400Gb/s QSFP-DD FR4 Transceiver

OD-PPMR4F410ST0

400Gb/s QSFP-DD FR4 2km Optical Transceiver

1. Features

- Compliant to QSFP-DD MSA Type2
- 4 CWDM wavelength lanes MUX/DEMUX
- 100G Lambda MSA 400G-FR4
- Up to 2km over SMF with FEC
- 8 x 53.125Gb/s electrical interface (400GAUI-8)
- Data Rate 106.25Gb/s (PAM4) per channel.
- Maximum power consumption 10W
- +3.3V Single Power Supply
- Duplex LC connector
- Lead-Free and RoHS compliant

Applications

400G Ethernet (400G-FR4)
Data Center Interconnect

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1Absolute Maximum Ratings

Item No	Parameter	Unit	Specification			Note
			Min	Typ.	Max	
Ab-1	Storage Temperature (Ts)	deg.C	-40		85	
Ab-2	Supply Voltage (Vcc1, VccTx, VccRx)	V	0		4	
Ab-3	Relative Humidity (non-condensing)	%	10		90	
Ab-4	Damage Threshold, each lane	dBm	4.5			

2. Operating Conditions

Item No	Items	Unit	Min.	Typ.	Max.	Remarks
Oc-1	Transmission Cable		SMF (ITU-T G.652)			
Oc-2	Case Temperature (Tc)	deg.C	0		70	
Oc-3	Power supply voltage (Vcc)	V	3.135	3.300	3.465	
Oc-4	Power Consumption	W			10	
Oc-5	Link Distance	km	0.002		2	Note 1.
Oc-6	Pre-FEC Bit Error Ratio				2.4×10^{-4}	

Notes:
1. FEC required on host system to support maximum distance.

3. Block Diagram

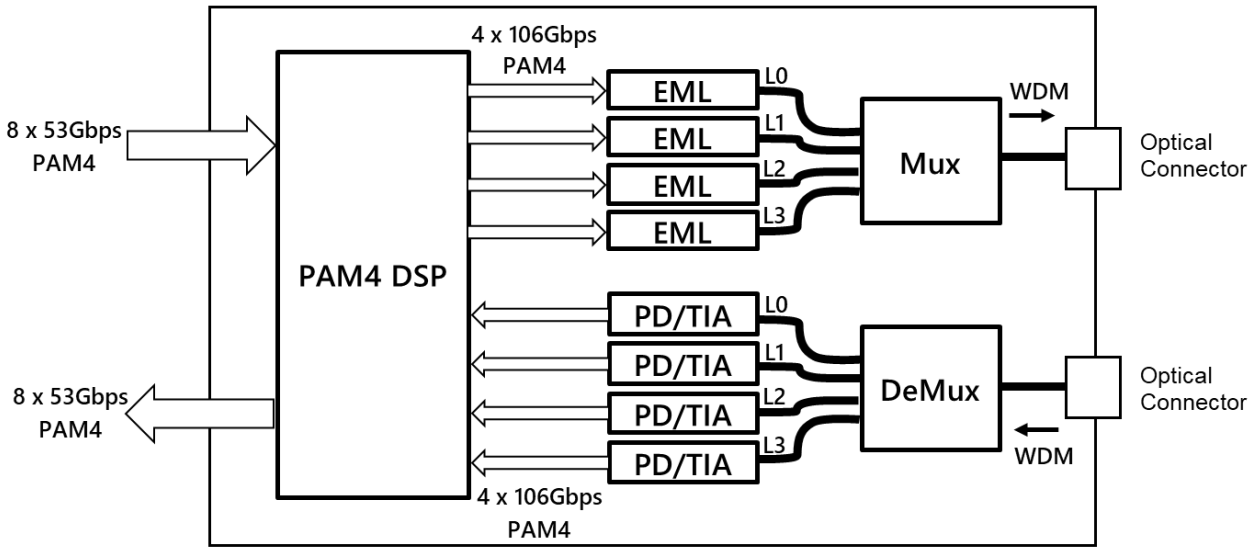


Figure 1. Block Diagram

4. Optical Interface

4.1 Transmitter Section

Item No	Parameter	Symbol	Min.	Typ.	Max.	Units	Remarks
TO-1	Data Rate			53.125		GBd	±100 ppm
TO-2	Modulation Format			PAM4			
TO-3	Center wavelength range	L0	1264.5	1271	1277.5	nm	
		L1	1284.5	1291	1297.5	nm	
		L2	1304.5	1311	1317.5	nm	
		L3	1324.5	1331	1337.5	nm	
TO-4	Side mode suppression ratio	SMSR	30			dB	
TO-5	Total Average Launch Power	Po_total			9.3	dBm	
TO-6	Average launch power, each lane	Po_avg	-3.3		3.5	dBm	Note 1.
TO-7	Outer Optical Modulation Amplitude (OMA_{outer}), each Lane	Po_oma	-0.3		3.7	dBm	Note 2.
TO-8	Transmitter and dispersion eye closure for PAM4, each Lane	TDECQ			3.4	dB	
TO-9	TDECQ - 10*$\log_{10}$ (Ceq), each Lane				3.4	dB	Note 3.
TO-10	Extinction ratio	ER	3.5		-	dB	
TO-11	Average launch power of off transmitter, each lane				-20	dBm	
TO-12	$RIN_{17.1}OMA$	RIN			-136	dB/Hz	
TO-13	Optical return loss tolerance	ORL			17.1	dB	
TO-14	Transmitter reflectance	TR			-26	dB	
TO-15	Launch Power in OMA outer minus TDECQ, each Lane for ER ≥ 4.5dB for ER < 4.5dB		 -1.7 -1.6			dB	
TO-16	Difference in Launch Power between any Two Lanes (OMA_{outer})				4	dB	

Note 1. Average launch power (min) is informative and not the principal indicator of signal strength.

Note 2. Even if the TDECQ < 1.4 dB for an extinction ratio of ≥ 4.5 dB or TDECQ < 1.3 dB for an extinction ratio of < 4.5 dB, the OMA_{outer} (min) must exceed the minimum value specified here.

Note 3. Ceq is a coefficient defined in IEEE Std 802.3-2018 clause 121.8.5.3 which accounts for reference equalizer noise enhancement.

4.2 Receiver Section

Item No	Parameter	Symbol	Min.	Typ.	Max.	Units	Remarks
RO-1	Data Rate			53.125		GBd	±100 ppm
RO-2	Modulation Format			PAM4			
RO-3	Center wavelength range	L0	1264.5	1271	1277.5	nm	
		L1	1284.5	1291	1297.5	nm	
		L2	1304.5	1311	1317.5	nm	
		L3	1324.5	1331	1337.5	nm	
RO-4	Average receiver power,each lane	Pr_avg	-7.3		3.5	dBm	Note 1
RO-5	Receiver power (OMA_{outer}), each lane	Pr_oma			3.7	dBm	
RO-6	Receiver reflectance	RR			-26	dB	
RO-7	Receiver sensitivity (OMA_{outer}), each lane				max(−4.6, SECQ – 6.0)	dBm	Note 2
RO-8	Stressed Receiver Sensitivity (OMA_{outer}), each Lane	SRS			-2.6	dBm	
RO-9	LOS Assert Level	LOSA	-20.0			dBm	
RO-10	LOS Deassert Level	LOSD			-10.3	dBm	
RO-11	LOS Hysteresis	LOSH	0.5			dB	
RO-12	Difference in Receiver Power between any Two Lanes (OMA_{outer})				4.1	dB	
RO-13	Stressed Eye Closure for PAM4 (SECQ), Lane under Test			3.4		dB	
RO-14	SECQ $-10*\log_{10}(C_{eq})$, Lane under Test			3.4		dB	
RO-15	OMA_{outer} of each Aggressor Lane			1.5		dBm	

Note 1. The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level.

Note 2. Receiver sensitivity (OMAouter) is informative and is defined for a transmitter with a value of SECQ up to 3.4 dB, Receiver sensitivity should meet the equation in the table, which is illustrated in Figure 2.

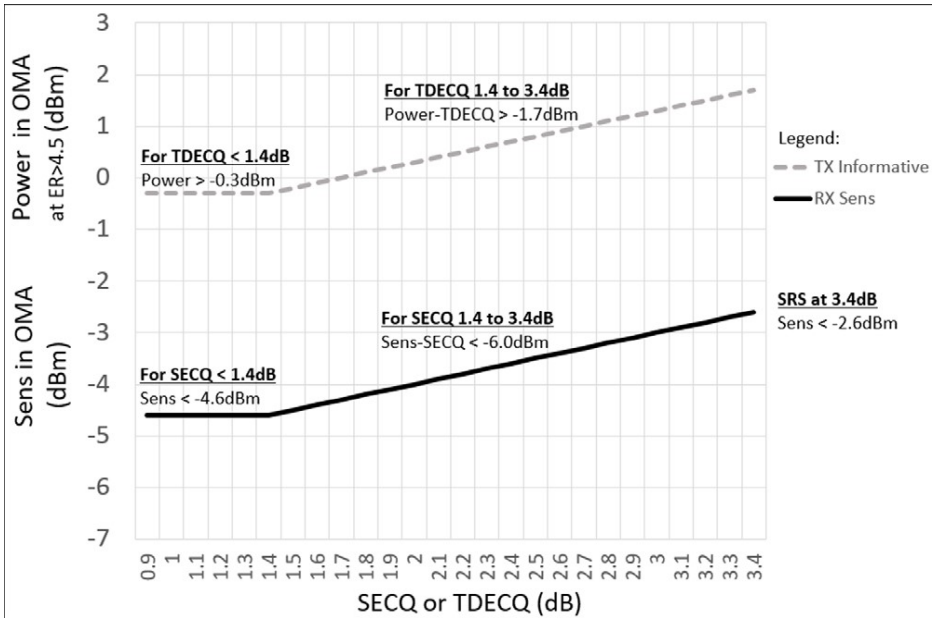


Figure2. Illustration of receiver sensitivity mask for 400G-FR4

5. Electrical Interface

5.1 High Speed electrical Interface Specifications

Table 1. Transmitter High Speed Electrical Specifications (each lane)

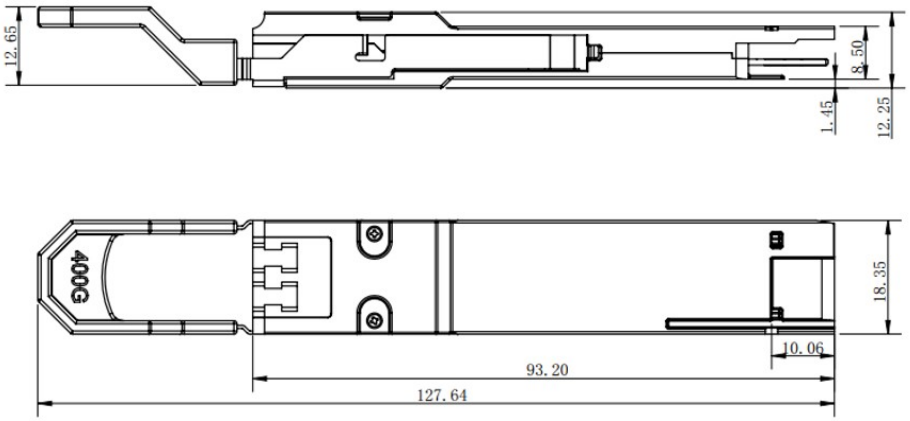
Parameter	Min.	Typ.	Max.	Units	Conditions
Signaling rate	26.5625 ± 100 ppm			Gbd	
Differential pk-pk Input voltage Tolerance	900			mVpp	IEEE 802.3bs 120E.3.1.2
Input impedance mismatch			10	%	
Single-ended Voltage Tolerance Range(min)	-0.4 to 3.3			V	
DC Common Mode input Voltage (Vcm)	-350		2850	mV	

Table 2. Receiver High Speed Electrical Specifications (each lane)

Parameter	Min.	Typ.	Max.	Units	Conditions
Signaling rate	26.5625 ± 100 ppm			Gbd	
Differential pk-pk Output voltage			900	mVpp	
AC Common Mode Output Voltage, RMS			17.5	mV	
Differential Termination Resistance Mismatch			10	%	At 1 MHz
Transition Time, 20 to 80%	9.5			ps	
Near-end Eye Symmetry Mask Width ESMW		0.265		UI	
Near-end Eye Height , Differential	70			mV	
Far-end Eye Symmetry Mask Width ESMW		0.2		UI	
Far-end Eye Height , Differential	30			mV	
Far-end Pre-cursor ISI Ratio	-4.5		2.5	%	
Common Mode Output Voltage(Vcm)	-350		2850	mV	

6. Outline Drawings

6.1 Package Outline



(Unit: mm)

Figure 3. Transceiver outline

6.2 Printed Circuit Board Connector Layout

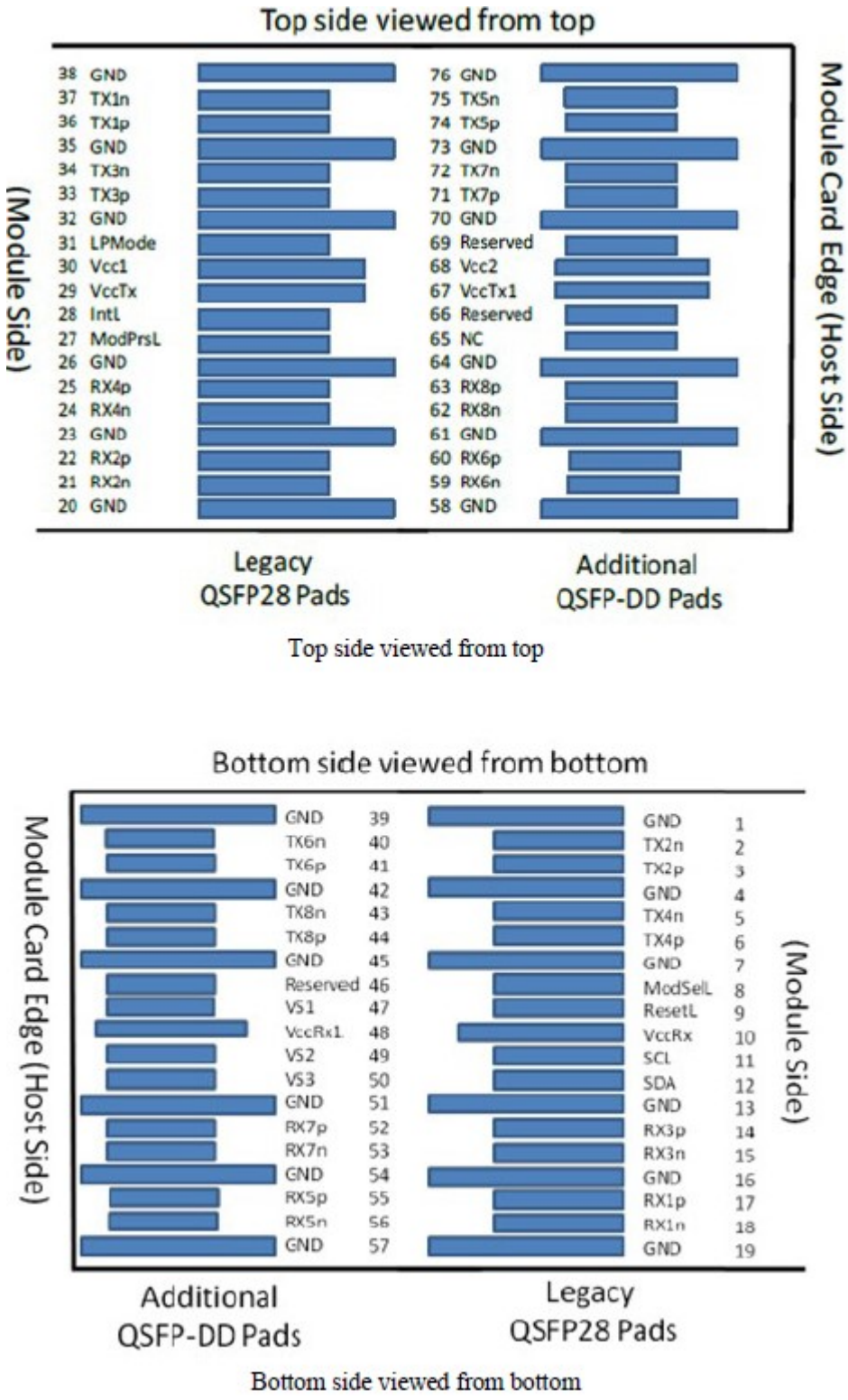


Figure 4. Pattern Layout for QSFP Printed Circuit Board

7. Pin Configuration

Table 3. Pin description

Pin #	Logic	Symbol	Description	Plug Sequence	Notes
1		GND	Ground	1B	1
2	CML-I	Tx2n	Transmitter Inverted Data Input	3B	
3	CML-I	Tx2p	Transmitter Non-Inverted Data Input	3B	
4		GND	Ground	1B	1
5	CML-I	Tx4n	Transmitter Inverted Data Input	3B	
6	CML-I	Tx4p	Transmitter Non-Inverted Data Input	3B	
7		GND	Ground	1B	1
8	LVTTL-I	ModSelL	Module Select	3B	
9	LVTTL-I	ResetL	Module Reset	3B	
10		VccRx	+3.3V Power Supply Receiver	2B	2
11	LVCMOS-I/O	SCL	2-wire serial interface clock	3B	
12	LVCMOS-I/O	SDA	2-wire serial interface data	3B	
13		GND	Ground	1B	1
14	CML-O	Rx3p	Receiver Non-Inverted Data Output	3B	
15	CML-O	Rx3n	Receiver Inverted Data Output	3B	
16		GND	Ground	1B	1
17	CML-O	Rx1p	Receiver Non-Inverted Data Output	3B	
18	CML-O	Rx1n	Receiver Inverted Data Output	3B	
19		GND	Ground	1B	1
20		GND	Ground	1B	1
21	CML-O	Rx2n	Receiver Inverted Data Output	3B	
22	CML-O	Rx2p	Receiver Non-Inverted Data Output	3B	
23		GND	Ground	1B	1
24	CML-O	Rx4n	Receiver Inverted Data Output	3B	
25	CML-O	Rx4p	Receiver Non-Inverted Data Output	3B	
26		GND	Ground	1B	1
27	LVTTL-O	ModPrsL	Module Present	3B	
28	LVTTL-O	IntL	Interrupt	3B	
29		VccTx	+3.3V Power supply transmitter	2B	2
30		Vcc1	+3.3V Power supply	2B	2
31	LVTTL-I	LPMode	Low Power Mode	3B	
32		GND	Ground	1B	1
33	CML-I	Tx3p	Transmitter Non-Inverted Data Input	3B	
34	CML-I	Tx3n	Transmitter Inverted Data Input	3B	
35		GND	Ground	1B	1
36	CML-I	Tx1p	Transmitter Non-Inverted Data Input	3B	
37	CML-I	Tx1n	Transmitter Inverted Data Input	3B	
38		GND	Ground	1B	1
39		GND	Ground	1A	1
40	CML-I	Tx6n	Transmitter Inverted Data Input	3A	

41	CML-I	Tx6p	Transmitter Non-Inverted Data Input	3A	
42		GND	Ground	1A	1
43	CML-I	Tx8n	Transmitter Inverted Data Input	3A	
44	CML-I	Tx8p	Transmitter Non-Inverted Data Input	3A	
45		GND	Ground	1A	1
46		Reserved	For future use	3A	3
47		VS1	Module Vendor Specific 1	3A	3
48		VccRx1	3.3V Power Supply	2A	2
49		VS2	Module Vendor Specific 2	3A	3
50		VS3	Module Vendor Specific 3	3A	3
51		GND	Ground	1A	1
52	CML-O	Rx7p	Receiver Non-Inverted Data Output	3A	
53	CML-O	Rx7n	Receiver Inverted Data Output	3A	
54		GND	Ground	1A	1
55	CML-O	Rx5p	Receiver Non-Inverted Data Output	3A	
56	CML-O	Rx5n	Receiver Inverted Data Output	3A	
57		GND	Ground	1A	1
58		GND	Ground	1A	1
59	CML-O	Rx6n	Receiver Inverted Data Output	3A	
60	CML-O	Rx6p	Receiver Non-Inverted Data Output	3A	
61		GND	Ground	1A	1
62	CML-O	Rx8n	Receiver Inverted Data Output	3A	
63	CML-O	Rx8p	Receiver Non-Inverted Data Output	3A	
64		GND	Ground	1A	1
65		NC	No Connect	3A	3
66		Reserved	For future use	3A	3
67		VccTx1	3.3V Power Supply	2A	2
68		Vcc2	3.3V Power Supply	2A	2
69		Reserved	For Future Use	3A	3
70		GND	Ground	1A	1
71	CML-I	Tx7p	Transmitter Non-Inverted Data Input	3A	
72	CML-I	Tx7n	Transmitter Inverted Data Input	3A	
73		GND	Ground	1A	1
74	CML-I	Tx5p	Transmitter Non-Inverted Data Input	3A	
75	CML-I	Tx5n	Transmitter Inverted Data Input	3A	
76		GND	Ground	1A	1

Note 1: QSFP-DD uses common ground (GND) for all signals and supply (power). All are common within the QSFP-DD module and all module voltages are referenced to this potential unless otherwise noted. Connect these directly to the host board signal-common ground plane. Each connector Gnd contact is rated for a steady state current of 500 mA.

Note 2: VccRx, VccRx1, Vcc1, Vcc2, VccTx and VccTx1 shall be applied concurrently. For power classes 4 and above the module differential loading of input voltage pads must not result in exceeding contact current limits. Each connector Vcc contact is rated for a steady state current of 1500 mA.

Note 3: Reserved pad recommended to be terminated with 10 k ohm to ground on the host. Pad 65 (No Connect) Shall be left unconnected within the module, optionally pad 65 may get terminated with 10 k ohm to ground on the host.

Plug Seq.: Pin engagement sequence during hot plugging.

8. Recommended interface circuit

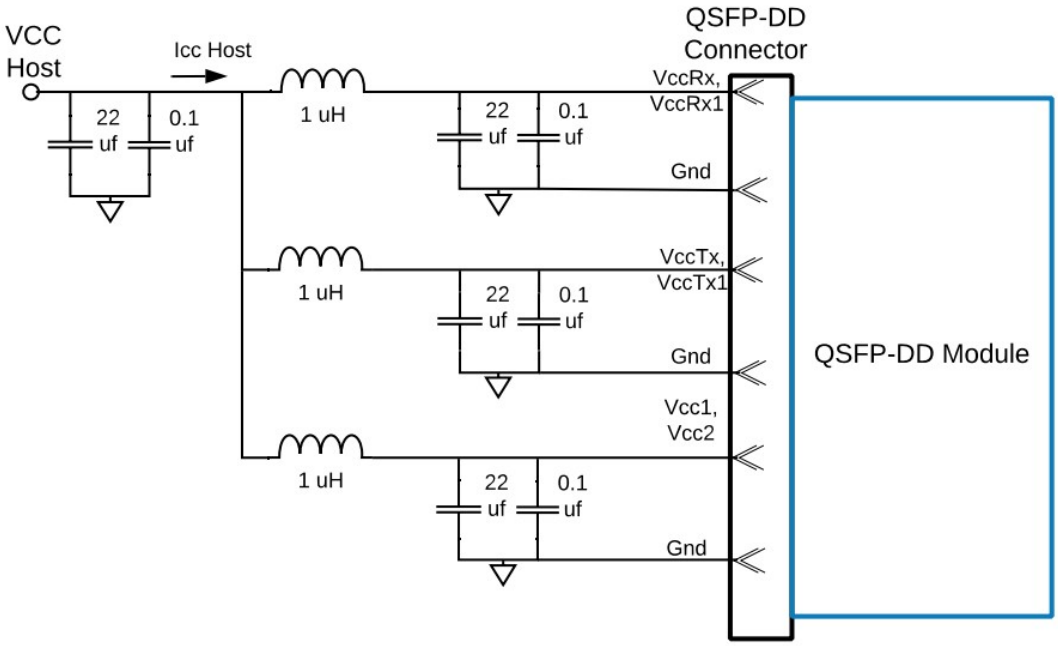


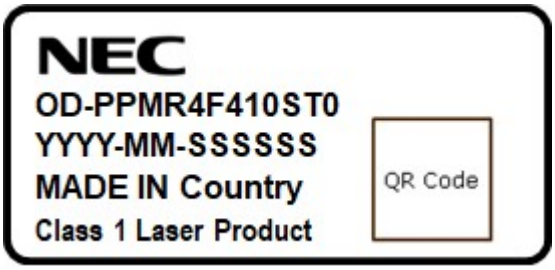
Figure 5. Recommended Host Board Supply Filtering Network

9. Digital Diagnostic Monitor Accuracy

Table 4. DDM Accuracy

Parameter	Unit	Accuracy
Tx Optical Power (Average)	dB	+/– 3
Rx Optical Power (Average)	dB	+/– 3
Channel Bias Current	%	+/– 10
Power Supply Voltage	%	+/-5
Temperature (Case)	deg.C	+/– 3

10. Label



Line 1 ; NEC logo
Line 2 ; Part Number
Line 3 ; Serial Number
Line 4 ; Country of Manufacture
Line 5; Class 1 Laser Product

11.Ordering Information

Part Number	Fiber Optical Connector	Transmission distance	Case Temperature
OD-PPMR4F410ST0	LC	Up to 2km	0 to 70 deg.C

- Revision history -

Revision	Date	Contents
01E	26th June 2024	First Release
02E	16th June 2025	Srial Number Format Changed

Area of caution

Areas of caution in the handling of laser diode products.

●This product complies with EN 60825-1:2014 + A11:2021, IEC 60825-1:2014, IEC 60825-1:2007 and 21 CFR 1040.10, which correspond to the category “Class 1 Laser Product” under EN regulation, “Class 1 Laser Product” under IEC regulation and “Class I Laser product” under FDA regulation.

●During operations, the laser diode discharges red beams and infrared beams invisible to the eye. Since it is very hazardous if these beams directly, or bypassing through a lens, get in one’s eyes, please try to avoid this.

● Take proper Electrostatic-discharge (ESD) precautions while handling the device. The device is sensitive to ESD.

● May cause of damage if drop or subject to shock. This product includes optical parts.

●Caution-use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Areas of caution in handling GaAs.

There are some products in our catalogue that use GaAs. Please strictly adhere to the caution items appearing below, in order to prevent dangerous situations.

○Do not put the product in your mouth.

○Do not turn the product into a vaporous or powdered form through burning, grinding or chemical processing.

○When disposing of the product, follow related laws, and your company’s internal waste control regulations.

Areas of caution in handling optical fiber products.

●Be careful not to pierce your skins as the tips of optical fibers are extremely sharp. Especially you must attention in case of hazardous if they pierce one’s eyes.

● Do not apply extreme stress to optical fiber, or it may cause deterioration of characteristics or disconnection. The force of pull should be less than 200gf, and a radius for bending should be larger than R30 mm

● Do not hold only optical fiber or module package, because extreme stress is easy to apply to the optical fiber edge of the module

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