NEC

100Gbps QSFP28 BiDi Transceiver

OD-PPSQ1LBwxST0

100GBASE-LR1 QSFP28 BiDi Optical Transceiver

1. Features

- Compliant to QSFP28 MSA(SFF-8665)
- Digital Diagnostic Monitoring Function (SFF-8636)
- 4 x 25G serial Interface (CEI-28G-VSR)
- Supports 106.25Gb/s bit rate
- Up to 10km over SMF (ITU-T G.652)
- Single Power Supply Voltage of +3.3V
- Hot-pluggable 38 pin electrical interface
- LC receptacle connector
- Lead-Free and RoHS Compliant

Applications
100G BASE-LR1 Ether CAUI-4

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2. Product Number Information

O D – P P S Q 1 L B w x S T 0

Data Rate
0 : Ether CAUI-4

Transmitter wavelength
U : 1291nm/1311nm
D : 1311nm/1291nm

Case Temperature
1 : 0 deg.C to +70 deg.C
3 : –40 deg.C to +85 deg.C

3. Absolute 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	-	3.6	
Ab-3	Relative Humidity (non-condensing)	%	0	-	85	
Ab-4	Damage Threshold, each lane	dBm	5.8	-	-	

4. 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	OD-PPSQ1LB1xST0
			–40		85	OD-PPSQ1LB3xST0
Oc-3	Power supply voltage (Vcc)	V	3.135	3.300	3.465	
Oc-4	Power Consumption	W			4.0	OD-PPSQ1LB1xST0
					4.5	OD-PPSQ1LB3xST0
Oc-5	Link Distance	km			10	

5. Block Diagram

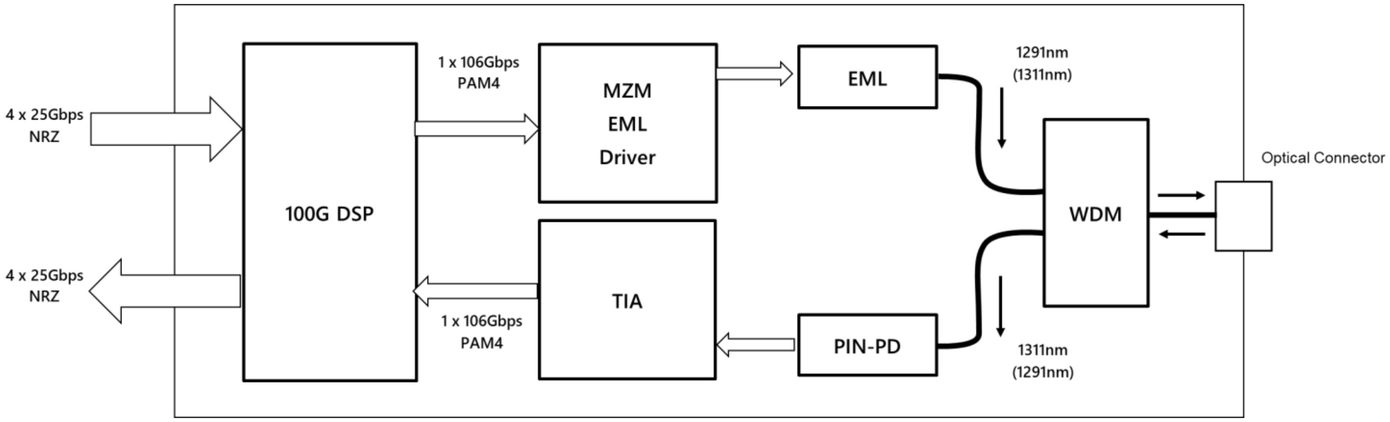


Figure 1. Block Diagram

6. Optical Interface

6.1 Transmitter Section

Item No	Parameter	Symbol	Min.	Typ.	Max.	Units	Remarks
TO-1	Data Rate			53.125		GBd	±100 ppm(CAUI-4)
TO-2	Modulation Format		PAM4				
TO-3	Center wavelength range	WL_{tx}	1284.5	1291	1297.5	nm	OD-PPSQ1LBwUST0
			1304.5	1311	1317.5		OD-PPSQ1LBwDST0
TO-5	Side mode suppression ratio	SMSR	30	-	-	dB	
TO-6	Average launch power	Po_avg	-1.9	-	4.8	dBm	Note 1.
TO-7	Outer Optical Modulation Amplitude for TECQ<1.4dB for 1.4dB≦TECQ	Po_oma	1.1 -0.3+TECQ	- -	5.0 -	dBm	
TO-8	Transmitter and dispersion eye closure	TDECQ			3.4	dB	
TO-9	Transmitter eye closure	TECQ			3.4	dB	
TO-10	|TDECQ-TECQ| (max)				2.5	dB	
TO-11	Extinction ratio	ER	3.5	-	-	dB	
TO-12	Average launch power of off transmitter		-	-	-15	dBm	
TO-13	$\text{RIN}_{15.6}$OMA	RIN	-	-	-136	dB/Hz	
TO-14	Optical return loss tolerance	ORL	-	-	15.6	dB	
TO-15	Transmitter reflectance	TR	-	-	-26	dB	

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

6.2 Receiver Section

Item No	Parameter	Symbol	Min.	Typ.	Max.	Units	Remarks
RO-1	Data Rate			53.125		GBd	±100 ppm(CAUI-4)
RO-2	Modulation Format		PAM4				
RO-3	Center wavelength range	WL_{rx}	1304.5	1311	1317.5	nm	OD-PPSQ1LBwUST0
			1284.5	1291	1297.5		OD-PPSQ1LBwDST0
RO-4	Average receiver power	Pr_avg	-8.2	-	4.8	dBm	Note 1
RO-5	Receiver power (OMA_{outer})	Pr_oma	-	-	5.0	dBm	
RO-6	Receiver reflectance	RR	-	-	-26	dB	
RO-7	Receiver sensitivity (OMA_{outer}) for TECQ<1.4dB for 1.4dB≦TECQ				-6.1 -7.5+TECQ	dBm	
RO-8	LOS Assert Level	LOSA	-20.0	-	-14.0	dBm	
RO-9	LOS Deassert Level	LOSD	-	-	-11.0	dBm	
RO-10	LOS Hysteresis	LOSH	0.5	-	-	dB	

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

7. Electrical Interface

7.1 Low Speed Signal Descriptions

7.1.1 ModSelL

ModSelL is an input signal. When held low by the host, the module responds to two-wire serial communication commands. The ModSelL signal allows the use of multiple modules on a single two-wire interface. When ModSelL is high, the module shall not respond to or acknowledge any two-wire interface communication from the host. The ModSelL signal input node shall be pulled towards Vcc in the module.

In order to avoid conflicts, the host system shall not attempt two-wire interface communications within the ModSelL de-assert time after any modules are deselected. Similarly, the host shall wait at least for the period of the ModSelL assert time before communicating with the newly selected module. The assertion and de-assertion periods of different modules may overlap as long as the above timing requirements are met.

7.1.2 ResetL

The ResetL signal shall be pulled towards Vcc in the module. A low level on ResetL for longer than the minimum pulse length (t_Reset_init) initiates a complete module reset, returning all user module settings to their default state. Module Reset Assert Time (t_init) starts on the rising edge after the low level of the ResetL pad is released. During the execution of a reset (t_init) the host shall disregard all status bits until the module indicates a completion of reset interrupt. The module indicates this by asserting "low" an IntL signal with the Data_Not_Ready bit negated. However, on power up (including hot insertion) the module should post this completion of reset interrupt without the host pulling ResetL low.

7.1.3 LPMode

The LPMode pin shall be pulled up to Vcc in the module. The pin is a hardware control used to put modules into a low power mode when high. By using the LPMode pin and a combination of the Power_override and Power_set software control bits (Address A0h, byte 93 bits 0,1), the host controls how much power a module can dissipate. The allowed QSFP28 power consumption is shown in below truth table.

LPMode PIN state	Power_override bit	Power_set bit	Power Allowed
1	0	X	1.5W
0	0	X	4.5W
X	1	1	1.5W
X	1	0	4.5W

7.1.4 ModPrsL

ModPrsL is pulled up to Vcc_Host on the host board and grounded in the module. The ModPrsL is asserted "Low" when inserted and deasserted "High" when the module is physically absent from the host connector.

7.1.5 IntL

IntL is an output pin. When IntL is "Low", it indicates a possible module operational fault or a status critical to the host system. The host identifies the source of the interrupt using the two-wire serial interface. The IntL pin is an open collector output and shall be pulled to host supply voltage on the host board. The INTL pin is deasserted "High" after completion of reset, when byte 2 bit 0 (Data Not Ready) is read with a value of '0' and the flag field is read (see SFF-8636).

7.2 High Speed electrical Interface Specifications

Table 1. Transmitter High Speed Electrical Specifications

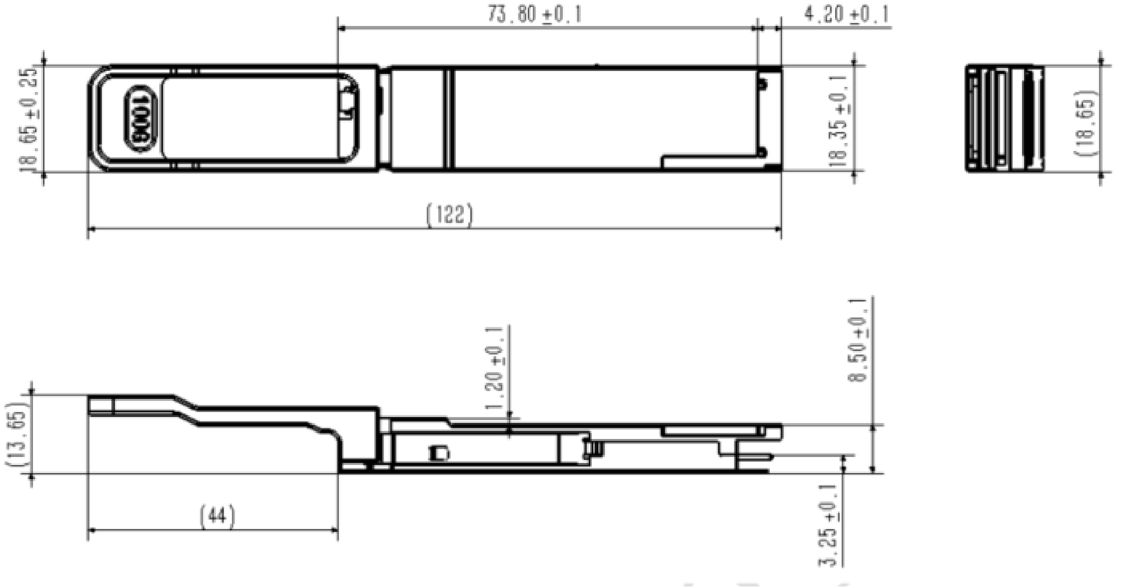
Parameter	Min.	Typ.	Max.	Units	Conditions
Signaling rate	25.78			Gbps	CAUI-4
Differential Input Impedance	-	100	-	ohm	
Differential Input voltage per lane	-	-	900	mVpp	
Input impedance mismatch	-	-	10	%	
Input High Voltage	2	-	Vcc+0.3-	V	
Input Low Voltage	-0.3	-	0.8	V	

Table 2. Receiver High Speed Electrical Specifications

Parameter	Min.	Typ.	Max.	Units	Conditions
Signaling rate	25.78			Gbps	CAUI-4
Common Mode Voltage (Vcm)	-350	-	2850	mV	
Common Mode Noise, RMS	-	-	17.5	mV	
Differential Termination Resistance Mismatch	-	-	10	%	At 1 MHz
Transition Time, 20 to 80%	9.5	-	-	ps	
Vertical Eye Closure (VEC)	-	-	6.5	dB	
Eye Width at 10-15 probability (EW15)	0.57	-	-	UI	
Eye Height at 10-15 probability (EH15)	228	-	-	mV	

8. Outline Drawings

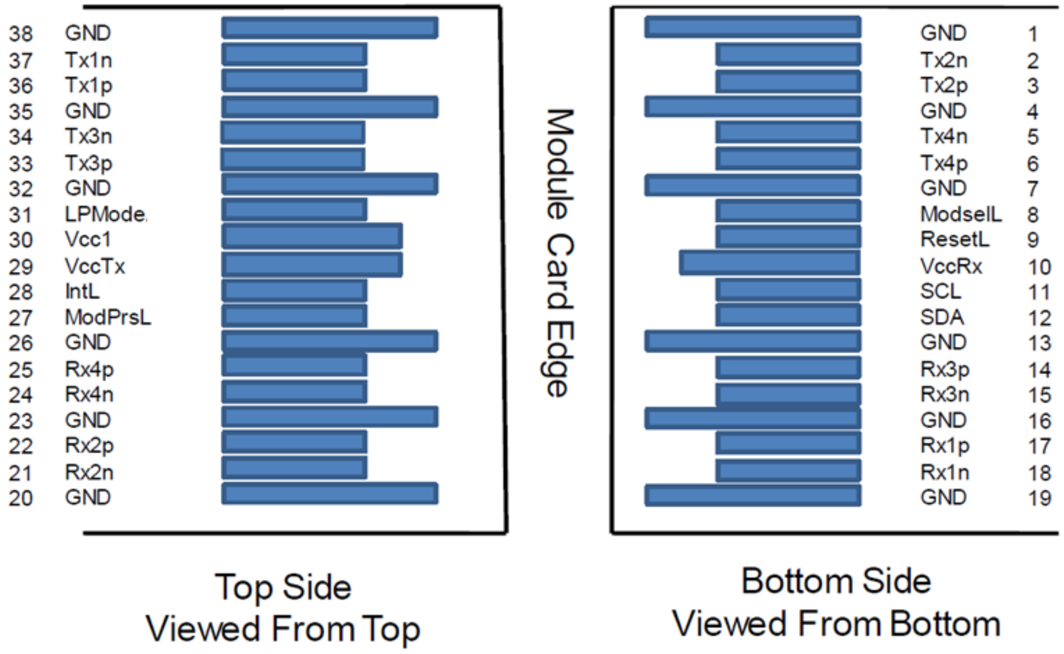
8.1 Package Outline



(Unit: mm)

Figure 2. Transceiver outline

8.2 Printed Circuit Board Connector Layout



38	GND	GND	1
37	Tx1n	Tx2n	2
36	Tx1p	Tx2p	3
35	GND	GND	4
34	Tx3n	Tx4n	5
33	Tx3p	Tx4p	6
32	GND	GND	7
31	LPMode	ModselL	8
30	Vcc1	ResetL	9
29	VccTx	VccRx	10
28	IntL	SCL	11
27	ModPrsL	SDA	12
26	GND	GND	13
25	Rx4p	Rx3p	14
24	Rx4n	Rx3n	15
23	GND	GND	16
22	Rx2p	Rx1p	17
21	Rx2n	Rx1n	18
20	GND	GND	19

Figure 3. Pattern Layout for QSFP Printed Circuit Board

9. Pin Configuration

Table 3. Pin description

Pin No.	Symbol	Function	Plug Seq.	Notes
case	case	Module case	-	Note 1
1	GND	Ground	1st	Note 2
2	Tx2n	Transmitter Inverted Data Input	3rd	Note 5
3	Tx2p	Transmiter Non-Inverted Data Input	3rd	Note 5
4	GND	Ground	1st	Note 2
5	Tx4n	Transmitter Inverted Data Input	3rd	Note 5
6	Tx4p	Transmiter Non-Inverted Data Input	3rd	Note 5
7	GND	Ground	1st	Note 2
8	ModSelL	Module Select	3rd	Described in Section 6.1
9	ResetL	Module Reset	3rd	Described in Section 6.1
10	VccRx	+3.3V Power Supply Receiver	2nd	3.3 (+/-) 5% , Note 4
11	SCL	Two-wire interface clock	3rd	Note 3
12	SDA	Two-wire interface data	3rd	Note 3
13	GND	Ground	1st	Note 2
14	Rx3p	Receiver Non-Inverted Data Output	3rd	Note 6
15	Rx3n	Receiver Inverted Data Output	3rd	Note 6
16	GND	Ground	1st	Note 2
17	Rx1p	Receiver Non-Inverted Data Output	3rd	Note 6
18	Rx1n	Receiver Inverted Data Output	3rd	Note 6
19	GND	Ground	1st	Note 2
20	GND	Ground	1st	Note 2
21	Rx2n	Receiver Inverted Data Output	3rd	Note 6
22	Rx2p	Receiver Non-Inverted Data Output	3rd	Note 6
23	GND	Ground	1st	Note 2
24	Rx4n	Receiver Inverted Data Output	3rd	Note 6
25	Rx4p	Receiver Non-Inverted Data Output	3rd	Note 6
26	GND	Ground	1st	Note 2
27	ModPrsL	Module Present	3rd	Note 3
28	IntL	Interrupt	3rd	Described in Section 6.1
29	VccTx	+3.3V Power Supply Transmitter	2nd	3.3 (+/-) 5% , Note 4
30	Vcc1	+3.3V Power Supply	2nd	3.3 (+/-) 5% , Note 4
31	LPMode	Low Power Mode	3rd	Described in Section 6.1
32	GND	Ground	1st	Note 2
33	Tx3p	Transmiter Non-Inverted Data Input	3rd	Note 5
34	Tx3n	Transmitter Inverted Data Input	3rd	Note 5
35	GND	Ground	1st	Note 2
36	Tx1p	Transmiter Non-Inverted Data Input	3rd	Note 5
37	Tx1n	Transmitter Inverted Data Input	3rd	Note 5
38	GND	Ground	1st	Note 2

Plug Seq.: Pin engagement sequence during hot plugging.

1) The case makes electrical contact to the cage before any of the board edge contacts are made.

2) The module signal ground contacts, GND should be isolated from the module case.

3) SCL is the clock line of two wire serial interface for serial ID.
SDA is the data line of two wire serial interface for serial ID.
ModPrsL is grounded by the module to indicate that the module is present.

4) VccRx, VccTx and Vcc1 are the receiver, transmitter and module power supplies. They are defined as 3.3V±5% at the QSFP connector pin. Recommended host board power supply filtering is shown below. Inductors with DC resistance of less than 0.1 Ω should be used in order to maintain the required voltage at the host edge card connector.
It is recommended that the 22uF capacitors each have an equivalent series resistance of 0.22 Ω.

5) Tx1p/n - Tx4p/n are the differential transmitter inputs. They are AC-coupled, differential lines with 100ohm differential termination inside the module. See Section 7.2 for detail electrical specification.

6) Rx1p/n - Rx4p/n are the differential receiver outputs. They are AC coupled 100ohm differential lines which should be terminated with 100ohm (differential) at the host. See Section 7.2 for detail electrical specification.

10. Recommended interface circuit

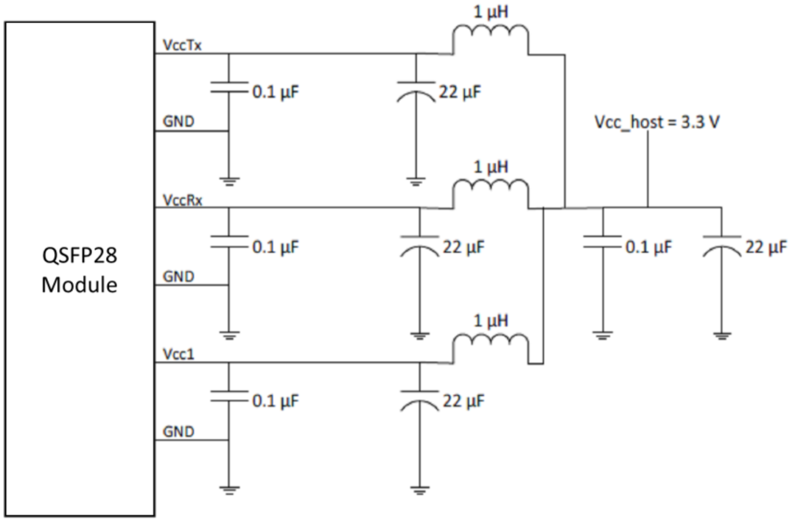


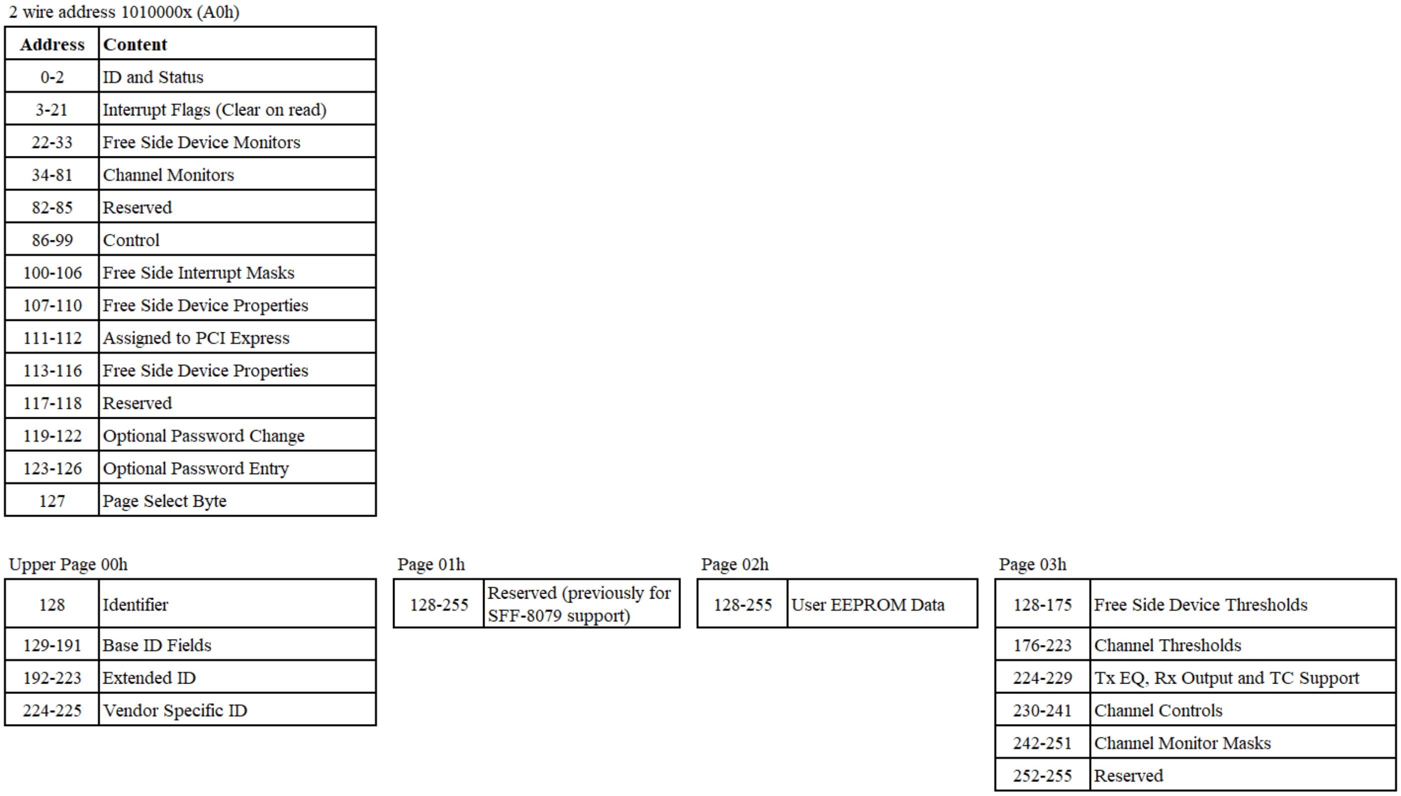
Figure 4. Recommended Host Board Supply Filtering Network

11. Digital Diagnostic Monitor Accuracy

Table 4. DDM Accuracy

Parameter	Unit	Accuracy
Tx Optical Power (Average)	dB	+/– 3
Rx Optical Power (Average)	dB	+/– 3
Bias Current	%	+/– 10
Power Supply Voltage	V	+/– 0.1
Temperature (Case)	deg.C	+/– 3

12. Memory map



2 wire address 1010000x (A0h)

Address	Content
0-2	ID and Status
3-21	Interrupt Flags (Clear on read)
22-33	Free Side Device Monitors
34-81	Channel Monitors
82-85	Reserved
86-99	Control
100-106	Free Side Interrupt Masks
107-110	Free Side Device Properties
111-112	Assigned to PCI Express
113-116	Free Side Device Properties
117-118	Reserved
119-122	Optional Password Change
123-126	Optional Password Entry
127	Page Select Byte

Upper Page 00h

128	Identifier
129-191	Base ID Fields
192-223	Extended ID
224-225	Vendor Specific ID

Page 01h

128-255	Reserved (previously for SFF-8079 support)

Page 02h

128-255	User EEPROM Data

Page 03h

128-175	Free Side Device Thresholds
176-223	Channel Thresholds
224-229	Tx EQ, Rx Output and TC Support
230-241	Channel Controls
242-251	Channel Monitor Masks
252-255	Reserved

Figure 5. Memory map

Note.1 Current Address Read sequence is not supported. Please use Random Read sequence, or Sequential Address Read starting with Random Read to read A0h EEPROM address.

13. Label

NEC
OD-PPSQ1xxxxxxx
YYYY-MM ZZZZZZ
Txyyyynm/Rxyyyynm
MADE IN CHINA
Class 1 Laser Product

Line 1 ; NEC logo
Line 2 ; Part Number (depend on each PN)
Line 3 ; Year, Month of Manufacture/2space/6-digit Serial Number
Line 4 ; Wavelength: Tx yyyynm/Rx yyyynm (depend on each PN)
Line 5 ; Country of Manufacture
Line 6 ; Class 1 Laser Product

14. Ordering Information

Part Number	Fiber Optical Connector	Pull tab color	Tx wavelength	Case Temperature
OD-PPSQ1LB1UST0	LC	Golden Yellow	1291 nm	0 to 70 deg.C
OD-PPSQ1LB1DST0		Blue	1311 nm	
OD-PPSQ1LB3UST0		Golden Yellow	1291 nm	–40 to 85 deg.C
OD-PPSQ1LB3DST0		Blue	1311 nm	

- Revision history -

Revision	Date	Contents
01	7th July. 2023	Initial Release
02	31st July. 2023	Add I-temp

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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