

This transceiver module is designed for 500m optical communication, operating at a 50Gbaud data rate on a 1310nm wavelength. It uses an EML Driver integrated in the DSP with a cooled EML for transmission, and a PIN photodiode detector for reception. A DSP-based gearbox converts 4x25Gbps NRZ signals to 1x50Gbaud PAM4, with an integrated 4-channel re-timer and FEC block.

The module's electrical interface follows IEEE 802.3cd and QSFP28 MSA standards, while the optical interface complies with IEEE 802.3cd and 100G Lambda MSA using a Duplex LC connector. Power consumption is limited to 4.0W.

Designed to meet QSFP28 MSA specifications, the module is robust, withstanding harsh conditions like extreme temperatures, humidity, and EMI. It converts a 4-channel 100Gbps NRZ input into a single 50Gbaud PAM4 optical output using a DSP-based gearbox and a cooled Electro-absorption Modulated DFB Laser (EML). The receiver converts the 50Gbaud PAM4 optical input back to 50Gbaud electrical, then into four 25Gbps NRZ signals.

A +3.3V power supply is required, with VccTx and VccRx pins applied together. The module also features seven low-speed control pins per MSA specifications, including ModSelL, SCL, SDA, ResetL, LPMode, ModPrsL, and IntL.

### Features

- QSFP28 MSA compliant
- Supports 53.125Gbaud
- 100G Lambda MSA 100G-DR specification compliant
- Up to 500 m transmission on single mode fiber (SMF) with FEC
- Operating case temperature: 0 to 70°C
- 4x25G electrical interface (OIF CEI-28G- VSR)
- Maximum power consumption 4W
- Accepts LC duplex connectors
- RoHS compliant

### Applications

- Data Center Interconnect
- 100G Ethernet
- Enterprise networking



### General Specifications

ITEM	DETAIL
Speed	103.125Gb/s aggregate bit rate
Optical connector	Dual LC
Operating distance	500 m with FEC
Power Supply	Single 3.3V
Fiber type	Single-mode 9/125um, two strands
Wavelength	1310nm, EML laser, 50Gbps PAM
Compliance	QSFP28 MSA, RoHS 2.0
Digital Diagnostic	Yes (SFF-8472, SFF-8636 compliant)

PART NUMBER	DESCRIPTION
SSF-QSFP-100GDR1	100G QSFP28 DR1 500m Single Lambda with FEC optical transceiver with full real-time digital diagnostic monitoring and pull tab

## Functional Description

Module Select (ModSelL) is an input pin. When held low by the host, this product responds to 2-wire serial communication commands. The ModSelL allows the use of this product on a single 2-wire interface bus – individual ModSelL lines must be used.

Serial Clock (SCL) and Serial Data (SDA) are required for the 2-wire serial bus communication interface and enable the host to access the memory map.

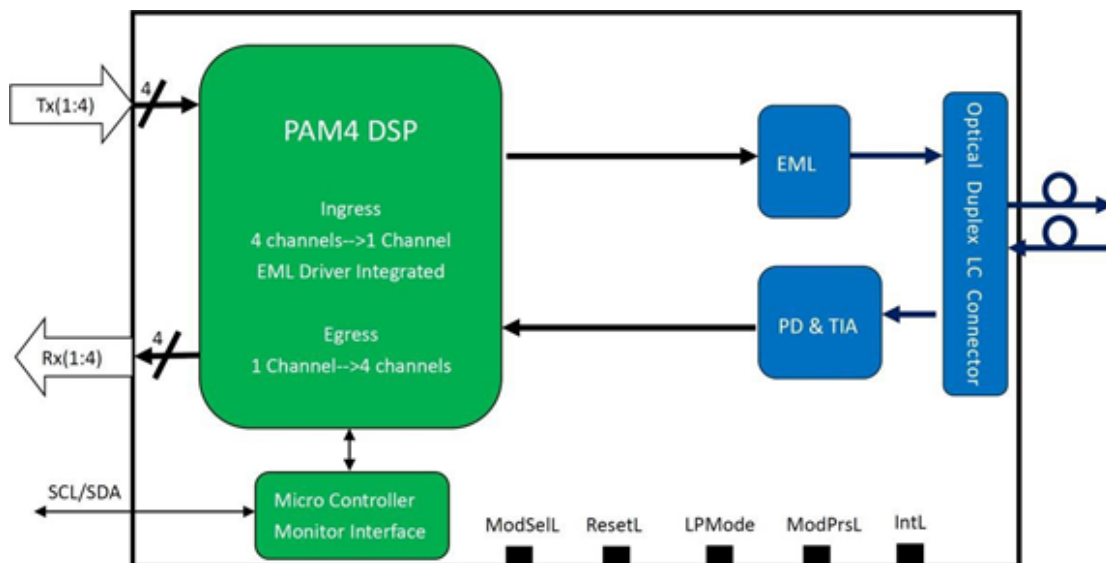
The ResetL pin enables a complete reset, returning the settings to their default state, when a low level on the ResetL pin is held for longer than the minimum pulse length. During the execution of a reset the host shall disregard all status bits until it indicates a completion of the reset interrupt. The product indicates this by posting an IntL (Interrupt) signal with the Data\_Not\_Ready bit negated in the memory map. Note that on power up (including hot insertion) the module should post this completion of reset interrupt without requiring a reset.

Low Power Mode (LPMMode) pin is used to set the maximum power consumption for the product in order to protect hosts that are not capable of cooling higher power modules, should such modules be accidentally inserted.

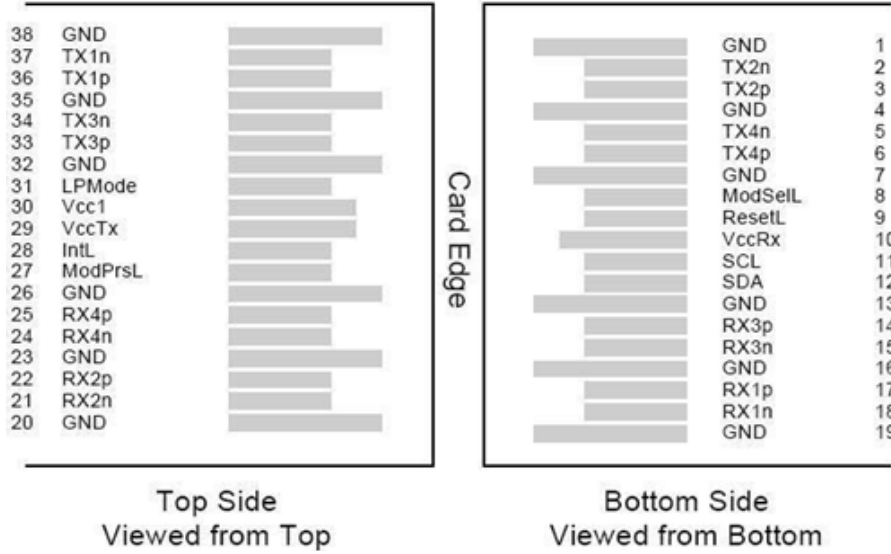
Module Present (ModPrsL) is a signal local to the host board which, in the absence of a product, is normally pulled up to the host Vcc. When the product is inserted into the connector, it completes the path to ground through a resistor on the host board and asserts the signal. ModPrsL then indicates its present by setting ModPrsL to a “Low” state.

Interrupt (IntL) is an output pin. “Low” indicates a possible operational fault or a status critical to the host system. The host identifies the source of the interrupt using the 2-wire serial interface. The IntL pin is an open collector output and must be pulled to the Host Vcc voltage on the Host board.

## Transceiver Block Diagram



**Pin Assignment and Description**



**Pin Definition**

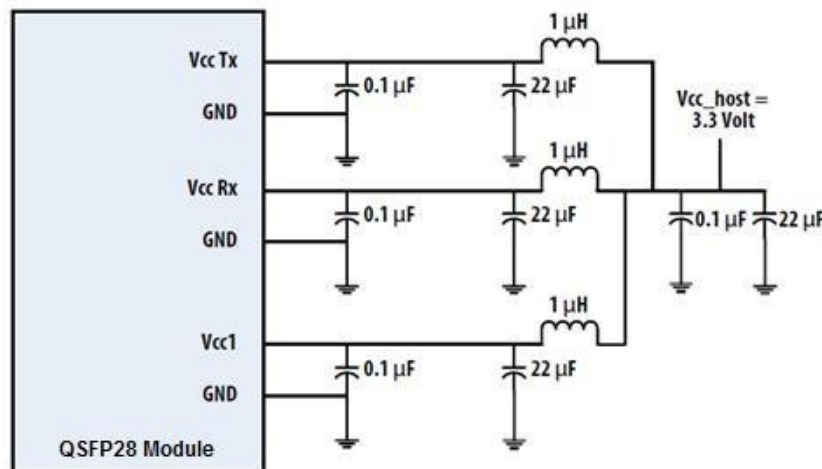
CONTACTS	LOGIC	SYMBOL	NAME/DESCRIPTION	NOTES
1		GND	Ground	1
2	CML-I	Tx2n	Transmitter Inverted Data Input	
3	CML-I	Tx2p	Transmitter Non-Inverted Data output	
4		GND	Ground	1
5	CML-I	Tx4n	Transmitter Inverted Data Input	
6	CML-I	Tx4p	Transmitter Non-Inverted Data output	
7		GND	Ground	1
8	LVTTLL-I	ModSelL	Module Select	
9	LVTTLL-I	ResetL	Module Reset	
10		VccRx	+3.3V Power Supply Receiver	2
11	LVCNOS-I/O	SCL	2-Wire Serial Interface Clock	
12	LVCNOS-I/O	SDA	2-Wire Serial Interface Data	
13		GND	Ground	
14	CML-O	Rx3p	Receiver Non-Inverted Data Output	
15	CML-O	Rx3n	Receiver Inverted Data Output	
16		GND	Ground	1
17	CML-O	Rx1p	Receiver Non-Inverted Data Output	
18	CML-O	Rx1n	Receiver Inverted Data Output	
19		GND	Ground	1
20		GND	Ground	1
21	CML-O	Rx2n	Receiver Inverted Data Output	

CONTACTS	LOGIC	SYMBOL	NAME/DESCRIPTION	NOTES
22	CML-O	Rx2p	Receiver Non-Inverted Data Output	
23		GND	Ground	1
24	CML-O	Rx4n	Receiver Inverted Data Output	1
25	CML-O	Rx4p	Receiver Non-Inverted Data Output	
26		GND	Ground	1
27	LVTTTL-O	ModPrsL	Module Present	
28	LVTTTL-O	IntL	Interrupt	
29		VccTx	+3.3 V Power Supply transmitter	2
30		Vcc1	+3.3 V Power Supply	2
31	LVTTTL-I	LPMODE	Low Power Mode	
32		GND	Ground	1
33	CML-I	Tx3p	Transmitter Non-Inverted Data Input	
34	CML-I	Tx3n	Transmitter Inverted Data Output	
35		GND	Ground	1
36	CML-I	Tx1p	Transmitter Non-Inverted Data Input	
37	CML-I	Tx1n	Transmitter Inverted Data Output	
38		GND	Ground	1

**Notes**

- GND is the symbol for signal and supply (power) common for QSFP28 modules. All are common within the QSFP28 module and all module voltages are referenced to this potential unless otherwise noted. Connect these directly to the host board signal common ground plane.
- VccRx, Vcc1 and VccTx are the receiving and transmission power suppliers and shall be applied concurrently. Recommended host board power supply filtering is shown in Figure 3 below. Vcc Rx, Vcc1 and Vcc Tx may be internally connected within the QSFP28 transceiver module in any combination. The connector pins are each rated for a maximum current of 1000mA.

**Recommended Power Supply Filter**



## Absolute Maximum Ratings

These values represent the damage threshold of the module. Stress in excess of any of the individual Absolute Maximum Ratings can cause immediate catastrophic damage to the module.

**Table 1 - Absolute Maximum Ratings**

PARAMETERS	SYMBOL	MIN.	MAX.	UNIT
Storage Temperature	$T_s$	-40	85	degC
Operating Case Temperature	$T_{OP}$	0	70	degC
Power Supply Voltage	$V_{CC}$	-0.5	3.6	V
Relative Humidity (non-condensation)	RH	0	85	%
Damage Threshold	$TH_d$	5.5		dBm

## Recommended Operating Conditions and Power Supply Requirements

PARAMETER	SYMBOL	MIN	TYPICAL	MAX	UNIT	NOTES
Operating Case Temperature	$T_{OP}$	0		70	degC	
Power Supply Voltage	$V_{CC}$	3.135	3.3	3.465	V	
Power Supply Noise	$V_n$			66	mV	
Electrical Data Rate, each Lane (NRZ)			25.78125		Gb/s	
Optical Data Rate (PAM4)			53.125		GBd	
Data Rate Accuracy		-100		100	ppm	
Pre-FEC Bit Error Ratio				$2.4 \times 10^{-4}$		
Post-FEC Bit Error Ratio				$1 \times 10^{-12}$		1
Control Input Voltage High		2		$V_{CC}$	V	
Control Input Voltage Low		0		0.8	V	
Link Distance with G.652	D	0.002		2	km	2

### Notes

1. FEC feature is embedded in the module.
2. FEC required to be turned on to support maximum transmission distance.

**Electrical Characteristics**

The following electrical characteristics are defined over the Recommended Operating Environment unless otherwise specified.

PARAMETER	TEST POINT	MIN	TYPICAL	MAX	UNITS	NOTES
Power Consumption				4	W	
Supply Current	I <sub>cc</sub>			1.21	A	
TRANSMITTER (EACH LANE)						
Overload Differential Voltage pk-pk	TP1a	900			mV	
Common Mode Voltage (V <sub>cm</sub> )	TP1	-350		2850	mV	1
Differential Termination Resistance Mismatch	TP1			10	%	At 1MHz
Differential Return Loss (SDD11)	TP1			See CEI- 28G-VSR Equation 13-19	dB	
Common Mode to Differential Conversion and Differential to Common Mode Conversion (SDC11, SCD11)	TP1			See CEI- 28G-VSR Equation 13-20	dB	
Stressed Input Test	TP1a	See CEI- 28G-VSR Section 13.3.11.2.1"				
RECEIVER (EACH LANE)						
Differential Voltage, pk-pk	TP4			900	mV	
Common Mode Voltage (V <sub>cm</sub> )	TP4	-350		2850	mV	1
Common Mode Noise, RMS	TP4			17.5	mV	
Differential Termination Resistance Mismatch	TP4			10	%	At 1MHz
Differential Return Loss (SDD22)	TP4			See CEI- 28G-VSR Equation 13-19	dB	
Common Mode to Differential Conversion and Differential to Common Mode Conversion (SDC22, SCD22)	TP4			See CEI- 28G-VSR Equation 13-21"	dB	
Common Mode Return Loss (SCC22)	TP4			-2	dB	2
Transition Time, 20 to 80%	TP4	9.5			ps	
Vertical Eye Closure (VEC)	TP4			5.5	dB	
Eye Width at 10-15 probability (EW15)	TP4	0.57			UI	
Eye Height at 10-15 probability (EH15)	TP4	228			mV	

**Notes:**

1. V<sub>cm</sub> is generated by the host. Specification includes effects of ground offset voltage.
2. From 250MHz to 30GHz.

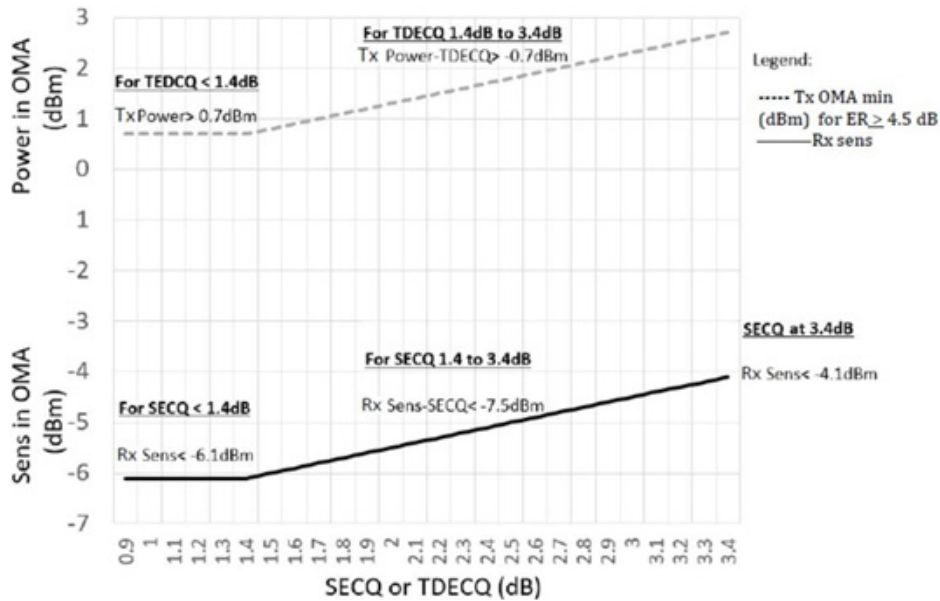
**Optical Characteristics**

PARAMETER	SYMBOL	MIN	TYPICAL	MAX	UNIT	NOTES
<b>TRANSMITTER</b>						
Center Wavelength	$\lambda_t$	1304.5		1317.5	nm	
Side Mode Suppression Ratio	SMSR	30			dB	
Average Launch Power	$P_{AVG}$	-2.4		4	dBm	1
Outer Optical Modulation Amplitude ( $OMA_{outer}$ )	$P_{OMA}$	-0.8		4.2	dBm	2
Launch Power in $OMA_{outer}$ minus TDECQ for $ER \geq 4.5dB$ for $ER < 4.5dB$		-2.2 -1.9			dBm	
Transmitter and Dispersion Eye Closure for PAM4 (TDECQ)	TDECQ			3.4	dB	
TDECQ - $10 \cdot \log_{10}(C_{eq})$				3.4	dB	3
Extinction Ratio	ER	3.5			dB	
RIN <sub>17.1OMA</sub>	RIN			-136	dB/Hz	
Optical Return Loss Tolerance	TOL			15.5	dB	
Transmitter Reflectance	RT			-26	dB	
Transmitter Transition Time				17	ps	
Average Launch Power of OFF Transmitter	$P_{off}$			-15	dBm	
LOS Assert Level	LOSA		50		mV	4
LOS Deassert Level	LOSD		100		mV	
<b>RECEIVER</b>						
Center Wavelength	$\lambda_r$	1304.5		1317.5	nm	
Damage Threshold	THd	5			dBm	5
Average Receive Power		-5.9		4.0	dBm	6
Receive Power ( $OMA_{outer}$ )				4.2	dBm	
Receiver Sensitivity ( $OMA_{outer}$ )	SEN			Equation (1)	dBm	7
Stressed Receiver Sensitivity ( $OMA_{outer}$ )	SRS			-1.9	dBm	8
Receiver Reflectance	RR			-26	dB	
LOS Assert	LOSA	-15			dBm	9
LOS Deassert	LOSD			-8.9	dBm	
LOS Hysteresis	LOSH	0.5			dB	
Conditions of Stress Receiver Sensitivity Test (Note 10)						
Stressed Eye Closure for PAM4 (SECQ)			3.4		dB	
SECQ - $10 \cdot \log_{10}(C_{eq})$				3.4	dB	

- Notes:**
1. 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.
  2. Even if the TDECQ < 1.4dB for an extinction ratio of  $\geq 5dB$  or TDECQ < 1.1dB for an extinction ratio of < 5dB, the  $OMA_{outer}$  (min) must exceed the minimum value specified here.
  3.  $C_{eq}$  is a coefficient defined in IEEE Std 802.3-2018 clause 121.8.5.3 which accounts for reference equalizer noise enhancement.
  4. Average receive power (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be

- compliant; however, a value above this does not ensure compliance.
5. The receiver shall be able to tolerate, without damage, continuous exposure to a modulated optical input signal having this power level on one lane. The receiver does not have to operate correctly at this input power.
  6. Receiver sensitivity ( $OMA_{outer}$ ) (max) is informative and is defined for a transmitter with a value of SECQ up to 3.4 dB. It should meet Equation (1), which is illustrated in Figure 4.  $RS = \max(-3.9, SECQ - 5.3)$  dBm where RS is the receiver sensitivity and SECQ is the SECQ of the transmitter used to measure the receiver sensitivity.
  7. Measured with conformance test signal at TP3 for the BER equal to  $2.4 \times 10^{-4}$ . These test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

**Figure 4. Illustration of Receiver Sensitivity Mask for 100G-FR**



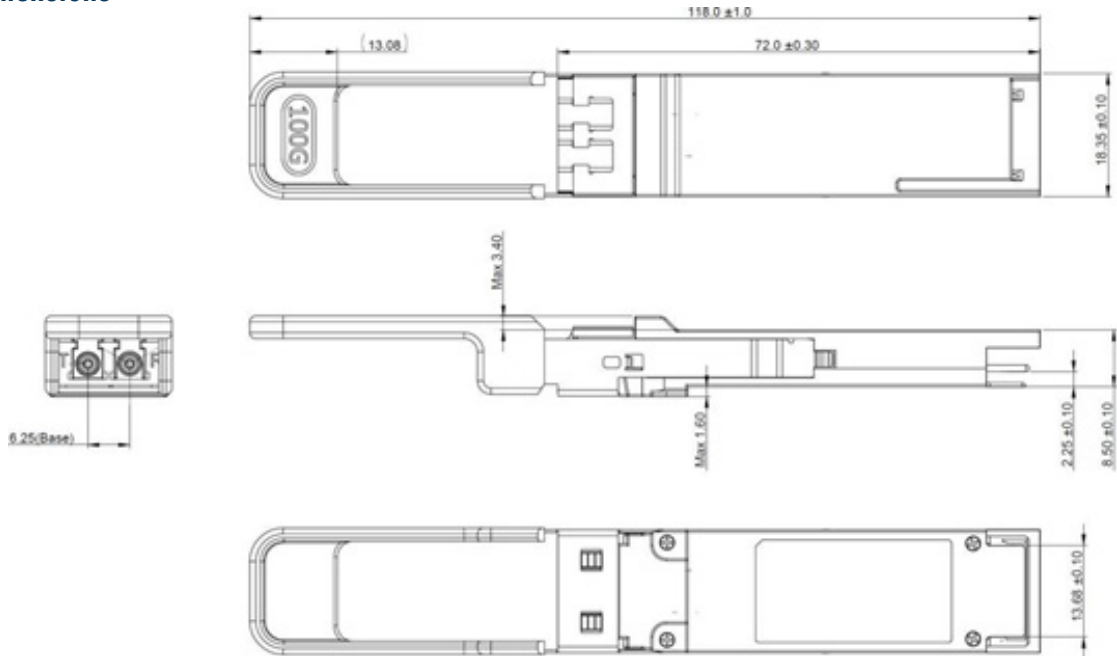
**Digital Diagnostic Functions**

The following digital diagnostic characteristics are defined over the normal operating conditions unless otherwise specified.

PARAMETER	SYMBOL	MIN	MAX	UNIT	CONDITIONS
Temperature Monitor Absolute Error	DMI_Temp	-3	3	degC	Over operating temperature range
Supply Voltage Monitor Absolute Error	DMI_VCC	-0.1	0.1	V	Over full operating range
RX Power Monitor Absolute Error	DMI_RX	-2	2	dB	1
Bias Current Monitor	DMI_Ibias	-10%	10%	mA	
TX Power Monitor Absolute Error	DMI_TX	-2	2	dBm	1

- Notes:**
- Due to measurement accuracy of different single mode fibers, there could be an additional +/- 1 dB fluctuation, or a +/- 3 dB total accuracy.

**Mechanical Dimensions**



## ESD

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This transceiver is specified as ESD threshold 1kV for high-speed data pins and 2kV for all other electrical input pins, tested per MIL-STD-883, Method 3015.4 / JESD22-A114-A (HBM). However, normal ESD precautions are still required during the handling of this module. This transceiver is shipped in ESD protective packaging. It should be removed from the packaging and handled only in an ESD protected environment.

## Laser Safety

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This is a Class 1 Laser Product according to EN 60825-1:2014. This product complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated (June 24, 2007).

Caution: Use of controls or adjustments or performance specified herein may result in hazardous radiation exposure.