unmarked
  The Preempt mode is inactive. The router assumes the role of a backup router and listens for master router advertisements. After the Master Down interval expires, and no advertisements received from the master router, the router participates in the master router election process.

VRRP master candidate
Specifies the IP address for the primary virtual router. Physical routers within a virtual router instance use the VRRP IP address for the communication. If the virtual router IP address is the same as the IP address of a router interface, then the router is the IP address owner and the master router.

Possible values:
- Valid IPv4 address (default setting: 0.0.0.0)
  The default setting 0.0.0.0 indicates that the router is using the lower IP address as the Master IP address.
  You can select the IP address of a router interface set up in the Routing > Interfaces > Configuration dialog.
Master IP address

Displays the current master router interface IP address.

Possible values:
 ▶ Valid IPv4 address  (default setting: 0.0.0.0)

Setting up the VRRP router instance

The device lets you set up to 8 virtual routers per router interface.

Before you set up a VRRP instance, verify that network routing functions properly and set the IP addresses on the router interfaces used for the VRRP instances.

Perform the following steps:
 □ In the Routing > L3-Redundancy > VRRP > Configuration dialog, open the Wizard window.
   □ In the Wizard window, open the Create or select entry dialog.
     – Select a router interface in the Port drop-down list.
     – Specify the Virtual Router Identifier in the VRID column.
 □ In the Wizard window, open the Edit entry dialog.
     – In VRRP tab in the Configuration frame, specify the values for the following parameters:
       Priority
       Preempt mode
       Advertisement interval [s]
       Ping answer
     – Select the VRRP master candidate IP address in the drop-down list.
 □ To transfer the settings to the VRRP router interface table, click the Finish button.
 □ In the Routing > L3-Redundancy > VRRP > Configuration dialog, select the On radio button in the Operation frame. Then click the ✔ button.

Editing an existing VRRP router instance

Perform one of the following steps:
 □ In the Routing > L3-Redundancy > VRRP > Configuration dialog, select a table row and click the ✂ button to edit it.
   Or
 □ Double-click a field in the table and edit the entry directly.
   Or
 □ Right-click a field and select a value.
Deleting a VRRP router instance

Perform the following step:

- In the Routing > L3-Redundancy > VRRP > Configuration dialog, select a table row and click the button.

Wizard: VRRP configuration

The Wizard window helps you create a VRRP router instance.

Prerequisites:
- Network routing is functioning correctly.
- On the router interfaces used in the VRRP instance the IP addresses are specified.

The Wizard window guides you through the following steps:
- Create or select entry
- Edit entry
- Tracking
- Virtual IP addresses

Create or select entry

VRRP instances

Displays the existing instances available in the device. Select an entry to continue. Alternatively, select a port and specify a value in the VRID field below.

Port

Specifies the port-based or VLAN-based router interface. You verify in the Routing > Interfaces > Configuration dialog if a router interface is set up on the port.

Possible values:
- <Port number>
  Port-based router interface
- VLAN/ <VLAN ID>
  VLAN-based router interface

VRID

Specifies the Virtual Router Identifier.

Possible values:
- 1..255
  A virtual router uses 00-00-5E-00-01-XX as its MAC address. The value specified here replaces the last octet (XX) in the MAC address. Assign a unique value to every physical router within a virtual router instance. The device changes the effective priority value to 255 for a physical router with the same IP address as the virtual router.
**Edit entry**

For each instance you can specify the parameters using the following tabs:

- **Edit entry - VRRP**

**Edit entry - VRRP**

**Operation**

Enables/disables the VRRP redundancy for the current instance.

Possible values:

- **On**
  - The VRRP function is enabled for the current instance.
- **Off** (default setting)
  - The VRRP function is disabled for the current instance.

**Configuration**

**Base priority**

Specifies the priority of the virtual router. If the value differs from the value in the **Priority** field, then the tracked object is down or the virtual router is the IP address owner.

Possible values:

- **1..254** (default setting: **100**)
  - The higher the number, the higher the priority. When you set up multiple VRRP routers in a single instance, distribute the priority values uniformly on the routers. For example, assign the priority value of **50** to the primary router, the value of **100** to the next router. Repeat the steps with the value **150**, and so on. This distribution simplifies adding another router later with a priority between the existing values, for example with the value **75**.

**Priority**

Displays the VRRP priority value. You specify the priority in the **Routing > OSPF > Interfaces** dialog. The router with the higher priority value takes over the master router role. If the virtual router IP address is the same as the IP address of a router interface, then the router is the IP address owner. If an IP address owner exists, then the VRRP function lets the device assign the IP address owner the priority value **255** and declares the router as the master router.

Possible values:

- **0**
  - The higher the number, the higher the priority. When you disable or remove a VRRP router, which is in the master role, you force the instance to send an advertisement with priority value **0**. This lets the other backup routers know that the master does not participate. Sending a priority value **0** forces a new election.
- **1..255**
  - The value **255** means that the virtual router is the IP address owner.
Preempt mode

Activates/deactivates the preempt mode. This setting specifies if this router, as a backup router, takes over the master router role when the master router has a lower VRRP priority.

Possible values:

- **marked** (default setting)
  The Preempt mode is active. The router takes the master router role from a router with a lower VRRP priority without an election.

- **unmarked**
  The Preempt mode is inactive. The router assumes the role of a backup router and listens for master router advertisements. After the Master Down interval expires, and no advertisements received from the master router, the router participates in the master router election process.

Advertisement interval [s]

Specifies the interval between master router advertisements in seconds.

Possible values:

- **1..255** (default setting: 1)

**Note:** The longer the advertisement interval, the longer the time for which backup routers wait for a message from the master router before starting a new election process (master down interval). Also, specify the same value on every participant in a given virtual router instance.

Ping answer

Activates/deactivates the ping answer function in the device. You use the VRRP ping for connectivity analyses. The prerequisite for allowing the device to answer ping requests from the interfaces is that you activate the Send echo reply function globally. To do this, mark in the Routing > Global dialog, ICMP filter frame the Send echo reply checkbox.

Possible values:

- **marked** (default setting)
  The Ping answer function in the device is active. The device answers ICMP ping requests.

- **unmarked**
  The Ping answer function in the device is inactive. The device ignores ICMP ping requests.

VRRP master candidate

Specifies the IP address for the primary virtual router. Physical routers within a virtual router instance use the VRRP IP address for the communication. If the virtual router IP address is the same as the IP address of a router interface, then the router is the IP address owner and the master router.

Possible values:

- **Valid IP address** (default setting: 0.0.0.0)
  You can select the IP address of a router interface set up in the Routing > Interfaces > Configuration dialog.
Tracking

Current track entries
Displays the existing tracking objects available in the device. You set up tracking objects in the Routing > Tracking > Configuration dialog. Select an entry to continue. Alternatively, select a tracking object in the Track name field below. Each tracking object contains the following parameters separated by a dash:

- Type of the tracking object
- Identification number of the tracking object
- Name of the tracking object

There are the following types of tracking objects:

- **Interface**
  The device monitors the link status of its physical ports or of its link aggregation, LRE or VLAN router interface.

- **Ping**
  The device monitors the route to a remote router or end device by means of periodic ping requests.

- **Logical**
  The device monitors tracking objects logically linked to each other and thus enables complex monitoring tasks.

Assigned track entries
Displays the tracking objects assigned with a Decrement value. You can remove an item clicking the icon.

Track name
Specifies the name of the tracking object to which the virtual router is linked. Select an item from the drop-down list to continue. You set up tracking objects in the Routing > Tracking > Configuration dialog.

If the result for a tracking object is negative, then the VRRP instance reduces the priority of the virtual router. The tracking object is negative for example, if the monitored interface is inactive or the monitored router cannot be reached.

Possible values:
- Name of the tracking object, made up of Type and Track ID.

Decrement
Specifies the value by which the VRRP instance reduces the priority of the virtual router when the monitoring result is negative.

Possible values:
- 1..253 (default setting: 20)

**Note:** If in the Routing > L3-Redundancy > VRRP > Configuration dialog the value in the Priority column is 255, then the virtual router is the IP address owner. In this case, the priority of the virtual router remains unchanged.
Add

Creates an item in the **Assigned track entries** field based on the values specified in the **Track name** and **Decrement** fields.

**Virtual IP addresses**

**IP address**

Displays the primary IP address of the router interface.

Possible values:
- Valid IPv4 address  (default setting: `0.0.0.0`)

**Multinetting**

Displays the secondary IP address for the router interface and the subnet mask of the secondary IP addresses. You specify the secondary IP address and subnet mask in the **Routing > Interfaces > Configuration** dialog.

**Virtual IP addresses**

Displays the virtual IP address that you specified in the **IP address** field. You can remove an item clicking the **X** icon.

**IP address**

Specifies the assigned IP address of the master router within a virtual router.

Possible values:
- Valid IPv4 address

**Add**

Creates an item in the **Virtual IP addresses** field based on the value specified in the **IP address** field.
8.9.1.2 VRRP Statistics

This dialog displays the number of counters that count events relevant to the VRRP function.

Information

Checksum errors
Displays the number of VRRP messages received with the wrong checksum.

Version errors
Displays the number of VRRP messages received with an unknown or unsupported version number.

VRID errors
Displays the number of VRRP messages received with an invalid Virtual Router IDentifier for this virtual router.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Port
Displays the router interface number to which the table row relates.

VRID
Displays the Virtual Router IDentifier.

Become master
Displays the number of times that the device has taken the master role. This entry helps you to analyze the network. When this number is low, your network is relatively stable.

Advertise received
Displays the number of VRRP advertisements received.

Advertise interval errors
Displays the number of VRRP advertisements received by the router outside the advertisement interval. The value lets you determine if the routers have the same advertise interval specified across the virtual router instance.
Authentication failures
Displays the number of VRRP advertisements received with authentication errors.

IP TTL errors
Displays the number of VRRP advertisements received with an IP TTL not equal to 255.

Priority zero packets received
Displays the number of VRRP advertisements received with priority 0.

Priority zero packets sent
Displays the number of VRRP advertisements that the device sent with priority 0.

Invalid type packets received
Displays the number of VRRP advertisements received with an invalid type.

Address list errors
Displays the number of VRRP advertisements received for which the address list does not match the address list configured locally for the virtual router.

Invalid authentication type
Displays the number of VRRP advertisements received with an invalid authentication type.

Authentication type mismatch
Displays the number of VRRP advertisements received with an incorrect authentication type.

Packet length errors
Displays the number of VRRP advertisements received with an incorrect packet length.
8.9.1.3 VRRP Tracking

VRRP tracking lets you follow the operation of specific object and react to a change in the object status. The function is periodically notified about the tracked object and displays the changes in the table. The table displays the object statuses as either up, down or notReady.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

 Opens the Create window to add a table row.

▶ In the Port VRID drop-down list, you select the interface and router ID of a virtual router that has been set up.

▶ In the Track name drop-down list, you select the tracking object with which the device links the virtual router.

Remove

Removes the selected table row.

Port

Displays the router interface number of the virtual router.

VRID

Displays the virtual router ID for this virtual router.

Track name

Displays the name of the tracking object to which the virtual router is linked.

If the result for a tracking object is negative, then the VRRP instance reduces the priority of the virtual router. The tracking object is negative for example, if the monitored interface is inactive or the monitored router cannot be reached.

Possible values:

▶ Name of the tracking object, made up of Type and Track ID.

▶ Logical trackers, which combine multiple trackers

▶ – No tracking object selected.

You set up tracking objects in the Routing > Tracking > Configuration dialog.
Decrement

Specifies the value by which the VRRP instance reduces the priority of the virtual router when the monitoring result is negative.

Possible values:

- 1..253 (default setting: 20)

**Note:** If in the **Routing > L3-Redundancy > VRRP > Configuration** dialog the value in the **Priority** column is 255, then the virtual router is the IP address owner. In this case, the priority of the virtual router remains unchanged.

Status

Displays the monitoring result of the tracking object.

Possible values:

- **notReady**
  The tracking object is not operating.
- **up**
  The monitoring result is positive:
  - The link status is active.
  or
  - The remote router or end device is reachable.
- **down**
  The monitoring result is negative:
  - The link status is inactive.
  or
  - The remote router or end device is not reachable.
- A combination of the **up** and **down** trackers.

Active

Displays if the monitoring of the tracking object is active or inactive.

Possible values:

- **marked**
  The monitoring of the tracking object is active.
- **unmarked**
  The monitoring of the tracking object is inactive. You activate the monitoring in the **Routing > Tracking > Configuration** dialog, **Active** column.

### 8.10 NAT

The menu contains the following dialogs:

- **NAT Global**
- **1:1 NAT**
- **Destination NAT**
- **Masquerading NAT**
- **Double NAT**
8.10.1 NAT Global

Network Address Translation (NAT) contains several procedures which automatically change the IP address information in the data packet. When configured in the device, the NAT function enables communication links between devices in different networks.

The device provides a multi-step approach to set up and apply the NAT rules:
- Create rule.
- Assign rule to a router interface.
- Up to this step, changes have no effect on the behavior of the device and the data stream.
- Apply the rule to the data stream. To do this, click in the Routing > NAT > NAT Global dialog the button.

This dialog displays how many NAT rules can be set up for the individual NAT processes and indicates changes to the active NAT rules. By clicking the button, you apply the NAT rules configured to the data stream.

Information

Buttons

Commit changes
Applies the rules saved in the device to the data stream.

In the process, the device also removes the state information from the packet filter. This includes potential DCE RPC information of the OPC enforcer. In the process, the device interrupts open communication connections.

Note: While the device is activating the saved rules, the establishment of any new communication connections is impossible.

1:1 NAT rules (max.)
Displays how many rules can be configured in the device for the 1:1 NAT function.

Destination NAT rules (max.)
Displays how many rules can be configured in the device for the Destination NAT function.

Masquerading NAT rules (max.)
Displays how many rules can be configured in the device for the Masquerading NAT function.

Double NAT rules (max.)
Displays how many rules can be configured in the device for the Double NAT function.
1:1 NAT pending actions

Displays if the 1:1 NAT rules used in the data stream differ from the saved 1:1 NAT rules.

To apply the pending rules to the data stream, click the button.

Possible values:
- marked
  - At least one saved 1:1 NAT rule contains modified settings.
- unmarked
  - The device applies the saved 1:1 NAT rules to the data stream.

Destination NAT pending actions

Displays if the Destination NAT rules used in the data stream differ from the saved Destination NAT rules.

To apply the pending rules to the data stream, click the button.

Possible values:
- marked
  - At least one saved Destination NAT rule contains modified settings.
- unmarked
  - The device applies the saved Destination NAT rules to the data stream.

Masquerading NAT pending actions

Displays if the Masquerading NAT rules used in the data stream differ from the saved Masquerading NAT rules.

To apply the pending rules to the data stream, click the button.

Possible values:
- marked
  - At least one saved Masquerading NAT rule contains modified settings.
- unmarked
  - The device applies the saved Masquerading NAT rules to the data stream.

Double NAT pending actions

Displays if the Double NAT rules used in the data stream differ from the saved Double NAT rules.

To apply the pending rules to the data stream, click the button.

Possible values:
- marked
  - At least one saved Double NAT rule contains modified settings.
- unmarked
  - The device applies the saved Double NAT rules to the data stream.
8.10.2 1:1 NAT

The 1:1 NAT function lets you establish communication links within a local network to devices that are located in other networks. The NAT router virtually “shifts” the devices into the public network. To do this, the NAT router replaces the virtual with the actual IP address in the data packet while sending it. A typical application is connecting some identically structured production cells with the same IP address to a server farm.

The prerequisite for the 1:1 NAT process is that the NAT router itself responds to ARP requests. To make this happen, turn on the Proxy ARP function on the ingress interface.

To use the NAT function, set up a router interface for each network and turn on the routing function in the device.

The data packets go through the filter functions of the device in the following sequence:
The menu contains the following dialogs:

- 1:1 NAT Rule
8.10.2.1 1:1 NAT Rule

In this dialog you generate and edit the 1:1 NAT rules and assign router interfaces to which the device applies the 1:1 NAT rules.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row.

In the Destination address field, you specify the destination address of the data packets to which the device applies the rule. The device sends data packets with this destination address to the destination address specified in the New destination address column.

Possible values:
- Valid IPv4 address
  The device applies the 1:1 NAT rule only to data packets which contain the destination address specified here.
- Valid IPv4 address and netmask in CIDR notation
  The device applies the 1:1 NAT rule only to data packets which contain a destination address in the subnet specified here.

In the New destination address field, you specify the actual IP address of the destination device. The device sends data packets to the destination address specified here.

Possible values:
- Valid IPv4 address
  The device replaces the destination address in the data packet with this new destination address.
- Valid IPv4 address and netmask in CIDR notation
  The device replaces the destination address in the data packet with a destination address in the subnet specified here.

When you click the Ok button, the device creates a new table row. The device assigns the values specified in the Destination address and New destination address fields to this table row.

Remove

Removes the selected table row.
Routing

[Routing > NAT > 1:1 NAT > Rule]

Index

Displays the index number to which the table row relates.

Possible values:

▶ 1..255

Rule name

Displays the name of the 1:1 NAT rule. To change the name, click the relevant field.

Possible values:

▶ Alphanumeric ASCII character string with 0..32 characters

Priority

Specifies the priority of the 1:1 NAT rule.

Using the priority, you specify the order in which the device applies several rules to the data stream. The device applies the rules in ascending order starting with priority 0.

Possible values:

▶ 0..6500 (default setting: 0)

Ingress interface

Assigns the 1:1 NAT rule to the router interface on which the device receives data packets. The 1:1 NAT rule makes the destination device virtually accessible in the network connected here.

Possible values:

▶ <Interface number>
   The device applies the 1:1 NAT rule to this router interface, and only to data packets addressed to the IP address specified in the Destination address column.

▶ no Port
   No router interface is assigned to the 1:1 NAT rule. Someone removed the router interface after the last edit of the 1:1 NAT rule.

You enable on the ARP proxy function on this router interface in the Routing > Interfaces > Configuration dialog.

Destination address

Specifies the destination address of the data packets to which the device applies the 1:1 NAT rule. The device sends data packets with this destination address to the destination address specified in the New destination address column.

Possible values:

▶ Valid IPv4 address
   The device applies the 1:1 NAT rule only to data packets which contain the destination address specified here.

▶ Valid IPv4 address and netmask in CIDR notation
   The device applies the 1:1 NAT rule only to data packets which contain a destination address in the subnet specified here.
**Egress interface**

Assigns the 1:1 NAT rule to the router interface on which the device forwards the modified data packets. The destination device can actually be reached in the network connected here.

Possible values:
- `<Interface number>`
  The device forwards the modified data packets on this router interface.
- `no Port`
  No router interface is assigned to the 1:1 NAT rule. Someone removed the router interface after the last edit of the 1:1 NAT rule.

**New destination address**

Specifies the actual IP address of the destination device. The device sends data packets to the destination address specified here.

Possible values:
- Valid IPv4 address
  The device replaces the destination address in the data packet with this new destination address.
- Valid IPv4 address and netmask in CIDR notation
  The device replaces the destination address in the data packet with a destination address in the subnet specified here.

**Trap**

Activates/deactivates the sending of SNMP traps when the device applies a 1:1 NAT rule to a data packet.

Possible values:
- `marked`
  The sending of SNMP traps is active.
  If the device applies the 1:1 NAT rule to a data packet, then the device sends an SNMP trap.
- `unmarked` (default setting)
  The sending of SNMP traps is inactive.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.

**Log**

Activates/deactivates the logging in the log file. See the Diagnostics > Report > System Log dialog.

Possible values:
- `marked`
  Logging is activated.
  When the device applies the 1:1 NAT rule to a data packet, the device places an entry in the log file.
- `unmarked` (default setting)
  Logging is deactivated.
8.10.3 **Destination NAT**

The **Destination NAT** function lets you divert the data stream of outgoing communication links to or through a server in a local network.

A special form of the **Destination NAT** function is **port forwarding**. You use **port forwarding** to hide the structure of a network from the outside while still allowing communication links from the outside into the network. A typical application is remote control of a PC in a production cell. The maintenance station establishes the communication link to the **NAT** router, and the **Destination NAT** function takes care of the routing to the production cell.

To use the **NAT** function, set up a router interface for each network and turn on the routing function in the device.
The data packets go through the filter functions of the device in the following sequence:

![Diagram showing the processing sequence of data packets in the device]

Figure 6: Processing sequence of the data packets in the device

The menu contains the following dialogs:
- Destination NAT Rule
- Destination NAT Mapping
- Destination NAT Overview
8.10.3.1 Destination NAT Rule

In this dialog you create and edit the Destination NAT rules.

You assign a router interface to the affected Destination NAT rule in the Routing > NAT > Destination NAT > Mapping dialog.

An overview of which Destination NAT rule is to be assigned to which router interface can be found in the Routing > NAT > Destination NAT > Overview dialog.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row.

In the New destination address field, you specify the actual IP address of the destination device. The device sends data packets to the destination address specified here.

Possible values:
- Valid IPv4 address
  The device replaces the destination address in the data packet with this new destination address.

When you click the Ok button, the device creates a new table row. The device assigns the value specified in the New destination address field to this table row.

Remove

Removes the selected table row.
Index

Displays the index number to which the table row relates.

Possible values:

- 1..255

Rule name

Displays the name of the Destination NAT rule. To change the name, click the relevant field.

Possible values:

- Alphanumeric ASCII character string with 0..32 characters

Source address

Specifies the source address of the data packets to which the device applies the Destination NAT rule.

Possible values:

- any (default setting)
  The device applies the Destination NAT rule to data packets with any source address.
- Valid IPv4 address
  The device applies the Destination NAT rule only to data packets containing the source address specified here.
- Valid IPv4 address and netmask in CIDR notation
  The device applies the Destination NAT rule only to data packets containing a source address in the subnet specified here.
- An exclamation mark (!) preceding the IP address reverses the expression into its opposite. The device applies the Destination NAT rule to data packets NOT containing the source address specified here.

Source port

Specifies the source port of the data packets to which the device applies the Destination NAT rule.

The prerequisite for specifying a source port is that, in the Protocol field, you specify the value TCP or UDP.

Possible values:

- any (default setting)
  The device applies the Destination NAT rule to every data packet without evaluating the source port.
- 1..65535
  The device applies the Destination NAT rule only to data packets containing the specified source port.
  The field lets you specify the following options:
  - You specify a port with a single numerical value, for example 21.
  - You specify multiple individual ports with numerical values separated by commas, for example 21,80,110.
  - You specify a port range with numerical values connected by dashes, for example 2000-3000.
  - You can also combine ports and port ranges, for example 21,2000-3000,65535.
  The column lets you specify up to 15 numerical values. When you enter 21,2000-3000,65535, for example, you use 4 of 15 numerical values.
Routing
[Routing > NAT > Destination NAT > Rule]

Destination address

Specifies the destination address of the data packets to which the device applies the *Destination NAT* rule. The device sends data packets with this destination address to the destination address specified in the *New destination address* column.

Possible values:

- **any**
  - The device applies the *Destination NAT* rule to data packets with any destination address.
- **Valid IPv4 address**
  - The device applies the *Destination NAT* rule only to data packets containing the destination address specified here.
- **Valid IPv4 address and netmask in CIDR notation**
  - The device applies the *Destination NAT* rule only to data packets containing a destination address in the subnet specified here.
- **An exclamation mark (!) preceding the IP address reverses the expression into its opposite.**
  - The device applies the *Destination NAT* rule to data packets NOT containing the destination address specified here.

Destination port

Specifies the destination port of the data packets to which the device applies the *Destination NAT* rule.

Possible values:

- **any** (default setting)
  - The device applies the *Destination NAT* rule to every data packet without evaluating the destination port.
- **1–65535**
  - The device applies the *Destination NAT* rule only to data packets containing the specified destination port.

The field lets you specify the following options:

- You specify a port with a single numerical value, for example **21**.
- You specify multiple individual ports with numerical values separated by commas, for example **21,80,110**.
- You specify a port range with numerical values connected by dashes, for example **2000–3000**.
- You can also combine ports and port ranges, for example **21,2000–3000,65535**.

The column lets you specify up to 15 numerical values. When you enter **21,2000–3000,65535**, for example, you use 4 of 15 numerical values.

New destination address

Specifies the actual IP address of the destination device. The device sends data packets to the destination address specified here.

Possible values:

- **Valid IPv4 address**
  - The device replaces the destination address in the data packet with this new destination address.
New destination port

Specifies the port of the destination device. The device forwards data packets to the destination port specified here.

Possible values:

- **any**
  The device retains the original destination port in the data packet.
- **1..65535**
  The device replaces the destination port in the packet with this new destination port.

Protocol

Restricts the Destination NAT rule to an IP protocol. The device applies the Destination NAT rule only to packets of the specified IP protocol.

Possible values:

- **icmp**
  Internet Control Message Protocol (RFC 792)
- **igmp**
  Internet Group Management Protocol
- **ipip**
  IP in IP tunneling (RFC 1853)
- **tcp**
  Transmission Control Protocol (RFC 793)
- **udp**
  User Datagram Protocol (RFC 768)
- **esp**
  IPsec Encapsulated Security Payload (RFC 2406)
- **ah**
  IPsec Authentication Header (RFC 2402)
- **icmpv6**
  Internet Control Message Protocol for IPv6
- **any** (default setting)
  The device applies the Destination NAT rule to every data packet without evaluating the IP protocol.

Log

Activates/deactivates the logging in the log file. See the Diagnostics > Report > System Log dialog.

Possible values:

- **marked**
  Logging is activated.
  When the device applies the Destination NAT rule to a data packet, the device places an entry in the log file.
- **unmarked** (default setting)
  Logging is deactivated.
**Trap**

Activates/deactivates the sending of SNMP traps when the device applies a Destination NAT rule to a data packet.

Possible values:

- **marked**
  The sending of SNMP traps is active.
  If the device applies the Destination NAT rule to a data packet, then the device sends an SNMP trap.

- **unmarked** (default setting)
  The sending of SNMP traps is inactive.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.

**Active**

Activates/deactivates the Destination NAT rule.

Possible values:

- **marked**
  The rule is active.

- **unmarked** (default setting)
  The rule is inactive.
8.10.3.2 Destination NAT Mapping

In this dialog you assign the Destination NAT rules to a router interface. To do this, click the button.

You create and edit the Destination NAT rules in the Routing > NAT > Destination NAT > Rule.

An overview of which Destination NAT rule is to be assigned to which router interface can be found in the Routing > NAT > Destination NAT > Overview dialog.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Remove

Removes the selected table row.

Assign

Opens the Assign window. In this window you assign a configured router interface of an existing Destination NAT rule.

Port

Displays the number of the router interface on which the device applies the Destination NAT rule.

Rule index

Displays the sequential number of the Destination NAT rule. See the Index column in the Routing > NAT > Destination NAT > Rule dialog.

Rule name

Displays the name of the Destination NAT rule. See the Rule name column in the Routing > NAT > Destination NAT > Rule dialog.

Direction

Displays if the device applies the Destination NAT rule to data packets received or sent.

Possible values:

- ingress
  The device applies the Destination NAT rule to data packets received on the router interface.
Routing
[Routing > NAT > Destination NAT > Mapping]

Priority

Specifies the priority of the Destination NAT rule.

Using the priority, you specify the order in which the device applies several rules to the data stream. The device applies the rules in ascending order starting with priority 1.

Possible values:
▶ 1..6500 (default setting: 1)

Active

Activates/deactivates the Destination NAT rule.

Possible values:
▶ marked
   The rule is active.
▶ unmarked  (default setting)
   The rule is inactive.
8.10.3.3 Destination NAT Overview

In this dialog you will find an overview of which Destination NAT rule is assigned to which router interface.

You create and edit the Destination NAT rules in the Routing > NAT > Destination NAT > Rule.

You assign a router interface to the affected Destination NAT rule in the Routing > NAT > Destination NAT > Mapping dialog.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

| Port | Displays the number of the router interface on which the device applies the Destination NAT rule. |
| Rule index | Displays the sequential number of the Destination NAT rule. See the Index column in the Routing > NAT > Destination NAT > Rule dialog. |
| Rule name | Displays the name of the Destination NAT rule. See the Rule name column in the Routing > NAT > Destination NAT > Rule dialog. |
| Destination address | Displays the destination address of the data packets to which the device applies the Destination NAT rule. The device sends data packets with this destination address to the destination address specified in the New destination address column. |
| New destination address | Displays the actual IP address of the destination device. The device sends data packets to the destination address specified here. |
| Trap | Displays if the device sends an SNTP trap when it applies the Destination NAT rule to a data packet. |

Possible values:

- **marked**
  - The device sends an SNMP trap.
- **unmarked**
  - The device does not send an SNMP trap.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.
Log

Displays if the device places an entry in the log file when it applies the Destination NAT rule to a data packet.

Possible values:

- **marked**
  
  When the device applies the Destination NAT rule to a data packet, the device places an entry in the log file. See the Diagnostics > Report > System Log dialog.

- **unmarked**
  
  Logging is disabled.

Direction

Displays if the device applies the Destination NAT rule to data packets received or sent.

Possible values:

- **ingress**
  
  The device applies the Destination NAT rule to data packets received on the router interface.

Priority

Displays the priority of the Destination NAT rule.

The device applies rules to the data stream in ascending order starting with priority 1.

8.10.4 Masquerading NAT

The Masquerading NAT function hides any number of devices behind the IP address of the NAT router and thus hides the structure of a network from other networks. To do this, the NAT router replaces the sender address in the data packet with its own IP address. Also, the NAT router replaces the source port in the data packet with its own value to send the response data packets back to the original sender later on.

![Masquerading NAT Diagram](image-url)

**Figure 7:** How the Masquerading NAT function works
To use the *NAT* function, set up a router interface for each network and turn on the routing function in the device.

**Note:** If you enable the *VRRP* function on a router interface, then the *Masquerading NAT* function is ineffective on this router interface.

The data packets go through the filter functions of the device in the following sequence:

---

**Figure 8: Processing sequence of the data packets in the device**

The menu contains the following dialogs:

- Masquerading NAT Rule
- Masquerading NAT Mapping
- Masquerading NAT Overview
8.10.4.1 Masquerading NAT Rule

In this dialog you create and edit the Masquerading NAT rules.

You assign a router interface to the affected Masquerading NAT rule in the Routing > NAT > Masquerading NAT > Mapping dialog.

An overview of which Masquerading NAT rule is to be assigned to which router interface can be found in the Routing > NAT > Masquerading NAT > Overview dialog.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Adds a table row.

Remove

Removes the selected table row.

Index

Displays the index number to which the table row relates.

Possible values:

1..128

Rule name

Displays the name of the Masquerading NAT rule. To change the name, click the relevant field.

Possible values:

Alphanumeric ASCII character string with 0..32 characters

Source address

Specifies the source address of the data packets to which the device applies the Masquerading NAT rule.

Possible values:

any

The device applies the Masquerading NAT rule to data packets with any source address.

Valid IPv4 address

The device applies the Masquerading NAT rule only to data packets containing the source address specified here.
Valid IPv4 address and netmask in CIDR notation
The device applies the **Masquerading NAT** rule only to data packets containing a source address in the subnet specified here.

An exclamation mark (!) preceding the IP address reverses the expression into its opposite. The device applies the **Masquerading NAT** rule to data packets NOT containing the source address specified here.

Source port

Specifies the source port of the data packets to which the device applies the **Masquerading NAT** rule.

Possible values:

- **any** (default setting)
  The device applies the **Masquerading NAT** rule to every data packet without evaluating the source port.

- **1..65535**
  The device applies the **Masquerading NAT** rule only to data packets containing the specified source port.

The field lets you specify the following options:

- You specify a port with a single numerical value, for example **21**.
- You specify multiple individual ports with numerical values separated by commas, for example **21,80,110**.
- You specify a port range with numerical values connected by dashes, for example **2000-3000**.
- You can also combine ports and port ranges, for example **21,2000-3000,65535**.

The column lets you specify up to 15 numerical values. When you enter **21,2000-3000,65535**, for example, you use 4 of 15 numerical values.

Protocol

Restricts the **Masquerading NAT** rule to an IP protocol. The device applies the **Masquerading NAT** rule only to packets of the specified IP protocol.

Possible values:

- **tcp**
  Transmission Control Protocol (RFC 793)

- **udp**
  User Datagram Protocol (RFC 768)

- **any** (default setting)
  The device applies the **Masquerading NAT** rule to every data packet without evaluating the IP protocol.

Log

Activates/deactivates the logging in the log file. See the **Diagnostics > Report > System Log** dialog.

Possible values:

- **marked**
  Logging is activated.
  When the device applies the **Masquerading NAT** rule to a data packet, the device places an entry in the log file.

- **unmarked** (default setting)
  Logging is deactivated.
Trap

Activates/deactivates the sending of SNMP traps when the device applies a *Masquerading NAT* rule to a data packet.

Possible values:
- **marked**
  - The sending of SNMP traps is active.
  - If the device applies the *Masquerading NAT* rule to a data packet, then the device sends an SNMP trap.
- **unmarked** (default setting)
  - The sending of SNMP traps is inactive.

The prerequisite for sending SNMP traps is that you enable the function in the *Diagnostics > Status Configuration > Alarms (Traps)* dialog and specify at least one trap destination.

IPsec exempt

Activates/deactivates applying the *Masquerading NAT* rule to IPsec data packets.

Possible values:
- **marked**
  - The device does not apply the *Masquerading NAT* rule to the IPsec data packets. The device transmits IPsec data packets through the VPN tunnel without any modification.
- **unmarked** (default setting)
  - The device applies the *Masquerading NAT* rule to the IPsec data packets. The device transmits IPsec data packets through the VPN tunnel depending on the settings of the Traffic Selector in the *Source address (CIDR)* and *Source restrictions* columns. See the *Virtual Private Network > Connections* dialog.

Active

Activates/deactivates the *Masquerading NAT* rule.

Possible values:
- **marked**
  - The rule is active.
- **unmarked** (default setting)
  - The rule is inactive.
8.10.4.2 Masquerading NAT Mapping

In this dialog you assign the Masquerading NAT rules to a router interface. To do this, click the button.

You create and edit the Masquerading NAT rules in the Routing > NAT > Masquerading NAT > Rule.

An overview of which Masquerading NAT rule is to be assigned to which router interface can be found in the Routing > NAT > Masquerading NAT > Overview dialog.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- Remove
  
Removes the selected table row.

- Assign
  
Opens the Assign window. In this window you assign a configured router interface of an existing Masquerading NAT rule.

**Port**

Displays the number of the router interface on which the device applies the Masquerading NAT rule.

**Rule index**

Displays the sequential number of the Masquerading NAT rule. See the Index column in the Routing > NAT > Masquerading NAT > Rule dialog.

**Rule name**

Displays the name of the Masquerading NAT rule. See the Rule name column in the Routing > NAT > Masquerading NAT > Rule dialog.

**Direction**

Displays if the device applies the Masquerading NAT rule to data packets received or sent.

Possible values:

- egress
  
  The device applies the Masquerading NAT rule to data packets sent on the router interface.
Routing

[Routing > NAT > Masquerading NAT > Mapping]

Priority

Specifies the priority of the Masquerading NAT rule.

Using the priority, you specify the order in which the device applies several rules to the data stream. The device applies the rules in ascending order starting with priority 1.

Possible values:
- 1..6500 (default setting: 1)

Active

Activates/deactivates the Masquerading NAT rule.

Possible values:
- marked
  The rule is active.
- unmarked (default setting)
  The rule is inactive.
8.10.4.3 Masquerading NAT Overview

In this dialog you will find an overview of which Masquerading NAT rule is assigned to which router interface.

You create and edit the Masquerading NAT rules in the Routing > NAT > Masquerading NAT > Rule.

You assign a router interface to the affected Masquerading NAT rule in the Routing > NAT > Masquerading NAT > Mapping dialog.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Port

Displays the number of the router interface on which the device applies the Masquerading NAT rule.

Rule index

Displays the sequential number of the Masquerading NAT rule. See the Index column in the Routing > NAT > Masquerading NAT > Rule dialog.

Rule name

Displays the name of the Masquerading NAT rule. See the Rule name column in the Routing > NAT > Masquerading NAT > Rule dialog.

Trap

Displays if the device sends an SNTP trap when it applies the Masquerading NAT rule to a data packet.

Possible values:

- **marked**
  - The device sends an SNMP trap.

- **unmarked**
  - The device does not send an SNMP trap.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.
Log

Displays if the device places an entry in the log file when it applies the *Masquerading NAT* rule to a data packet.

Possible values:

- **marked**
  - When the device applies the *Masquerading NAT* rule to a data packet, the device places an entry in the log file. See the *Diagnostics > Report > System Log* dialog.
- **unmarked**
  - Logging is disabled.

Direction

Displays if the device applies the *Masquerading NAT* rule to data packets received or sent.

Possible values:

- **egress**
  - The device applies the *Masquerading NAT* rule to data packets sent on the router interface.

Priority

Displays the priority of the *Masquerading NAT* rule.

The device applies rules to the data stream in ascending order starting with priority 1.
8.10.5 Double NAT

The Double NAT function lets you establish communication links between end devices located in different IP networks, which have no way to specify a default gateway or default route. The NAT router virtually “shifts” the devices into the other network. To do this, the NAT router replaces the source address and the destination address in the data packet during sending. A typical application is the linking of controllers located in different networks.

The prerequisite for the Double NAT function is that the NAT router itself responds to ARP requests from the respective network. To make this happen, turn on the ARP proxy function on the ingress interface and on the egress interface.

![Diagram of Double NAT](image)

**Figure 9:** How the Double NAT function works

To use the NAT function, set up a router interface for each network and turn on the routing function in the device.
The data packets go through the filter functions of the device in the following sequence:

![Diagram of data packet processing sequence]

*Figure 10: Processing sequence of the data packets in the device*

The menu contains the following dialogs:

- Double NAT Rule
- Double NAT Mapping
- Double NAT Overview
8.10.5.1 Double NAT Rule

In this dialog you create and edit the Double NAT rules.

You assign the router interfaces to the related Double NAT rule in the Routing > NAT > Double NAT > Mapping dialog.

An overview of which Double NAT rule is assigned to which router interfaces you find in the Routing > NAT > Double NAT > Overview dialog.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row.

▶ In the Local internal IP address field, you specify the actual IP address for the device placed in the first network.
   Possible values:
   – Valid IPv4 address
     The device applies the Double NAT rule only to data packets containing the source address specified here.

▶ In the Local external IP address field, you specify the virtual IP address in the second network for the device placed in the first network.
   Possible values:
   – Valid IPv4 address
     The device applies the Double NAT rule only to data packets containing the source address specified here.

▶ In the Remote internal IP address field, you specify the actual IP address for the device placed in the second network.
   Possible values:
   – Valid IPv4 address
     The device applies the Double NAT rule only to data packets containing the source address specified here.

▶ In the Remote external IP address field, you specify the virtual IP address in the first network for the device placed in the second network.
   Possible values:
   – Valid IPv4 address
     The device applies the Double NAT rule only to data packets containing the source address specified here.

When you click the Ok button, the device creates a new table row. The device assigns the values specified in the Local internal IP address, Local external IP address, Remote internal IP address and Remote external IP address fields to this table row.

Remove

Removes the selected table row.
Routing

[Routing > NAT > Double NAT > Rule]

Index

Displays the index number to which the table row relates.

Possible values:
- 1..255

Rule name

Displays the name of the Double NAT rule. To change the name, click the relevant field.

Possible values:
- Alphanumeric ASCII character string with 0..32 characters

Local internal IP address

Specifies the actual IP address for the device placed in the first network.

Possible values:
- Valid IPv4 address
  - The device applies the Double NAT rule only to data packets containing the source address specified here.

Local external IP address

Specifies the virtual IP address in the second network for the device placed in the first network.

Possible values:
- Valid IPv4 address
  - The device applies the Double NAT rule only to data packets containing the source address specified here.

Remote internal IP address

Specifies the actual IP address for the device placed in the second network.

Possible values:
- Valid IPv4 address
  - The device applies the Double NAT rule only to data packets containing the source address specified here.

Remote external IP address

Specifies the virtual IP address in the first network for the device placed in the second network.

Possible values:
- Valid IPv4 address
  - The device applies the Double NAT rule only to data packets containing the source address specified here.
Log

Activates/deactivates the logging in the log file. See the Diagnostics > Report > System Log dialog.

Possible values:
- **marked**
  - Logging is activated.
  - The device places an entry in the log file when it applies the Double NAT rule to a data packet.
- **unmarked** (default setting)
  - Logging is deactivated.

Trap

Activates/deactivates the sending of SNMP traps when the device applies a Double NAT rule to a data packet.

Possible values:
- **marked**
  - The sending of SNMP traps is active.
  - If the device applies the Double NAT rule to a data packet, then the device sends an SNMP trap.
- **unmarked** (default setting)
  - The sending of SNMP traps is inactive.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.

Active

Activates/deactivates the Double NAT rule.

Possible values:
- **marked**
  - The rule is active.
- **unmarked** (default setting)
  - The rule is inactive.
8.10.5.2 Double NAT Mapping

In this dialog you assign the Double NAT rules to a router interface. To do this, click the button.

You create and edit the Double NAT rules in the Routing > NAT > Double NAT > Rule.

An overview of which Double NAT rule is assigned to which router interfaces you find in the Routing > NAT > Double NAT > Overview dialog.

### Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

### Buttons

- **Remove**
  
  Removes the selected table row.

- **Assign**
  
  Opens the Assign window. In this window you assign a configured router interface of an existing Double NAT rule.

### Port

Displays the number of the router interface on which the device applies the Double NAT rule.

### Rule index

Displays the sequential number of the Double NAT rule. See the Index column in the Routing > NAT > Double NAT > Rule dialog.

### Rule name

Displays the name of the Double NAT rule. See the Rule name column in the Routing > NAT > Double NAT > Rule dialog.

### Direction

Displays if the device applies the Double NAT rule to data packets received or sent.

Possible values:

- **ingress**
  
  The device applies the Double NAT rule to data packets received on the router interface.
Routing

[Routing > NAT > Double NAT > Mapping]

- **egress**
  The device applies the *Double NAT* rule to data packets sent on the router interface.

- **both**
  The device applies the *Double NAT* rule to data packets received or sent on the router interface.

You can change the value when you click the 🗑️ button.

**Priority**

Specifies the priority of the *Double NAT* rule.

Using the priority, you specify the order in which the device applies several rules to the data stream. The device applies the rules in ascending order starting with priority **1**.

Possible values:
- **1..6500** (default setting: 1)

**Active**

Activates/deactivates the *Double NAT* rule.

Possible values:
- **marked**
  The rule is active.
- **unmarked** (default setting)
  The rule is inactive.
### 8.10.5.3 Double NAT Overview

In this dialog you will find an overview of which Double NAT rule is assigned to which router interface.

You create and edit the Double NAT rules in the Routing > NAT > Double NAT > Rule.

You assign the router interfaces to the related Double NAT rule in the Routing > NAT > Double NAT > Mapping dialog.

#### Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>Port</th>
<th>Displays the number of the router interface on which the device applies the Double NAT rule.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule index</td>
<td>Displays the sequential number of the Double NAT rule. See the Index column in the Routing &gt; NAT &gt; Double NAT &gt; Rule dialog.</td>
</tr>
<tr>
<td>Rule name</td>
<td>Displays the name of the Double NAT rule. See the Rule name column in the Routing &gt; NAT &gt; Double NAT &gt; Rule dialog.</td>
</tr>
<tr>
<td>Local internal IP address</td>
<td>Displays the actual IP address for the device placed in the first network.</td>
</tr>
<tr>
<td>Local external IP address</td>
<td>Displays the virtual IP address in the second network for the device placed in the first network.</td>
</tr>
<tr>
<td>Remote internal IP address</td>
<td>Displays the actual IP address for the device placed in the second network.</td>
</tr>
<tr>
<td>Remote external IP address</td>
<td>Displays the virtual IP address in the first network for the device placed in the second network.</td>
</tr>
</tbody>
</table>
Trap

Displays if the device sends an SNTP trap when it applies the Double NAT rule to a data packet.

Possible values:

- **marked**
  - The device sends an SNMP trap.
- **unmarked**
  - The device does not send an SNMP trap.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.

Log

Displays if the device places an entry in the log file when it applies the Double NAT rule to a data packet.

Possible values:

- **marked**
  - When the device applies the Double NAT rule to a data packet, the device places an entry in the log file. See the Diagnostics > Report > System Log dialog.
- **unmarked**
  - Logging is disabled.

Direction

Displays if the device applies the Double NAT rule to data packets received or sent.

Possible values:

- **ingress**
  - The device applies the Double NAT rule to data packets received on the router interface.
- **egress**
  - The device applies the Double NAT rule to data packets sent on the router interface.
- **both**
  - The device applies the Double NAT rule to data packets received or sent on the router interface.

Priority

Displays the priority of the Double NAT rule.

The device applies rules to the data stream in ascending order starting with priority 1.
9 Diagnostics

The menu contains the following dialogs:
- Status Configuration
- System
- Syslog
- Ports
- LLDP
- Report

9.1 Status Configuration

The menu contains the following dialogs:
- Device Status
- Security Status
- Signal Contact
- Alarms (Traps)
9.1.1 Device Status

The device status provides an overview of the overall condition of the device. Many process visualization systems record the device status for a device in order to present its condition in graphic form.

The device displays its current status as `error` or `ok` in the Device status frame. The device determines this status from the individual monitoring results.

The device displays detected faults in the Status tab and also in the Basic Settings > System dialog, Device Status frame.

The dialog contains the following tabs:
- [Global]
- [Port]
- [Status]

[Global]

Device status

Displays the current status of the device. The device determines the status from the individual monitored parameters.

Possible values:
- `ok`
- `error`

The device displays this value to indicate a detected error in one of the monitored parameters.

Traps

Send trap

Activates/deactivates the sending of SNMP traps when the device detects a change in a monitored function.

Possible values:
- `marked` (default setting)
  - The sending of SNMP traps is active.
  - If the device detects a change in the monitored functions, then the device sends an SNMP trap.
- `unmarked`
  - The sending of SNMP traps is inactive.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.
**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Connection errors**

Activates/deactivates the monitoring of the link status of the port/interface.

Possible values:

- **marked**
  Monitoring is active.
  If the link interrupts on a monitored port/interface, then in the Device status frame, the value changes to error.

- **unmarked** (default setting)
  Monitoring is inactive.

**Temperature**

Activates/deactivates the monitoring of the temperature in the device.

Possible values:

- **marked** (default setting)
  Monitoring is active.
  If the temperature exceeds or falls below the specified threshold values, then in the Device status frame, the value changes to error.

- **unmarked**
  Monitoring is inactive.

You specify the temperature threshold values in the Basic Settings > System dialog, Upper temp. limit [°C] field and Lower temp. limit [°C] field.

**External memory removal**

Activates/deactivates the monitoring of the active external memory.

Possible values:

- **marked**
  Monitoring is active.
  If you remove the active external memory from the device, then in the Device status frame, the value changes to error.

- **unmarked** (default setting)
  Monitoring is inactive.

You specify the active external memory in the Basic Settings > Load/Save dialog, External memory frame.
External memory not in sync

Activates/deactivates the monitoring of the configuration profile in the device and in the external memory.

Possible values:

- marked
  Monitoring is active.
  In the Device status frame, the value changes to error in the following situations:
  - The configuration profile only exists in the device.
  - The configuration profile in the device differs from the configuration profile in the external memory.

- unmarked (default setting)
  Monitoring is inactive.

Power supply

Activates/deactivates the monitoring of the power supply unit.

Possible values:

- marked (default setting)
  Monitoring is active.
  If the device has a detected power supply fault, then in the Device status frame, the value changes to error.

- unmarked
  Monitoring is inactive.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Port

Displays the port number.

Propagate connection error

Activates/deactivates the monitoring of the link on the port/interface.

Possible values:

- marked
  Monitoring is active.
  If the link on the selected port/interface is interrupted, then in the Device status frame, the value changes to error.

- unmarked (default setting)
  Monitoring is inactive.

This setting takes effect when you mark the Connection errors checkbox in the Global tab.
[Status]

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Timestamp**

Displays the date and time of the event in the format, *Month Day, Year hh:mm:ss AM/PM*.

**Cause**

Displays the event which caused the SNMP trap.
9.1.2 Security Status

This dialog gives you an overview of the status of the safety-relevant settings in the device.

The device displays its current status as error or ok in the Security status frame. The device determines this status from the individual monitoring results.

The device displays detected faults in the Status tab and also in the Basic Settings > System dialog, Security status frame.

The dialog contains the following tabs:
- [Global]
- [Port]
- [Status]

[Global]

Security status

Displays the current status of the security-relevant settings in the device. The device determines the status from the individual monitored parameters.

Possible values:
- ok
- error

The device displays this value to indicate a detected error in one of the monitored parameters.

Traps

Send trap

Activates/deactivates the sending of SNMP traps when the device detects a change in a monitored function.

Possible values:
- marked
  The sending of SNMP traps is active.
  If the device detects a change in the monitored functions, then the device sends an SNMP trap.
- unmarked (default setting)
  The sending of SNMP traps is inactive.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.
Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Password default settings unchanged

Activates/deactivates the monitoring of the password for the locally set up user accounts user and admin.

Possible values:

- marked (default setting)
  Monitoring is active.
  If the password is set to the default setting for the user or admin user accounts, then in the Security status frame, the value changes to error.

- unmarked
  Monitoring is inactive.

You set the password in the Device Security > User Management dialog.

Min. password length < 8

Activates/deactivates the monitoring of the Min. password length policy.

Possible values:

- marked (default setting)
  Monitoring is active.
  If the value for the Min. password length policy is less than 8, then in the Security status frame, the value changes to error.

- unmarked
  Monitoring is inactive.

You specify the Min. password length policy in the Device Security > User Management dialog in the Configuration frame.

Password policy settings deactivated

Activates/deactivates the monitoring of the Password policies settings.

Possible values:

- marked (default setting)
  Monitoring is active.
  If the value for at least one of the following policies is less than 1, then in the Security status frame, the value changes to error.
  - Upper-case characters (min.)
  - Lower-case characters (min.)
  - Digits (min.)
  - Special characters (min.)

- unmarked
  Monitoring is inactive.

You specify the policy settings in the Device Security > User Management dialog in the Password policy frame.
User account password policy check deactivated

Activates/deactivates the monitoring of the Policy check function.

Possible values:

- **marked**
  Monitoring is active.
  If the Policy check function is inactive for at least one user account, then in the Security status frame, the value changes to error.

- **unmarked** (default setting)
  Monitoring is inactive.

You activate the Policy check function in the Device Security > User Management dialog.

HTTP server active

Activates/deactivates the monitoring of the HTTP server.

Possible values:

- **marked** (default setting)
  Monitoring is active.
  If you enable the HTTP server, then in the Security status frame, the value changes to error.

- **unmarked**
  Monitoring is inactive.

You enable/disable the HTTP server in the Device Security > Management Access > Server dialog, HTTP tab.

SNMP unencrypted

Activates/deactivates the monitoring of the SNMP server.

Possible values:

- **marked** (default setting)
  Monitoring is active.
  If at least one of the following conditions applies, then in the Security status frame, the value changes to error:
  - The SNMPv1 function is enabled.
  - The SNMPv2 function is enabled.
  - The encryption for SNMPv3 is disabled.
    You enable the encryption in the Device Security > User Management dialog, in the SNMP encryption type column.

- **unmarked**
  Monitoring is inactive.

You specify the settings for the SNMP agent in the Device Security > Management Access > Server dialog, SNMP tab.

Access to system monitor with serial interface possible

Activates/deactivates the monitoring of the system monitor.

When the system monitor is active, you have the possibility to change to the system monitor via a serial connection.
Possible values:

- **marked**
  Monitoring is active.
  If you activate the system monitor, then in the Security status frame, the value changes to error.

- **unmarked** (default setting)
  Monitoring is inactive.

You activate/deactivate the system monitor in the Diagnostics > System > Selftest dialog.

### Saving the configuration profile on the external memory possible

Activates/deactivates the monitoring of the configuration profile in the external memory.

Possible values:

- **marked**
  Monitoring is active.
  If you activate the saving of the configuration profile in the external memory, then in the Security status frame, the value changes to error.

- **unmarked** (default setting)
  Monitoring is inactive.

You activate/deactivate the saving of the configuration profile in the external memory in the Basic Settings > External Memory dialog.

### Link interrupted on enabled device ports

Activates/deactivates the monitoring of the link on the active ports.

Possible values:

- **marked**
  Monitoring is active.
  If the link interrupts on an active port, then in the Security status frame, the value changes to error. In the Port tab, you have the option of selecting the ports to be monitored individually.

- **unmarked** (default setting)
  Monitoring is inactive.

### Access with HiDiscovery possible

Activates/deactivates the monitoring of the HiDiscovery function.

Possible values:

- **marked** (default setting)
  Monitoring is active.
  If you enable the HiDiscovery function, then in the Security status frame, the value changes to error.

- **unmarked**
  Monitoring is inactive.

You enable/disable the HiDiscovery function in the Basic Settings > Network > Global dialog.
Load unencrypted config from external memory

Activates/deactivates the monitoring of loading unencrypted configuration profiles from the external memory.

Possible values:

- **marked** (default setting)
  Monitoring is active.
  If the settings allow the device to load an unencrypted configuration profile from the external memory, then in the **Security status** frame, the value changes to **error**.
  If the following preconditions are fulfilled, then the **Security status** frame in the **Basic Settings > System** dialog, displays an alarm.
  - The configuration profile stored in the external memory is unencrypted.
  - The **Config priority** column in the **Basic Settings > External Memory** dialog has the value **first** or **second**.

- **unmarked**
  Monitoring is inactive.

Self-signed HTTPS certificate present

Activates/deactivates the monitoring of the HTTPS certificate.

Possible values:

- **marked** (default setting)
  Monitoring is active.
  If the HTTPS server uses a self-created digital certificate, then in the **Security status** frame, the value changes to **error**.

- **unmarked**
  Monitoring is inactive.

### Port

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Port**

Displays the port number.
Link interrupted on enabled device ports

Activates/deactivates the monitoring of the link on the active ports.

Possible values:

- **marked**
  Monitoring is active.
  If the port is enabled (Basic Settings > Port dialog, Configuration tab, Port on checkbox is marked) and the link is down on the port, then in the Security status frame, the value changes to error.

- **unmarked** (default setting)
  Monitoring is inactive.

This setting takes effect when you mark the Link interrupted on enabled device ports checkbox in the Diagnostics > Status Configuration > Security Status dialog, Global tab.

[Status]

### Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Timestamp**

Displays the date and time of the event in the format, Month Day, Year hh:mm:ss AM/PM.

**Cause**

Displays the event which caused the SNMP trap.

### 9.1.3 Signal Contact

The signal contact is a potential-free relay contact. The device thus lets you perform remote diagnosis. The device uses the relay contact to signal the occurrence of events by opening the relay contact and interrupting the closed circuit.

**Note:** The device can contain several signal contacts. Each contact contains the same monitoring functions. Several contacts allow you to group various functions together providing flexibility in system monitoring.

The menu contains the following dialogs:

- Signal Contact 1 / Signal Contact 2
9.1.3.1 Signal Contact 1 / Signal Contact 2

In this dialog you specify the trigger conditions for the signal contact.

The signal contact gives you the following options:
- Monitoring the correct operation of the device.
- Signaling the device status of the device.
- Signaling the security status of the device.
- Controlling external devices by manually setting the signal contacts.

The device displays detected faults in the Status tab and also in the Basic Settings > System dialog, Signal contact status frame.

The dialog contains the following tabs:
- [Global]
- [Port]
- [Status]

[Global]

Configuration

Mode

Specifies which events the signal contact indicates.

Possible values:
- Manual setting (default setting for Signal Contact 2, if present)
  You use this setting to manually open or close the signal contact, for example to turn on or off a remote device. See the Contact option list.
- Monitoring correct operation (default setting)
  Using this setting the signal contact indicates the status of the parameters specified in the table below.
- Device status
  Using this setting the signal contact indicates the status of the parameters monitored in the Diagnostics > Status Configuration > Device Status dialog. In addition, you can read the status in the Signal contact status frame.
- Security status
  Using this setting the signal contact indicates the status of the parameters monitored in the Diagnostics > Status Configuration > Security Status dialog. In addition, you can read the status in the Signal contact status frame.
- Device/Security status
  Using this setting the signal contact indicates the status of the parameters monitored in the Diagnostics > Status Configuration > Device Status and the Diagnostics > Status Configuration > Security Status dialog. In addition, you can read the status in the Signal contact status frame.
Contact

Toggles the signal contact manually. The prerequisite is that in the Mode drop-down list you select the Manual setting item.

Possible values:

- **open**
  - The signal contact is opened.

- **close**
  - The signal contact is closed.

**Signal contact status**

Displays the current status of the signal contact.

Possible values:

- **Opened (error)**
  - The signal contact is opened. The circuit is interrupted.

- **Closed (ok)**
  - The signal contact is closed. The circuit is closed.

**Trap configuration**

Send trap

Activates/deactivates the sending of SNMP traps when the device detects a change in a monitored function.

Possible values:

- **marked**
  - The sending of SNMP traps is active.
  - If the device detects a change in the monitored functions, then the device sends an SNMP trap.

- **unmarked** (default setting)
  - The sending of SNMP traps is inactive.

The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.
Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Connection errors

Activates/deactivates the monitoring of the link status of the port/interface.

Possible values:

- marked
  Monitoring is active.
  If the link interrupts on a monitored port/interface, then the signal contact opens.
  In the Port tab, you have the option of selecting the ports/interfaces to be monitored individually.
- unmarked (default setting)
  Monitoring is inactive.

Temperature

Activates/deactivates the monitoring of the temperature in the device.

Possible values:

- marked (default setting)
  Monitoring is active.
  If the temperature exceeds or falls below the specified threshold values, then the signal contact opens.
- unmarked
  Monitoring is inactive.

You specify the temperature threshold values in the Basic Settings > System dialog, Upper temp. limit [°C] field and Lower temp. limit [°C] field.

External memory removed

Activates/deactivates the monitoring of the active external memory.

You specify the active external memory in the Basic Settings > Load/Save dialog, External memory frame.

Possible values:

- marked
  Monitoring is active.
  If you remove the active external memory from the device, then the signal contact opens.
- unmarked (default setting)
  Monitoring is inactive.
External memory not in sync with NVM

Activates/deactivates the monitoring of the configuration profile in the device and in the external memory.

Possible values:

- **marked**
  Monitoring is active.
  The signal contact opens in the following situations:
  - The configuration profile only exists in the device.
  - The configuration profile in the device differs from the configuration profile in the external memory.

- **unmarked** (default setting)
  Monitoring is inactive.

Power supply

Activates/deactivates the monitoring of the power supply unit.

Possible values:

- **marked** (default setting)
  Monitoring is active.
  If the device has a detected power supply fault, then the signal contact opens.

- **unmarked**
  Monitoring is inactive.

[Port]

Table

For information on how to customize the appearance of the table, see "Working with tables" on page 16.

Port

Displays the port number.

Propagate connection error

Activates/deactivates the monitoring of the link on the port/interface.

Possible values:

- **marked**
  Monitoring is active.
  If the link interrupts on the selected port/interface, then the signal contact opens.

- **unmarked** (default setting)
  Monitoring is inactive.

This setting takes effect when you mark the **Connection errors** checkbox in the **Global** tab.
[Status]

Table
For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Timestamp
Displays the date and time of the event in the format, Month Day, Year hh:mm:ss AM/PM.

Cause
Displays the event which caused the SNMP trap.

9.1.4 Alarms (Traps)
[Diagnoses > Status Configuration > Alarms (Traps)]

The device lets you send an SNMP trap as a reaction to specific events. In this dialog you specify the trap destinations to which the device sends the SNMP traps.

The events for which the device triggers an SNMP trap, you specify, for example, in the following dialogs:

- in the Diagnostics > Status Configuration > Device Status dialog
- in the Diagnostics > Status Configuration > Security Status dialog

When loopback interfaces are set up, the device uses the IP address of the 1st loopback interface as the source of the SNMP traps. Otherwise, the device uses the address of the device management.

Operation

Operation
 Enables/disables the sending of SNMP traps to the trap destinations.

Possible values:

- **On** (default setting)
  The sending of SNMP traps is enabled.

- **Off**
  The sending of SNMP traps is disabled.
Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Add

Opens the Create window to add a table row.

▶ In the Name field you specify a name for the trap destination.
▶ In the Address field you specify the IP address and the port number of the trap destination.

If you choose not to enter a port number, then the device automatically adds the port number 162.

Remove

Removes the selected table row.

Name

Specifies the name of the trap destination.

Possible values:
▶ Alphanumeric ASCII character string with 1..32 characters

Address

Specifies the IP address and the port number of the trap destination.

Possible values:
▶ <Valid IPv4 address>:<port number>

Active

Activates/deactivates the sending of SNMP traps to this trap destination.

Possible values:
▶ marked (default setting)
  The sending of SNMP traps to this trap destination is active.
▶ unmarked
  The sending of SNMP traps to this trap destination is inactive.
9.2 System

The menu contains the following dialogs:

- System Information
- Configuration Check
- ARP
- Selftest
9.2.1 System Information

This dialog displays the current operating condition of individual components in the device. The displayed values are a snapshot; they represent the operating condition at the time the dialog was loaded to the page.

Buttons

Save system information

Opens the HTML page in a new web browser window or tab. You can save the HTML page on your PC using the appropriate web browser command.
9.2.2 **Configuration Check**

The device lets you compare the settings in the device with the settings in its neighboring devices. For this purpose, the device uses the information that it received from its neighboring devices through topology recognition (LLDP).

The dialog lists the detected deviations, which affect the performance of the communication between the device and the recognized neighboring devices. When the table remains empty, the configuration check was successful and the settings in the device are compatible with the settings in the detected neighboring devices. You update the content of the table by clicking the \(\text{Update}\) button.

**Note:** The dialog displays the devices detected as connected to the neighboring device as if they were directly connected to the device itself.

**Information**

When you click the \(\text{Information}\) button in the Banner, a tooltip displays the summary of the information in this frame.

**Error**

Displays the number of **ERROR** level deviations that the device detected during the configuration check.

**Warning**

Displays the number of **WARNING** level deviations that the device detected during the configuration check.

If you have set up more than 39 VLANs in the device, then the dialog continuously displays a warning. The reason is the limited number of possible VLAN data sets in LLDP packets with a maximum length. The device compares the first 39 VLANs automatically. If you have set up 40 or more VLANs in the device, then check the congruence of the further VLANs manually, if necessary.

**Information**

Displays the number of **INFORMATION** level deviations that the device detected during the configuration check.
Diagnostics

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Displays detailed information about the detected deviations in the area below the table row. To hide the detailed information again, click the button. If you click the icon in the table header, you display or hide the detailed information for each table row.

ID

Displays the rule ID of the deviations having occurred. The dialog combines several deviations with the same rule ID under one rule ID.

Level

Displays the level of deviation between the settings in this device and the settings in the detected neighboring devices.

The device differentiates between the following access statuses:

- **INFORMATION**
  - The performance of the communication between the two devices is not impaired.

- **WARNING**
  - The performance of the communication between the two devices is possibly impaired.

- **ERROR**
  - The communication between the two devices is impaired.

Message

Displays a summary of the detected deviations.
### 9.2.3 ARP

This dialog displays the MAC and IP addresses of the neighboring devices connected to the device management.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- **Reset ARP table**
  
  Removes the dynamically set up addresses from the ARP table.

**Port**

Displays the port number.

**IP address**

Displays the IPv4 address of a neighboring device.

**MAC address**

Displays the MAC address of a neighboring device.

**Last updated**

Displays the time in seconds since the current settings of the entry were registered in the ARP table.

**Type**

Displays the type of the entry.

**Possible values:**

- **static**
  
  Static entry. When the ARP table is deleted, the device keeps the static entry.

- **dynamic**
  
  Dynamic entry. When the Aging time [s] has been exceeded and the device does not receive any data from this device during this time, the device deletes the dynamic entry.

**Active**

Displays that the ARP table contains the IP/MAC address assignment as an active entry.
9.2.4 **Selftest**

This dialog lets you do the following:
- Enable/disable the option of entering the system monitor upon the system start.
- Specify how the device behaves in the case of an error.

**Configuration**

If the device does not detect any readable configuration profile when restarting, then the following settings block your access to the device permanently.
- **SysMon1 is available** checkbox is **unmarked**.
- **Load default config on error** checkbox is **unmarked**.

This is the case, for example, if the password of the configuration profile that you are loading differs from the password set in the device. To have the device unlocked again, contact your sales partner.

**SysMon1 is available**

Activates/deactivates the access to the system monitor during the restart.

Possible values:
- **marked** (default setting)
  - The device lets you open the system monitor during the restart.
- **unmarked**
  - The device starts without the option of opening to the system monitor.

Among other things, the system monitor lets you update the device software and to delete saved configuration profiles.

**Load default config on error**

Activates/deactivates the loading of the default settings if the device does not detect any readable configuration profile when restarting.

Possible values:
- **marked** (default setting)
  - The device loads the default settings.
- **unmarked**
  - The device interrupts the restart and stops. The access to the device management is possible only using the Command Line Interface through the serial interface.
  - To regain the access to the device through the network, open the system monitor and reset the settings. Upon restart, the device loads the default settings.

**Table**

In this table you specify how the device behaves in the case of an error.

For information on how to customize the appearance of the table, see “Working with tables” on page 16.
Cause

Error causes to which the device reacts.

Possible values:

- **task**
  - The device detects errors in the applications executed, for example if a task terminates or is not available.

- **resource**
  - The device detects errors in the resources available, for example if the memory is becoming scarce.

- **software**
  - The device detects software errors, for example error in the consistency check.

- **hardware**
  - The device detects hardware errors, for example in the chip set.

Action

Specifies how the device behaves if the adjacent event occurs.

Possible values:

- **logOnly**
  - The device registers the detected error in the log file. See the Diagnostics > Report > System Log dialog.

- **sendTrap**
  - The device sends an SNMP trap.
  - The prerequisite for sending SNMP traps is that you enable the function in the Diagnostics > Status Configuration > Alarms (Traps) dialog and specify at least one trap destination.

- **reboot** (default setting)
  - The device triggers a restart.
9.3 Syslog

The device lets you report selected events, independent of the severity of the event, to different syslog servers. In this dialog you specify the settings for this function and manage up to 8 syslog servers.

Operation

Enables/disables the sending of events to the syslog servers.

Possible values:

- **On**
  
  The sending of events is enabled.
  
  The device sends the events specified in the table to the specified syslog servers.

- **off** (default setting)
  
  The sending of events is disabled.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

- **Add**
  
  Adds a table row.

- **Remove**
  
  Removes the selected table row.

Index

Displays the index number to which the table row relates.

When you delete a table row, this leaves a gap in the numbering. When you create a new table row, the device fills the first gap.
Possible values:

- **1..8**

**IP address**

Specifies the IP address of the syslog server.

Possible values:

- Valid IPv4 address (default setting: **0.0.0.0**)
- Hostname

**Destination UDP port**

Specifies the UDP port on which the syslog server expects the log entries.

Possible values:

- **1..65535** (default setting: **514**)

**Min. severity**

Specifies the minimum severity of the events. The device sends a log entry for events with this severity and with more urgent severities to the syslog server.

Possible values:

- emergency
- alert
- critical
- error
- warning (default setting)
- notice
- informational
- debug

**Type**

Specifies the type of the log entry transmitted by the device.

Possible values:

- systemlog (default setting)
- audittrail

**Active**

Activates/deactivates the transmission of events to the syslog server:

- marked
  - The device sends events to the syslog server.
- unmarked (default setting)
  - The transmission of events to the syslog server is deactivated.
9.4 **Ports**

The menu contains the following dialogs:
- **SFP**
9.4.1 SFP

This dialog lets you look at the SFP transceivers currently connected to the device and their properties.

**Table**

The table displays valid values if the device is equipped with SFP transceivers.

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

<table>
<thead>
<tr>
<th>Port</th>
<th>Displays the port number.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module type</td>
<td>Type of the SFP transceiver, for example M-SFP-SX/LC.</td>
</tr>
<tr>
<td>Serial number</td>
<td>Displays the serial number of the SFP transceiver.</td>
</tr>
<tr>
<td>Connector type</td>
<td>Displays the connector type.</td>
</tr>
<tr>
<td>Supported</td>
<td>Displays if the device supports the SFP transceiver.</td>
</tr>
<tr>
<td>Temperature [°C]</td>
<td>Operating temperature of the SFP transceiver in °Celsius.</td>
</tr>
<tr>
<td>Tx power [mW]</td>
<td>Transmission power of the SFP transceiver in mW.</td>
</tr>
<tr>
<td>Rx power [mW]</td>
<td>Receiving power of the SFP transceiver in mW.</td>
</tr>
<tr>
<td>Tx power [dBm]</td>
<td>Transmission power of the SFP transceiver in dBm.</td>
</tr>
<tr>
<td>Rx power [dBm]</td>
<td>Receiving power of the SFP transceiver in dBm.</td>
</tr>
</tbody>
</table>
9.5 LLDP

The device lets you gather information about neighboring devices. For this, the device uses the Link Layer Discovery Protocol (LLDP). This information lets a network management station map the structure of your network.

This menu lets you configure the topology discovery and to display the information received in table form.

The menu contains the following dialogs:
- LLDP Configuration
- LLDP Topology Discovery
9.5.1 LLDP Configuration

This dialog lets you configure the topology discovery for every port.

**Operation**

**Enables/disables the LLDP function.**

Possible values:

- **On** (default setting)
  The LLDP function is enabled.
  The topology discovery using LLDP is active in the device.
- **Off**
  The LLDP function is disabled.

**Configuration**

**Transmit interval [s]**

Specifies the interval in seconds at which the device transmits LLDP data packets.

Possible values:

- 5..32768 (default setting: 30)

**Transmit interval multiplier**

Specifies the factor for determining the time-to-live value for the LLDP data packets.

Possible values:

- 2..10 (default setting: 4)

The time-to-live value coded in the LLDP header results from multiplying this value with the value in the *Transmit interval [s]* field.

**Reinit delay [s]**

Displays the delay in seconds for the reinitialization of a port.

If in the **Operation** column the value off is specified, then the device tries to reinitialize the port after the time specified here has elapsed.

**Transmit delay [s]**

Displays the delay in seconds for transmitting successive LLDP data packets after configuration changes in the device occur.
Notification interval [s]

Specifies the interval in seconds for transmitting LLDP notifications.

Possible values:
- \(5...3600\) (default setting: 5)

After transmitting a notification trap, the device waits for a minimum of the time specified here before transmitting the next notification trap.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Port**

Displays the port number.

**Operation**

Specifies if the port transmits and receives LLDP data packets.

Possible values:
- **transmit**
  The port transmits LLDP data packets but does not save any information about neighboring devices.
- **receive**
  The port receives LLDP data packets but does not transmit any information to neighboring devices.
- **receive and transmit** (default setting)
  The port transmits LLDP data packets and saves information about neighboring devices.
- **disabled**
  The port does not transmit LLDP data packets and does not save information about neighboring devices.

**Notification**

Activates/deactivates the LLDP notifications on the port.

Possible values:
- **marked**
  LLDP notifications are active on the port.
- **unmarked** (default setting)
  LLDP notifications are inactive on the port.
Transmit port description

Activates/deactivates the transmitting of a TLV (Type Length Value) with the port description.

Possible values:
- **marked** (default setting)
  
  The transmitting of the TLV is active.
  
  The device transmits the TLV with the port description.
- **unmarked**
  
  The transmitting of the TLV is inactive.
  
  The device does not transmit a TLV with the port description.

Transmit system name

Activates/deactivates the transmitting of a TLV (Type Length Value) with the device name.

Possible values:
- **marked** (default setting)
  
  The transmitting of the TLV is active.
  
  The device transmits the TLV with the device name.
- **unmarked**
  
  The transmitting of the TLV is inactive.
  
  The device does not transmit a TLV with the device name.

Transmit system description

Activates/deactivates the transmitting of the TLV (Type Length Value) with the system description.

Possible values:
- **marked** (default setting)
  
  The transmitting of the TLV is active.
  
  The device transmits the TLV with the system description.
- **unmarked**
  
  The transmitting of the TLV is inactive.
  
  The device does not transmit a TLV with the system description.

Transmit system capabilities

Activates/deactivates the transmitting of the TLV (Type Length Value) with the system capabilities.

Possible values:
- **marked** (default setting)
  
  The transmitting of the TLV is active.
  
  The device transmits the TLV with the system capabilities.
- **unmarked**
  
  The transmitting of the TLV is inactive.
  
  The device does not transmit a TLV with the system capabilities.
Neighbors (max.)

Limits the number of neighboring devices to be recorded for this port.

Possible values:
- **1..50** (default setting: **10**)

FDB mode

Specifies which function the device uses to record neighboring devices on this port.

Possible values:
- **lldpOnly**
  The device uses only LLDP data packets to record neighboring devices on this port.
- **macOnly**
  The device uses learned MAC addresses to record neighboring devices on this port. The device uses the MAC address only if there is no other entry in the address table (FDB, Forwarding Database) for this port.
- **both**
  The device uses LLDP data packets and learned MAC addresses to record neighboring devices on this port.
- **autoDetect** (default setting)
  If the device receives LLDP data packets at this port, then the device operates the same as with the **lldpOnly** setting. Otherwise, the device operates the same as with the **macOnly** setting.
9.5.2 LLDP Topology Discovery

Devices in networks send notifications in the form of packets which are also known as “LLDPDU” (LLDP data units). The data that is sent and received via LLDPDU are useful for many reasons. Thus the device detects which devices in the network are neighbors and via which ports they are connected.

The dialog lets you display the network and to detect the connected devices along with their specific features.

This dialog displays the collected LLDP information for the neighboring devices. This information lets a network management station map the structure of your network.

When devices both with and without an active topology discovery function are connected to a port, the topology table hides the devices without active topology discovery.

When only devices without active topology discovery are connected to a port, the table contains one line for this port to represent every device. This line contains the number of connected devices.

The Forwarding Database (FDB) address table contains MAC addresses of devices that the topology table hides for the sake of clarity.

When you use one port to connect several devices, for example via a hub, the table contains one line for each connected device.

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Port

Displays the port number.

Neighbor identifier

Displays the chassis ID of the neighboring device. This can be the basis MAC address of the neighboring device, for example.

FDB

Displays if the connected device has active LLDP support.

Possible values:

- **marked**
  
  The connected device does not have active LLDP support. The device uses information from its address table (FDB, Forwarding Database)

- **unmarked**
  
  The connected device has active LLDP support.

Neighbor IP address

Displays the IP address with which the access to the neighboring device management is possible.
Diagnostics

[ Diagnostics > Report ]

Neighbor port description

Displays a description for the port of the neighboring device.

Neighbor system name

Displays the device name of the neighboring device.

Neighbor system description

Displays a description for the neighboring device.

Port ID

Displays the ID of the port through which the neighboring device is connected to the device.

Autonegotiation supported

Displays if the port of the neighboring device supports autonegotiation.

Autonegotiation

Displays if autonegotiation is active on the port of the neighboring device.

PoE supported

Displays if the port of the neighboring device supports Power over Ethernet (PoE).

PoE enabled

Displays if Power over Ethernet (PoE) is active on the port of the neighboring device.

9.6 Report

[ Diagnostics > Report ]

The menu contains the following dialogs:

- Report Global
- Persistent Logging
- System Log
- Audit Trail
9.6.1 **Report Global**

The device lets you log specific events using the following outputs:
- on the console
- on one or more syslog servers
- on a connection to the Command Line Interface set up using SSH

In this dialog you specify the required settings. By assigning the severity you specify which events the device registers.

The dialog lets you save a ZIP archive with detailed device information for support purposes on your PC.

**Console logging**

**Buttons**

![Download support information](image)

Generates a ZIP archive which the web browser lets you download from the device.

The ZIP archive contains files with detailed device information for support purposes. For further information, see “Support Information: Files in ZIP archive” on page 441.

**Operation**

Enables/disables the *Console logging* function.

Possible values:
- **On**
  - The *Console logging* function is enabled. The device logs the events on the console.
- **Off** (default setting)
  - The *Console logging* function is disabled.

**Severity**

Specifies the minimum severity for the events. The device logs events with this severity and with more urgent severities. For further information, see “Meaning of the event severities” on page 441.

The device outputs the messages on the serial interface.

Possible values:
- **emergency**
- **alert**
- **critical**
- **error**
- **warning** (default setting)
- **notice**
SNMP logging

When you enable the logging of SNMP requests, the device sends these as events with the preset severity notice to the list of syslog servers. The preset minimum severity for a syslog server entry is critical.

To send SNMP requests to a syslog server, you have a number of options to change the default settings. Select the ones that meet your requirements best.

- Set the severity for which the device creates SNMP requests as events to warning or error. Change the minimum severity for a syslog entry for one or more syslog servers to the same value. You also have the option of creating a separate syslog server entry for this.
- Set only the severity for SNMP requests to critical or higher. The device then sends SNMP requests as events with the severity critical or higher to the syslog servers.
- Set only the minimum severity for one or more syslog server entries to notice or lower. Then it is possible that the device sends many events to the syslog servers.

Log SNMP get request

Enables/disables the logging of SNMP Get requests.

Possible values:

- **On**
  - The logging is enabled.
  - The device registers SNMP Get requests as events in the syslog.
  - In the Severity get request drop-down list, you select the severity for this event.

- **Off** (default setting)
  - The logging is disabled.

Log SNMP set request

Enables/disables the logging of SNMP Set requests.

Possible values:

- **On**
  - The logging is enabled.
  - The device registers SNMP Set requests as events in the syslog.
  - In the Severity set request drop-down list, you select the severity for this event.

- **Off** (default setting)
  - The logging is disabled.

Severity get request

Specifies the severity of the event that the device registers for SNMP Get requests. For further information, see "Meaning of the event severities" on page 441.

Possible values:

- emergency
- alert
- critical
Severity set request

Specifies the severity of the event that the device registers for SNMP Set requests. For further information, see “Meaning of the event severities” on page 441.

Possible values:
- emergency
- alert
- critical
- error
- warning
- notice (default setting)
- informational
- debug

Buffered logging

The device buffers logged events in 2 separate storage areas so that the log entries for urgent events are kept.

This dialog lets you specify the minimum severity for events that the device buffers in the storage area with a higher priority.

Severity

Specifies the minimum severity for the events. The device buffers log entries for events with this severity and with more urgent severities in the storage area with a higher priority. For further information, see “Meaning of the event severities” on page 441.

Possible values:
- emergency
- alert
- critical
- error
- warning (default setting)
- notice
- informational
- debug
**CLI logging**

Enables/disables the CLI logging function.

Possible values:

▶ **On**
  
  The CLI logging function is enabled.
  
  The device logs every command received using the Command Line Interface.

▶ **Off** (default setting)
  
  The CLI logging function is disabled.

**Support Information: Files in ZIP archive**

<table>
<thead>
<tr>
<th>File name</th>
<th>Format</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>audittrail.html</td>
<td>HTML</td>
<td>Contains the chronological recording of the system events and saved user changes in the Audit Trail.</td>
</tr>
<tr>
<td>config.xml</td>
<td>XML</td>
<td>Contains the settings of the device saved in the &quot;Selected&quot; configuration profile.</td>
</tr>
<tr>
<td>defaultconfig.xml</td>
<td>XML</td>
<td>Contains the default settings of the device.</td>
</tr>
<tr>
<td>script</td>
<td>TEXT</td>
<td>Contains the output of the command <code>show running-config</code>.</td>
</tr>
<tr>
<td>runningconfig.xml</td>
<td>XML</td>
<td>Contains the current operating settings of the device.</td>
</tr>
<tr>
<td>supportinfo.html</td>
<td>TEXT</td>
<td>Contains device internal service information.</td>
</tr>
<tr>
<td>systeminfo.html</td>
<td>HTML</td>
<td>Contains information about the current settings and operating parameters.</td>
</tr>
<tr>
<td>systemlog.html</td>
<td>HTML</td>
<td>Contains the logged events in the Log file. See the Diagnostics &gt; Report &gt; System Log dialog.</td>
</tr>
</tbody>
</table>

**Meaning of the event severities**

<table>
<thead>
<tr>
<th>Severity</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>emergency</td>
<td>Device not ready for operation</td>
</tr>
<tr>
<td>alert</td>
<td>Immediate user intervention required</td>
</tr>
<tr>
<td>critical</td>
<td>Critical status</td>
</tr>
<tr>
<td>error</td>
<td>Error status</td>
</tr>
<tr>
<td>warning</td>
<td>Warning</td>
</tr>
<tr>
<td>notice</td>
<td>Significant, normal status</td>
</tr>
<tr>
<td>informational</td>
<td>Informal message</td>
</tr>
<tr>
<td>debug</td>
<td>Debug message</td>
</tr>
</tbody>
</table>
9.6.2 Persistent Logging

The device lets you save log entries permanently in a file in the external memory. Therefore, even after the device is restarted you have access to the log entries.

In this dialog you limit the size of the log file and specify the minimum severity for the events to be saved. When the log file reaches the specified size, the device archives this file and saves the following log entries in a newly created file.

In the table the device displays you the log files held in the external memory. As soon as the specified maximum number of files has been attained, the device deletes the oldest file and renames the remaining files. This helps ensure that there is enough memory space in the external memory.

**Note:** Verify that an external memory is connected. To verify if an external memory is connected, see the *Status* column in the *Basic Settings > External Memory* dialog. We recommend to monitor the external memory connection using the *Device Status* function, see the *External memory removal* parameter in the *Diagnostics > Status Configuration > Device Status* dialog.

**Operation**

Enables/disables the *Persistent Logging* function.

Only activate this function if the external memory is available in the device.

**Possible values:**

- **On** *(default setting)*
  - The *Persistent Logging* function is enabled.
  - The device saves the log entries in a file in the external memory.

- **Off**
  - The *Persistent Logging* function is disabled.

**Configuration**

**Max. file size [kbyte]**

Specifies the maximum size of the log file in KBytes. When the log file reaches the specified size, the device archives this file and saves the following log entries in a newly created file.

**Possible values:**

- **0..4096** *(default setting: 1024)*

  The value 0 deactivates saving of log entries in the log file.
Files (max.)

Specifies the number of log files that the device keeps in the external memory.

As soon as the specified maximum number of files has been attained, the device deletes the oldest file and renames the remaining files.

Possible values:

- 0..25 (default setting: 4)

The value 0 deactivates saving of log entries in the log file.

Severity

Specifies the minimum severity of the events. The device saves the log entry for events with this severity and with more urgent severities in the log file in the external memory.

Possible values:

- emergency
- alert
- critical
- error
- warning (default setting)
- notice
- informational
- debug

Log file target

Specifies the external memory device for logging.

Possible values:

- sd (default setting)
  
  External SD memory (ACA31)
- usb
  
  External USB memory (ACA21/ACA22)

Table

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

Buttons

Delete persistent log file

Removes the log files from the external memory.
Diagnostics

[Diagnosis > Report > Persistent Logging]

Index

Displays the index number to which the table row relates.

Possible values:

- 1..25

The device automatically assigns this number.

File name

Displays the file name of the log file in the external memory.

Possible values:

- messages
- messages.X

File size [byte]

Displays the size of the log file in the external memory in bytes.
9.6.3 System Log

The device logs device-internal events in a log file (System Log).

This dialog displays the log file (System Log). The dialog lets you save the log file in HTML format on your PC.

In order to search the log file for search terms, use the search function of your web browser.

The log file is kept until a restart is performed in the device. After the restart the device creates the file again.

Buttons

Save log file
Opens the HTML page in a new web browser window or tab. You can save the HTML page on your PC using the appropriate web browser command.

Delete log file
Removes the logged events from the log file.
9.6.4 **Audit Trail**

This dialog displays the log file (Audit Trail). The dialog lets you save the log file as an HTML file on your PC.

In order to search the log file for search terms, use the search function of your web browser.

The device logs system events and writing user actions in the device. This lets you keep track of WHO changes WHAT in the device and WHEN. The prerequisite is that the access role auditor or administrator is assigned to your user account.

The device logs the following user actions, among others:
- A user logging in with the Command Line Interface (local or remote)
- A user logging off manually
- Automatic logging off of a user in the Command Line Interface after a specified period of inactivity
- Device restart
- Locking of a user account due to too many unsuccessful login attempts
- Locking of the access to the device management due to unsuccessful login attempts
- Commands executed in the Command Line Interface, apart from show commands
- Changes to configuration variables
- Changes to the system time
- File transfer operations, including firmware updates
- Configuration changes via HiDiscovery
- Firmware updates and automatic configuration of the device via the external memory
- Opening and closing of SNMP via an HTTPS tunnel

The device does not log passwords. The logged entries are write-protected and remain saved in the device after a restart.

**Note:** During the restart, access to the system monitor is possible using the default settings of the device. If an attacker gains physical access to the device, then he is able to reset the device settings to its default values using the system monitor. After this, the device and log file are accessible using the standard password. Take appropriate measures to restrict physical access to the device. Otherwise, deactivate access to the system monitor. See the Diagnostics > System > Selftest dialog, SysMon1 is available checkbox.

**Buttons**

- **Save audit trail file**

  Opens the HTML page in a new web browser window or tab. You can save the HTML page on your PC using the appropriate web browser command.
10 Advanced

The menu contains the following dialogs:
- DNS
- Command Line Interface

10.1 DNS

The menu contains the following dialogs:
- DNS Client
- DNS Cache

10.1.1 DNS Client

DNS (Domain Name System) is a service in the network that translates host names into IP addresses. This name resolution lets you contact other devices using their host names instead of their IP addresses.

Using the Client function the device sends requests for resolving hostnames in IP addresses to a DNS server.

The menu contains the following dialogs:
- DNS Client Global
- DNS Client Current
- DNS Client Static
10.1.1.1 DNS Client Global

In this dialog you enable the Client function.

Operation

Enables/disables the Client function.

Possible values:

- **On**
  The Client function is enabled.
  The device sends requests for resolving hostnames in IP addresses to a DNS server.

- **Off** (default setting)
  The Client function is disabled.
10.1.1.2 DNS Client Current

This dialog displays to which DNS servers the device sends requests for resolving hostnames in IP addresses.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Index**

Displays the sequential number of the DNS server.

**Address**

Displays the IP address of the DNS server. The device forwards requests for resolving hostnames in IP addresses to the DNS server with this IP address.
10.1.1.3 DNS Client Static

In this dialog you specify the DNS servers to which the device forwards requests for resolving host names in IP addresses.

The device lets you specify up to 4 IP addresses.

**Configuration**

Configuration source

Specifies the source from which the device obtains the IP address of DNS servers to which the device addresses requests.

Possible values:

- **user**
  
The device uses the IP addresses specified in the table.

**Table**

For information on how to customize the appearance of the table, see “Working with tables” on page 16.

**Buttons**

- ![Add](image)
  
  Adds a table row.

- ![Remove](image)
  
  Removes the selected table row.

**Index**

Displays the sequential number of the DNS server.

The device lets you specify up to 4 DNS servers.
10.1.2 DNS Cache

The Cache function lets the device respond to requests for resolving host names in IP addresses.

The menu contains the following dialogs:

▶ DNS Cache Global
10.1.2.1 DNS Cache Global

In this dialog you enable the Cache function. When the Cache function is enabled, the device operates as a Caching DNS server.

When a downstream device requests the IP address of an unknown hostname and the Caching DNS server finds a matching entry in its cache, the Caching DNS server returns the IP address.

The cache provides memory space for up to 128 hostnames with associated IP address.

Operation

Buttons

Flush cache

Removes every entry from the DNS cache.

Operation

Enables/disables the Cache function.

Possible values:

- **On** (default setting)
  
  The Cache function is enabled.

- **Off**
  
  The Cache function is disabled.

10.2 Command Line Interface

This dialog lets you access the device using the Command Line Interface.

The prerequisites are:

- In the device, enable the SSH server in the Device Security > Management Access > Server dialog, tab SSH.

- On your workstation, install a SSH-capable client application which registers a handler for URLs starting with ssh:// in your operating system.
**Buttons**

**Open SSH connection**

Opens the SSH-capable client application.

When you click the button, the web application passes the URL of the device starting with `ssh://` and the user name of the currently logged in user.

If the web browser finds a SSH-capable client application, then the SSH-capable client establishes a connection to the device using the SSH protocol.
## A Index

### 0-9
- 1to1 NAT .......................................................... 369
- 802.1D/p mapping .................................................. 263

### A
- Access control lists .............................................. 199
- Access restriction ................................................. 86
- ACL ................................................................. 199
- Aging time ....................................................... 253, 424
- Alarms ............................................................ 418
- ARP ................................................................. 284, 289
- ARP table .......................................................... 289, 424
- Audit trail .......................................................... 446
- Authentication list ............................................. 64

### C
- Certificate .......................................................... 21, 37, 69, 83, 85, 225, 412
- CLI ................................................................. 90
- Command line interface ........................................ 90
- Community names ............................................... 92
- Configuration check .......................................... 422
- Configuration profile ......................................... 16, 31
- Counter reset .................................................... 49

### D
- Deep packet inspection ......................................... 121
- Destination NAT ................................................ 374
- Device software ............................................... 28
- Device software backup ...................................... 28
- Device status ..................................................... 19, 404
- DNP3 enforcer .................................................... 130
- DNS ............................................................... 447
- DNS cache ........................................................ 451
- DNS client ........................................................ 448
- Domain name system ......................................... 447
- DoS ................................................................. 195
- Double NAT ...................................................... 393
- DPI ................................................................. 121
- DPI DNP3 enforcer ............................................ 130
- DPI Modbus enforcer ......................................... 122
- DPI OPC enforcer ............................................... 128

### E
- Egress rate limiter ............................................... 255
- Encryption ......................................................... 31
- ENVM ............................................................. 30, 38, 41, 405, 411, 416, 443
- Event severity .................................................... 441
- External memory ............................................... 23, 30, 38, 41, 443
F
FAQ .......................................................... 459
FDB .......................................................... 258
Filter MAC addresses ..................................... 258
Fingerprint .................................................. 80, 84
Firewall learning mode ..................................... 105
Flash memory ............................................... 30
Flow control ............................................... 253
Forwarding database ...................................... 258

H
Hardware clock .............................................. 51
HiDiscovery .................................................. 25, 411, 446
Host key ...................................................... 81
HTML ......................................................... 421, 445
HTTP ......................................................... 410
HTTP server ............................................... 81
HTTPS ......................................................... 82

I
ICMP redirect ................................................. 279, 284
Industrial HiVision ......................................... 9, 77
Ingress filtering .............................................. 269
Ingress rate limiter ......................................... 255
IP access restriction ........................................ 86
IPv4 rule ...................................................... 201

L
L3 relay ......................................................... 345
LDAP .......................................................... 64
LLDP .......................................................... 431
Load/save ..................................................... 31
Log file ....................................................... 49, 445
Login banner ............................................... 91, 93
Loopback interface ......................................... 350

M
MAC address table .......................................... 258
MAC rule ..................................................... 208
Management access ........................................ 25, 86
Management VLAN ......................................... 25
Modbus enforcer ............................................ 122

N
NAT ............................................................ 367, 369, 393
Network address translation .............................. 367
Network time protocol ..................................... 52
NTP ........................................................... 52
NVM .......................................................... 16, 30, 38

O
OPC enforcer .................................................. 128
OSPF .......................................................... 295
Index

P
Password ............................................................... 60, 409
Password length ......................................................... 60, 409
Persistent logging ........................................................... 442
Port configuration .......................................................... 262
Port forwarding .............................................................. 374
Port priority ............................................................... 262
Port VLAN ................................................................. 268
Power supply .............................................................. 21, 406, 417
Pre-Login banner ......................................................... 93
Priority queue ............................................................. 261
Proxy ARP ................................................................. 284

Q
Queues ................................................................. 261

R
RADIUS ................................................................. 64, 96
RAM ..................................................................... 38
RAM test ................................................................. 425
Rate limiter ................................................................. 255
Reboot ................................................................. 49
Relay ................................................................. 345
Router interface ............................................................ 266, 282
Routing table .............................................................. 333

S
Secure shell ............................................................... 78
Security status .............................................................. 20, 408
Self-test ................................................................. 425
Serial interface ............................................................ 410
Settings ................................................................. 31
Severity ................................................................. 441
SFP module ................................................................. 430
Signal contact ............................................................. 20, 413
SNMP server .............................................................. 76, 410
SNMP traps ............................................................... 47, 298, 340, 353, 404, 408, 415, 418
SNMPv1/v2 ............................................................... 92
Software backup ............................................................ 28
Software update ............................................................ 28
Source routing ............................................................. 279
SSH server ............................................................... 78
Stratum ................................................................. 52, 54
Support information (ZIP archive) ........................................ 441
Syslog ................................................................. 427
System information ........................................................ 421
System log ............................................................... 445
System monitor ........................................................... 425
Index

T
Technical questions .......................................................... 459
Temperature ................................................................. 21, 405, 416
Threshold values network load .......................................... 255
Time to live ................................................................. 281
Topology discovery ......................................................... 436
Tracking ................................................................. 336, 365
Training courses .......................................................... 459
Trap destination .......................................................... 418
Traps ............................................................... 47, 298, 340, 353, 404, 408, 415, 418
Trust mode .............................................................. 262
TTL ................................................................. 281

U
User administration ...................................................... 59

V
Virtual local area network ........................................... 264
Virtual router redundancy protocol .................................. 352
VLAN ................................................................. 25, 264
VLAN configuration ...................................................... 266
VLAN ports .............................................................. 268
VRRP ................................................................. 352
VRRP statistics .......................................................... 363
VRRP tracking .......................................................... 365

W
Watchdog ............................................................... 31, 33
Web server .............................................................. 81, 82

Z
ZIP archive with support information ............................... 441
B Further support

Technical questions

For technical questions, please contact any Hirschmann dealer in your area or Hirschmann directly.

You find the addresses of our partners on the Internet at www.hirschmann.com.

A list of local telephone numbers and email addresses for technical support directly from Hirschmann is available at hirschmann-support.belden.com. This site also includes a free of charge knowledge base and a software download section.

Technical Documents

The current manuals and operating instructions for Hirschmann products are available at doc.hirschmann.com.

Customer Innovation Center

The Customer Innovation Center is ahead of its competitors on three counts with its complete range of innovative services:
- Consulting incorporates comprehensive technical advice, from system evaluation through network planning to project planning.
- Training offers you an introduction to the basics, product briefing and user training with certification.
  You find the training courses on technology and products currently available at www.belden.com/solutions/customer-innovation-center.
- Support ranges from the first installation through the standby service to maintenance concepts.

With the Customer Innovation Center, you decide against any compromise in any case. Our client-customized package leaves you free to choose the service components you want to use.
C  Readers’ Comments

What is your opinion of this manual? We are constantly striving to provide as comprehensive a description of our product as possible, as well as important information to assist you in the operation of this product. Your comments and suggestions help us to further improve the quality of our documentation.

Your assessment of this manual:

<table>
<thead>
<tr>
<th></th>
<th>Very Good</th>
<th>Good</th>
<th>Satisfactory</th>
<th>Mediocre</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precise description</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Readability</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Understandability</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Examples</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Structure</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Graphics</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Drawings</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Tables</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

Did you discover any errors in this manual?
If so, on what page?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Suggestions for improvement and additional information:
General comments:

__________________________________________________________

__________________________________________________________

__________________________________________________________

Sender:

Company / Department:

Name / Telephone number:

Street:

Zip code / City:

E-mail:

Date / Signature:

Dear User,

Please fill out and return this page

- as a fax to the number +49 (0)7127/14-1600 or
- per mail to
  Hirschmann Automation and Control GmbH
  Department 01RD-NT
  Stuttgarter Str. 45-51
  72654 Neckartenzlingen
  Germany
User Manual

Configuration
Industrial Security Router
EAGLE20/30
The naming of copyrighted trademarks in this manual, even when not specially indicated, should not be taken to mean that these names may be considered as free in the sense of the trademark and tradename protection law and hence that they may be freely used by anyone.

© 2022 Hirschmann Automation and Control GmbH

Manuals and software are protected by copyright. All rights reserved. The copying, reproduction, translation, conversion into any electronic medium or machine scannable form is not permitted, either in whole or in part. An exception is the preparation of a backup copy of the software for your own use.

The performance features described here are binding only if they have been expressly agreed when the contract was made. This document was produced by Hirschmann Automation and Control GmbH according to the best of the company’s knowledge. Hirschmann reserves the right to change the contents of this document without prior notice. Hirschmann can give no guarantee in respect of the correctness or accuracy of the information in this document.

Hirschmann can accept no responsibility for damages, resulting from the use of the network components or the associated operating software. In addition, we refer to the conditions of use specified in the license contract.

You find the latest user documentation for your device at: doc.hirschmann.com

Hirschmann Automation and Control GmbH
Stuttgarter Str. 45-51
72654 Neckartenzlingen
Germany
Contents

Safety instructions .................................................................................................................. 9

About this Manual ................................................................................................................ 11

Key ......................................................................................................................................... 12

Replacing a faulty device .................................................................................................... 13

1 User interfaces .................................................................................................................... 15

1.1 Graphical User Interface ............................................................................................... 15

1.2 Command Line Interface ............................................................................................... 16

1.2.1 Preparing the data connection .................................................................................. 16

1.2.2 Access to the Command Line Interface using SSH (Secure Shell) ......................... 16

1.2.3 Access to the Command Line Interface using the serial interface ......................... 18

1.2.4 Mode-based command hierarchy ............................................................................ 20

1.2.5 Executing the commands ......................................................................................... 24

1.2.6 Structure of a command ......................................................................................... 24

1.2.7 Examples of commands ......................................................................................... 27

1.2.8 Input prompt ........................................................................................................... 28

1.2.9 Key combinations .................................................................................................... 29

1.2.10 Data entry elements .............................................................................................. 31

1.2.11 Use cases ............................................................................................................. 32

1.2.12 Service Shell ........................................................................................................ 33

1.3 System monitor ............................................................................................................. 36

1.3.1 Functional scope .................................................................................................... 36

1.3.2 Starting the System Monitor .................................................................................. 36

2 Specifying the IP parameters ............................................................................................ 39

2.1 IP parameter basics ..................................................................................................... 39

2.1.1 IPv4 ...................................................................................................................... 39

2.2 Specifying the IP parameters using the Command Line Interface ............................ 43

2.2.1 IPv4 ...................................................................................................................... 43

2.3 Specifying the IP parameters using HiDiscovery ....................................................... 45

2.4 Specifying the IP parameters using the Graphical User Interface ............................ 47

2.4.1 IPv4 ...................................................................................................................... 47

3 Access to the device .......................................................................................................... 49

3.1 Access roles ................................................................................................................ 49

3.2 First login (Password change) ..................................................................................... 50

3.3 Authentication lists ................................................................................................... 51

3.3.1 Applications ......................................................................................................... 51

3.3.2 Policies ................................................................................................................ 51

3.3.3 Managing authentication lists .............................................................................. 51

3.3.4 Adjust the settings ............................................................................................... 52
3.4 User management ......................................................... 54
  3.4.1 Access roles ....................................................... 54
  3.4.2 Managing user accounts ......................................... 56
  3.4.3 Default setting ................................................... 56
  3.4.4 Changing default passwords ................................. 56
  3.4.5 Setting up a new user account ......................... 57
  3.4.6 Deactivating the user account ............................. 58
  3.4.7 Adjusting policies for passwords ....................... 59
  3.5 LDAP ........................................................................ 61
    3.5.1 Coordination with the server administrator .......... 61
    3.5.2 Example configuration ......................................... 62
  3.6 SNMP access .......................................................... 65
    3.6.1 SNMPv1/v2 access .............................................. 65
    3.6.2 SNMPv3 access .................................................. 65
  4.2 IKE – Internet Key Exchange ...................................... 69
    4.2.1 Authentication .................................................. 69
    4.2.2 Encryption ...................................................... 69
  5.1 Basic settings .......................................................... 77
    5.1.1 Setting the time .................................................. 77
    5.1.2 Automatic daylight saving time changeover ........ 78
  5.2 NTP ........................................................................ 79
    5.2.1 Preparing the NTP configuration ....................... 79
    5.2.2 NTP configuration .............................................. 80
  6.1 Detecting changed settings ........................................ 83
    6.1.1 Volatile memory (RAM) and non-volatile memory (NVM) ........................................... 83
    6.1.2 External memory (ACA) and non-volatile memory (NVM) ........................................ 84
  6.2 Saving the settings ..................................................... 85
    6.2.1 Saving the configuration profile in the device .... 85
    6.2.2 Saving the configuration profile in the external memory ........................................ 87
  6.3 Loading settings ........................................................ 89
    6.3.1 Activating a configuration profile .................... 89
    6.3.2 Loading the configuration profile from the external memory .................................... 89
    6.3.3 Importing a configuration profile ..................... 90
  7.1 Loading a previous software version ....................... 95
  7.2 Software update from the PC .................................... 96
  7.3 Software update from a server .................................. 97
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.4</td>
<td>Software update from the external memory</td>
</tr>
<tr>
<td>7.4.1</td>
<td>Manually—initiated by the administrator</td>
</tr>
<tr>
<td>7.4.2</td>
<td>Automatically—initiated by the device</td>
</tr>
<tr>
<td>8</td>
<td>Configuring the ports</td>
</tr>
<tr>
<td>8.1</td>
<td>Enabling/disabling the port</td>
</tr>
<tr>
<td>8.2</td>
<td>Selecting the operating mode</td>
</tr>
<tr>
<td>9</td>
<td>Assistance in the protection from unauthorized access</td>
</tr>
<tr>
<td>9.1</td>
<td>Changing the SNMPv1/v2 community</td>
</tr>
<tr>
<td>9.2</td>
<td>Disabling SNMPv1/v2</td>
</tr>
<tr>
<td>9.3</td>
<td>Disabling HTTP</td>
</tr>
<tr>
<td>9.4</td>
<td>Disabling the HiDiscovery access</td>
</tr>
<tr>
<td>9.5</td>
<td>Activating the IP access restriction</td>
</tr>
<tr>
<td>9.6</td>
<td>Adjusting the session timeouts</td>
</tr>
<tr>
<td>10</td>
<td>Controlling the data traffic</td>
</tr>
<tr>
<td>10.1</td>
<td>Packet Filter – Routed Firewall Mode</td>
</tr>
<tr>
<td>10.1.1</td>
<td>Description</td>
</tr>
<tr>
<td>10.1.2</td>
<td>Application example</td>
</tr>
<tr>
<td>10.2</td>
<td>Helping protect against DoS attacks</td>
</tr>
<tr>
<td>10.2.1</td>
<td>Filters for TCP and UDP packets</td>
</tr>
<tr>
<td>10.2.2</td>
<td>Filters for IP packets</td>
</tr>
<tr>
<td>10.2.3</td>
<td>Filters for ICMP packets</td>
</tr>
<tr>
<td>10.3</td>
<td>ACL</td>
</tr>
<tr>
<td>10.3.1</td>
<td>Creating and editing IPv4 rules</td>
</tr>
<tr>
<td>10.3.2</td>
<td>Creating and configuring an IP ACL using the Command Line Interface</td>
</tr>
<tr>
<td>10.3.3</td>
<td>Creating and editing MAC rules</td>
</tr>
<tr>
<td>10.3.4</td>
<td>Creating and configuring a MAC ACL using the Command Line Interface</td>
</tr>
<tr>
<td>10.3.5</td>
<td>Assigning ACLs to a port or VLAN</td>
</tr>
<tr>
<td>10.4</td>
<td>Deep Packet Inspection</td>
</tr>
<tr>
<td>10.5</td>
<td>Deep Packet Inspection - Modbus Enforcer function</td>
</tr>
<tr>
<td>10.5.1</td>
<td>Application example for Modbus Enforcer function</td>
</tr>
<tr>
<td>10.6</td>
<td>Deep Packet Inspection - DNP3 Enforcer function</td>
</tr>
<tr>
<td>10.6.1</td>
<td>Application example for DNP3 Enforcer function</td>
</tr>
<tr>
<td>10.7</td>
<td>Deep Packet Inspection - IEC104 Enforcer function</td>
</tr>
<tr>
<td>10.7.1</td>
<td>Application example for IEC104 Enforcer function</td>
</tr>
<tr>
<td>10.8</td>
<td>Deep Packet Inspection - ENIP Enforcer function</td>
</tr>
<tr>
<td>10.8.1</td>
<td>Application example for ENIP Enforcer function</td>
</tr>
<tr>
<td>11</td>
<td>Network load control</td>
</tr>
<tr>
<td>11.1</td>
<td>Direct packet distribution</td>
</tr>
<tr>
<td>11.1.1</td>
<td>Learning MAC addresses</td>
</tr>
<tr>
<td>11.1.2</td>
<td>Aging of learned MAC addresses</td>
</tr>
<tr>
<td>11.1.3</td>
<td>Static address entries</td>
</tr>
<tr>
<td>11.2</td>
<td>Rate limiter</td>
</tr>
<tr>
<td>11.3</td>
<td>QoS/Priority</td>
</tr>
<tr>
<td>11.3.1</td>
<td>Handling of received priority information</td>
</tr>
<tr>
<td>11.3.2</td>
<td>VLAN tagging</td>
</tr>
<tr>
<td>11.3.3</td>
<td>Setting prioritization</td>
</tr>
</tbody>
</table>
Contents

11.4 Flow control ......................................................... 151
  11.4.1 Halfduplex or fullduplex link ............................ 151
  11.4.2 Setting up the Flow Control ........................... 152

12 VLANs ............................................................... 153
  12.1 Examples of VLANs ........................................ 153
    12.1.1 Example 1 ............................................ 154
    12.1.2 Example 2 ............................................ 157

13 Routing ............................................................ 163
  13.1 Configuration ................................................ 163
  13.2 Routing - Basics ........................................... 164
    13.2.1 ARP .................................................... 165
    13.2.2 CIDR .................................................... 167
    13.2.3 Multinetting ......................................... 168
  13.3 Static Routing ............................................... 169
    13.3.1 Port-based Router Interface ........................ 169
    13.3.2 VLAN-based Router-Interface ...................... 171
    13.3.3 Configuration of a Static Route .................. 173
    13.3.4 Static route tracking ............................... 176
  13.4 NAT – Network Address Translation ...................... 180
    13.4.1 Applying the NAT Rules ............................ 180
    13.4.2 1:1 NAT .............................................. 181
    13.4.3 Destination NAT .................................... 183
    13.4.4 Masquerading NAT ................................. 186
    13.4.5 Double NAT ......................................... 187
  13.5 Tracking ....................................................... 191
    13.5.1 Interface tracking .................................. 191
    13.5.2 Ping tracking ....................................... 192
    13.5.3 Logical tracking .................................... 193
    13.5.4 Configuring the tracking ........................... 193
  13.6 VRRP .......................................................... 201
    13.6.1 VRRP ................................................ 201
    13.6.2 VRRP with load sharing ............................ 204
    13.6.3 VRRP with Multinetting ........................... 204
  13.7 OSPF .......................................................... 206
    13.7.1 OSPF-Topology ...................................... 207
    13.7.2 General Operation of OSPF ........................ 211
    13.7.3 Setting up the Adjacency .......................... 212
    13.7.4 Synchronization of the LSDB ....................... 213
    13.7.5 Route Calculation ................................. 214
    13.7.6 Configuring OSPF .................................... 215
    13.7.7 Limiting the distribution of the routes using an ACL. 218
  13.8 Entering the IP Parameters ................................. 229

14 Operation diagnosis .............................................. 233
  14.1 Sending SNMP traps .......................................... 233
    14.1.1 List of SNMP traps ................................ 234
    14.1.2 SNMP traps for configuration activity ........... 235
    14.1.3 SNMP trap setting .................................. 235
    14.1.4 ICMP messaging ..................................... 236
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Index</td>
<td>279</td>
</tr>
<tr>
<td>D</td>
<td>Further support</td>
<td>285</td>
</tr>
<tr>
<td>E</td>
<td>Readers’ Comments</td>
<td>286</td>
</tr>
</tbody>
</table>
### Safety instructions

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNCONTROLLED MACHINE ACTIONS</strong></td>
</tr>
<tr>
<td>To avoid uncontrolled machine actions caused by data loss, configure all the data transmission devices individually.</td>
</tr>
<tr>
<td>Before you start any machine which is controlled via data transmission, be sure to complete the configuration of all data transmission devices.</td>
</tr>
<tr>
<td><strong>Failure to follow these instructions can result in death, serious injury, or equipment damage.</strong></td>
</tr>
</tbody>
</table>
About this Manual

The “Configuration” user manual contains the information you need to start operating the device. It takes you step by step from the first startup operation through to the basic settings for operation in your environment.

The “Installation” user manual contains a device description, safety instructions, a description of the display, and the other information that you need to install the device.

The “Graphical User Interface” reference manual contains detailed information on using the graphical user interface to operate the individual functions of the device.

The “Command Line Interface” reference manual contains detailed information on using the Command Line Interface to operate the individual functions of the device.

The Industrial HiVision Network Management software provides you with additional options for smooth configuration and monitoring:
- Auto-topology discovery
- Browser interface
- Client/server structure
- Event handling
- Event log
- Simultaneous configuration of multiple devices
- Graphical user interface with network layout
- SNMP/OPC gateway
The designations used in this manual have the following meanings:

<table>
<thead>
<tr>
<th>Designation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>List</td>
<td></td>
</tr>
<tr>
<td>Work step</td>
<td></td>
</tr>
<tr>
<td>Link</td>
<td>Cross-reference with link</td>
</tr>
</tbody>
</table>

**Note:** A note emphasizes a significant fact or draws your attention to a dependency.

**Courier:** Representation of a CLI command or field contents in the graphical user interface.

- Execution in the Graphical User Interface
- Execution in the Command Line Interface
Replacing a faulty device

The device provides the following plug-and-play solutions for replacing a faulty device with a device of the same type:

- The new device loads the configuration profile of the replaced device from the external memory. See “Loading the configuration profile from the external memory” on page 89.

With each solution, upon reboot, the new device gets the same IP settings that the replaced device had.

- For accessing the device management using HTTPS, the device uses a digital certificate. You have the option to import your own certificate to the device. See “HTTPS certificate management” on page 264.
- For accessing the device management using SSH, the device uses an RSA host key. You have the option to import your own host key in PEM format to the device. See “Loading your own key onto the device” on page 261.
1 User interfaces

The device lets you specify the settings of the device using the following user interfaces.

<table>
<thead>
<tr>
<th>User interface</th>
<th>Can be reached through ...</th>
<th>Prerequisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphical User Interface</td>
<td>Ethernet (In-Band)</td>
<td>Web browser</td>
</tr>
<tr>
<td>Command Line Interface</td>
<td>Ethernet (In-Band)</td>
<td>Terminal emulation software</td>
</tr>
<tr>
<td></td>
<td>Serial interface (Out-of-Band)</td>
<td></td>
</tr>
<tr>
<td>System monitor</td>
<td>Serial interface (Out-of-Band)</td>
<td>Terminal emulation software</td>
</tr>
</tbody>
</table>

1.1 Graphical User Interface

System requirements

To open the Graphical User Interface, you need the desktop version of a web browser with HTML5 support.

Note: Third-party software such as web browsers validate certificates based on criteria such as their expiration date and current cryptographic parameter recommendations. Old certificates can cause errors for example, when they expire or cryptographic recommendations change. To solve validation conflicts with third-party software, transfer your own up-to-date certificate onto the device or regenerate the certificate with the latest firmware.

Starting the Graphical User Interface

The prerequisite for starting the Graphical User Interface is that the IP parameters are configured in the device. See “Specifying the IP parameters” on page 39.

Perform the following steps:

- Start your web browser.
- Type the IP address of the device in the address field of the web browser. Use the following form: https://xxx.xxx.xxx.xxx
  The web browser sets up the connection to the device and displays the login dialog.
- When you want to change the language of the Graphical User Interface, click the appropriate link in the top right corner of the login dialog.
- Enter the user name.
- Enter the password.
- Click the Login button.
  The web browser displays the Graphical User Interface.
1.2 Command Line Interface

The Command Line Interface lets you use the functions of the device through a local or remote connection.

The Command Line Interface provides IT specialists with a familiar environment for configuring IT devices. As an experienced user or administrator, you have knowledge about the basics and about using Hirschmann devices.

1.2.1 Preparing the data connection

Information for assembling and starting up your device can be found in the "Installation" user manual.

- Connect the device with the network. The prerequisite for a successful data connection is the correct setting of the network parameters.

You can access the user interface of the Command Line Interface for example, with the freeware program PuTTY. You can download the software from www.putty.org.

- Install the PuTTY program on your computer.

1.2.2 Access to the Command Line Interface using SSH (Secure Shell)

In the following example we use the PuTTY program. Another option to access your device using SSH is the OpenSSH Suite.

Perform the following steps:

- Start the PuTTY program on your computer.
In the *Host Name (or IP address)* field you enter the IP address of your device. The IP address consists of 4 decimal numbers with values from 0 to 255. The 4 decimal numbers are separated by points.

To specify the connection type, select the *SSH* radio button in the *Connection type* option list. After selecting and setting the required parameters, the device lets you set up the data connection using SSH.

Click the *Open* button to set up the data connection to your device. Depending on the device and the time at which SSH was configured, setting up the connection takes up to a minute.

When you first log in, towards the end of the connection setup, the *PuTTY* program displays a security alert message and lets you check the fingerprint of the key.

![PuTTY Security Alert](image)

**Figure 2:** Security alert prompt for the fingerprint

Check the fingerprint. This helps protect yourself from unwelcome guests.

When the fingerprint matches the fingerprint of the device key, click the *Yes* button.

The device lets you display the finger prints of the device keys with the command *show ssh* or in the dialog, *SSH* tab.

The Command Line Interface appears on the screen with a window for entering the user name. The device enables up to 5 users to have access to the Command Line Interface at the same time.

Enter the user name.
The default user name is *admin*.

Press the <Enter> key.
Enter the password.
The default password is *private*.

Press the <Enter> key.

**Note:** This device is a security-relevant product. Change the password during the first startup procedure.
1.2 Command Line Interface

1.2.3 Access to the Command Line Interface using the serial interface

The serial interface is used to locally connect an external network management station (VT100 terminal or PC with terminal emulation). The interface lets you set up a data connection to the Command Line Interface and to the system monitor.

VT 100 terminal settings

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>115200 bit/s</td>
</tr>
<tr>
<td>Data</td>
<td>8 bit</td>
</tr>
<tr>
<td>Stopbit</td>
<td>1 bit</td>
</tr>
<tr>
<td>Handshake</td>
<td>off</td>
</tr>
<tr>
<td>Parity</td>
<td>none</td>
</tr>
</tbody>
</table>
Perform the following steps:

- Connect the device to a terminal using the serial interface. Alternatively connect the device to a COM port of your PC using terminal emulation based on VT100 and press any key.
- Alternatively you set up the serial data connection to the device with the serial interface using the PuTTY program. Press the <Enter> key.

![Figure 4: Serial data connection with the serial interface using the PuTTY program](image)

- Press any key on your terminal keyboard a number of times until the login screen indicates the CLI mode.
- Enter the user name. The default user name is **admin**.
- Press the <Enter> key.
- Enter the password. The default password is **private**.
- Press the <Enter> key.

**Note:** This device is a security-relevant product. Change the password during the first startup procedure.
1.2.4 Mode-based command hierarchy

In the Command Line Interface, the commands are grouped in the related modes, according to the type of the command. Every command mode supports specific Hirschmann software commands.

The commands available to you as a user depend on your privilege level (administrator, operator, guest, auditor). They also depend on the mode in which you are currently working. When you switch to a specific mode, the commands of the mode are available to you.

The User Exec mode commands are an exception. The Command Line Interface also lets you execute these commands in the Privileged Exec mode.
The following figure displays the modes of the Command Line Interface.

Figure 6: Structure of the Command Line Interface

The Command Line Interface supports, depending on the user level, the following modes:

- **User Exec mode**
  When you log in with the Command Line Interface, you are in the User Exec mode. The User Exec mode contains a limited range of commands.
  Command prompt: (EAGLE) >

- **Privileged Exec mode**
  To access the entire range of commands, you change to the Privileged Exec mode. The prerequisite for changing to the Privileged Exec mode is that you log in as a privileged user. In the Privileged Exec mode, you are able to execute the User Exec mode commands, too.
  Command prompt: (EAGLE) #

- **VLAN mode**
  The VLAN mode contains VLAN-related commands.
  Command prompt: (EAGLE) (VLAN) #

- **Service Shell**
  The Service Shell is for service purposes only.
  Command prompt: /mnt/fastpath #
Global Config mode
The Global Config mode lets you perform modifications to the current configuration. This mode groups general setup commands.
Command prompt: (EAGLE) (config)#

Interface Range mode
The commands in the Interface Range mode affect a specific port, a selected group of multiple ports or all port of the device. The commands modify a value or switch a function on/off on one or more specific ports.
- All physical ports in the device
  Command prompt: (EAGLE) ((interface) all)#
  Example: When you switch from the Global Config mode to the Interface Range mode, the command prompt changes as follows:
  (EAGLE) (config)#interface all
  (EAGLE) ((Interface)all)#
- A single port on one interface
  Command prompt: (EAGLE) (interface <slot/port>)#
  Example: When you switch from the Global Config mode to the Interface Range mode, the command prompt changes as follows:
  (EAGLE) (config)#interface 2/1
  (EAGLE) (interface 2/1)#
- A range of ports on one interface
  Command prompt: (EAGLE) (interface <interface range>)#
  Example: When you switch from the Global Config mode to the Interface Range mode, the command prompt changes as follows:
  (EAGLE) (config)#interface 1/2-1/4
  (EAGLE) ((Interface)1/2-1/4)#
- A list of single ports
  Command prompt: (EAGLE) (interface <interface list>)#
  Example: When you switch from the Global Config mode to the Interface Range mode, the command prompt changes as follows:
  (EAGLE) (config)#interface 1/2,1/4,1/5
  (EAGLE) ((Interface)1/2,1/4,1/5)#
- A list of port ranges and single ports
  Command prompt: (EAGLE) (interface <complex range>)#
  Example: When you switch from the Global Config mode to the Interface Range mode, the command prompt changes as follows:
  (EAGLE) (config)#interface 1/2-1/4,1/6-1/9
  (EAGLE) ((Interface)1/2-1/4,1/6-1/9)

The following table displays the command modes, the command prompts (input request characters) visible in the corresponding mode, and the option with which you quit this mode.

<table>
<thead>
<tr>
<th>Command mode</th>
<th>Access method</th>
<th>Quit or start next mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Exec mode</td>
<td>First access level. Perform basic tasks and list system information.</td>
<td>To quit you enter <code>logout</code>: (EAGLE) &gt;logout Are you sure (Y/N) ?y</td>
</tr>
<tr>
<td>Privileged Exec mode</td>
<td>From the User Exec mode, you enter the command <code>enable</code>: (EAGLE) &gt;enable (EAGLE)#</td>
<td>To quit the Privileged Exec mode and return to the User Exec mode, you enter <code>exit</code>: (EAGLE) #exit (EAGLE) &gt;</td>
</tr>
</tbody>
</table>
When you enter a question mark (?) after the prompt, the Command Line Interface displays a list of the available commands and a short description of the commands.

<table>
<thead>
<tr>
<th>Command mode</th>
<th>Access method</th>
<th>Quit or start next mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLAN mode</td>
<td>From the Privileged Exec mode, you enter the command <code>vlan database</code>:</td>
<td>To end the VLAN mode and return to the Privileged Exec mode, you enter <code>exit</code> or press Ctrl Z.</td>
</tr>
<tr>
<td></td>
<td>(EAGLE) <code>#vlan database</code></td>
<td>(EAGLE) <code>{Vlan}</code></td>
</tr>
<tr>
<td></td>
<td>(EAGLE) <code>{Vlan}</code></td>
<td>(EAGLE) <code>#</code></td>
</tr>
<tr>
<td>Global Config mode</td>
<td>From the Privileged Exec mode, you enter the command <code>configure</code>:</td>
<td>To quit the Global Config mode and return to the Privileged Exec mode, you enter <code>exit</code>:</td>
</tr>
<tr>
<td></td>
<td>(EAGLE) <code>{config}</code></td>
<td>(EAGLE) <code>#</code></td>
</tr>
<tr>
<td></td>
<td>From the User Exec mode, you enter the command <code>enable</code>, and then in Privileged Exec mode, enter the command <code>Configure</code>:</td>
<td>To then quit the Privileged Exec mode and return to the User Exec mode, you enter <code>exit</code> again:</td>
</tr>
<tr>
<td></td>
<td>(EAGLE) <code>&gt;enable</code></td>
<td>(EAGLE) <code>#</code></td>
</tr>
<tr>
<td></td>
<td>(EAGLE) <code>#configure</code></td>
<td>(EAGLE) <code>&gt;</code></td>
</tr>
<tr>
<td></td>
<td>(EAGLE) <code>{config}</code></td>
<td></td>
</tr>
<tr>
<td>Interface Range mode</td>
<td>From the Global Config mode you enter the command <code>interface</code> {all</td>
<td>&lt;slot/port&gt;</td>
</tr>
<tr>
<td></td>
<td>(EAGLE) <code>{config}</code>#</td>
<td>(EAGLE) <code>#</code></td>
</tr>
<tr>
<td></td>
<td>(EAGLE) <code>#interface &lt;slot/port&gt;</code></td>
<td>(EAGLE) <code>#</code></td>
</tr>
<tr>
<td></td>
<td>(EAGLE) <code>#interface slot/port</code>#</td>
<td>(EAGLE) <code>#</code></td>
</tr>
</tbody>
</table>

When you enter a question mark (?) after the prompt, the Command Line Interface displays a list of the available commands and a short description of the commands.

```
{EAGLE}> cli
Set the CLI preferences.

{EAGLE}> enable
Turn on privileged commands.

{EAGLE}> help
Display help for various special keys.

{EAGLE}> history
Show a list of previously run commands.

{EAGLE}> logout
Exit this session.

{EAGLE}> ping
Send ICMP echo packets to a specified IP address.

{EAGLE}> show
Display device options and settings.
```

Figure 7: Commands in the User Exec mode
1.2.5 Executing the commands

Syntax analysis

When you log in with the Command Line Interface, you are in the User Exec mode. The Command Line Interface displays the prompt (EAGLE) > on the screen.

When you enter a command and press the <Enter> key, the Command Line Interface starts the syntax analysis. The Command Line Interface searches the command tree for the desired command.

When the command is outside the Command Line Interface command range, a message informs you of the detected error.

Example:

You want to execute the `show system info` command, but enter `info` without `f` and press the <Enter> key.

The Command Line Interface then displays a message:

(EAGLE) > show system ino

Error: Invalid command 'ino'

Command tree

The commands in the Command Line Interface are organized in a tree structure. The commands, and where applicable the related parameters, branch down until the command is completely defined and therefore executable. The Command Line Interface checks the input. When you entered the command and the parameters correctly and completely, you execute the command with the <Enter> key.

After you entered the command and the required parameters, the other parameters entered are treated as optional parameters. When one of the parameters is unknown, the Command Line Interface displays a syntax message.

The command tree branches for the required parameters until the required parameters have reached the last branch in the structure.

With optional parameters, the command tree branches until the required parameters and the optional parameters have reached the last branch in the structure.

1.2.6 Structure of a command

This section describes the syntax, conventions and terminology, and uses examples to represent them.
**Format of commands**

Most of the commands include parameters.

When the command parameter is missing, the Command Line Interface informs you about the detection of an incorrect command syntax.

This manual displays the commands and parameters in the **Courier** font.

**Parameters**

The sequence of the parameters is relevant for the correct syntax of a command.

Parameters are required values, optional values, selections, or a combination of these things. The representation indicates the type of the parameter.

<table>
<thead>
<tr>
<th>Table 3: Parameter and command syntax</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;command&gt;</td>
</tr>
<tr>
<td>Commands in pointed brackets (&lt;&gt;) are obligatory.</td>
</tr>
<tr>
<td>[command]</td>
</tr>
<tr>
<td>Commands in square brackets ([]) are optional.</td>
</tr>
<tr>
<td>&lt;parameter&gt;</td>
</tr>
<tr>
<td>Parameters in pointed brackets (&lt;&gt;) are obligatory.</td>
</tr>
<tr>
<td>[parameter]</td>
</tr>
<tr>
<td>Parameters in square brackets ([]) are optional.</td>
</tr>
<tr>
<td>...</td>
</tr>
<tr>
<td>An ellipsis (3 points in sequence without spaces) after an element indicates that you can repeat the element.</td>
</tr>
<tr>
<td>[Choice1</td>
</tr>
<tr>
<td>A vertical line enclosed in brackets indicates a selection option. Select one value. Elements separated by a vertical line and enclosed in square brackets indicate an optional selection (Option1 or Option2 or no selection).</td>
</tr>
<tr>
<td>{list}</td>
</tr>
<tr>
<td>Curved brackets ({}) indicate that a parameter is to be selected from a list of options.</td>
</tr>
<tr>
<td>[Choice1</td>
</tr>
<tr>
<td>Elements separated by a vertical line and enclosed in curved brackets ({}) indicate an obligatory selection option (option1 or option2).</td>
</tr>
<tr>
<td>[{param1 {Choice1</td>
</tr>
<tr>
<td>Displays an optional parameter that contains an obligatory selection.</td>
</tr>
<tr>
<td>&lt;a.b.c.d&gt;</td>
</tr>
<tr>
<td>Small letters are wild cards. You enter parameters with the notation a.b.c.d with decimal points (for example IP addresses)</td>
</tr>
<tr>
<td>&lt;cr&gt;</td>
</tr>
<tr>
<td>You press the &lt;Enter&gt; key to create a line break (carriage return).</td>
</tr>
</tbody>
</table>
The following list displays the possible parameter values within the Command Line Interface:

**Table 4: Parameter values in the Command Line Interface**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP address</td>
<td>This parameter represents a valid IPv4 address. The address consists of 4 decimal numbers with values from 0 to 255. The 4 decimal numbers are separated by a decimal point. The IP address 0.0.0.0 is a valid entry.</td>
</tr>
<tr>
<td>MAC address</td>
<td>This parameter represents a valid MAC address. The address consists of 6 hexadecimal numbers with values from 00 to FF. The numbers are separated by a colon, for example, 00:F6:29:B2:81:40.</td>
</tr>
<tr>
<td>string</td>
<td>User-defined text with a length in the specified range, for example a maximum of 32 characters.</td>
</tr>
<tr>
<td>character string</td>
<td>Use double quotation marks to indicate a character string, for example &quot;System name with space character&quot;.</td>
</tr>
<tr>
<td>number</td>
<td>Whole integer in the specified range, for example 0..999999.</td>
</tr>
<tr>
<td>date</td>
<td>Date in format YYYY-MM-DD.</td>
</tr>
<tr>
<td>time</td>
<td>Time in format HH:MM:SS.</td>
</tr>
</tbody>
</table>

**Network addresses**

Network addresses are a requirement for establishing a data connection to a remote workstation, a server, or another network. You distinguish between IP addresses and MAC addresses.

The IP address is an address allocated by the network administrator. The IP address is unique in one network area.

The MAC addresses are assigned by the hardware manufacturer. MAC addresses are unique worldwide.

The following table displays the representation and the range of the address types:

**Table 5: Format and range of network addresses**

<table>
<thead>
<tr>
<th>Address Type</th>
<th>Format</th>
<th>Range</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP Address</td>
<td>nnn.nnn.nnn.nnn</td>
<td>nnn: 0 to 255 (decimal)</td>
<td>192.168.11.110</td>
</tr>
<tr>
<td>MAC Address</td>
<td>mm:mm:mm:mm:mm:mm</td>
<td>mm: 00 to ff (hexadecimal number pairs)</td>
<td>A7:C9:89:DD:A9:B3</td>
</tr>
</tbody>
</table>

**Strings**

A string is indicated by quotation marks. For example, "System name with space character". Space characters are not valid user-defined strings. You enter a space character in a parameter between quotation marks.

Example:

```
*(EAGLE)#cli prompt Device name
Error: Invalid command 'name'
```

```
*(EAGLE)#cli prompt 'Device name'
```
1.2.7 Examples of commands

Example 1: clear arp-table-switch
Command for clearing the ARP table of the management agent (cache).

`clear arp-table-switch` is the command name. The command is executable without any other parameters by pressing the `<Enter>` key.

Example 2: radius server timeout
Command to configure the RADIUS server timeout value.

```
(EAGLE) (config)#radius server timeout
<1..30>       Timeout in seconds (default: 5).
```

`radius server timeout` is the command name.

The parameter is required. The value range is `1..30`.

Example 3: radius server auth modify <1..8>
Command to set the parameters for RADIUS authentication server 1.

```
(EAGLE) (config)#radius server auth modify 1
[name]       RADIUS authentication server name.
[msgauth]    Enable or disable the message authenticator attribute for this server.
[primary]    Configure the primary RADIUS server.
[status]     Enable or disable a RADIUS authentication server entry.
[secret]     Configure the shared secret for the RADIUS authentication server.
[encrypted]  Configure the encrypted shared secret.
<cr>         Press Enter to execute the command.
```

`radius server auth modify` is the command name.

The parameter `<1..8>` (RADIUS server index) is required. The value range is `1..8` (integer).

The parameters `[name], [port], [msgauth], [primary], [status], [secret] and [encrypted]` are optional.
1.2.8 Input prompt

Command mode

With the input prompt, the Command Line Interface displays which of the three modes you are in:
- (EAGLE) > User Exec mode
- (EAGLE) # Privileged Exec mode
- (EAGLE) (config)# Global Config mode
- (EAGLE) (Vlan)# VLAN Database mode
- (EAGLE) ((Interface)all)# Interface Range mode / All ports of the device
- (EAGLE) ((Interface)2/1)# Interface Range mode / A single port on one interface
- (EAGLE) ((Interface)1/2-1/4)# Interface Range mode / A range of ports on one interface
- (EAGLE) ((Interface)2/1,1/4,1/5)# Interface Range mode / A list of single ports
- (EAGLE) ((Interface)1-1/2,1/4-1/6)# Interface Range mode / A list of port ranges and single ports

Asterisk, pound sign and exclamation point

- Asterisk *
  An asterisk * in the first or second position of the input prompt displays you that the settings in the volatile memory and the settings in the non-volatile memory are different. In your configuration, the device has detected modifications which have not been saved.
  *(EAGLE)>*
- Pound sign #
  A pound sign # at the beginning of the input prompt displays you that the boot parameters and the parameters during the boot phase are different.
  *#(EAGLE)>#
- Exclamation point !
  An exclamation point ! at the beginning of the input prompt displays: the password for the user or admin user account corresponds with the default setting.
  !(EAGLE)>!

Wildcards

The device lets you change the command line prompt.

The Command Line Interface supports the following wildcards:

<table>
<thead>
<tr>
<th>Wildcard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>%d</td>
<td>System date</td>
</tr>
<tr>
<td>%t</td>
<td>System time</td>
</tr>
</tbody>
</table>

Table 6: Using wildcards within the Command Line Interface input prompt
### Table 6: Using wildcards within the Command Line Interface input prompt

<table>
<thead>
<tr>
<th>Wildcard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>%i</td>
<td>IP address of the device</td>
</tr>
<tr>
<td>%m</td>
<td>MAC address of the device</td>
</tr>
<tr>
<td>%p</td>
<td>Product name of the device</td>
</tr>
</tbody>
</table>

!(EAGLE)>enable

!(EAGLE)#cli prompt %i

!192.168.1.5#cli prompt (EAGLE)%d

!*EAGLE)2022-03-14#cli prompt (EAGLE)%d%t

!*EAGLE)2022-03-14 12:31:36#cli prompt %m

!*AA:BB:CC:DD:EE:FF#

### 1.2.9 Key combinations

The following key combinations make it easier for you to work with the Command Line Interface:

### Table 7: Key combinations in the Command Line Interface

<table>
<thead>
<tr>
<th>Key combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;CTRL&gt; + &lt;H&gt;,</td>
<td>Delete previous character</td>
</tr>
<tr>
<td>&lt;Backspace&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;A&gt;</td>
<td>Go to beginning of line</td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;E&gt;</td>
<td>Go to end of line</td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;F&gt;</td>
<td>Go forward one character</td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;B&gt;</td>
<td>Go backward one character</td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;D&gt;</td>
<td>Delete current character</td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;U&gt;,</td>
<td>Delete to beginning of line</td>
</tr>
<tr>
<td>&lt;X&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;K&gt;</td>
<td>Delete to end of line</td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;W&gt;</td>
<td>Delete previous word</td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;P&gt;</td>
<td>Go to previous line in history buffer</td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;R&gt;</td>
<td>Rewrite or paste the line</td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;N&gt;</td>
<td>Go to next line in history buffer</td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;Z&gt;</td>
<td>Return to root command prompt</td>
</tr>
<tr>
<td>&lt;CTRL&gt; + &lt;G&gt;</td>
<td>Aborts running tcpdump session</td>
</tr>
<tr>
<td>&lt;Tab&gt;, &lt;SPACE&gt;</td>
<td>Command line completion</td>
</tr>
<tr>
<td>Exit</td>
<td>Go to next lower command prompt</td>
</tr>
<tr>
<td>&lt;?&gt;</td>
<td>List choices</td>
</tr>
</tbody>
</table>
The Help command displays the possible key combinations in Command Line Interface on the screen:

**(EAGLE)** `#help`

HELP:
Special keys:

- Ctrl-H, BkSp delete previous character
- Ctrl-A .... go to beginning of line
- Ctrl-E .... go to end of line
- Ctrl-F .... go forward one character
- Ctrl-B .... go backward one character
- Ctrl-D .... delete current character
- Ctrl-U, X .. delete to beginning of line
- Ctrl-K .... delete to end of line
- Ctrl-W .... delete previous word
- Ctrl-P .... go to previous line in history buffer
- Ctrl-R .... rewrites or pastes the line
- Ctrl-N .... go to next line in history buffer
- Ctrl-Z .... return to root command prompt
- Ctrl-G .... aborts running tcpdump session
- Tab, <SPACE> command-line completion
- Exit .... go to next lower command prompt
- ? .... list choices

**(EAGLE)** `#`

*Figure 8: Listing the key combinations with the Help command*
1.2.10 Data entry elements

Command completion

To simplify typing commands, the Command Line Interface lets you use command completion (Tab Completion). Thus you are able to abbreviate key words.

- Type in the beginning of a keyword. When the characters entered identify a keyword, the Command Line Interface completes the keyword after you press the tab key or the space key. When there is more than one option for completion, enter the letter or the letters necessary for uniquely identifying the keyword. Press the tab key or the space key again. After that, the system completes the command or parameter.
- When you make a non-unique entry and press <Tab> or <Space> twice, the Command Line Interface provides you with a list of options.
- On a non-unique entry and pressing <Tab> or <Space>, the Command Line Interface completes the command up to the end of the uniqueness. When several commands exist and you press <Tab> or <Space> again, the Command Line Interface provides you with a list of options.

Example:

```
(EAGLE) (Config)#lo
(EAGLE) (Config)#log
logging logout
```

When you enter `lo` and <Tab> or <Space>, the Command Line Interface completes the command up to the end of the uniqueness to `log`. When you press <Tab> or <Space> again, the Command Line Interface provides you with a list of options (`logging logout`).

Possible commands/parameters

You can obtain a list of the commands or the possible parameters by entering `help` or `?`, for example by entering

```
(EAGLE) >show ?
```

When you enter the command displayed, you get a list of the parameters available for the command `show`.

When you enter the command without space character in front of the question mark, the device displays the help text for the command itself:

```
!*#(EAGLE) (Config)#show?
```

```
show          Display device options and settings.
```
1.2.11 Use cases

Saving the Configuration

To help ensure that your password settings and your other configuration changes are kept after the device is reset or after an interruption of the voltage supply, you save the configuration. To do this, perform the following steps:

- Enter `enable` to change to the Privileged Exec mode.
- Enter the following command:
  ```
  save [profile]
  ```
- Execute the command by pressing the <Enter> key.

Syntax of the „radius server auth add“ command

Use this command to add a RADIUS authentication server.

- Mode: Global Config mode
- Privilege Level: Administrator
- Format: `radius server auth add <1..8> ip <a.b.c.d> [name <string>] [port <1..65535>]`
  - `[name]`: RADIUS authentication server name.
  - `[port]`: RADIUS authentication server port (default value: 1813).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Meaning</th>
<th>Possible values</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;1..8&gt;</code></td>
<td>RADIUS server index.</td>
<td>1..8</td>
</tr>
<tr>
<td><code>&lt;a.b.c.d&gt;</code></td>
<td>RADIUS accounting server IP address.</td>
<td>IP address</td>
</tr>
<tr>
<td><code>&lt;string&gt;</code></td>
<td>Enter a user-defined text, max. 32 characters.</td>
<td></td>
</tr>
<tr>
<td><code>&lt;1..65535&gt;</code></td>
<td>Enter port number between 1 and 65535.</td>
<td>1..65535</td>
</tr>
</tbody>
</table>

Mode and Privilege Level:

- The prerequisite for executing the command: You are in the Global Config mode. See “Mode-based command hierarchy” on page 20.
- The prerequisite for executing the command: You have the access role administrator.

Syntax of commands and parameters: See “Structure of a command” on page 24.

Examples for executable commands:

- `radius server auth add 1 ip 192.168.30.40`
- `radius server auth add 2 ip 192.168.40.50 name radiusserver2`
- `radius server auth add 3 ip 192.168.50.60 port 1813`
- `radius server auth add 4 ip 192.168.60.70 name radiusserver4 port 1814`
1.2.12 **Service Shell**

The Service Shell is for service purposes only.

The Service Shell lets users have access to internal functions of the device. When you need assistance with your device, the service personnel use the Service Shell to monitor internal conditions for example, the switch or CPU registers.

Do not execute internal functions without service technician instructions. Executing internal functions such as deleting the content of the non-volatile memory (NVM) possibly leads to inoperability of your device.

### Start the Service Shell

The prerequisite is that you are in User Exec mode: `{EAGLE} >`

Perform the following steps:

- Enter `enable` and press the <Enter> key.
  - To reduce the effort when typing:
    - Enter `e` and press the <Tab> key.

- Enter `serviceshell start` and press the <Enter> key.
  - To reduce the effort when typing:
    - Enter `ser` and press the <Tab> key.
    - Enter `s` and press the <Tab> key.

---

```bash
!/mnt/fastpath #
```

---

### Working with the Service Shell

When the Service Shell is active, the timeout of the Command Line Interface is inactive. To help prevent configuration inconsistencies, end the Service Shell before any other user starts transferring a new configuration to the device.
**Display the Service Shell commands**

The prerequisite is that you already started the Service Shell.

Perform the following steps:
- Enter `help` and press the <Enter> key.

```
/mnt/fastpath # help
Built-in commands:
------------------
   . : [ ]( alias bg break cd chdir command continue echo eval exec
   exit export false fg getopts hash help history jobs kill let
   local pwd readreadonly return set shift source test times trap
   true type ulimit umask unalias unset wait
/mnt/fastpath #
```

**End the Service Shell**

Perform the following steps:
- Enter `exit` and press the <Enter> key.

**Deactivate the Service Shell permanently in the device**

When you deactivate the Service Shell, you are still able to configure the device. However, you limit the service personnel's possibilities to perform system diagnostics. The service technician will no longer be able to access internal functions of your device.

The deactivation is irreversible. The Service Shell remains permanently deactivated. **In order to reactivate the Service Shell, the device requires disassembly by the manufacturer.**

The prerequisites are:
- The Service Shell is not started.
- You are in User Exec mode: `{EAGLE} >`

Perform the following steps:
- Enter `enable` and press the <Enter> key.
  - To reduce the effort when typing:
    - Enter `e` and press the <Tab> key.
Enter `serviceshell deactivate` and press the <Enter> key.
To reduce the effort when typing:
- Enter `ser` and press the <Tab> key.
- Enter `dea` and press the <Tab> key.

This step is irreversible!
Press the <Y> key.

!EAGLE >enable

!*EAGLE #serviceshell deactivate
Notice: If you continue, then the Service Shell is permanently deactivated.
This step is irreversible!
For details, refer to the Configuration Manual.
Are you sure (Y/N) ?
1.3 System monitor

The System Monitor lets you set basic operating parameters before starting the operating system.

1.3.1 Functional scope

In the System Monitor, you carry out the following tasks, for example:
- Managing the operating system and verifying the software image
- Updating the operating system
- Starting the operating system
- Deleting configuration profiles, resetting the device to the factory defaults
- Checking boot code information

1.3.2 Starting the System Monitor

Prerequisites:
- Terminal cable for connecting the device to your PC (available as an optional accessory).
- PC with VT100 terminal emulation (such as the PuTTY program) or serial terminal
Perform the following steps:

- Use the terminal cable to connect the serial interface of the device with the COM port of the PC.
- Start the VT100 terminal emulation on the PC.
- Specify the following transmission parameters:

<table>
<thead>
<tr>
<th>VT 100 terminal settings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Speed</strong></td>
</tr>
<tr>
<td><strong>Data</strong></td>
</tr>
<tr>
<td><strong>Stopbit</strong></td>
</tr>
<tr>
<td><strong>Handshake</strong></td>
</tr>
<tr>
<td><strong>Parity</strong></td>
</tr>
</tbody>
</table>

- Set up a connection to the device.
- Turn on the device. When the device is already on, reboot it.
  - The screen displays the following message after rebooting:
    
    Press <1> to enter System Monitor 1.

- Press the <1> key within 3 seconds.
  - The device starts the System Monitor. The screen displays the following view:

```
System Monitor 1
(Selected OS: ...-4.3 (2022-03-12 09:20))

1  Manage operating system
2  Update operating system
3  Start selected operating system
4  Manage configurations
5  Show boot code information
q  End (reset and reboot)
```

```
sysMon1>
```

*Figure 9: System Monitor 1 screen display*

- Select a menu item by entering the number.
- To leave a submenu and return to the main menu of System Monitor 1, press the <ESC> key.
User interfaces

1.3 System monitor
2 Specifying the IP parameters

When you install the device for the first time, specify the IP parameters.

The device provides the following options for entering the IP parameters during the first installation:

- Entry using the Command Line Interface.
  When you preconfigure your device outside its operating environment, or restore the network access (“In-Band”) to the device, choose this “Out-of-Band” method.
- Entry using the HiDiscovery protocol.
  When you have a previously installed network device or you have another Ethernet connection between your PC and the device, you choose this “In-Band” method.
- Configuration using the external memory.
  When you are replacing a device with a device of the same type and have already saved the configuration in the external memory, you choose this method.
- Configuration using the Graphical User Interface.
  When the device already has an IP address and is reachable using the network, the Graphical User Interface provides you with another option for configuring the IP parameters.

2.1 IP parameter basics

2.1.1 IPv4

IP address

The IP addresses consist of 4 bytes. Write these 4 bytes in decimal notation, separated by a decimal point.

RFC 1340 written in 1992, defines 5 IP Address classes.

Table 8: IP address classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Network address</th>
<th>Host address</th>
<th>Address range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1 Byte</td>
<td>3 Bytes</td>
<td>0.0.0.0 to 127.255.255.255</td>
</tr>
<tr>
<td>B</td>
<td>2 Bytes</td>
<td>2 Bytes</td>
<td>128.0.0.0 to 191.255.255.255</td>
</tr>
<tr>
<td>C</td>
<td>3 Bytes</td>
<td>1 Byte</td>
<td>192.0.0.0 to 223.255.255.255</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td>224.0.0.0 to 239.255.255.255</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td>240.0.0.0 to 255.255.255.255</td>
</tr>
</tbody>
</table>

The first byte of an IP address is the network address. The worldwide leading regulatory board for assigning network addresses is the IANA (“Internet Assigned Numbers Authority”). When you require an IP address block, contact your Internet Service Provider (ISP). Your ISP contacts their local higher-level organization to reserve an IP address block:

- APNIC (Asia Pacific Network Information Center)
  Asia/Pacific Region
- ARIN (American Registry for Internet Numbers)
  Americas and Sub-Sahara Africa
Specifying the IP parameters
2.1 IP parameter basics

- LACNIC (Regional Latin-American and Caribbean IP Address Registry)
  Latin America and some Caribbean Islands
- RIPE NCC (Réseaux IP Européens)
  Europe and Surrounding Regions

![Bit representation of the IP address](image)

When the first bit of an IP address is a zero, it belongs to class A for example, the first octet is less than 128.

When the first bit of an IP address is a one and the second bit is a zero, it belongs to class B for example, the first octet is between 128 and 191.

When the first 2 bits of an IP address are a one, it belongs to class C for example, the first octet is higher than 191.

Assigning the host address (host ID) is the responsibility of the network operator. The network operator alone is responsible for the uniqueness of the assigned IP addresses.

**Netmask**

Routers and Gateways subdivide large networks into subnetworks. The netmask assigns the IP addresses of the individual devices to a particular subnetwork.

You perform subnetwork division using the netmask in much the same way as the division of the network addresses (net id) into classes A to C.

Set the bits of the host address (host id) that represent the mask to one. Set the remaining host address bits to zero (see the following examples).

Example of a subnet mask:

Decimal notation
255.255.192.0

Binary notation
11111111.11111111.11000000.00000000

Subnetwork mask bits
   Class B
Example of applying the subnet mask to IP addresses for subnetwork assignment:

**Decimal notation**
129.218.65.17

128 < 129  191  Class B

**Binary notation**
10000001.11011010.01000001.00010001

---

**Decimal notation**
129.218.129.17

128 < 129  191  Class B

**Binary notation**
10000001.11011010.10000001.00010001

---

**Example of how the netmask is used**

In a large network it is possible that Gateways and routers separate the management agent from its network management station. How does addressing work in such a case?

![Diagram](image)

*Figure 11: The management agent is separated from its network management station by a router*

The network management station “Romeo” wants to send data to the management agent “Juliet”. Romeo knows Juliet’s IP address and also knows that the router “Lorenzo” knows the way to Juliet.

Romeo therefore puts his message in an envelope and writes Juliet's IP address as the destination address; for the source address he writes his own IP address on the envelope.

Romeo then places this envelope in a second one with Lorenzo's MAC address as the destination and his own MAC address as the source. This process is comparable to going from Layer 3 to Layer 2 of the ISO/OSI base reference model.

Finally, Romeo puts the entire data packet into the mailbox which is comparable to going from Layer 2 to Layer 1, that means to sending the data packet over the Ethernet.
Lorenzo receives the letter, removes the outer envelope and recognizes from the inner envelope that the letter is meant for Juliet. He places the inner envelope in a new outer envelope and searches his address list (the ARP table) for Juliet's MAC address; he writes her MAC address on the outer envelope as the destination address and his own MAC address as the source address. He then places the entire data packet in the mailbox.

Juliet receives the letter and removes the outer envelope. She finds the inner envelope with Romeo's IP address. Opening the inner envelope and reading its contents corresponds to transferring the message to the higher protocol layers of the ISO/OSI layer model.

Juliet would now like to send a reply to Romeo. She places her reply in an envelope with Romeo's IP address as destination and her own IP address as source. But where is she to send the answer? For she did not receive Romeo's MAC address. It was lost, because Lorenzo replaced the outer envelope.

In the MIB, Juliet finds Lorenzo listed under the variable hmNetGatewayIPAddr as a means of communicating with Romeo. She therefore puts the envelope with the IP addresses in a further envelope with Lorenzo's MAC destination address.

The letter now travels back to Romeo via Lorenzo, the same way the first letter traveled from Romeo to Juliet.

**Classless Inter-Domain Routing**

Class C with a maximum of 254 addresses was too small, and class B with a maximum of 65534 addresses was too large for most users. Resulting in an ineffective usage of the available class B addresses.

Class D contains reserved Multicast addresses. Class E is for experimental purposes. A non-participating Gateway ignores experimental datagrams with these destination addresses.

Since 1993, RFC 1519 has been using Classless Inter-Domain Routing (CIDR) to provide a solution. CIDR overcomes these class boundaries and supports classless address ranges.

With CIDR, you specify the number of bits that designate the IP address range. You represent the IP address range in binary form and count the mask bits that designate the netmask. The mask bits equal the number of bits used for the subnet in a given IP address range.

Example:

<table>
<thead>
<tr>
<th>IP address, decimal</th>
<th>Network mask, decimal</th>
<th>IP address, binary</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.112.1</td>
<td>255.255.255.128</td>
<td>11000000 10101000 01100000 00000001</td>
</tr>
<tr>
<td>192.168.112.127</td>
<td>255.255.255.128</td>
<td>11000000 10101000 01110000 01111111</td>
</tr>
</tbody>
</table>

CIDR notation: 192.168.112.0/25

The term “supernetting” refers to combining a number of class C address ranges. Supernetting lets you subdivide class B address ranges to a fine degree.
2.2 Specifying the IP parameters using the Command Line Interface

2.2.1 IPv4

There are the following methods you enter the IP parameters:
- HiDiscovery protocol
- External memory
- Command Line Interface using the serial connection

The device lets you specify the IP parameters using the HiDiscovery protocol or using the Command Line Interface over the serial interface.

![Flow chart for entering IP addresses](image)

**Figure 12: Flow chart for entering IP addresses**

**Note:** If a terminal or PC with terminal emulation is unavailable in the vicinity of the installation location, you can configure the device at your own workstation, then take it to its final installation location.

Perform the following steps:
- Set up a connection to the device.
  - The start screen appears.
Enter the IP parameters.

- **Local IP address**
  
  In the default setting, the local IP address is **0.0.0.0**.

- **Netmask**
  
  When you divided your network into subnetworks, and these are identified with a netmask, enter the netmask here. In the default setting, the local netmask is **0.0.0.0**.

- **IP address of the Gateway**.
  
  This entry is only required, in cases where the device and the network management station are located in different subnetworks (see on page 41 “Example of how the netmask is used”). Specify the IP address of the Gateway between the subnetwork with the device and the path to the network management station. In the default setting, the IP address is **0.0.0.0**.

Save the configuration specified using `copy config running-config nvm`.

```plaintext
enable

network parms 10.0.1.23 255.255.255.0

To change to the Privileged EXEC mode.

To assign the device the IP address 10.0.1.23 and the netmask 255.255.255.0. You have the option of also assigning a Gateway address.

copy config running-config nvm

To save the current settings in the non-volatile memory (nvm) in the “selected” configuration profile.
```

After entering the IP parameters, you easily configure the device using the Graphical User Interface.
2.3 Specifying the IP parameters using HiDiscovery

The HiDiscovery protocol lets you assign IP parameters to the device using the Ethernet.

You easily configure other parameters using the Graphical User Interface.

Perform the following steps:
- Install the HiDiscovery program on your computer.
  You can download the software from https://catalog.belden.com/index.cfm?event=pdf&p=PF_HiDiscovery.
- Start the HiDiscovery program.

When HiDiscovery is started, HiDiscovery automatically searches the network for those devices which support the HiDiscovery protocol.

HiDiscovery uses the first network interface found for the PC. When your computer has several network cards, you can select the one you desire in the HiDiscovery toolbar.

HiDiscovery displays a line for every device that responds to a HiDiscovery protocol inquiry.

HiDiscovery lets you identify the devices displayed.
- Select a device line.
- To set the LEDs to flashing for the selected device, click the Signal button on the tool bar. To stop the flashing, click the Signal button again.
- By double-clicking a line, you open a window in which you specify the device name and the IP parameter.
Note: Disable the HiDiscovery function in the device, after you have assigned the IP parameters to the device.

Note: Save the settings so that you will still have the entries after a restart.
2.4 Specifying the IP parameters using the Graphical User Interface

2.4.1 IPv4

Perform the following steps:

- Open the dialog.
  In this dialog you specify the VLAN in which the device management can be accessed and configure the HiDiscovery access.
- In the VLAN ID column you specify the VLAN in which the device management can be accessed over the network.
  Note here that you can only access the device management using ports that are members of the relevant VLAN.
  The MAC address field displays the MAC address of the device with which you access the device over the network.
- In the HiDiscovery protocol v1/v2 frame you specify the settings for accessing the device using the HiDiscovery software.
  The HiDiscovery protocol lets you allocate an IP address to the device on the basis of its MAC address. Activate the HiDiscovery protocol if you want to allocate an IP address to the device from your PC with the HiDiscovery software.
- Open the dialog.
  In this dialog you specify the source from which the device gets its IP parameters after starting.
  In the Management interface frame you first specify where the device gets its IP parameters from:
  - In the Local mode, the device uses the network parameters from the internal device memory.
  Note: When you change the allocation mode of the IP address, the device activates the new mode immediately after you click the ✓ button.
- If required, you enter the IP address, the netmask and the Gateway in the IP parameter frame.
- Save the changes temporarily. To do this, click the ✓ button.
Specifying the IP parameters
2.4 Specifying the IP parameters using the Graphical User Interface
3 Access to the device

3.1 Access roles

The device functions available to you as a user depend on your access role. When you are logged in with a specific access role, the functions of the access role are available to you.

The commands available to you as a user, also depend on the Command Line Interface mode in which you are currently working. See “Mode-based command hierarchy” on page 20.

The device offers the following access roles:

- **guest**: Users logged in with the access role guest are authorized to monitor the device.
- **auditor**: Users logged in with the access role auditor are authorized to monitor the device and to save the log file in the dialog.
- **operator**: Users logged in with the access role operator are authorized to monitor the device and to change the settings – with the exception of security settings for device access.
- **administrator**: Users logged in with the access role administrator are authorized to monitor the device and to change the settings.
- **unauthorized**: Unauthorized users are blocked, and the device rejects the user login. Assign this value to temporarily lock the user account. If a detected error occurs during an access role change, then the device assigns this access role to the user account.

Table 9: Access roles and scope of user authorizations

<table>
<thead>
<tr>
<th>Access role</th>
<th>User authorizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>guest</td>
<td>Users logged in with the access role guest are authorized to monitor the device.</td>
</tr>
<tr>
<td>auditor</td>
<td>Users logged in with the access role auditor are authorized to monitor the device and to save the log file in the dialog.</td>
</tr>
<tr>
<td>operator</td>
<td>Users logged in with the access role operator are authorized to monitor the device and to change the settings – with the exception of security settings for device access.</td>
</tr>
<tr>
<td>administrator</td>
<td>Users logged in with the access role administrator are authorized to monitor the device and to change the settings.</td>
</tr>
<tr>
<td>unauthorized</td>
<td>Unauthorized users are blocked, and the device rejects the user login. Assign this value to temporarily lock the user account. If a detected error occurs during an access role change, then the device assigns this access role to the user account.</td>
</tr>
</tbody>
</table>
3.2 First login (Password change)

To help prevent undesired access to the device, it is imperative that you change the default password during initial setup.

Perform the following steps:
- Open the Graphical User Interface, the HiView application, or the Command Line Interface the first time you log in.
- Log in with the default password.
- Type in your new password.
  To help increase security, choose a password that contains at least 8 characters which includes upper-case characters, lower-case characters, numerical digits, and special characters.
- When you log in with the Command Line Interface, the device prompts you to confirm your new password.
- Log in again with your new password.

Note: If you lost your password, then contact your local support team.

For further information, see hirschmann-support.belden.com.
3.3 Authentication lists

When a user accesses the device using a specific connection, the device verifies the login credentials of the user in an authentication list which contains the policies that the device applies for authentication.

The prerequisite for a user's access to the device management is that at least one policy is assigned to the authentication list of the application through which access is performed.

3.3.1 Applications

The device provides an application for each type of connection through which someone accesses the device:

- Access to the Command Line Interface using a serial connection: Console(V.24)
- Access to the Command Line Interface using SSH: SSH
- Access to the Graphical User Interface: WebInterface

3.3.2 Policies

When a user logs in with valid login data, the device lets the user have access to its device management. The device authenticates the users using the following policies:

- User management of the device
- LDAP
- RADIUS

The device gives you the option of a fall-back solution. For this, you specify more than one policy in the authentication list. When authentication is unsuccessful using the current policy, the device applies the next specified policy.

3.3.3 Managing authentication lists

You manage the authentication lists in the Graphical User Interface or in the Command Line Interface. To do this, perform the following steps:

- Open the dialog.
- The dialog displays the authentication lists that are set up.
3.3 Authentication lists

3.3.4 Adjust the settings

Example: Set up a separate authentication list for the application WebInterface which is by default included in the authentication list defaultLoginAuthList.

The device forwards authentication requests to a RADIUS server in the network. As a fall-back solution, the device authenticates users using the local user management. To do this, perform the following steps:

1. Create an authentication list loginGUI.

   - Open the dialog.
   - Click the button. The dialog displays the Create window.
   - Enter a meaningful name in the Name field. In this example, enter the name loginGUI.
   - Click the Ok button. The device adds a table row.

2. Select the policies for the authentication list loginGUI.

   - In the Policy 1 column, select the value radius.
   - In the Policy 2 column, select the value local.
   - In the Policy 3 to Policy 5 columns, select the value reject to help prevent further fall-back.
   - In the Active column, mark the checkbox.

3. Save the changes temporarily. To do this, click the button.
### 3.3 Authentication lists

To assign the policies `radius`, `local` and `reject` to the authentication list `loginGUI`.

To display the authentication lists that are set up.

To activate the authentication list `loginGUI`.

#### Assign an application to the authentication list `loginGUI`.

- Open the dialog.
- In the table, select the authentication list `loginGUI`.
- Click the button.
  The dialog displays the **Allocate applications** window.
- Click the application `WebInterface` to highlight it.
- Click the `Ok` button.
  The dialog displays the updated settings:
  - The **Dedicated applications** column of authentication list `loginGUI` displays the application `WebInterface`.
  - The **Dedicated applications** column of authentication list `defaultLoginAuthList` does not display the application `WebInterface` anymore.

- Save the changes temporarily. To do this, click the button.

#### To display the applications and the allocated lists.

- `show applists`
- `applists set-authlist WebInterface loginGUI`

To assign the `loginGUI` application to the authentication list `WebInterface`. 
3.4 User management

When a user logs in with valid login data, the device lets the user have access to its device management. The device authenticates the users either using the local user management or with a RADIUS server in the network. To get the device to use the user management, assign the local policy to an authentication list, see the dialog.

In the local user management, you manage the user accounts. One user account is usually allocated to each user.

3.4.1 Access roles

The device lets you use a role-based authorization model to specifically control the access to the device management. Users to whom a specific authorization profile is allocated are allowed to use commands and functions from the same authorization profile or a lower one.

The device uses the authorization profiles on every application with which the device management can be accessed.
Every user account is linked to an access role that regulates the access to the individual functions of the device. Depending on the planned activity for the respective user, you assign a pre-defined access role to the user. The device differentiates between the following access roles.

Table 10: Access roles for user accounts

<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
<th>Authorized for the following activities</th>
</tr>
</thead>
</table>
| administrator | The user is authorized to monitor and administer the device. | All activities with read/write access, including the following activities reserved for an administrator:  
- Add, modify or delete user accounts  
- Activate, deactivate or unlock user accounts  
- Change every password  
- Configure password management  
- Set or change system time  
- Load files to the device, for example device configurations, certificates or software images  
- Reset settings and security-related settings to the state on delivery  
- Configure RADIUS server and authentication lists  
- Apply scripts using the Command Line Interface  
- Enable/disable CLI logging and SNMP logging  
- External memory activation and deactivation  
- System monitor activation and deactivation  
- Enable/disable the services for the access to the device management (for example SNMP).  
- Configure access restrictions to the Graphical User Interface or the Command Line Interface based on the IP addresses |
| operator | The user is authorized to monitor and configure the device - with the exception of security-related settings. | All activities with read/write access, with the exception of the above-named activities, which are reserved for an administrator:  
- Configure password management  
- Set or change system time  
- Load files to the device, for example device configurations, certificates or software images  
- Reset settings and security-related settings to the state on delivery  
- Configure RADIUS server and authentication lists  
- Apply scripts using the Command Line Interface  
- Enable/disable CLI logging and SNMP logging  
- External memory activation and deactivation  
- System monitor activation and deactivation  
- Enable/disable the services for the access to the device management (for example SNMP).  
- Configure access restrictions to the Graphical User Interface or the Command Line Interface based on the IP addresses |
| auditor | The user is authorized to monitor the device and to save the log file in the dialog. | Monitoring activities with read access. |
| guest | The user is authorized to monitor the device - with the exception of security-related settings. | Monitoring activities with read access. |
| unauthorized | No access to the device possible.  
- As an administrator you assign this access role to temporarily lock a user account.  
- If an administrator assigns a different access role to the user account and an error occurs, then the device assigns this access role to the user account. | No activities allowed. |
3.4.2 Managing user accounts

You manage the user accounts in the Graphical User Interface or in the Command Line Interface. To do this, perform the following steps:

1. Open the dialog.
   The dialog displays the user accounts that are set up.

2. show users
   To display the user accounts that are set up.

3.4.3 Default setting

In the state on delivery, the user accounts admin and user are set up in the device.

Table 11: Default settings for the factory setting user accounts

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>User name</td>
<td>admin</td>
</tr>
<tr>
<td>Password</td>
<td>private</td>
</tr>
<tr>
<td>Role</td>
<td>administrator</td>
</tr>
<tr>
<td>User locked</td>
<td>unmarked</td>
</tr>
<tr>
<td>Policy check</td>
<td>unmarked</td>
</tr>
<tr>
<td>SNMP auth type</td>
<td>hmacmd5</td>
</tr>
<tr>
<td>SNMP encryption type</td>
<td>des</td>
</tr>
</tbody>
</table>

Change the password for the admin user account before making the device available in the network.

3.4.4 Changing default passwords

To help prevent undesired access, change the password of the default user accounts. To do this, perform the following steps:

1. Change the passwords for the admin and user user accounts.

2. Open the dialog.
   The dialog displays the user accounts that are set up.

3. To obtain a higher level of complexity for the password, mark the checkbox in the Policy check column.
   Before saving it, the device checks the password according to the policy specified in the Password policy frame.
3.4.5 Setting up a new user account

Allocate a separate user account to each user that accesses the device management. In this way you can specifically control the authorizations for the access.

In the following example, we will set up the user account for a user USER with the access role operator. Users with the access role operator are authorized to monitor and configure the device - with the exception of security-related settings. To do this, perform the following steps:

- Create a new user account.

- Open the dialog.
- Click the + button. The dialog displays the Create window.
- Enter the name in the User name field. In this example, we give the user account the name USER.
- Click the Ok button.
- To obtain a higher level of complexity for the password, mark the checkbox in the Policy check column. Before saving it, the device checks the password according to the policy specified in the Password policy frame.

Note: The password check can lead to a message in the Security status frame in the dialog. You specify the settings that cause this message in the dialog.

- Click the table row of the relevant user account in the Password field. Enter a password of at least 6 characters. Up to 64 alphanumeric characters are allowed.
  - The device differentiates between upper and lower case.
  - The minimum length of the password is specified in the Configuration frame. The device constantly checks the minimum length of the password.

- Save the changes temporarily. To do this, click the ✓ button.

enable
configure
users password-policy-check <user>

Note: When you display the security status, the password check can lead to a message (show security-status all). You specify the settings that cause this message with the command security-status monitor pwd-policy-inactive.

users password <user> SECRET

save

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To activate the checking of the password for the <user> user account based on the specified policy. In this way, you obtain a higher level of complexity for the password.

Note: When you display the security status, the password check can lead to a message (show security-status all). You specify the settings that cause this message with the command security-status monitor pwd-policy-inactive.

users password <user> SECRET

To specify the password SECRET for the <user> user account. Enter at least 6 characters.

To save the settings in the non-volatile memory (nvm) in the “selected” configuration profile.
3.4 User management

3.4.6 Deactivating the user account

After a user account is deactivated, the device denies the related user access to the device management. In contrast to completely deleting it, deactivating a user account lets you keep the settings and reuse them in the future. To do this, perform the following steps:

- To keep the user account settings and reuse them in the future, you temporarily deactivate the user account.

- Open the dialog.
  The dialog displays the user accounts that are set up.

- In the table row for the relevant user account, unmark the checkbox in the Active column.

- Save the changes temporarily. To do this, click the ✓ button.

**Note:** When you are setting up a new user account in the Command Line Interface, remember to allocate the password.
To permanently deactivate the user account settings, you delete the user account.

Select the table row of the relevant user account.

Click the button.

To delete the user account.

To display the user accounts that are set up.

To save the settings in the non-volatile memory (nvm) in the “selected” configuration profile.

### 3.4.7 Adjusting policies for passwords

The device lets you check if the passwords for the user accounts match the specified policy. When the passwords match the policy, you obtain a higher level of complexity for the passwords.

The user management of the device lets you activate or deactivate the check separately in each user account. When you mark the checkbox and the new password fulfills the requirements of the policy, the device accepts the password change.
In the default settings, practical values for the policy are set up in the device. You have the option of adjusting the policy to meet your requirements. To do this, perform the following steps:

- Adjust the policy for passwords to meet your requirements.

- Open the dialog.

  In the **Configuration** frame you specify the number user login attempts before the device locks out the user. You also specify the minimum number of characters that defines a password.

  **Note:** The device lets only users with the **administrator** authorization remove the lock.

  The number of login attempts as well as the possible lockout of the user apply only when accessing the device management through:
  - the Graphical User Interface
  - the **SSH** protocol

  **Note:** When accessing the device management using the Command Line Interface through the serial connection, the number of login attempts is unlimited.

- Specify the values to meet your requirements.
  - In the **Login attempts** field you specify the number of times that a user attempts to log in. The field lets you define this value in the range 0..5.
    - In the above example, the value 0 deactivates the function.
  - The **Min. password length** field lets you enter values in the range 1..64.

  The dialog displays the policy set up in the **Password policy** frame.

- Adjust the values to meet your requirements.
  - Values in the range 1 through 16 are allowed.
    - The value 0 deactivates the relevant policy.

  To apply the entries specified in the **Configuration** and **Password policy** frames, mark the checkbox in the **Policy check** column for a particular user.

- Save the changes temporarily. To do this, click the **✓** button.

```
enable
configure
passwords min-length 6
passwords min-lowercase-chars 1
passwords min-numeric-chars 1
passwords min-special-chars 1
passwords min-uppercase-chars 1
show passwords
save
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To specify the policy for the minimum length of the password.
To specify the policy for the minimum number of lower-case letters in the password.
To specify the policy for the minimum number of digits in the password.
To specify the policy for the minimum number of special characters in the password.
To specify the policy for the minimum number of upper-case letters in the password.
To display the policies that are set up.
To save the settings in the non-volatile memory (**nvm**) in the “selected” configuration profile.
3.5 LDAP

Server administrators manage Active Directories which contain user login credentials for applications used in the office environment. The Active Directory is hierarchical in nature, containing user names, passwords, and the authorized read/write permission levels for each user.

This device uses the Lightweight Directory Access Protocol (LDAP) to retrieve user login information and permission levels from a Active Directory. This provides a “single sign on” for network devices. Retrieving the login credentials from an Active Directory lets the user log in with the same login credentials used in the office environment.

An LDAP session starts with the device contacting the Directory System Agent (DSA) to search the Active Directory of an LDAP server. If the server finds multiple entries in the Active Directory for a user, then the server sends the higher permission level found. The DSA listens for information requests and sends responses on TCP port 389 for LDAP, or on TCP port 636 for LDAP over SSL (LDAPS). Clients and servers encode LDAPS requests and responses using the Basic Encoding Rules (BER). The device opens a new connection for every request and closes the connection after receiving a response from the server.

The device lets you upload a CA certificate to validate the server for Secure Socket Level (SSL) and Transport Layer Security (TLS) sessions. Whereby, the certificate is optional for TLS sessions.

The device is able to cache login credentials for up to 1024 users in memory. If the active directory servers are unreachable, then the users are still able to log in using their office login credentials.

3.5.1 Coordination with the server administrator

Configuring the LDAP function requires that the network administrator request the following information from the server administrator:

- The server name or IP address
- The location of the Active Directory on the server
- The type of connection used
- The TCP listening port
- When required, the location of the CA certificate
- The name of the attribute containing the user login name
- The names of the attribute containing the user permission levels

The server administrator can assign permission levels individually using an attribute such as description, or to a group using the memberOf attribute. In the dialog you specify which attributes receive the various permission levels.

You also have the option to retrieve the name of the attributes containing the user login name and permission levels using a LDAP browser such as JXplorer or Softerra.
3.5.2 Example configuration

The device is able to establish an encrypted link to a local server using only the server name or to a server on a different network using an IP address. The server administrator uses attributes to identify login credentials of a user and assign individual and group permission levels.

Using information received from the server administrator, specify which attributes in the Active Directory contain the user login credentials and permission level. The device then compares the user login credentials with the permission levels specified in the device and lets the user log in at the assigned permission level.

![Diagram: LDAP Example Configuration]

For this example, the server administrator sent the following information:

<table>
<thead>
<tr>
<th>Information</th>
<th>Primary Server</th>
<th>Backup Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>The server name or IP address</td>
<td>local.server</td>
<td>10.16.1.2</td>
</tr>
<tr>
<td>The location of the Active Directory on the server</td>
<td>Country/City/User</td>
<td>Country/Company/User</td>
</tr>
<tr>
<td>The type of connection used</td>
<td>TLS (with certificate)</td>
<td>SSL</td>
</tr>
<tr>
<td>The server administrator sent the CA certificate in an email.</td>
<td>CA certificate for primary server saved locally</td>
<td>CA certificate for backup server saved locally</td>
</tr>
<tr>
<td>The TCP listening port</td>
<td>389 (tls)</td>
<td>636 (ssl)</td>
</tr>
<tr>
<td>Name of the attribute containing the user name</td>
<td>userPrincipalName</td>
<td>userPrincipalName</td>
</tr>
<tr>
<td>The names of the attribute containing the user permission levels</td>
<td>OPERATOR</td>
<td>OPERATOR</td>
</tr>
<tr>
<td></td>
<td>ADMINISTRATOR</td>
<td>ADMINISTRATOR</td>
</tr>
</tbody>
</table>

Perform the following steps:

- Open the dialog.
- To configure the device to retrieve the user login credentials, during login using the Graphical User Interface, from the Active Directory first, specify for the defaultLoginAuthList list the value ldap in the Policy 1 column.
- Open the dialog.
- The device lets you specify the length of time that it saves the user login credentials in the cache. To cache user login credentials for a day, in the Configuration frame, Client cache timeout [min] field, specify the value 1440.
- The Bind user entry is optional. When specified, users enter only their user name to log in. The service user can be anyone with login credentials listed in the Active Directory under the attribute specified in the User name attribute column. In the Bind user column, specify the user name and the domain.
The **Base DN** is a combination of the domain component (dc) and the organizational unit (ou). The **Base DN** lets the device locate a server in a domain (dc) and find the Active Directory (ou). Specify the location of the Active Directory. In the **Base DN** column, specify the value `ou=Users,ou=City,ou=Country,dc=server,dc=local`.

In the **User name attribute** column, enter the value `userPrincipalName` to specify the attribute under which the server administrator lists the users.

The device uses a CA certificate to verify the server. When the certificate is located on your PC or on a network drive, drag and drop the certificate in the area. Alternatively, click in the area to select the certificate.

To transfer the CA certificate onto the device, click the **Start** button.

To add a table row, click the button.

To specify a description, enter the value **Primary AD Server** in the **Description** column.

To specify the server name and domain of the primary server, in the **Address** column, enter the value `local.server`.

The primary server uses the TCP port **389** for communication which is the **Destination TCP port** default value.

The primary server uses TLS for encrypting communication and a CA certificate for server validation. In the **Connection security** column, specify the value **startTLS**.

To activate the table row, mark the checkbox in the **Active** column.

Using the information received from the server administrator for the Backup server, add, configure and activate another table row.

Open the dialog.

To add a table row, click the button.

When a user logs in, with LDAP configured and enabled, the device searches the Active Directory for the login credentials of the user. If the device finds the user name and the password is correct, then the device searches for the value specified in the **Type** column. If the device finds the attribute and the text in the **Parameter** column matches the text in the Active Directory, then the device lets the user log in with the assigned permission level. When the value `attribute` is specified in the **Type** column, specify the value in the **Parameter** column in the following form: `attributeName=attributeValue`.

In the **Role** column, enter the value **operator** to specify the access role.

To activate the table row, mark the checkbox in the **Active** column.

Click the button.

The dialog displays the **Create** window.

Enter the values received from the server administrator for the access role `administrator`.

To activate the table row, mark the checkbox in the **Active** column.

Open the dialog.

To enable the function, select the **On** radio button in the **Operation** frame.
The following table describes how to configure the LDAP function in the device using the Command Line Interface. The table displays the commands for Index 1. To configure Index 2, use the same commands and substitute the appropriate information.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>enable</td>
<td>To change to the Privileged EXEC mode.</td>
</tr>
<tr>
<td>configure</td>
<td>To change to the Configuration mode.</td>
</tr>
<tr>
<td>ldap cache-timeout 1440</td>
<td>To specify the device to flush the non-volatile memory after a day.</td>
</tr>
<tr>
<td>ldap client server add 1 local.server port 389</td>
<td>To add a connection to the remote authentication client server with the host name local.server and the UDP port 389.</td>
</tr>
<tr>
<td>ldap client server modify 1 security startTLS</td>
<td>To specify the type of security used for the connection.</td>
</tr>
<tr>
<td>ldap client server modify 1 description Primary_AD_Server</td>
<td>To specify the configuration name of the entry.</td>
</tr>
<tr>
<td>ldap basedn ou=Users,ou=City,ou=Country,dc=server,dc=local</td>
<td>To specify the Base Domain Name used to find the Active Directory on the server.</td>
</tr>
<tr>
<td>ldap search-attr userPrincipalName</td>
<td>To specify the attribute to search for in the Active Directory which contains the login credential of the users.</td>
</tr>
<tr>
<td>ldap bind-user <a href="mailto:user@company.com">user@company.com</a></td>
<td>To specify the name and domain of the service user.</td>
</tr>
<tr>
<td>ldap bind-passwd Ur-123456</td>
<td>To specify the password of the service user.</td>
</tr>
<tr>
<td>ldap client server enable 1</td>
<td>To enable the remote authentication client server connection.</td>
</tr>
<tr>
<td>ldap mapping add 1 access-role operator mapping-type attribute mapping-parameter OPERATOR</td>
<td>To add a remote authentication role mapping entry for the access role operator. Map the access role operator to the attribute containing the word OPERATOR.</td>
</tr>
<tr>
<td>ldap mapping enable 1</td>
<td>To enable the remote authentication role mapping entry.</td>
</tr>
<tr>
<td>ldap operation</td>
<td>To enable the remote authentication function.</td>
</tr>
</tbody>
</table>
3.6 SNMP access

The SNMP protocol lets you work with a network management system to monitor the device over the network and change its settings.

3.6.1 SNMPv1/v2 access

Using SNMPv1 or SNMPv2 the network management system and the device communicate unencrypted. Every SNMP packet contains the community name in plain text and the IP address of the sender.

The community names public for read accesses and private for write accesses are preset in the device. If SNMPv1/v2 is enabled, then the device lets anyone who knows the community name have access to the device.

Make undesired access to the device more difficult. To do this, perform the following steps:

- Change the default community names in the device.
  - Treat the community names with discretion. Anyone who knows the community name for write access, has the ability to change the settings of the device.
- Specify a different community name for read/write access than for read access.
- Use SNMPv1 or SNMPv2 only in environments protected from eavesdropping. The protocols do not use encryption.
- We recommend using SNMPv3 and disabling the access using SNMPv1 and SNMPv2 in the device.

3.6.2 SNMPv3 access

Using SNMPv3 the network management system and the device communicate encrypted. The network management system authenticates itself with the device using the login credentials of a user. The prerequisite for the SNMPv3 access is that in the network management system uses the same settings that are defined in the device.

The device lets you specify the SNMP auth type and SNMP encryption type parameters individually in each user account.

When you set up a new user account in the device, the parameters are preset so that the network management system Industrial HiVision reaches the device immediately.

The user accounts set up in the device use the same passwords in the Graphical User Interface, in the Command Line Interface, and for SNMPv3.

To adapt the SNMPv3 parameters of the user account settings to the settings in your network management system, perform the following steps:

- Open the dialog.
  - The dialog displays the user accounts that are set up.
Access to the device
3.6 SNMP access

- Click the table row of the relevant user account in the **SNMP auth type** field. Select the desired setting.
- Click the table row of the relevant user account in the **SNMP encryption type** field. Select the desired setting.
- Save the changes temporarily. To do this, click the ✓ button.

```
enable
configure
users snmpv3 authentication <user> md5 | sha1
users snmpv3 encryption <user> des | aescfb128 | none
show users
save
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To assign the HMAC-MD5 or HMACSHA protocol for authentication requests to the user account `<user>`.
To assign the DES or AES-128 algorithm to the user account `<user>`.
With this algorithm, the device encrypts authentication requests. The value none removes the encryption.
To display the user accounts that have been configured.
To save the settings in the non-volatile memory (nvm) in the “selected” configuration profile.
4 VPN – Virtual Private Network

A virtual private network (VPN) refers to the part of a public network that someone uses for their private purposes.

The special feature of a VPN, as the name “private” suggests, is that the VPN tunnels the private data through a public network. Different measures help protect the data of the virtual private network from spying, data falsification and other attacks from external subscribers.

In the industrial environment, for example, a VPN serves to connect 2 plant sections with each other using the public Internet.

![Figure 16: VPN for connecting 2 plant sections](image)

4.1 IPsec – Internet Protocol Security

IPsec is a protocol suite that authenticates and encrypts data packets sent over public networks.

Data transmission in a VPN involves:

- **Integrity protection**
  Integrity protection helps verify that the data transmitted is genuine, for example, that the data source is a trustworthy sender (is authentic) and that the recipient receives the data in its true form.

- **Encryption**
  Encryption helps protect the data prohibiting unauthorized persons from viewing the data. Encryption procedures code the data being transmitted using a code (key) that is only available to the authorized communication subscribers.

- **Traffic flow confidentiality**
  The traffic flow confidentiality helps protect the identification of the recipient and sender of the data packet from unauthorized person.

IPsec performs this in the tunnel mode by encrypting the complete IP packet.
The 2 endpoints negotiation which security parameters to use on the VPN connection. IPsec provides 2 modes for the negotiations

- **Transport mode**
  In the transport mode, the 2 endpoints authenticate themselves to each other, then they set up the parameters required for signatures and encryption. As the communication is taking place between the 2 specific endpoints, the recipient and sender addresses remain visible.

- **Tunnel mode**
  In the tunnel mode, the 2 Routers/Gateways authenticate themselves to each other, then they set up the parameters required for signatures and encryption. With the 2 Routers/Gateways specific, the VPN connection has 2 addressable endpoints. But the communication takes place between the subscribers of the network connected to the Routers/Gateways. This permits the transmission of encryption communication data, including the recipient and sender addresses. The endpoints of the VPN connection use the addresses of the Routers/Gateways to send data.
  The device also lets you use the tunnel mode for the VPN connection between an endpoint and a Router/Gateway. Thus, the address data within the network connected to the Router/Gateway remains hidden.
4.2 IKE – Internet Key Exchange

IPsec uses the IKE protocol (Internet Key Exchange) for authentication, for exchanging keys and for agreeing on further parameters for the security arrangement of a VPN connection.

4.2.1 Authentication

Use authentication as part of the security arrangement. During authentication, the connection peers display each other their ID cards, so to speak.

This ID card consists of the following:

- a pre-shared key, which is a character string previously exchanged using a different communication channel.
- a digital certificate, which was issued by a certification authority (CA).

Certificates based on the X.509 standard contain the following:

- information about the certification authority
- validity period of the certificate
- information about the permitted usage
- the designated name (X.500 DN), which is the identity of the person that the certification authority assigned the certificate too
- the public key belonging to this identity
- the digital signature for verifying the connection between this identity and its related public key

Larger companies and authorities usually have their own certification authority.

A commonly used file extension for a certificate based on the PKCS#12 standard is .p12. You can also find the information contained in a PKCS#12 file separately in individual files with the file extension .pem.

4.2.2 Encryption

To help protect the data, IKE uses various cryptographic algorithms for data encryption. The endpoints of the VPN connection require the key to code and decode the data.

The following list contains the initial steps in setting up the IKE security arrangement between the VPN connection endpoints:

- the endpoints agree on a cryptographic algorithm which subsequently uses the key for coding and decoding the IKE protocol messages
- the endpoints specify the time periods during which the key exchange takes place
- the endpoints identify the devices on which the coding and decoding takes place. The administrator specifies the endpoints beforehand in the settings of each endpoint.

After the endpoints complete the steps listed above, the devices agree on the key to code and decode the data.
4.2.3 Creating a certificate using OpenSSL

Using OpenSSL lets you create and sign a server certificate to use for VPN authentication.

Prerequisite: On a Windows system, you need a text editor that correctly handles Unix line breaks, for example the Notepad++ application.

Create a certificate. To do this, perform the following steps:

- Download OpenSSL from https://www.openssl.org and install the application.
- Specify the install directory c:\openssl and accept the other installation defaults.
- Start the Command Prompt program on your computer.
- To create the appropriate directories and files, enter the following commands in the Administrator window in the Command Prompt window:
  ```
  C:\Users\username> cd \\
  C:\> cd openssl
  C:\openssl> md certs
  C:\openssl\certs> cd certs
  C:\openssl\certs> md nameCA
  C:\openssl\certs> md nameCA\newcerts
  C:\openssl\certs\notepad++ nameCA\index.txt
  ```
- Save the index.txt file and exit the Notepad++ program.
- In the Command Prompt window, create a file named serial.txt, with the following command:
  ```
  C:\openssl\certs> notepad++ nameCA\serial.txt
  ```
- Open the serial.txt file using the Notepad++ program.
- In the Notepad++ window, enter the value 01 on the first line.
- Save the serial.txt file and exit the Notepad++ program.
- To set the path to the OpenSSL application, enter the following command in the Command Prompt window:
  ```
  C:\> set path=c:\openssl\bin;%path%
  ```
- To set the path to the OpenSSL configuration file, enter the following command in the Command Prompt window:
  ```
  C:\openssl\certs> set OPENSSL_CONF=c:\openssl\bin\openssl.cfg
  ```
- Using a text editor, edit the configuration file openssl.cfg located in the c:\openssl\bin directory. The countryName and stateOrProvinceName values are optional. Therefore change the value match to optional. Save the settings. The resulting configuration is as follows:
  ```
  # For the CA policy
  [ policy_match ]
  countryName = optional
  stateOrProvinceName = optional
  organizationName = match
  organizationalUnitName = optional
  commonName = supplied
  emailAddress = optional
  ```
- To create an RSA certificate named ca.key, enter the following commands in the Command Prompt window:
  ```
  C:\openssl\certs> openssl genrsa -out ca.key 1024
  ```
  The window displays the following text during certificate generation:
  ```
  Loading 'screen' into random state - done
  Generating RSA private key, 1024 bit long modulus
  ................+............
  +.................................................................+
  e is 65537 (0x10001)
  ```
The OpenSSL application also lets you generate other certificate types. To display the various certificate types, open the `openssl.exe` application located in the `c:\OpenSSL\bin` directory, and enter the `?` character in the Command Prompt window.

- To create and sign a Certificate Signing Request (CSR), enter the following commands in the Command Prompt window:

  ```
  C:\OpenSSL\certs> openssl req -new -x509 -days 365 -key ca.key -out nameCA/cacert.pem
  ```

- When requested, enter the appropriate distinguished name (DN) information for the CA certificate. When you press the <Enter> key, you can leave the optional fields blank.

- For example, enter the following values:

  ```
  Country Name: de
  State or Province Name: BW
  Locality Name: Neckartenzlingen
  Organization Name: Hirschmann Automation and Control
  Org. Unit Name: INET
  Common Name: EAGLE-ECE555d5e548
  ```
4.3 Application examples

The following examples describe the special features occurring in frequently used applications.

4.3.1 Connecting 2 subnetworks

In a large company network, a transfer network connects the subnetworks to each other. A VPN connects 2 of these subnetworks for example, the production control and the production hall. To hide the internal IP addresses, configure the VPN to function in the tunnel mode.

The following information about the VPN is available:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Router 1</th>
<th>Router 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP address of internal port</td>
<td>10.0.1.0/24</td>
<td>10.0.3.0/24</td>
</tr>
<tr>
<td>IP address of external port</td>
<td>10.0.2.0/24</td>
<td>10.0.2.0/24</td>
</tr>
<tr>
<td>Pre-shared key</td>
<td>123456abcdef</td>
<td>123456abcdef</td>
</tr>
<tr>
<td>Start IKE mode as</td>
<td>Initiator</td>
<td>Responder</td>
</tr>
<tr>
<td>IP parameters of the connecting networks</td>
<td>10.0.1.0/24</td>
<td>10.0.3.0/24</td>
</tr>
</tbody>
</table>

Prerequisite for further configuration:
- Both device 1 and 2 are in the router mode.
- Specify the IP parameters on the router interfaces.
- The devices in the 10.0.1.0/24 subnet have the IP address of the internal interface on Router 1, as their Gateway.

![Diagram of connecting 2 subnetworks using a transfer network](image_url)
Perform the following steps:

☐ Create a VPN connection.

☐ Open the dialog.

☐ Click the button.

The Create or select entry table displays the VPN connections already available in the device.

☐ In the VPN index field, enter an available index number.

☐ In the VPN description column, specify a connection name for example, Production Control - Production Hall 1.

☐ Click the Next button.

☐ Specify the authentication parameters.

The device uses the values specified in the Authentication dialog to validate its identity. In this example, the device authenticates itself using a pre-shared key.

☐ Select in the Authentication type frame, Authentication type field the value Pre-shared key (PSK).

☐ In the Pre-shared key (PSK) frame, specify the following settings:

   - The value 123456abcdef in the Pre-shared key column
   - The value 123456abcdef in the Confirm column

The default setting of the Change checkbox lets you enter and confirm the pre-shared key for new VPN connections. For existing VPN connections the Pre-shared key and the Confirm fields are inactive. To activate the fields, mark the checkbox in the Change column.

☐ Click the Next button.

☐ Specify the Endpoint and Traffic Selector parameters.

The device uses the values specified in the Endpoint and traffic selectors dialog to identify the data source and destination. The table displays the type of data to send through the VPN tunnel.

☐ In the Endpoints frame, specify the following settings:

   - The value 10.0.2.1 in the Local endpoint column
   - The value 10.0.2.2 in the Remote endpoint column

In the current example, the external ports of the 2 device are the endpoints for of the VPN connection.

☐ To identify data that the device sends through the VPN tunnel, click the Add traffic selector button in the Add traffic selector frame.
In the **Add traffic selector** dialog, specify the following settings:

- The value 1 in the **Traffic selector index** column
  - The device enters the index number, but also lets you change it.
- The value **Any Traffic** in the **Traffic selector description** column
- The value 10.0.1.0/24 in the **Source address (CIDR)** column
- The value in the **Source restrictions** column is optional.
  - The default setting is **any/any**. The device sends only the type of data specified through the VPN tunnel.
- The value 10.0.3.0/24 in the **Destination address (CIDR)** column
- The value in the **Destination restrictions** column is optional.
  - The default setting is **any/any**. The device excepts only the specified type of data from the VPN tunnel.

- Click the **Ok** button.
- Click the **Next** button.
Enter the IKE key exchange IPSec parameters.

The device uses the values specified in the Advanced configuration dialog. In this example the device is the initiator and selects the protocol automatically.

In the General frame, Margin time [s] field, the default setting is 540 s. This is equal to 9 minutes.

In the IKE/Key-exchange frame, specify the following settings:

- The value auto in the Version column
  - With this, the device selects the protocol version automatically, depending on the VPN remote terminal.
- The value initiator in the Startup column
  - The device initiates the VPN connection to the remote terminal.
- The value email in the IKE local identifier type column
- For example, the value user1@company.com in the IKE local ID column
- The value email in the Remote identifier type column
- For example, the value user2@company.com in the Remote ID column
- The value main in the IKE exchange mode column
- The value modp1024 in the IKE key agreement column
- The value hmacsha1 in the IKE integrity (MAC) column
- The value aes128 in the IKE encryption column
- The value 120 in the DPD timeout [s] column
  - If the device does not receive a sign of life from the remote terminal within 120 seconds, then it terminates the VPN connection.
- The value 28800 in the IKE lifetime [s] column
  - After the lifetime elapses, the 2 participating devices agree on new keys for the IKE security arrangement (IKE SA). The lifetime provides a periodic key change for the IKE SA.

In the IPSec/Data-exchange frame, specify the following settings:

- The value modp1024 in the IPsec key agreement column
- The value hmacsha1 in the IPsec integrity (MAC) column
- The value aes128 in the IPsec encryption column
- The value 3600 in the IPsec lifetime [s] column

To apply the changes, click the Finish button.

Activate the connection.

To activate the connection, mark the checkbox in the VPN active column.

Save the settings.

Save the changes temporarily. To do this, click the ✓ button.

Make exactly the same settings on both devices.
- On the second device, replace the IP address and specify the value responder in the Startup column.
5 Synchronizing the system time in the network

Many applications rely on a time that is as correct as possible. The necessary accuracy, and thus the allowable deviation from the actual time, depends on the application area.

Examples of application areas include:
- Log entries
- Time stamping of production data
- Process control

The device lets you synchronize the time on the network using the following options:
- The Network Time Protocol (NTP) is accurate to the order of sub-milliseconds.

5.1 Basic settings

In the dialog, you specify general settings for the time.

5.1.1 Setting the time

When no reference time source is available to you, you have the option to set the time in the device.

After a cold start or reboot, if no real-time clock is available or the real-time clock contains an invalid time, then the device initializes its clock with January 1, 00:00h. After the power supply is switched off, the device buffers the settings of the real-time clock up to 24 hours.

Alternatively, you configure the settings in the device so that it automatically obtains the current time from an NTP server.

Perform the following steps:

- Open the dialog.
  - The System time (UTC) field displays the current UTC (Universal Time Coordinated) of the device. UTC is the time relating to the coordinated world time measurement. UTC is the same worldwide and does not take local time shifts into account.
  - The time in the System time field comes from the System time (UTC) plus the Local offset [min] value and a possible shift due to daylight saving time.
- In order to cause the device to apply the time of your PC to the System time field, click the Set time from PC button.
  - Based on the value in the Local offset [min] field, the device calculates the time in the System time (UTC) field: The System time (UTC) comes from the System time minus the Local offset [min] value and a possible shift due to daylight saving time.
  - The Time source field displays the origin of the time data. The device automatically selects the source with the greatest accuracy.
  - The source is initially local.
  - When NTP is active and the device receives a valid NTP packet, the device sets its time source to ntp.
Synchronizing the system time in the network

5.1 Basic settings

5.1.2 Automatic daylight saving time changeover

When you operate the device in a time zone in which there is a summer time change, you set up the automatic daylight saving time changeover on the Daylight saving time tab.

When daylight saving time is enabled, the device sets the local system time forward by 1 hour at the beginning of daylight saving time. At the end of daylight saving time, the device sets the local system time back again by 1 hour. To do this, perform the following steps:

- Open the dialog, Daylight saving time tab.
- To select a preset profile for the start and end of daylight saving time, click the Profile... button in the Operation frame.
- When no matching daylight saving time profile is available, you specify the changeover times in the Summertime begin and Summertime end fields. For both time points, you specify the month, the week within this month, the weekday, and the time of day.
- To enable the function, select the On radio button in the Operation frame.
- Save the changes temporarily. To do this, click the ✓ button.

The Local offset [min] value specifies the time difference between the local time and the System time (UTC).

In order to cause the device to determine the time zone on your PC, click the Set time from PC button. The device calculates the local time difference from UTC and enters the difference into the Local offset [min] field.

Save the changes temporarily. To do this, click the ✓ button.

 enable
 configure
 clock set <YYYY-MM-DD> <HH:MM:SS>
 clock timezone offset <-780..840>
 save

to change to the Privileged EXEC mode.

to change to the Configuration mode.

to set the system time of the device.

to enter the time difference between the local time and the received UTC time in minutes.

to save the settings in the non-volatile memory (nvm) in the “selected” configuration profile.

5.1.2 Automatic daylight saving time changeover

When you operate the device in a time zone in which there is a summer time change, you set up the automatic daylight saving time changeover on the Daylight saving time tab.

When daylight saving time is enabled, the device sets the local system time forward by 1 hour at the beginning of daylight saving time. At the end of daylight saving time, the device sets the local system time back again by 1 hour. To do this, perform the following steps:

- Open the dialog, Daylight saving time tab.
- To select a preset profile for the start and end of daylight saving time, click the Profile... button in the Operation frame.
- When no matching daylight saving time profile is available, you specify the changeover times in the Summertime begin and Summertime end fields. For both time points, you specify the month, the week within this month, the weekday, and the time of day.
- To enable the function, select the On radio button in the Operation frame.
- Save the changes temporarily. To do this, click the ✓ button.

 enable
 configure
 clock set <YYYY-MM-DD> <HH:MM:SS>
 clock timezone offset <-780..840>
 save

to change to the Privileged EXEC mode.

to change to the Configuration mode.

to set the system time of the device.

to enter the time difference between the local time and the received UTC time in minutes.

to save the settings in the non-volatile memory (nvm) in the “selected” configuration profile.

 enable
 configure
 clock summer-time mode <disable|recurring|eu|usa>
 clock summer-time recurring start
 clock summer-time recurring end
 save

to change to the Privileged EXEC mode.

to change to the Configuration mode.

to configure the automatic daylight saving time changeover: enable/disable or activate with a profile.

to enter the start time for the changeover.

to enter the end time for the changeover.

to save the settings in the non-volatile memory (nvm) in the “selected” configuration profile.
5.2 NTP

The Network Time Protocol (NTP) lets you synchronize the system time in your network. The device supports the NTP client and the NTP server function.

NTP uses levels, or hierarchies, of clock sources called stratum layers. Stratum layers define the distance from the reference clock. The layers start with zero as the top layer. The stratum zero layer consists of clock devices such as radio clocks, atomic clocks, or GPS clocks. The device operates at stratum layers 1 through 16.

Furthermore, an NTP device operates as a primary server, secondary server, or client. Synchronize the primary NTP-Server directly to the stratum zero layer.

A secondary NTP-Server synchronizes to one or more servers and provides a synchronization signal for one or more servers or clients. When you use the device in client mode, the device sends requests to the active NTP-Servers listed in the dialog. In the client-server mode, the device also answers requests sent from dependent servers and clients.

An NTP-Client synchronizes to one or more upstream NTP-Servers. In order to synchronize to the NTP-Server, configure the client devices to send Unicast requests or listen for Broadcasts.

Note: To obtain as accurate a system time distribution as possible, use multiple NTP servers for an NTP client.

5.2.1 Preparing the NTP configuration

Perform the following steps:

- To get an overview of how the time is passed on, draw a network plan with the devices participating in NTP. When planning, bear in mind that the accuracy of the time depends on the signal runtime.

Figure 18: NTP cascading
Enable the NTP function in the devices whose time you want to set using NTP. The NTP server of the device responds to received Unicast requests and sends Broadcast requests as soon as it is configured and enabled.

If no reference clock is available, then specify a device as the reference clock and set its system time as accurately as possible.

### 5.2.2 NTP configuration

In the **Client only** frame:
- **Client** – Enable/disable the function
- **Mode** – In the unicast mode the device sends a request to a designated Unicast server and expects a reply from that server. In the broadcast mode, the device sends no request and waits for a Broadcast from one or more Broadcast servers.

In the **Client and server** frame:
- **Server** – Enable/disable the function
- **Mode** – Set the connection parameters
- **Stratum** – This setting helps prevent other clients from using the device as a reference time source (default setting: 12).

Configure an NTP client, using the example for switch 2. To do this, perform the following steps:

1. **Open the dialog.**
2. **Before you enable the Client function, disable the Server function.** Select the Off radio button in the Client and server frame.
   - To enable the function, select the On radio button in the Client only frame.
3. **In the Mode field, specify the value unicast.**
4. **Save the changes temporarily.** To do this, click the button.
5. **Open the dialog.**
6. **To add a table row, click the button.**
7. **For switch 2:**
   - In the Address column, specify the value 192.168.1.2.
8. **To activate the table row, mark the checkbox in the Active column.**
9. **Save the changes temporarily.** To do this, click the button.
Configure an NTP client server, using the example for switch 1 and 3. To do this, perform the following steps:

- Open the dialog.
- Before you enable the **Server** function, disable the **Client** function. Select the **Off** radio button in the **Client only** frame.
  - To enable the function, select the **On** radio button in the **Client and server** frame.
- In the **Mode** field, specify the value **client-server**.
- Save the changes temporarily. To do this, click the **✓** button.
- Open the dialog.
- To add a table row, click the **✚** button.
- For switch 1 and switch 3:
  - In the **Address** column, specify the value **192.168.43.17**.
  - To activate the table row, mark the checkbox in the **Active** column.
- Save the changes temporarily. To do this, click the **✓** button.

Configure both switch 1 and 3 with the following commands:

```bash
enable
configure
ntp client operation enable
ntp server operation enable
ntp server operating-mode client-server
ntp peers add 1 ip 192.168.43.17
```
Synchronizing the system time in the network

5.2 NTP
6 Managing configuration profiles

If you change the settings of the device during operation, then the device stores the changes in its memory (RAM). After a reboot the settings are lost.

In order to keep the changes after a reboot, the device lets you save the settings in a configuration profile in the non-volatile memory (NVM). In order to make it possible to quickly switch to other settings, the non-volatile memory offers storage space for multiple configuration profiles.

If an external memory is connected, then the device automatically saves a copy of the configuration profile in the external memory (ENVM). You can disable this function.

6.1 Detecting changed settings

The device stores changes made to settings during operation in its volatile memory (RAM). The configuration profile in the non-volatile memory (NVM) remains unchanged until you save the changed settings explicitly. Until then, the configuration profiles in memory and non-volatile memory are different. The device helps you recognize changed settings.

6.1.1 Volatile memory (RAM) and non-volatile memory (NVM)

You can recognize if the settings in the volatile memory (RAM) differ from the settings of the "selected" configuration profile in the non-volatile memory (NVM). To do this, perform the following steps:

- Check the banner of the Graphical User Interface:
  - When the icon is visible, the settings differ.
  - When no icon is visible, the settings match.

Or:

- Open the dialog.
- Check the status of the checkbox in the Information frame:
  - When the checkbox is marked, the settings match.
  - When the checkbox is unmarked, the settings differ.

```
show config status
Configuration Storage sync State
--------------------------------
  running-config to NV.................. out of sync
...```

6.1.2 External memory (ACA) and non-volatile memory (NVM)

You can recognize if the settings copied to the external memory (ACA) differ from the settings of the configuration profile in the non-volatile memory (NVM). To do this, perform the following steps:

- Open the dialog.
- Check the status of the checkbox in the Information frame:
  - When the checkbox is marked, the settings match.
  - When the checkbox is unmarked, the settings differ.

```
show config status
Configuration Storage sync State
---------------------------------
... NV to ACA..........................out of sync ...```

6.2  Saving the settings

6.2.1  Saving the configuration profile in the device

If you change the settings of the device during operation, then the device stores the changes in its memory (RAM). In order to keep the changes after a reboot, save the configuration profile in the non-volatile memory (NVM).

Saving a configuration profile

The device stores the settings in the "selected" configuration profile in the non-volatile memory (NVM).

Perform the following steps:

- Open the dialog.
- Verify that the required configuration profile is "Selected".
  You can recognize the "selected" configuration profile because the checkbox in the Selected column is marked.
- Click the button.

show config profiles nvm
To display the configuration profiles contained in the non-volatile memory (nvm).

enable
To change to the Privileged EXEC mode.

save
To save the settings in the non-volatile memory (nvm) in the "selected" configuration profile.

Copying settings to a configuration profile

The device lets you store the settings saved in the memory (RAM) in a configuration profile other than the "selected" configuration profile. In this way you create a new configuration profile in the non-volatile memory (NVM) or overwrite an existing one.

Perform the following steps:

- Open the dialog.
- Click the button and then the Save as.. item.
  The dialog displays the Save as.. window.
- In the Name field, change the name of the configuration profile. If you keep the proposed name, the device will overwrite an existing configuration profile of the same name.
- Click the Ok button.
  The new configuration profile is designated as "Selected".
Selecting a configuration profile

When the non-volatile memory (NVM) contains multiple configuration profiles, you have the option to select any configuration profile there. The device stores the settings in the “selected” configuration profile. Upon reboot, the device loads the settings of the “selected” configuration profile into the memory (RAM).

Perform the following steps:

1. Open the dialog. The table displays the configuration profiles present in the device. You can recognize the “selected” configuration profile because the checkbox in the Selected column is marked.
2. Select the table row of the desired configuration profile stored in the non-volatile memory (NVM).
3. Click the button and then the Select item. In the Selected column, the checkbox of the configuration profile is now marked.

To display the configuration profiles contained in the non-volatile memory (nvm). To change to the Privileged EXEC mode. To save the current settings in the configuration profile named <string> in the non-volatile memory (nvm). If present, the device overwrites a configuration profile of the same name. The new configuration profile is designated as “Selected”.

To change to the Privileged EXEC mode.

To display the configuration profiles contained in the non-volatile memory (nvm).

To change to the Configuration mode.

To select the configuration profile. Take note of the adjacent name of the configuration profile.

To save the settings in the non-volatile memory (nvm) in the “selected” configuration profile.
6.2.2 Saving the configuration profile in the external memory

When an external memory is connected and you save a configuration profile, the device automatically saves a copy in the Selected external memory. In the default setting, the function is enabled. You can disable this function.

Perform the following steps:

- Open the dialog.
- Mark the checkbox in the Backup config when saving column in order to enable the device to automatically save a copy in the external memory during the saving process.
- To deactivate the function, unmark the checkbox in the Backup config when saving column.
- Save the changes temporarily. To do this, click the button.

```
enable
configure
config envm config-save sd
config envm config-save usb
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To enable the function.
When you save a configuration profile, the device saves a copy in the external memory.

```
sd = External SD memory
usb = External USB memory
```

To disable the function.
The device does not save a copy in the external memory.

```
no config envm config-save sd
no config envm config-save usb
```

To save the settings in the non-volatile memory (nvm) in the “selected” configuration profile.

6.2.3 Exporting a configuration profile

The device lets you save a configuration profile to a server as an XML file. If you use the Graphical User Interface, then you have the option to save the XML file directly to your PC.

Prerequisites:
- To save the file on a server, you need a configured server on the network.
- To save the file to an SCP or SFTP server, you also need the user name and password for accessing this server.

Perform the following steps:

- Open the dialog.
- Select the table row of the desired configuration profile.

Export the configuration profile to your PC. To do this, perform the following steps:

- Click the link in the Profile name column.
The configuration profile is downloaded and saved as an XML file on your PC.
Export the configuration profile to a remote server. To do this, perform the following steps:

- Click the button and then the Export... item.
  The dialog displays the Export... window.
- In the URL field, specify the file URL on the remote server:
- Click the Ok button.
  The configuration profile is now saved as an XML file in the specified location.

show config profiles nvm

enable

copy config nvm remote sftp://<user_name>:<password>@<IP_address>/<path>/<file_name>

To display the configuration profiles contained in the non-volatile memory (nvm).
To change to the Privileged EXEC mode.
To save the selected configuration profile in the non-volatile memory (nvm) on a SFTP server.
6.3 Loading settings

If you save multiple configuration profiles in the memory, then you have the option to load a different configuration profile.

6.3.1 Activating a configuration profile

The non-volatile memory of the device can contain multiple configuration profiles. If you activate a configuration profile stored in the non-volatile memory (NVM), then you immediately change the settings in the device. The device does not require a reboot.

Perform the following steps:

- Open the dialog.
- Select the table row of the desired configuration profile.
- Click the button and then the Activate item.
  The device copies the settings to the memory (RAM) and disconnects from the Graphical User Interface. The device immediately uses the settings of the configuration profile.
- Reload the Graphical User Interface.
- Log in again.
  In the Selected column, the checkbox of the configuration profile that was activated before is marked.

```plaintext
show config profiles nvm
enable
copy config nvm profile config3 running-config
```

To display the configuration profiles contained in the non-volatile memory (nvm).
To change to the Privileged EXEC mode.
To activate the settings of the configuration profile config3 in the non-volatile memory (nvm).
The device copies the settings into the volatile memory and disconnects the connection to the Command Line Interface. The device immediately uses the settings of the configuration profile config3.

6.3.2 Loading the configuration profile from the external memory

If an external memory is connected, then the device loads a configuration profile from the external memory upon restart automatically. The device lets you save these settings in a configuration profile in non-volatile memory.

When the external memory contains the configuration profile of an identical device, you have the possibility to transfer the settings from one device to another.
Perform the following steps:

☐ Verify that the device loads a configuration profile from the external memory upon restart.
   In the default setting, the function is enabled. If the function is disabled, enable it again as follows:

☐ Open the dialog.

☐ In the **Config priority** column, select the value **first**.

☐ Save the changes temporarily. To do this, click the **✓** button.

<table>
<thead>
<tr>
<th>enable</th>
<th>To change to the Privileged EXEC mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td>configure</td>
<td>To change to the Configuration mode.</td>
</tr>
<tr>
<td>config envm load-priority sd first</td>
<td>To enable the function. Upon reboot, the device loads a configuration profile from the external memory.</td>
</tr>
<tr>
<td>config envm load-priority usb first</td>
<td>To enable the function. Upon reboot, the device loads a configuration profile from the external memory.</td>
</tr>
<tr>
<td>show config envm settings</td>
<td>To display the settings of the external memory (<strong>envm</strong>)</td>
</tr>
</tbody>
</table>

**sd** = External SD memory

**usb** = External USB memory

<table>
<thead>
<tr>
<th>Type</th>
<th>Status</th>
<th>Auto Update</th>
<th>Save</th>
<th>Config</th>
<th>Config Load Prio</th>
</tr>
</thead>
<tbody>
<tr>
<td>sd</td>
<td>ok</td>
<td>[x]</td>
<td>[x]</td>
<td>second</td>
<td>second</td>
</tr>
<tr>
<td>usb</td>
<td>ok</td>
<td>[x]</td>
<td>[x]</td>
<td>first</td>
<td>first</td>
</tr>
</tbody>
</table>

**save**

To save the settings in a configuration profile in the non-volatile memory (**NVM**) of the device.

Using the Command Line Interface, the device lets you copy the settings from the external memory directly into the non-volatile memory (**NVM**).

| show config profiles nvm | To display the configuration profiles contained in the non-volatile memory (**nvm**). |
| enable | To change to the Privileged EXEC mode. |
| copy config envm profile config3 nvm | To copy the configuration profile **config3** from the external memory (**envm**) to the non-volatile memory (**nvm**) |

### 6.3.3 Importing a configuration profile

The device lets you import from a server a configuration profile saved as an XML file. If you use the Graphical User Interface, then you can import the XML file directly from your PC.

**Prerequisites:**
- To save the file on a server, you need a configured server on the network.
- To save the file to an SCP or SFTP server, you also need the user name and password for accessing this server.
Perform the following steps:

- Open the dialog.
- Click the button and then the item. The dialog displays the window.
- In the Select source drop-down list, select the location from where the device imports the configuration profile.
  - PC/URL
    - The device imports the configuration profile from the local PC or from a remote server.
  - External memory
    - The device imports the configuration profile from the selected external memory.

Import the configuration profile from the local PC or from a remote server. To do this, perform the following steps:

- Import the configuration profile:
  - When the file is located on your PC or on a network drive, drag and drop the file in the area. Alternatively click in the area to select the file.
  - You also have the option of transferring the file from your PC to the device through SFTP or SCP:
    - On your PC, open an SFTP or SCP client, for example WinSCP.
    - Use the SFTP or SCP client to open a connection to the device.
    - Transfer the file to the directory in the device.
  - In the Destination frame, specify where the device saves the imported configuration profile:
    - In the Profile name field, specify the name under which the device saves the configuration profile.
    - In the Storage type field, specify the storage location for the configuration profile.
  - Click the Ok button.
  - The device copies the configuration profile into the specified memory.

If you specified the value ram in the Destination frame, then the device disconnects the Graphical User Interface and uses the settings immediately.

Import the configuration profile from the external memory. To do this, perform the following steps:

- In the Import profile from external memory frame, Profile name drop-down list, select the name of the configuration profile to be imported.
  - The prerequisite is that the external memory contains an exported configuration profile.
- In the Destination frame, specify where the device saves the imported configuration profile:
  - In the Profile name field, specify the name under which the device saves the configuration profile.
- Click the Ok button.
  - The device copies the configuration profile into the non-volatile memory (NVM) of the device.

If you specified the value ram in the Destination frame, then the device disconnects the Graphical User Interface and uses the settings immediately.
enable

copy config remote sftp://<user name>:<password>@<IP_address>/YYYY/MM/DD
<path>/<file_name> running-config

To change to the Privileged EXEC mode.
To import and activate the settings of a configuration profile saved on a SFTP server. The device copies the settings into the volatile memory and disconnects the connection to the Command Line Interface. The device immediately uses the settings of the imported configuration profile.
6.4 Reset the device to the factory defaults

If you reset the settings in the device to the delivery state, then the device deletes the configuration profiles in the volatile memory and in the non-volatile memory.

If an external memory is connected, then the device also deletes the configuration profiles saved in the external memory.

The device then reboots and loads the factory settings.

6.4.1 Using the Graphical User Interface or Command Line Interface

Perform the following steps:

☐ Open the **dialog**.

☐ Click the **button**, then **Back to factory...**
  The dialog displays a message.

☐ Click the **Ok** button.
  The device deletes the configuration profiles in the memory (**RAM**) and in the non-volatile memory (**NVM**).

If an external memory is connected, then the device also deletes the configuration profiles saved in the external memory.

After a brief period, the device restarts and loads the delivery settings.

```
enable
```

```
clear factory
```

To change to the Privileged EXEC mode.
To delete the configuration profiles from the non-volatile memory and from the external memory.
If an external memory is connected, then the device also deletes the configuration profiles saved in the external memory.
After a brief period, the device restarts and loads the delivery settings.

6.4.2 Using the System Monitor

Prerequisite:
- Your PC is connected with the serial connection of the device using a terminal cable.

Perform the following steps:

☐ Restart the device.

☐ To change to the System Monitor, press the <1> key within 3 seconds when prompted during reboot.
  The device loads the System Monitor.

☐ To change from the main menu to the **Manage configurations** menu, press the <4> key.

☐ To execute the **Clear configs and boot params** command, press the <1> key.
To load the factory settings, press the <Enter> key. The device deletes the configuration profiles in the memory (RAM) and in the non-volatile memory (NVM).

If an external memory is connected, then the device also deletes the configuration profiles saved in the external memory.

To change to the main menu, press the <q> key.

To reboot the device with factory settings, press the <q> key.
7 Loading software updates

Hirschmann is continually working on improving and developing their software. Check regularly if there is an updated version of the software that provides you with additional benefits. You find information and software downloads on the Hirschmann product pages on the Internet at www.hirschmann.com.

The device gives you the following options for updating the device software:
- Loading a previous software version
- Software update from the PC
- Software update from a server
- Software update from the external memory

Note: The device settings are kept after updating the device software.

You see the version of the installed device software in the login dialog of the Graphical User Interface.

To display the version of the installed software when you are already logged in, perform the following steps:

- Open the dialog.
  The Running version field displays the version number and creation date of the device software that the device loaded during the last restart and is currently running.

- enable
  To change to the Privileged EXEC mode.

- show system info
  To display the system information such as the version number and creation date of the device software that the device loaded during the last restart and is currently running.

7.1 Loading a previous software version

The device lets you replace the device software with a previous version. The basic settings in the device are kept after replacing the device software.

Note: Only the settings for functions which are available in the newer device software version are lost.
7.2 Software update from the PC

The prerequisite is that the image file of the device software is saved on a data carrier which is accessible from your PC.

Perform the following steps:

- Navigate to the folder where the image file of the device software is saved.
- Open the dialog.
- Drag and drop the image file in the area. Alternatively click in the area to select the file.
- To start the update procedure, click the Start button.

As soon as the update procedure is completed successfully, the device displays an information that the software is successfully updated.

Upon restart, the device loads the installed device software.

You also have the option of transferring the file from your PC to the device through SFTP or SCP. To do this, perform the following steps:

- On your PC, open an SFTP or SCP client, for example WinSCP.
- Use the SFTP or SCP client to open a connection to the device.
- Transfer the file to the directory /upload/firmware in the device.

When the file transfer is complete, the device starts updating the device software. When the update was successful, the device creates an ok file in the directory /upload/firmware and deletes the image file.

The device loads the device software during the next restart.
7.3 Software update from a server

To update the software using SFTP or SCP you need a server on which the image file of the device software is saved.

Perform the following steps:

- Open the dialog.
- To start the update procedure, click the Start button. The device copies the currently running device software into the backup memory. As soon as the update procedure is completed successfully, the device displays an information that the software is successfully updated. Upon restart, the device loads the installed device software.
7.4 Software update from the external memory

7.4.1 Manually—initiated by the administrator

The device lets you update the device software with a few mouse clicks. The prerequisite is that the image file of the device software is located in the external memory.

Perform the following steps:

- Open the dialog.
- Mark the table row which displays the name of the desired image file in the external memory.
- Right-click to display the context menu.
- To start the update procedure, click in the context menu the Update item.

The device copies the currently running device software into the backup memory. As soon as the update procedure is completed successfully, the device displays an information that the software is successfully updated.

Upon restart, the device loads the installed device software.

7.4.2 Automatically—initiated by the device

When the following files are located in the external memory during a restart, the device updates the device software automatically:

- the image file of the device software
- a text file startup.txt with the content autoUpdate=<Image_file_name>.bin

The prerequisite is that in the dialog, you mark the checkbox in the Software auto update column. This is the default setting in the device.

Perform the following steps:

- Copy the image file of the new device software into the main directory of the external memory. Use only an image file suitable for the device.
- Create a text file startup.txt in the main directory of the external memory.
- Open the startup.txt file in the text editor and add the following line:
  autoUpdate=<Image_file_name>.bin
- Install the external memory in the device.
Restart the device.
During the booting process, the device checks automatically the following criteria:
- Is an external memory connected?
- Is a startup.txt file in the main directory of the external memory?
- Does the image file exist which is specified in the startup.txt file?
- Is the software version of the image file more recent than the software currently running in the device?

When the criteria are fulfilled, the device starts the update procedure. The device copies the currently running device software into the backup memory. As soon as the update procedure is completed successfully, the device reboots automatically and loads the new software version.

Check the result of the update procedure. The log file in the dialog contains one of the following messages:
- S_nexton AUTOMATIC_SWUPDATE_SUCCESS
  Software update completed successfully
- S_nexton AUTOMATIC_SWUPDATE_ABORTED
  Software update aborted
- S_nexton AUTOMATIC_SWUPDATE_ABORTED_WRONG_FILE
  Software update aborted due to wrong image file
- S_nexton AUTOMATIC_SWUPDATE_ABORTED_SAVING_FILE
  Software update aborted because the device did not save the image file.
Loading software updates
7.4 Software update from the external memory
8 Configuring the ports

The following port configuration functions are available.
- Enabling/disabling the port
- Selecting the operating mode

8.1 Enabling/disabling the port

In the default setting, every port is enabled. For a higher level of access security, disable unconnected ports. To do this, perform the following steps:

- Open the dialog, Configuration tab.
- To enable a port, mark the checkbox in the Port on column.
- To disable a port, unmark the checkbox in the Port on column.
- Save the changes temporarily. To do this, click the ✓ button.

```
   enable
   configure
   interface 1/1
   no shutdown
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To change to the interface configuration mode of interface 1/1.
To enable the interface.
8.2 Selecting the operating mode

In the default setting, the ports are set to Automatic configuration operating mode.

Note: The active automatic configuration has priority over the manual configuration.

Perform the following steps:

- Open the dialog, Configuration tab.
- If the device connected to this port requires a fixed setting, then perform the following steps:
  - Deactivate the function. Unmark the checkbox in the Automatic configuration column.
  - In the Manual configuration column, specify the desired operating mode (transmission rate, duplex mode).
- Save the changes temporarily. To do this, click the button.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>enable</td>
<td>To change to the Privileged EXEC mode.</td>
</tr>
<tr>
<td>configure</td>
<td>To change to the Configuration mode.</td>
</tr>
<tr>
<td>interface 1/1</td>
<td>To change to the interface configuration mode of interface 1/1.</td>
</tr>
<tr>
<td>no auto-negotiate</td>
<td>To disable the automatic configuration mode.</td>
</tr>
<tr>
<td>speed 100 full</td>
<td>To set port speed 100 MBit/s and full duplex.</td>
</tr>
</tbody>
</table>
9 Assistance in the protection from unauthorized access

The device offers functions that help you protect the device against unauthorized access.

After you set up the device, carry out the following steps in order to reduce possible unauthorized access to the device.

- Changing the SNMPv1/v2 community
- Disabling SNMPv1/v2
- Disabling HTTP
- Using your own HTTPS certificate
- Using your own SSH key
- Disabling HiDiscovery
- Enable IP access restriction
- Adjusting the session timeouts

9.1 Changing the SNMPv1/v2 community

SNMPv1/v2 works unencrypted. Every SNMP packet contains the IP address of the sender and the plaintext community name with which the sender accesses the device. If SNMPv1/v2 is enabled, then the device lets anyone who knows the community name access the device.

The community names **public** for read accesses and **private** for write accesses are preset. If you are using SNMPv1 or SNMPv2, then change the default community name. Treat the community names with discretion. To do this, perform the following steps:

1. Open the dialog.
   The dialog displays the communities that are set up.
2. For the **Write community**, specify in the **Name** column the community name.
   - Up to 32 alphanumeric characters are allowed.
   - The device differentiates between upper and lower case.
   - Specify a different community name than for read access.
3. Save the changes temporarily. To do this, click the ![checkmark] button.

   ```
   enable
   configure
   snmp community rw <community name>
   show snmp community
   save
   ```

   To change to the Privileged EXEC mode.
   To change to the Configuration mode.
   To specify the community for read/write access.
   To display the communities that have been configured.
   To save the settings in the non-volatile memory (**nvm**) in the “selected” configuration profile.
9.2 Disabling SNMPv1/v2

If you need SNMPv1 or SNMPv2, then use these protocols only in environments protected from eavesdropping. SNMPv1 and SNMPv2 do not use encryption. The SNMP packets contain the community in clear text. We recommend using SNMPv3 in the device and disabling the access using SNMPv1 and SNMPv2. To do this, perform the following steps:

- Open the dialog, **SNMP** tab. The dialog displays the settings of the SNMP server.
- To deactivate the SNMPv1 protocol, you unmark the **SNMPv1** checkbox.
- To deactivate the SNMPv2 protocol, you unmark the **SNMPv2** checkbox.
- Save the changes temporarily. To do this, click the **✓** button.

```
enable
configure
no snmp access version v1
no snmp access version v2
show snmp access
save
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To deactivate the SNMPv1 protocol.
To deactivate the SNMPv2 protocol.
To display the SNMP server settings.
To save the settings in the non-volatile memory (**nvm**) in the “selected” configuration profile.
9.3 Disabling HTTP

The web server provides the Graphical User Interface with the protocol HTTP or HTTPS. HTTPS connections are encrypted, while HTTP connections are unencrypted.

The HTTP protocol is enabled by default. If you disable HTTP, then no unencrypted access to the Graphical User Interface is possible. To do this, perform the following steps:

- Open the dialog, HTTP tab.
- To disable the HTTP protocol, select the Off radio button in the Operation frame.
- Save the changes temporarily. To do this, click the ✓ button.

<table>
<thead>
<tr>
<th>enable</th>
<th>To change to the Privileged EXEC mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td>configure</td>
<td>To change to the Configuration mode.</td>
</tr>
<tr>
<td>no http server</td>
<td>To disable the HTTP protocol.</td>
</tr>
</tbody>
</table>

If the HTTP protocol is disabled, then you can reach the Graphical User Interface of the device only by HTTPS. In the address bar of the web browser, enter the string https:// before the IP address of the device.

If the HTTPS protocol is disabled and you also disable HTTP, then the Graphical User Interface is unaccessible. To work with the Graphical User Interface, enable the HTTPS server using the Command Line Interface. To do this, perform the following steps:

<table>
<thead>
<tr>
<th>enable</th>
<th>To change to the Privileged EXEC mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td>configure</td>
<td>To change to the Configuration mode.</td>
</tr>
<tr>
<td>https server</td>
<td>To enable the HTTPS protocol.</td>
</tr>
</tbody>
</table>
9.4 Disabling the HiDiscovery access

HiDiscovery lets you assign IP parameters to the device over the network during commissioning. HiDiscovery communicates in the device management VLAN without encryption and authentication.

After the device is commissioned, we recommend to set HiDiscovery to read-only or to disable HiDiscovery access completely. To do this, perform the following steps:

- Open the dialog.
- To take away write permission from the HiDiscovery software, in the HiDiscovery protocol v1/v2 frame, specify the value `readOnly` in the Access field.
- To disable HiDiscovery access completely, select the `Off` radio button in the HiDiscovery protocol v1/v2 frame.
- Save the changes temporarily. To do this, click the `✓` button.

```
enable
network hidiscovery mode read-only
no network hidiscovery operation
```

To change to the Privileged EXEC mode.
To disable write permission of the HiDiscovery software.
To disable HiDiscovery access.
9.5 Activating the IP access restriction

In the default setting, you access the device management from any IP address and with the supported protocols.

The IP access restriction lets you restrict access to the device management to selected IP address ranges and selected IP-based protocols.

Example:

The device is to be accessible only from the company network using the Graphical User Interface. The administrator has additional remote access using SSH. The company network has the address range 192.168.1.0/24 and remote access from a mobile network with the IP address range 109.237.176.0/24. The SSH application program knows the fingerprint of the RSA key.

Table 13: Parameters for the IP access restriction

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Company network</th>
<th>Mobile phone network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network address</td>
<td>192.168.1.0</td>
<td>109.237.176.0</td>
</tr>
<tr>
<td>Netmask</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Desired protocols</td>
<td>https, snmp</td>
<td>ssh</td>
</tr>
</tbody>
</table>

Perform the following steps:

- Open the dialog.
- Unmark the checkbox in the Active column for the table row. This entry lets users have access to the device from any IP address and the supported protocols.

Address range of the company network:

- To add a table row, click the button.
- Specify the address range of the company network in the IP address range column: 192.168.1.0/24
- For the address range of the corporate network, deactivate the undesired protocols. The HTTPS, SNMP, and Active checkboxes remain marked.

Address range of the mobile phone network:

- To add a table row, click the button.
- Specify the address range of the mobile network in the IP address range column: 109.237.176.0/24
- For the address range of the mobile network, deactivate the undesired protocols. The SSH and Active checkboxes remain marked.

Before you enable the function, verify that at least one active table row lets you have access. Otherwise, if you change the settings, then the connection to the device terminates. Access to the device management is only possible using the Command Line Interface through the serial interface of the device.

- To enable IP access restriction, select the On radio button in the Operation frame.
- Save the changes temporarily. To do this, click the button.
9.5 Activating the IP access restriction

To change to the Privileged EXEC mode.

To display if IP access restriction is enabled or disabled.

To display the entries that have been configured.

To disable the IP access restriction.

To create the entry for the address range of the company network.

Number of the next available index in this example: 2.

To specify the IP address of the company network.

To specify the netmask of the company network.

To deactivate SSH for the address range of the company network.

Repeat the operation for every unwanted protocol.

To deactivate SNMP for the address range of the mobile phone network.

Repeat the operation for every unwanted protocol.

To deactivate the default entry.

This entry lets users have access to the device from any IP address and the supported protocols.

To activate an entry for the address range of the company network.

To activate an entry for the address range of the mobile phone network.

To display the entries that have been configured.

To enable the IP access restriction.
9.6 Adjusting the session timeouts

The device lets you automatically terminate the session upon inactivity of the logged-on user. The session timeout is the period of inactivity after the last user action.

You can specify a session timeout for the following applications:
- Command Line Interface sessions using an SSH connection
- Command Line Interface sessions using a serial connection
- Graphical User Interface

**Timeout for Command Line Interface sessions using a SSH connection**

Perform the following steps:

- Open the dialog, **SSH** tab.
- Specify the timeout period in minutes in the **Configuration** frame, **Session timeout [min]** field.
- Save the changes temporarily. To do this, click the ✔️ button.

```
enable
configure
ssh timeout <0..160>
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To specify the timeout period in minutes for Command Line Interface sessions using an SSH connection.

**Timeout for Command Line Interface sessions using a serial connection**

Perform the following steps:

- Open the dialog, **Global** tab.
- Specify the timeout period in minutes in the **Configuration** frame, **Serial interface timeout [min]** field.
- Save the changes temporarily. To do this, click the ✔️ button.

```
enable
cli serial-timeout <0..160>
```

To change to the Privileged EXEC mode.
To specify the timeout period in minutes for Command Line Interface sessions using a serial connection.
Session timeout for the Graphical User Interface

Perform the following steps:

- Open the dialog.
- Specify the timeout period in minutes in the Configuration frame, Web interface session timeout [min] field.
- Save the changes temporarily. To do this, click the button.

To change to the Privileged EXEC mode.

To specify the timeout period in minutes for Graphical User Interface sessions.
10 Controlling the data traffic

The device checks the data packets to be forwarded in accordance with defined rules. Data packets to which the rules apply are either forwarded by the device or blocked. If data packets do not correspond to any of the rules, then the device blocks the packets.

Routing ports to which no rules are assigned allow packets to pass. As soon as a rule is assigned, the assigned rules are processed first. After that, the specified standard action of the device takes effect.

The device provides the following functions for controlling the data stream:
- Checking the contents and states of data packets (packet filter)
- Service request control (Denial of Service, DoS)
- Denying access to devices based on their IP or MAC address (Access Control List)

The device observes and monitors the data stream. The device takes the results of the observation and the monitoring and combines them with the rules for the network security to create what is known as a status table. Based on this status table, the device decides whether to accept, drop or reject data.

The data packets go through the filter functions of the device in the following sequence:
- DoS … if permit or accept, then progress to the next rule
- ACL … if permit or accept, then progress to the next rule

The device processes data packets in the following sequence:

![Processing sequence of the data packets in the device](image)

**Figure 19: Processing sequence of the data packets in the device**

**Note:** The device uses hardware to filter the data stream through the packet filters. This causes the device to process the data stream at a slow rate. For this reason, when you expect high volumes, use ACLs. To track the “connection state”, use packet filters.


10.1 Packet Filter – Routed Firewall Mode

10.1.1 Description

The Routed Firewall Mode (Layer 3) packet filter contains rules which the device applies successively to the data stream on its routing ports. The filtering naturally includes checking and evaluation of the data stream. The device contains a stateful firewall. A stateful firewall tracks the state of the connections transversing it.

The firewall filters both the contents and the status of the conveyed data packets. For each type, you have different criteria that you compile into individual rules as required.

In case of filtering for the content of a packet, the device checks the following criteria:
- IP header (source address, target address, protocol)
- TCP/UDP header (source port, target port)

You can configure the corresponding values in the table of the dialog.

When filtering according to the status of a packet, the firewall checks the criteria, which you can optionally configure in the Parameters field.

When you create a rule in this dialog, the value in the Parameters column is none initially. This default value causes filtering according to the status or the Ethernet header of a packet.

In order to activate optional, status or content filter criteria, you can enter different parameters, which each have the form key=<value>. Which keys are valid depends in part on the protocol of the rule. The keys mac=<value> and state=<value> apply everywhere and are independent of the protocol. The keys type=<value> and code=<value> are permitted only for the ICMP protocol; the key flags=<value> is only permitted for the TCP protocol.

In the table below, you will find several examples for entries in the Parameters column and their effect on filtering. You have the option to enter several keys separated by commas. You can also enter several values separated by dashes. In addition, you can also enter different keys with several values in each case.

Table 14: Possible entries in the Parameters column

<table>
<thead>
<tr>
<th>Entry</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>mac=de:ad:de:ad:be:ef</td>
<td>This rule only applies to packets with the source MAC address de:ad:de:ad:be:ef.</td>
</tr>
<tr>
<td>state=new</td>
<td>This rule only applies to packets coming from a new connection.</td>
</tr>
<tr>
<td>state=est</td>
<td>This rule only applies to packets coming from a connection that already exists.</td>
</tr>
<tr>
<td>state=new</td>
<td>est</td>
</tr>
<tr>
<td>type=5</td>
<td>This rule only applies to packets with ICMP type 5.</td>
</tr>
<tr>
<td>flags=syn</td>
<td>This rule only applies to packets for which the SYN flag is set.</td>
</tr>
<tr>
<td>state=new</td>
<td>rel,flags=rst</td>
</tr>
</tbody>
</table>

For further information on valid entries in the Parameters column, see the "Graphical User Interface" reference manual.
The device enables simultaneous filtering according to content and status of data packets. You can compile any combinations of both types of filtering into individual rules. The device lets you create up to 2048 individual rules.

Upon receipt of a data packet to be routed, the device generally applies the packet filter rules to the data packet. The device executes one rule after the other, until the data packet reaches the first rule that applies to it. The rules that follow are ignored.

To remove a rule, select the affected table row and click the button.

When none of the rules you configured applies to a data packet or you have not configured individual rules, the Routed Firewall Mode packet filter applies a default rule. Three possible default rules are available here:

<table>
<thead>
<tr>
<th>Rule</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>accept</td>
<td>The device forwards the data packet in accordance with the address information.</td>
</tr>
<tr>
<td>drop</td>
<td>The device deletes the data packet without informing the sender.</td>
</tr>
<tr>
<td>reject</td>
<td>The device deletes the data packet and informs the sender.</td>
</tr>
</tbody>
</table>

Note: In the default setting, the device applies the accept action. You can change this setting in the dialog, Default policy field.

The Routed Firewall Mode packet filter follows a two-stage concept to activate newly created or modified rules. If you click the button, then the rules listed in the table are initially saved without activation taking place.

To transfer the rules and apply them to the device, in the dialog, click the button.

When you have configured and activated the status-dependent filter criteria, you can have the corresponding effects displayed in the status table. You can find this table with the name “Firewall state (connection tracking) table” on the bottom of the dialog. Based on the entries listed there, you can check which connections are currently established. Verify that the data packets permitted by you actually pass through the firewall, for example.

Note: To delete the information from the firewall state table, click in the dialog the Clear firewall table button.

### Application example

The figure displays a typical application case:

A production controller wants to request data from a production robot.

The production robot is located in a production cell which a firewall keeps separate from the company network. The firewall is to help prevent data stream between the production cell and the rest of the company network. Only the data stream between the robot and the production controller’s PC is allowed to flow freely.
The following is known:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Robot</th>
<th>Firewall</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP address interface</td>
<td>1/1</td>
<td>10.0.1.201</td>
<td></td>
</tr>
<tr>
<td>IP address interface</td>
<td>1/4</td>
<td>10.0.2.1</td>
<td></td>
</tr>
<tr>
<td>IP address</td>
<td>10.0.1.5</td>
<td>10.0.2.17</td>
<td></td>
</tr>
<tr>
<td>Gateway</td>
<td>10.0.1.201</td>
<td>10.0.2.1</td>
<td></td>
</tr>
</tbody>
</table>

Prerequisite for further configuration:
- The firewall is in Router mode.
- The IP parameters of the firewall router interface are configured.
- The devices in the internal network have the IP address of port 1 of the firewall as their Gateway.
- The Gateway and the IP address of the PC and the robot are configured.

Create a rule for incoming IP packets. To do this, perform the following steps:

- Open the dialog.

  By default, no interface is assigned an explicit rule. In the Default policy field, the value accept is specified. Consequently, the data stream passes through the device without restriction. Creating a rule and assigning it to the relevant interface changes this condition.

- Create a new rule.

- Specify the following settings for the rule:
  - The value 10.0.2.17 or 10.0.2.17/32 in the Source address column
  - The value any in the Source port column
  - The value 10.0.1.5 or 10.0.1.5/32 in the Destination address column
  - The value any in the Destination port column
  - The value any in the Protocol column
  - The value accept in the Action column

  The device lets you limit the rule to IP packets that fulfill certain ICMP criteria. Additionally, specify the following settings for the rule:
  - The value icmp in the Protocol column
  - The value type=3,code=1 in the Parameters column
  type=3 = Destination Unreachable  
  code=1 = Host Unreachable

  The values behind type and code are 1- to 3-digit decimal values. For the possible values, see the "Graphical User Interface" reference manual. Entering an ICMP code is optional.

- To activate the rule, mark the checkbox in the Active column.

- Save the changes temporarily. To do this, click the ✓ button.
Controlling the data traffic

10.1 Packet Filter – Routed Firewall Mode

Create rules for sending IP packets. To do this, perform the following steps:

- Open the dialog.
- Create a rule drop everything that drops every IP packet. Specify the following settings for the rule:
  - The value drop everything in the Description column
  - The value any in the Source address column
  - The value any in the Source port column
  - The value any in the Destination address column
  - The value any in the Destination port column
  - The value any in the Protocol column
  - The value drop in the Action column
  - Unmarking the checkbox in the Log column
- Create a rule filter data that explicitly allows to send selected IP packets. Specify the following settings for the rule:
  - The value filter data in the Description column
  - The value 10.0.1.5/32 in the Source address column
  - The value any in the Source port column
  - The value 10.0.2.17/32 in the Destination address column
  - The value any in the Destination port column
  - The value any in the Protocol column
  - The value accept in the Action column
- Save the changes temporarily. To do this, click the ✔ button.
- Apply the rule to an interface. To do this, perform the following steps:
  - Open the dialog.
  - Click the button. The dialog displays the Create window.
  - In the Interface field, specify the value 1/4.
  - In the Direction field, specify the value ingress to activate this rule for the incoming data stream.
  - In the Rule index column, specify the index number of the rule.
  - Click the Ok button.
- Specify the priority of the rules in the Priority column:
  - The value 1 for the filter data rule
  - The value 2 for the drop everything rule
- To activate the rules, mark the checkbox in the Active column.
☐ Save the changes temporarily. To do this, click the ✔ button.
☐ Open the dialog.
☐ To apply the rules to the data stream, click the ↩ button.
10.2 **Helping protect against DoS attacks**

DoS is a cyber-attack that aims to bring down specific services or devices. Attackers as well as network administrators can use the port scan method to discover open ports in a network to find vulnerable devices. The function helps you protect your network against invalid or falsified data packets targeted at causing the failure of certain services or devices. You have the option of specifying filters in order to restrict the data stream for protection against DoS attacks. The filters check the received data packets. The device discards a data packet if it matches the filter criteria.

To help protect the device itself and other devices in the network from DoS attacks, the device lets you specify the following filters:
- Filters for **TCP and UDP packets**
- Filters for **IP packets**
- Filters for **ICMP packets**

The filters help prevent an attacking station from:
- Detecting services and applications that use the open ports
- Detecting active devices in a network
- Accessing sensitive data in a network
- Detecting active security devices like a firewall used in a network

**Note:** You can combine the filters in any way. When you activate several filters, the device applies the filters in the order in which they are specified in the IP table. If an incoming data packet matches a filter, the device discards the respective data packet and then stops further processing.

### 10.2.1 Filters for TCP and UDP packets

To selectively process **TCP** and **UDP** packets, the device offers you the following filters:
- Activate the Null Scan filter function
- Activate the Xmas filter function
- Activate the SYN/FIN filter function
- Activate the TCP Offset protection function
- Activate the TCP SYN protection function
- Activate the L4 Port protection function
- Activate the Min. Header Size filter function

**Activate the Null Scan filter function**

With the *Null Scan* method, the attacking station sends data packets with the following properties:
- No *TCP* flags are set.
- The *TCP* sequence number is 0.

The device uses the *Null Scan filter* function to discard incoming *TCP* packets that contain malicious properties.
In the default setting, the Null Scan filter function is disabled. To activate the Null Scan filter function, perform the following steps:

- Open the dialog.
- Activate the Null Scan filter function. To do this, in the TCP/UDP frame, mark the Null Scan filter checkbox.
- Save the changes temporarily. To do this, click the ✓ button.

```
enable
configure
dos tcp-null
no dos tcp-null
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To activate the Null Scan filter function.
To deactivate the Null Scan filter function.

### Activate the Xmas filter function

With the Xmas method, the attacking station sends data packets with the following properties:
- The TCP flags FIN, URG, and PSH are simultaneously set.
- The TCP sequence number is 0.

The device uses the Xmas filter function to discard incoming TCP packets that contain malicious properties.

In the default setting, the Xmas filter function is disabled. To activate the Xmas filter function, perform the following steps:

- Open the dialog.
- Activate the Xmas filter function. To do this, in the TCP/UDP frame, mark the Xmas filter checkbox.
- Save the changes temporarily. To do this, click the ✓ button.

```
enable
configure
dos tcp-xmas
no dos tcp-xmas
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To activate the Xmas filter function.
To deactivate the Xmas filter function.
Activate the SYN/FIN filter function

With the SYN/FIN method, the attacking station sends data packets with the TCP flags SYN and FIN set simultaneously. The device uses the SYN/FIN filter function to discard incoming packets with the TCP flags SYN and FIN set simultaneously.

In the default setting, the SYN/FIN filter function is disabled. To activate the SYN/FIN filter function, perform the following steps:

- Open the dialog.
- Activate the SYN/FIN filter function. To do this, in the TCP/UDP frame, mark the SYN/FIN filter checkbox.
- Save the changes temporarily. To do this, click the ✓ button.

enable
configure
dos tcp-syn-fin
no dos tcp-syn-fin

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To activate the SYN/FIN filter function.
To deactivate the SYN/FIN filter function.

Activate the TCP Offset protection function

With the TCP Offset method, the attacking station sends data packets whose fragment offset is equal to 1. The fragment offset is a field in the IP header which helps to identify the sequence of fragments in received data packets. The device uses the TCP Offset protection function to discard incoming TCP data packets whose fragment offset field in the IP header is equal to 1.

Note: The device accepts UDP and ICMP packets whose fragment offset field of the IP header is equal to 1.

In the default setting, the TCP Offset protection function is disabled. To activate the TCP Offset protection function, perform the following steps:

- Open the dialog.
- Activate the TCP Offset protection function. To do this, in the TCP/UDP frame, mark the TCP Offset protection checkbox.
- Save the changes temporarily. To do this, click the ✓ button.

enable
configure
dos tcp-offset
no dos tcp-offset

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To activate the TCP Offset protection function.
To deactivate the TCP Offset protection function.
Controlling the data traffic
10.2 Helping protect against DoS attacks

Activate the TCP SYN protection function

With the TCP SYN method, the attacking station sends data packets with the TCP flag SYN set and an L4 (layer 4) source port <1024. The device uses the TCP SYN protection function to discard incoming packets with the TCP flag SYN set and an L4 source port <1024.

In the default setting, the TCP SYN protection function is disabled. To activate the TCP SYN protection function, perform the following steps:

- Open the dialog.
- Activate the TCP SYN protection function. To do this, in the TCP/UDP frame, mark the TCP SYN protection checkbox.
- Save the changes temporarily. To do this, click the ✓ button.

Enable   To change to the Privileged EXEC mode.
configure To change to the Configuration mode.
dos tcp-syn To activate the TCP SYN protection function.
no dos tcp-syn To deactivate the TCP SYN protection function.

Activate the L4 Port protection function

An attacking station can send TCP or UDP data packets whose source port number and destination port number are identical. The device uses the L4 Port protection function to discard incoming TCP and UDP packets whose L4 source port and destination port number are identical.

In the default setting, the L4 Port protection function is disabled. To activate the L4 Port protection function, perform the following steps:

- Open the dialog.
- Activate the L4 Port protection function. To do this, in the TCP/UDP frame, mark the L4 Port protection checkbox.
- Save the changes temporarily. To do this, click the ✓ button.

enable   To change to the Privileged EXEC mode.
configure To change to the Configuration mode.
dos l4-port To activate the L4 Port protection function.
no dos l4-port To deactivate the L4 Port protection function.

Activate the Min. Header Size filter function

The device uses the Min. Header Size filter function to check the TCP header of received data packets. The device discards the data packet when (data offset value × 4) < minimum TCP header size.

The Min. Header Size filter function detects received data packets with the following properties:
(IP payload length in the IP header - IP header outer size) < minimum TCP header size.

In the default setting, the Min. Header Size filter function is disabled. To activate the Min. Header Size filter function, perform the following steps:

1. Open the dialog.
2. Activate the Min. Header Size filter function. To do this, in the TCP/UDP frame, mark the Min. Header Size filter checkbox.
3. Save the changes temporarily. To do this, click the ✓ button.

To change to the Privileged EXEC mode:
- enable
- configure
- dos tcp-min-header
- no dos tcp-min-header

To change to the Configuration mode:
- dos tcp-min-header
- no dos tcp-min-header

10.2.2 Filters for IP packets

To selectively process IP packets, the device offers you the following filters:
- Activate the Land Attack filter function
- Deactivate the Drop IP Source Route function

Activate the Land Attack filter function

With the Land Attack method, the attacking station sends data packets whose source and destination addresses are identical to the IP address of the recipient. The device uses the Land Attack filter function to discard received packets whose source and destination addresses are identical.

In the default setting, the Land Attack filter function is disabled. To activate the Land Attack filter function, perform the following steps:

1. Open the dialog.
2. Activate the Land Attack filter function. To do this, in the IP frame, mark the Land Attack filter checkbox.
3. Save the changes temporarily. To do this, click the ✓ button.

To change to the Privileged EXEC mode:
- enable
- configure
- dos ip-land enable
- no dos ip-land disable

To change to the Configuration mode:
- dos ip-land enable
- no dos ip-land disable

To activate the Land Attack filter function:
- dos ip-land enable
- no dos ip-land disable

To deactivate the Land Attack filter function:
- dos ip-land disable
Deactivate the Drop IP Source Route function

The device uses the Drop IP Source Route function to filter the received IP data packets with the Strict Source Routing or Loose Source Routing option set. The device discards IP data packets with a specified source routing path in the IP header.

Strict Source Routing or Loose Source Routing is an option in the IP header where the sender specifies the routing path. A router that respects these options sends the respective data packets to the next destination controlled by this option. An attacking station can use the IP Source Route method to find the route that the data packets take to reach their destination. For this, the attacking station sends an IP packet with the Strict Source Routing or Loose Source Routing option set and uses the response from the router to get information about the route of the data packet.

In the default setting, the Drop IP Source Route function is enabled. To deactivate the Drop IP Source Route function, perform the following steps:

1. Open the dialog.
2. Deactivate the Drop IP Source Route function. To do this, in the IP frame, unmark the Drop IP Source Route checkbox.
3. Save the changes temporarily. To do this, click the ✓ button.

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To deactivate the Drop IP Source Route function.
To activate the Drop IP Source Route function.

10.2.3 Filters for ICMP packets

To selectively process ICMP packets, the device offers you the following filters:
- Activate the Fragmented packets filter function
- Activate the Packet size filter function

Activate the Fragmented packets filter function

The device uses the Fragmented packets filter function to protect the network from attacking stations that send fragmented ICMP packets. Fragmented ICMP packets can cause the destination device to fail if the destination device processes fragmented ICMP packets incorrectly. The device uses the Fragmented packets filter function to discard fragmented ICMP packets.

In the default setting, the Fragmented packets filter function is disabled. To activate the Fragmented packets filter function, perform the following steps:

1. Open the dialog.
2. Activate the Fragmented packets filter function. To do this, in the ICMP frame, mark the Fragmented packets filter checkbox.
3. Save the changes temporarily. To do this, click the ✓ button.
Controlling the data traffic

10.2 Helping protect against DoS attacks

Activate the Packet size filter function

The device uses the Packet size filter to discard data packets whose payload size exceeds the size specified in the Allowed payload size [byte] field.

The Packet size filter function helps protect the network from attacking stations that send ICMP packets whose payload size exceeds the size specified in the Allowed payload size [byte] field.

In the default setting, the Packet size filter function is disabled. To activate the Packet size filter function, perform the following steps:

1. Open the dialog.
2. Activate the Packet size filter function. To do this, in the ICMP frame, mark the Packet size filter checkbox.
3. Save the changes temporarily. To do this, click the ✓ button.

enable
configure
dos icmp-fragmented
no dos icmp-fragmented

to change to the Privileged EXEC mode.
to change to the Configuration mode.
to activate the Fragmented packets filter function.
to deactivate the Fragmented packets filter function.

enable
configure
dos icmp payload-check
no dos icmp payload-check

to change to the Privileged EXEC mode.
to change to the Configuration mode.
to activate the Packet size filter function.
to deactivate the Packet size filter function.
In this menu you can enter the parameters for the Access Control Lists (ACLs).

The device uses ACLs to filter data packets received on VLANs or on individual or multiple ports. In an ACL, you specify rules that the device uses to filter data packets. When such a rule applies to a packet, the device applies the actions specified in the rule to the packet. The available actions are as follows:

- allow (permit)
- discard (deny)
- redirect to a certain port (see Redirection port field)
- mirror (see Mirror port field)

The list below contains criteria that you can apply to filter the data packets:

- Source or destination address of a packet (MAC)
- Source or destination address of a data packet (IPv4)
- Type of the transmitting protocol (MAC/IPv4)
- Source or destination port of a data packet (IPv4)
- Service class of a packet (MAC)
- Membership of a specific VLAN (MAC)
- DSCP classification (IPv4)
- ToS classification (IPv4)
- Packet Fragmentation (IPv4)

You can specify the following ACL types:

- IP ACLs for VLANs
- IP ACLs for ports
- MAC ACLs for VLANs
- MAC ACLs for ports

When you assign both an IP ACL and MAC ACL to the same interface, the device first uses the IP ACL to filter the data stream. The device applies the MAC ACL rules only after the packets are filtered through the IP ACL. The priority of an ACL is independent of the index of a rule.

Within an ACL, the device processes the rules in order. The index of the respective rule determines the order in which the device filters the data stream. When you assign an ACL to a port or VLAN, you can specify its priority with the index. The lower the number, the higher the priority. The device processes the rule with the higher priority first.

If none of the rules specified in an ACL applies to a data packet, then the implicit deny rule applies. As a result, the device drops the received data packets.

Keep in mind that the device directly implements the implicit deny rule.

Note: The number of available ACLs depends on the device. For further information about the ACL values, see chapter “Technical Data” on page 275.

Note: You can assign a single ACL to any number of ports or VLANs.

Note: If you activate the Packet fragmented function for a rule, then the rule processes IPv4 fragments with the offset other than zero. The rule processes every IPv4 fragment except for the initial IPv4 fragment.
The ACL menu contains the following dialogs:
- ACL IPv4 Rule
- ACL MAC Rule
- ACL Assignment

These dialogs provide the following options:
- To specify the rules for the various ACL types.
- To provide the rules with the required priorities.
- To assign the ACLs to ports or VLANs.

10.3.1 Creating and editing IPv4 rules

When filtering IPv4 data packets, the device lets you:
- create new groups and rules
- add new rules to existing groups
- edit an existing rule
- activate and deactivate groups and rules
- delete existing groups and rules
- change the order of existing rules

Perform the following steps:

- Open the dialog.
- Click the button.
- The dialog displays the Create window.
- Specify the name of the ACL (group).
  - To create the rule in an existing ACL, click the Group name field and select the name from the drop-down list.
  - To create the rule in a new ACL, specify a meaningful name in the Group name field and click the icon.
- In the Index field you specify the number for the rule within the ACL. This number defines the priority of the rule.
- Click the Ok button.
  - The device adds the rule to the ACL (group) in the table. The rule is active immediately.
- To deactivate an ACL (group) or rule, unmark the checkbox in the Active column.
- To remove a rule, select the desired table row and click the button.
- Edit the rule parameters in the table. To change a value, double-click the relevant field.
- Save the changes temporarily. To do this, click the button.

Note: The device lets you use wildcards with the Source IP address and Destination IP address parameters. If you enter for example, 192.168.?.?, then the device allows addresses that start with 192.168.

Note: The prerequisite for changing the values in the Source TCP/UDP port and Destination TCP/UDP port column is that you specify the value tcp or udp in the Protocol column.

Note: The prerequisite for changing the value in the Redirection port and Mirror port column is that you specify the value permit in the Action column.
10.3.2 Creating and configuring an IP ACL using the Command Line Interface

In the following example, you configure ACLs to block communications from computers B and C, to computer A via IP (TCP, UDP, etc.).

![Figure 21: Example of an IP ACL](image)

Perform the following steps:

```bash
enable
cfg
ip access-list extended name filter1
deny src 10.0.1.11-0.0.0.0 dst 10.0.1.158-0.0.0.0 assign-queue 1
ip access-list extended name filter1
permit src any dst any
show access-list ip filter1
ip access-list extended name filter2
deny src 10.0.1.13-0.0.0.0 dst 10.0.1.158-0.0.0.0 assign-queue 1
show access-list ip filter2
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To add an IP ACL with name `filter1`. To add a rule denying IP data packets from `10.0.1.11` to `10.0.1.158`. Priority 1 (highest priority).
To add a rule to the IP ACL admitting IP data packets.
To display the rules of the IP ACL `filter1`.
To add an IP ACL with name `filter2`. To add a rule denying IP data packets from `10.0.1.13` to `10.0.1.158`. Priority 1 (highest priority).
To display the rules of the IP ACL `filter2`.

10.3.3 Creating and editing MAC rules

When filtering MAC data packets, the device lets you:
- create new groups and rules
- add new rules to existing groups
- edit an existing rule
- activate and deactivate groups and rules
- delete existing groups and rules
- change the order of existing rules
Perform the following steps:

- Open the dialog.
- Click the button.
  The dialog displays the Create window.
- Specify the name of the ACL (group).
  - To create the rule in an existing ACL, click the Group name field and select the name from the drop-down list.
  - To create the rule in a new ACL, specify a meaningful name in the Group name field and click the icon.
- In the Index field you specify the number for the rule within the ACL. This number defines the priority of the rule.
- Click the Ok button.
  The device adds the rule to the ACL (group) in the table.
  The rule is active immediately.
- To deactivate an ACL (group) or rule, unmark the checkbox in the Active column.
- To remove a rule, select the desired table row and click the button.
- Edit the rule parameters in the table. To change a value, double-click the relevant field.
- Save the changes temporarily. To do this, click the button.

Note: In the Source MAC address and Destination MAC address fields you can use wildcards in the FF:??:??:??:??:?? or ??:??:??:??:00:01 form. Use capital letters here.

### 10.3.4 Creating and configuring a MAC ACL using the Command Line Interface

In the following example, AppleTalk and IPX are to be filtered out from the entire network. To do this, perform the following steps:

```bash
enable
configure
mac acl add 1 macfilter

mac acl rule add 1 1 deny src any any dst any any etype appletalk
mac acl rule add 1 2 deny src any any dst any any etype ipx-old
mac acl rule add 1 3 deny src any any dst any any etype ipx-new
mac acl rule add 1 4 permit src any any dst any any
show acl mac rules 1
interface 1/1,1/2,1/3,1/4,1/5,1/6
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To add a MAC ACL with the ID 1 and the name macfilter.
To add a rule to position 1 of the MAC ACL with the ID 1 rejecting packets with EtherType 0x809B (AppleTalk).
To add a rule to position 2 of the MAC ACL with the ID 1 rejecting packets with EtherType 0x8137 (IPX alt).
To add a rule to position 3 of the MAC ACL with the ID 1 rejecting packets with EtherType 0x8138 (IPX).
To add a rule to position 4 of the MAC ACL with the ID 1 forwarding packets.
To display the rules of the MAC ACL with the ID 1.
To change to the interface configuration mode of the interfaces 1/1 to 1/6.
10.3.5 Assigning ACLs to a port or VLAN

When you assign ACLs to a port or VLAN, the device gives you the following options:
- To select the port or VLAN.
- To specify the ACL priority.
- To select the ACL using the group name.

Perform the following steps:

- Open the dialog.
- Click the button.
  The dialog displays the Create window.
  - In the Port/VLAN field, specify the desired port or the desired VLAN.
  - In the Priority field, specify the priority.
  - In the Direction field, specify the data packets to which the device applies the rule.
  - In the Group name field, specify the rule the device assigns to the port or the VLAN.
- Click the Ok button.
- Save the changes temporarily. To do this, click the button.
10.4 Deep Packet Inspection

The Deep Packet Inspection function (DPI) lets you monitor and filter data packets. The function supports you in protecting your network from undesirable content, such as spam or viruses.

The Deep Packet Inspection function inspects data packets for undesirable characteristics and protocol violations. The protocol inspects the header and the payload of the data packets.
10.5 Deep Packet Inspection - Modbus Enforcer function

The Modbus protocol is widely used in the automation sector.
- The protocol is based on Function code, the commands.
- Some of the Function code let you specify register or coil address ranges.

The device uses the Deep Packet Inspection function to discard data packets that violate the specified profiles. When the checkbox in the TCP reset column is marked, then the device terminates the Modbus or TCP connection if it detects any of the following conditions:
- Violation of the Modbus standard as specified in the Sanity check column.
- Violation of the possible function codes as specified in the Function code column.
- Violation of the unit identifiers as specified in the Unit identifier column.

10.5.1 Application example for Modbus Enforcer function

The device uses the Deep Packet Inspection function to monitor the data stream between the Modbus master and Modbus client (outstation). The Deep Packet Inspection function inspects the data packets for the specified characteristics.

![Figure 22: Inspection of data packets](image)

The network administrator wants the device to forward data packets from the Modbus master to Modbus client (outstation). The data packets contain the following function codes and unit identifiers:
- **Function code:**
  - 1 (Read Coils)
  - 2 (Read Discrete Inputs)
  - 3 (Read Holding Registers)
  - 23|128-255|512-1023 (Read/Write Multiple Registers), read address range 128..255, write address range 512..1023.
- **Unit identifier** = 254,255
- **Sanity check** = marked
Create a Modbus Enforcer profile

For the purpose described in the application example, create the Modbus Enforcer profile with the above values and name my-modbus.

Perform the following steps:

- Open the dialog.
- Click the button. The dialog displays the Create window.
- In the Index field, specify the value 1.
- Click the Ok button. The device creates a profile.
- Specify the following settings for the profile:
  - Description column = my-modbus
  - Function type column = advanced
  - Function code column = 1,2,3,23|128-255|512-1023
  - Unit identifier column = 254,255

- Save the changes temporarily. To do this, click the button.

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To create the Modbus Enforcer profile.
* dpi modbus addprofile 1 description my-modbus function-type advanced function-code-list 1,2,3,23|128-255|512-1023 unit-identifier-list 254,255

Activate the Modbus Enforcer profile

Perform the following steps:

- Mark the checkbox in the Profile active column.
- Save the changes temporarily. To do this, click the button.

To activate the Modbus Enforcer profile.
After activating the profile, the device helps prevent profile modifications.

dpi modbus enableprofile 1

To activate the Modbus Enforcer profile 1.
Apply the Modbus Enforcer profile to the data stream

Perform the following step:

☐ Click the button.

dpi modbus commit

To apply the Modbus Enforcer profiles.
10.6 **Deep Packet Inspection - DNP3 Enforcer function**

The DNP3 protocol (Distributed Network Protocol v3) provides multiplexing, error checking, link control, prioritization, and Layer 2 addressing services for user data.

- The protocol is based on the profile that contains function code list, objects, and commands. The DNP3 function uses objects to transmit values and information between devices. The DNP3 function uses group numbers to categorize the data type and variation numbers to specify how the data within the group is encoded. Each instance of an encoded information element that defines a valid group and variation in the message, is an object.
- To control how the device processes the data packets during inspection, you specify the value of each object in the following fields in the Graphical User Interface:
  - Index of Default Object List
  - Type
  - Group no.
  - Variation
  - Function
  - Function name
  - Length
  - Qualifier

The device uses the Deep Packet Inspection function to discard data packets that violate the specified profiles. When the checkbox in the TCP reset column is marked, then the device terminates the TCP connection if it detects any of the following conditions:

- Violation of the DNP3 standard as specified in the Sanity check and CRC check columns.
- Violation of the allowed function codes as specified in the Function code list column.
- Violation of the allowed objects as specified in the following fields in the Graphical User Interface:
  - Index of Default Object List
  - Type
  - Group no.
  - Variation
  - Function
  - Function name
  - Length
  - Qualifier

10.6.1 **Application example for DNP3 Enforcer function**

The device uses the Deep Packet Inspection function to monitor the data stream between the DNP3 master and DNP3 client (outstation). The Deep Packet Inspection function inspects the data packets for the specified characteristics.

Figure 23: Inspection of data packets
The network administrator wants the device to forward data packets from the DNP3 master to DNP3 client (outstation). The data packets contain the following function codes and objects:

- **Function code list:**
  - 1 (Read)
  - 2 (Write)
  - 3 (Select)
  - 23 (Delay Measurement)
- **Index of Default Object List** column = 6
- **Sanity check** column = marked
- **Objects:**
  - **Index** = 1 - dnp3
  - **Object index** = 1
  - **Type** = request
  - **Group no.** = 5
  - **Variation** = 1
  - **Function** = 2
  - **Function name** = WRITE
  - **Length** = 1
  - **Qualifier** = 0x17,0x28

### Create a DNP3 Enforcer profile

For the purpose described in the application example, create the **DNP3 Enforcer** profile with the above values and name *my-dnp3*.

Perform the following steps:

- Open the **dialog**.
- Click the **button**.
  - The dialog displays the **Create** window.
  - In the **Index** field, specify the value 1.
  - Click the **Ok** button.
    - The device creates a profile.

- Specify the following settings for the profile:
  - **Description** column = my-dnp3
  - **Function code list** column = 1,2,3,23
  - **Index of Default Object List** column = 6

- Save the changes temporarily. To do this, click the **✓** button.
Create and apply the Objects to the **DNP3 Enforcer** profile. To do this, perform the following steps:

- Open the dialog.
- Click the ![Create](image) button. The dialog displays the **Create** window.
- In the **Index** drop-down list, select the value **1 - dnp3**.
- In the **Object index** field, specify the value **1**.
- In the **Type** drop-down list, select the value **request**.
- In the **Group no.** field, specify the value **5**.
- In the **Variation** field, specify the value **1**.
- In the **Function** field, specify the value **2**.
- In the **Qualifier** field, specify the value **0x17,0x28**.
- Click the **Ok** button. The device creates a new object.

Specify the following settings for the object:
- **Function name** column = **WRITE**
- **Length** column = **1**

Save the changes temporarily. To do this, click the ![Ok](image) button.

enable
configure
dpi dnp3 profile add 1 description my-dnp3 function-code-list 1,2,3,23 default-object-list 6

dpi dnp3 object 1 add 1 object-type request group-number 5 variation-number 1 function-code 2 function-name write function-length 1 qualifier-code-list 0x17,0x28

To change to the Privileged EXEC mode.
To change to the Configuration mode.

To create the **DNP3 Enforcer** profile.

* dpi dnp3 profile add 1
to add the **DNP3 Enforcer** profile with index = **1**.
* description my-dnp3
to specify the user-specific name my-dnp3.
* function-code-list 1,2,3,23
to specify the **function codes** 1,2,3,23.
* default-object-list 6
to specify the index of **default object list** 6.

To add the user-specific objects to the **DNP3 Enforcer** profile 1.

* dpi dnp3 object 1
to select the **DNP3 Enforcer** profile 1.
* add 1
to add **object** with index = **1**.
* object-type request
to specify the **object type** request.
* group-number 5
to specify the **group number type** 5.
* variation-number 1
to specify the **variation number** 1.
* function-code 2
to specify the **function code** 2.
* function-name write
to specify the **function name** write.
* function-length 1
to specify the **function length** 1.
* qualifier-code-list 0x17,0x28
to specify the **qualifier code** 0x17,0x28.
Activate the DNP3 Enforcer profile

Perform the following steps:

- Open the dialog.
- Mark the checkbox in the *Profile active* column.
- Save the changes temporarily. To do this, click the ✔️ button.

```shell
dpi dnp3 profile enable 1
```

To activate the *DNP3 Enforcer* profile 1. After activating the profile, you cannot add further objects to the profile.

Apply the DNP3 Enforcer profile to the data stream

Perform the following step:

- Click the ✅ button.

```shell
dpi dnp3 profile commit
show dpi dnp3 profiletable
```

To apply the *DNP3 Enforcer* profiles.

<table>
<thead>
<tr>
<th>Profile Index</th>
<th>Sanity Check</th>
<th>CRC Check</th>
<th>TCP Reset</th>
<th>Outstation-Traffic</th>
<th>Description</th>
<th>Enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>[x]</td>
<td>[x]</td>
<td>[x]</td>
<td>[ ]</td>
<td>my-dnp3</td>
<td>[x]</td>
</tr>
<tr>
<td>1,2,3,23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

```shell
show dpi dnp3 objectlist 1
```

To display the *object* list that the device applies to *DNP3 Enforcer* profile 1.

<table>
<thead>
<tr>
<th>Index</th>
<th>Object Type</th>
<th>Group Number</th>
<th>Variation</th>
<th>Function Code</th>
<th>Function Name</th>
<th>Function Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>request</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>write</td>
<td>1</td>
</tr>
<tr>
<td>0x17, 0x28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
10.7 Deep Packet Inspection - IEC104 Enforcer function

The IEC104 Enforcer function activates the Deep Packet Inspection (DPI) firewall capabilities for the IEC104 data stream. The protocol is based on a profile that contains the following parameters:

- Type IDs
- Originator Address
- Common Address
- Cause of transmission size
- Common Addresses size
- IO Address size
- IEC101 Type IDs
- Sanity check

The device uses the Deep Packet Inspection function to discard data packets that violate the specified profiles. When the checkbox in the TCP reset column is marked, then the device terminates the TCP connection if it detects any of the following conditions:

- Violation of the IEC104 standard as specified in the Sanity check column.
- Violation of the allowed Type ID values as specified in the Function type and Advanced type ID list columns.
- Violation of the allowed addresses as specified in the Originator address list and Common address list columns.
- Violation of the allowed sizes as specified in the Cause of transmission size, Common address size, and IO address size columns.
- Violation of the allowed IEC101 Type ID values as specified in the Allow IEC_60870_5_101 column.

10.7.1 Application example for IEC104 Enforcer function

The device uses the Deep Packet Inspection function to monitor the data stream between the IEC104 control station (client) and substation (server). The Deep Packet Inspection function inspects the data packets for the specified characteristics.

![Figure 24: Inspection of data packets](image)

The network administrator wants the device to forward data packets from the IEC104 control station (client) to substation (server). The data packets contain the following characteristics:

- **Function type** = `readOnly`
  (corresponding **Type IDs** = 1, 3, 5, 7, 9, 11, 13, 15, 20, 21, 30-40, 70, 100-102)
- **Advanced type ID list**:
  - 2 (Single point information with time tag M_SP_TA_1)
  - 4 (Double point information with time tag M_DP_TA_1)
  - 6 (Step position information with time tag M_ST_TA_1)
- **Originator address list** = 254, 255
- **Common address list** = 254, 255
- **Allow IEC_60870_5_101** = marked
  (corresponding **Type IDs** = 2, 4, 6, 8, 10, 12, 14, 16, 17, 18, 19, 103, 104, 105, 106)
- **Sanity check** = marked
Create an IEC104 Enforcer profile

For the purpose described in the application example, create the IEC104 Enforcer profile with the above values and name my-iecl04.

Perform the following steps:

- Open the dialog.
- Click the button. The dialog displays the Create window.
- In the Index field, specify the value 1.
- Click the Ok button. The device creates a profile.
- Specify the following settings for the profile:
  - **Description column** = my-iecl04
  - **Function type column** = readOnly
    - The device assigns the Type ID values 1,3,5,7,9,11,13,15,20,21,30-40,70,100-102 corresponding to the function type = readOnly.
  - **Advanced type ID list column** = 2,4,6
  - **Originator address list column** = 254,255
  - **Common address list column** = 254,255
  - **Allow IEC_60870_5_101 column** = marked
    - The device assigns the IEC101 Type ID values 2,4,6,8,10,12,14,16,17,18,19,103,104,105,106.
- Save the changes temporarily. To do this, click the button.

```
enable
configure
dpi iec104 add 1 description my-iecl04
  function-type readonly adv-type-id-list 2,4,6 originator-addr-list 254,255
  common-addr-list 254,255 allow-101
enable
```
To change to the Privileged EXEC mode.
To change to the Configuration mode.
To create the IEC104 Enforcer profile.
- dpi iec104 add 1
  - To add the IEC104 Enforcer profile with index = 1.
  - description my-iecl04
  - function-type readonly
    - To specify the function type readonly.
  - adv-type-id-list 2,4,6
  - To specify advanced type IDs 2,4,6.
  - originator-addr-list 254,255
  - To specify originator addresses 254,255.
  - common-addr-list 254,255
  - To specify common addresses 254,255.
  - allow-101 enable
    - To enable the IEC101.
Activate the IEC104 Enforcer profile

Perform the following steps:

☐ Mark the checkbox in the Profile active column.
☐ Save the changes temporarily. To do this, click the ✔ button.

dpi iec104 enable 1

To activate the IEC104 Enforcer profile. After activating the profile, the device helps prevent profile modifications.

Apply the IEC104 Enforcer profile to the data stream

Perform the following step:

☐ Click the ▲ button.

dpi iec104 commit

To apply the IEC104 Enforcer profiles.
10.8 Deep Packet Inspection - ENIP Enforcer function

The ENIP protocol is part of the CIP protocol (Common Industrial Protocol). The CIP protocol defines the object structure and specifies the message transfer. The ENIP Enforcer function applies the Deep Packet Inspection (DPI) to the ENIP and CIP data stream. The ENIP protocol is used to monitor and control industrial automation equipment such as PLCs (Programmable Logic Controllers), sensors, and meters.

The device performs the DPI function based on the specified profiles. Every profile contains the following parameters:
- Function types
- Allow embedded PCCC
- Sanity check
- Objects

To control how the device processes the data packets during inspection, you specify the Class IDs, Service codes, or the combination of both in the following fields in the Graphical User Interface:
- Default object list
- Wildcard service codes
- Class ID
- Service codes

The device uses the Deep Packet Inspection function to discard data packets that violate the specified profiles. When the TCP reset function is enabled, then the device terminates the TCP connection if it detects any of the following conditions:
- Violation of the ENIP standard as specified in the Allow embedded PCCC and Sanity check columns.
- Violation of the allowed Function types as specified in the Function type column.
- Violation of the allowed Objects as specified in the following fields in the Graphical User Interface:
  - Default object list
  - Wildcard service codes
  - Class ID
  - Service codes

10.8.1 Application example for ENIP Enforcer function

The device uses the Deep Packet Inspection function to monitor the data stream between the ENIP control station (server) and the PLC (client). The Deep Packet Inspection function inspects the data packets for the specified characteristics.

Figure 25: Inspection of data packets

The network administrator wants the device to forward data packets from the ENIP control station (server) to the PLC (client). The data packets contain the following characteristics:
- Function type = advanced
- Allow embedded PCCC column = marked
Create a ENIP Enforcer profile

For the purpose described in the application example, create the ENIP Enforcer profile with the above values and the name my-enip.

Perform the following steps:

1. Open the dialog.
2. Click the button.
   The dialog displays the Create window.
3. In the Index field, specify the value 1.
4. Click the Ok button.
   The device creates a profile.
5. Specify the following settings for the profile:
   - Description column = my-enip
   - Function type column = advanced
   - Allow embedded PCCC column = marked
   - Default object list column = 6
   - Wildcard service codes column = 0x01
     The device applies the Wildcard service code to every Class ID available in the Default object list and the Service codes columns.
6. Save the changes temporarily. To do this, click the button.
7. Create and apply the Objects to the ENIP Enforcer profile. To do this, open the dialog.
8. Click the  button.
   The dialog displays the Create window.
9. In the Index drop-down list, select the value 1 - enip.
10. In the Class ID field, specify the value 0x100.
11. In the Service codes field, specify the value 0x0E.
12. In the Description field, specify the value my-enip-object.
13. Save the changes temporarily. To do this, click the button.
Controlling the data traffic
10.8 Deep Packet Inspection - ENIP Enforcer function

Activate the ENIP Enforcer profile

Perform the following steps:

☐ Open the dialog.
☐ Mark the checkbox in the Profile active column.
☐ Save the changes temporarily. To do this, click the ✓ button.

dpi enip profile enable 1

To activate the ENIP Enforcer profile 1.
After activating the profile, you cannot add further objects to the profile.

Apply the ENIP Enforcer profile to the data stream

Perform the following steps:

☐ Click the ✅ button.

dpi enip profile commit

To apply the ENIP Enforcer profiles.
show dpi enip profiletable
To display the ENIP Enforcer profiles.
show dpi enip objecttable
To display the ENIP Enforcer objects.

dpi enip object add 1 0x100 0x0E
description my-enip-object

to add the user-specific objects to the ENIP Enforcer profile 1.
• dpi enip object add 1
  To add the object to the ENIP Enforcer profile 1.
  • 0x100
    To specify the Class ID 0x100.
  • 0x0E
    To specify the Service code 0x0E.
  • description my-enip-object
    To specify the description my-enip-object.

• Open the dialog.
• Mark the checkbox in the Profile active column.
• Save the changes temporarily. To do this, click the ✓ button.

dpi enip profile enable 1

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To create the ENIP Enforcer profile.
• dpi enip profile add 1
  To add the ENIP Enforcer profile with index 1.
  • description my-enip
    To specify the user-specific name my-enip.
  • function-type advanced
    To specify the function type advanced.
  • def-list 6
    To specify the default object list 6.
  • wildcard-list 0x01
    To specify the Wildcard service code 0x01.
  • allow-emb-pccc enable
    To enable the inspection of PCCC messages.

• Open the dialog.
• Mark the checkbox in the Profile active column.
• Save the changes temporarily. To do this, click the ✓ button.

dpi enip profile enable 1

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To create the ENIP Enforcer profile.
• dpi enip profile add 1
  To add the ENIP Enforcer profile with index 1.
  • description my-enip
    To specify the user-specific name my-enip.
  • function-type advanced
    To specify the function type advanced.
  • def-list 6
    To specify the default object list 6.
  • wildcard-list 0x01
    To specify the Wildcard service code 0x01.
  • allow-emb-pccc enable
    To enable the inspection of PCCC messages.

• Open the dialog.
• Mark the checkbox in the Profile active column.
• Save the changes temporarily. To do this, click the ✓ button.

dpi enip profile enable 1

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To create the ENIP Enforcer profile.
• dpi enip profile add 1
  To add the ENIP Enforcer profile with index 1.
  • description my-enip
    To specify the user-specific name my-enip.
  • function-type advanced
    To specify the function type advanced.
  • def-list 6
    To specify the default object list 6.
  • wildcard-list 0x01
    To specify the Wildcard service code 0x01.
  • allow-emb-pccc enable
    To enable the inspection of PCCC messages.
11 Network load control

The device features a number of functions that can help you reduce the network load:

- Direct packet distribution
- Rate limiter
- Prioritization - QoS
- Flow control

11.1 Direct packet distribution

The device reduces the network load with direct packet distribution.

On each of its ports, the device learns the sender MAC address of received data packets. The device stores the combination “port and MAC address” in its MAC address table (FDB).

By applying the “Store and Forward” method, the device buffers data received and checks it for validity before forwarding it. The device rejects invalid and defective data packets.

11.1.1 Learning MAC addresses

When the device receives a data packet, it checks if the MAC address of the sender is already stored in the MAC address table (FDB). When the MAC address of the sender is unknown, the device generates a new entry. The device then compares the destination MAC address of the data packet with the entries stored in the MAC address table (FDB):

- The device forwards packets with a known destination MAC address directly to ports that have already received data packets from this MAC address.
- The device floods data packets with unknown destination addresses, that is, the device forwards these data packets to every port.

11.1.2 Aging of learned MAC addresses

Addresses that have not been detected by the device for an adjustable period of time (aging time) are deleted from the MAC address table (FDB) by the device. A reboot or resetting of the MAC address table deletes the entries in the MAC address table (FDB).

11.1.3 Static address entries

In addition to learning the sender MAC address, the device also provides the option to set MAC addresses manually. These MAC addresses remain configured and survive resetting of the MAC address table (FDB) as well as rebooting of the device.

Static address entries allow the device to forward data packets directly to selected ports. If you do not specify a destination port, then the device discards the corresponding data packets.
You manage the static address entries in the Graphical User Interface or in the Command Line Interface.

Perform the following steps:

☐ Create a static address entry.

☐ Open the dialog.

☐ Add a user-configurable MAC address:

  ▶ Click the button.
  
  ▶ In the Address field, specify the destination MAC address.
  
  ▶ In the VLAN ID field, specify the ID of the VLAN.
  
  ▶ In the Port list, select the ports to which the device forwards data packets with the specified destination MAC address in the specified VLAN.

  When you have defined a Unicast MAC address in the Address field, select only one port.
  
  When you have defined a Multicast MAC address in the Address field, select one or more ports.
  
  If you want the device to discard data packets with the destination MAC address, then do not select any port.

  ▶ Click the Ok button.

☐ Save the changes temporarily. To do this, click the button.
Network load control
11.1 Direct packet distribution

To change to the Privileged EXEC mode.

To change to the Configuration mode.

To create the MAC address filter, consisting of a MAC address and VLAN ID.

To change to the interface configuration mode of interface 1/1.

To assign the port to a previously created MAC address filter.

To save the settings in the non-volatile memory (nvm) in the “selected” configuration profile.

- Convert a learned MAC address into a static address entry.

- Open the dialog.

- To convert a learned MAC address into a static address entry, select the value permanent in the Status column.

- Save the changes temporarily. To do this, click the button.

- Disable a static address entry.

- Open the dialog.

- To disable a static address entry, remove it from the table. To do this, select the table row that contains the value permanent in the Status column, then click the button.

- Save the changes temporarily. To do this, click the button.

- Delete learned MAC addresses.

- To delete the learned addresses from the MAC address table (FDB), click the button. Alternatively, open the dialog and click the Reset MAC address table button.
clear mac-addr-table

To delete the learned MAC addresses from the MAC address table (FDB).
11.2 Rate limiter

The rate limiter function helps ensure stable operation even with high traffic volumes by limiting traffic on the ports. The rate limitation is performed individually for each port, as well as separately for inbound and outbound traffic.

If the data rate on a port exceeds the defined limit, then the device discards the overload on this port.

Rate limitation occurs entirely on Layer 2. In the process, the rate limiter function ignores protocol information on higher levels such as IP or TCP. This can affect the TCP traffic.

To minimize these effects, use the following options:
- Limit the rate limitation to certain packet types, for example, Broadcasts, Multicasts, and Unicasts with an unknown destination address.
- Limit the outbound data traffic instead of the inbound traffic. The outbound rate limitation works better with TCP flow control due to device-internal buffering of the data packets.
- Increase the aging time for learned Unicast addresses.

Perform the following steps:

- Open the dialog.
  - Activate the rate limiter and set limits for the data rate. The settings apply on a per port basis and are broken down by type of traffic:
    - Received Broadcast data packets
    - Received Multicast data packets
    - Received Unicast data packets with an unknown destination address
  
  To activate the rate limiter on a port, mark the checkbox for at least one category. In the Threshold unit column, you specify if the device interprets the threshold values as percent of the port bandwidth or as packets per second. The threshold value 0 deactivates the rate limiter.

- Save the changes temporarily. To do this, click the button.
11.3 QoS/Priority

QoS (Quality of Service) is a procedure defined in IEEE 802.1D which is used to distribute resources in the network. QoS lets you prioritize the data of necessary applications.

When there is a heavy network load, prioritizing helps prevent data traffic with lower priority from interfering with delay-sensitive data traffic. Delay-sensitive data traffic includes, for example, voice, video, and real-time data.

11.3.1 Handling of received priority information

Applications label data packets with the following prioritization information:

- VLAN priority based on IEEE 802.1Q/802.1D (Layer 2)

11.3.2 VLAN tagging

For the VLAN and prioritizing functions, the IEEE 802.1Q standard provides for integrating a MAC frame in the VLAN tag. The VLAN tag consists of 4 bytes and is between the source address field (“Source Address Field”) and type field (“Length / Type Field”).

Figure 26: Ethernet data packet with tag
For data packets with VLAN tags, the device evaluates the following information:

- Priority information
- When VLANs are configured, VLAN tagging

Data packets with VLAN tags containing priority information but no VLAN information (VLAN ID = 0), are known as Priority Tagged Frames.

**Note:** Network protocols and redundancy mechanisms use the highest traffic class 7. Therefore, select other traffic classes for application data.

When using VLAN prioritizing, consider the following special features:

- End-to-end prioritizing requires the VLAN tags to be transmitted to the entire network. The prerequisite is that every network component is VLAN-capable.
- Routers are not able to send and receive packets with VLAN tags through port-based router interfaces.

### 11.3.3 Setting prioritization

#### Assigning the port priority

Perform the following steps:

1. Open the dialog.
2. In the Port priority column, you specify the priority with which the device forwards the data packets received on this port without a VLAN tag.
3. Save the changes temporarily. To do this, click the button.

```
enable
configure
interface 1/1
vlan priority 3
exit
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To change to the interface configuration mode of interface 1/1.
To assign interface 1/1 the port priority 3.
To change to the Configuration mode.
Assigning VLAN priority to a traffic class

Perform the following steps:

☐ Open the dialog.
☐ To assign a traffic class to a VLAN priority, insert the associated value in the Traffic class column.
☐ Save the changes temporarily. To do this, click the ✔️ button.

```
enable
configure
classofservice dot1p-mapping 0 2
classofservice dot1p-mapping 1 2
exit
show classofservice dot1p-mapping
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To assign a VLAN priority of 0 to traffic class 2.
To assign a VLAN priority of 1 to traffic class 2.
To change to the Privileged EXEC mode.
To display the assignment.
11.4 Flow control

If a large number of data packets are received in the priority queue of a port at the same time, then this can cause the port memory to overflow. This happens, for example, when the device receives data on a Gigabit port and forwards it to a port with a lower bandwidth. The device discards surplus data packets.

The flow control mechanism described in standard IEEE 802.3 helps ensure that no data packets are lost due to a port memory overflowing. Shortly before a port memory is completely full, the device signals to the connected devices that it is not accepting any more data packets from them.

- In full-duplex mode, the device sends a pause data packet.
- In half-duplex mode, the device simulates a collision.

The following figure displays how flow control works. Workstations 1, 2, and 3 want to simultaneously transmit a large amount of data to Workstation 4. The combined bandwidth of Workstations 1, 2, and 3 is greater than the bandwidth of Workstation 4. This causes an overflow on the receive queue of port 4. The left funnel symbolizes this status.

When the flow control function on ports 1, 2 and 3 of the device is enabled, the device reacts before the funnel overflows. The funnel on the right illustrates ports 1, 2 and 3 sending a message to the transmitting devices to control the transmission speed. This results in the receiving port no longer being overwhelmed and is able to process the incoming traffic.

![Figure 28: Example of flow control](image)

11.4.1 Halfduplex or fullduplex link

Flow Control with a half duplex link

In the example, there is a halfduplex link between Workstation 2 and the device.

Before the send queue of port 2 overflows, the device sends data back to Workstation 2. Workstation 2 detects a collision and stops transmitting.
Flow Control with a full duplex link

In the example, there is a full-duplex link between Workstation 2 and the device.

Before the send queue of port 2 overflows, the device sends a request to Workstation 2 to include a small break in the sending transmission.

11.4.2 Setting up the Flow Control

Perform the following steps:

- Open the dialog.
- Mark the Flow control checkbox.
  With this setting you enable flow control in the device.
- Open the dialog, Configuration tab.
- To enable the Flow Control on a port, mark the checkbox in the Flow control column.
- Save the changes temporarily. To do this, click the button.
12 VLANs

In the simplest case, a virtual LAN (VLAN) consists of a group of network participants in one network segment who can communicate with each other as though they belonged to a separate LAN.

More complex VLANs span out over multiple network segments and are also based on logical (instead of only physical) connections between network participants. VLANs are an element of flexible network design. It is easier to reconfiguring logical connections centrally than cable connections.

The device supports independent VLAN learning in accordance with the IEEE 802.1Q standard which defines the VLAN function.

Using VLANs has many benefits. The following list displays the top benefits:

- **Network load limiting**
  VLANs reduce the network load considerably as the devices transmit Broadcast, Multicast, and Unicast packets with unknown (unlearned) destination addresses only inside the virtual LAN. The rest of the data network forwards traffic as normal.

- **Flexibility**
  You have the option of forming user groups based on the function of the participants apart from their physical location or medium.

- **Clarity**
  VLANs give networks a clear structure and make maintenance easier.

### 12.1 Examples of VLANs

The following practical examples provide a quick introduction to the structure of a VLAN.

**Note:** When configuring VLANs you use an interface for accessing the device management that will remain unchanged. For this example, you use either interface 1/6 or the serial connection to configure the VLANs.
12.1.1 Example 1

The example displays a minimal VLAN configuration (port-based VLAN). An administrator has connected multiple end devices to a transmission device and assigned them to 2 VLANs. This effectively prohibits any data transmission between the VLANs, whose members communicate only within their own VLANs.

![Figure 29: Example of a simple port-based VLAN](image)

When setting up the VLANs, you create communication rules for every port, which you specify in ingress (incoming) and egress (outgoing) tables.

The ingress table specifies which VLAN ID a port assigns to the incoming data packets. Hereby, you use the port address of the end device to assign it to a VLAN.

The egress table specifies on which ports the device sends the packets from this VLAN.

- **T** = Tagged (with a tag field, marked)
- **U** = Untagged (without a tag field, unmarked)

For this example, the status of the TAG field of the data packets has no relevance, so you use the setting **U**.

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Port</th>
<th>Port VLAN identifier (PVID)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 16: Ingress table**

<table>
<thead>
<tr>
<th>VLAN ID</th>
<th>Port</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>U</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>U</td>
<td></td>
<td>U</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 17: Egress table**
Perform the following steps:

- Setting up the VLAN

  - Open the dialog.
  - Click the button. The dialog displays the Create window.
  - In the VLAN ID field, specify the value 2.
  - Click the Ok button.
  - For the VLAN, specify the name VLAN2:
    - Double-click in the Name column and specify the name.
    - For VLAN 1, in the Name column, change the value Default to VLAN1.
  - Repeat the previous steps to create a VLAN 3 with the name VLAN3.

- Setting up the ports

  - Open the dialog.
  - To assign the port to a VLAN, specify the desired value in the corresponding column. Possible values:
    - T = The port is a member of the VLAN. The port transmits tagged data packets.
    - U = The port is a member of the VLAN. The port transmits untagged data packets.
    - F = The port is not a member of the VLAN.
    - - = The port is not a member of this VLAN.
    - Because end devices usually interpret untagged data packets, you specify the value U.
  - Save the changes temporarily. To do this, click the button.
  - Open the dialog.
  - In the Port-VLAN ID column, specify the VLAN ID of the related VLAN: 2 or 3.
Because end devices usually interpret untagged data packets, in the Acceptable packet types column, you specify the value admitAll for end device ports.

Save the changes temporarily. To do this, click the ✔ button.

The value in the Ingress filtering column has no affect on how this example functions.

```
able
configure
interface 1/1
vlan participation include 2
vlan pvid 2
exit
interface 1/2
vlan participation include 3
vlan pvid 3
exit
interface 1/3
vlan participation include 3
vlan pvid 3
exit
interface 1/4
vlan participation include 2
vlan pvid 2
exit
exit
show vlan id 3
VLAN ID : 3
VLAN Name : VLAN3
VLAN Type : Static
Interface   Current  Configured  Tagging
----------  --------  -----------  --------
1/1            -      Autodetect   Tagged
1/2         Include   Include      Untagged
1/3         Include   Include      Untagged
1/4            -      Autodetect   Tagged
1/5            -      Autodetect   Tagged
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To change to the interface configuration mode of interface 1/1.

The port 1/1 becomes a member of the VLAN 2 and transmits the data packets without a VLAN tag.

To assign the port VLAN ID 1/1 to port 2.
To change to the Configuration mode.
To change to the interface configuration mode of interface 1/2.

The port 1/2 becomes a member of the VLAN 3 and transmits the data packets without a VLAN tag.

To assign the port VLAN ID 1/2 to port 3.
To change to the Configuration mode.
To change to the interface configuration mode of interface 1/3.

The port 1/3 becomes a member of the VLAN 3 and transmits the data packets without a VLAN tag.

To assign the port VLAN ID 1/3 to port 3.
To change to the Configuration mode.
To change to the interface configuration mode of interface 1/4.

The port 1/4 becomes a member of the VLAN 2 and transmits the data packets without a VLAN tag.

To assign the port VLAN ID 1/4 to port 2.
To change to the Configuration mode.
To change to the Privileged EXEC mode.
To display details for VLAN 3.
12.1.2 Example 2

The second example displays a more complex configuration with 3 VLANs (1 to 3). Along with the Switch from example 1, you use a 2nd Switch (on the right in the example).

The terminal devices of the individual VLANs (A to H) are spread over 2 transmission devices (Switches). Such VLANs are therefore known as distributed VLANs. If the VLAN is configured correctly, then an optional network management station is also shown, which enables access to every network component.

Note: In this case, VLAN 1 has no significance for the end device communication, but it is required for the administration of the transmission devices via what is known as the Management VLAN.

As in the previous example, uniquely assign the ports with their connected terminal devices to a VLAN. With the direct connection between the 2 transmission devices (uplink), the ports transport packets for both VLANs. To differentiate these uplinks you use “VLAN tagging”, which handles the data packets accordingly. Thus, you maintain the assignment to the respective VLANs.

Perform the following steps:
- Add Uplink Port 5 to the ingress and egress tables from example 1.
- Create new ingress and egress tables for the right switch, as described in the first example.

The egress table specifies on which ports the device sends the packets from this VLAN.
- T = Tagged (with a tag field, marked)
- U = Untagged (without a tag field, unmarked)

In this example, tagged packets are used in the communication between the transmission devices (Uplink), as packets for different VLANs are differentiated at these ports.

Table 18: Ingress table for device on left

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Port</th>
<th>Port VLAN identifier (PVID)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Uplink</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>
The communication relationships here are as follows: end devices on ports 1 and 4 of the left device and end devices on ports 2 and 4 of the right device are members of VLAN 2 and can thus communicate with each other. The behavior is the same for the end devices on ports 2 and 3 of the left device and the end devices on ports 3 and 5 of the right device. These belong to VLAN 3.

The end devices “see” their respective part of the network. Participants outside this VLAN cannot be reached. The device also sends Broadcast, Multicast, and Unicast packets with unknown (unlearned) destination addresses only inside a VLAN.

Here, the devices use VLAN tagging (IEEE 801.1Q) within the VLAN with the ID 1 (Uplink). The letter T in the egress table of the ports indicates VLAN tagging.

The configuration of the example is the same for the device on the right. Proceed in the same way, using the ingress and egress tables created above to adapt the previously configured left device to the new environment.

Perform the following steps:

- Setting up the VLAN
  - Open the dialog.
  - Click the button.
    The dialog displays the Create window.
  - In the VLAN ID field, specify the VLAN ID, for example 2.
Setting up the ports

- Click the Ok button.
- For the VLAN, specify the name VLAN2:
  - Double-click in the Name column and specify the name VLAN2.
- For VLAN 1, in the Name column, change the value Default to VLAN1.
- Repeat the previous steps to create a VLAN 3 with the name VLAN3.

```
enable
vlan database
vlan add 2
name 2 VLAN2
vlan add 3
name 3 VLAN3
name 1 VLAN1
exit
show vlan brief
Max. VLAN ID................................. 4042
Max. supported VLANs...................... 64
Number of currently configured VLANs...... 3
VLAN unaware mode.......................... disabled

<table>
<thead>
<tr>
<th>VLAN ID</th>
<th>VLAN Name</th>
<th>VLAN Type</th>
<th>VLAN Creation Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VLAN1</td>
<td>default</td>
<td>0 days, 00:00:05</td>
</tr>
<tr>
<td>2</td>
<td>VLAN2</td>
<td>static</td>
<td>0 days, 02:44:29</td>
</tr>
<tr>
<td>3</td>
<td>VLAN3</td>
<td>static</td>
<td>0 days, 02:52:26</td>
</tr>
</tbody>
</table>
```

- Open the dialog.
- To assign the port to a VLAN, specify the desired value in the corresponding column.
  - Possible values:
    - T = The port is a member of the VLAN. The port transmits tagged data packets.
    - U = The port is a member of the VLAN. The port transmits untagged data packets.
    - F = The port is not a member of the VLAN.
    - - = The port is not a member of this VLAN.
  - Because end devices usually interpret untagged data packets, you specify the value U.
  - You specify the T setting on the uplink port on which the VLANs communicate with each other.

- Save the changes temporarily. To do this, click the ✓ button.
- Open the dialog.
- In the Port-VLAN ID column, specify the VLAN ID of the related VLAN: 1, 2 or 3
- Because end devices usually interpret untagged data packets, in the Acceptable packet types column, you specify the value admitAll for end device ports.
- For the uplink port, in the Acceptable packet types column, specify the value admitOnlyVlanTagged.
- Mark the checkbox in the Ingress filtering column for the uplink ports to evaluate VLAN tags on this port.
- Save the changes temporarily. To do this, click the ✓ button.
Examples of VLANs

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To change to the interface configuration mode of interface 1/1.

The port 1/1 becomes a member of the VLAN 1 and transmits the data packets without a VLAN tag.
The port 1/1 becomes a member of the VLAN 2 and transmits the data packets without a VLAN tag.
The port 1/1 becomes a member of the VLAN 2 and transmits the data packets with a VLAN tag.
The port 1/1 becomes a member of the VLAN 3 and transmits the data packets without a VLAN tag.
The port 1/1 becomes a member of the VLAN 3 and transmits the data packets with a VLAN tag.

To assign the Port VLAN ID 1 to port 1/1.
To activate ingress filtering on port 1/1.
Port 1/1 only forwards packets with a VLAN tag.
To change to the Configuration mode.
To change to the interface configuration mode of interface 1/2.

The port 1/2 becomes a member of the VLAN 2 and transmits the data packets without a VLAN tag.
To assign the Port VLAN ID 2 to port 1/2.
To change to the Configuration mode.
To change to the interface configuration mode of interface 1/3.

The port 1/3 becomes a member of the VLAN 3 and transmits the data packets without a VLAN tag.
To assign the Port VLAN ID 3 to port 1/3.
To change to the Configuration mode.
To change to the interface configuration mode of interface 1/4.

The port 1/4 becomes a member of the VLAN 2 and transmits the data packets without a VLAN tag.
To assign the Port VLAN ID 2 to port 1/4.
To change to the Configuration mode.
To change to the interface configuration mode of interface 1/5.

The port 1/5 becomes a member of the VLAN 3 and transmits the data packets without a VLAN tag.
To assign the Port VLAN ID 3 to port 1/5.
To change to the Configuration mode.
**Exit**

To change to the Privileged EXEC mode.

**Show VLAN 3**

To display details for VLAN 3.

<table>
<thead>
<tr>
<th>Interface</th>
<th>Current</th>
<th>Configured</th>
<th>Tagging</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1</td>
<td>Include</td>
<td>Include</td>
<td>Tagged</td>
</tr>
<tr>
<td>1/2</td>
<td>-</td>
<td>Autodetect</td>
<td>Untagged</td>
</tr>
<tr>
<td>1/3</td>
<td>Include</td>
<td>Include</td>
<td>Untagged</td>
</tr>
<tr>
<td>1/4</td>
<td>-</td>
<td>Autodetect</td>
<td>Untagged</td>
</tr>
<tr>
<td>1/5</td>
<td>Include</td>
<td>Include</td>
<td>Untagged</td>
</tr>
</tbody>
</table>
VLANs
12.1 Examples of VLANs
13 Routing

13.1 Configuration

Because the configuration of a router is very dependent on the conditions in your network, you are first provided with a general list of the individual configuration steps. To optimally cover the large number of options, this list is followed by examples of networks that usually occur in the industry sector.

The configuration of the Routing function usually contains the following steps:

- **Drawing a network plan**
  Create a picture of your network so that you can clearly see the division into subnetworks and the related distribution of the IP addresses. This step is necessary. Good planning of the subnetworks with the corresponding network masks makes the router configuration much easier.

- **Router basic settings**
  Along with the global switching on of the Routing function, the router basic settings also contain the assignment of IP addresses and network masks to the router interfaces.

**Note:** Match the sequence of the individual configuration steps so that the configuration computer has access to every Layer 3 device throughout the entire configuration phase.

**Note:** When you assign an IP address from the subnetwork of the device management IP address to a router interface, the device deletes the IP address of the device management. You access the device management via the IP address of the router interface.

Activate the routing globally before you assign an IP address from the subnetwork of the device management IP address to a router interface.

**Note:** When you assign the VLAN ID of the device management VLAN to a router interface, the device deactivates the IP address of the device management. You access the device management via the IP address of the router interface. The device management VLAN is the VLAN by means of which you access the device management of every device.

**Note:** Depending on your configuration steps, it can be necessary to change the IP parameters of your configuration computer to enable access to the Layer 3 devices.

- **Selecting a routing procedure**
  On the basis of the network plan and the communication requirements of the connected devices, you select the optimal routing procedure (static routes, OSPF) for your situation. In doing so, consider which routing procedures the routers can use along a route.

- **Configuring a routing procedure**
  Configure the selected routing procedure.
A router is a node for exchanging data on the Layer 3 of the ISO/OSI reference model.

This ISO/OSI reference model had the following goals:
- To define a standard for information exchange between open systems;
- To provide a common basis for developing additional standards for open systems;
- To provide international teams of experts with functional framework as the basis for independent development of every layer of the model;
- To include in the model developing or already existing protocols for communications between heterogeneous systems;
- To leave sufficient room and flexibility for the inclusion of future developments.

The OSI reference model consists of 7 layers, ranging from the application layer to the physical layer.

<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Application</td>
</tr>
<tr>
<td>6</td>
<td>Presentation</td>
</tr>
<tr>
<td>5</td>
<td>Session</td>
</tr>
<tr>
<td>4</td>
<td>Transport</td>
</tr>
<tr>
<td>3</td>
<td>Network</td>
</tr>
<tr>
<td>2</td>
<td>Data-Link</td>
</tr>
<tr>
<td>1</td>
<td>Physical</td>
</tr>
</tbody>
</table>

What does the data exchange on the Layer 3 mean in comparison with the data exchange on the Layer 2?

On the Layer 2, the MAC address signifies the destination of a data packet. The MAC address is an address tied to the hardware of a device. The Layer 2 expects the receiver in the connected network. The data exchange to another network is the task of Layer 3. Layer 2 data traffic is spread over the entire network. Every subscriber filters the data relevant for him from the data stream. Layer 2 devices are capable of steering the data traffic that is intended for a specific MAC address. It thus relieves some of the load on the network. Broadcast and multicast data packets are forwarded by the Layer 2 devices on every port.
IP is a protocol on the Layer 3. IP provides the IP address for addressing data packets. The IP address is assigned by the network administrator. By systematically assigning IP addresses, he can thus structure his network, breaking it down into subnets (see on page 167 “CIDR”). The bigger a network gets, the greater the data volume. Because the available bandwidth has physical limitations, the size of a network is also limited. Dividing large networks into subnets limits the data volume on these subnets. Routers divide the subnets from each other and only transmit the data that is intended for another subnet.

Figure 32: MAC Data Transmission: Unicast Data Packet (left) and Broadcast Data Packet (right)

This illustration clearly shows that broadcast data packets can generate a considerable load on larger networks. You also make your network easier to understand by forming subnets, which you connect with each other using routers and, strange as it sounds, also separate securely from each other.

A switch uses the MAC destination address to transmit, and thus uses Layer 2. A router uses the IP destination address to transmit, and thus uses Layer 3.

The subscribers associate the MAC and IP addresses using the Address Resolution Protocol (ARP).

### 13.2.1 ARP

The Address Resolution Protocol (ARP) determines the MAC address that belongs to an IP address. What is the benefit of this?

Let’s suppose that you want to configure the device using the Web-based interface. You enter the IP address of the device in the address line of your browser. But which MAC address will your PC now use to display the information in the device in your browser window?

If the IP address of the device is in the same subnetwork as your PC, then your PC sends what is known as an ARP request. This is a MAC broadcast data packet that requests the owner of the IP address to send back his MAC address. The device replies with a unicast data packet containing its MAC address. This unicast data packet is called an ARP reply.

Figure 33: ARP request and reply

Query to everyone: Whoever has the IP address 149.218.112.101 please send me your MAC address.

Reply to PC: My MAC address is 00:80:63:10:11:25.
Routing

13.2 Routing - Basics

When the IP address of the device is in a different subnetwork, the PC asks for the MAC address of the gateway entered in the PC. The gateway/router replies with its MAC address.

Now the PC packs the IP data packet with the IP address of the device, the final destination, into a MAC frame with the MAC destination address of the gateway/router and sends the data.

The router receives the data and releases the IP data packet from the MAC frame, so that it can then forward it in accordance with its transmission rules.

All end devices still working with IPs of the first generation, for example, are not yet familiar with the term 'subnet'. When they are looking for the MAC address for an IP address in a different subnet, they also send an ARP request. They neither have a network mask with which they could recognize that the subnet is a different one, nor do they have a gateway entry. In the example below, the left PC is looking for the MAC address of the right PC, which is in a different subnet. In this example, it would normally not get a reply.

Because the router knows the route to the right PC, the **Proxy ARP** function replies to this router interface on behalf of the right PC with its own MAC address. Thus the left PC can address its data to the MAC address of the router, which then forwards the data to the right PC.

The **Proxy ARP** function is available on the router interfaces on which you enable the proxy ARP.

**Note:** The **1:1 NAT** function also lets you integrate the devices into a larger L3 network.
13.2.2 CIDR

The original class allocation of the IP addresses only planned for three address classes to be used by the users.

Since 1992, five classes of IP address have been defined in the RFC 1340.

**Table 23: IP address classes**

<table>
<thead>
<tr>
<th>Class</th>
<th>Network part</th>
<th>Host part</th>
<th>Address range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1 byte</td>
<td>3 bytes</td>
<td>1.0.0.0 … 126.255.255.255</td>
</tr>
<tr>
<td>B</td>
<td>2 bytes</td>
<td>2 bytes</td>
<td>128.0.0.0 … 191.255.255.255</td>
</tr>
<tr>
<td>C</td>
<td>3 bytes</td>
<td>1 byte</td>
<td>192.0.0.0 … 223.255.255.255</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td>224.0.0.0 … 239.255.255.255</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td>240.0.0.0 … 255.255.255.255</td>
</tr>
</tbody>
</table>

Class C with a maximum of 254 addresses was too small, and class B with a maximum of 65534 addresses was too large for most users, as they would not require so many addresses. This resulted in ineffective usage of the class B addresses available.

Class D contains reserved multicast addresses. Class E is reserved for experimental purposes. A gateway not participating in these experiments ignores datagrams with this destination address.

The Classless Inter-Domain Routing (CIDR) provides a solution to these problems. The CIDR overcomes these class boundaries and supports classless address ranges.

With CIDR, you specify the number of bits that designate the IP address range. You represent the IP address range in binary form and count the mask bits that designate the network mask. The network mask indicates the number of bits that are identical for every IP address, the network part, in a given address range. Example:

<table>
<thead>
<tr>
<th>IP address, decimal</th>
<th>Network mask, decimal</th>
<th>IP address, binary</th>
</tr>
</thead>
<tbody>
<tr>
<td>149.218.112.1</td>
<td>255.255.255.128</td>
<td>10010101 11011010 01110000 00000001</td>
</tr>
<tr>
<td>149.218.112.127</td>
<td></td>
<td>10010101 11011010 01110000 01111111</td>
</tr>
</tbody>
</table>

CIDR notation: 149.218.112.0/25

The combination of a number of class C address ranges is known as “supernetting”. This lets you subdivide class B address ranges to a very fine degree.

Using mask bits simplifies the routing table. The router determines in that direction in which most of the mask bits match (longest prefix match).
13.2.3 Multinetting

Multinetting lets you connect a number of subnets to one router port. When you want to connect existing subnets to a router within a physical medium, multinetting provides a solution. In this case you can use multinetting to assign a number of IP addresses for the different subnets to the routing port to which you are connecting the physical medium.

For a long-term solution, other network design strategies provide more advantages with regard to problem solving and bandwidth management.

*Figure 36: Example of multinetting*
13.3 Static Routing

Static routes are user-defined routes which the router uses to transmit data from one subnet to another.

You specify to which router (next hop) the local router forwards data for a particular subnet. Static routes are kept in a table which is permanently stored in the router.

Compared to dynamic routing, the advantage of this transparent route selection is offset by the increased workload involved in configuring the static routes. Static routing is therefore suited to very small networks or to selected areas of larger networks. Static routing makes the routes transparent for the administrator and can be easily configured in small networks.

If, for example, a line interruption causes the topology to change, then the dynamic routing can react automatically to this, in contrast to the static routing. When you combine static and dynamic routing, you can configure the static routes in such a way that they have a higher priority than a route selected by a dynamic routing procedure.

The first step in configuring the router is to globally enable the Routing function and configure the router interfaces.

The device lets you define port-based and VLAN-based router interfaces.

Figure 37: Static routes: Example of connecting two production cells

13.3.1 Port-based Router Interface

A characteristic of the port-based router interface is that a subnet is connected to a port. See figure 37 on page 169.

Special features of port-based router interfaces:

- When there is no active connection, the entry is omitted from the routing table, because the router transmits only to those ports for which the data transfer is likely to be successful. The entry in the interface configuration table remains.
- A port-based router interface does not recognize VLANs, which means that the router rejects tagged packets which it receives on a port-based router interface.
- A port-based router interface rejects the non-routable packets.

In the following section you find an example of the simplest case of a routing application with port-based router interfaces.
Configuration of the router interfaces

Perform the following steps:

```
enable
configure
interface 2/1
  ip address primary 10.0.1.1 255.255.255.0
  ip routing
  exit
interface 2/2
  ip address primary 10.0.2.1 255.255.255.0
  ip routing
  exit
show ip interface 2/1
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To change to the interface configuration mode of interface 2/1.
To assign the interface its primary IP parameters.
To activate the Routing function on this interface.
To change to the Configuration mode.
To change to the interface configuration mode of interface 2/2.
To assign the interface its IP parameters.
To activate the Routing function on this interface.
To change to the Configuration mode.
To enable the Routing function globally.
To change to the Privileged EXEC mode.
To check the entries on interface 2/1.

```
Routing Mode............................. enabled
Admin mode............................... manual
IP address................................ 10.0.1.1/255.255.255.0
Secondary IP address (es).............. none
Proxy ARP................................. disabled
MAC Address.............................. EC:E5:55:F6:3E:09
IP MTU................................... 1500
ICMP Redirect............................ enabled
ICMP Unreachable........................ enabled
Admin State.............................. enabled
Link State............................... up
show ip route all
```

To verify the routing table:

```
Network Address    Protocol  Next Hop IP  Next Hop If  Pref Active
---  ----------  -----------  ----  -----  
10.0.1.0/24  Local     10.0.1.1     2/1          0     [x]
10.0.2.0/24  Local     10.0.2.1     2/2          0     [x]
```

Note: To be able to see these entries in the routing table, you need an active connection on the interfaces.
13.3.2 **VLAN-based Router-Interface**

A characteristic of the VLAN-based router interface is that a number of devices in a VLAN are connected to different ports.

Within a VLAN, the switch exchanges data packets on Layer 2.

Terminal devices address data packets with a destination address in another subnet to the router. The device then exchanges the data packets on Layer 3.

Below you will find an example of the simplest case of a routing application with VLAN-based router interfaces. For VLAN 2, the router combines interfaces 3/1 and 3/2 into the VLAN router interface vlan/2. A VLAN router interface remains in the routing table as long as at least one port of the VLAN has a connection.

![VLAN-based router interface](image)

*Figure 39: VLAN-based router interface*

Configure a VLAN router interface. To do this, perform the following steps:

- Create a VLAN and assign ports to the VLAN.
- Create a VLAN-based router interface.
- Assign an IP address to the VLAN-based router interface.
- Activate routing on the VLAN-based router interface.
- Enable the *Routing* function globally.

```
enable
vlan database
vlan add 2
name 2 VLAN2
routing add 2
exit
show ip interface
```

To change to the Privileged EXEC mode.
To change to the VLAN configuration mode.
To create a VLAN by entering the VLAN ID. The VLAN ID range is between 1 to 4094.
To assign the name *VLAN2* to the VLAN.
To create a virtual router interface. To activate the *Routing* function on this interface.
To change to the Privileged EXEC mode.
To check the entry for the virtual router interface.

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>IP Mask</th>
</tr>
</thead>
<tbody>
<tr>
<td>vlan/2</td>
<td>0.0.0.0</td>
<td>0.0.0.0</td>
</tr>
</tbody>
</table>

```
configure
interface vlan/2
ip address primary 10.0.2.1
255.255.255.0
ip routing
exit
```

To change to the Configuration mode.
To change to the interface configuration mode of interface vlan/2.
To assign the IP parameters to the virtual router interface.
To activate the *Routing* function on this interface.
To change to the Configuration mode.
To change to the interface configuration mode of interface 3/1.
To remove port 3/1 from VLAN 1. In the default setting, every port is assigned to VLAN 1.
To declare port 3/1 a member of VLAN 2.
To specify port VLAN ID 2. Therefore, the device assigns data packets that the port receives without a VLAN tag to VLAN 2.
To change to the Configuration mode.
To change to the interface configuration mode of interface 3/2.
To remove port 3/2 from VLAN 1. In the default setting, every port is assigned to VLAN 1.
To declare port 3/2 a member of VLAN 1.
To specify port VLAN ID 2. Therefore, the device assigns data packets that the port receives without a VLAN tag to VLAN 2.
To change to the Configuration mode.
To enable the Routing function globally.
To change to the Privileged EXEC mode.
To check your entries in the static VLAN table.

VLAN ID.........................2
VLAN Name.......................VLAN002
VLAN Creation Time.............0 days, 01:47:17
VLAN Type.........................static

<table>
<thead>
<tr>
<th>Interface</th>
<th>Current</th>
<th>Configured</th>
<th>Tagging</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/1</td>
<td>Include</td>
<td>Include</td>
<td>Untagged</td>
</tr>
<tr>
<td>3/2</td>
<td>Include</td>
<td>Include</td>
<td>Untagged</td>
</tr>
<tr>
<td>3/3</td>
<td>Exclude</td>
<td>Autodetect</td>
<td>Untagged</td>
</tr>
<tr>
<td>3/4</td>
<td>Exclude</td>
<td>Autodetect</td>
<td>Untagged</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To check the VLAN-specific port settings.

<table>
<thead>
<tr>
<th>Port</th>
<th>Acceptable</th>
<th>IngressInterface</th>
<th>VLAN ID</th>
<th>Frame Types</th>
<th>Filtering</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/1</td>
<td>2</td>
<td>admit all</td>
<td>disable</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/2</td>
<td>2</td>
<td>admit all</td>
<td>disable</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/3</td>
<td>1</td>
<td>admit all</td>
<td>disable</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4</td>
<td>1</td>
<td>admit all</td>
<td>disable</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Open the dialog.

Click the button.
The dialog displays the ARP window.
In the VLAN ID field, specify a number in the range between 1 and 4042.
For this example, specify the value 2.
Click the Next button.
13.3 Static Routing

In the example below, router A requires the information that it can reach the subnet 10.0.3.0/24 via the router B (next hop). It can obtain this information via a dynamic routing protocol or via a static routing entry. With this information, router A can transmit data from subnet 10.0.1.0/24 via router B into subnet 10.0.3.0/24.

Vice versa to be able to forward data of subnet 10.0.1.0/24 router B also needs an equivalent route.

You can enter static routing for port-based and VLAN-based router interfaces.
Configuration of a simple static route

Enter a static route for router A based on the configuration of the router interface in the previous example. See figure 38 on page 170.

To do this, perform the following steps:

- `enable`
- `configure`
- `ip route add 10.0.3.0 255.255.255.0 10.0.2.2`
- `ip routing`
- `exit`
- `show ip route all`

<table>
<thead>
<tr>
<th>Network Address</th>
<th>Protocol</th>
<th>Next Hop IP</th>
<th>Next Hop If</th>
<th>Pref</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0.1.0</td>
<td>Local</td>
<td>10.0.1.1</td>
<td>2/1</td>
<td>1</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.2.0</td>
<td>Local</td>
<td>10.0.2.1</td>
<td>2/2</td>
<td>1</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.3.0</td>
<td>Static</td>
<td>10.0.2.2</td>
<td>2/2</td>
<td>1</td>
<td>[x]</td>
</tr>
</tbody>
</table>

Enter a static route for router A based on the configuration of the router interface in the previous example. See figure 38 on page 170.

Configure router B in the same way.

Configuration of a redundant static route

To establish a stable connection between the two routers, you can connect the two routers with two or more links.

Perform the following steps on router A:

- `enable`
- `configure`
- `interface 2/3`
- `ip address primary 10.0.4.1 255.255.255.0`

You have the option of assigning a **Preference** (distance) to a route. When there are a number of routes to a destination, the router chooses the route with the highest **Preference**.
You have the option of changing the default value of the Preference. When you do not assign a value for the Preference during the configuration, the router uses the default value.

```
ip routing
exit
ip route add 10.0.3.0 255.255.255.0 10.0.4.2 preference 2
```

To create the static routing entry for the redundant route. The value 2 at the end of the command indicates the preference value.

When both routes are available, the router uses the route via subnetwork 10.0.2.0/24, because this route has the higher preference (see on page 174 “Configuration of a simple static route”).

```
ip route distance
show ip route all
```

To set the default preference for static routes.
(default setting: 1)

To verify the routing table:

<table>
<thead>
<tr>
<th>Network Address</th>
<th>Protocol</th>
<th>Next Hop IP</th>
<th>Next Hop If</th>
<th>Pref</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0.1.0</td>
<td>Local</td>
<td>10.0.1.1</td>
<td>2/1</td>
<td>1</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.2.0</td>
<td>Local</td>
<td>10.0.2.1</td>
<td>2/2</td>
<td>1</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.3.0</td>
<td>Static</td>
<td>10.0.2.2</td>
<td>2/2</td>
<td>1</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.3.0</td>
<td>Static</td>
<td>10.0.4.2</td>
<td></td>
<td>2</td>
<td>[ ]</td>
</tr>
<tr>
<td>10.0.4.0</td>
<td>Local</td>
<td>10.0.4.1</td>
<td>2/3</td>
<td>1</td>
<td>[x]</td>
</tr>
</tbody>
</table>

Configure router B in the same way, using the values for router B.

### Configuration of a redundant static route with load sharing

When the routes have the same Preference (distance), the router shares the load between the 2 routes (load sharing). To do this, perform the following steps:

```
enable
configure
ip route modify 10.0.3.0 255.255.255.0 10.0.2.2 preference 2
```

To assign a Preference of 2 to the existing static routing entry (see on page 174 “Configuration of a simple static route”).

When both routes are available, the router uses both routes for the data transmission.

To verify the routing table:

<table>
<thead>
<tr>
<th>Network Address</th>
<th>Protocol</th>
<th>Next Hop IP</th>
<th>Next Hop If</th>
<th>Pref</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0.1.0</td>
<td>Local</td>
<td>10.0.1.1</td>
<td>2/1</td>
<td>1</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.2.0</td>
<td>Local</td>
<td>10.0.2.1</td>
<td>2/2</td>
<td>1</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.3.0</td>
<td>Static</td>
<td>10.0.2.2</td>
<td>2/2</td>
<td>2</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.3.0</td>
<td>Static</td>
<td>10.0.4.2</td>
<td>2/3</td>
<td>2</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.4.0</td>
<td>Local</td>
<td>10.0.4.1</td>
<td>2/3</td>
<td>1</td>
<td>[x]</td>
</tr>
</tbody>
</table>
13.3.4 Static route tracking

Description of the static route tracking function

With static routing, when there are a number of routes to a destination, the router chooses the route with the highest preference. The router detects an existing route by the state of the router interface. While connection L 1 on the router interface can be fine, the connection to remote router B via L 2 can be interrupted. In this case, the router continues transmitting via the interrupted route.

![Figure 42: Example of static route tracking](image)

With the static route tracking function, the router uses a tracking object such as a ping tracking object to detect the connection interruption. The active static route tracking function then deletes the interrupted route from the current routing table. When the tracking object returns to the up state, the router enters the static route in the current routing table again.

Application example for the static route tracking function

The following figure displays an example of the static route tracking function.

Router A monitors the best route via L 1 with ping tracking. If there is a connection interruption, then router A transmits using the redundant connection L 3.

For the example the following information is known:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Router A</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP address interface (IF) 1/1</td>
<td>10.0.4.1</td>
</tr>
<tr>
<td>IP address interface (IF) 1/2</td>
<td>10.0.2.1</td>
</tr>
<tr>
<td>IP address interface (IF) 1/4</td>
<td>10.0.1.112</td>
</tr>
<tr>
<td>Netmask</td>
<td>255.255.255.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Router B</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP address interface (IF) 1/2</td>
<td>10.0.4.2</td>
</tr>
<tr>
<td>IP address interface (IF) 1/3</td>
<td>10.0.2.53</td>
</tr>
<tr>
<td>IP address interface (IF) 2/2</td>
<td>10.0.5.1</td>
</tr>
<tr>
<td>Netmask</td>
<td>255.255.255.0</td>
</tr>
</tbody>
</table>
The following list contains prerequisites for further configuration:

- The IP parameters of the router interfaces are configured. (see on page 170 “Configuration of the router interfaces”)
- The Routing function is enabled in the device and also active on the router interface.
- Ping tracking on interface 1/2 of router A is configured (see on page 192 “Ping tracking”).

Perform the following steps:

- Create the tracking objects on router A for the routes to the destination network 10.0.5.0/24. The default values, entered in the other cells, remain unchanged for this example.

- Open the **dialog**.
- Click the **button**.
- Enter the data for the first tracking rule:
  
  - **Type**: ping
  - **Track ID**: 1

- Click the **Ok** button.
- In the ping-1 table row, **IP address** column, specify the IP address 10.0.2.53.
- In the ping-1 table row, **Ping port** column, specify the interface 1/2.
- To activate the table row, mark the checkbox in the **Active** column.

- Click the **button**.
- Specify the settings for the first static route:
  
  - **Type**: ping
  - **Track ID**: 2

- Click the **Ok** button.
- In the ping-2 table row, **IP address** column, specify the IP address 10.0.4.2.
- In the ping-2 table row, **Ping port** column, specify the interface 1/1.
- To activate the table row, mark the checkbox in the **Active** column.

- Save the changes temporarily. To do this, click the ** ✓** button.

| enable | To change to the Privileged EXEC mode. |
| configure | To change to the Configuration mode. |
| track add ping 1 | To create a tracking object with track ID 1. |
| track modify ping 1 address 10.0.2.53 | To modify the ping1 entry with the IP address 10.0.2.53. |
| track modify ping 1 interface 1/2 | To set the source interface number of the ping tracking instance to 1/2. |
Routing
13.3 Static Routing

track enable ping 1
track add ping 2
track modify ping 2 address 10.0.4.2
track modify ping 2 interface 1/1
track enable ping 2
exit
show track ping

To activate the tracking object.
To create a tracking object with track ID 2.
To modify the ping 2 entry with the IP address 10.0.4.2.
To set the source interface number of the ping tracking instance to 1/1.
To activate the tracking object.
To change to the Privileged EXEC mode.
To verify the entries in the tracking table.

<table>
<thead>
<tr>
<th>Name</th>
<th>Interface</th>
<th>Intv [ms]</th>
<th>Succ</th>
<th>TTL</th>
<th>BR-If</th>
<th>State Active</th>
<th>Inet-Address</th>
<th>Timeout</th>
</tr>
</thead>
<tbody>
<tr>
<td>ping-1</td>
<td>1/2</td>
<td>1000</td>
<td>2</td>
<td>128</td>
<td>0</td>
<td>up</td>
<td>10.0.2.53</td>
<td>100</td>
</tr>
<tr>
<td>ping-2</td>
<td>1/1</td>
<td>1000</td>
<td>2</td>
<td>128</td>
<td>0</td>
<td>down</td>
<td>10.0.4.2</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: To activate the table row, first verify that the link on the interface is up.

Next enter the routes to the destination network 10.0.5.0/24 in the static routing table of router A.

Open the dialog.

Click the button.
The dialog displays the Create window.

Specify the settings for the first static route:
Network address: 10.0.5.0
Netmask: 255.255.255.0
Next hop IP address: 10.0.2.53
Preference: 1
Track name: ping-1

Click the Ok button.

Click the button.
The dialog displays the Create window.

Specify the settings for the first static route:
Network address: 10.0.5.0
Netmask: 255.255.255.0
Next hop IP address: 10.0.4.2
Preference: 2
Track name: ping-2

Click the Ok button.

Save the changes temporarily. To do this, click the button.

Note: To make the configuration available even after a restart, save the settings permanently in the dialog.
On router B, create a ping tracking object with the track ID, for example 22, for IP address 10.0.2.1.

Enter the two routes to destination network 10.0.1.0/24 in the static routing table of router B.

Table 24: Static routing entries for router B

<table>
<thead>
<tr>
<th>Destination Network</th>
<th>Destination Netmask</th>
<th>Next Hop</th>
<th>Preference</th>
<th>Track ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0.1.0</td>
<td>255.255.255.0</td>
<td>10.0.2.1</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td>10.0.1.0</td>
<td>255.255.255.0</td>
<td>10.0.4.1</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
13.4 NAT – Network Address Translation

The Network Address Translation (NAT) protocol describes a procedure for automatically and transparently changing IP address information in data packets while still transmitting the data packets to their precise destination.

When you do not want IP addresses of an internal network to be visible from outside, use NAT. The reasons for this can include, for example:

- Keeping the structure of the internal network hidden from the outside world.
- Keeping private IP addresses hidden.
- Using IP addresses multiple times – by forming identical production cells, for example.

Depending on your reason for using NAT, it offers you various procedures for using the IP address information. In the following sections, you will find additional information on this process.

13.4.1 Applying the NAT Rules

The device provides a multi-step approach to set up and apply the NAT rules:

- Create rule.
- Assign rule to a router interface.
  - Up to this step, changes have no effect on the behavior of the device and the data stream.
- Apply the rule to the data stream.

The data packets go through the filter functions of the device in the following sequence:

![Diagram showing the processing sequence of data packets](image)

*Figure 44: Processing sequence of the data packets in the device*
13.4.2 1:1 NAT

The 1:1 NAT function lets you establish communication links within a local network to devices that are actually located in other networks. The NAT router virtually “shifts” the devices into the public network. For this, the NAT router replaces the virtual with the actual IP address in the data packet while sending it. A typical application is the connecting of several identically structured production cells with the same IP address to a server farm.

The prerequisite for the 1:1 NAT process is that the NAT router itself responds to ARP requests. To make this happen, activate the Proxy ARP function on the ingress interface.

![Diagram of 1:1 NAT function](image)

**Figure 45: How the 1:1 NAT function works**

**Note:** With the 1:1 NAT function the device responds to ARP requests from the external network to addresses which it maps from the internal network. This is also the case where no device with the IP address exists in the internal network. Therefore, in the external network, only allocate to devices IP addresses located outside the area which the 1:1 NAT function maps from the internal network to the external network.

**Application example for 1:1 NAT**

You have multiple identical production cells and want to connect them with the host computer. As even the IP addresses used in the production cells are identical, you convert the IP addresses using the 1:1 NAT function.

![Diagram of connecting identical production cells](image)

**Figure 46: Connect identical production cells with the host computer (application example)**

Prerequisites for further configuration:
- You need two NAT routers.
- The Routing function is enabled in every device.
Two router interfaces are configured in every device. One router interface is connected to the company network and one to the network of the production cell.

The IP address and gateway are set in the devices of the production cell. The devices use the IP address of the egress interface of the NAT router as the gateway.

Perform the following steps:

- Activate the **Proxy ARP** function on the ingress interfaces.

- Open the dialog.
- On the router interface that is connected to the company network, mark the checkbox in the **Proxy ARP** field.
- Save the changes temporarily. To do this, click the **✓** button.

- Generate rule.

- Open the dialog.
- Add a table row. To do this, click the **>Create** button.
  
  The dialog displays the **Create** window.
- In the **Destination address** field, specify the virtual IP address of the device in the production cell. In the example this is **192.168.1.100** in NAT router 1 and **192.168.1.200** in NAT router 2.
- In the **New destination address** field, specify the IP address of the device in the production cell. In the example this is **192.168.2.100** in NAT router 1 and NAT router 2.
- Click the **Ok** button.
- In the **Rule name** column, specify the name of the NAT rule.
- In the **Priority** column, specify any value between **1** and **6500**.
- In the **Ingress interface** column, select the router interface that is connected to the company network.
- In the **Egress interface** column, select the router interface connected with the production cell.
- Save the changes temporarily. To do this, click the **✓** button.

- Activate the rule.

- Mark the checkbox in the **Active** column.
- Save the changes temporarily. To do this, click the **✓** button.

- Apply the rule to the data stream.

- Open the dialog.
- Click the **Enable** button.

When changes to the rules affect existing entries in the state table of the firewall, it helps to clear the state table. See the **Clear firewall table** button in the dialog. It is possible, that the device interrupts open communication connections.
13.4.3 Destination NAT

The Destination NAT function lets you divert the data stream of outgoing communication links to or through a server in a local network.

A special form of the Destination NAT function is port forwarding. You use port forwarding to hide the structure of a network from the outside while still allowing communication links from the outside into the network. A typical application is remote control of a PC in a production cell. The maintenance station establishes the communication link to the NAT router, and the Destination NAT function takes care of the routing to the production cell.

![Diagram of Destination NAT function](image)

**Figure 47:** How the Destination NAT function works

### Application example for port forwarding

You have a production cell. The network of the production cell is not visible on the company network. The NAT router establishes the connection between the production cell and the company network. To allow an administrator from the company network to manage a server in the production cell, use the port forwarding function.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Administrator PC</th>
<th>NAT router</th>
<th>Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP Address</td>
<td></td>
<td>192.168.1.1</td>
<td></td>
</tr>
<tr>
<td>Port 1</td>
<td></td>
<td>192.168.1.2</td>
<td></td>
</tr>
<tr>
<td>IP Address</td>
<td>192.168.2.55</td>
<td>192.168.1.8</td>
<td></td>
</tr>
<tr>
<td>Gateway</td>
<td>192.168.2.8</td>
<td>192.168.1.1</td>
<td></td>
</tr>
</tbody>
</table>
Prerequisites for further configuration:

- The *Routing* function is enabled in the device.
- In the device, a router interface is set up and connected to the company network.
- In the devices in the production cell, the IP address and gateway are defined. The devices use the IP address of port 1 of the NAT router as the gateway.
Perform the following steps:

- Generate rule.

- Open the dialog.

- Add a table row. To do this, click the button.

- In the New destination address field, specify the IP address of the server in the production cell. In the example this is 192.168.1.8. The NAT router forwards the connection to this address.

- Click the Ok button.

- In the Rule name field, specify the name of the NAT rule.

- In the Destination address field, specify the IP address of the router interface in the company network. In the example this is 192.168.2.8. The PC of the administrator establishes the connection to this address.

- In the Destination port field, specify the port number. In the example this is 8080. The PC of the administrator establishes the connection to this port.

- In the New destination port field, specify the port number. In the example this is 80. The NAT router forwards the connection to this port.

- To forward connections only from the PC of the administrator to the server in the production cell, change the value in the Source address field to the IP address of the PC. In the example this is 192.168.2.55. Otherwise, leave the value any.

- To forward only TCP data packets to the server in the production cell, change the value in the Protocol field to tcp. Otherwise, leave the value any.

- Save the changes temporarily. To do this, click the button.

- Activate the rule.

- Mark the checkbox in the Active column to enable the created rule.

- Save the changes temporarily. To do this, click the button.

- Assign rule to a router interface.

- Open the dialog.

- Click the Assign button.

- In the Port field, select the router interface that is connected to the company network.

- Select the created rule in the Rule index field.

- Click the Ok button.

- Activate assignment of the rule to the router interface.

- Mark the checkbox in the Active column to activate assignment of the rule to the router interface.

- Save the changes temporarily. To do this, click the button.

- Apply the rule to the data stream.
13.4.4 Masquerading NAT

The Masquerading NAT function hides any number of devices behind the IP address of the NAT router and thus hides the structure of a network from other networks. For this, the NAT router replaces the sender address in the data packet with its own IP address. In addition, the NAT router replaces the source port in the data packet with its own value in order to send the response data packets back to the original sender at a later point.

Adding the port information also gave the IP Masquerading the name “Network Address Port Translation” (NAPT).

The devices establish communication links to the outside from the hidden network by converting the IP address. However, it is not possible to establish a connection in the other direction, because the devices outside only know the external IP address of the NAT router.

Figure 48: How the Masquerading NAT function works

Note: If you enable the VRRP function on a router interface, then the Masquerading NAT function is ineffective on this router interface.
13.4.5 Double NAT

The Double NAT function lets you establish communication links between end devices located in different IP networks, which have no way to specify a default gateway or default route. The NAT router virtually “shifts” the devices into the other network. For this, the NAT router replaces the source address and the destination address in the data packet during sending. A typical application is the linking of controllers located in different networks.

The Double NAT function requires that the NAT router itself responds to ARP requests from the respective network. To make this happen, activate the Proxy ARP function on the ingress interface and on the egress interface.

The figure shows which IP addresses the devices use to communicate with each other and how the NAT router changes the IP addresses:

- The device on the left sends a data packet to the device on the right.
  - The data packet contains the source address 192.168.1.8 and the destination address 192.168.1.100.
  - The NAT router replaces both addresses.
  - The data packet that the device on the right receives contains the source address 192.168.2.8 and the destination address 192.168.2.100.

- In the reverse direction, the device on the right sends a data packet to the device on the left.
  - The data packet contains the source address 192.168.2.100 and the destination address 192.168.2.8.
  - The NAT router replaces both addresses.
  - The data packet that the device on the left receives contains the source address 192.168.1.100 and the destination address 192.168.1.8.

The NAT router changes the source and destination addresses in the data packets. Both devices communicate with each other in the same network, even though they are actually in different networks.
**Application example for Double NAT**

You want to connect the device on the left (a workstation in the company network, for example) with the device to the right (a robot controller in the production cell, for example). The robot controller only communicates with devices on the same logical network. When communicating between the networks, the NAT router translates the IP addresses.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Device on the left</th>
<th>Device on the right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local internal IP address</td>
<td>192.168.1.8</td>
<td></td>
</tr>
<tr>
<td>Local external IP address</td>
<td></td>
<td>192.168.2.8 (virtual)</td>
</tr>
<tr>
<td>Remote internal IP address</td>
<td></td>
<td>192.168.2.100</td>
</tr>
<tr>
<td>Remote external IP address</td>
<td></td>
<td>192.168.1.100 (virtual)</td>
</tr>
</tbody>
</table>

Prerequisites for further configuration:

- The *Routing* function is enabled in the device.
- Two router devices are configured in the device. One router interface is connected to the company network and one to the network of the production cell.
- The IP address is set in the device on the left and in the device on the right.
Perform the following steps:

- **Activate the Proxy ARP function on the router interfaces.**
  - Open the dialog.
  - On the router interfaces that are connected to the company network and to the production cell, mark the checkbox in the Proxy ARP field.
  - Save the changes temporarily. To do this, click the ✓ button.

- **Generate rule.**
  - Open the dialog.
  - Add a table row. To do this, click the button.
  - In the Local internal IP address field, specify the IP address of the device on the left in the company network. In the example this is 192.168.1.8.
  - In the Local external IP address field, specify the virtual IP address of the device on the left in the production cell. In the example this is 192.168.2.8.
  - In the Remote internal IP address field, specify the IP address of the device on the right in the production cell. In the example this is 192.168.2.100.
  - In the Remote external IP address field, specify the virtual IP address of the device on the right in the company network. In the example this is 192.168.1.100.
  - Click the Ok button.
  - In the Rule name field, specify the name of the NAT rule.
  - Save the changes temporarily. To do this, click the ✓ button.

- **Activate the rule.**
  - Mark the checkbox in the Active column to enable the created rule.
  - Save the changes temporarily. To do this, click the ✓ button.

- **Assign the rule to the ingress interface connected to the company network.**
  - Open the dialog.
  - Click the Assign button.
  - In the Port field, select the router interface that is connected to the company network.
  - Select the value ingress in the Direction field.
  - Select the created rule in the Rule index field.
  - Click the Ok button.

- **Assign the rule to the egress interface connected to the production cell.**
Open the dialog.
- Click the **Assign** button.
- In the **Port** field, select the router interface connected with the production cell.
- Select the value **egress** in the **Direction** field.
- Select the created rule in the **Rule index** field.
- Click the **Ok** button.

- **Activate assignment of the rule to the router interface.**

- Mark the checkbox in the **Active** column to activate assignment of the rule to the router interface.

- Save the changes temporarily. To do this, click the **✓** button.

- **Apply the rule to the data stream.**

Open the dialog.
- Click the **button.

When changes to the rules affect existing entries in the state table of the firewall, it helps to clear the state table. See the **Clear firewall table** button in the dialog. It is possible, that the device interrupts open communication connections.
13.5 Tracking

The tracking function lets you monitor certain objects, such as the availability of an interface or reachability of a network.

A special feature of this function is that it forwards an object status change to an application, for example VRRP, which previously registered as an interested party for this information.

Tracking can monitor the following objects:
- Link status of an interface (interface tracking)
- Accessibility of a device (ping tracking)
- Result of logical connections of tracking entries (logic tracking)

An object can have the following statuses:
- up (OK)
- down (not OK)
- notReady (not enabled)

The definition of "up" and "down" depends on the type of the tracking object (for example interface tracking).

Tracking can forward the state changes of an object to the following applications:
- VRRP
- Static routing

13.5.1 Interface tracking

With interface tracking the device monitors the link status of:
- physical ports
- Link Aggregation interfaces
- VLAN router interfaces

![Diagram of interface tracking](image)

*Figure 50: Monitoring a line with interface tracking*

Ports/interfaces can have the following link statuses:
- interrupted physical link (link down)
- existing physical link (link up)

If the link to the participating ports is interrupted, then a Link Aggregation interface has link status "down".

If the link is interrupted from the physical ports/Link Aggregation interfaces that are members of the corresponding VLAN, then the VLAN router interface has the link status "down".

Setting a delay time lets you insert a delay before informing the application about an object status change.
If the physical link interruption remains for longer than the “link down delay” delay time, then the interface tracking object has the status “down”.

When the physical link holds for longer than the “link up delay” delay time, the interface tracking object has the status “up”.

State on delivery: delay times = 0 seconds.

This means that in case where a status changes, the registered application is informed immediately.

You can set the “link down delay” and “link up delay” delay times independently of each other in the range from 0 to 255 seconds.

You can define an interface tracking object for each interface.

13.5.2 Ping tracking

With ping tracking, the device uses ping requests to monitor the link status to other devices.

The device sends ping requests to the device with the IP address that you entered in the IP address column.

The Ping interval [ms] column lets you define the frequency for sending ping requests, and thus the additional network load.

When the response comes back within the time entered in the Ping timeout [ms] column, this response is a valid Ping replies to receive.

When the response comes back after the time entered in the Ping timeout [ms] column, or not at all, this response is evaluated as Ping replies to lose.

Ping tracking objects can have the following statuses:

- the number of Ping replies to lose is greater than the number entered (down)
- the number of Ping replies to receive is greater than the number entered (up)
- the instance is inactive (notReady)

Entering a number for unreceived or received ping responses lets you set the sensitivity of the ping behavior of the device. The device informs the application about an object status change.

Ping tracking lets you monitor the accessibility of specified devices. As soon as a monitored device can no longer be accessed, the device can choose to use an alternative path.
13.5.3 **Logical tracking**

Logical tracking lets you logically link multiple tracking objects with each other and thus perform relatively complex monitoring tasks.

You can use logical tracking, for example, to monitor the link status for a network node to which redundant paths lead (see on page 196 “Application example for logical tracking”).

The device provides the following options for a logical link:
- **and**
- **or**

For a logical link, you can combine up to 2 operands with one operator.

Logical tracking objects can have the following statuses:
- The result of the logical link is incorrect (**down**).
- The result of the logical link is correct (**up**).
- The monitoring of the tracking object is inactive (**notReady**).

When a logical link delivers the result **down**, the device can choose to use an alternative path.

13.5.4 **Configuring the tracking**

You configure the tracking by setting up tracking objects. The following steps are required to set up a tracking object:
- Enter the tracking object ID number (track ID).
- Select a tracking type, for example interface.
- Depending on the track type, enter additional options such as “port” or “link up delay” in the interface tracking.

**Note**: The registration of applications (for example VRRP) to which the tracking function reports status changes is performed in the application itself.

**Configuring interface tracking**

Set up interface tracking on port 1/1 with a link down delay of 0 seconds and a link up delay of 3 seconds. To do this, perform the following steps:

- Open the dialog.
- Click the **+** button.
  - The dialog displays the **Create** window.
- Select type:
- Enter the values you desire, for example:
  
  - **Type**: interface
  - **Track ID**: 11
Application example for ping tracking

The interface tracking monitors the directly connected link. See figure 50 on page 191.

The ping tracking monitors the entire link to device S2. See figure 51 on page 192.

Perform the following steps:
- Set up ping tracking at port 1/2 for IP address 10.0.2.53 with the preset parameters.
- Open the dialog.
- To add a table row, click the button.

Select type:
- Enter the values you desire, for example:
  - Type: 21
  - Track ID: ping
Click **Ok**.

Properties:

- Enter the values you desire, for example:
  - **Port**: 1/2
  - **IP address**: 10.0.2.53
  - **Ping interval [ms]**: 500
  - **Ping replies to lose**: 3
  - **Ping replies to receive**: 2
  - **Ping timeout [ms]**: 100

Save the changes temporarily. To do this, click the ✓ button.

To change to the Privileged EXEC mode.

To change to the Configuration mode.

To add a tracking object to the table.

To specify the parameters for this tracking object.

To activate the tracking object.

To change to the Privileged EXEC mode.

To display the configured tracks.

---

Enable

Configure

Track add ping 21

Track modify ping 21 ifnumber 1/2

Address 10.0.2.53

Interval 500

Miss 3

Success 2

Timeout 100

Track enable ping 21

Tracking ID ping-21 created

Target IP address set to 10.0.2.53

Ping interval for target set to 500 ms

Max. no. of missed ping replies from target set to 3

Min. no. of received ping replies from target set to 2

Timeout for ping replies from target set to 100 ms

Tracking ID 21 activated

Exit

Show track

Ping Tracking Instance

-----------------------------------

Name...........................................ping-21
Interface Number of outgoing ping packets......1/2
Target router network address....................10.0.2.53
Interval of missed repl. the state is down.....3
Interval of received repl. the state is up.....2
Maximal roundtrip-time .........................100
Time-To-Live for a transmitted ping request....128
Ifnumber which belongs to the best route.......State...........................................down
Send State Change trap..........................disabled
Number of state changes.......................0
Time of last change............................2014-06-18 14:00:03
Description....................................
**Application example for logical tracking**

The following figure displays an example of monitoring the connection to a redundant ring.

By monitoring lines L 2 and L 4, you can detect a line interruption from router A to the redundant ring.

With a ping tracking object on port 1/1 of router A, you monitor the connection to device S2.

With an additional ping tracking object on port 1/1 of router A, you monitor the connection to device S4.

Only the OR link of both ping tracking objects delivers the precise result that router A has no connection to the ring.

One ping tracking object for device S3 could indicate an interrupted connection to the redundant ring, but in this case there could be another reason for the lack of a ping response from device S3. For example, there could be a power failure at device S3.

The following is known:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operand No. 1 (track ID)</td>
<td>21</td>
</tr>
<tr>
<td>Operand No. 2 (track ID)</td>
<td>22</td>
</tr>
</tbody>
</table>

Prerequisites for further configuration:

- The ping tracking objects for operands 1 and 2 are configured (see on page 194 “Application example for ping tracking”).

![Figure 52: Monitoring the accessibility of a device in a redundant ring](image)

Set up a logical tracking object as an OR link. To do this, perform the following steps:

- Open the dialog.
- Click the button. The dialog displays the Create window.
- Select type:
- Enter the values you desire, for example:
  - **Type**: 31
  - **Track ID**: logical
Click the **Ok** button.

**Properties:**
- Enter the values you desire, for example:

<table>
<thead>
<tr>
<th>Logical operand A</th>
<th>Logical operand B</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>ping-21</td>
<td>ping-22</td>
<td>or</td>
</tr>
</tbody>
</table>

- Save the changes temporarily. To do this, click the ✅ button.

```
enable
configure
track add logical 31
track modify logical 31 ping-21 or ping-22
track enable logical 31
Tracking ID logical-31 created Logical Instance ping-21 included
  Logical Instance ping-22 included
  Logical Operator set to or
Tracking ID 31 activated
exit
show track ping 21
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To add a tracking object to the table.
To specify the parameters for the tracking object.
To activate the tracking object.

```
To change to the Privileged EXEC mode.
To display the configured tracks.
```

```
show track ping 22
```

```
To display the configured tracks.
```
Application example for logical tracking

The following figure displays an example of monitoring the connection to a redundant ring.

By monitoring lines L 2 and L 4, you can detect a line interruption from router A to the redundant ring.

With a ping tracking object on port 1/1 of router A, you monitor the connection to device S2.

With an additional ping tracking object on port 1/1 of router A, you monitor the connection to device S4.

Only the OR link of both ping tracking objects delivers the precise result that router A has no connection to the ring.

One ping tracking object for device S3 could indicate an interrupted connection to the redundant ring, but in this case there could be another reason for the lack of a ping response from device S3. For example, there could be a power failure at device S3.

The following is known:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operand No. 1 (track ID)</td>
<td>21</td>
</tr>
<tr>
<td>Operand No. 2 (track ID)</td>
<td>22</td>
</tr>
</tbody>
</table>
Routing
13.5 Tracking

Prerequisites for further configuration:

- The ping tracking objects for operands 1 and 2 are configured (see on page 194 “Application example for ping tracking”).

Figure 53: Monitoring the accessibility of a device in a redundant ring

- Set up a logical tracking object as an OR link. To do this, perform the following steps:
  - Open the dialog.
  - Click the button. The dialog displays the Create window.
  - Select type:
    - Enter the values you desire, for example:
      - Type: 31
      - Track ID: logical
  - Click the Ok button.
  - Properties:
    - Enter the values you desire, for example:
      - Logical operand A: ping-21
      - Logical operand B: ping-22
      - Operator: or
  - Save the changes temporarily. To do this, click the button.

enable
configure
track add logical 31
track modify logical 31 ping-21 or ping-22
track enable logical 31
Tracking ID logical-31 created Logical Instance ping-21 included
Tracking ID 31 activated
exit
show track ping 21

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To add a tracking object to the table.
To specify the parameters for the tracking object.
To activate the tracking object.
To display the configured tracks.
Ping Tracking Instance-----------------------------------
Name...........................................ping-21
Interface Number of outgoing ping packets......1/2
Target router network address....................10.0.2.53
Interval of missed repl. the state is down.....3
Interval of received repl. the state is up.....2
Maximal roundtrip-time ..........................100
Time-To-Live for a transmitted ping request....128
If number which belongs to the best route......
State..........................................down
Send State Change trap.........................disabled
Number of state changes........................0
Time of last change............................2014-06-18 14:23:22
Description.......................................
show track ping 22
To display the configured tracks.

Ping Tracking Instance-----------------------------------
Name...........................................ping-22
Interface Number of outgoing ping packets......1/3
Target router network address....................10.0.2.54
Interval of missed repl. the state is down.....3
Interval of received repl. the state is up.....2
Maximal roundtrip-time ..........................100
Time-To-Live for a transmitted ping request....128
If number which belongs to the best route......
State..........................................up
Send State Change trap.........................disabled
Number of state changes........................0
Time of last change............................2014-06-18 14:23:55
Description.......................................
show track logical 31
To display the configured tracks.

Logical Tracking Instance-----------------------------------
Name...........................................logical-31
Operand A......................................ping-21
Operand B......................................ping-22
Operator.......................................or
State..........................................up
Send State Change trap.........................disabled
Number of state changes........................0
Time of last change............................2014-06-18 14:24:25
Description.......................................
show track logical 31
To display the configured tracks.
13.6 **VRRP**

End devices usually let you specify one default gateway for forwarding data packets in external subnetworks. Here the term "Gateway" applies to a router with which end devices communicate with other subnetworks.

If this router fails, then the end device cannot send any more data to the external subnetworks.

In this case, the Virtual Router Redundancy Protocol (VRRP) provides assistance.

VRRP is a type of "gateway redundancy". VRRP describes a process that groups multiple routers into one virtual router. End devices constantly address the virtual router, and VRRP helps ensure that a physical router belonging to the virtual router transmits the data.

When a physical router fails, VRRP helps ensure that another physical router continues to route the data as part of the virtual router.

When a physical router fails, VRRP has a typical failover time of 3 to 4 seconds.

**Note:** The device supports only VRRP packets without authentication information. In order for the device to operate in conjunction with other devices that support VRRP authentication, verify that on those devices the VRRP authentication is not applied.

13.6.1 **VRRP**

The routers within a network on which VRRP is active specify among themselves which router is the master. The master router controls the IP and MAC address of the virtual router. The devices in the network that have entered this virtual IP address as the default gateway use the master as the default gateway.

![Illustration of the virtual router](image)

When the master fails, then the remaining backup routers use VRRP to specify a new master. The backup router that wins the election process then controls the IP address and MAC address of the virtual router. Thus, the devices find the route through the default gateway, as before. The devices see only the master router with the virtual MAC and IP addresses, regardless of which physical router is actually behind this virtual address.

The administrator assigns the virtual router IP address.

VRRP specifies the virtual MAC address with: 00:00:5e:00:01:<VRID>. 

---

*UM Config EAGLE20/30*

*Release 4.3 03/2022*
The first 5 octets form the fixed part in accordance with RFC 3768. The last octet is the virtual router ID (VRID). The VRID is a number from 1 through 255. Based on the number of VRIDs, VRRP lets the administrator specify up to 255 virtual routers within a network.

![Virtual MAC address](image)

In order to determine the master, a VRRP router sends IP Multicast messages to the IP Multicast address 224.0.0.18. The physical router with the higher VRRP priority becomes the master. The administrator specifies the VRRP priority of each physical router. When the VRRP priorities are the same, the physical router with higher IP interface address in the VRRP domain becomes the master. When the virtual IP address is the same as the IP address of a router interface, this router is the IP address owner. VRRP sets the VRRP priority of an IP address owner to the value of 255 and thus declares this router the master. When there is no IP address owner, VRRP declares the router with the higher VRRP priority the master.

In order to signal that the master router is ready for operation, the master router sends IP Multicast advertisements in regular intervals (default: 1 s) to the other VRRP routers (backup routers). When 3 intervals pass without the other VRRP routers receiving an advertisement, VRRP initiates the master router election process. The VRRP backup router with the higher VRRP priority declares itself the new master.

<table>
<thead>
<tr>
<th>Table 25: Who shall be the master?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The IP address owner as it has the higher VRRP priority (255) by definition.</td>
</tr>
<tr>
<td>2. The VRRP router with the higher VRRP priority.</td>
</tr>
<tr>
<td>3. When the priorities are the same, the VRRP router with the higher IP address.</td>
</tr>
</tbody>
</table>

**VRRP terms:**
- **Virtual router**
  A virtual router is a physical router or group of physical routers that act as the default gateway in a network using the Virtual Router Redundancy Protocol.

- **VRRP router**
  A VRRP router is a physical router with VRRP enabled. The VRRP router is part of one or more virtual routers.

- **Master router**
  The master router is the physical router within a virtual domain that is responsible for forwarding data packets and responding to ARP queries. The master router periodically sends messages (advertisements) to the backup routers in the virtual domain to inform them about its existence. The backup routers save the advertisement interval and VRRP priority contained in the master router advertisements to calculate the master down time and skew time.

- **IP address owner**
  The IP address owner is the VRRP router whose IP address is identical to the IP address of the virtual router. By definition, it has the VRRP priority of 255 and is thus automatically the master router.

- **Backup router**
  When the master router fails, the backup router is a VRRP router providing a stand-by route for the master router. The backup router is ready to take over the master role.

- **VRRP priority**
  The VRRP priority is a number from 1 through 255. VRRP uses the priority number to determine the master router. VRRP reserves the priority value 255 for the IP address owner.

- **VRID**
  The virtual router ID (VRID) uniquely identifies a virtual router. The VRID defines the last octet of the virtual router MAC address.
Routing

13.6 VRRP

- **Virtual router MAC address**
  The MAC address of the virtual router instance. See figure 55 on page 202.
- **Virtual router IP address**
  The IP address of the virtual router instance.
- **Advertisement interval**
  The advertisement interval describes the frequency with which the master router sends
  advertisements to the backup routers within the same virtual router. The values for the
  advertisement interval are from 1 through 255 seconds. The default interval value for VRRP
  advertisements is 1 second.
- **Skew time**
  The skew time uses the VRRP priority of the master router to determine how long a backup
  router waits, after declaring the master down, until it initiates the master router election process.
  Skew time = (256 - VRRP priority) / 256) * 1 second
- **Master down interval**
  The master down interval uses the advertisement interval of the master router to specify the time
  that elapses before a backup router declares the master down.
  Master down interval = 3 * advertisement interval + skew time

**Configuration of VRRP**

The configuration of VRRP requires the following steps:
- Enable the *Routing* function globally.
- Enable VRRP globally.
- Assign an IP address and subnet mask to the port.
- Enable VRRP on the port.
- Create the virtual router ID (VRID), because you have the option of activating multiple virtual
  routers on each port.
- Assign the virtual router IP address.
- Enable the virtual router.
- Assign the VRRP priority.

You specify every active VRRP port the same way.
You also perform the same configuration on the backup router.
### 13.6.2 VRRP with load sharing

With the simple configuration, a router performs the gateway function for the end devices. The capacity of the backup router lies idle. VRRP lets you also use the capacity of the backup router. Setting up a number of virtual routers lets you specify different default gateways on the connected end devices and thus steer the data flow.

When both routers are active, the data flows through the router on which the IP address of the default gateway has the higher VRRP priority. When a router fails, the data flows through the remaining routers.

Configure load sharing. To do this, perform the following steps:

- Define a second VRID for the same router interface.
- Assign the router interface its own IP address for the second VRID.
- Assign the second virtual router a lower priority than the first virtual router.
- When configuring the backup router, verify that you assign the second virtual router a higher priority than the first.
- Give the end devices one of the virtual router IP addresses as a default gateway.

### 13.6.3 VRRP with Multinetting

The router lets you combine VRRP with Multinetting.

Configure VRRP with multinetting on the basis of an existing VRRP configuration. See figure 54 on page 201.
To do this, perform the following steps:

- Assign a second (secondary) IP address to the port.
- Assign a second (secondary) IP address to the virtual router.

```
Interface 2/3
ip address secondary 10.0.2.1 255.255.255.0
ip vrrp virtual-address add 1 10.0.2.100
```

To select the port at which you want to configure multinetting.
To assign the second IP address to the port.
To assign a second IP address to the virtual router with the VRID 1.

- Perform the same configuration on the backup router.
13.7 OSPF

Open Shortest Path First (OSPF) is a dynamic routing protocol based on the Link State Algorithm. This algorithm is based on the link states between the routers involved.

The significant metric in OSPF is the "OSPF costs", which is calculated from the available bit rate of a link.

OSPF was developed by IETF. OSPF is currently specified as OSPFv2 in RFC 2328. Along with many other advantages of OSPF, the fact that it is an open standard has contributed to the wide usage of this protocol. OSPF has replaced the Routing Information Protocol (RIP) as the standard Interior Gateway Protocol (IGP) in large networks.

OSPF has a number of significant advantages to offer:
- Cost-based routing metrics: In contrast to RIP, OSPF provides clear metrics based on the bandwidth of each individual network connection. OSPF provides major flexibility in designing a network, because you can change these costs.
- Routing using multiple paths (equal cost multiple path/ECMP): OSPF is able to support a number of equal paths to a given destination. OSPF thus provides efficient utilization of the network resources (load distribution) and improves the availability (redundancy).
- Hierarchical routing: By logically dividing the network into areas, OSPF shortens the time required to distribute routing information. The messages about changes in a subnetwork remain within the subnetwork, without putting any load on the rest of the network.
- Support of Classless Inter-Domain Routing (CIDR) and Variable Length Subnet Mask (VLSM): This lets the network administrator assign the IP address resources efficiently.
- Fast tuning time: OSPF supports the fast distribution of messages about route changes. This speeds up the tuning time for updating the network topology.
- Saving network resources / bandwidth optimization: Because OSPF, in contrast to RIP, does not exchange the routing tables at regular, short intervals, no bandwidth is unnecessarily "wasted" between the routers.
- Support of authentication: OSPF supports the authentication of nodes that send routing information.

Table 26: Advantages and disadvantages of Link State Routing

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every router calculates its routes independently of the other routers.</td>
<td>Complicated to implement</td>
</tr>
<tr>
<td>The routers have the same basic information.</td>
<td>Complex administration due to the large number of options.</td>
</tr>
<tr>
<td>Rapid detection of link interruptions and rapid calculation of alternative routes.</td>
<td></td>
</tr>
<tr>
<td>The data volume for router information is relatively small, because information is only sent in cases where it is required, and only the information that applies to the immediate neighbors.</td>
<td></td>
</tr>
<tr>
<td>Optimal path selection through evaluation of the link quality.</td>
<td></td>
</tr>
<tr>
<td>OSPF is a routing protocol based on the states of the links between the routers.</td>
<td></td>
</tr>
</tbody>
</table>

Using the link states collected from every router and the Shortest Path First algorithm, an OSPF router dynamically creates its routing table.
**13.7.1 OSPF-Topology**

OSPF is hierarchically structured in order to limit the scope of the OSPF information to be exchanged in large networks. You divide up your network using what are known as areas.

**Autonomous System**

An Autonomous System (AS) is a number of routers that are managed by a single administration and use the same Interior Gateway Protocol (IGP). Exterior Gateway Protocols (EGP), on the other hand, are used to connect a number of autonomous systems. OSPF is an Interior Gateway Protocol.

![Figure 58: Autonomous System](image)

An AS uses an “Autonomous System Boundary Router” (ASBR) to connect with the outside world. An ASBR understands multiple protocols and serves as a gateway to routers outside the areas. An ASBR is able to transfer routes from different protocols into OSPF. This process is known as redistribution.

**Router ID**

The router ID in the form of an IP address is used to uniquely identify every router within an autonomous system. To improve the transparency, it is necessary to manually configure the router ID of every OSPF router. Thus there is no automatic function that selects the router ID from the IP interfaces of the router.

```
enable
configure
ip ospf router-id 192.168.1.2
ip ospf operation
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To assign the router ID, for example **192.168.1.2**.
To enable the **OSPF** function globally.
Areas

Each area first forms its own database using the link states within the area. The data exchange required for this remains within the area. Each area uses an Area Border Router (ABR) to link to other areas. The routing information is summarized as much as possible between the areas (route summarization).

Every OSPF router has to be a member of at least one area.

An individual router interface can only be assigned to one area. By default, every router interface is assigned to the backbone area.

OSPF distinguishes between the following particular area types:

- **Backbone Area:**
  This is by definition the area 0.0.0.0. An OSPF network consists of at least the backbone area. It is the central area, which is linked to the other areas directly. The backbone area receives the routing information and is responsible for forwarding this information.

- **Stub Area:**
  When external LSAs are not to be flooded into the area, you define an area as a stub area. External means outside the autonomous system. These external LSAs are the yellow and orange links (see figure 59 on page 208). Thus the routers within a stub area only learn internal routes (blue links – for example no routes that are exported into OSPF from another log / redistributing). The destinations outside the autonomous system are assigned to a default route. Stub areas are thus generally used in cases where only one router in the area has a link to outside the area. The use of stub areas keeps the routing table small within the stub area.

  Configuration notes:
  - For a stub area, the routers within the stub area have to be specified as stub routers.
  - A stub area does not allow passage for a virtual link.
  - The backbone area cannot be specified as a stub area.

- **Not So Stubby Area (NSSA):**
  You define an area as NSSA in cases where the external (yellow) routes of a system directly connected to the NSSA that is outside your autonomous system are to be led into the area (redistributed). These external (yellow) LSAs then also lead from the NSSA to other areas in your autonomous system. External (orange) LSAs within your own autonomous system do not, on the other hand, lead into an NSSA.

  By using NSSAs, you can integrate ASBRs into the area without foregoing the advantage of stub areas, namely that external routes from the backbone are not flooded into the corresponding area.

  Thus NSSAs have the advantage that external routes coming from the backbone are not entered in the routing tables of the internal routers. At the same time, however, a limited number of external networks, which can be reached across the boundaries of the NSSA, can be propagated into the backbone area.

![Figure 59: LSA distribution into the area types](image-url)
Perform the following steps:

```
enable
config
ip ospf area 2.2.2.2 nssa add import-nssa
ip ospf area 3.3.3.3 stub add 0
ip ospf area 3.3.3.3 stub modify 0 default-cost 10
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To specify area 2.2.2.2 as NSSA.
To specify area 3.3.3.3 as stub area.
To instruct the ABR to inject the default route with the metric 10 into the stub area.

**Virtual Link**

OSPF requires that the backbone area to be connected to every area. However, when this is not actually possible, OSPF provides a virtual link (VL) to connect parts of the backbone area with each other. A VL even lets you connect an area that is connected with the backbone area via another area.

Configuration for expanding the backbone area:

```
enable
config
ip ospf area 1.1.1.1 virtual-link add 2.2.2.2
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To enter the neighboring router ID for a virtual link in area 1.1.1.1.
Configure router 2. To do this, perform the following steps:

- `enable` To change to the Privileged EXEC mode.
- `configure` To change to the Configuration mode.
- `ip ospf area 1.1.1.1 virtual-link add 1.1.1.1` To enter the neighboring router ID for a virtual link in area 1.1.1.1.

**OSPF Router**

OSPF distinguishes between the following router types:
- **Internal router:**
  The OSPF interfaces of an internal router are within the same area.
- **Area Border Router (ABR):**
  ABRs have OSPF interfaces in a number of areas, including the backbone area. The ABRs thus participate in multiple areas. Where possible, you summarize a number of routes and send “Summary LSAs” to the backbone area.
- **Autonomous System Area Border Router (ASBR):**
  An ASBR is located on the boundary of an autonomous system and links OSPF to other autonomous systems / routing protocols. These external routes are transferred into OSPF using what is known as redistribution and are then summarized as “AS-external LSAs” and flooded into the area.
  Enable the redistributing explicitly.
  When you want to use subnetting, you enter this explicitly.
  In OSPF, the following “routing protocols” can be exported:
  - connected (local subnetworks on which OSPF is not switched on)
  - static (static routes)

**Link State Advertisement**

As a basis for building up a database using the link states, OSPF uses Link State Advertisements (LSA).

An LSA contains the following information:
- the router,
- the connected subnets,
- the routes that can be reached,
- the network masks and
- the metric.

OSPF distinguishes between the following LSA types:
- **Router LSAs (type 1 LSAs):**
  Every router sends a router LSA to every other router in the same area. They describe the state and the costs of the router links (router interfaces) that the router has in the corresponding area.
  Router LSAs are only flooded within the area.
- **Network LSAs (type 2 LSAs):**
  These LSAs are generated by the designated router, DR (see on page 212 “Setting up the Adjacency”) and are sent for every connected network/subnet within an area.
- **Summary LSAs (type 3 /type 4 LSAs)**
  Summary LSAs are generated by ABRs and describe inter-area destinations, meaning destinations in different areas of the same autonomous system.
  Type 3 LSAs describe targets for IP networks (individual routes or summarized routes).
  Type 4 LSAs describe routes to ASBRs.
AS-external LSAs (type 5 LSAs):
These LSAs are generated by ASBRs and describe routes outside the autonomous system. These LSAs are flooded everywhere except for stub areas and NSSAs.

NSSA external LSAs (type 7 LSAs):
A stub area does not flood any external routes (represented by type 5 LSAs) and therefore does not support any Autonomous System Border Routers (ASBRs) at its boundaries. Thus an ASBR cannot carry any routes from other protocols into a stub area. RFC 1587 specifies the NSSAs functions. According to RFC 1587, the ASBRs send type 7 LSAs instead of type 5 LSAs for the external routes within an NSSA. These type 7 LSAs are then converted into type 5 LSAs by an ABR and flooded into the backbone area. This "translator role" is negotiated among the ABRs in an NSSA (the router with the highest router ID), but it can also be configured manually.

13.7.2 General Operation of OSPF

OSPF was specially tailored to the needs of larger networks and provides a fast convergence and minimum usage of protocol messages.

The concept of OSPF is based on the creation, maintenance and distribution of what is called the link state database. This data base describes

- every router within a routing domain (area) and
- their active interfaces and routes,
- how they are linked to each other and
- the costs of these links.

The routers within an area have an identical data base, which means that every router knows the exact topology within its area.

Every router plays its part in setting up the respective data base by propagating its local viewpoint as Link State Advertisements (LSAs). These LSAs are then flooded to the other routers within an area.

OSPF supports a range of different network types such as point-to-point networks (for example, packet over SONET/SDH), broadcast networks (Ethernet) or non-broadcast networks.

Broadcast networks are distinguished by the fact that a number of systems (end devices, switches, routers) are connected to the same segment and thus can be addressed simultaneously using broadcasts/multicasts.

OSPF generally performs the following steps in carrying out its tasks in the network:

- Setting up the Adjacencies using the Hello protocol
- Synchronizing the link state database
- Route calculation
13.7.3 Setting up the Adjacency

When a router boots, it uses what are called Hello packets to contact its neighboring routers. With these Hello packets, an OSPF router finds out which OSPF routers are near it and if they are suitable for setting up an adjacency.

In broadcast networks such as Ethernet, the number of neighbors increases with the number of routers connected, as does the information exchange for clarifying and maintaining the Adjacency. To reduce these volumes within an area, OSPF uses the “Hello” protocol to determine a designated router (DR) within the corresponding area. Thus every router in an area only sets up the Adjacency with its designated router, instead of with every neighbor. The designated router is responsible for the distribution of the link state information to its neighbor routers.

For security reasons, OSPF provides for the selection of a backup designated router (BDR), which takes over the tasks of the DR in case the DR fails. The OSPF router with the highest router priority is the DR. The router priority is specified by the administrator. When routers have the same priority, the router with the higher router ID is selected. The router ID is the smallest IP address of a router interface. You configure this router ID manually during booting of the OSPF router “Router ID” on page 207.

![Figure 62: LSA distribution with designated router and backup designated router](image-url)

To exchange information, OSPF uses reserved multicast addresses.

<table>
<thead>
<tr>
<th>Destination</th>
<th>Multicast IP address</th>
<th>Mapped Multicast MAC address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every OSPF router</td>
<td>224.0.0.5</td>
<td>01:00:5E:00:00:05</td>
</tr>
<tr>
<td>Designated routers</td>
<td>224.0.0.6</td>
<td>01:00:5E:00:00:06</td>
</tr>
</tbody>
</table>

Hello packets are also used to check the configuration within an area (area ID, timer values, priorities) and to monitor the Adjacencies. Hello packets are sent cyclically (Hello interval). When Hello packets are not received for a specific period (Dead interval), the Adjacency is terminated and the corresponding routes are deleted.

The Hello interval (default setting: 10 seconds) and the Dead interval (default setting: 40 seconds) can be configured for each router interface. When reconfiguring the timers, verify that they are uniform within an area.

Perform the following steps:

- `enable` To change to the Privileged EXEC mode.
- `configure` To change to the Configuration mode.
- `interface 1/1` To change to the interface configuration mode of interface 1/1.
- `ip ospf hello-interval 20` To specify the Hello interval as 20 seconds.
- `ip ospf dead-interval 60` To specify the Dead interval as 60 seconds.
- `exit` To change to the Configuration mode.
The following list contains the states of the Adjacencies:

<table>
<thead>
<tr>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Down</td>
<td>No Hello packets received yet</td>
</tr>
<tr>
<td>Init</td>
<td>Receiving Hello packets</td>
</tr>
<tr>
<td>2-way</td>
<td>Bidirectional communication, determination of the DR and the BDR</td>
</tr>
<tr>
<td>Exstart</td>
<td>Determination of master/slave for LSA exchange</td>
</tr>
<tr>
<td>Exchange</td>
<td>LSAs are exchanged or flooded</td>
</tr>
<tr>
<td>Loading</td>
<td>Completion of the LSA exchange</td>
</tr>
<tr>
<td>Full</td>
<td>Data basis complete and uniform in the area. Routes can now be calculated</td>
</tr>
</tbody>
</table>

### 13.7.4 Synchronization of the LSDB

The central part of the OSPF is the link state database (LSDB). This database contains a description of the network and the states of every router. The LSDB is the source for calculating the routing table and reflects the topology of the network. The LSDB is set up after the designated router or the backup designated router has been determined within an area (Broadcast networks).

To set up the LSDB and update any topology changes, the OSPF router sends link status advertisements (LSA) to the directly accessible OSPF routers. These link state advertisements consist of the interfaces and the neighbors of the sending OSPF router reachable through these interfaces. OSPF routers put this information into their databases and flood the information to the ports.

When no topology changes occur, the routers send a LSA every 30 minutes.

You can view the content of the Link State Database with the command `show ip ospf database` using the Command Line Interface, whereby the entries are output in accordance with the areas. To do this, perform the following steps:

```bash
exit
show ip ospf neighbor 1/1
show ip ospf neighbor 1/2
show ip ospf neighbor 1/3
show ip ospf neighbor 1/4

neighbor ID       IP Address    Interface    State    Dead Time
-----            --------        --------      -----    --------
192.168.1.1      10.0.1.1       1/1         Full     
192.168.1.2      11.0.1.1       1/2         Full     
192.168.1.3      12.0.1.1       1/3         Full     
192.168.1.4      13.0.1.1       1/4         Full     

192.168.1.1        10.0.1.1        1/1       Full     
192.168.1.2        11.0.1.1        1/2       Full     
192.168.1.3        12.0.1.1        1/3       Full     
192.168.1.4        13.0.1.1        1/4       Full     
```

To change to the Privileged EXEC mode.

To display the Adjacencies of the router.

To change to the Privileged EXEC mode.

To display the internal Adjacencies of the router.
13.7.5 Route Calculation

After the LSDs are learned and the neighbor relationships go to the full state, every router calculates a path to every destination using the Shortest Path First (SPF) algorithm. After the optimal path to every destination has been determined, these routes are entered in the routing table. The route calculation is generally based on the accessibility of a hop and the metric (costs). The costs are added up for every hop to the destination.

The cost of individual router interfaces are based on the available bandwidth of this link. The calculation for the standard setting is based on the following formula:

\[
\text{Metric} = \frac{\text{Autocost reference bandwidth}}{\text{bandwidth (bits/sec)}}
\]

For Ethernet, this leads to the following costs:

<table>
<thead>
<tr>
<th>Bandwidth</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Mbit</td>
<td>10</td>
</tr>
<tr>
<td>100 Mbit</td>
<td>1</td>
</tr>
<tr>
<td>1000 Mbit</td>
<td>1 (0.1 rounded up to 1)</td>
</tr>
</tbody>
</table>

The table displays that this form of calculation in the standard configuration does not permit any distinction between Fast Ethernet and Gigabit Ethernet.

You can change the standard configuration by assigning a different value for the costs to each OSPF interface. This lets you differentiate between Fast Ethernet and Gigabit Ethernet. To do this, perform the following steps:

1. **enable**
   - To change to the Privileged EXEC mode.
2. **configure**
   - To change to the Configuration mode.
3. **interface 1/1**
   - To change to the interface configuration mode of interface 1/1.
4. **ip ospf cost 2**
   - To assign the value 1/1 to port 2 for the OSPF costs.
13.7.6 Configuring OSPF

In the delivery state, the default values are selected so that you can configure simple OSPF functions in a few steps. After the router interface is specified and the OSPF function is enabled, OSPF automatically enters the required routes in the routing table.

The example below displays a simple OSPF configuration. Area 0.0.0.0 is already specified by default. The end devices do not support OSPF, so you do not have to activate the OSPF function on the corresponding router interface. By activating the Redistribution function, you can inject the routes to the end devices into OSPF.

Figure 63: Example of the configuration of OSPF

Configure the OSPF functions. To do this, perform the following steps:
- Configure router interfaces – assign IP address and network mask.
- Activate the OSPF function on the port.
- Enable the OSPF function globally.
- Enable routing globally (if this has not already been done).
**Configuration for Router B**

Perform the following steps:

```
enable
configure
interface 2/2
  ip address primary 10.0.3.1 255.255.255.0
  ip routing
  ip ospf operation
  exit
interface 2/1
  ip address primary 10.0.2.2 255.255.255.0
  ip routing
  ip ospf operation
  exit
  ip ospf router-id 10.0.2.2
  ip ospf operation
  ip ospf re-distribute connected [subnets]
  exit
  exit
  show ip ospf global
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To change to the interface configuration mode of interface 2/2.
To assign the IP parameters to the port.
To activate routing on this port.
To activate the **OSPF** function on this port.
To change to the Configuration mode.
To change to the interface configuration mode of interface 2/1.
To assign the IP parameters to the port.
To activate routing on this port.
To activate the **OSPF** function on this port.
To change to the Configuration mode.
To assign router ID 10.0.2.2 to router B.
To enable the **OSPF** function globally.
To specify the **OSPF** parameters for the following actions:
  ▶ send the routes of the locally connected interfaces
  ▶ include subnetworks without OSPF in **OSPF** (CIDR).
To change to the Configuration mode.
To change to the Privileged EXEC mode.
To display the settings for the **OSPF Global** configuration.
Routing

13.7 OSPF

- OSPF Admin Mode: enabled
- Router ID: 10.0.2.2
- ASBR Mode: enabled
- RFC 1583 Compatibility: enabled
- ABR Status: disabled
- Exit Overflow Interval: 0
- External LSA Count: 0
- External LSA Checksum: 0
- New LSAs Originated: 0
- LSAs Received: 0
- External LSDB Limit: no limit
- SFP delay time: 5
- SFP hold time: 10
- Auto cost reference bandwidth: 100
- Default Metric: not configured
- Default Route Advertise: disabled
- Always: false
- Metric: 0
- Metric Type: external-type2
- Maximum Path: 4
- Trap flags: disabled

--More-- or (q)uit

To display the settings for the OSPF Interfaces configuration.

- IP address: 10.0.2.2
- OSPF admin mode: enabled
- OSPF area ID: 1.1.1.1
- Transmit delay: 1
- Hello interval: 10
- Dead interval: 40
- Re-transmit interval: 5
- Authentication type: none
- OSPF interface type: broadcast
- Status: not Ready
- Designated Router: 0.0.0.0
- Backup designated Router: 0.0.0.0
- State: down
- MTU ignore flag: disabled
- Metric cost: 1

configure
ip routing
exit

To change to the Configuration mode.
To enable the Routing function globally.
To change to the Privileged EXEC mode.

Also perform the corresponding configuration on the other OSPF routers.

show ip ospf neighbor brief

To display the OSPF Adjacencies.
13.7.7 Limiting the distribution of the routes using an ACL

With Redistributing enabled, the OSPF function distributes every static route configured in the device without further interference. The distribution of the rip routes and connected routes is analogous. You can restrict this behavior using Access Control Lists.

Using IP rules, you specify which routes the device distributes to other devices in OSPF:
- To distribute a few routes in OSPF, you use the explicit permit rules. Using the permit rules, you specify exactly which routes the device distributes in OSPF.
- To distribute many routes in OSPF, you use the explicit deny rules, combined with an explicit permit rule. The device then distributes every route except those specified with a deny rule.

In the following example, you restrict the distribution of static routes in OSPF using Access Control Lists.

The example contains the following sections:
- Setting up and distributing routes
- Explicitly enabling a route using a permit rule
- Explicitly disabling a route using a deny rule

Setting up and distributing routes

On Router A, you configure 2 static routes for the subnets 8.1.2.0/24 and 8.1.4.0/24. Router A distributes these routes in OSPF to Router B. On router B, you check the distribution of the routes configured on router A.

---

Neighbor ID       IP Address    Interface    State    Dead Time
------------      -----------   -----------  ------   ----------
10.0.2.1          10.0.2.1        2/1        Full

show ip route all

To display the router table:

<table>
<thead>
<tr>
<th>Network Address</th>
<th>Protocol</th>
<th>Next Hop IP</th>
<th>Next Hop If</th>
<th>Pref</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0.1.0</td>
<td>OSPF</td>
<td>10.0.2.1</td>
<td>2/1</td>
<td>110</td>
<td>[x]</td>
</tr>
</tbody>
</table>

---
**Routing 13.7 OSPF**

**Router A**

- Enable routing globally.
  ```
  enable
  configure
  ip routing
  ```

  To change to the Privileged EXEC mode.
  To change to the Configuration mode.
  To enable routing globally.

- Setting up the first router interface 10.0.1.1/24.
  Activate routing.
  Activate the OSPF function on the router interface.
  ```
  interface 1/1
  ip address primary 10.0.1.1 255.255.255.0
  ip routing
  ip ospf operation
  exit
  ```

  To change to the interface configuration mode of interface 1/1.
  To specify the IP address and subnet mask.
  To activate routing.
  To activate the OSPF function on the router interface.
  To change to the Configuration mode.

- Setting up the second router interface 10.0.2.1/24.
  Activate routing.
  Activate the OSPF function on the router interface.
  ```
  interface 1/2
  ip address primary 10.0.2.1 255.255.255.0
  ip routing
  ip ospf operation
  exit
  ```

  To change to the interface configuration mode of interface 1/2.
  To specify the IP address and subnet mask.
  To activate routing.
  To activate the OSPF function on the router interface.
  To change to the Configuration mode.

- Enable the OSPF function globally.
  ```
  ip ospf router-id 10.0.1.1
  ip ospf operation
  show ip route all
  ```

  To assign the router ID (for example 10.0.1.1).
  To enable the OSPF function globally.

- Configure and distribute static routes
  ```
  enable
  configure
  ```

  To change to the Privileged EXEC mode.
  To change to the Configuration mode.
To configure the static route 8.1.2.0 through the gateway 10.0.2.2.
To configure the static route 8.1.4.0 through the gateway 10.0.2.4.
To distribute the configured routes in the OSPF function.
**Router B**

- **Enable routing globally.**
  
  ```
  enable
  configure
  ip routing
  ```

  To change to the Privileged EXEC mode.
  To change to the Configuration mode.
  To enable routing globally.

- **Setting up the router interface 10.0.1.2/24.**

  **Activate routing.**

  **Activate the OSPF function on the router interface.**

  ```
  interface 2/2
  ip address primary 10.0.1.2 255.255.255.0
  ip routing
  ip ospf operation
  exit
  ```

  To change to the interface configuration mode of interface 2/2.
  To specify the IP address and subnet mask.
  To activate routing.
  To activate the OSPF function on the router interface.
  To change to the Configuration mode.

- **Enable the OSPF function globally.**

  ```
  ip ospf router-id 10.0.1.2
  ip ospf operation
  ```

  To assign the router ID (for example 10.0.1.2).
  To enable the OSPF function globally.

- **Directly connect the port of the router interface 10.0.1.2** to the first router interface of router A. **Check the availability of the OSPF neighbors.**

  ```
  show ip ospf neighbor
  ```

  To check the router table:

<table>
<thead>
<tr>
<th>Neighbor ID</th>
<th>IP address</th>
<th>Interface</th>
<th>State</th>
<th>Dead Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0.1.1</td>
<td>10.0.1.1</td>
<td>2/2</td>
<td>full</td>
<td>00:00:34</td>
</tr>
</tbody>
</table>

- **Check the distribution of the routes configured on router A**

  **Router A distributes both configured routes.**

  ```
  show ip route all
  ```

  To check the router table:

<table>
<thead>
<tr>
<th>Network Address</th>
<th>Protocol</th>
<th>Next Hop IP</th>
<th>Next Hop If</th>
<th>Pref</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1.2.0/24</td>
<td>OSPF</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
<tr>
<td>8.1.4.0/24</td>
<td>OSPF</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.1.0/24</td>
<td>Local</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.2.0/24</td>
<td>OSPF</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
</tbody>
</table>
To explicitly enable a route with a permit rule, refer to the “Explicitly enabling a route using a permit rule” on page 222 section.

To explicitly disable a route with a deny rule, refer to the “Explicitly disabling a route using a deny rule” on page 224 section.

Explicitly enabling a route using a permit rule

The route for the 8.1.2.0/24 subnet is enabled for distribution in OSPF.
- Using a permit rule, you explicitly enable the route for the 8.1.2.0/24 subnet.
- Due to the implicit deny rule embedded in the device, every other route is disabled for distribution in OSPF.
Router A

- Set up an Access Control List with an explicit `permit` rule.

  ```plaintext
  ip access-list extended name OSPF-rule
  permit src 8.1.2.0-0.0.0.0 dst 255.255.255.0-0.0.0.0 proto ip
  ```

  To create the `OSPF-rule` Access Control List. To set up a `permit` rule for the `8.1.2.0` subnet.
  - `src 8.1.2.0-0.0.0.0` = address of the destination network and inverse mask
  - `dst 255.255.255.0-0.0.0.0` = mask of the destination network and inverse mask

  The device lets you assign the address and mask of the destination network with bit-level accuracy using the inverse mask.

- Check the configured rules.

  ```plaintext
  show access-list ip
  ```

  To display the configured Access Control Lists and rules.

<table>
<thead>
<tr>
<th>Index</th>
<th>AclName</th>
<th>RuleNo</th>
<th>Action</th>
<th>SrcIP</th>
<th>DestIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>OSPF-rule</td>
<td>1</td>
<td>Permit</td>
<td>8.1.2.0</td>
<td>255.255.255.0</td>
</tr>
</tbody>
</table>

  ```plaintext
  show access-list ip OSPF-rule 1
  ```

  To display the rule 1 (explicit `permit` rule) in the `OSPF-rule` Access Control List.

  ```plaintext
  IP access-list rule detail
  ```

  | IP access-list index................. | 1000 |
  | IP access-list name.................. | OSPF-rule |
  | Action............................... | Permit |
  | Match every......................... | False |
  | Protocol............................. | IP |
  | Source IP address................... | 8.1.2.0 |
  | Source IP mask....................... | 0.0.0.0 |
  | Source L4 port operator.......... | eq |
  | Source port........................ | -1 |
  | Destination IP address........... | 255.255.255.0 |
  | Destination IP mask............... | 0.0.0.0 |
  | Source L4 port operator.......... | eq |
  | Destination port.................. | -1 |
  | Flag Bits.......................... | -1 |
  | Flag Mask.......................... | -1 |
  | Established....................... | False |
  | ICMP Type.......................... | 0 |
  | ICMP Code.......................... | 0 |
  |--More-- or (q)uit                 | |

- Apply the Access Control List to the `OSPF` function.

  ```plaintext
  ip ospf distribute-list out static OSPF-rule
  ```

  To apply the `OSPF-rule` Access Control List to the `OSPF` function.
**Routing 13.7 OSPF**

**Router B**
- Check the distribution of the routes configured on router A.
  - Router A only distributes the route for the subnet 8.1.2.0/24 due to the configured Access Control List.

To check the router table:

<table>
<thead>
<tr>
<th>Network Address</th>
<th>Protocol</th>
<th>Next Hop IP</th>
<th>Next Hop If</th>
<th>Pref</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1.2.0/24</td>
<td>OSPF</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.1.0/24</td>
<td>Local</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.2.0/24</td>
<td>OSPF</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
</tbody>
</table>

**Explicitly disabling a route using a deny rule**

The route for the 8.1.4.0/24 subnet is disabled for distribution in OSPF.
- Using an explicit `permit` rule, you enable every rule for distribution in OSPF.
- Using a `deny` rule, you explicitly disable the route for the 8.1.4.0/24 subnet.
**Router A**

- **Delete permit rule.**
  These steps are necessary only in case you have configured a *permit* rule, as described in section “Explicitly enabling a route using a permit rule” on page 222.

  ```
  no ip ospf distribute-list out static OSPF-rule
  ip access-list extended del OSPF-rule
  ```

  To separate the *OSPF-rule* Access Control List from the *OSPF* function.

  To delete the Access Control List *OSPF-rule* and the associated rules.

- **Set up an Access Control List with an explicit *deny* rule.**

  ```
  ip access-list extended name OSPF-rule
deny src 8.1.4.0-0.0.0.0 dst 255.255.255.0-0.0.0.0 proto ip
  ```

  To create the *OSPF-rule* Access Control List. To set up a *deny* rule for the *8.1.4.0* subnet.
  - src 8.1.4.0-0.0.0.0 = address of the destination network and inverse mask
  - dst 255.255.255.0-0.0.0.0 = mask of the destination network and inverse mask
  The device lets you assign the address and mask of the destination network with bit-level accuracy using the inverse mask.

- **Apply the Access Control List to the *OSPF* function.**

  ```
  ip ospf distribute-list out static OSPF-rule
  ```

  To apply the rule *OSPF-rule* to the *OSPF* function.

**Router B**

- **Check the distribution of the routes configured on router A.**
  Due to the implicit *deny* rule embedded in the device, Router A does not distribute routes.

  ```
  show ip route all
  ```

  To check the router table:

<table>
<thead>
<tr>
<th>Network Address</th>
<th>Protocol</th>
<th>Next Hop IP</th>
<th>Next Hop If</th>
<th>Pref</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1.2.0/24</td>
<td>OSPF</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.0.2/24</td>
<td>Local</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.0.2/24</td>
<td>OSPF</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
</tbody>
</table>

  The route 10.0.2.0/24 remains available because the Access Control List helps prevent only the distribution of static routes.
**Routing**

**13.7 OSPF**

**Router A**

- Adding the explicit **permit** rule to Access Control List.

```
ip access-list extended name OSPF-rule
permit src any dst any proto ip
```

To add a **permit** rule for every subnet to the **OSPF-rule** Access Control List.

- Check the configured rules.

```
show access-list ip
```

To display the configured Access Control Lists and rules.

<table>
<thead>
<tr>
<th>Index</th>
<th>AclName</th>
<th>RuleNo</th>
<th>Action</th>
<th>SrcIP</th>
<th>DestIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>OSPF-rule</td>
<td>1</td>
<td>Deny</td>
<td>8.1.4.0</td>
<td>255.255.255.0</td>
</tr>
<tr>
<td>1000</td>
<td>OSPF-rule</td>
<td>2</td>
<td>Permit</td>
<td>0.0.0.0</td>
<td>0.0.0.0</td>
</tr>
</tbody>
</table>

```
show access-list ip OSPF-rule 1
```

To display the rule 1 (explicit **deny** rule) in the **OSPF-rule** Access Control List.
IP access-list rule detail
--------------------------
IP access-list index..............1000
IP access-list name................OSPF-rule
IP access-list rule index..........1
Action..............................Deny
Match every .........................False
Protocol.............................IP
Source IP address...................8.1.4.0
Source IP mask.......................0.0.0.0
Source L4 port operator............eq
Source port..........................-1
Destination IP address..............255.255.255.0
Destination IP mask...............0.0.0.0
Source L4 port operator............eq
Destination port.....................-1
Flag Bits..........................-1
Flag Mask..........................-1
Established.........................False
ICMP Type..........................0
ICMP Code..........................0
--More-- or (q)uit

show access-list ip OSPF-rule

To display the rule 2 (explicit permit rule) in the OSPF-rule Access Control List.

IP access-list rule detail
--------------------------
IP access-list index..............1000
IP access-list name................OSPF-rule
IP access-list rule index..........2
Action..............................Permit
Match every .........................False
Protocol.............................IP
Source IP address...................0.0.0.0
Source IP mask.......................255.255.255.255
Source L4 port operator............eq
Source port..........................-1
Destination IP address..............0.0.0.0
Destination IP mask...............255.255.255.255
Source L4 port operator............eq
Destination port.....................-1
Flag Bits..........................-1
Flag Mask..........................-1
Established.........................False
ICMP Type..........................0
ICMP Code..........................0
--More-- or (q)uit
**Router B**

- Check the distribution of the routes configured on router A.
- Router A only distributes the route for the subnet 8.1.2.0/24 due to the configured Access Control List.

```
show ip route all
To check the router table:

<table>
<thead>
<tr>
<th>Network Address</th>
<th>Protocol</th>
<th>Next Hop IP</th>
<th>Next Hop If</th>
<th>Pref</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1.2.0/24</td>
<td>OSPF</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.1.0/24</td>
<td>Local</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
<tr>
<td>10.0.2.0/24</td>
<td>OSPF</td>
<td>10.0.1.2</td>
<td>2/2</td>
<td>0</td>
<td>[x]</td>
</tr>
</tbody>
</table>
```
13.8 Entering the IP Parameters

To configure the Layer 3 function, you require access to the device management.

Depending on your own application, you will find many options for assigning IP addresses to the devices. The following example describes one option that often arises in practice. Although you have other prerequisites, this example shows the general method for entering the IP parameters and points out significant things that you should note.

The prerequisites for the following example are:
- All Layer 2 and Layer 3 devices have the IP address 0.0.0.0 (= default setting)
- The IP addresses of the devices and router interfaces and the gateway IP addresses are specified in the network plan.
The devices and their connections are installed.
- Redundant connections are open (see VRRP). To help avoid loops in the configuration phase, close the redundant connections only after the configuration phase.

Figure 65: Network plan with management IP addresses

Perform the following steps:
- Assign the IP parameters to your configuration computer. During the configuration phase, the configuration computer is located in subnet 100. This is necessary, so that the configuration computer has access to the Layer 3 devices throughout the entire configuration phase.
- Start HiDiscovery on your configuration computer.
Assign the IP parameters to every Layer 2 and Layer 3 device in accordance with the network plan. When you have completed the following router configuration, you can access the devices in subnets 10 to 14 again.

Configure the *Routing* function for the Layer 3 devices.

Note the sequence:
- First the Layer 3 device C.
- Then the Layer 3 device B.

The sequence is necessary; you thus retain access to the devices. When you assign an IP address from the subnetwork of the device management IP address (= SN 100) to a router interface, the device deletes the IP address of the device management. You access the device management via the IP address of the router interface.

Perform the following steps:
- Configure the *Routing* function for Layer 3 device A.
  You first configure the router interface at a port to which the configuration computer is connected. The result of this is that in future you will access the Layer 3 device via subnet 10.
- Change the IP parameters of your configuration computer to the values for subnetwork 10. You thus access Layer 3 device A again, namely via the IP address of the router interface set up beforehand.
- Finish the router configuration for Layer 3 device A. See the previous figures.

After configuring the *Routing* function on every Layer 3 device, you have access to every device.
Routing
13.8 Entering the IP Parameters
14 Operation diagnosis

The device provides you with the following diagnostic tools:
- Sending SNMP traps
- Monitoring the Device Status
- Out-of-Band signaling using the signal contact
- Event counter at port level
- Detecting non-matching duplex modes
- Auto-Disable
- Displaying the SFP status
- Topology discovery
- Detecting IP address conflicts
- Detecting loops
- Reports
- Monitoring data traffic on a port (port mirroring)
- Syslog
- Event log
- Cause and action management during selftest

14.1 Sending SNMP traps

The device immediately reports unusual events which occur during normal operation to the network management station. This is done by messages called SNMP traps that bypass the polling procedure (“polling” means querying the data stations at regular intervals). SNMP traps allow you to react quickly to unusual events.

Examples of such events are:
- Hardware reset
- Changes to the configuration
- Segmentation of a port

The device sends SNMP traps to various hosts to increase the transmission reliability for the messages. The unacknowledged SNMP trap message consists of a packet containing information about an unusual event.

The device sends SNMP traps to those hosts entered in the trap destination table. The device lets you configure the trap destination table with the network management station using SNMP.
14.1 Sending SNMP traps

14.1.1 List of SNMP traps

The following table displays possible SNMP traps sent by the device.

<table>
<thead>
<tr>
<th>Name of the SNMP trap</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>authenticationFailure</td>
<td>When a station attempts to access an agent without authorisation, this trap is sent.</td>
</tr>
<tr>
<td>coldStart</td>
<td>Sent after a restart.</td>
</tr>
<tr>
<td>hm2DevMonSenseExtNvmRemoval</td>
<td>When the external memory has been removed, this trap is sent.</td>
</tr>
<tr>
<td>linkDown</td>
<td>When the connection to a port is interrupted, this trap is sent.</td>
</tr>
<tr>
<td>linkUp</td>
<td>When connection is established to a port, this trap is sent.</td>
</tr>
<tr>
<td>hm2DevMonSensePSState</td>
<td>When the status of a power supply unit changes, this trap is sent.</td>
</tr>
<tr>
<td>hm2SigConStateChange</td>
<td>When the status of the signal contact changes in the operation monitoring, this trap is sent.</td>
</tr>
<tr>
<td>newRoot</td>
<td>When the sending agent becomes the new root of the spanning tree, this trap is sent.</td>
</tr>
<tr>
<td>topologyChange</td>
<td>When the port changes from blocking to forwarding or from forwarding to blocking, this trap is sent.</td>
</tr>
<tr>
<td>alarmRisingThreshold</td>
<td>When the RMON input exceeds its upper threshold, this trap is sent.</td>
</tr>
<tr>
<td>alarmFallingThreshold</td>
<td>When the RMON input goes below its lower threshold, this trap is sent.</td>
</tr>
<tr>
<td>hm2AgentPortSecurityViolation</td>
<td>When a MAC address detected on this port does not match the current settings of the parameter hm2AgentPortSecurityEntry, this trap is sent.</td>
</tr>
<tr>
<td>hm2DiagSelftestActionTrap</td>
<td>When a self test for the four categories “task”, “resource”, “software”, and “hardware” is performed according to the configured settings, this trap is sent.</td>
</tr>
<tr>
<td>hm2MrpReconfig</td>
<td>When the configuration of the MRP Ring changes, this trap is sent.</td>
</tr>
<tr>
<td>hm2DiagIfaceUtilizationTrap</td>
<td>When the threshold of the interface exceeds or undercuts the upper or lower threshold specified, this trap is sent.</td>
</tr>
<tr>
<td>hm2LogAuditStartNextSector</td>
<td>When the audit trail after completing one sector starts a new one, this trap is sent.</td>
</tr>
<tr>
<td>hm2ConfigurationSavedTrap</td>
<td>After the device has successfully saved its configuration locally, this trap is sent.</td>
</tr>
<tr>
<td>hm2ConfigurationChangedTrap</td>
<td>When you change the configuration of the device for the first time after it has been saved locally, this trap is sent.</td>
</tr>
<tr>
<td>hm2PlatformStpInstanceLoopInconsistentStartTrap</td>
<td>When the port in this STP instance changes to the “loop inconsistent” status, this trap is sent.</td>
</tr>
<tr>
<td>hm2PlatformStpInstanceLoopInconsistentEndTrap</td>
<td>When the port in this STP instance leaves the “loop inconsistent” status receiving a BPDU packet, this trap is sent.</td>
</tr>
</tbody>
</table>
14.1.2 SNMP traps for configuration activity

After you save a configuration in the memory, the device sends a `hm2ConfigurationSavedTrap`. This SNMP trap contains both the state variables of non-volatile memory (`NVM`) and external memory (`ENVM`) indicating if the running configuration is in sync with the non-volatile memory, and with the external memory. You can also trigger this SNMP trap by copying a configuration file to the device, replacing the active saved configuration.

Furthermore, the device sends a `hm2ConfigurationChangedTrap`, whenever you change the local configuration, indicating a mismatch between the running and saved configuration.

14.1.3 SNMP trap setting

The device lets you send an SNMP trap as a reaction to specific events. Create at least one trap destination that receives SNMP traps.

Perform the following steps:

- Open the dialog.
- Click the button. The dialog displays the Create window.
- In the Name frame, specify the name that the device uses to identify itself as the source of the SNMP trap.
- In the Address frame, specify the IP address of the trap destination to which the device sends the SNMP traps.
- In the Active column you select the entries that the device should take into account when it sends SNMP traps.
- Save the changes temporarily. To do this, click the button.

For example, in the following dialogs you specify when the device triggers an SNMP trap:
14.1.4 ICMP messaging

The device lets you use the Internet Control Message Protocol (ICMP) for diagnostic applications, for example ping and trace route. The device also uses ICMP for time-to-live and discarding messages in which the device forwards an ICMP message back to the packet source device.

Use the ping network tool to test the path to a particular host across an IP network. The traceroute diagnostic tool displays paths and transit delays of packets across a network.
14.2 Monitoring the Device Status

The device status provides an overview of the overall condition of the device. Many process visualization systems record the device status for a device in order to present its condition in graphic form.

The device displays its current status as error or ok in the Device status frame. The device determines this status from the individual monitoring results.

The device lets you:
- Out-of-Band signalling using a signal contact
- signal the changed device status by sending an SNMP trap
- detect the device status in the dialog of the Graphical User Interface
- query the device status in the Command Line Interface

The Global tab of the dialog lets you configure the device to send a trap to the management station for the following events:
- Incorrect supply voltage
  - at least one of the 2 supply voltages is not operating
  - the internal supply voltage is not operating
- When the device is operating outside of the user-defined temperature threshold values
- The interruption of link connection(s)
  Configure at least one port for this feature. When the link is down, you specify which ports the device signals in the Port tab of the dialog in the Propagate connection error column.
- The removal of the external memory
  The configuration in the external memory is out-of-sync with the configuration in the device.

Select the corresponding entries to decide which events the device status includes.

**Note:** With a non-redundant voltage supply, the device reports the absence of a supply voltage. To disable this message, feed the supply voltage over both inputs or ignore the monitoring.

14.2.1 Events which can be monitored

Table 29: Device Status events

<table>
<thead>
<tr>
<th>Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection errors</td>
<td>Activate this function to monitor every port link event in which the Propagate connection error checkbox is marked.</td>
</tr>
<tr>
<td>Temperature</td>
<td>Activate this function to monitor when the temperature exceeds or falls below the specified threshold values.</td>
</tr>
<tr>
<td>External memory removal</td>
<td>Activate this function to monitor the presence of an external storage device.</td>
</tr>
<tr>
<td>External memory not in sync</td>
<td>The device monitors synchronization between the device configuration and the configuration stored in the external memory (ENVM).</td>
</tr>
<tr>
<td>Power supply</td>
<td>Activate this function to monitor the power supply.</td>
</tr>
</tbody>
</table>
14.2.2 Configuring the Device Status

Perform the following steps:

- Open the dialog, **Global** tab.
- For the parameters to be monitored, mark the checkbox in the **Monitor** column.
- To send an SNMP trap to the management station, activate the **Send trap** function in the **Traps** frame.
- In the dialog, create at least one trap destination that receives SNMP traps.
- Save the changes temporarily. To do this, click the ✔ button.
- Open the dialog.
- To monitor the temperature, in the **System data** frame, you specify the temperature threshold values.
- Save the changes temporarily. To do this, click the ✔ button.

### Commands

- **enable**
  - To change to the Privileged EXEC mode.
- **configure**
  - To change to the Configuration mode.
- **device-status trap**
  - To send an SNMP trap when the device status changes.
- **device-status monitor envm-not-in-sync**
  - To monitor the configuration profiles in the device and in the external memory. The **Device status** changes to **error** in the following situations:
    - The configuration profile only exists in the device.
    - The configuration profile in the device differs from the configuration profile in the external memory.
- **device-status monitor envm-removal**
  - To monitor the active external memory. When you remove the active external memory from the device, the value in the **Device status** frame changes to **error**.
- **device-status monitor power-supply 1**
  - To monitor the power supply unit 1. When the device has a detected power supply fault, the value in the **Device status** frame changes to **error**.
- **device-status monitor temperature**
  - To monitor the temperature in the device. When the temperature exceeds or falls below the specified thresholds, the value in the **Device status** frame changes to **error**.

In order to enable the device to monitor an active link without a connection, first enable the global function, then enable the individual ports.

Perform the following steps:

- Open the dialog, **Global** tab.
- For the **Connection errors** parameter, mark the checkbox in the **Monitor** column.
14.2 Monitoring the Device Status

14.2.3 Displaying the Device Status

Perform the following steps:

- Open the dialog.

  `enable`  
  `show device-status all`

To change to the Privileged EXEC mode.
To display the device status and the setting for the device status determination.

Note: The above commands activate monitoring and trapping for the supported components. When you want to activate or deactivate monitoring for individual components, you will find the corresponding syntax in the “Command Line Interface” reference manual or in the help of the Command Line Interface console. To display the help in Command Line Interface, insert a question mark `?` and press the <Enter> key.
14.3 **Security Status**

The Security Status provides an overview of the overall security of the device. Many processes aid in system visualization by recording the security status of the device and then presenting its condition in graphic form. The device displays the overall security status in the dialog, **Security status** frame.

In the **Global** tab of the **dialog** the device displays its current status as **error** or **ok** in the **Security status** frame. The device determines this status from the individual monitoring results.

The device lets you:
- Out-of-Band signalling using a signal contact
- signal the changed security status by sending an SNMP trap
- detect the security status in the **dialog** of the Graphical User Interface
- query the security status in the Command Line Interface

### 14.3.1 Events which can be monitored

Perform the following steps:
- Specify the events that the device monitors.
- For the corresponding parameter, mark the checkbox in the **Monitor** column.

Table 30: **Security Status events**

<table>
<thead>
<tr>
<th>Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Password default settings unchanged</strong></td>
<td>After installation change the passwords to increase security. When active and the default passwords remain unchanged, the device displays an alarm.</td>
</tr>
<tr>
<td><strong>Min. password length &lt; 8</strong></td>
<td>Create passwords more than 8 characters long to maintain a high security posture. When active, the device monitors the <strong>Min. password length</strong> setting.</td>
</tr>
<tr>
<td><strong>Password policy settings deactivated</strong></td>
<td>The device monitors the settings located in the <strong>dialog</strong> for password policy requirements.</td>
</tr>
<tr>
<td><strong>User account password policy check deactivated</strong></td>
<td>The device monitors the settings of the <strong>Policy check</strong> checkbox. When <strong>Policy check</strong> is inactive, the device sends an SNMP trap.</td>
</tr>
<tr>
<td><strong>HTTP server active</strong></td>
<td>Activate this function to monitor when the <strong>HTTP</strong> function is active.</td>
</tr>
<tr>
<td><strong>SNMP unencrypted</strong></td>
<td>Activate this function to monitor when the <strong>SNMPv1</strong> or <strong>SNMPv2</strong> function is active.</td>
</tr>
<tr>
<td><strong>Access to system monitor with serial interface possible</strong></td>
<td>The device monitors the System Monitor status.</td>
</tr>
<tr>
<td><strong>Saving the configuration profile on the external memory possible</strong></td>
<td>The device monitors the possibility to save configurations to the external non-volatile memory.</td>
</tr>
<tr>
<td><strong>Link interrupted on enabled device ports</strong></td>
<td>The device monitors the link status of active ports.</td>
</tr>
</tbody>
</table>
### 14.3.2 Configuring the Security Status

Perform the following steps:

- Open the dialog, Global tab.
- For the parameters to be monitored, mark the checkbox in the Monitor column.
- To send an SNMP trap to the management station, activate the Send trap function in the Traps frame.
- Save the changes temporarily. To do this, click the ✓ button.
- In the dialog, create at least one trap destination that receives SNMP traps.

<table>
<thead>
<tr>
<th>Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access with HiDiscovery possible</td>
<td>Activate this function to monitor when the HiDiscovery function has write access to the device.</td>
</tr>
<tr>
<td>Load unencrypted config from external memory</td>
<td>The device monitors the security settings for loading the configuration from the external NVM.</td>
</tr>
<tr>
<td>Self-signed HTTPS certificate present</td>
<td>The device monitors the HTTPS server for self-created digital certificates.</td>
</tr>
</tbody>
</table>

**Table 30: Security Status events (cont.)**

<table>
<thead>
<tr>
<th>Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>security-status monitor pwd-change</td>
<td>To monitor the password for the locally set up user accounts user and admin. When the password for the user or admin user accounts is the default setting, the value in the Security status frame changes to error.</td>
</tr>
<tr>
<td>security-status monitor pwd-min-length</td>
<td>To monitor the value specified in the Min. password length policy. When the value for the Min. password length policy is less than 8, the value in the Security status frame changes to error.</td>
</tr>
<tr>
<td>security-status monitor pwd-policy-config</td>
<td>To monitor the password policy settings. When the value for at least one of the following policies is specified as 0, the value in the Security status frame changes to error. * Upper-case characters (min.) * Lower-case characters (min.) * Digits (min.) * Special characters (min.)</td>
</tr>
<tr>
<td>security-status monitor pwd-policy-inactive</td>
<td>To monitor the password policy settings. When the value for at least one of the following policies is specified as 0, the value in the Security status frame changes to error.</td>
</tr>
<tr>
<td>security-status monitor http-enabled</td>
<td>To monitor the HTTP server. When you enable the HTTP server, the value in the Security status frame changes to error.</td>
</tr>
</tbody>
</table>
In order to enable the device to monitor an active link without a connection, first enable the global function, then enable the individual ports.

Perform the following steps:

- Open the dialog, Global tab.
- For the Link interrupted on enabled device ports parameter, mark the checkbox in the Monitor column.
- Save the changes temporarily. To do this, click the ✓ button.
- Open the dialog, Port tab.
- For the Link interrupted on enabled device ports parameter, mark the checkbox in the column of the ports to be monitored.
- Save the changes temporarily. To do this, click the ✓ button.

- enable
- configure
- security-status monitor no-link-enabled
- interface 1/1
- security-status monitor no-link

14.3.3 Displaying the Security Status

Perform the following steps:

- Open the dialog.
enable

show security-status all

To change to the Privileged EXEC mode.
To display the security status and the setting for the security status determination.
14.4 **Out-of-Band signaling**

The device uses the signal contact to control external devices and monitor device functions. Function monitoring lets you perform remote diagnostics.

The device reports the operating status using a break in the potential-free signal contact (relay contact, closed circuit) for the selected mode. The device monitors the following functions:

- Incorrect supply voltage
  - at least one of the 2 supply voltages is not operating
  - the internal supply voltage is not operating
- When the device is operating outside of the user-defined temperature threshold values
- The interruption of link connection(s)
  Configure at least one port for this feature. In the *Propagate connection error* frame, you specify which ports the device signals for a link interruption. In the default setting, link monitoring is inactive.
- The removal of the external memory.
  The configuration in the external memory does not match the configuration in the device.

Select the corresponding entries to decide which events the device status includes.

**Note:** With a non-redundant voltage supply, the device reports the absence of a supply voltage. To disable this message, feed the supply voltage over both inputs or ignore the monitoring.

14.4.1 **Controlling the Signal contact**

With the *Manual setting* mode you control this signal contact remotely.

Application options:

- Simulation of an error detected during SPS error monitoring
- Remote control of a device using SNMP, such as switching on a camera

Perform the following steps:

- Open the dialog, *Global* tab.
- To control the signal contact manually, in the *Configuration* frame, select the *Manual setting* item in the *Mode* drop-down list.
- To open the signal contact, you select the *open* radio button in the *Configuration* frame.
- To close the signal contact, you select the *close* radio button in the *Configuration* frame.
- Save the changes temporarily. To do this, click the ✓ button.

```
enable
configure
signal-contact 1 mode manual
signal-contact 1 state open
signal-contact 1 state closed
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To select the manual setting mode for signal contact 1.
To open signal contact 1.
To close signal contact 1.
14.4.2 Monitoring the Device and Security Statuses

In the Configuration field, you specify which events the signal contact indicates.

- **Device status**
  Using this setting the signal contact indicates the status of the parameters monitored in the dialog.

- **Security status**
  Using this setting the signal contact indicates the status of the parameters monitored in the dialog.

- **Device/Security status**
  Using this setting the signal contact indicates the status of the parameters monitored in the dialog and the dialog.

Configuring the operation monitoring

Perform the following steps:

- Open the dialog, Global tab.
- To monitor the device functions using the signal contact, in the Configuration frame, specify the value Monitoring correct operation in the Mode field.
- For the parameters to be monitored, mark the checkbox in the Monitor column.
- To send an SNMP trap to the management station, activate the Send trap function in the Traps frame.
- Save the changes temporarily. To do this, click the button.
- In the dialog, create at least one trap destination that receives SNMP traps.
- Save the changes temporarily. To do this, click the button.
- You specify the temperature threshold values for the temperature monitoring in the dialog.

```bash
enable
cfg
signal-contact 1 monitor temperature
signal-contact 1 monitor ring-redundancy
signal-contact 1 monitor link-failure
signal-contact 1 monitor envm-removal
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To monitor the temperature in the device. When the temperature exceeds or falls below the specified threshold values, the signal contact opens.
To monitor the ring redundancy. The signal contact opens in the following situations:
- The redundancy function becomes active (loss of redundancy reserve).
- The device is a normal ring participant and detects an error in its settings.
To monitor the ports/interfaces link. When the link interrupts on a monitored port/interface, the signal contact opens.
To monitor the active external memory. When you remove the active external memory from the device, the signal contact opens.
In order to enable the device to monitor an active link without a connection, first enable the global function, then enable the individual ports.

Perform the following steps:

1. In the Monitor column, activate the Link interrupted on enabled device ports function.
2. Open the dialog, Port tab.

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To monitor the ports/interfaces link. When the link interrupts on a monitored port/interface, the signal contact opens.
To change to the interface configuration mode of interface 1/1.
To monitor the port/interface link. When the link interrupts on the port/interface, the signal contact opens.

**Events which can be monitored**

<table>
<thead>
<tr>
<th>Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Connection errors</strong></td>
<td>Activate this function to monitor every port link event in which the Propagate connection error checkbox is marked.</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>Activate this function to monitor when the temperature exceeds or falls below the specified threshold values.</td>
</tr>
</tbody>
</table>
Displaying the signal contact's status

The device gives you additional options for displaying the status of the signal contact:
- Display in the Graphical User Interface
- Query in the Command Line Interface

Perform the following steps:

1. Open the dialog.
   The Signal contact status frame displays the signal contact status and informs you about alarms that have occurred.

2. show signal-contact 1 all

   To display the signal contact settings for the specified signal contact.

<table>
<thead>
<tr>
<th>Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>External memory removed</td>
<td>Activate this function to monitor the presence of an external storage device.</td>
</tr>
<tr>
<td>External memory not in sync with NVM</td>
<td>The device monitors synchronization between the device configuration and the configuration stored in the external memory (ENVM).</td>
</tr>
<tr>
<td>Power supply</td>
<td>Activate this function to monitor the power supply.</td>
</tr>
</tbody>
</table>

Table 31: Device Status events (cont.)
**14.5 Port event counter**

The port statistics table lets experienced network administrators identify possible detected problems in the network.

This table displays the contents of various event counters. The packet counters add up the events sent and the events received. In the dialog, you can reset the event counters.

Table 32: Examples indicating known weaknesses

<table>
<thead>
<tr>
<th>Counter</th>
<th>Indication of known possible weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received fragments</td>
<td>• Non-functioning controller of the connected device</td>
</tr>
<tr>
<td></td>
<td>• Electromagnetic interference in the transmission medium</td>
</tr>
<tr>
<td>CRC Error</td>
<td>• Non-functioning controller of the connected device</td>
</tr>
<tr>
<td></td>
<td>• Electromagnetic interference in the transmission medium</td>
</tr>
<tr>
<td></td>
<td>• Inoperable component in the network</td>
</tr>
<tr>
<td>Collisions</td>
<td>• Non-functioning controller of the connected device</td>
</tr>
<tr>
<td></td>
<td>• Network over extended/lines too long</td>
</tr>
<tr>
<td></td>
<td>• Collision or a detected fault with a data packet</td>
</tr>
</tbody>
</table>

Perform the following steps:

☐ To display the event counter, open the dialog, Statistics tab.
☐ To reset the counters, in the dialog, click the Clear port statistics button.

**14.5.1 Detecting non-matching duplex modes**

Problems occur when 2 ports directly connected to each other have mismatching duplex modes. These problems are difficult to track down. The automatic detection and reporting of this situation has the benefit of recognizing mismatching duplex modes before problems occur.

This situation arises from an incorrect configuration, for example, deactivation of the automatic configuration on the remote port.

A typical effect of this non-matching is that at a low data rate, the connection seems to be functioning, but at a higher bi-directional traffic level the local device records a lot of CRC errors, and the connection falls significantly below its nominal capacity.

The device lets you detect this situation and report it to the network management station. In the process, the device evaluates the error counters of the port in the context of the port settings.

**Possible causes of port error events**

The following table lists the duplex operating modes for TX ports, with the possible fault events. The meanings of terms used in the table are as follows:

- **Collisions**
  - In half-duplex mode, collisions mean normal operation.
- **Duplex problem**
  - Mismatching duplex modes.
EMI
Electromagnetic interference.

Network extension
The network extension is too great, or too many cascading hubs.

Collisions, Late Collisions
In full-duplex mode, no incrementation of the port counters for collisions or Late Collisions.

CRC Error
The device evaluates these errors as non-matching duplex modes in the manual full duplex mode.

Table 33: Evaluation of non-matching of the duplex mode

<table>
<thead>
<tr>
<th>No.</th>
<th>Automatic configuration</th>
<th>Current duplex mode</th>
<th>Detected error events (≥ 10 after link up)</th>
<th>Duplex modes detected</th>
<th>Possible causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>marked</td>
<td>Half duplex</td>
<td>None</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>marked</td>
<td>Half duplex</td>
<td>Collisions</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>marked</td>
<td>Half duplex</td>
<td>Late Collisions</td>
<td>Duplex problem detected</td>
<td>Duplex problem, EMI, network extension</td>
</tr>
<tr>
<td>4</td>
<td>marked</td>
<td>Half duplex</td>
<td>CRC Error</td>
<td>OK</td>
<td>EMI</td>
</tr>
<tr>
<td>5</td>
<td>marked</td>
<td>Full duplex</td>
<td>None</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>marked</td>
<td>Full duplex</td>
<td>Collisions</td>
<td>OK</td>
<td>EMI</td>
</tr>
<tr>
<td>7</td>
<td>marked</td>
<td>Full duplex</td>
<td>Late Collisions</td>
<td>OK</td>
<td>EMI</td>
</tr>
<tr>
<td>8</td>
<td>marked</td>
<td>Full duplex</td>
<td>CRC Error</td>
<td>OK</td>
<td>EMI</td>
</tr>
<tr>
<td>9</td>
<td>unmarked</td>
<td>Half duplex</td>
<td>None</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>unmarked</td>
<td>Half duplex</td>
<td>Collisions</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>unmarked</td>
<td>Half duplex</td>
<td>Late Collisions</td>
<td>Duplex problem detected</td>
<td>Duplex problem, EMI, network extension</td>
</tr>
<tr>
<td>12</td>
<td>unmarked</td>
<td>Half duplex</td>
<td>CRC Error</td>
<td>OK</td>
<td>EMI</td>
</tr>
<tr>
<td>13</td>
<td>unmarked</td>
<td>Full duplex</td>
<td>None</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>unmarked</td>
<td>Full duplex</td>
<td>Collisions</td>
<td>OK</td>
<td>EMI</td>
</tr>
<tr>
<td>15</td>
<td>unmarked</td>
<td>Full duplex</td>
<td>Late Collisions</td>
<td>OK</td>
<td>EMI</td>
</tr>
<tr>
<td>16</td>
<td>unmarked</td>
<td>Full duplex</td>
<td>CRC Error</td>
<td>Duplex problem detected</td>
<td>Duplex problem, EMI</td>
</tr>
</tbody>
</table>
14.6 Displaying the SFP status

The SFP status display lets you look at the current SFP module connections and their properties. The properties include:

- module type
- serial number of media module
- temperature in °C
- transmission power in mW
- receive power in mW

Perform the following step:

☐ Open the dialog.
14.7 Topology discovery

IEEE 802.1AB defines the Link Layer Discovery Protocol (LLDP). LLDP lets you automatically detect the LAN network topology.

Devices with LLDP active:
- broadcast their connection and management information to neighboring devices on the shared LAN. When the receiving device has its LLDP function active, evaluation of the devices occur.
- receive connection and management information from neighbor devices on the shared LAN, provided these adjacent devices also have LLDP active.
- build a management information database and object definitions for storing information about adjacent devices with LLDP active.

As the main element, the connection information contains an exact, unique identifier for the connection end point: MAC (Service Access Point). This is made up of a device identifier which is unique on the entire network and a unique port identifier for this device.
- Chassis identifier (its MAC address)
- Port identifier (its port-MAC address)
- Description of port
- System name
- System description
- Supported system capabilities
- System capabilities currently active
- Interface ID of the management address
- VLAN-ID of the port
- Auto-negotiation status on the port
- Medium, half/full duplex setting and port speed setting
- Information about the VLANs installed in the device (VLAN-ID and VLAN name, irrespective of whether the port is a VLAN participant).

A network management station can call up this information from devices with activated LLDP. This information lets the network management station map the topology of the network.

Non-LLDP devices normally block the special Multicast LLDP IEEE MAC address used for information exchange. Non-LLDP devices therefore discard LLDP packets. If you position a non-LLDP capable device between 2 LLDP capable devices, then the non-LLDP capable device prohibits information exchanges between the 2 LLDP capable devices.

The Management Information Base (MIB) for a device with LLDP capability holds the LLDP information in the lldp MIB and in the private HM2-LLDP-EXT-HM-MIB and HM2-LLDP-MIB.

14.7.1 Displaying the Topology discovery results

Display the topology of the network. To do this, perform the following step:

Open the dialog, LLDP tab.

When you use a port to connect several devices, for example via a hub, the table contains a line for each connected device.

Activating Display FDB Entries at the bottom of the table lets you display devices without active LLDP support in the table. In this case, the device also includes information from its FDB (forwarding database).
If you connect the port to devices with the topology discovery function active, then the devices exchange LLDP Data Units (LLDPDU) and the topology table displays these neighboring devices.

When a port connects only devices without an active topology discovery, the table contains a line for this port to represent the connected devices. This line contains the number of connected devices.

The FDB address table contains MAC addresses of devices that the topology table hides for the sake of clarity.
14.8 Reports

The following lists reports and buttons available for diagnostics:

- System Log file
  The log file is an HTML file in which the device writes device-internal events.

- Audit Trail
  Logs successful commands and user comments. The file also includes SNMP logging.

- Persistent Logging
  When the external memory is present, the device saves log entries in a file in the external memory. These files are available after power down. The maximum size, maximum number of retainable files and the severity of logged events are configurable. After obtaining the user-defined maximum size or maximum number of retainable files, the device archives the entries and starts a new file. The device deletes the oldest file and renames the other files to maintain the configured number of files. To review these files use the Command Line Interface or copy them to an external server for future reference.

- Download support information
  This button lets you download system information as a ZIP archive.

In service situations, these reports provide the technician with the necessary information.

14.8.1 Global settings

Using this dialog you enable or disable where the device sends reports, for example, to a Console, a Syslog Server, or a connection to the Command Line Interface. You also set at which severity level the device writes events into the reports.

Perform the following steps:

☐ Open the dialog.
☐ To send a report to the console, specify the desired level in the Console logging frame, Severity field.
☐ To enable the function, select the On radio button in the Console logging frame.
☐ Save the changes temporarily. To do this, click the ✓ button.

The device buffers logged events in 2 separate storage areas so that the device keeps log entries for urgent events. Specify the minimum severity for events that the device logs to the buffered storage area with a higher priority.

Perform the following steps:

☐ To send events to the buffer, specify the desired level in the Buffered logging frame, Severity field.
☐ Save the changes temporarily. To do this, click the ✓ button.

When you activate the logging of SNMP requests, the device logs the requests as events in the Syslog. The Log SNMP get request function logs user requests for device configuration information. The Log SNMP set request function logs device configuration events. Specify the minimum level for events that the device logs in the Syslog.
Perform the following steps:

- Enable the **Log SNMP get request** function for the device in order to send SNMP Read requests as events to the Syslog server.
  To enable the function, select the **On** radio button in the **SNMP logging** frame.
- Enable the **Log SNMP set request** function for the device in order to send SNMP Write requests as events to the Syslog server.
  To enable the function, select the **On** radio button in the **SNMP logging** frame.
- Choose the desired severity level for the get and set requests.
- Save the changes temporarily. To do this, click the **✓** button.

When active, the device logs configuration changes made using the Command Line Interface, to the audit trail. This feature is based on the IEEE 1686 standard for Substation Intelligent Electronic Devices.

Perform the following steps:

- Open the **Log SNMP get request** dialog.
  - To enable the function, select the **On** radio button in the **CLI logging** frame.
- Save the changes temporarily. To do this, click the **✓** button.

The device lets you save the following system information data in one ZIP file on your PC:
- `audittrail.html`
- `config.xml`
- `defaultconfig.xml`
- `script`
- `runningconfig.xml`
- `supportinfo.html`
- `systeminfo.html`
- `systemlog.html`

The device creates the file name of the ZIP archive automatically in the format `<IP_address>_system_name>.zip`.

Perform the following steps:

- Click the **Download** button.
  After a while, you can download the ZIP archive.
- Select the directory in which you want to save the support information.
- Click the **Ok** button.
14.8.2 Syslog

The device lets you send messages about device internal events to one or more Syslog servers (up to 8). Additionally, you also include SNMP requests to the device as events in the Syslog.

Note: To display the logged events, open the dialog or the dialog.

Perform the following steps:

- Open the dialog.
- To add a table row, click the button.
- In the IP address column, enter the IP address or Hostname of the Syslog server.
- In the Destination UDP port column, specify the UDP port on which the Syslog server expects the log entries.
- In the Min. severity column, specify the minimum severity level that an event requires for the device to send a log entry to this Syslog server.
- Mark the checkbox in the Active column.
- To enable the function, select the On radio button in the Operation frame.
- Save the changes temporarily. To do this, click the button.

In the SNMP logging frame, configure the following settings for read and write SNMP requests:

Perform the following steps:

- Open the dialog.
- Enable the Log SNMP get request function for the device in order to send SNMP Read requests as events to the Syslog server.
  To enable the function, select the On radio button in the SNMP logging frame.
- Enable the Log SNMP set request function for the device in order to send SNMP Write requests as events to the Syslog server.
  To enable the function, select the On radio button in the SNMP logging frame.
- Choose the desired severity level for the get and set requests.
- Save the changes temporarily. To do this, click the button.

```bash
enable
configure
logging host add 1 addr 10.0.1.159 severity 3

logging syslog operation
exit
show logging host

<table>
<thead>
<tr>
<th>No.</th>
<th>Server IP</th>
<th>Port</th>
<th>Max. Severity</th>
<th>Type</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10.0.1.159</td>
<td>514</td>
<td>error</td>
<td>systemlog</td>
<td>active</td>
</tr>
</tbody>
</table>

logging snmp-requests get operation
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To add a recipient in the Syslog servers list. The value 3 specifies the severity level of the event that the device logs. The value 3 means error.
To enable the Syslog function.
To change to the Privileged EXEC mode.
To display the Syslog host settings.
14.8 Reports

14.8.3 System Log

The device lets you call up a log file of the system events. The table in the dialog lists the logged events.

Perform the following steps:

- To update the content of the log, click the button.
- To save the content of the log as an HTML file, click the button.
- To delete the content of the log, click the button.
- To search the content of the log for a key word, use the search function of your web browser.

Note: You have the option to also send the logged events to one or more Syslog servers.

14.8.4 Audit Trail

The dialog contains system information and changes to the device configuration performed through the Command Line Interface and SNMP. In the case of device configuration changes, the dialog displays Who changed What and When.

The dialog lets you specify up to 8 Syslog servers to which the device sends Audit Trails.

The following list contains log events:

- changes to configuration parameters
- Commands (except show commands) using the Command Line Interface
- Command logging audit-trail <string> using the Command Line Interface which logs the comment
- Automatic changes to the System Time
- watchdog events
- locking a user after several unsuccessful login attempts
- User login, either locally or remote, using the Command Line Interface
- Manual, user-initiated, logout
Timed logout after a user-defined period of inactivity in the Command Line Interface
- file transfer operation including a Firmware Update
- Configuration changes using HiDiscovery
- Automatic configuration or firmware updates using the external memory
- Blocked access to the device management due to invalid login
- rebooting
- opening and closing SNMP over HTTPS tunnels
- Detected power failures
Operation diagnosis
14.8 Reports
15 Advanced functions of the device

15.1 Using the device as a DNS client

The Domain Name System (DNS) client queries DNS servers to resolve host names and IP addresses of network devices. Much like a telephone book, the DNS client converts names of devices into IP addresses. When the DNS client receives a request to resolve a new name, the DNS client first queries its internal static database, then the assigned DNS servers for the information. The DNS client saves the queried information in a cache for future requests.

The device lets you assign host names to IP addresses statically.

The DNS client provides the following user functions:
- DNS server list, with space for 4 domain name server IP addresses
- host cache, with space for 128 entries

15.1.1 Configuring a DNS server example

Name the DNS client and configure it to query a DNS server to resolve host names. To do this, perform the following steps:

- Open the dialog.
- In the Configuration frame, Configuration source field, specify the value user.
- In the Configuration frame, Domain name field, specify the value device1.
- To add a table row, click the button.
- In the Address column, specify the value 192.168.3.5 as the IPv4 address of the DNS server.
- Mark the checkbox in the Active column.
- Open the dialog.
- To enable the function, select the On radio button in the Operation frame.
- Save the changes temporarily. To do this, click the button.

```
enable
configure
dns client source user
dns client domain-name device1
dns client servers add 1 ip 192.168.3.5
dns client adminstate
```

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To specify that the user manually configures the DNS client settings.
To specify the string device1 as a unique domain name for the device.
To add a DNS name server with an IPv4 address of 192.168.3.5 as index 1.
To enable the DNS Client function globally.
Advanced functions of the device
15.1 Using the device as a DNS client
A Setting up the configuration environment

A.1 Preparing access via SSH

You can connect to the device using SSH. To do this, perform the following steps:

- Generate a key in the device.
- or
- Transfer your own key onto the device.
- Prepare access to the device in the SSH client program.

Note: In the default setting, the key is already existing and access using SSH is enabled.

A.1.1 Generating a key in the device

The device lets you generate the key directly in the device. To do this, perform the following steps:

- Open the dialog, SSH tab.
- To disable the SSH server, select the Off radio button in the Operation frame.
- Save the changes temporarily. To do this, click the ✓ button.
- To create a RSA key, in the Signature frame, click the Create button.
- To enable the SSH server, select the On radio button in the Operation frame.
- Save the changes temporarily. To do this, click the ✓ button.

enable
configure
ssh key rsa generate

To change to the Privileged EXEC mode.
To change to the Configuration mode.
To generate a new RSA key.

A.1.2 Loading your own key onto the device

OpenSSH gives experienced network administrators the option of generating an own key. To generate the key, enter the following commands on your PC:

```
ssh-keygen(.exe) -q -t rsa -f rsa.key -C '' -N ''
r rsa param -out rsaparam.pem 2048
```

The device lets you transfer your own SSH key onto the device. To do this, perform the following steps:

- Open the dialog, SSH tab.
- To disable the SSH server, select the Off radio button in the Operation frame.
- Save the changes temporarily. To do this, click the ✓ button.
Setting up the configuration environment
A.1 Preparing access via SSH

Perform the following steps:
- Copy the self-generated key from your PC to the external memory.
- Copy the key from the external memory into the device.

### Preparing the SSH client program

The PuTTY program lets you access the device using SSH. You can download the software from www.putty.org.

Perform the following steps:
- Start the program by double-clicking on it.
- In the **Host Name (or IP address)** field you enter the IP address of your device. The IP address (a.b.c.d) consists of 4 decimal numbers with values from 0 to 255. The 4 decimal numbers are separated by points.
- To select the connection type, select the **SSH** radio button in the **Connection type** option list.
- Click the **Open** button to set up the data connection to your device.

---

[Image of PuTTY input screen]

**Figure 67: PuTTY input screen**

- When the host key is located on your PC or on a network drive, drag and drop the file that contains the key in the area. Alternatively click in the area to select the file.
- Click the **Start** button in the **Key import** frame to load the key onto the device.
- To enable the SSH server, select the **On** radio button in the **Operation** frame.
- Save the changes temporarily. To do this, click the **✓** button.
- To change to the Privileged EXEC mode, type:
  ```
  enable
  ```
  Then type:
  ```
  copy sshkey envm <file name>
  ```
  To load your own key onto the device from the external memory.
Before the connection is established, the PuTTY program displays a security alarm message and lets you check the key fingerprint.

![PuTTY Security Alert](image)

Figure 68: Security alert prompt for the fingerprint

Before the connection is established, the PuTTY program displays a security alarm message and lets you check the key fingerprint.

☐ Check the fingerprint of the key to help ensure that you have actually connected to the desired device.

☐ When the fingerprint matches your key, click the Yes button.

For experienced network administrators, another way of accessing your device through an SSH is by using the OpenSSH Suite. To set up the data connection, enter the following command:

```bash
ssh admin@10.0.112.53
```

**admin** is the user name.

**10.0.112.53** is the IP address of your device.
A.2 HTTPS certificate

Your web browser establishes the connection to the device using the HTTPS protocol. The prerequisite is that you enable the HTTPS server function in the dialog, HTTPS tab.

**Note:** Third-party software such as web browsers validate certificates based on criteria such as their expiration date and current cryptographic parameter recommendations. Old certificates can cause errors for example, an expired certificate or cryptographic recommendations change. To solve validation conflicts with third-party software, transfer your own up-to-date certificate onto the device or regenerate the certificate with the latest firmware.

A.2.1 HTTPS certificate management

A standard certificate according to X.509/PEM (Public Key Infrastructure) is required for encryption. In the default setting, a self-generated certificate is already present in the device. To do this, perform the following steps:

- Open the dialog, HTTPS tab.
- To create a X509/PEM certificate, in the Certificate frame, click the Create button.
- Save the changes temporarily. To do this, click the button.
- Restart the HTTPS server to activate the key. Restart the server using the Command Line Interface.

The device also lets you transfer an externally generated X.509/PEM certificate onto the device:

- Open the dialog, HTTPS tab.
- When the certificate is located on your PC or on a network drive, drag and drop the certificate in the area. Alternatively click in the area to select the certificate.
- Click on the Start button to copy the certificate to the device.
- Save the changes temporarily. To do this, click the button.
Note: To activate the certificate after you created or transferred it, reboot the device or restart the HTTPS server. Restart the HTTPS server using the Command Line Interface.

### A.2.2 Access through HTTPS

The default setting for HTTPS data connection is TCP port 443. If you change the number of the HTTPS port, then reboot the device or the HTTPS server. Thus the change becomes effective. To do this, perform the following steps:

- Open the dialog, HTTPS tab.
- To enable the function, select the On radio button in the Operation frame.
- To access the device by HTTPS, enter HTTPS instead of HTTP in your browser, followed by the IP address of the device.

```plaintext
enable
configure
https port 443
https server
show https
```

When you make changes to the HTTPS port number, disable the HTTPS server and enable it again in order to make the changes effective.

The device uses HTTPS protocol and establishes a new data connection. When you log out at the end of the session, the device terminates the data connection.
B Appendix

B.1 Literature references

A small selection of books on network topics, ordered by publication date (newest first):

- TSN – Time-Sensitive Networking (in German)
  Wolfgang Schulte
  VDE Verlag, 2020
  ISBN 978-3-8007-5078-8

- Time-Sensitive Networking For Dummies, Belden/Hirschmann Special Edition (in English)
  Oliver Kleineberg and Axel Schneider
  Wiley, 2018
  Get your free PDF copy on https://www.belden.com/resources/knowledge/ebooks/time-sensitive-networking-for-dummies-lp

- IPv6: Grundlagen - Funktionalität - Integration (in German)
  Silvia Hagen
  Sunny Connection, 3rd edition, 2016
  ISBN 978-3-9522942-3-9 (Print), ISBN 978-3-9522942-8-4 (eBook)

- IPv6 Essentials (in English)
  Silvia Hagen
  O'Reilly, 3rd edition, 2014

- TCP/IP Illustrated, Volume 1: The Protocols (2nd Edition) (in English)
  W. R. Stevens and Kevin R. Fall
  Addison Wesley, 2011

- Measurement, Control and Communication Using IEEE 1588 (in English)
  John C. Eidson
  Springer, 2006

- TCP/IP: Der Klassiker. Protokollanalyse. Aufgaben und Lösungen (in German)
  W. R. Stevens
  Hüthig-Verlag, 2008
  ISBN 978-3-7785-4036-7

- Optische Übertragungstechnik in der Praxis (in German)
  Christoph Wrobel
  Hüthig-Verlag, 3rd edition, 2004
  ISBN 978-3-8266-5040-6
B.2 Maintenance

Hirschmann is continually working on improving and developing their software. Check regularly if there is an updated version of the software that provides you with additional benefits. You find information and software downloads on the Hirschmann product pages on the Internet at www.hirschmann.com.
B.3 Management Information Base (MIB)

The Management Information Base (MIB) is designed in the form of an abstract tree structure.

The branching points are the object classes. The "leaves" of the MIB are called generic object classes.

When this is required for unique identification, the generic object classes are instantiated, that means the abstract structure is mapped onto reality, by specifying the port or the source address.

Values (integers, time ticks, counters or octet strings) are assigned to these instances; these values can be read and, in some cases, modified. The object description or object ID (OID) identifies the object class. The subidentifier (SID) is used to instantiate them.

Example:

The generic object class \texttt{hm2PSState} (OID = 1.3.6.1.4.1.248.11.11.1.1.1.1.2) is the description of the abstract information \textit{power supply status}. However, it is not possible to read any value from this, as the system does not know which power supply is meant.

Specifying the subidentifier 2 maps this abstract information onto reality (instantiates it), thus identifying it as the operating status of power supply 2. A value is assigned to this instance and can be read. The instance \texttt{get 1.3.6.1.4.1.248.11.11.1.1.1.1.2.1} returns the response 1, which means that the power supply is ready for operation.

<table>
<thead>
<tr>
<th>Definition of the syntax terms used:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Integer</strong></td>
</tr>
<tr>
<td><strong>IP address</strong></td>
</tr>
<tr>
<td><strong>MAC address</strong></td>
</tr>
<tr>
<td><strong>Object Identifier</strong></td>
</tr>
<tr>
<td><strong>Octet String</strong></td>
</tr>
<tr>
<td><strong>PSID</strong></td>
</tr>
<tr>
<td><strong>TimeTicks</strong></td>
</tr>
<tr>
<td><strong>Timeout</strong></td>
</tr>
<tr>
<td><strong>Type field</strong></td>
</tr>
</tbody>
</table>
| **Counter** | Integer \((0-2^{32}-1)\), when certain events occur, the value increases by 1.
When you have downloaded a software update from the product pages on the Internet, the ZIP archive of the device software also contains the MIBs.
### B.4 List of RFCs

<table>
<thead>
<tr>
<th>RFC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>768</td>
<td>UDP</td>
</tr>
<tr>
<td>791</td>
<td>IP</td>
</tr>
<tr>
<td>792</td>
<td>ICMP</td>
</tr>
<tr>
<td>793</td>
<td>TCP</td>
</tr>
<tr>
<td>826</td>
<td>ARP</td>
</tr>
<tr>
<td>1157</td>
<td>SNMPv1</td>
</tr>
<tr>
<td>1155</td>
<td>SMIv1</td>
</tr>
<tr>
<td>1191</td>
<td>Path MTU Discovery</td>
</tr>
<tr>
<td>1212</td>
<td>Concise MIB Definitions</td>
</tr>
<tr>
<td>1213</td>
<td>MIB2</td>
</tr>
<tr>
<td>1493</td>
<td>Dot1d</td>
</tr>
<tr>
<td>1643</td>
<td>Ethernet-like -MIB</td>
</tr>
<tr>
<td>1757</td>
<td>RMON</td>
</tr>
<tr>
<td>1812</td>
<td>Requirements for IP Version 4 Routers</td>
</tr>
<tr>
<td>1867</td>
<td>Form-Based File Upload in HTML</td>
</tr>
<tr>
<td>1901</td>
<td>Community based SNMP v2</td>
</tr>
<tr>
<td>1905</td>
<td>Protocol Operations for SNMP v2</td>
</tr>
<tr>
<td>1906</td>
<td>Transport Mappings for SNMP v2</td>
</tr>
<tr>
<td>1945</td>
<td>HTTP/1.0</td>
</tr>
<tr>
<td>2068</td>
<td>HTTP/1.1 protocol as updated by draft-ietf-http-v11-spec-rev-03</td>
</tr>
<tr>
<td>2233</td>
<td>The Interfaces Group MIB using SMI v2</td>
</tr>
<tr>
<td>2246</td>
<td>The TLS Protocol, Version 1.0</td>
</tr>
<tr>
<td>2328</td>
<td>OSPF v2</td>
</tr>
<tr>
<td>2346</td>
<td>AES Ciphersuites for Transport Layer Security</td>
</tr>
<tr>
<td>2365</td>
<td>Administratively Scoped IP Multicast</td>
</tr>
<tr>
<td>2578</td>
<td>SMIv2</td>
</tr>
<tr>
<td>2579</td>
<td>Textual Conventions for SMI v2</td>
</tr>
<tr>
<td>2580</td>
<td>Conformance statements for SMI v2</td>
</tr>
<tr>
<td>2618</td>
<td>RADIUS Authentication Client MIB</td>
</tr>
<tr>
<td>2620</td>
<td>RADIUS Accounting MIB</td>
</tr>
<tr>
<td>2663</td>
<td>IP Network Address Translator (NAT) Terminology and Considerations</td>
</tr>
<tr>
<td>2674</td>
<td>Dot1p/Q</td>
</tr>
<tr>
<td>2818</td>
<td>HTTP over TLS</td>
</tr>
<tr>
<td>2851</td>
<td>Internet Addresses MIB</td>
</tr>
<tr>
<td>2863</td>
<td>The Interfaces Group MIB</td>
</tr>
<tr>
<td>2865</td>
<td>RADIUS Client</td>
</tr>
<tr>
<td>3022</td>
<td>Traditional IP Network Address Translator</td>
</tr>
<tr>
<td>3164</td>
<td>The BSD Syslog Protocol</td>
</tr>
<tr>
<td>3410</td>
<td>Introduction and Applicability Statements for Internet Standard Management Framework</td>
</tr>
<tr>
<td>3412</td>
<td>Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)</td>
</tr>
<tr>
<td>RFC 3413</td>
<td>Simple Network Management Protocol (SNMP) Applications</td>
</tr>
<tr>
<td>RFC 3414</td>
<td>User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)</td>
</tr>
<tr>
<td>RFC 3415</td>
<td>View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)</td>
</tr>
<tr>
<td>RFC 3418</td>
<td>Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)</td>
</tr>
<tr>
<td>RFC 3584</td>
<td>Coexistence between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework</td>
</tr>
<tr>
<td>RFC 3768</td>
<td>VRRP</td>
</tr>
<tr>
<td>RFC 4022</td>
<td>Management Information Base for the Transmission Control Protocol (TCP)</td>
</tr>
<tr>
<td>RFC 4113</td>
<td>Management Information Base for the User Datagram Protocol (UDP)</td>
</tr>
<tr>
<td>RFC 4188</td>
<td>Definitions of Managed Objects for Bridges</td>
</tr>
<tr>
<td>RFC 4251</td>
<td>SSH protocol architecture</td>
</tr>
<tr>
<td>RFC 4252</td>
<td>SSH authentication protocol</td>
</tr>
<tr>
<td>RFC 4253</td>
<td>SSH transport layer protocol</td>
</tr>
<tr>
<td>RFC 4254</td>
<td>SSH connection protocol</td>
</tr>
<tr>
<td>RFC 4293</td>
<td>Management Information Base for the Internet Protocol (IP)</td>
</tr>
<tr>
<td>RFC 4318</td>
<td>Definitions of Managed Objects for Bridges with Rapid Spanning Tree Protocol</td>
</tr>
<tr>
<td>RFC 4363</td>
<td>Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering, and Virtual LAN Extensions</td>
</tr>
<tr>
<td>RFC 4836</td>
<td>Definitions of Managed Objects for IEEE 802.3 Medium Attachment Units (MAUs)</td>
</tr>
<tr>
<td>RFC 5905</td>
<td>NTPv4</td>
</tr>
</tbody>
</table>
## B.5 Underlying IEEE Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.1AB</td>
<td>Station and Media Access Control Connectivity Discovery</td>
</tr>
<tr>
<td>IEEE 802.1D</td>
<td>MAC Bridges (switching function)</td>
</tr>
<tr>
<td>IEEE 802.1Q</td>
<td>Virtual LANs (VLANs, MRP, Spanning Tree)</td>
</tr>
<tr>
<td>IEEE 802.3</td>
<td>Ethernet</td>
</tr>
<tr>
<td>IEEE 802.3ac</td>
<td>VLAN Tagging</td>
</tr>
<tr>
<td>IEEE 802.3x</td>
<td>Flow Control</td>
</tr>
<tr>
<td>IEEE 802.3af</td>
<td>Power over Ethernet</td>
</tr>
</tbody>
</table>
B.6 Underlying ANSI Norms

ANSI/TIA-1057  Link Layer Discovery Protocol for Media Endpoint Devices, April 2006
## B.7 Technical Data

### 15.1.2 Switching

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of the MAC address table (incl. static filters)</td>
<td>16384</td>
</tr>
<tr>
<td>Max. number of statically configured MAC address filters</td>
<td>100</td>
</tr>
<tr>
<td>Number of priority queues</td>
<td>8 Queues</td>
</tr>
<tr>
<td>Port priorities that can be set</td>
<td>0..7</td>
</tr>
<tr>
<td>MTU (Max. allowed length of packets a port can receive or transmit)</td>
<td>1996 Bytes</td>
</tr>
</tbody>
</table>

### 15.1.3 VLAN

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLAN ID range</td>
<td>1..4042</td>
</tr>
<tr>
<td>Number of VLANs</td>
<td>max. 64 simultaneously per device max. 64 simultaneously per port</td>
</tr>
</tbody>
</table>

### 15.1.4 Access Control Lists (ACL)

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port-based IP ACLs</td>
<td>max. 128 incl. max. 239 rules</td>
</tr>
<tr>
<td>Port-based MAC ACLs</td>
<td>max. 128 incl. max. 239 rules</td>
</tr>
<tr>
<td>VLAN-based IP ACLs</td>
<td>max. 128 incl. max. 176 rules (plus 63 implicit Deny All rules)</td>
</tr>
<tr>
<td>VLAN-based MAC ACLs</td>
<td>max. 128 incl. max. 176 rules (plus 63 implicit Deny All rules)</td>
</tr>
<tr>
<td>Assignment per port</td>
<td>max. 478 rules</td>
</tr>
<tr>
<td>Assignment per VLAN</td>
<td>max. 352 rules</td>
</tr>
</tbody>
</table>

### 15.1.5 Routing/Switching

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTU (Max. allowed length of over-long packets a router interface can receive or transmit)</td>
<td>1500</td>
</tr>
<tr>
<td>Number of loopback interfaces</td>
<td>8</td>
</tr>
</tbody>
</table>
### 15.1.6 Firewall

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. number of L3 firewall rules</td>
<td>2048</td>
</tr>
</tbody>
</table>

### 15.1.7 NAT

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. number of 1:1 NAT rules</td>
<td>255</td>
</tr>
<tr>
<td>Max. number of Destination NAT rules</td>
<td>255</td>
</tr>
<tr>
<td>Max. number of Double NAT rules</td>
<td>255</td>
</tr>
<tr>
<td>Max. number of Masquerading NAT rules</td>
<td>128</td>
</tr>
<tr>
<td>Max. number of Connection Tracking entries</td>
<td>7768</td>
</tr>
</tbody>
</table>
B.8 Copyright of integrated Software

The product contains, among other things, Open Source Software files developed by third parties and licensed under an Open Source Software license.

You can find the license terms in the Graphical User Interface in the dialog.
## B.9 Abbreviations used

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACA</td>
<td>Name of the external memory</td>
</tr>
<tr>
<td>ACL</td>
<td>Access Control List</td>
</tr>
<tr>
<td>BOOTP</td>
<td>Bootstrap Protocol</td>
</tr>
<tr>
<td>CLI</td>
<td>Command Line Interface</td>
</tr>
<tr>
<td>DHCP</td>
<td>Dynamic Host Configuration Protocol</td>
</tr>
<tr>
<td>EUI</td>
<td>Extended Unique Identifier</td>
</tr>
<tr>
<td>FDB</td>
<td>Forwarding Database</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
</tr>
<tr>
<td>HTTP</td>
<td>Hypertext Transfer Protocol</td>
</tr>
<tr>
<td>HTTPS</td>
<td>Hypertext Transfer Protocol Secure</td>
</tr>
<tr>
<td>ICMP</td>
<td>Internet Control Message Protocol</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IGMP</td>
<td>Internet Group Management Protocol</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>LLDP</td>
<td>Link Layer Discovery Protocol</td>
</tr>
<tr>
<td>MAC</td>
<td>Media Access Control</td>
</tr>
<tr>
<td>MIB</td>
<td>Management Information Base</td>
</tr>
<tr>
<td>NMS</td>
<td>Network Management System</td>
</tr>
<tr>
<td>NTP</td>
<td>Network Time Protocol</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>QoS</td>
<td>Quality of Service</td>
</tr>
<tr>
<td>RFC</td>
<td>Request For Comment</td>
</tr>
<tr>
<td>RM</td>
<td>Redundancy Manager</td>
</tr>
<tr>
<td>SCP</td>
<td>Secure Copy</td>
</tr>
<tr>
<td>SFP</td>
<td>Small Form-factor Pluggable</td>
</tr>
<tr>
<td>SFTP</td>
<td>SSH File Transfer Protocol</td>
</tr>
<tr>
<td>SNMP</td>
<td>Simple Network Management Protocol</td>
</tr>
<tr>
<td>TCP</td>
<td>Transmission Control Protocol</td>
</tr>
<tr>
<td>TP</td>
<td>Twisted Pair</td>
</tr>
<tr>
<td>UDP</td>
<td>User Datagram Protocol</td>
</tr>
<tr>
<td>URL</td>
<td>Uniform Resource Locator</td>
</tr>
<tr>
<td>UTC</td>
<td>Coordinated Universal Time</td>
</tr>
<tr>
<td>VLAN</td>
<td>Virtual Local Area Network</td>
</tr>
</tbody>
</table>
## Index

### 0-9
1to1 NAT ........................................................................................................... 181

### A
- ABR ........................................................................................................... 208, 210
- Access roles ................................................................................................ 55
- Access security .............................................................................................. 101
- Address Resolution Protocol ...................................................................... 165
- Adjacency ....................................................................................................... 212
- Advertisement ................................................................................................ 202
- Advertisement interval ................................................................................... 203
- Alarm ............................................................................................................. 235
- Alarm messages ............................................................................................. 233
- APNIC ............................................................................................................ 39
- Area Border Router ....................................................................................... 208, 210
- ARIN ............................................................................................................ 39
- ARP ............................................................................................................... 42, 165, 166
- ASBR ............................................................................................................ 207, 210
- Authentication ................................................................................................ 69
- Authentication list .......................................................................................... 51
- Automatic configuration ............................................................................... 102
- Autonomous System Area Border Router ..................................................... 210
- Autonomous System Boundary Router ......................................................... 207

### B
- Backbone Area .............................................................................................. 208
- Backup Designated Router .......................................................................... 212, 213
- Backup router ................................................................................................ 202
- Bandwidth ...................................................................................................... 151
- BDR ............................................................................................................... 212
- Broadcast ....................................................................................................... 164

### C
- CA ................................................................................................................... 69
- Certificate ...................................................................................................... 69
- Certification authority (CA) .......................................................................... 69
- CIDR .............................................................................................................. 42, 167, 206
- Classless inter domain routing ..................................................................... 42
- Classless Inter-Domain Routing .................................................................. 167, 206
- Closed circuit .............................................................................................. 244
- Command Line Interface ............................................................................. 16
- Command tree ............................................................................................. 24
- Confidentiality ............................................................................................... 67
- Configuration modifications .......................................................................... 233
Index

D
Data traffic .......................................................... 111
Daylight saving time ................................................. 78
Deep Packet Inspection .............................................. 129
Default gateway ..................................................... 201, 202
Denial of Service ................................................... 111, 117
Designated Router .................................................. 221, 212
Destination NAT ..................................................... 183
Destination table ..................................................... 233
Device status ......................................................... 237
Distance ............................................................. 174, 175
DoS ................................................................. 111, 117
Double NAT .......................................................... 187
DPI ................................................................. 129
DR ................................................................. 212

E
Event log .............................................................. 256

F
FAQ ................................................................. 285
Faulty device replacement .......................................... 13
First installation ..................................................... 39
Flow control ......................................................... 151

G
Gateway ............................................................... 40, 44
Generic object classes .............................................. 269
Global Config mode ................................................. 21, 22

H
Hardware reset ....................................................... 233
Hello .............................................................. 212
HiDiscovery ......................................................... 39
HiView .............................................................. 50
Host address ......................................................... 40

I
IANA ............................................................... 39
IEEE MAC Adresse .................................................. 251
IKE ............................................................... 69
Importance .......................................................... 176
Industrial HiVision .................................................. 11
Instantiation ........................................................ 269
Integrity ............................................................ 67
Interface tracking ................................................... 191, 193, 194
Interface tracking object ........................................... 192
Internal router ....................................................... 210
Internet Key Exchange ............................................. 69
Internet key exchange protocol .................................. 69
Internet Protocol Security ........................................ 67
IP ................................................................. 165
IP address .......................................................... 39, 44, 201
IP address owner .................................................... 202
IP Masquerading .................................................... 186
IPsec ............................................................... 67, 69
ISO/OSI layer model ............................................... 42
ISO/OSI reference model ......................................... 164
L
LACNIC ................................................................. 40
LDAP ................................................................. 51
Link Aggregation interface ........................................... 191
Link down delay ....................................................... 192
Link monitoring ..................................................... 237, 244
Link State Advertisement ............................................ 210
Link State Database ............................................... 213
Link up delay ........................................................ 192
Load sharing ......................................................... 175
Logical tracking ..................................................... 191, 193, 196, 198
Login dialog ........................................................ 15
LSA ................................................................. 210, 213
LSD ................................................................. 213

M
MAC address ......................................................... 201
MAC address filter .................................................. 143
MAC destination address .......................................... 42
Masquerading NAT ................................................. 186
Master router ......................................................... 202
Memory (RAM) ....................................................... 83
Message ............................................................ 233
Mode ............................................................... 102
Multicast ........................................................... 164
Multicast address .................................................. 212
Multinetting ......................................................... 168

N
NAPT ............................................................... 186
NAT ............................................................... 180
NAT (1
1 NAT) ............................................................. 181
NAT (Double NAT) ................................................ 187
NAT (Masquerading NAT) ......................................... 186
Netmask ........................................................... 40, 44
Network Address Port Translation ................................ 186
Network Address Translation ...................................... 180
Network plan ....................................................... 163
Network Time Protocol ............................................ 77
Non-volatile memory (NVM) ...................................... 83
Not So Stubby Area ............................................... 208
NSSA ............................................................. 208
NTP ............................................................... 77
NVM (non-volatile memory) ....................................... 83

O
Object classes ...................................................... 269
Object description ................................................ 269
Object ID .......................................................... 269
Open Shortest Path First .......................................... 206
OpenSSH-Suite ..................................................... 16
OpenSSL .......................................................... 70
Operand ........................................................... 196, 199
Operation monitoring ............................................ 244
Operators .......................................................... 193
OSI reference model ............................................... 164
OSPF ............................................................ 163, 206
Index

P
Packet filter ................................................................. 111
Packet filter (Routed Firewall Mode) .................................. 112
Password ................................................................. 17, 19
Ping response ............................................................. 192
Ping tracking ............................................................... 176, 191, 192
Polling ................................................................. 233
Port forwarding ......................................................... 183
Port-based router interface ............................................. 169
Pre-shared key ........................................................... 69
Priority ................................................................. 149
Priority tagged frames .................................................. 149
Privileged Exec mode .................................................. 21
Proxy ARP ............................................................... 166
PuTTY ................................................................. 16

Q
QoS ................................................................. 148

R
RADIUS ................................................................. 51
RAM (memory) .......................................................... 83
Real time ............................................................... 148
Redistributing .......................................................... 208
Redistribution ........................................................... 207
Redundant static route .................................................. 174
Reference clock ........................................................ 80
Reference time source ................................................... 77
Relay contact ........................................................... 244
Remote diagnostics ..................................................... 244
Report ................................................................. 253
RFC ................................................................. 271
RIPE NCC ............................................................. 40
Route Summarization .................................................... 208
Route tracking .......................................................... 176
Routed Firewall Mode (Packet filter) ................................ 112
Router ................................................................. 40
Router ID ............................................................... 212
Router priority .......................................................... 212
Routing table ........................................................... 170, 176
S
Secure shell ................................................................. 16
Segmentation ............................................................ 233
Serial interface ......................................................... 16, 18
Service ................................................................. 253
Service shell ............................................................ 21
Service Shell deactivation ........................................... 34
Setting the time ......................................................... 77
SFP module ............................................................ 250
Shortest Path First ................................................... 214
Signal contact ....................................................... 244
Signal runtime ....................................................... 79
Skew time ............................................................ 203
SNMP ............................................................... 233
SNMP trap ........................................................... 233, 235
Software version .................................................... 95
SPF ............................................................... 214
SSH ............................................................... 16
Starting the graphical user interface ...................... 15
Static route tracking ............................................. 176
Static routes ......................................................... 163
Static routing ......................................................... 191
Store-and-forward ................................................ 143
Stub Area ........................................................... 208
Subidentifier ......................................................... 269
Subnet ............................................................. 44
System requirements (Graphical User Interface) ...... 15
System time .......................................................... 80

T
Tab Completion ..................................................... 31
Technical questions ............................................ 285
Tracking ........................................................... 176
Tracking (VRRP) .................................................. 191
Traffic flow confidentiality ..................................... 67
Training courses .................................................. 285
Transmission reliability ......................................... 233
Trap .............................................................. 233, 235
Trap destination table .......................................... 233
Tunnel mode ....................................................... 68

U
Update ............................................................. 36
User Exec mode ................................................... 21
User name ......................................................... 17, 19
<table>
<thead>
<tr>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>V</strong></td>
</tr>
<tr>
<td>Variable Length Subnet Mask</td>
</tr>
<tr>
<td>virtual link</td>
</tr>
<tr>
<td>Virtual MAC address</td>
</tr>
<tr>
<td>Virtual router</td>
</tr>
<tr>
<td>Virtual router ID</td>
</tr>
<tr>
<td>Virtual router IP address</td>
</tr>
<tr>
<td>Virtual router MAC address</td>
</tr>
<tr>
<td>VLAN</td>
</tr>
<tr>
<td>VLAN priority</td>
</tr>
<tr>
<td>VLAN router interface</td>
</tr>
<tr>
<td>VLAN tag</td>
</tr>
<tr>
<td>VLSM</td>
</tr>
<tr>
<td>VPN</td>
</tr>
<tr>
<td>VRID</td>
</tr>
<tr>
<td>VRRP</td>
</tr>
<tr>
<td>VRRP priority</td>
</tr>
<tr>
<td>VRRP router</td>
</tr>
<tr>
<td>VRRP Tracking</td>
</tr>
<tr>
<td>VT100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>X.509 rsa</td>
</tr>
</tbody>
</table>
D Further support

Technical questions

For technical questions, please contact any Hirschmann dealer in your area or Hirschmann directly.

You find the addresses of our partners on the Internet at www.hirschmann.com.

A list of local telephone numbers and email addresses for technical support directly from Hirschmann is available at hirschmann-support.belden.com. This site also includes a free of charge knowledge base and a software download section.

Technical Documents

The current manuals and operating instructions for Hirschmann products are available at doc.hirschmann.com.

Customer Innovation Center

The Customer Innovation Center is ahead of its competitors on three counts with its complete range of innovative services:

- Consulting incorporates comprehensive technical advice, from system evaluation through network planning to project planning.
- Training offers you an introduction to the basics, product briefing and user training with certification.
  You find the training courses on technology and products currently available at www.belden.com/solutions/customer-innovation-center.
- Support ranges from the first installation through the standby service to maintenance concepts.

With the Customer Innovation Center, you decide against any compromise in any case. Our client-customized package leaves you free to choose the service components you want to use.
E  Readers’ Comments

What is your opinion of this manual? We are constantly striving to provide as comprehensive a description of our product as possible, as well as important information to assist you in the operation of this product. Your comments and suggestions help us to further improve the quality of our documentation.

Your assessment of this manual:

<table>
<thead>
<tr>
<th></th>
<th>Very Good</th>
<th>Good</th>
<th>Satisfactory</th>
<th>Mediocre</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precise description</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Readability</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Understandability</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Examples</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Structure</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Graphics</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Drawings</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tables</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Did you discover any errors in this manual? If so, on what page?

________________________________________

________________________________________

________________________________________

________________________________________

Suggestions for improvement and additional information:

________________________________________

________________________________________

________________________________________

________________________________________
General comments:


Sender:

Company / Department:

Name / Telephone number:

Street:

Zip code / City:

E-mail:

Date / Signature:

Dear User,

Please fill out and return this page
➤ as a fax to the number +49 (0)7127/14-1600 or
➤ per mail to
  Hirschmann Automation and Control GmbH
  Department 01RD-NT
  Stuttgarter Str. 45-51
  72654 Neckartenzlingen
  Germany