

# QSFP28 100GBASE-LR4 1310nm 10km Industrial Transceiver

SM100G-LR-I-LL



## Application

- 100GBASE-LR4 100G Ethernet, Telecom

## Features

- Compliant with QSFP28 Standard:SFF-8665 Revision 1.9, SFF-8636 Revision 2.6
- Compliant with IEEE 802.3ba 100GBASE-LR4
- High speed I/O electrical interface (CAUI-4) compliant with IEEE 802.3bm
- Maximum power consumption 4.5W
- -40~85 °C Case Operating Temperature
- LAN WDM EML laser and PIN Receiver Array
- QSFP28 MSA package with duplex LC connector
- Two Wire Serial Interface with Digital Diagnostic Monitoring
- Complies with EU Directive 2011/65/EU (RoHS compliant)
- Single 3.3V Supply Voltage
- Class 1 Laser

## Product Specifications

### I. Absolute Maximum Ratings

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
Storage Temperature	$T_s$	-40		+85	°C	
Supply Voltage	$V_{CC}$	-0.5		3.6	V	
Operating Humidity (non-condensing)	RH	5		95	%	
Data Input Voltage – Differential	$ V_{DIP} - V_{DIN} $			1.0	V	
Control Input Voltage	$V_1$	-0.3		$V_{CC} + 0.5$	V	
Control Output Current	$I_o$	-20		20	mA	

### II. Recommended Operating Environment

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
Operating Case Temperature	$T_{OPR}$	-40		85	°C	
Power Supply Voltage	$V_{CC}$	3.135	3.3	3.465	V	
Instantaneous peak current at hot plug	$I_{CCIP}$			1800	mA	Per pin
Sustained peak current at hot plug	$I_{CCSP}$			1485	mA	Per pin
Maximum Power Dissipation	$P_{DLP}$			4.5	W	
Maximum Power Dissipation, Low Power Mode	$P_{DLP}$			1.5	W	
Aggregate Bit Rate	ABR		103.125		Gb/s	
Data Rate per Lane	DRL		25.78		Gb/s	

<b>Control Input Voltage High</b>	$V_{IH}$	$V_{CC}*0.7$		$V_{CC}+0.3$	V	
<b>Control Input Voltage Low</b>	$V_{IL}$	-0.3		$V_{CC}*0.3$	V	
<b>Two Wire Serial Interface Clock Rate</b>				400	kHz	
<b>Power Supply Noise</b>				66	mVpp	10Hz-10MHz
<b>Rx Differential Data Output Load</b>			100		ohms	
<b>Operating Distance</b>		2		10000	m	

### III. Optical Characteristics

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
<b>Transmitter</b>						
<b>Wavelength L0</b>	$\lambda_{C0}$	1294.53	1295.56	1296.59	nm	
<b>Wavelength L1</b>	$\lambda_{C1}$	1299.02	1300.05	1301.09	nm	
<b>Wavelength L2</b>	$\lambda_{C2}$	1303.54	1304.58	1305.63	nm	
<b>Wavelength L3</b>	$\lambda_{C3}$	1308.09	1309.14	1310.19	nm	
<b>Side-mode suppression ratio</b>	SMSR	30			dB	
<b>Total Average Optical Launch Power</b>	$P_{OUT}$			10.5	dBm	
<b>Average Launch Power Tx_Off (Each Lane)</b>	$P_{OUT\_OFF}$			-30	dBm	
<b>Average Optical Launch Power (Each Lane)</b>	$P_{OUTL}$	-4.3		4.5	dBm	
<b>Extinction Ratio</b>	ER	4			dB	
<b>Spectral Width</b>	$\Delta\lambda$			1	nm	

<b>Optical Modulation Amplitude (Each Lane)</b>	OMA	-1.3		4.5	dBm	
<b>Launch Power in OMA minus TDP (Each Lane)</b>	OMA-TDP	-2.3			dBm	
<b>Difference in launch power between any two lanes (OMA)</b>	DT_OMA			5	dB	
<b>Transmitter and Dispersion Penalty (Each Lane)</b>	TDP			2.2	dB	
<b>Optical Return Loss Tolerance</b>	ORLT			20	dB	
<b>Transmitter Eye Mask Definition</b>	IEEE 802.3ba-2010					
<b>Relative Intensity Noise</b>	RIN			-130	dB/Hz	
<b>Receiver</b>						
<b>Wavelength L0</b>	$\lambda_{C0}$	1294.53	1295.56	1296.59	nm	
<b>Wavelength L1</b>	$\lambda_{C1}$	1299.02	1300.05	1301.09	nm	
<b>Wavelength L2</b>	$\lambda_{C2}$	1303.54	1304.58	1305.63	nm	
<b>Wavelength L3</b>	$\lambda_{C3}$	1308.09	1309.14	1310.19	nm	
<b>Receiver Sensitivity (OMA) per Lane</b>				-8.6	dBm	
<b>Stressed Receiver Sensitivity in OMA (Each Lane)</b>				-6.8	dBm	
<b>Stressed Receiver Sensitivity Test Conditions:</b>						
<b>Stressed Eye J2 Jitter (Each Lane)</b>			0.3		UI	
<b>Stressed Eye J9 Jitter (Each Lane)</b>			0.47		UI	
<b>Vertical Eye Closure Penalty</b>			1.8		dB	
<b>Damage Threshold for Receiver</b>	$P_{in,damage}$	5.5			dBm	
<b>Average Receive Power (Each Lane)</b>		-10.6		4.5	dBm	

<b>Receive Power in OMA (Each Lane), Overload</b>	OMA			4.5	dBm	
<b>Difference in receive power between any two lanes (OMA)</b>	DR_OMA			5.5	dB	
<b>Receiver 3dB electrical upper cut-off frequency (each lane)</b>	F_C			31	GHz	
<b>Receiver Reflectance</b>	RX <sub>R</sub>			-26	dB	

**Note:**

 1. Measured with a PRBS2<sup>31</sup>-1 test pattern @25.78125Gbps, BER≤10<sup>-12</sup>

## IV. Electrical Characteristics

High-Speed Signal: Compliant to CAUI-4 (IEEE 802.3bm)

Low-Speed Signal: Compliant to SFF-8679

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
<b>Transmitter</b>						
<b>Differential Data Input Amplitude</b>	V <sub>IN,P-P</sub>	95		900	mVpp	1
<b>Differential Termination Mismatch</b>				10	%	
<b>LPMODE, Reset and ModSelL</b>	V <sub>IL</sub>	-0.3		0.8	V	
	V <sub>IH</sub>	2		V <sub>CC</sub> +0.3	V	
<b>Receiver</b>						
<b>Differential Data Output Amplitude</b>	V <sub>OUT,P-P</sub>	250		900	mVpp	1
<b>Differential Termination Mismatch</b>				10	%	
<b>Output Rise/Fall Time, 20%~80%</b>	T <sub>R</sub>	9.5			ps	

<b>ModPrsL and IntL</b>	$V_{OL}$	0		0.4	V	$I_{OL}=4mA$
	$V_{OH}$	$V_{CC}-0.5$		$V_{CC}+0.3$	V	$I_{OL}=4mA$

**Note:**

1. Amplitude customization beyond these specs is dependent on validation in customer system.

## V. Digital Diagnostic Monitoring Information

Parameter	Range	Accuracy	Unit	Calibration
<b>Temperature</b>	-5 to 85	$\pm 3$	$^{\circ}C$	Internal
<b>Voltage</b>	0 to $V_{CC}$	0.1	V	Internal
<b>Tx Bias Current (Each Lane)</b>	0 to 100	10%	mA	Internal
<b>Tx Output Power (Each Lane)</b>	-4.3 to 4.5	$\pm 3$	dB	Internal
<b>Rx Power (Each Lane)</b>	-10.6 to 4.5	$\pm 3$	dB	Internal

## VI. Timing

### Timing for QSFP+ Soft Control and Status Functions

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
<b>Initialization Time</b>	$t_{init}$			10	s	1
<b>Reset Init Assert Time</b>	$t_{reset\_init}$			50	$\mu s$	4
<b>Serial Bus Hardware Ready Time</b>	$t_{serial}$			2000	ms	
<b>Monitor Data Ready Time</b>	$t_{data}$			2000	ms	

<b>Reset Assert Time</b>	t_reset			5	s	1,3
<b>LPMODE Assert Time</b>	ton_LPMODE			50	ms	
<b>LPMODE De-assert Time</b>	toff_LPMODE			10	s	1
<b>IntL Assert Time</b>	ton_IntL			200	ms	
<b>IntL Deassert Time</b>	toff_IntL			500	μs	
<b>Rx LOS Assert Time</b>	ton_lol			100	ms	
<b>Tx Fault Assert Time</b>	ton_Txfault			200	ms	
<b>Flag Assert Time</b>	ton_flag			200	ms	
<b>Mask Assert Time</b>	ton_mask			100	ms	
<b>Mask Deassert Time</b>	toff_mask			100	ms	
<b>Application or Rate Select Change Time</b>	t_ratesel			N/A	ms	2
<b>Power_over-ride or Power-set Assert Time</b>	ton_Pdown			100	ms	
<b>Power_over-ride or Power-set De-assert Time</b>	toff_Pdown			10	s	1

**Notes:**

1. Required for temperature stabilization; measured at room temperature condition.
2. This feature is unsupported.
3. Maximum reset hold time 100ms. If exceeded, reset assert time will be equal to initialization time.
4. A reset is generated by a low level longer than t\_reset\_init present on the ResetL input.

**Timing for Squelch & Disable**

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
<b>Rx Squelch Assert Time</b>	ton_Rxsq			80	μs	
<b>Rx Squelch Deassert Time</b>	toff_Rxsq			80	μs	

<b>Tx Squelch Assert Time</b>	ton_Txsq			400	ms	1
<b>Tx Squelch Deassert Time</b>	toff_Txsq			400	ms	1
<b>Tx Disable Assert Time</b>	ton_txdis			100	ms	
<b>Tx Disable Deassert Time</b>	toff_txdis			400	ms	
<b>Rx Output Disable Assert Time</b>	ton_rxdis			100	ms	
<b>Rx Output Disable Deassert Time</b>	toff_rxdis			100	ms	
<b>Squelch Disable Assert Time</b>	ton_sqdis			100	ms	
<b>Squelch Disable Deassert Time</b>	toff_sqdis			100	ms	

**Note:**

1. Not implemented by default. This feature is configurable at factory, if enabled module power consumption will increase.



## VII. Pin Description

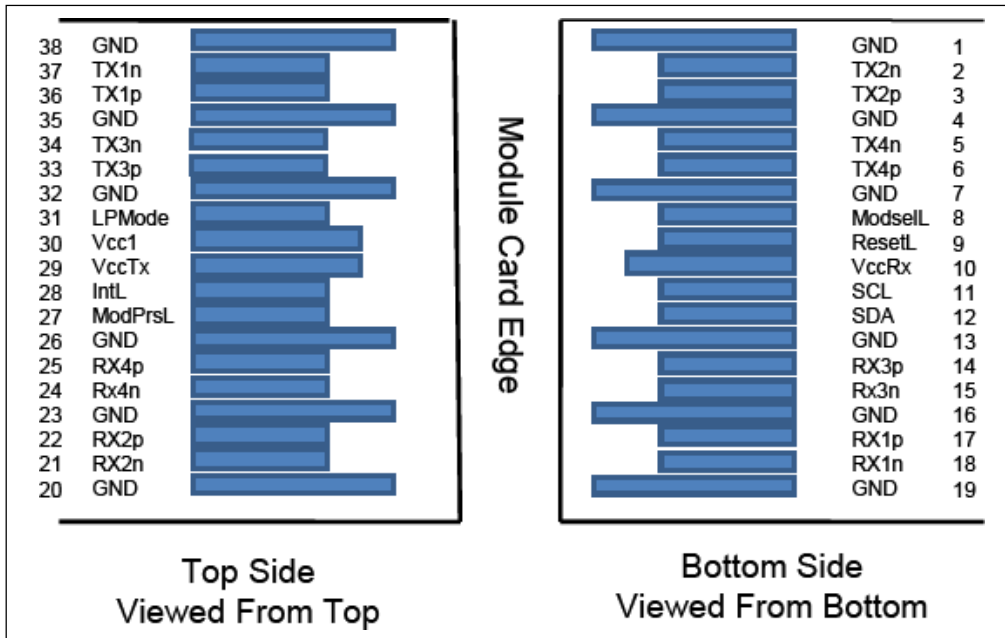


Figure 1 – QSFP+ Module Pad Layout

Pin	Logic	Symbol	Description	Plug Sequence	Notes
1		GND	Ground	1	1
2	CML-I	Tx2n	Transmitter Inverted Data Input	3	
3	CML-I	Tx2p	Transmitter Non-Inverted Data Input	3	
4		GND	Ground	1	1
5	CML-I	Tx4n	Transmitter Inverted Data Input	3	
6	CML-I	Tx4p	Transmitter Non-Inverted Data Input	3	
7		GND	Ground	1	1
8	LVTTL-I	ModSelL	Module Select	3	
9	LVTTL-I	ResetL	Module Reset	3	
10		Vcc Rx	+3.3 V Power Supply Receiver	2	2
11	LVC MOS-I/O	SCL	2-wire serial interface clock	3	
12	LVC MOS-I/O	SDA	2-wire serial interface data	3	
13		GND	Ground	1	1

14	CML-O	Rx3p	Receiver Non-Inverted Data Output	3	
15	CML-O	Rx3n	Receiver Inverted Data Output	3	
16		GND	Ground	1	1
17	CML-O	Rx1p	Receiver Non-Inverted Data Output	3	
18	CML-O	Rx1n	Receiver Inverted Data Output	3	
19		GND	Ground	1	1
20		GND	Ground	1	1
21	CML-O	Rx2n	Receiver Inverted Data Output	3	
22	CML-O	Rx2p	Receiver Non-Inverted Data Output	3	
23		GND	Ground	1	1
24	CML-O	Rx4n	Receiver Inverted Data Output	3	
25	CML-O	Rx4p	Receiver Non-Inverted Data Output	3	
26		GND	Ground	1	1
27	LVTTTL-O	ModPrsL	Module Present	3	
28	LVTTTL-O	IntL	Interrupt	3	
29		VccTx	+3.3V Power supply transmitter	2	2
30		Vcc1	+3.3V Power supply	2	2
31	LVTTTL-I	LPMode	Low Power Mode	3	
32		GND	Ground	1	1
33	CML-I	Tx3p	Transmitter Non-Inverted Data Input	3	
34	CML-I	Tx3n	Transmitter Inverted Data Input	3	
35		GND	Ground	1	1
36	CML-I	Tx1p	Transmitter Non-Inverted Data Input	3	
37	CML-I	Tx1n	Transmitter Inverted Data Input	3	

38		GND	Ground	1	1
----	--	-----	--------	---	---

**Notes:**

1. GND is the symbol for signal and supply (power) common for the QSFP+ module. All are common within the QSFP+ 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. Vcc Rx, Vcc1 and Vcc Tx are the receiver and transmitter power supplies and shall be applied concurrently.

**VIII. Recommended Boot-up Sequence**

1. Host asserts LPMODE input.
2. Host powers up module and module will be held in low power mode.
3. Host brings up PHY/MAC/PCS and makes sure RF signal is transmitted towards module (Comment: RF signal can be offered anywhere during boot-up.)
4. (Optional) Host checks Initialization Complete Flag (byte 06 bit 0). When "1" is read, module enters low power mode.
5. Host de-asserts LPMODE input and writes "1" to High\_Power\_Class\_En bit (byte 93 bit 2), the module will enter high power mode.
6. Host delay t\_init (2s).
7. Host checks Initialization Complete Flag (byte 06 bit 0). After entering high power mode, this bit will be "1" and cleared after read. The typical timing is 5s and longest timing under extreme conditions can be up to 60s. If no "1" is read, the boot-up has failed.
8. Host reads interrupt flags (A0.02-0E including Data\_Not\_Ready flag and all of the interrupt flags) to clear IntL output during initialization.

**Note:**

1. The requirement of SFF-8636 v1.9 and higher versions is ignored and the module will boot up in high power mode regardless of power consumption.

### IX. Diagram Mechanical Drawing

