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User Manual

Installation
Dragon PTN TRMs
(Transmit Receive Modules: SFP, XFP, QSFP+)

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1. INTRODUCTION

1.1 General

This document is valid as of Dragon PTN Release 4.3DR.

1.2 Manual References

Table 1 is an overview of the manuals referred to in this manual. '&' refers to the language code, '*' refers to the manual issue. All these manuals can be found in the HiProvision (=Dragon PTN Management System) Help function.

Table 1 Manual References

Ref.	Number	Title
[1]	DRA-DRM801-&-*	Dragon PTN Installation and Operation
[2Mgt]	DRA-DRM830-&-*	HiProvision Management Operation
[2Leg]	DRA-DRM832-&-*	Dragon PTN Legacy Services
[2]	DRB-DRM802-&-*	Dragon PTN Aggregation Nodes: PTN2210, PTN2206, PTN1104, PTN2209
[2b]	DRB-DRM840-&-*	Dragon PTN Core Nodes: PTN2215
[3]	DRE-DRM807-&-*	Dragon PTN Interface Module: PTN-4-GC-LW/ PTN-4-GCB-LW
[4]	DRE-DRM808-&-*	Dragon PTN Interface Module: PTN-1-10G-LW
[5]	DRE-DRM809-&-*	Dragon PTN Interface Module: PTN-2-C37.94
[6]	DRE-DRM809-&-*	Dragon PTN Interface Module: PTN-4-GO-LW
[7]	DRE-DRM823-&-*	Dragon PTN Interface Module: PTN-9-L3A-L (=Main) / PTN-9-L3EA-L (=Extension)
[8]	DRE-DRM842-&-*	Dragon PTN Interface Module: PTN-1-40G-LW
[9]	DRE-DRM843-&-*	Dragon PTN Interface Module: PTN-4-10G-LW

1.3 Optical Connectors

In Dragon PTN, the LC connector (LC/PC or LC/UPC type) is used for pluggable SFP/XFP/QSFP+ modules, see figure below.

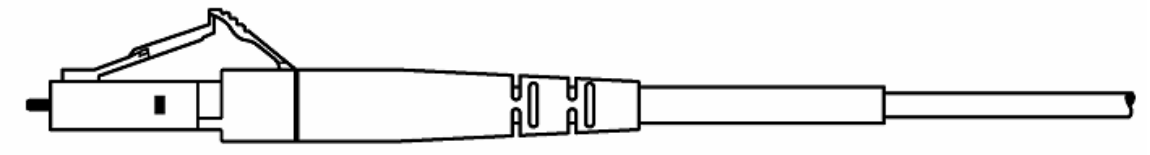

Figure 1 Optical LC Connector

1.4 Glossary

Find below some explained terms that are used in the tables further on:

- **SFP**: The small form-factor pluggable (SFP) is a compact, hot-pluggable transceiver used for both telecommunication and data communications applications. The SFP can be used

to interface some IFMs (see tables below) to fiber (=Optical). The SFP is used up to data rate speed of 1 Gbps.

- **XFP**: The XFP (10 Gigabit Small Form Factor Pluggable) is a standard for transceivers for high-speed (10 Gbps) optical links.
- **QSFP+**: The QSFP+ (40 Gigabit Quad Small Form Factor Pluggable) is a standard for transceivers for very high-speed (40 Gbps) optical links. Quad means 4 channels.
- **Smart SFP**: Smart SFP is a hot-pluggable optical transceiver that converts incoming STM/OC frames from a fiber-optic SDH/SONET network into Ethernet frames at e.g. the 4-GC-LW front port 1 or vice versa for outgoing frames. As a result, Dragon PTN allows to transparently transport synchronous digital bit streams from an SDH/SONET network. Smart SFP is also called TSoP (Transparent Sonet/SDH over Packet). The available smart SFPs are listed in the tables further on. Smart SFPs need some extra configuration in HiProvision, see Ref. [2Leg] in Table 1. See the feature matrix in Ref.[2Net] to find out which IFMs support smart SFP.

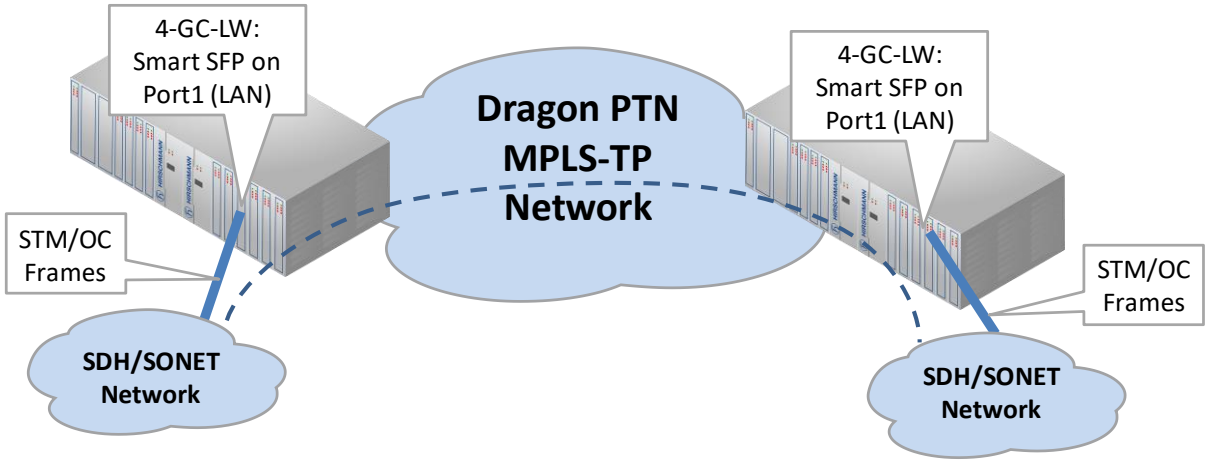

Figure 2 SDH/SONET over Dragon PTN via Smart SFPs

- **Fiber Type**: The fiber type mentioned in the table is the recommended one.
- **Distance**: The distance that can be travelled by the optical signal over a suited optical fiber; the distances can be found in the tables further on. The distance that can be spanned is a result of multiple factors:
  - Transceiver optical budget = (Min. Pout – Min. Pin); more info on Pout and Pin, see below;
  - Link attenuation as a result of connector and splice losses (see Table 2/Table 3);
  - Chromatic and modal dispersion causing signal deformation (see Table 2/Table 3).
- **Pout**: Average TRM Output Power at the transmit side;
- **Pin**: Required TRM Input Power at the receiver side to have a valid optical signal. ATTENTION: measure the received input power before connecting the fiber to the TRM receiver. Exceeding 'Pin Max.' (See tables below) could damage the TRM!
- **Eye Safety**: All mentioned TRMs are class 1 laser products and comply with IEC 825-1, EN60825 and FDA 21 CFR 1040.10.

- **CWDM**: Coarse Wavelength Division Multiplexing technique multiplexes different optical signals with different wavelengths into one fiber. At the destination, the different optical signals are demultiplexed again into separate optical signals. Wavelength spacing is 20 nm, allowing for cost efficient multiplexers.
- **DWDM**: Dense Wavelength Division Multiplexing technique multiplexes different optical signals with different wavelengths into one fiber. At the destination, the different optical signals are demultiplexed again into separate optical signals. Wavelength spacing is about 1 nm so allowing for a lot of wavelengths in the useful spectrum of the fiber. As a result DWDM can multiplex a lot more optical signals on the fiber than CWDM.

1.5 Optical Attenuator

The input power at the receiver is not allowed to exceed the maximum input power. If it does exceed, replace the TRM of the transmitting node with a TRM with less output power or install an optical attenuator to avoid receiver overload. The value of this attenuator must be at least the difference between the received power and the maximum input power.

The figure below shows a male-female attenuator, which can be directly plugged onto the TRM connector. It is recommended to install the attenuator on the Rx side (to minimize the reflected light into the transmitter).

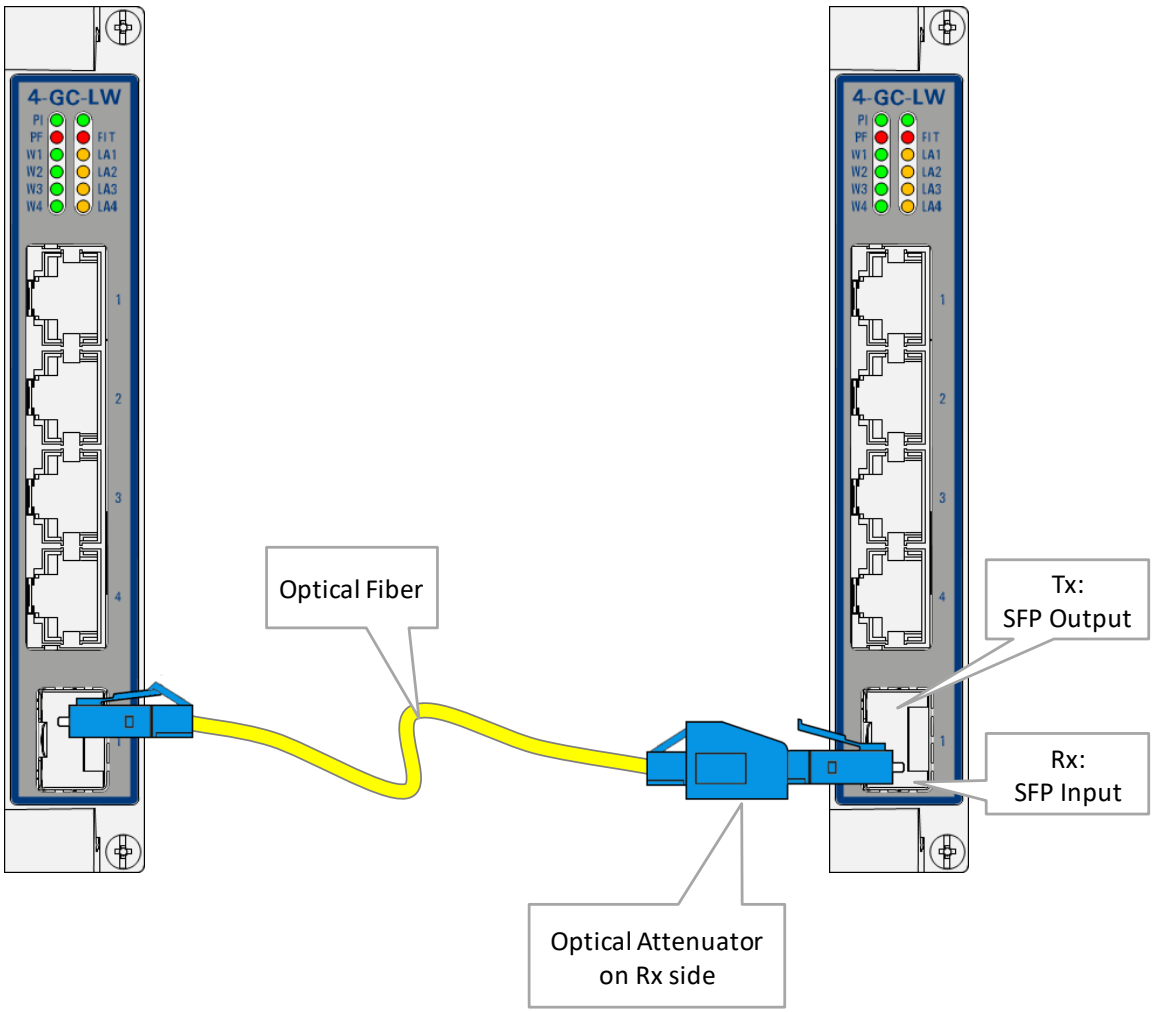

Figure 3 Optical Attenuator on Rx Side

Table 2 Fiber Losses (kilometers)

	Attenuation *dB/km*		Chromatic Dispersion Coefficient *nm/(ps.km)*		Modal Dispersion *Mhz.km*		Splice losses *dB/km*		Spare for repair splices *dB/km*		Conn. Losses *dB*
	Typ	**Best**	**Typ**	**Best**	**Typ**	**Best**	**Typ**	**Best**	**Typ**	**Best**	
50/125 (OM3) @850nm	3.0	2.5	---	---	2000	4700	0.1	0.05	0.1	0.05	0.5
50/125 (OM2) @1310nm	0.8	0.4	---	---	800	2000	0.1	0.05	0.1	0.05	0.5
62.5/125 (OM1) @850nm	3.0	2.5	---	---	300	500	0.1	0.05	0.1	0.05	0.5
62.5/125 (OM1) @1310nm	1.0	0.5	---	---	600	1000	0.1	0.05	0.1	0.05	0.5
9/125 (G.652) @1310nm	0.4	0.3	4.0	3.0	---	---	0.025	0.010	0.020	0.010	0.5
9/125 (G.652) @1550nm	0.25	0.17	17.0	15.0	---	---	0.025	0.010	0.020	0.010	0.5
9/125 (G.653/G.655) @1310nm	0.4	0.3	18.0	15.0	---	---	0.025	0.010	0.020	0.010	0.5
9/125 (G.653/G.655) @1550nm	0.25	0.19	4.0	3.0	---	---	0.025	0.010	0.020	0.010	0.5

Table 3 Fiber Losses (miles)

	Attenuation *dB/mile*		Chromatic Dispersion Coefficient *nm/(ps.mile)*		Modal Dispersion *Mhz.mile*		Splice losses *dB/mile*		Spare for repair splices *dB/mile*		Conn. Losses *dB*
	Typ	**Best**	**Typ**	**Best**	**Typ**	**Best**	**Typ**	**Best**	**Typ**	**Best**	
50/125 (OM3) @850nm	4.8	4.0	---	---	1240	2914	0.16	0.08	0.16	0.08	0.5
50/125 (OM2) @1310nm	1.29	0.65	---	---	496	1240	0.16	0.08	0.16	0.08	0.5
62.5/125 (OM1) @850nm	4.8	4.0	---	---	186	310	0.16	0.08	0.16	0.08	0.5
62.5/125 (OM1) @1310nm	1.6	0.81	---	---	372	620	0.16	0.08	0.16	0.08	0.5
9/125 (G.652) @1310nm	0.65	0.48	6.5	4.8	---	---	0.040	0.016	0.032	0.010	0.5
9/125 (G.652) @1550nm	0.4	0.27	27.4	24.2	---	---	0.040	0.016	0.032	0.010	0.5
9/125 (G.653/G.655) @1310nm	0.65	0.48	29.0	24.2	---	---	0.025	0.016	0.032	0.010	0.5
9/125 (G.653/G.655) @1550nm	0.40	0.31	6.5	4.8	---	---	0.040	0.016	0.032	0.010	0.5

2. SFP/SMART SFP MODULES

Table 4 Optical SFP Modules on IFMs

IFM	Speed (Mbps)	SFP Type	Order Number	Fiber (*1) (Minimum Modal Bandwidth@ λ)	Typical Distance (km/miles)	λ (nm)	Max. Allowed Dispersion (ps/nm)	Pout (dbm)		Pin (dbm)	
								Min	Max	Min	Max
4-GC-LW 4-GCB-LW 4-GO-LW 9-L3A-L 9-L3EA-L	1000	1000BASE-SX	942 245-017	MM 62.5 (160 MHz.km) MM 62.5 OM1 (200 MHz.km) MM 50 (400 MHz.km) MM 50 OM2 (500 MHz.km) MM 50 OM3 (2000 MHz.km)	0.220/0.136 0.275/0.170 0.500/0.310 0.550/0.341 1.000/0.621	850	NA	-9.5	0	-17	0
		1000BASE-LX	942 245-018	MM 62.5 (500 MHz.km) MM 50 (400 MHz.km) MM 50 (500 MHz.km) G.652	0.550/0.341 0.550/0.341 0.550/0.341 10/6.2	1310	53	-9.5	-3	-19	-3
		1000BASE-EX	942 245-019	G.652	40/24.9	1310	130	-3.0	2	-23	-3
		1000BASE-ZX	942 245-020	G.652/G.653/G.655	70/43.5	1550	1485	0	5	-22	-3
		1000BASE-OX	942 245-021	G.653/G.655	100/62.1	1550	1600	-2	3	-28	-8
		1000BASE-EZ	942 245-022	G.653/G.655	120/74.6	1550	1485	0	5	-32	-8
		1000Base-BX-20-U (*U)	942 245-023	G.652	20/12.4	1310 (Tx) / 1550 (Rx)	400	-8	0	-22	-3
		1000Base-BX-20-D (*D)	942 245-024	G.652	20/12.4	1550 (Tx) / 1310 (Rx)	400	-8	0	-22	-3
		1000Base-BX-80-U (*U)	942 245-025	G.652/G.653/G.655	80/49.7	1490 (Tx) / 1590 (Rx)	1600	-2	4	-26	0
		1000Base-BX-80-D (*D)	942 245-026	G.652/G.653/G.655	80/49.7	1590 (Tx) / 1490 (Rx)	1600	-2	4	-26	0
		1000BASE-ZX CWDM (*2)	(*3)	G.652/G.653/G.655	70/43.5	See Table 10	1485	0	5	-23	-3
		1000BASE-EX CWDM (*2)	(*3)	G.652/G.653/G.655	40/24.9	See Table 10	1485	-5	0	-23	-3
4-GC-LW 4-GCB-LW 4-GO-LW	100	100BASE-FX	942 245-032	MM	2/1.2	1310	NA	-20	-14	-31	-14
	100	100BASE-LX	942 245-033	SM	15/9.3	1310	NA	-15	-8	-28	-8
	1000	1000BASE-UX	942 245-034	G.652/G.653/G.655	160/99.4	1550 (CWDM)	3000	4	7	-35	-10
2-C37.94	2	C37.94	942 245-028	MM 62.5 MM 50	2/1.2	850	NA	-19 -23	-11 -11	-32 -32	-3 -3
		C37.94 S1	942 245-029	G.652/G.653/G.655	15/9.3	1310	NA	-15	-8	-34	-3

(*1) : Preferred fiber type. If other than the mentioned fibers are used, dispersion effects can limit the distance. Due to cut-off wavelength it is possible G.655 will not work together with 1310 nm SFP.
(*2) : These modules have a limited ambient temperature range of [-20...50°C/-4...122°F].
(*3) : 'xx' represents a number referring to a module depending on the wavelength. See Table 10 to find out which wavelengths are available.
(*U)/(*D) : Bi-directional SFP = Bidi SFP → Always use (*U)/(*D) together over one optical link, e.g. (*U) at one side of the optical link and (*D) at the other side of the optical link.

Table 5 Optical Smart SFP Modules on IFMs

IFM	Speed (Mbps)	SFP Type	Order Number	Fiber (*1)	Typical Distance (km/miles)	λ (nm)	Max. Allowed Dispersion (ps/nm)	Pout (dbm)		Pin (dbm)	
								Min	Max	Min	Max
4-GC-LW (*2) 4-GCB-LW (*2) 4-GO-LW (*3)	155.52 ← → 1000	TSOP: STM1 S1/OC3 I1 ← → 1000BASE	942 245-030	G.652	15/9.32	1310	96	-15	-7	-28	-8
		TSOP: STM1 L1/OC3 L1 ← → 1000BASE	942 245-037	G.652	40/24.9	1310	246	-5	0	-34	-10
		TSOP: STM1 L2/OC3 L2 ← → 1000BASE	942 245-035	G.652/G.653	80/49.7	1550	1600	-5	0	-34	-10
	622.08 ← → 1000	TSOP: STM4 S1/OC12 I1 ← → 1000BASE	942 245-031	G.652	15/9.32	1310	74	-15	-7	-28	-8
		TSOP: STM4 L1/OC12 L1 ← → 1000BASE	942 245-038	G.652	40/24.9	1310	180	-2	3	-28	-8
		TSOP: STM4 L2/OC12 L2 ← → 1000BASE	942 245-036	G.652/G.653	80/49.7	1550	1600	-2	3	-28	-8

NOTE: Smart SFPs need some extra configuration in HiProvision, see Ref. [2Leg] in Table 1.
(*1) : Preferred fiber type. If other than the mentioned fibers are used, dispersion effects can limit the distance.
(*2) : CAUTION: When using this IFM with Smart SFP in Aggregation Nodes (see Ref. [2] in Table 1) limit the ambient node temperature to 50°C/122°F.
(*3) : CAUTION: Using this IFM with Smart SFP in Core Nodes is fully supported. Using this IFM with Smart SFP in Aggregation Nodes (see Ref. [2] in Table 1) is limited:
- Maximum two smart SFPs are allowed in this IFM.
- When using one smart SFP: use port 4 and limit the ambient node temperature to 50°C/122°F.
- When using two smart SFPs: use port 3 & 4 and limit the ambient node temperature to 40°C/104°F.

Table 6 Electrical SFP Modules on IFMs

IFM	Speed (Mbps)	SFP Type	Order Number	Typical Distance (km/miles)
4-GO-LW 9-L3A-L 9-L3EA-L	10/100/1000	10/100/1000Base-T (via RJ-45)	942 245-027	0.1/0.62

3. XFP MODULES

Table 7 Optical XFP Modules

IFM	Speed (Gbps)	XFP Type	Order Number	Fiber (*1) (Minimum Modal Bandwidth@ λ)	Typical Distance (km/miles)	Typical λ (nm)	Max. Allowed Dispersion (ps/nm)	Pout (dbm)		Pin (dbm)	
								Min	Max	Min	Max
1-10G-LW 4-10G-LW 9-L3A-L 9-L3EA-L	10	10GBASE-SR/-SW	942 246-001	MM 62.5 (160 MHz.km) MM 62.5 OM1 (200 MHz.km) MM 50 (400 MHz.km) MM 50 OM2 (500 MHz.km) MM 50 OM3 (2000 MHz.km)	0.026/0.016 0.033/0.020 0.066/0.041 0.082/0.051 0.300/0.186	850	NA	-7.3	-1	-9.9	-1
		10GBASE-LR/-LW	942 246-002	G.652	10/6.2	1310	NA	-8.2	-0.5	-14.4	0.5
		10GBASE-ER/-EW	942 246-003	G.652/G.653/G.655	40/24.8	1550	800	-1	2	-16	-1
		10GBASE-ZR/-ZW	942 246-004	G.652/G.653/G.655	80/49.7	1550	1600	0	4	-24	-7
		10GBASE-ER/-EW DWDM	942 247-0xx (*2)	G.652/G.653/G.655	40/24.8	See Table 11	800	-2	3	-16	-1
		10GBASE-ZR/-ZW DWDM	942 248-0xx (*2)	G.652/G.653/G.655	70/43.5	See Table 11	1450	0	4	-23	-10

(*1) : Preferred fiber type. If other than the mentioned fibers are used, dispersion effects can limit the distance.
(*2) : 'xx' represents a number referring to a module depending on the wavelength. See Table 11 to find out which wavelengths are available.
(XFP Type) : -<x>R/-<x>W (e.g. –SR/-SW) = 'R' represents the LAN PHY mode whereas 'W' represents the WAN PHY Mode. Each XFP supports both LAN PHY and WAN PHY mode, see also 1-10G-LW manual Ref. [4] in Table 1 for more information on LAN PHY/WAN PHY.

4. QSFP+ MODULES

Table 8 Optical QSFP+ Modules

IFM	Speed (Gbps)	QSFP+ Type	Order Number	Fiber (*1) (Minimum Modal Bandwidth@ λ)	Typical Distance (km/miles)	Typical λ (nm)	Pout (dbm)		Pin (dbm)	
							Min	Max	Min	Max
1-40G-LW	40	40GBASE-BIDI (see figure below)	942 296-001	MM 50 OM2 (500 MHz.km) MM 50 OM3 (2000 MHz.km) MM 50 OM4 (4700 MHz.km)	0.030/0.019 0.100/0.062 0.150/0.093	850/900	-4.0	5	-6.0	pending
		40GBASE-LR4-lite	942 296-002	G.652	2/1.2	1271/1291/ 1311/1331	-10.0 (per lane)	2.3 (per lane) 8.3 (total)	-13.7 (per lane)	2.3 (per lane)
		40GBASE-LR4	942 296-003	G.652	10/6.2	1271/1291/ 1311/1331	-7.0 (per lane)	2.3 (per lane) 8.3 (total)	-13.7 (per lane)	2.3 (per lane)
		40GBASE-ER4	942 296-004	G.652	40/24.8 (*2)	1271/1291/ 1311/1331	-2.7 (per lane)	4.5 (per lane) 10.5 (total)	-21.2 (per lane)	pending
(*1): Preferred fiber type. If other than the mentioned fibers are used, dispersion effects can limit the distance. (*2): 40 km / 24.8 miles are considered engineered links										

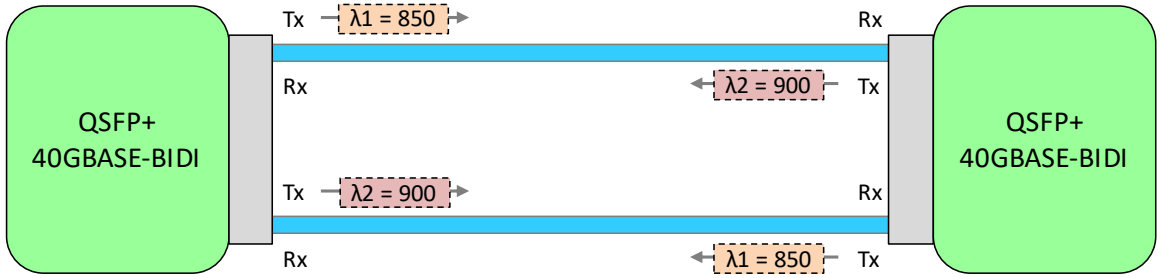

Figure 4 40GBASE-BIDI, 2 Wavelengths λ1 and λ2

5. MTBF (=MEAN TIME BETWEEN FAILURES)

Table 9 MTBF (=Mean Time Between Failures)

TRM	MTBF (Years)
SFP 850nm - SX	696
SFP 1310nm - LX	760
SFP 1310nm - EX	487
SFP 1550nm - ZX	482
XFP 850nm - SR	378
XFP 1310nm - LR	350
XFP 1550nm - ER	201
XFP 1550nm - ZR	764
QSFP+	115
Electrical SFP on L3	641

6. CWDM MODULES

Table 10 CWDM Modules

Wavelength λ (nm)	SFP 1000BASE-EX CWDM (40km)	SFP 1000BASE-ZX CWDM (80km)
1471	942 245-001	942 245-009
1491	942 245-002	942 245-010
1511	942 245-003	942 245-011
1531	942 245-004	942 245-012
1551	942 245-005	942 245-013
1571	942 245-006	942 245-014
1591	942 245-007	942 245-015
1611	942 245-008	942 245-016

7. DWDM ITU CHANNELS FOR OPTICAL MODULES

Table 11 DWDM ITU Channels for 1 or 10 Gbps , Frequency, Wavelengths

xx ITU Channel	Frequency (THz)	Wavelength λ (nm)	XFP PTN-XFP-DWDM-ER-xx 10GBASE-ER/EW DWDM 942 247-0xx	XFP PTN-XFP-DWDM-ZR-xx 10GBASE-ZR/ZW DWDM 942 248-0xx
17	191.7	1563.86	✓	✓
18	191.8	1563.05	✓	✓
19	191.9	1562.23	✓	✓
20	192.0	1561.42	✓	✓
21	192.1	1560.61	✓	✓
22	192.2	1559.79	✓	✓
23	192.3	1558.98	✓	✓
24	192.4	1558.17	✓	✓
25	192.5	1557.36	✓	✓
26	192.6	1556.56	✓	✓
27	192.7	1555.75	✓	✓
28	192.8	1554.94	✓	✓
29	192.9	1554.13	✓	✓
30	193.0	1553.33	✓	✓
31	193.1	1552.52	✓	✓
32	193.2	1551.72	✓	✓
33	193.3	1550.92	✓	✓
34	193.4	1550.12	✓	✓
35	193.5	1549.32	✓	✓
36	193.6	1548.52	✓	✓
37	193.7	1547.72	✓	✓
38	193.8	1546.92	✓	✓
39	193.9	1546.12	✓	✓
40	194.0	1545.32	✓	✓
41	194.1	1544.53	✓	✓
42	194.2	1543.73	✓	✓
43	194.3	1542.94	✓	✓
44	194.4	1542.14	✓	✓
45	194.5	1541.35	✓	✓
46	194.6	1540.56	✓	✓
47	194.7	1539.77	✓	✓
48	194.8	1538.98	✓	✓
49	194.9	1538.19	✓	✓
50	195.0	1537.40	✓	✓
51	195.1	1536.61	✓	✓
52	195.2	1535.82	✓	✓
53	195.3	1535.04	✓	✓
54	195.4	1534.25	✓	✓
55	195.5	1533.47	✓	✓
56	195.6	1532.68	✓	✓
57	195.7	1531.90	✓	✓
58	195.8	1531.12	✓	✓
59	195.9	1530.33	✓	✓
60	196.0	1529.55	✓	✓
61	196.1	1528.77	✓	✓

8. ABBREVIATIONS

BiDi	Bi-Directional SFP
CWDM	Coarse Wave Division Multiplexing
DWDM	Dense Wave Division Multiplexing
Gbps	Gigabits per Second
IFM	Interface Module
LC	Lucent Connector / Local Connector Snap
Mbps	Megabits per Second
MM	Multimode
MPLS-TP	Multiprotocol Label Switching – Transport Profile
MTBF	Mean Time Between Failures
PC	Physical Contact
QSFP	Quad Small Form Factor Pluggable
Rx	Receive
SFP	Small Form Factor Pluggable
SM	Single Mode
TRM	Transmit Receive Module
TSoP	Transparent Sonet/SDH over Packet
Tx	Transmit
UPC	Ultra Physical Contact
XFP	10G Small Form Factor Pluggable