Features

- QSFP28 MSA compliant

- Support 53.125Gbaud

- 100G Lambda MSA 100G-FR Specification compliant

- Up to 2km 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 4.5W

- LC duplex connector

- RoHS compliant

Applications

- Data Center Interconnect

- 100G Ethernet

- Enterprise networking

Description

This product is a transceiver module designed for 2km optical communication applications. The module incorporates one channel optical signal, on 1310nm center wavelength, operating at 50Gbaud data rate. The transmitter path incorporates an EML Driver and a cooled EML together. On the receiver path, the inpirt optical signal is coupled to a Pin photodiode detector. A DSP based gearbox is used to convert 4x25Gbps NRZ signals to 1x50Gbaud PAM4 signal. Also a 4-channel retimer and FEC block are integrated in this DSP. The electrical interface is compliant with IEEE 802.3cd and QSFP28 MSA in the transmitting and receiving directions, and optical interface is compliant to IEEE 802.3cd and 100G Lambda MSA with Duplex LC connector The module has a maximum power consumption of 4.5W.

The product is designed with form factor, optical/electrical connection and digital diagnostic interface according to the QSFP28 Multi-Source Agreement (MSA). It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference.

Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Units	Note
Storage Temperature	Ts	-40	85	℃	
Operating Case Temperature	T_{OP}	0	70	℃	
Supply Voltage	V_{CC}	-0.5	3.6	V	
Relative Humidity (non-condensation)	RH	0	85	%	
Damage Threshold, each Lane	TH_d	5.5		dBm	

Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
Operating Case Temperature	T_{OP}	0		70	℃	
Power Supply Voltage	Vcc	3.135	3.3	3.465	V	
Data Rate, each Lane			25.78125		Gb/s	
Optical Data Rate (PAM4)			53.125		GBd	
Data Rate Accuracy		-100		100	ppm	
Pre-FEC Bit Error Ratio				2.4×10^{-4}		
Post-FEC Bit Error Ratio				1×10^{-12}		1
Control Input Voltage High		2		Vcc	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.

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Diagnostics Monitoring

Parameter	Symbol	Accuracy	Unit	Notes
Temperature monitor absolute error	DMI_Temp	± 3	$^{\circ}$C	Over operating temperature range
Supply voltage monitor absolute error	DMI_VCC	± 0.1	V	Over full operating range
Channel RX power monitor absolute error	DMI_RX_Ch	± 2	dB	1
Channel Bias current monitor	DMI_Ibias_Ch	± 10%	mA	
Channel TX power monitor absolute error	DMI_TX_Ch	± 2	dB	1

Notes:

1. Due to measurement accuracy of different single mode fibers, there could be an additional +/-1 dB fluctuation, or

   a +/- 3 dB total accuracy.

Transmitter Electro-optical Characteristics (Each Lane)

Parameter	Test Point	Min	Typ.	Max	Units	Notes
Power Consumption				4.5	W	
Supply Current	Icc			1.36	A	
Overload Differential Voltage pk-pk	TP1a	900			mV	
Common Mode Voltage (Vcm)	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	
Center Wavelength	Λt	1304.5		1317.5	nm	
Side Mode Suppression Ratio	SMSR	30			dB	
Launch Power, each Lane	P_{AVG}	-2.4		4	dBm	1
Outer Optical Modulation Amplitude (OMA$_{outer}$)	P_{OMA}	-0.2		4.2	dBm	2
Launch Power in OMA minus TDECQ For ER $\geq$ 4.5dB For ER < 4.5dB		-1.6 -1.5			dBm	
Transmitter and Dispersion Eye Cloure for PAM4 (TDECQ)	TDECQ			3.4	dB	
TDECQ-10*log$_{10}$ (Ceq)				3.4	dB	3
Extinction Ratio	ER	3.5			dB	
RIN$_{17.1}$ OMA	RIN			-136	dB/Hz	
Optical Return Loss Tolerance	TOL			17.1	dB	
Transmitter Reflectance	R_T			-26	dB	
Transmitter Transition Time				17	ps	
Average Launch Power OFF Transmitter, each Lane	Poff			-15	dBm	

Receiver Electro-Optical Characteristics (each Lane)

Parameter	Test Point	Min	Typ.	Max	Units	Notes
Differential Voltage, pk-pk	TP4			900	mV	
Common Mode Voltage (Vcm)	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	
Transition Time, 20% to 80%	TP4	9.5			ps	
Common Mode Return Loss (SCC22)	TP4			-2	dB	2
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	
Center Wavelength	λr	1304.5		1317.5	nm	
Damage Threshold	THd	5.5			dBm	4
Average Receive Power		-6.4		4.5	dBm	5
Receive Power (OMAouter)				4.7	dBm	
Receiver Sensitivity (OMAouter)	SEN			Equation(1)	dBm	6
Stressed Receiver Sensitivity (OMAouter)	SRS			-2.5	dBm	7
Receiver Reflectance	RR			-26	dB	
LOS Assert	LOSA	15			dBm	
LOS Deassert	LOSD			-9.4	dBm	
LOS Hysteresis	LOSH	0.5			dB	
Conditions of Stress Receiver Sensitivity Test (Note 8)						
Stressed Eye Clousre for PAM4 (SECQ)			3.4		dB	
SECQ-10*log10(Ceq)				3.4	dB	

Notes:

1. Average launch power, each lane 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 < 1.4 dB for an extinction ratio of ≧4.5dB or TDECQ < 1.3dB for an extinction ratio of < 4.5dB, the OMAouter (min) must exceed the minimum value specified here.

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. Average receiver 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 (OMAouter) (max) is informative and is defined for a transmitter with a value of SECQ up to 3.4dB. It should meet Equation (1), which is illustrated in Figure 4.

7. Measured with conformance test signal at TP3 for the BER equal to 2.4×10^{-4}

8. The test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

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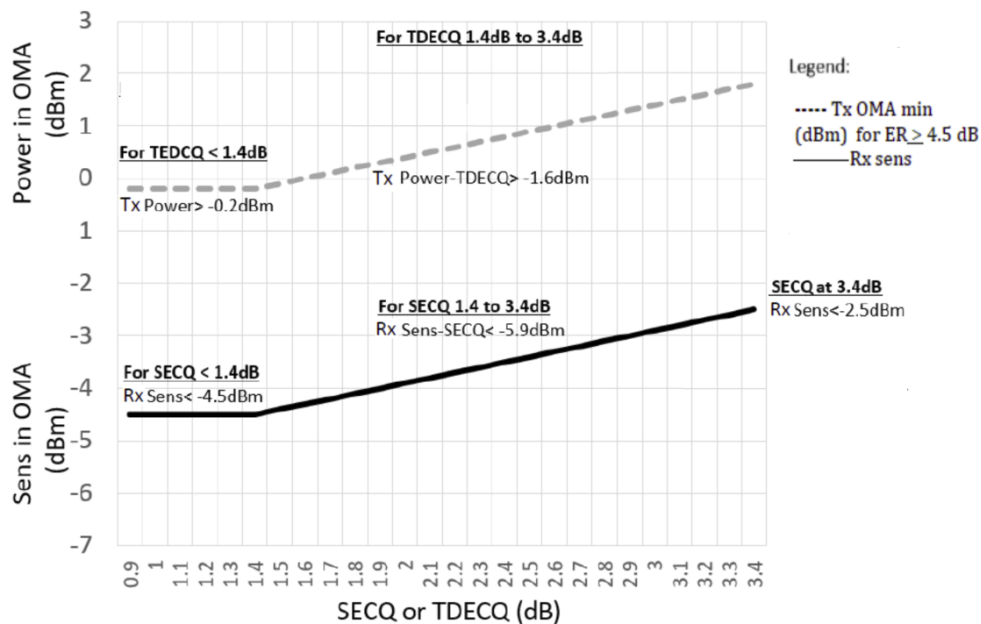
Block Diagram of Transceiver
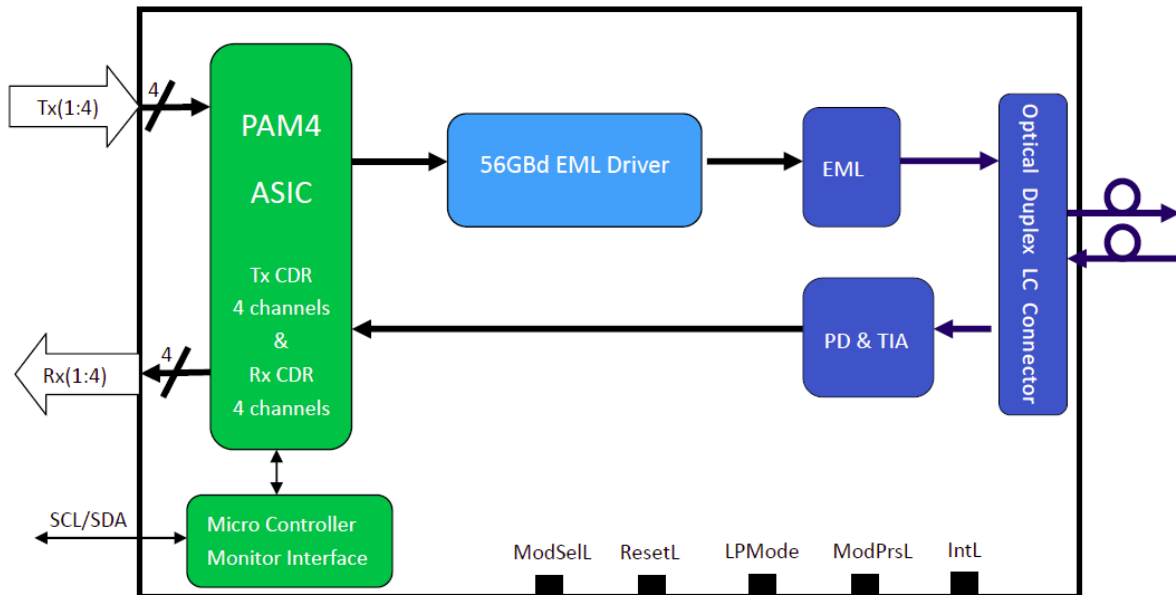
This product converts the 4-channel 100Gb/s aggregated NRZ electrical input data into one channel of 50Gbaud PAM4 optical signal (light) on 1310nm center wavelength through a DSP based gearbox, by a driven cooled Electro-absorption Modulated DFB Laser (EML). The light propagates out of the transmitter into an SMF fiber. The receiver module accepts the 50Gbaud PAM4 optical signal input, and converts it into a 50Gbaud PAM4 electrical signal via a linear amplifier. And then convert the 5Gbaud PAM4 signal into 4 channels of 25Gbps NRZ signals. Figure 1 shows the functional block diagram of this poduct.

A single +3.3V power supply is required to power up this product. Both power supply pins VccTx and VccRx are internally connected and should be applied concurrently. As per MSA specifications the module offers 7 low speed hardware control pins (including the 2-wire serial interface): ModSelL, SCL, SDA, ResetL, LPMode, ModPrsL and IntL.

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.
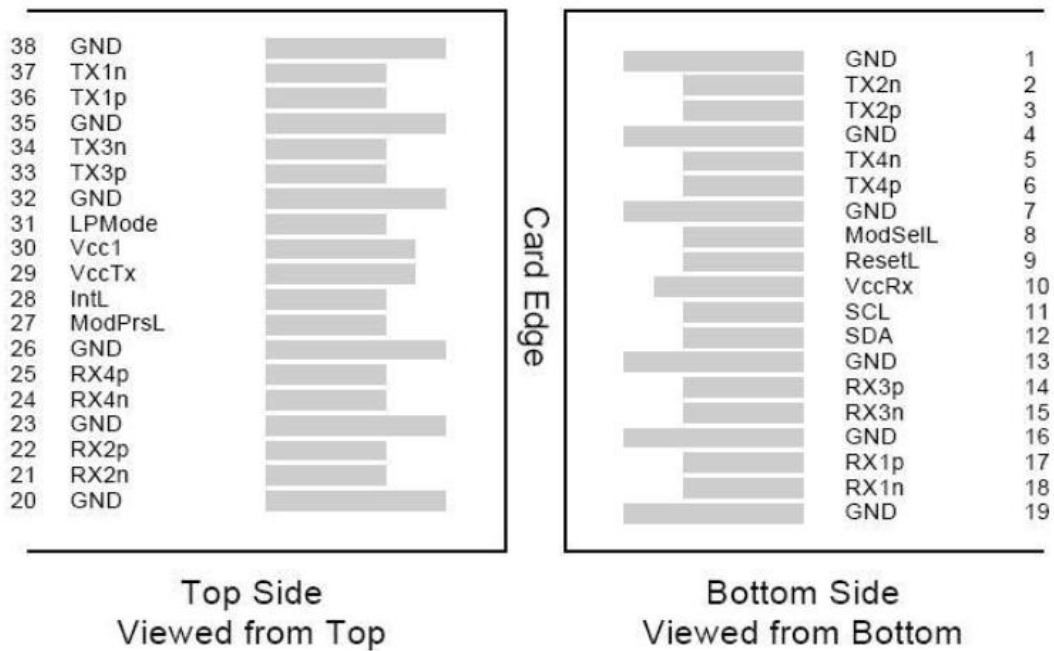
The ResetL pin enables a complete reset, returning the settings to their default state, when a low level on the ResetL pin is held for longer than the minimum pulse length. During the execution of a reset the host shall disregard all status bits until it indicates a completion of the reset interrupt. 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 (LPMode) 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

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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.

Pin Assignment

Top Side (Viewed from Top)		Bottom Side (Viewed from Bottom)	
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

Card Edge

MSA compliant Connector

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Pin Description

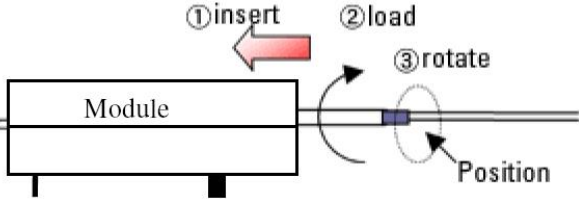| PIN	Logic	Symbol	Name/Description	Note
1		GND	Ground	1
2	CML-I	Tx2n	Transmitter Inverted Data Input	
3	CML-I	Tx2p	Transmitter Non-Inverted Data output	
4		GND	Ground	1
5	CML-I	Tx4n	Transmitter inverted Data Input	
6	CML-I	Tx4p	Transmitter Non-Inverted Data output	
7		GND	Ground	1
8	LVTLL-I	ModSelL	Module Select	
9	LVTLL-I	ResetL	Module Reset	
10		VccRx	+3.3V Power Supply Receiver	2
11	LVCMOS-I/O	SCL	2-Wire Serial Interface Clock	
12	LVCMOS-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	
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	LVTTL-O	ModPrsL	Module Present	
28	LVTTL-O	IntL	Interrupt	
29		VccTx	+3.3V Power Supply transmitter	2
30		Vcc1	+3.3V Power Supply	2
31	LVTTL-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

Note:

1. 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.

2. VccRx, Vcc1 and VccTx are the receiving and transmission power suppliers and shall be applied concurrently. 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.

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Dimensions

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Optical Receptacle Cleaning Recommendations:

All fiber stubs inside the receptacle portions were cleaned before shipment.   In the event of contamination of the optical ports, the recommended cleaning process is the use of forced nitrogen.   If contamination is thought to have remained, the optical ports can be cleaned using a NTT international Cletop® stick type and HFE7100 cleaning fluid.   Before the mating of patch-cord, the fiber end should be cleaned up by using Cletop® cleaning cassette.

Cleaning of patch-cord	**Cleaning of fiber stub**

	1. Insert
	   Ensure that stick is held straight when inserting into sleeve.
	2. Load
	   Apply sufficient pressure (approx 600-700g) to ensure ferrule a little depressed in sleeve.
	3. Rotate
	   Rotate stick clockwise 4-5 times, while ensuring direct contact with ferrule end-face is maintained.
	
	Notice: Number of possible wipes:
	Maintenance (repair) ~1 use / piece
	Equipment construction: 4 uses / piece (max.)

Note: The pictures were extracted from NTT-ME website. And the Cletop® is a trademark registered by NTT-ME

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Ordering Information

Model Number	Part Number	Voltage	Temperature
QSFP28-100G-FR1	OPCW-S02-13-CB1	3.3V	0°C to 70 $^\circ$C

Modification History

Revision	Date	Description
A1	Sep. 2020	Initial Release
A2	June. 2021	P/N revised

Note: All information contained in this document is subject to change without notice.

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