Product Specification
10GBd SFP+ 1310nm Limiting Transceivers
TRX10GDP0310

APPLICATIONS

10G Ethernet 10GBASE-LR/LW

MergeOptics SFP+ transceiver TRX10GDP0310 is compliant with the current SFP+ MSA specifications (SFF-8431 and SFF-8432) and with 10GBASE-LR/LW per IEEE 802.3ae. It is RoHS 6/6 complaint per Directive 2002/95/EC and laser class 1 safety compliant per IEC/CDRH. The sub watt power consumption and the excellent EMI performance allow system design with high port density.



SUPPORTED STANDARDS

Application	Standard	Data Rate
10G Ethernet LAN	IEEE 802.3ae 10GBASE-LR	10.3125GBd
10G Ethernet WAN	IEEE 802.3ae 10GBASE-LW	9.95328GBd

FEATURES & BENEFITS

- Compliant to SFP+ Electrical MSA SFF-8431
- Compliant to SFP+ Mechanical MSA SFF-8432
- 10G Ethernet
- Data rate transparent from 9.95Gbps to 11.3Gbps
- Support I2C for serial transceiver ID and digital diagnostic monitoring per SFF-8472.
- Transmission distance up to 10km (SM fiber)
- Low power consumption: 0.8W (Typ.)
- 0°C to +70°C case operating temperature range
- Laser Class 1 IEC / CDRH compliant
- RoHS 6/6 compliant
- Compliant with product safety standards

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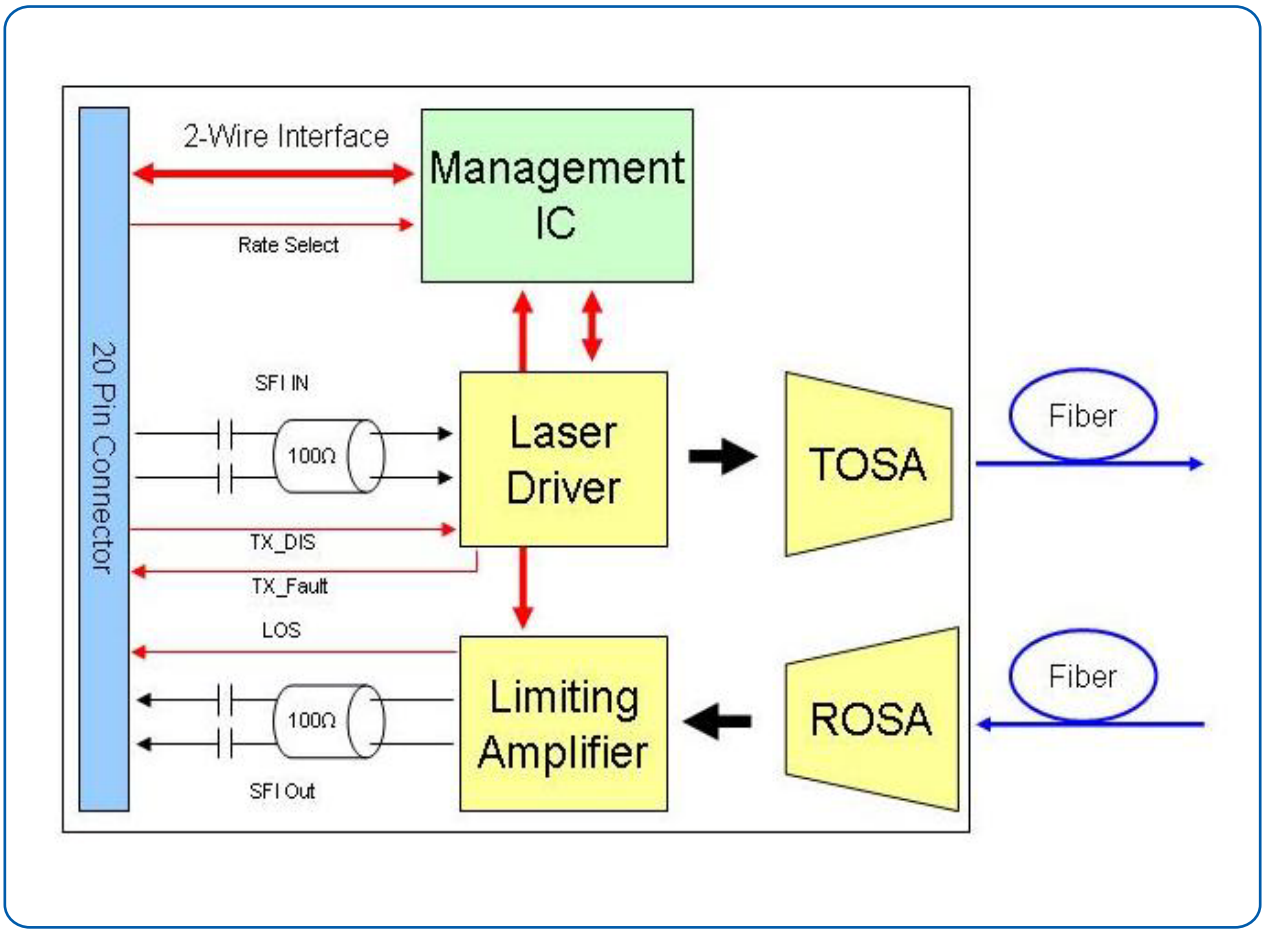
FUNCTIONAL DESCRIPTION

The Transceiver convert information from electrical to optical format, and back again, at different data rates depending upon the chosen standard.

The transmit path consists of an AC coupled 100 ohm differentially terminated driver coupled to a highly reliable 1310nm DFB. The laser output may be disabled by pulling the TX_DISABLE line high. The laser is also disabled if this line is left floating, as it is pulled high inside the transceiver. A fault condition is raised upon detection of an abnormal laser state.

The receiver path consists of a ROSA (receiver optical sub-assembly) for optical electrical conversion, followed by a limiting amplifier to boost the electrical signal. A LOSS_OF_SIGNAL (LOS) status line is provided to facilitate easy link detection. The receiver RATE_SELECT pin is not used by the transceiver.

Complete digital optical monitoring is implemented in compliance to SFF-8472 and made accessible via the 2-wire interface providing real time information about all important module parameters and status information.



ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Rating	Conditions	Symbol	Min	Max	Units
Storage Ambient Temperature Range		ϑ_{stg}	-40	+85	°C
Powered Case Temperature Range		ϑ_c	0	+75	°C
Operating Relative Humidity	Non condensing	RH	0	95	%
Supply Voltage Range @ 3.3V		V_{CC3}	-0.5	3.6	V
Open Drain VCC Level		V_{OD}		4.0	V
Static Discharge Voltage on High Speed Pins	HBM human body model per JEDEC JESD22-A114-B			1	kV
Static Discharge Voltage excluding High Speed Pins	HBM human body model			2	kV
Static Discharge Voltage on SFP+ Module	EN61000-4-2 Criterion B: Air Discharge Direct Contact discharge			15 8	kV

Any stress beyond the maximum ratings may result in permanent damage to the device. Specifications are guaranteed only under recommended operating conditions.

Recommended Operating Conditions

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Operating Case Temperature Range	altitude of < 3km	ϑ_{Case}	0		+70	°C
Power Supply Voltage @ 3.3V		V_{CC3}	3.135	3.300	3.465	V
DC Common Mode Voltage		V_{CM}	0		3.6	V

Low Speed Characteristics

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Supply Current Transmitter	@ V_{CCTX}	I_{VCCTX}		150		mA
Supply Current Receiver	@ V_{CCRX}	I_{VCCRX}		80		mA
Total Supply Current		I_{VCCTX} + I_{VCCRX}			285	mA
Power Consumption				0.80	1	W
TX_Fault, RX_LOS, SCL, SDA	Host Vcc Range 2V – 3.46V	V_{OL}	0		0.4	V
		V_{OH}	Host_ Vcc – 0.5		Host_ Vcc + 0.3	
TX_Dis	Low Voltage TTL	V_{IL}	-0.3		0.8	
		V_{IH}	2.0		VccT + 0.3	
SCL, SDA	Host Vcc Range 3.14V – 3.46V	V_{IL}	-0.3		VccT* 0.3	
		V_{IH}	VccT* 0.7		VccT + 0.5	
		V_{OL}	0.0		0.4	
		V_{OH}	Host_ Vcc – 0.5		Host_ Vcc + 0.3	

FUNCTIONAL DESCRIPTION

SFI Module Transmitter Input Characteristics

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Supported Data Rate		V_{ID}		10.3125		Gbd
Reference Differential Input Impedance		Z_d		100		Ω
Input AC Common Mode Input Voltage			0		25	mV (RMS)
Differential Input Voltage Swing		V_{ID}	150		900	mV
Differential Input S-parameter	0.01 – 3.9GHz	SDD11			-10	dB
	3.9 – 11.1GHz		See 1)		See 1)	dB
Differential to Common Mode Conversion [2)]	0.01 – 11.1Ghz	SCD11			-10	dB
Total Jitter		TJ			0.28	UI(p-p)
Data Dependant Jitter		DDJ			0.1	UI(p-p)
Uncorrelated Jitter		UJ			0.023	RMS
Eye Mask	See SFP+ MSA	X1			0.14	UI
		X2			0.35	UI

1) Differential Return Loss given by equation SDD11(dB) = -8+13.33 Log10(f/5.5), with f in GHz
2) Common mode reference impedance is 25Ω. Differential to common mode conversion relates to generation of EMI

SFI Module Receiver Output Characteristics

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Supported Data Rate				10.3125		Gbd
Reference Differential Output Impedance		Z_d		100		Ω
Termination Mismatch		ΔZ_d			5	%
Output AC Common Mode Voltage					15	mV (RMS)
Differential Output Amplitude	R_{Load} = 100Ohm, Differential	V_{OSPP}	350	530	800	mV
Output Rise and Fall time	20% to 80%	t_{RH}, t_{FH}	28	38		ps
Differential Output S-parameter	0.01 – 3.9GHz	SDD22			-10	dB
	3.9 – 11.1GHz				See 1)	dB
Common Mode Output Return Loss[2)]	0.01 – 6.5GHz	SCC22			-7	dB
	6.5 – 11.1GHz				-3	dB
Deterministic Jitter		DJ			0.42	UI(p-p)
Total Jitter	See SFP+ MSA	TJ			0.7	UI(p-p)

1) Return Loss given by equation Sxx22(dB) = -8+13.33 Log10(f/5.5), with f in GHz
2) Common mode reference impedance is 25Ω. Common mode return loss helps absorb reflection and noise improving EMI

OPTICAL CHARACTERISTICS

General Parameters

Parameter	Conditions	Min Modal Bandwidth (MHz*km)	Symbol	Min	Typical	Units
Operating Range	SMF		I_{OP}		10	km

Optical Transmitter

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Nominal Wavelength		λ_{TRP}	1290	1310	1330	nm
Side Mode Suppression Ratio		SMSR	30			dB
Average Launch Power		P_{avg}	-6.0	-3.2	0.5	dBm
Optical Modulation Amplitude	10.3125GBd Ethernet	P_{OMA}	-5.2			dBm
	Fiber Channel		-5.2			
Extinction Ratio		ER	3.5	5.0		dB
Relative Intensity Noise		RIN			-128	dB/Hz

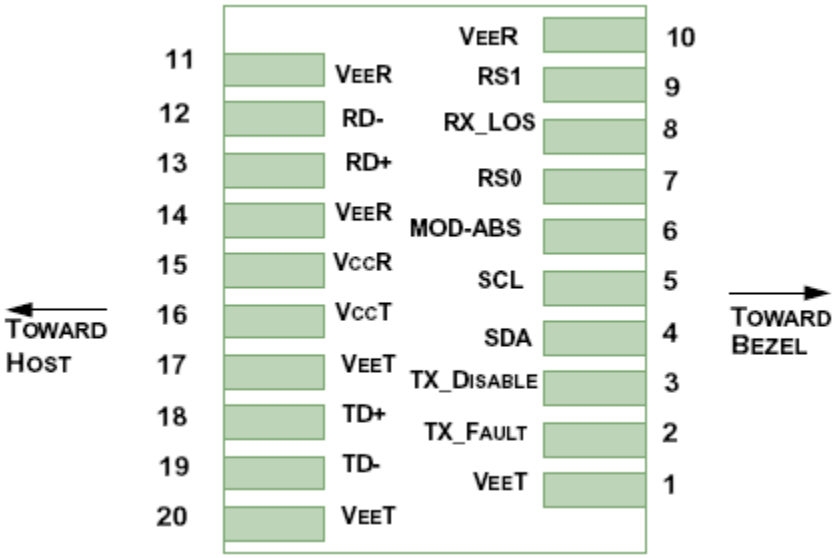
Optical Receiver

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Maximum Input Power		P_{MAX}			0.5	dBm
Center Wavelength		λ_C	1290	1310	1330	nm
Receiver Sensitivity	OMA, PRBS 2^{31}-1, BER < $1*10^{-12}$ @10.3125GBd	P_{IN}		-18	-15	dBm
Stressed Receiver Sensitivity	OMA, PRBS 2^{31}-1, BER < $1*10^{-12}$ @10.3125GBd	P_{IN}	-10.3	-15		dBm
Loss of Signal		P_{av_as}	-30	-21		dBm
		P_{OMA_deas}		-19	-15	
Loss of Signal Hysteresis			0.5	2		dBm

Note: The specified characteristics are met within the recommended range of operating. Unless otherwise noted typical data are quoted at nominal voltages and +25°C ambient temperature.

APPLICATION INFORMATION

Connector Pinout



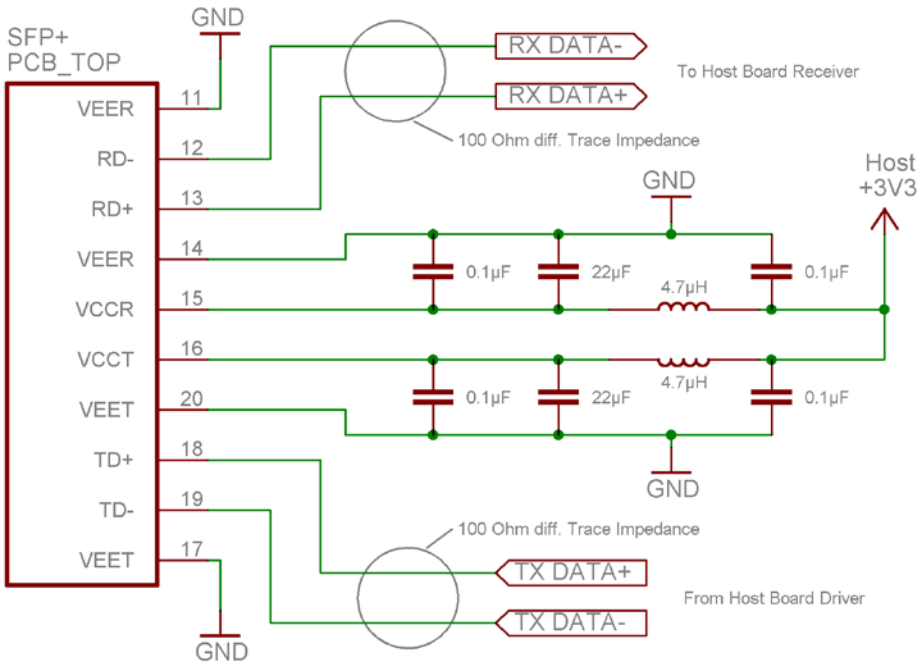
Electrical Pin Definition

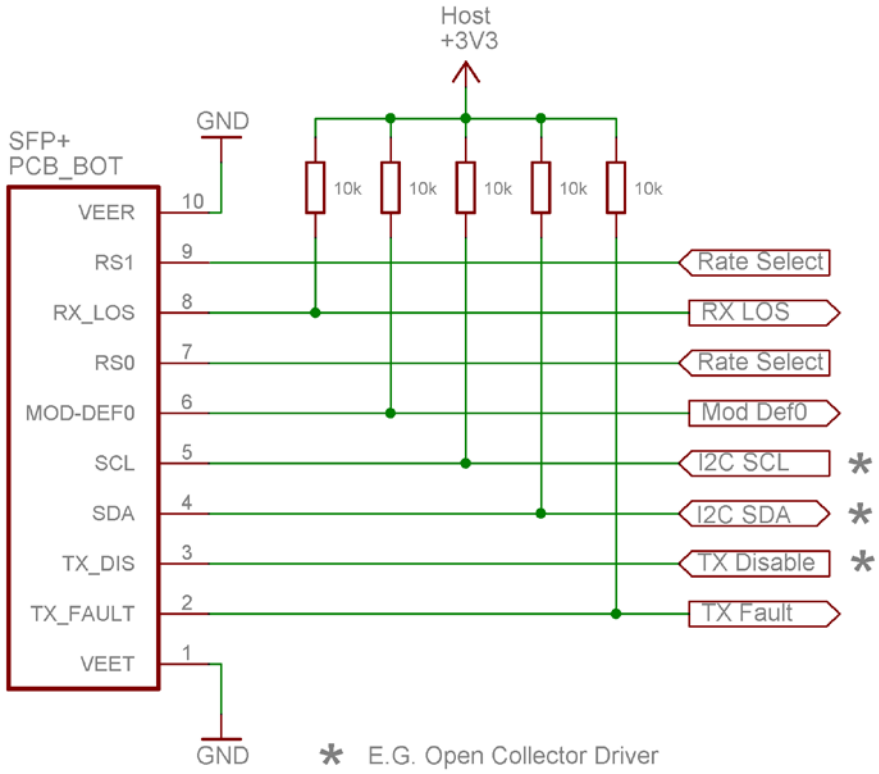
PIN	Logic	Symbol	Name / Description	Note
1		VeeT	Module Transmitter Ground	1
2	LVTTL-O	TX_Fault	Module Transmitter Fault	
3	LVTTL-I	TX_Dis	Transmitter Disable; Turns off transmitter laser output	
4	LVTTL-I	SCL	2-Wire Serial Interface Clock	2
5	LVTTL-I/O	SDA	2-Wire Serial Interface Data Line	2
6		MOD_DEF0	Module Definition, Grounded in the module	
7	LVTTL-I	RS0	Receiver Rate Select	
8	LVTTL-O	RX_LOS	Receiver Loss of Signal Indication Active LOW	
9	LVTTL-I	RS1	No function implemented	
10		VeeR	Module Receiver Ground	1
11		VeeR	Module Receiver Ground	1
12	CML-O	RD-	Receiver Inverted Data Output	
13	CML-O	RD+	Receiver Data Output	
14		VeeR	Module Receiver Ground	1
15		VccR	Module Receiver 3.3 V Supply	
16		VccT	Module Receiver 3.3 V Supply	
17		VeeT	Module Transmitter Ground	1
18	CML-I	TD-	Transmitter Inverted Data Input	
19	CML-I	TD+	Receiver Non-Inverted Data Output	
20		VeeT	Module Transmitter Ground	1

1. Module ground pins GND are isolated from the module case.
2. Shall be pulled up with 4.7K-10Kohms to a voltage between 3.15V and 3.45V on the host board.

APPLICATION SCHEMATICS

Recommended electrical connections to transceiver are shown below.





INTERFACING THE TRANSCEIVER

Communication is done by a serial 2-wire interface similar to the I2C bus protocol. As described in the document SFF-8472 there are two distinct address spaces:

Base Address A0(hex)	
Byte Address	**Content**
0 - 95	Serial Transceiver ID as defined in SFP MSA
96 - 127	MergeOptics Specific
128 - 255	Reserved

Base Address A2(hex)	
Byte Address	**Content**
0 - 55	Alarm & Warnings thresholds & limits
56 - 95	External calibration constants (not used)
96 – 119	Values from real time diagnostic monitoring
120 – 127	Not used
128 – 247	Customer specific, writable area
248 - 255	Not used

Module Identifier & Specific Data

Refer to SFF-8472 for a detailed listing of registers

Digital Diagnostic Monitoring

Transceivers offer the ability to monitor important module parameter during operation. The five parameters listed below are continuously monitored for getting information about the current module status. All data is calibrated internally; there is no need for external post processing.

Temperature

Internally measured temperature data is represented as two's complement of a signed 16-bit value in increments of 1/256 °C over a range of -40 to +100°C. Accuracy is better than +/-3%.

Supply Voltage (VCC)

Internally measured supply voltage. Represented as a 16-bit unsigned integer with the voltage defined as the full 16 bit value (0 – 65535) with LSB equal to 100 µVolt, which yields to a total range of 0 to +6.55 Volts. Accuracy is better than +/-3%.

Laser Bias Current

VCSEL bias current. Represented as a 16 bit unsigned integer with the current defined as the full 16-bit value (0 – 65535) with LSB equal to 2 µA, valid range is 0 to 20 mA. Accuracy is better than +/-10%.

Optical Transmitter Power

TX output power measurement is based on internal monitor diode feedback. Represented as a 16-bit unsigned integer with the power defined as the full 16 bit value (0 – 65535) with LSB equal to 0.1 µW. Accuracy is better than +/-3dB over a range of Pav_{min} to Pav_{max}.

Receiver Optical Power

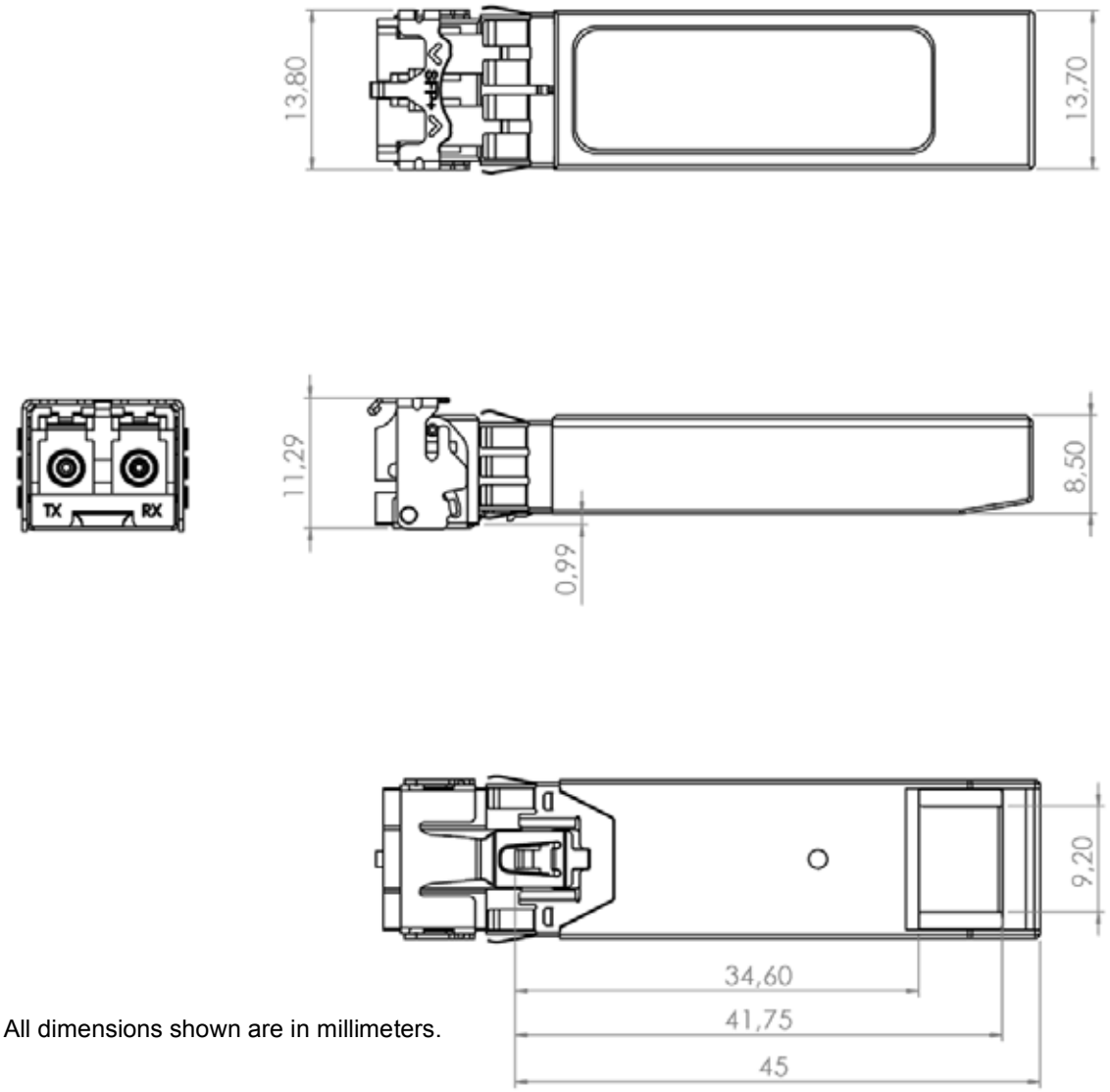
RX input power measurement is based on photodiode diode current. Represented as a 16-bit unsigned integer with the power defined as the full 16 bit value (0 – 65535) with LSB equal to 0.1 µW. Accuracy is better than +/-3dB over a range of -12dBm to -1dBm.

Digital Diagnostic Monitoring Accuracy

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Internally measured transceiver temperature	supply voltage 3.30V ± 5%	ΔT	-3	±1	3	°C
Internally measured supply voltage	transceiver temperature 0 to 70°C	ΔV	-0.1		0.1	V
Laser bias current		ΔI	-10		10	%
TX output power		ΔP_{Tx}	-2	±1	2	dBm
RX input power		ΔP_{Rx}	-2	±1	2	dBm

Note: min and max specs are met over specified full temperature and voltage range. Typ shows typical values at room temperature and nominal supply voltage.

MODULE OUTLINE



All dimensions shown are in millimeters.

ORDERING INFORMATION

Application	Standard	Part Number
10G Ethernet LAN	IEEE 802.3ae 10GBASE-LRT	RX10GDP0310
10G Ethernet WAN	IEEE 802.3ae 10GBASE-LWT	RX10GDP0310

REGULATORY COMPLIANCE

Module Safety

MergeOptics SFP+ LR modules are designed to meet international requirements and standards in terms of product safety. Tests were performed according to IEC 60950-1:2001 (CB scheme). The module is RoHS compliant according to the European Parliament requirements on the restriction of the use of hazardous substances in electrical and electronic equipment (RoHS). The modules optical output power meets Class 1 requirements for laser safety.

Requirements	Standard	Status
Module Safety	IEC 60950-1:2001 EN 60950-1:2001	TUV Report / Certificate available CB Report / Certificate available
RoHS Compliance	RoHS Directive 2002/95/EC Amendment 4054 (2005/747/EC)	RoHS 6/6 compliant Certificate of compliance available
Laser Eye Safety	CDRH 21 CFR 1040.10 and 1040.11 IEC 60825-1 Rev2 2007	Laser Class 1 according to FDA Laser Class 1 according to IEC Rev2

ESD & Electromagnetic compatibility

MergeOptics SFP+ LR modules are designed to withstand high ESD voltages. Its excellent performances in terms of EMI allow system designers to integrate the module in high density applications.

Requirements	Standard	Status
Electro Static Discharge to the Electrical Pins (ESD)	EIA/JESD22-A114-B MIL-STD 883C Method 3015.7	Exceeds requirements Class 1B (>1000V)
Immunity to ESD (housing, receptacle)	IEN 61000-4-2 IEC61000-4-2	Exceeds requirements Discharges ranging from 2kV to 25kV without damages to the transceiver
Electromagnetic Emission (EMI)	FCC Part 15, Class B EN 55022 Class B CISPR 22	Exceeds requirements Class B with more than 6dB margin

EYE SAFETY

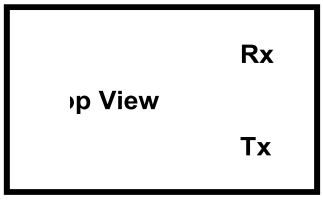
This laser based multimode transceiver is a Class 1 product. It complies with IEC 60825-1: 2007 and FDA performance standards for laser products (21 CFR 1040.10 and 1040.11) except for deviations pursuant to Laser Notice 50, dated June 24, 2007.

CLASS 1 LASER PRODUCT

Caution: use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation.

Note: All adjustments have been made at the factory prior to shipment of the devices. No maintenance or alteration to the device is required. Tampering with or modifying the performance of the device will result in voided product warranty. Failure to adhere to the above restrictions could result in a modification that is considered an act of "manufacturing", and will require, under law, recertification of the modified product with the U.S. Food and Drug Administration (ref. 21 CFR 1040.10 (i)).

Laser Emission Data



Laser Emission

Wavelength	1310 nm
Maximum total output power (as defined by IEC: 7 mm aperture at 70 mm distance)	15.6 mW / 11.9 dBm
Beam divergence (full angle) / NA (half angle)	11° / 0.1 rad

Required Labeling

FDA

Compliant to 21 CFR 1040.10 and 1040.11

IEC

Class 1 Laser Product

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More information about FCI's complete range of High Speed Input/Output products can be found on www.fciconnect.com/hsio

For more information about e-catalog or FCI sales offices, headquarters, agents and local distributors, visit www.fciconnect.com

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