

SNR-SFP56-DD-LR-10

Single-Mode, 100G SFP-DD

With LC interface

Features

- ◆ Supports 100Gbps
- ◆ 100G Lambda MSA 100G-LR Specification Compliant
- ◆ Single 3.3V Power Supply
- ◆ Power Dissipation < 3.5W
- ◆ Up to 10km over SMF with FEC
- ◆ SFP-DD MSA Compliant
- ◆ 2x53.125Gbps (PAM4) electrical interface
- ◆ LC duplex connector
- ◆ Commercial Case Temperature Range of 0°C to 70°C
- ◆ I2C Interface with Integrated Digital Diagnostic Monitoring
- ◆ Safety Certification: TUV/UL/FDA*1
- ◆ RoHS Compliant

Applications

- ◆ 100G Ethernet
- ◆ Data Center

Ordering information

Part No.	Data Rate	Fiber	Distance	Interface	Temp.
SNR-SFP56-DD-LR-10	100Gbps	SMF	10km	LC	0~+70°C

Note1: For the latest certification information, please check with NAG.

Note2: Over SMF.

Product Description

SNR's SFP-DD transceiver module is designed for use in 100 Gigabit Ethernet links over 10km single mode fiber. The module incorporates 1 channel optical signal, on 1311nm center wavelength, operating at 100Gbps data rate. This module has 2 independent electrical input/output channels which can convert 2 channels of 50Gbps (PAM4) electrical input data to 1 channel of 100Gbps (PAM4) optical signal, and also can convert 1 channel of 100Gbps (PAM4) optical signal to 2 channels of 50Gbps (PAM4) electrical output data. The electrical interface of the module is compliant with the 100GAUI-2 and SFP-DD MSA.

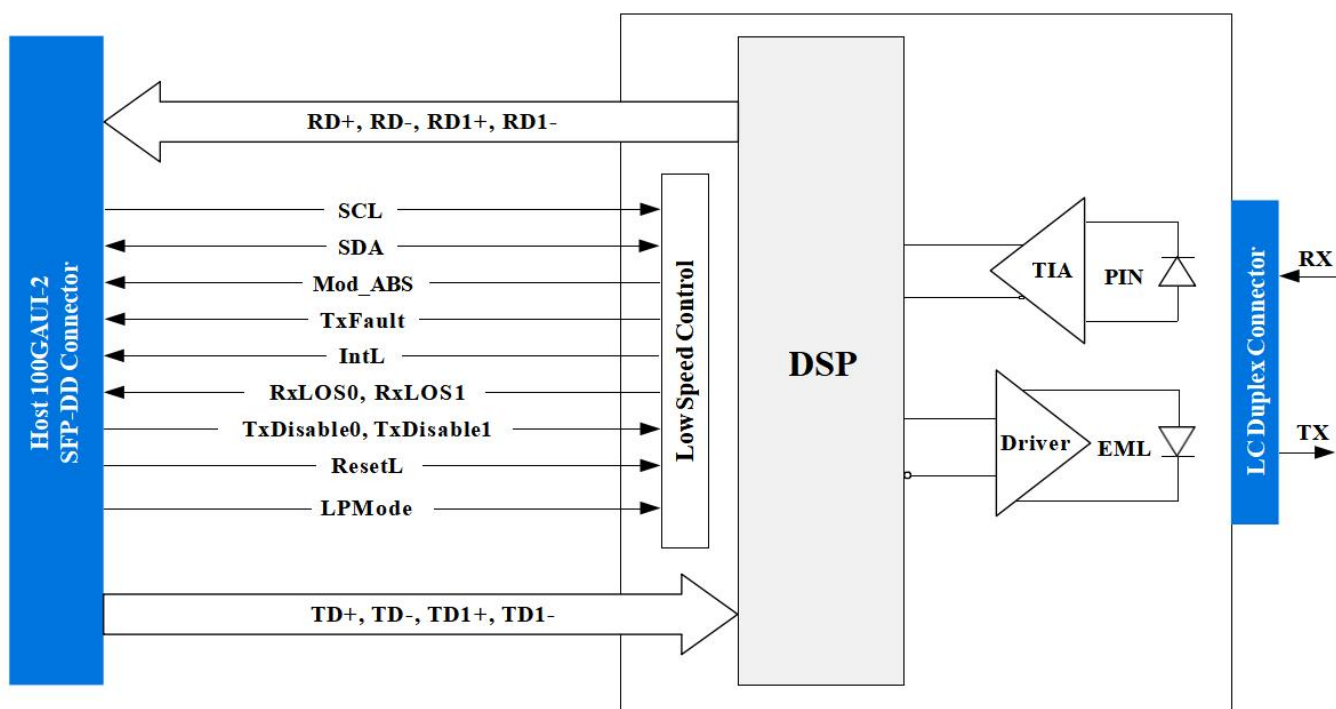


Figure 1: Transceiver Block Diagram

Only one lane shown for simplicity

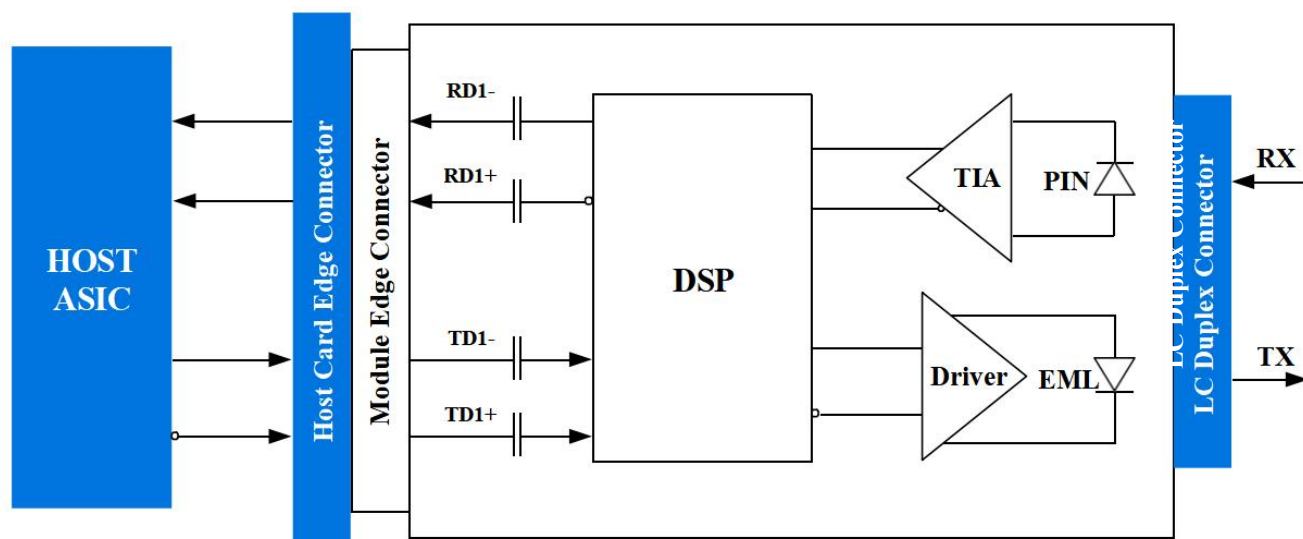


Figure 2: Application Reference Diagram

Transmitter

As shown in Figure 1, the transmitter path of the transceiver contains a 2x50Gbps 100GAUI-2 electrical input, integrated electrical multiplexer, EML driver, EML Laser and diagnostic monitor. The integrated electrical multiplexer converts 2 channels of 50Gbps (PAM4) electrical input data to 1 channel of 100Gbps (PAM4) optical signal.

Receiver

As shown in Figure 1, the receiver path of the transceiver contains a PIN photodiode, trans-impedance amplifier (TIA), integrated de-multiplexer and 2x50Gbps 100GAUI-2 compliant electrical output block. The integrated de-multiplexer converts 1 channel of 100Gbps (PAM4) optical signal to 2 channels of 50Gbps (PAM4) electrical output data.

High Speed Electrical Signal Interface

The interface between SFP-DD module and Host ASIC is shown in Figure 2. The high speed signal lines are internally AC-coupled and the electrical inputs are internally terminated to 100 Ohms differential. All transmitter and receiver electrical channels are compliant to 100GAUI-2 specification per IEEE 802.3cd.

Control Signal Interface

The module has the following low speed signals for control and status: TxDisable0, TxDisable1, RxLOS0, RxLOS1, TxFault, IntL, Mod_ABS, LPMode and ResetL. In addition, there is an industry standard two wire serial interface scaled for 3.3V LVTTTL. The definition of control signal interface and the registers of the serial interface memory are further defined in the Control Interface& Memory Map section.

Handling and Cleaning

Exposure to current surges and overvoltage events can cause immediate damage to the transceiver module. Observe the precautions for normal operation of electrostatic discharge sensitive equipment, and attention should also be taken to restrict exposure to the conditions defined in the absolute maximum ratings.

Optical connectors will be exposed as long as the port plug is not inserted, so always pay attention to protection. Each module is equipped with a port guard plug to protect the optical ports. The protective plug shall always be in place whenever the optical fiber is not inserted. Before inserting the optical fiber, it is recommended to clean the end of the optical fiber connector to avoid contamination of the module optical port due to dirty connector. If contamination occurs, use standard LC port cleaning methods.

Absolute Maximum Ratings

Exceeding the absolute maximum ratings table may cause permanent damage to the device. This is just an emphasized rating, and does not involve the functional operation of the device that exceeds the specifications of this technical specification under these or other conditions. Long-term operation under absolute maximum ratings will affect the reliability of the device.

Parameter	Symbol	Min.	Max.	Unit
Storage Temperature	Ts	-40	+85	°C
Supply voltage	Vcc	-0.5	3.6	V

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Damage threshold	$R_{x\text{dmg}}$	5.5		dBm
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Recommended Operating Conditions^{*note3}

For operations beyond the recommended operating conditions, optical and electrical characteristics are not defined, reliability is not implied, and such operations for a long time may damage the module

Parameter	Symbol	Min.	Typical	Max.	Unit
Operating case temperature ^{*note4}	T _c	0		70	°C
Storage temperature	T _s	-40		+85	°C
Power supply voltage	V _{cc}	3.135	3.3	3.465	V
Operating relative humidity	RH	5		85	%
Fiber Length (OM3)				30	m
Fiber Length (OM4)				50	m
Power dissipation	P _D			3.5	W
Electrical signal rate			26.5625		Gbaud
Optical signal rate			53.125		Gbaud
Power supply noise ^{*note5}				66	mVpp
Receiver differential data output load			100		Ohm
Fiber length (9μm SMF) ^{*note6}				10	km

Note3: Power supply specifications, instantaneous, sustained and steady state current compliant with SFP-DD MSA power classification.

Note4: The position of case temperature measurement is shown in Figure 9.

Note5: Power supply noise is defined as the peak-to-peak noise amplitude over the frequency range at the host supply side of the recommended power supply filter with the module and recommended filter in place. Voltage levels including peak-to-peak noise are limited to the recommended operating range of the associated power supply. See Figure 7 for recommended power supply filter.

Note6: 9μm SMF. The maximum link distance is based on an allocation of 1dB of attenuation and 3dB total connection and splice loss. The loss of a single connection shall not exceed 0.5dB.

General Electrical Characteristics

Unless otherwise stated, the following characteristics are defined under recommended operating conditions.

Parameter	Symbol	Min.	Typ.	Max	Unit
Transceiver Power Consumption				3.5	W
Transceiver Power Supply Total Current				1010.1	mA
AC Coupling Internal Capacitor			0.1		μF

Reference Points

Test Point	Description
TP1	Input to module compliance board through mated module compliance board and module connector. Used to test module input.
TP2	Optical transmitter output as measured at the end of the optical module.
TP3	Closest test point to the presumed optical receiver input.

TP4	Module output through the compliance board connectors at the output of the module compliance board. Also used to calibrate host input compliance signals.
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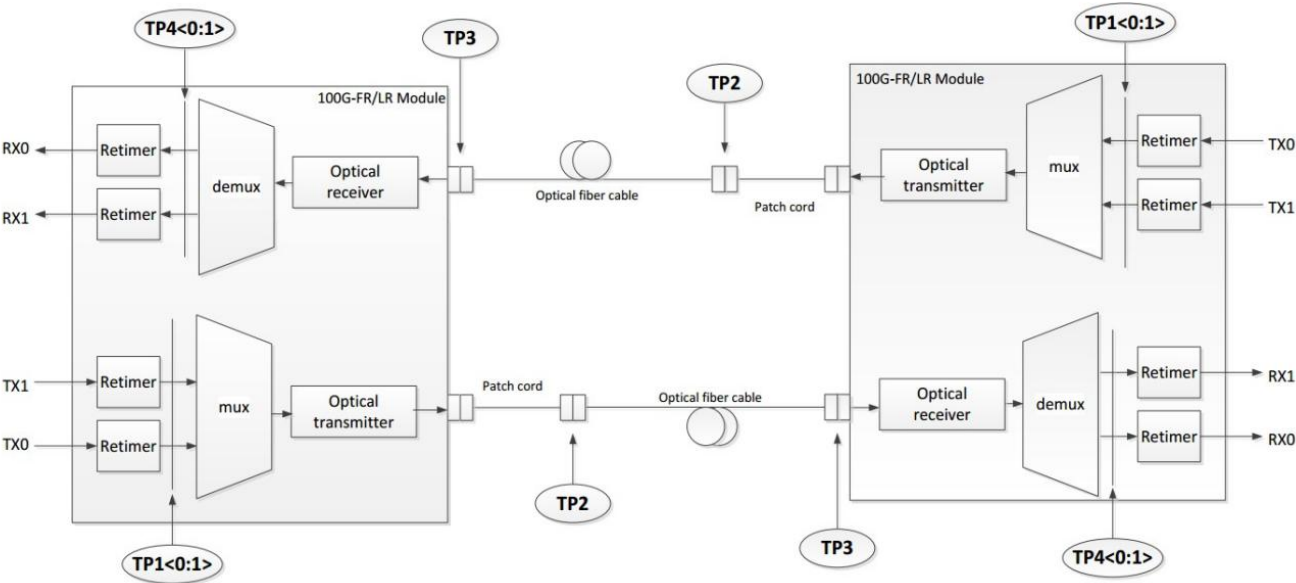


Figure 3: 100G-LR transmit/receive paths

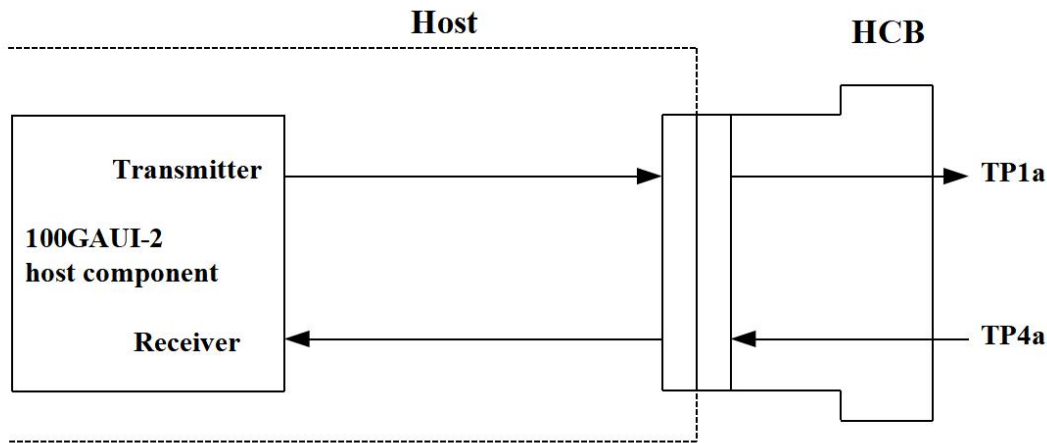


Figure 4: IEEE 802.3 100GAUI-2 compliance points TP1a, TP4a

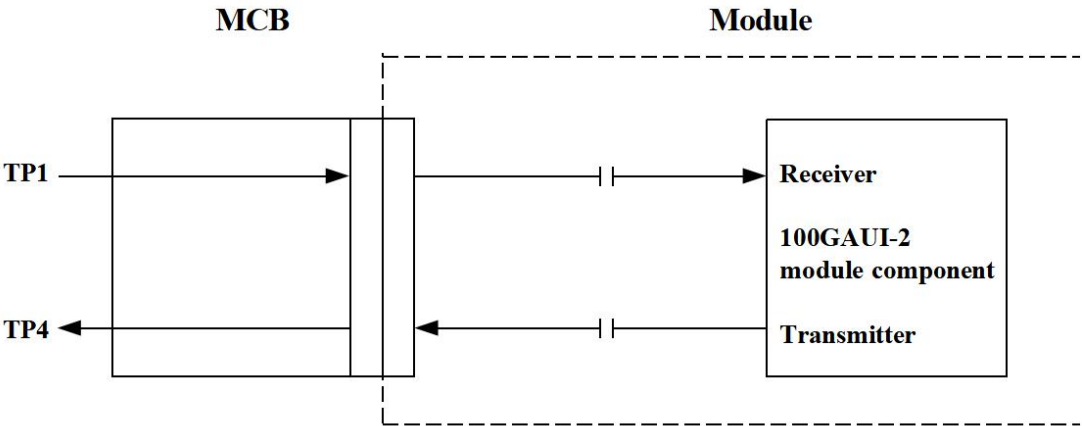


Figure 5: IEEE 802.3 100GAUI-2 compliance points TP1, TP4

High Speed Electrical Input Characteristics

Parameter	Test Point	Min.	Typical	Max.	Unit	Conditions
Transmitter						
Differential peak-peak input voltage tolerance	TP1a	900			mVp-p	
Differential input impedance	TP1	90	100	110	Ohm	
Module stressed input test	TP1a					See 802.3bs 120E.3.4.1
Output rise/fall time	TP1a	10			ps	20%~80%
Eye width	TP1a	0.22			UI	all 3 PAM4 eyes, 1E-5
Eye height, differential	TP1a	32			mV	all 3 PAM4 eyes, 1E-5
DC common mode voltage (Vcm) *note7	TP1	-350		2850	mV	

High Speed Electrical Output Characteristics

Unless otherwise stated, the following characteristics are defined under recommended operating conditions.

Parameter	Test Point	Min.	Typical	Max.	Unit	Conditions
Differential peak-peak output voltage	TP4			900	mVp-p	
Differential output impedance	TP4	90	100	110	Ohm	
Output rise/fall time	TP4	9.5			ps	20%~80%
Eye width	TP4	0.265			UI	all 3 PAM4 eyes, 1E-5
Near-end Eye height differential	TP4	70			mV	all 3 PAM4 eyes, 1E-5
Far-end Eye height differential	TP4	30			mV	all 3 PAM4 eyes, 1E-5
DC common mode voltage (Vcm) *note7	TP4	-350		2850	mV	

Note7: Vcm is generated by the host. Specification includes effects of ground offset voltage.

High Speed Optical Transmitter Characteristics

Unless otherwise stated, the following characteristics are defined under recommended operating conditions.

Optical Characteristics @TP2 Test Point

Parameter	Symbol	Min.	Typical	Max.	Unit
Transmitter					
Signaling speed			53.125		Gbaud
Modulation format			PAM4		
Center wavelength	λ_c	1304.5	1311	1317.5	nm
Side-mode suppression ratio	SMSR	30			dB
Extinction ratio	ER	3.5			dB

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Parameter	Symbol	Min.	Typical	Max.	Unit
Transmit OMA	Tx _{OMA}	0.7		4.7	dBm
Transmit average ^{*note8}	Tx _{AVG}	-1.4		4.5	dBm
Launch power in OMA _{outer} minus TDECQ ^{*note9}		-0.7			dBm
Launch power in OMA _{outer} minus TDECQ ^{*note10}		-0.6			dBm
Transmitter and dispersion eye closure	TDECQ			3.4	dB
Optical return loss tolerance ^{*note11}				15.6	dB

Note8: Average launch power (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.

Note9: for ER≥4.5dB.

Note10: for ER<4.5dB.

Note11: Transmitter reflectance is defined looking into the transmitter.

High Speed Optical Receiver Characteristics

Unless otherwise stated, the following characteristics are defined under recommended operating conditions.

Optical Characteristics @TP3 Test Point

Parameter	Symbol	Min.	Typical	Max.	Unit
Signaling speed			53.125		Gbaud
Center wavelength	λ_c	1304.5	1311	1317.5	nm
Damage threshold	Rxdmg	5.5			dBm
Receive power (OMA _{outer})	Rx _{OMA}			4.7	dBm
Average receive power	Rx _{AVG}	-7.7		4.5	dBm
Receiver sensitivity (OMA _{outer}) ^{*note12}	Sen _{OMA}			Max (-6.1, SECQ-7.5)	dBm
Receiver reflectance				-26	dB
LOS Assert	LOSA	-15			dBm
LOS De-Assert	LOSD			-12	dBm
LOS hysteresis		0.5			dB

Note12: Sensitivity is specified at 2.4×10^{-4} BER with PRBS31Q.

Regulatory Compliance Issues

Various standard and regulations apply to the SNR-SFP56-DD-LR-10 modules. These include eye-safety, Component Recognition, RoHS, ESD, EMC and Immunity. Please note the transmitter module is a Class 1 laser product. See Regulatory Compliance Table for details.

Regulatory Compliance Table

Feature	Test Method	Performance
Laser Eye Safety and Equipment Type Testing 	(IEC) EN 62368- 1:2014+A11 (IEC) EN 60825-1:2014 (IEC) EN 60825- 2:2004+A1+A2	CDRH Accession Number:2132182-000 TUV File: R 50457725 0001 CB File: JPTUV-100513
	Underwriters Laboratories (UL)	

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Component Recognition	and Canadian Standards Association (CSA) Joint Component Recognition for Information Technology Equipment including Electrical Business Equipment	UL File: E317337
RoHS Compliance	RoHS Directive 2011/65/EU&(EU)2015/863	Less than 100 ppm of cadmium. Less than 1000 ppm lead, mercury, hexavalent chromium, poly brominated biphenyls (PPB), poly brominated biphenyl ethers (PBDE), dibutyl phthalate, butyl benzyl phthalate, bis (2- ethylhexyl) phthalate and disobutyl phthalates.
Electrostatic Discharge (ESD) to the Electrical Contacts	JEDEC Human Body Model (HBM) (JESD22-A114-B)	High speed contacts shall withstand 1000V. All other contacts shall withstand 2000 V.
Electrostatic Discharge (ESD) to the Optical Connector Receptacle	IEC 61000-4-2:2008	When installed in a properly grounded housing and chassis the units are subjected to 15kV air discharges during operation and 8kV direct discharges to the case
Electromagnetic Interference (EMI)	FCC Part 15 Class B; CISPR 32 (EN55032) 2015;	System margins are dependent on customer board and chassis design.
Immunity	IEC 61000-4-3:2010; EN55035:2017	Typically shows no measurable effect from a 10V/m field swept from 80 MHz to 1 GHz applied to the module without a chassis enclosure.

Electrostatic Discharge (ESD)

The SNR-SFP56-DD-LR-10 modules comply with the ESD requirements described in the regulatory compliance table. However, in the normal processing and operation of optical transceiver, the following two types of situations need special attention.

Case I: Before inserting the transceiver into the rack meeting the requirements of SFP-DD MSA, ESD preventive measures must be taken to protect the equipment. For example, the grounding wrist strap, workbench and floor should be used wherever the transceiver is handled.

Case II: After the transceiver is installed, the electrostatic discharge outside the chassis of the host equipment shall be within the scope of system level ESD requirements. If the optical interface of the transceiver is exposed outside the host equipment cabinet, the transceiver may be subject to equipment system level ESD requirements.

Electromagnetic Interference (EMI)

Communication equipment with optical transceivers is usually regulated by FCC in the United States and CENELEC EN55032 (CISPR 32) in Europe. The compliance of SNR-SFP56-DD-LR-10 with these standards is detailed in the regulatory compliance table. The metal shell and shielding design of SNR-SFP56-DD-LR-10 will help equipment designers minimize the equipment level EMI challenges they face.

Flammability

The SNR-SFP56-DD-LR-10 optical transceiver meets UL certification requirements, its constituent materials have heat and corrosion resistance, and the plastic parts meet UL94V-0 requirements

SFP-DD Transceiver Electrical Pad Layout

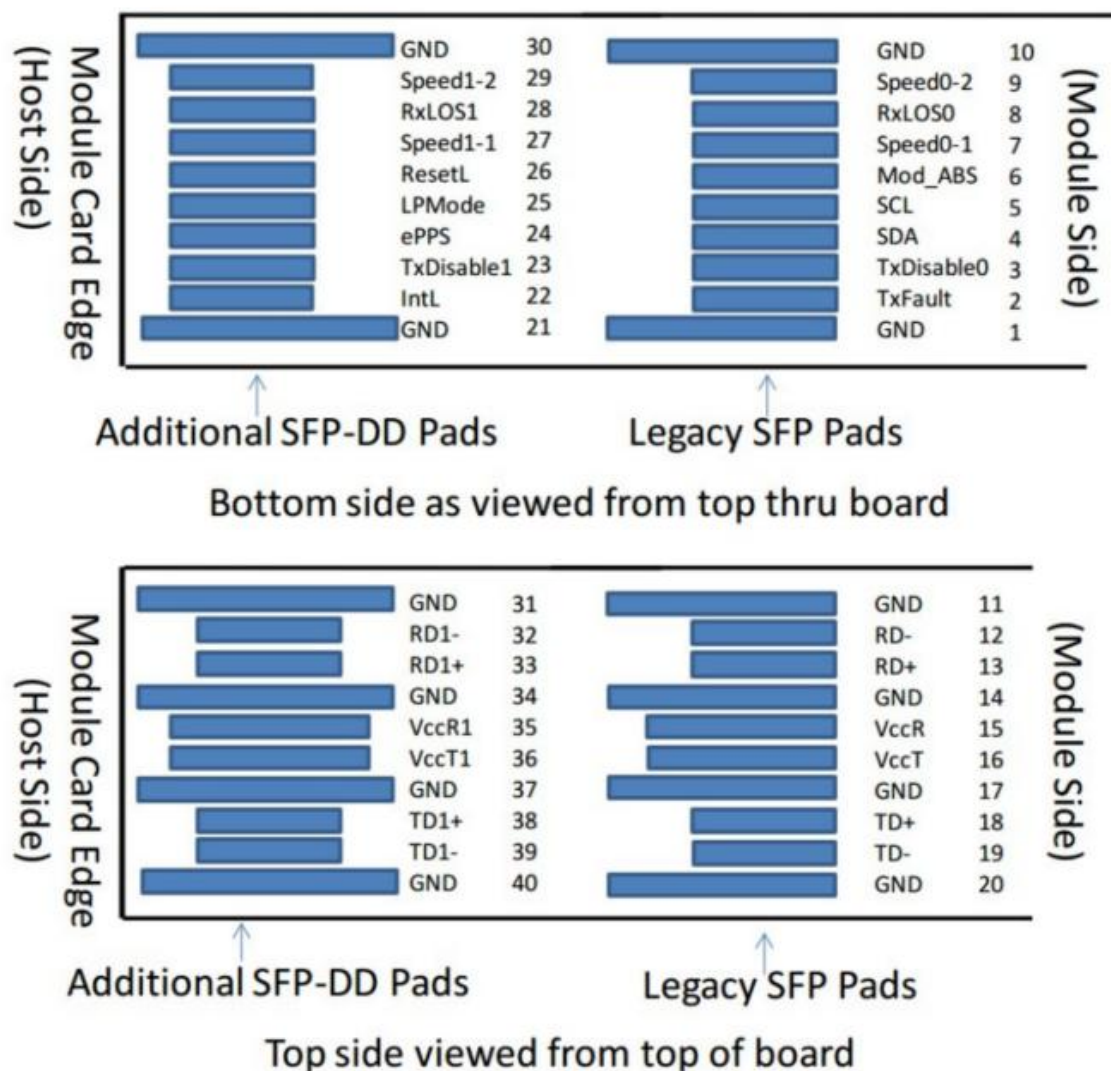


Figure 6: SFP-DD Module Pinout

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Pin Arrangement and Definition

Pin	Logic	Symbol	Description	Plug Sequence	Notes
1		GND	Ground	1B	1
2	LVTTL-O	TxFault	Transmitter Fault Indication	3B	
3	LVTTL-I	TxDisable0	Transmitter Disable	3B	
4	LVC MOS-I/O	SDA	Management I/F data line	3B	
5	LVC MOS-I/O	SCL	Management I/F clock	3B	
6	LVTTL-O	Mod_ABS	Module Absent	3B	
7	LVTTL-I	Speed0-1	Pulled low with 51k Ω resistor	3B	
8	LVTTL-O	RxLOS0	Rx Loss of Signal	3B	
9	LVTTL-I	Speed0-2	Pulled low with 51k resistor	3B	
10		GND	Ground	1B	1
11		GND	Ground	1B	1
12	CML-O	RD-	Inverse Received Data Out for channel 0	3B	
13	CML-O	RD+	Received Data Out for channel 0	3B	
14		GND	Ground	1B	1
15		VccR0	Receiver Power	2B	2
16		VccT0	Transmitter Power	2B	2
17		GND	Ground	1B	1
18	CML-I	TD+	Transmit Data In for channel 0	3B	
19	CML-I	TD-	Inverse Transmit Data In for channel 0	3B	
20		GND	Ground	1B	1
21		GND	Ground	1A	1
22	LVTTL-O	IntL	Module Interrupt	3A	
23	LVTTL-I	TxDisable1	NC	3A	
24	LVTTL-I	ePPS	Pulled low with 10k Ω resistor	3A	
25	LVTTL-I	LPMODE	Low Power Mode Control	3A	
26	LVTTL-I	ResetL	Module Reset	3A	
27	LVTTL-I	Speed1-1	Pulled low with 51k Ω resistor	3A	
28	LVTTL-O	RxLOS1	Pull down to GND within module	3A	
29	LVTTL-I	Speed1-2	Pulled low with 51k Ω resistor	3A	
30		GND	Ground	1A	1
31		GND	Ground	1A	1
32	CML-O	RD1-	Inverse Received Data Out for channel 1	3A	
33	CML-O	RD1+	Received Data Out for channel 1	3A	
34		GND	Ground	1A	1
35		VccR1	Receiver Power	2A	2
36		VccT1	Transmitter Power	2A	2
37		GND	Ground	1A	1
38	CML-I	TD1+	Transmit Data In for channel 1	3A	
39	CML-I	TD1-	Inverse Transmit Data In for channel 1	3A	
40		GND	Ground	1A	1

1: SFP-DD uses common ground (GND) for all signals and supply (power). All are common within the SFP-DD module and all module voltages are referenced to this potential unless otherwise noted. Connect them directly to the host board signal-common ground plane.

2: VccR, VccT are applied concurrently and VccR1, VccT1 are applied concurrently. VccR, VccT, VccR1, VccT1 are internally connected within the module in any combination. The connector Vcc pins are each rated for a maximum current of 1000mA.

*Plug sequence specifies the mating sequence of the host connector and module. The sequences are 1A, 2A,

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Pin	Logic	Symbol	Description	Plug Sequence	Notes
3A, 1B, 2B, 3B.			Contact sequence A will make, then break contact with additional SFP-DD pads. Sequence 1A, 1B will then occur simultaneously, followed by 2A, 2B, then followed by 3A, 3B.		

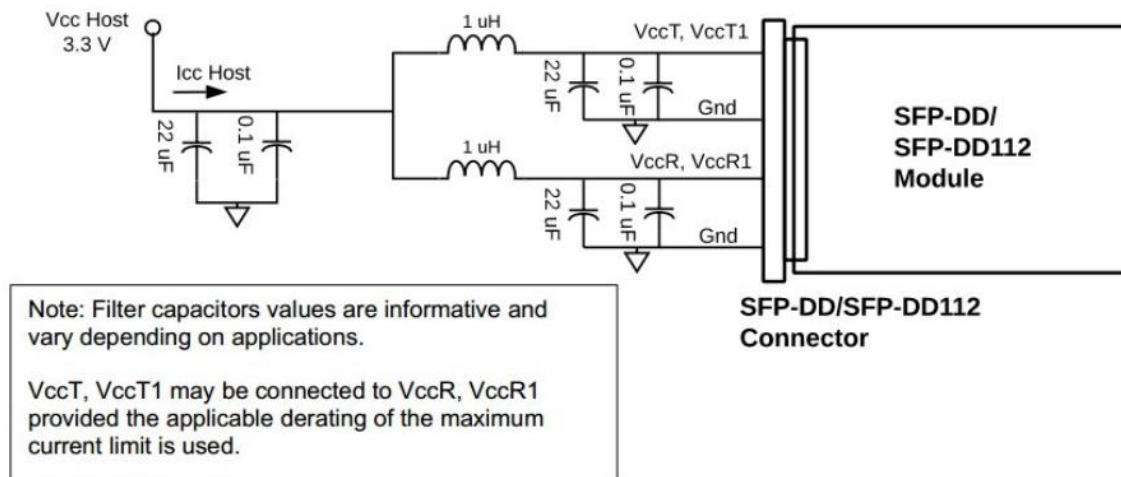


Figure 7: Host Board Power Supply Filter

During power transient events, the host should ensure that any neighboring modules sharing the same supply stay within their specified supply voltage limits. The host should also ensure that the intrinsic noise of the power rail is filtered in order to guarantee the correct operation of the optical modules.

Package Outline

The module is designed to meet the package outline defined in the QSFP28 MSA specification. See the package outline for details.

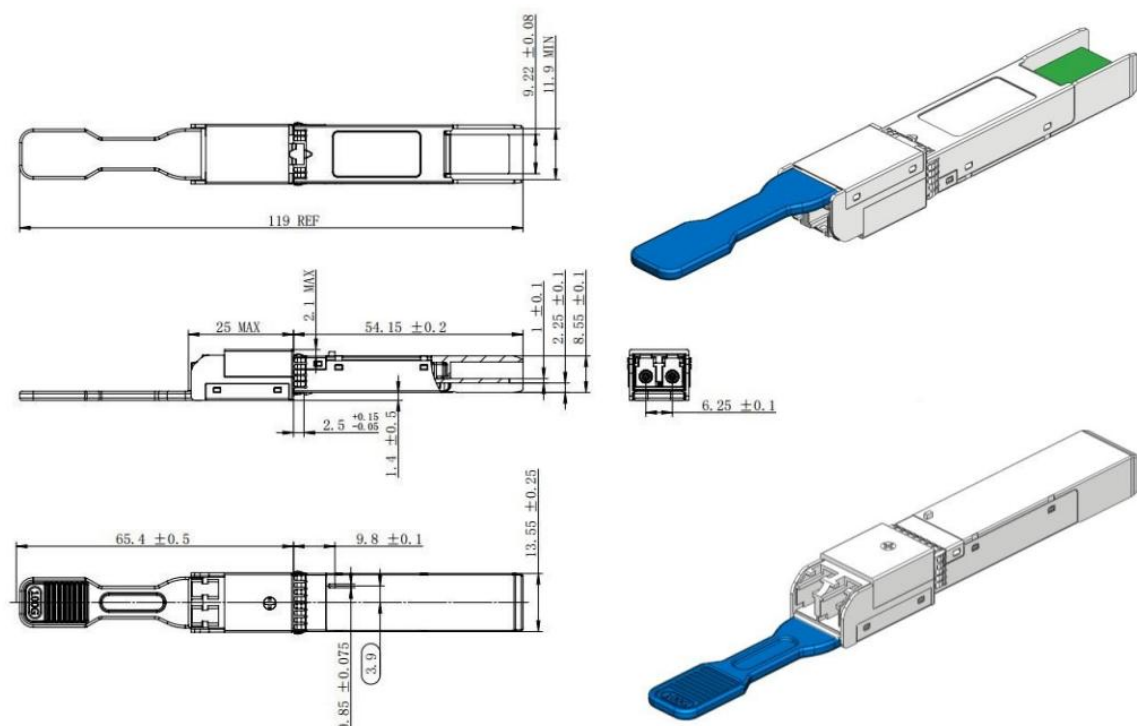


Figure 8: Mechanical Package Outline (All dimensions in mm)

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*This 2D drawing is only for reference, please check with SNR before ordering.

The below picture shows the location of the hottest spot for measuring module case temperature. In addition, the digital diagnostic monitors (DDM) temperature is also calibrated to this spot.

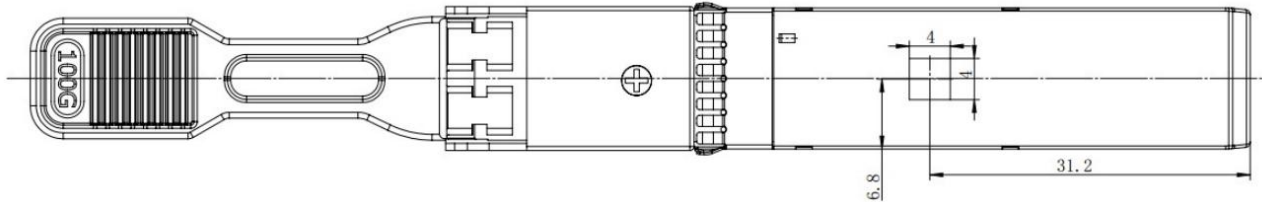


Figure 9: Case Temperature Measurement Point (All dimensions in mm)

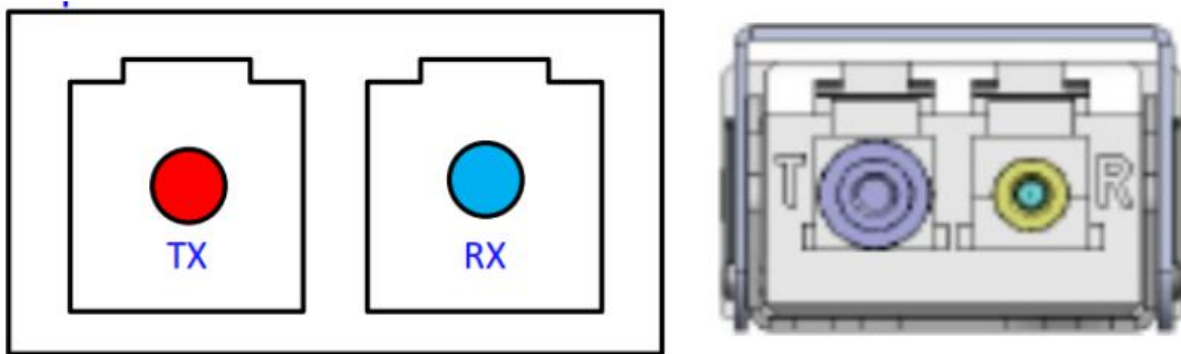


Figure 10: Module Optical Interface (looking into the optical port)

Control Interface & Memory Map

The control interface combines dedicated signal lines for TxDisable0, TxDisable1, RxLOS0, RxLOS1, TxFault, IntL, Mod_ABS, LPMMode, ResetL, interface clock (SCL) and data (SDA), signals to provide users rich functionality over an efficient and easily used interface.

TxDisable0, TxDisable1

TxDisable0 is module input signal. When TxDisable0 is asserted high or left open, the appropriate SFP-DD module transmitter output will be turned off. This signal is pulled up to Vcc in the module with a resistor of 10k Ω . When TxDisable0 is asserted low or grounded, the module transmitter is operating normally.

Since the module only has one media lane, it doesn't response to TxDisable1.

RxLOS0, RxLOS1

RxLOS0 is open drain output and should be pulled up to Vcc on the host board with a resistor in the range 4.7k Ω to 10k Ω . When RxLOS0 is high, it indicates that an optical signal level is lower than the threshold which is specified in the relevant standard. RxLOS0 assert min and de-assert max are defined in the relevant standard. To avoid spurious transition of LOS a minimum hysteresis of 0.5dB is recommended.

Since the module only has one media lane, RxLOS1 is held low and its corresponding register flag bit (lower page 00h byte 6 bit 5) is set to 0b.

TxFault

TxFault is a module wide output signal that when high, indicates that the module has detected a fault condition and has entered the fault state. The TxFault output is open drain output and should be pulled up to the Vcc on the host board with a resistor in the range 4.7k Ω to 10k Ω .

IntL

IntL is an open drain output and should be pulled up to Vcc on the host board with a resistor in the range 4.7k Ω to 10k Ω . When IntL is asserted low indicates a change in module state, a possible operational fault or a status critical to the host system. The IntL signal is de-asserted high after all set flags are read.

Mod_ABS

Mod_ABS is on the host board and pulled low in the module. The Mod_ABS is asserted low when the module is inserted. The Mod_ABS is de-asserted high when the module is physically absent from the host connector due to the pull-up resistor on the host board.

LPMode

LPMode is an input signal from the host operating with active high logic. The LPMode signal is pulled up to Vcc in the module with a resistor of 10k Ω . The LPMode signal allows the host to define the SFP-DD module to remain in low power mode until software enables the transition to the High Power Mode as defined in the SFP-DD management specification. In Low Power Mode (LPMode de-asserted low), the module will immediately transition to High Power Mode after the management interface is initialized.

ResetL

The ResetL signal is pulled up to Vcc in the module with a resistor of 10k Ω . A low level on the ResetL signal for longer than 10 μ s initiates a complete module reset, returning all user module settings to their default state.

SCL and SDA

The SCL and SDA is a two-wire serial interface between the host and module using the I2C protocols. SCL is defined as the serial interface clock signal and SDA as the serial interface data signal. Both signals are open-drain and should be pulled up to Vcc on the host.

The SDA signal is bi-directional. During binary data transfer, the SDA signal shall transition when SCL is low. SDA transitions when SCL is high are used to mark either the beginning (START) or ending (STOP) of a data transfer.

Control Interface Electrical Specifications

Parameter	Symbol	Min.	Max.	Unit
SCL and SDA	VOL	0	0.4	V
SCL and SDA	VIL	-0.3	VCC*0.3	V
	VIH	VCC*0.7	VCC+0.5	V
Capacitance for SCL and SDA I/O signal	Ci		14	pF
Total bus capacitive load for SCL and SDA	Cb		100	pF
			200	pF
TxDisable1, ResetL, LPMode	VIL	-0.3	0.8	V
	VIH	2	Vcc+0.3	V
	I _{lin}		360	μA
Mod_ABS	VOL	0	0.4	V
RxLOS1	VOL	-0.3	0.4	V

Note: Positive values indicate current flowing into the module.

Memory Map

The memory map of the SFP-DD module is compliant with the SFP-DD MSA and the module meets the following requirements:

1. The module initialize in hardware mode when LPMode is de-asserted.
2. The transmitter is disabled when the module is held in reset.
3. Tx Squelch function is implemented as defined by the SFP-DD MSA. When squelched, the transmitter remains on with the modulation turned off.
4. Rx Squelch function is implemented as defined by the SFP-DD MSA. When RxLOS0 or RxLOS1 is asserted, the receiver output is squelched.

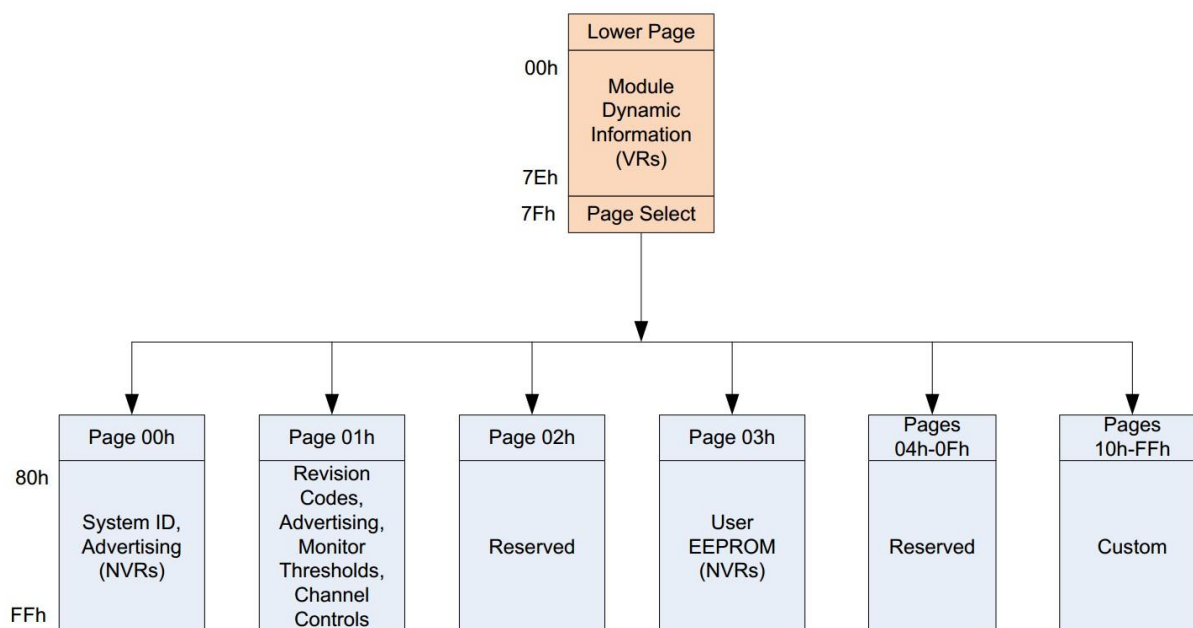


Figure 11: Simplified SFP-DD MIS Module Memory Map Architecture

GUARANTEE:



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