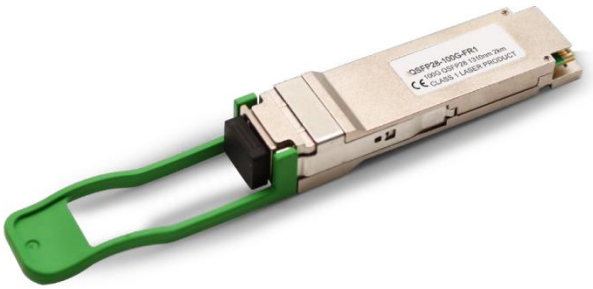
100G-QSFP28-FR1

100Gbps QSFP28 FR Single Lambda Transceiver, 2km Reach

Product Features



- QSFP28 MSA compliant
- 802.3cu compliant
- 100GE FR1 Specification compliant
- Non-hermetic package design
- Maximum power consumption 4.0 W
- LC connector
- Up to 2 km transmission on single mode fiber with FEC
- Operating case temperature: 0℃~70℃
- Single 3.3 V power supply
- RoHS 2 compliant

Applications

- Data Center Network

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General Description

100G-QSFP28-FR1 is a transceiver module designed for 2 km optical communication applications, and it is compliant with IEEE 802.3cu 100GE FR1 MSA standard. This module can convert 4-channel 25.78125 Gbit/s electrical data to 1-channel 106.25 Gbit/s optical signals. Similarly, it can convert 1-channel 106.25 Gbit/s optical signals to 4-channel output electrical data on the receiver side. It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference. The module offers very high functionality and feature integration, accessiblevia a two-wire serial interface.

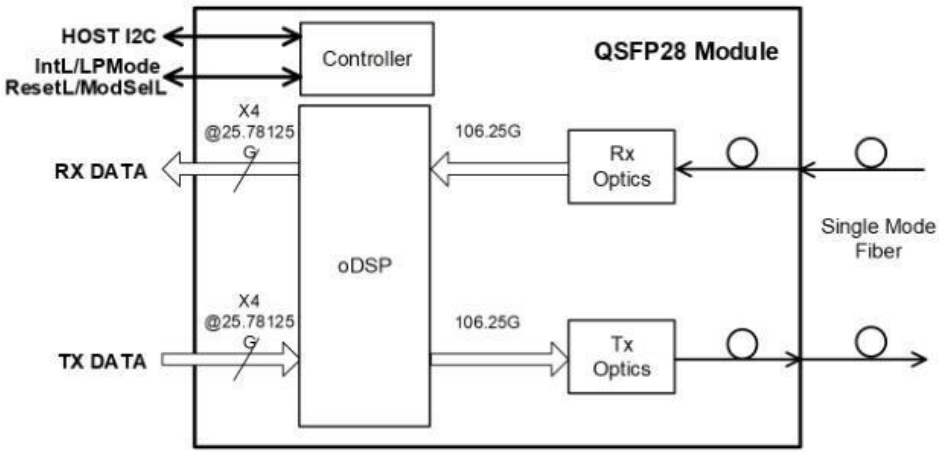


Figure 1 Transceiver block diagram

Absolute Maximum Ratings

It has to be noted that the operation in excess of any individual absolute maximum ratings might cause permanent damage to this module.

Parameter	Symbol	Min	Typical	Max	Unit
Maximum Supply Voltage	V_{CC}	-0.3	3.3	3.6	V
Storage Temperature	T_S	-40		85	℃
Relative Humidity (non-condensation)	RH	0		85	%
Damage Threshold, each Lane	TH_d	5			dBm

Recommended Operating Conditions

Electrical and optical characteristics below are defined under this operating environment, unless otherwise specified.

Parameter	Symbol	Min	Typical	Max	Units
Power Supply Voltage	V_{CC}	3.135	3.3	3.465	V
Operating Case Temperature	T	0		70	℃
Data Rate, each lane			25.78125		Gbit/s
Data Rate Accuracy		-100		100	ppm
Link Distance with G.652		2		2000	m

Electrical Characteristics

Parameter	Symbol	Min	Typical	Max	Units	Notes
Power Dissipation	P			4.0	W	
Supply Current	Icc			1.212	A	
Transmitter (module output)						
Data Rate, each lane		25.78125 ± 100ppm			GBd	
Differential input Voltage pk-pk	Vpp			900	mV	
Common Mode Voltage	Vcm	-350		2850	mV	
Common Mode Noise	RMS			17.5	mV	
Differential Termination Resistance Mismatch				10	%	1
Differential Return Loss	SDD22	See CEI-28-VSR Equation (13-2)			dB	
Common Mode to Differential Conversion	SDC22	See CEI-28-VSR Equation (13-4)			dB	
Common Mode Return Loss	SCC22			-2		2
Transition Time		9.5			ps	3
Vertical Eye Closure	VEC			5.5	dB	
Eye Width at 10-15 probability	EW15	0.57			UI	
Eye Height at 10-15 probability	EH15	228			mV	

Receiver (each Lane)						
Data Rate, each lane		25.78125 ± 100ppm			GBd	
Overload Differential Voltage pk-pk	Vpp	900			mV	
Common Mode Voltage	Vcm	-350		2850	mV	
Differential Termination Resistance Mismatch				10	%	1
Differential Return Loss	SDD11	See CEI-28-VSR Equation (13-2)			dB	
Differential to Common Mode Conversion	SCD11	See CEI-28-VSR Equation (13-3)			dB	
Stressed Input Test		See CEI-28-VSR Section 13.3.11.2.1				

Notes:
1. At 1 MHz
2. From 250MHz to 30GHz
3. 20%~80%

Optical Characteristics

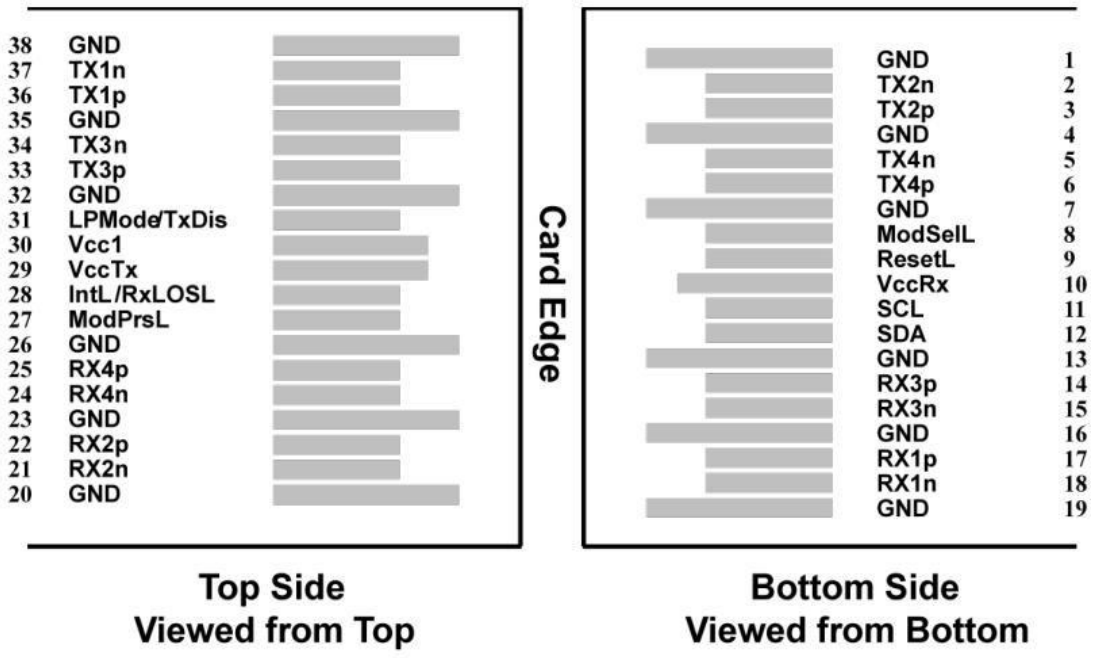
Parameter	Min	Typical	Max	Units	Notes
Transmitter					
Data Rate	53.125 ± 100 ppm			GBd	
Modulation Format	PAM4				
Line Wavelengths	1304.5	1311	1317.5	nm	
Average Launch Power	-3.1		4.0	dBm	
Optical Modulation Amplitude (OMA) for TDECQ < 1.4 dB for 1.4 dB ≤ TDECQ ≤ 3.4 dB	-0.1 - 1.5+TDECQ		4.2	dBm	
Extinction Ratio (ER)	3.5			dB	
Side-Mode Suppression Ratio (SMSR)	30			dB	
Transmitter and Dispersion Eye Clouser for PAM4 (TDECQ)			3.4	dB	
Transmitter eye closure for PAM4 (TECQ)			3.4	dB	
Transmitter transition time			17	Ps	
Optical Return Loss Tolerance			17.1	dB	
Transmitter Reflectance			-26	dB	

Average Launch Power of OFF Transmitter			-15	dBm	
Receiver					
Data Rate	53.125 ± 100 ppm			GBd	
Modulation Format	PAM4				
Damage Threshold	5.0			dBm	
Line wavelengths	1304.5	1311	1317.5	nm	
Average receiver power	-7.1		4.0	dBm	
Receiver power (OMA)			4.2	dBm	
Receiver Sensitivity (OMAouter) (max)			max(-4.5, SECQ-5.9)	dBm	1
Stressed receiver Sensitivity (OMAouter) (max)			-2.5	dBm	2
LOS Assert	-15			dBm	
LOS Deassert			-8.6	dBm	
LOS Hysteresis	0.5			dB	
Receiver reflectance			-26	dB	
Conditions of Stressed Receiver Sensitivity (Note 3)					
Stressed eye closure for PAM4 (SECQ), lane under test			3.4	dB	

Notes:

1. Receiver Receiver sensitivity (OMAouter), each lane (max) is informative and is defined for a transmitter with a value of SECQ up to 3.4 dB
2. Measured with conformance test signal for BER = 2.4x10-4.
3. These test conditions are for measuring stressed receiver sensitivity. They are not characteristics of

Pin Assignment and Description



MSA Compliant Connector

Pin Definition

PIN	Symbol	Description	Notes
1	GND	Ground	
2	Tx2n	Transmitter Inverted Data Input	
3	Tx2p	Transmitter Non-Inverted Data output	
4	GND	Ground	
5	Tx4n	Transmitter Inverted Data Input	
6	Tx4p	Transmitter Non-Inverted Data output	
7	GND	Ground	
8	ModSelL	Module Select	
9	ResetL	Module Reset	
10	VccRx	+3.3V Power Supply Receiver	
11	SCL	2-Wire Serial Interface Clock	
12	SDA	2-Wire Serial Interface Data	
13	GND	Ground	
14	Rx3p	Receiver Non-Inverted Data Output	

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

EEPROM (A0h) Definitions

Data Address	Name	Description	Value (hex)	Read/Write
0	Identifier	Identifier		Read-Only
1	Status	Revision Compliance		Read-Only
2		Flate_men/ IntL /Data_Not_Ready		Read-Only
3	Interrupt Flags	L-Tx/RX LOS, channel 1~4		Read-Only
4		L-Tx/RX Adapt EQ Fault, channel 1~4 L-TX Fault, channel 1~4		Read-Only
5		L-Tx/RX LOL, channel 1~4		Read-Only
6		L-Temp High/Low Alarm/Warning TC readiness flag Initialization complete flag		Read-Only
7		L-VCC High/Low Alarm/Warning		Read-Only
8		Vendor Specific		Read-Only
9		L-Rx Power High/Low Alarm/Warning, channel 1~2		Read-Only
10		L-RxPower High/Low Alarm/Warning, channel 3~4		Read-Only
11		L-Tx Bias High/Low Alarm/Warning, channel 1~2		Read-Only
12		L-Tx Bias High/Low Alarm/Warning, channel 3~4		Read-Only
13		L-Tx Power High/Low Alarm/Warning, channel 1~2		Read-Only
14		L-Tx Power High/Low Alarm/Warning, channel 3~4		Read-Only
15-18		Reserved		Read-Only
19-21		Hard Error Alarm		Read-Only
22	Free Side Device Monitors	Internally measured temperature (MSB)		Read-Only
23		Internally measured temperature (LSB)		Read-Only
24		Reserved		Read-Only
25				Read-Only
26		Internally measured supply voltage (MSB)		Read-Only
27		Internally measured supply voltage (LSB)		Read-Only
28-29		Reserved		Read-Only
30-33		Vendor Specific		Read-Only

34	Channel Monitors	Internally measured RX input power, channel 1 (MSB)		Read-Only
35		Internally measured RX input power, channel 1 (LSB)		Read-Only
36		Internally measured RX input power, channel 2 (MSB)		Read-Only
37		Internally measured RX input power, channel 2 (LSB)		Read-Only
38		Internally measured RX input power, channel 3 (MSB)		Read-Only
39		Internally measured RX input power, channel 3 (LSB)		Read-Only
40		Internally measured RX input power, channel 4 (MSB)		Read-Only
41		Internally measured RX input power, channel 4 (LSB)		Read-Only
42		Internally measured TX bias, channel 1 (MSB)		Read-Only
43		Internally measured TX bias, channel 1 (LSB)		Read-Only
44		Internally measured TX bias, channel 2 (MSB)		Read-Only
45		Internally measured TX bias, channel 2 (LSB)		Read-Only
46		Internally measured TX bias, channel 3 (MSB)		Read-Only
47		Internally measured TX bias, channel 3 (LSB)		Read-Only
48		Internally measured TX bias, channel 4 (MSB)		Read-Only
49		Internally measured TX bias, channel 4 (LSB)		Read-Only
50		Internally measured TX Power, channel 1 (MSB)		Read-Only
51		Internally measured TX Power, channel 1 (LSB)		Read-Only
52		Internally measured TX Power, channel 2 (MSB)		Read-Only
53		Internally measured TX Power, channel 2 (LSB)		Read-Only
54		Internally measured TX Power, channel 3 (MSB)		Read-Only
55		Internally measured TX Power, channel 3 (LSB)		Read-Only
56		Internally measured TX Power, channel 4 (MSB)		Read-Only
57		Internally measured TX Power, channel 4 (LSB)		Read-Only
58-73	Channel Monitors	Reserved channel monitor		Read-Only
74-81		Vendor Specific		Read-Only

82-85	Reserved			Read-Only
86	Control	Tx Disable, channel 1~4		Read/Write
87		Rx_Rate_select, channel 1~4		Read/Write
88		Tx_Rate_select, channel 1~4		Read/Write
89		Reserved		Read/Write
90		Reserved		Read/Write
91		Reserved		Read/Write
92		Reserved		Read/Write
93		SW Reset Reserved High Power Class Enable Power set Power override		Read/Write
94		Reserved		Read/Write
95		Reserved		Read/Write
96		Reserved		Read/Write
97		Reserved		Read/Write
98		Tx/Rx_CDR_control, channel 1~4		Read/Write
99		Reserved LP/TxDis ctrl IntL/LOSL ctrl		Read/Write
100	Module and Channel Masks	Masking Bit for TX/RX LOS indicator, channel 1~4		Read/Write
101		Masking Bit for TX, Adaptive EQ fault indicator, channel 1~4 Masking Bit for TX Transmitter/Laser indicator, channel 1~4		Read/Write
102		Masking Bit for TX/RX CDR Loss of Lock indicator, channel 1~4		Read/Write
103		Masking Bit for Temperature alarm/warning/ TC readiness flag		Read/Write
104		Masking Bit for Vcc alarm/warning		Read/Write
105	Loop Enable	0X00: LOOP_HOST_BIT 0X01: LOOP_HOST_FWD_BIT 0X02: LOOP_LINE_BIT 0X03: LOOP_LINE_FWD_BIT		Read/Write
106	Function Mode Select	0X00:FUNC_MODE_4_26G_NRZ_TO_1_106G_PAM4_FEC_BYPASS 0X01:FUNC_MODE_4_25G_NRZ_T		Read/Write

		O_1_106G_PAM4_FEC 0X02:FUNC_MODE_4_25G_NRZ_T O_1_106G_PAM4_NOFEC 0X03:FUNC_MODE_2_53G_NRZ_T O_1_106G_PAM4_FEC_BYPASS		
107		Max Power Consumption		Read/Write
108	Free Side Device	Propagation Delay MSB		Read-Only
109		Propagation Delay LSB		Read-Only
110	Free Side Device Properties	Advanced Low Power Mode Far Side Managed Min Operating Voltage		Read-Only
111		Assigned for use by PCI Express		Read-Only
112				Read/Write
113	Device Properties	Far-End Implementation Near-End Implementation		Read-Only
114		Tx_TurnOn MaxDuration DatapathInit MaxDuration		Read-Only
115		ModSelL wait time exponent ModSelL wait time mantissa		Read-Only
116		Secondary Extended Spec Compliance		Read-Only
117-118	Reserved			Read/Write
119-122	Password Change Entry Area			Read/Write
123-126	Password Entry Area			Read/Write
127	Page Select Byte	Page Select		Read/Write
128	Identifier	Identifier Type of serial Module		Read-Only
129	Ext. Identifier	Extended Identifier of Serial Module		Read-Only
130	Connector	Code for connector type		Read-Only
131-138	Specification compliance	Code for electronic compatibility or optical compatibility		Read-Only
139	Encoding	Code for serial encoding algorithm		Read-Only
140	BR, nominal	Nominal signaling rate, units of 100 MBd.		Read-Only
141	Extended Rate Select Compliance	Tags for extended rate select compli-ance		Read-Only
142	Length(SMF)	Link length supported for SMF fiber in km (note 1)		Read-Only
143	Length(OM3 50 um)	Link length supported for EBW 50/125 um fiber (OM3), units of 2 m		Read-Only

144	Length(OM2 50 um)	Link length supported for 50/125 um fiber (OM2), units of 1 m		Read-Only
145	Length(OM1 62.5 um) or Copper Cable Attenuation	Link length supported at the bit rate in byte 140 or page 00h byte 222, for 62.5/125 um fiber (OM1),units of 1 m *, or copper cable attenuation in dB at 25.78 GHz.		Read-Only
146	Length(passive copper or active cable or OM450um)	Length of passive or active cable assembly (units of 1 m) or link length supported at the bit rate in byte 140 or page 00h byte 222, for OM4 50/125 um fiber (units of 2 m) as indicated by Byte 147		Read-Only
147	Device technology	Device technology		Read-Only
148-163	Vendor name	QSFP+ vendor name (ASCII)		Read-Only
164	Extended Module	Extended Module codes for InfiniBand		Read-Only
165-167	Vendor OUI	QSFP+ vendor IEEE company ID		Read-Only
168-183	Vendor PN	Part number provided by QSFP+ vendor (ASCII)		Read-Only
184	Vendor rev	Revision level for part number provided by vendor (ASCII)		Read-Only
185				Read-Only
186	Wave length or Copper	Nominal laser wavelength (wavelength = value/20 in nm) or copper cable attenuation in dB at 2.5 GHz (Byte 186) and 5.0 GHz (Byte 187)		Read-Only
187				Read-Only
188	Wavelength tolerance	Guaranteed range of laser wave- length (+/- value) from nominal wave- length. (wavelength Tol.=value/200 in nm)		Read-Only
189				Read-Only
190	Max case temp.	Maximum case temperature in degrees C		Read-Only
191	CC_BASE	Check code for base ID fields (Bytes 28-190)		Read-Only
192	Link codes	Extended Specification Compliance Codes		Read-Only
193				Read-Only
194				Read-Only
195				Read-Only
196-211	Vendor SN	Serial number provided by vendor (ASCII)		Read-Only
212-219	Date Code	Vendor’s manufacturing date code		Read-Only
220	Diagnostic Monitoring Type	Indicates which types of diagnostic monitoring are implemented (if any) in the Module. Bit 1,0 Reserved		Read-Only

221	Enhanced Options	Indicates which optional enhanced features are implemented in the Module.		Read-Only
222	BR, nominal	Nominal bit rate per channel, units of 250 MBd. Complements Byte 140		Read-Only
223	CC_EXT	Check code for the Extended ID Fields (Bytes 192-222)		Read-Only
224-255	Vendor Specific EEPROM	Vendor Specific ID		Read-Only

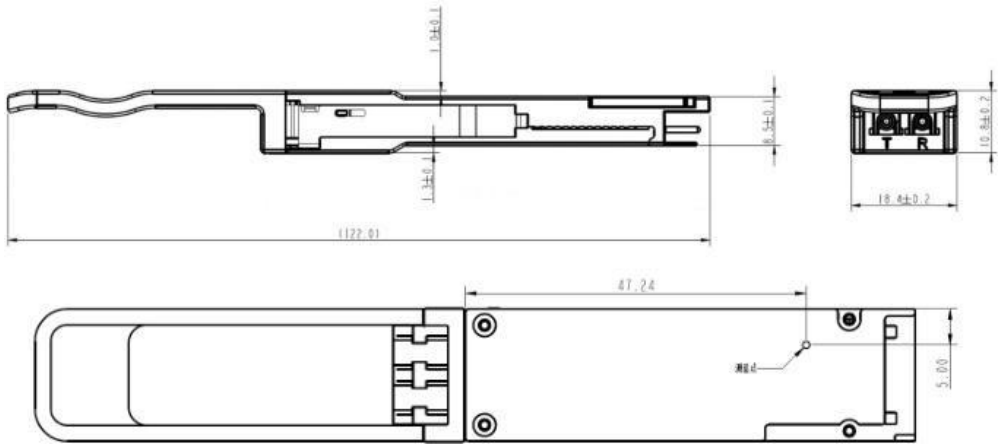
Note: represent that the values read from register varied according to module state.

Digital Diagnostic Functions

100G-QSFP28-FR1 supports the I2C-based Diagnostic Monitoring Interface (DMI) defined in document SFF-8636. The host can access real-time performance of transmitter and receiver optical power, temperature, supply voltage and bias current.

Performance item	Data address		
	Alarm & Warning	Alarm & Warning thresholds	Monitor
Module temperature	Lowpage 6	Page03 (128-135)	Lowpage (22-23)
Module voltage	Lowpage 7	Page03 (144-151)	Lowpage (26-27)
Bias current	Lowpage (11-12)	Page03 (184-191)	Lowpage (42-49)
Transmitter optical power	Lowpage (13-14)	Page03 (192-199)	Lowpage (50-57)
Receiver optical power	Lowpage (9-10)	Page03 (176-183)	Lowpage (34-41)

Mechanical Dimensions



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Ordering Information

Part Number	Product Description
100G-QSFP28-FR1	100Gbps, Single Lambda with FEC, LC Connector, 2km, with DDM