

SFP+ Optical Transceiver – 10 Gigabit Ethernet for up to 10km Reach JSH Series



Key Features

- Support line rates from 9.95 Gbps to 11.3 Gbps
- 1310 nm DFB laser for up to 10 km reach
- Operating temperature range of up to -40°C to 85°C
- Maximum power dissipation is 1.0W between -5°C to 70°C, and -40°C to 85°C between 1.2 W
- RoHS6/6 compliant
- Single 3.3 V power supply
- Limiting SFI AC-couple electrical output interface
- Digital Diagnostic Monitoring support

Applications

- Local Area Network (LAN)
- Storage Area Network (SAN)
- Wireless Radio Access Network (RAN)
- Ethernet switches and applications
- Fibre Channel switches and applications

Compliance

- IEEE 802.3-2008 Clause 52 standard
- 10 G Fibre Channel standard
- SFF 8431 Rev 4.1
- SFF 8432 Rev 5.0
- SFF 8472 Rev 11.0
- Class 1 Laser Safety
- Tested in accordance with Telcordia GR-468

The JDSU 10 Gbps 1310 nm SFP+ optical transceiver is a fully duplex, integrated fiber optic transceiver that provides a high-speed serial link at signaling rates from 9.95 Gbps to 11.3 Gbps. The transceiver complies with the Enhanced Small Form Factor Pluggable Module (SFP+) specification SFF-8431 Rev. 4.1 for the electrical interface, SFF-8432 Rev. 5.0 for the mechanical interface, and SFF-8472 Rev. 11.0 for the Management interface.

The SFP+ 1310 nm optical transceiver complies with IEEE 802.3-2008 clause 52 10GBase-LR/LW (Ethernet), 10GFC (Fibre Channel) and corresponding Forward Error Correction (FEC) rates.

The JDSU SFP+ optical transceiver integrates the receive and transmit path on one module. In the transmit side, the serial data stream is passed from the electrical connector to a laser driver. The laser driver biases and modulates a 1310 nm DFB (Distributed Feedback) laser, enabling data transmission over up to 10 km of the single-mode fiber through an industry standard LC connector. In the receive side, the 10 Gbps optical data stream is recovered from a PIN photodetector through a transimpedance amplifier and post amplifier to the electrical connector. This module features a hot-pluggable SFI compliant limiting electrical interface. An enhanced digital diagnostic feature set is present for real time transceiver performance monitoring. Transmit disable, loss of signal, and transmitter fault functions are also provided.

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

Section 1 Functional Description

The SFP+ 1310 nm LR optical transceiver is a fully duplex serial electric, serial optical device with both transmit and receive functions contained in a single module that provides a high-speed serial link at signaling rates from 9.95 Gbps to 11.3 Gbps. It is compliant with IEEE 802.3-2008 clause 52 10GBase-LR / LW (Ethernet), 10GFC (Fibre Channel) and corresponding Forward Error Correction (FEC) rates. The module complies with the Enhanced Small Form Factor Pluggable Module (SFP+) specification SFF-8431 Rev. 4.1 for the electrical interface, SFF-8432 Rev. 5.0 for the mechanical interface, and SFF-8472 Rev. 11.0 for the Management interface. A block diagram is shown in Figure 1 below.

The SFP+ optical transceiver has several low-speed interface connections. These connections include; transmitter fault (Tx_Fault), transmitter disable (TX_Disable), rate select (RS0 and RS1), module absent (Mod_ABS), receive loss of signal (RX_LOS), and a 2-wire serial interface clock (SCL) and data (SDA).

The SFP+ optical transceiver supports SFI electrical interface. The electrical interface is based on high speed, low voltage logic AC coupled limiting interface with a nominal differential impedance of 100 Ω .

Transmitter

The transmitter path converts serial NRZ electrical data from line rate of 9.95 Gbps to 11.3 Gbps to a standard compliant optical signal. The transmitter accepts a 100 Ω differential 190 mV peak-to-peak to 700 mV peak-to-peak 10 Gbps CML electrical signal on TD- and TD+ pins.

Inside the module, the differential signals is input to the laser driver which transforms the small swing voltage to an output modulation that drives an uncooled DFB laser. The optical signal is engineered to meet the 10 Gigabit Ethernet, 10G Fibre Channel and corresponding Forward Error Correction (FEC) rates specifications. Closed-loop control of the transmitted laser power and modulation swing over temperature and voltage variations is provided. The laser is coupled to single-mode optical fiber through an industry standard LC optical connector.

Receiver

The receiver converts incoming DC balanced serial NRZ optical data from line rate of 9.95 Gbps to 11.3 Gbps into serial SFI electrical data. Light is coupled to a PIN photodetector from single-mode optical fiber through an industry standard LC optical connector. The electrical current from the PIN photodetector is converted to a voltage in a transimpedance amplifier and a post amplifier. The amplified signal is output on the RD+ and RD- pins as a 100 Ω CML signal.

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

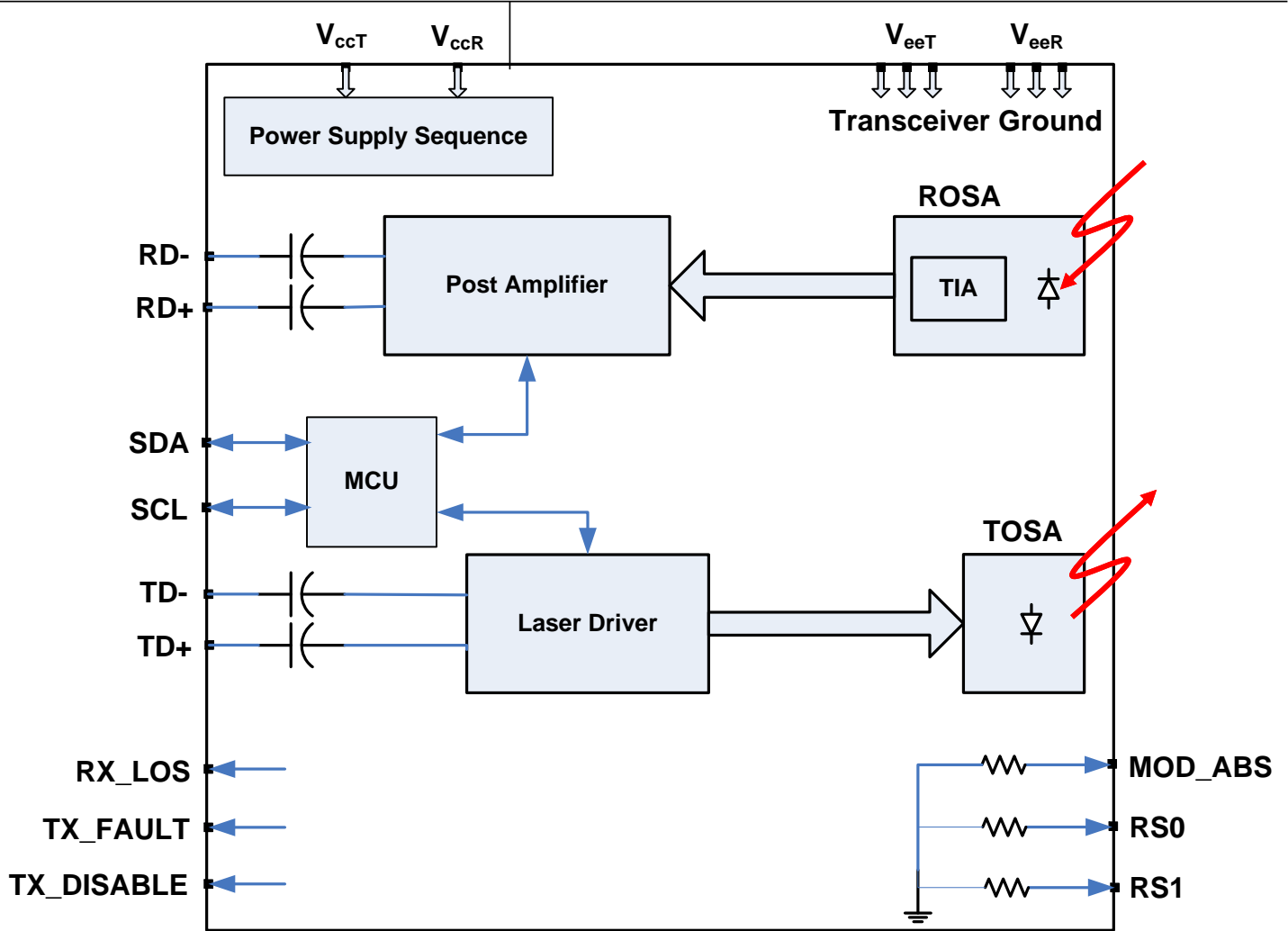


Figure 1 JDSU SFP+ LR Optical Transceiver functional block diagram

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

Low Speed Signaling

Low speed signaling is based on low voltage TTL (LVTTL) operating at a nominal voltage of 3.3 V. Hosts should use a pull-up resistor connected to Vcc 3.3 V on the two-wire interface SCL (clock), SDA (data), and all low speed outputs based on the SFF 8431 Rev. 4.1 requirements.

SCL/SDA: Two wire Serial interface clock and data line.

Tx_Fault: Output pin. When asserted high indicates that the module has detected a transmitter fault condition related to laser operation or safety..

TX_Disable: Input pin. When asserted high or left open the transmitter output is turned off. When Tx_Disable is asserted low or grounded the module transmitter is operating normally.

RS0 and RS1: Input pins. Pulled low to VeeT with > 100 kΩ resistors in the module. These pins are not used in this product.

Mod_ABS: Output pin. Asserted high when the SFP+ module is absent and is pulled low when the SFP+ module is inserted.

RX_LOS: Output pin. Asserted high when insufficient optical power for reliable signal reception is received.

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

Section 2 Application Schematics

Recommended MSA connections to the JDSU SFP+ Optical Transceiver are shown in Figure 2 below.

SFP+ modules are hot pluggable and active connections are powered by individual power connections for the transmitter (VccT) and the receiver (VccR). Multiple modules can share a single 3.3 V power supply with individual filtering for each VccT and VccR. The host shall generate an effective weighted integrated spectrum RMS noise less than 25 mV in the frequency range 10 Hz to 10 MHz. Power supply filtering components should be placed as close to the Vcc pins of the host connector as possible for optimal performance. Detailed power supply specifications are given in SFF-8431 Rev. 4.1 Section 2.8.

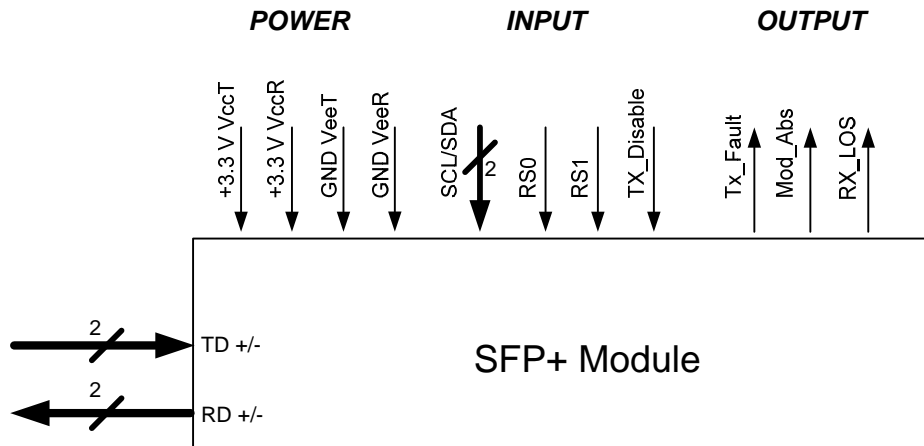


Figure 2 Application schematics for the JDSU 10 Gbps SFP+ optical transceiver

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

Section 3 Specifications

Technical specifications related to the JDSU 10 Gbps SFP+ Optical Transceiver includes:

Section 3.1	Pin Function Definitions
Section 3.2	SFP+ SFI Reference Model Compliance Points
Section 3.3	Absolute Maximum Ratings
Section 3.4	Operating Conditions
Section 3.5	Electrical Characteristics
Section 3.6	Jitter Specifications
Section 3.7	Timing Requirement of Control and Status I/O
Section 3.8	SFP+ 2-wire interface protocol and Management Interface
Section 3.9	Optical Transmitter Characteristics
Section 3.10	Optical Receiver Characteristics
Section 3.11	Regulatory Compliance
Section 3.12	PCB Layout
Section 3.13	Module Outline
Section 3.14	Connectors

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

3.1 Pin Function Definitions

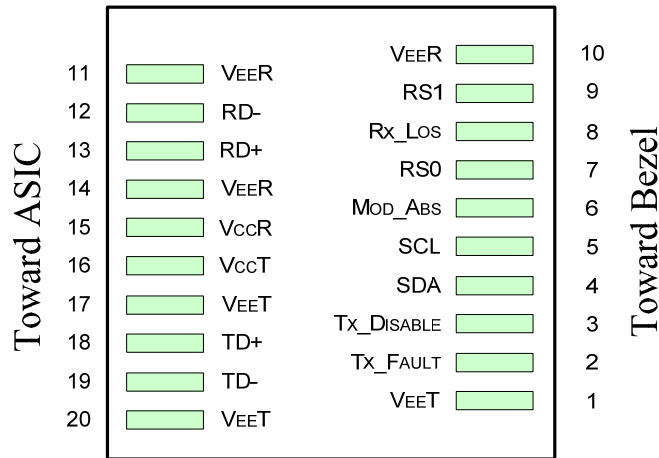


Figure 3 SFP+ optical transceiver pin-out on host board

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

Table 1 SFP+ optical transceiver pin descriptions

Pin no.	Type	Name	Description
1		VeeT ¹	Module transmitter ground
2	LVTTL-O	Tx_Fault ²	Module transmitter fault. Logic 1 indicates laser fault.
3	LVTTL-I	Tx_Disable	Transmitter disable; When held high or left open transmitter laser source turned off
4	LVTTL-I/O	SDA ²	Two wire interface data line
5	LVTTL-I	SCL ²	Two wire interface clock
6		Mod_Abs ²	Indicates module is not present. Grounded to VeeT or VeeR inside the module.
7	LVTTL-I	RS0	Rate select 0 (not used)
8	LVTTL-O	RX_LOS ²	Receiver loss of signal indicator
9	LVTTL-I	RS1	Rate select 1 (not used)
10		VeeR ¹	Module receiver ground
11		VeeR ¹	Module receiver ground
12	CML-O	RD-	Receiver Inverted Data Output
13	CML-O	RD+	Receiver Non-Inverted Data Output
14		VeeR ¹	Module receiver ground
15		VccR	Module receiver +3.3V supply
16		VccT	Module transmitter +3.3V supply
17		VeeT ¹	Module transmitter ground
18	CML-I	TD+	Transmitter Non-Inverted Data Input
19	CML-I	TD-	Transmitter Inverted Data Input
20		VeeT ¹	Module transmitter ground
1. Module ground pins (GND) are isolated from the module case and chassis ground within the module			
2. Shall be pulled up with 4.7 kΩ – 10 kΩ to a voltage between 3.15 V and 3.45 V on the host board			

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

3.2 SFP+ SFI Reference Model Compliance Points

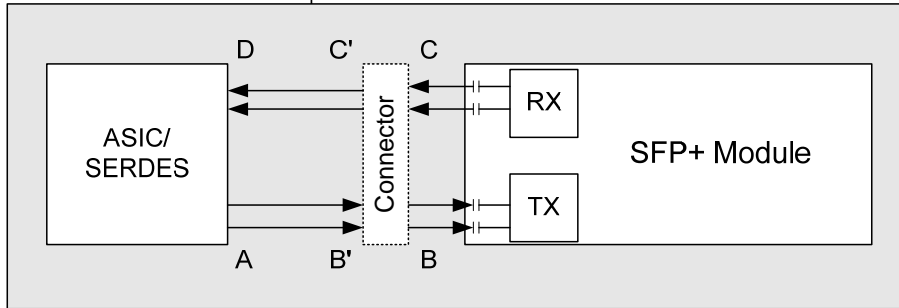


Figure 4 SFP+ optical transceiver model compliance points

3.3 Absolute Maximum Ratings

Absolute maximum ratings represent the damage threshold of the device. Damage may occur if the device is operated above the limits stated here except for brief excursions. Performance is not guaranteed and reliability is not implied for operation at any condition outside the recommended operating limits.

Parameter	Symbol	Ratings	Unit
Storage Temperature	T_{ST}	-40 to +85	°C
Operating Case Temperature	T_{OP}	-40 to +85	°C
Relative Humidity	RH	5 to 85 (non-condensing)	%
Static Electrical Discharge (Human Body Model)	ESD	500	V
Power Supply Voltages	V_{CCT}, V_{CCR}, \max	-0.3 to 4.0	V
Receive Input Optical Power (Damage threshold)	P_{dth}	+5	dBm

3.4 Operating Conditions

Performance is not guaranteed and reliability is not implied for operation at any condition outside the recommended operating limits.

Part Number	Operating Case Temperature Rating	Unit
JSH-01LWDA1	-5 to 70	°C
JSH-01LWDC1	-20 to 85	°C
JSH-01LWDD1	-40 to 85	°C

3.5 Electrical Characteristics

Parameter	Symbol	Min	Typ.	Max	Unit	Notes
Supply currents and voltages						
Voltage	V_{CC}	3.14	3.3	3.47	V	With Respect to GND
Supply current	I_{cc}			288	mA	JSH-01LWDA1
				346	mA	JSH-01LWDC1, JSH-01LWDD1
Power Dissipation	P_{wr}			1.0	W	JSH-01LWDA1
				1.2	W	JSH-01LWDC1, JSH-01LWDD1
Low speed control and sense signals (detailed specification in SFP+ MSA SFF 8431 Rev. 4.1)						
Outputs (TX_Fault, RX_LOS)	V_{OL}	-0.3		0.4	V	At 0.7 mA

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

	I _{OH}	-50		37.5	μA	Measured with a 4.7 kΩ load pulled up to V _{cc_host}
Inputs (TX_Disable, RS0, RS1)	V _{IL}	-0.3		0.8	V	Pulled up in module to V _{ccT}
	V _{IH}	2		V _{cc3+} 0.3	V	
SCL and SDA Inputs	V _{IL}	-0.3		V _{cc3*0.} 3	V	Rpullup pulled to V _{cc_host}
	V _{IH}	V _{cc3*0.} .7		V _{cc3+0.} 5	V	Rpullup pulled to V _{cc_host}

3.6 Jitter Specifications

Parameter	Symbol	Min	Max	Unit	Notes
Transmitter electrical input jitter from host at B ² (detailed specification in SFP+ MSA SFF 8431)					
Data dependent Jitter	DDJ		0.10	UI(p-p)	2 ⁹ -1pattern, TP1, at 10.3 Gbps
Uncorrelated Jitter	UJ		0.023	UI(rms)	
Pulse Width Shrinkage Jitter	DDPWS		0.055	UI(p-p)	
Total Jitter	TJ		0.28	UI(p-p)	2 ³¹ -1pattern, TP1, BER < 1x10 ⁻¹² , at 10.3 Gbps
Eye Mask	X1		0.12	UI	Mask hit ratio of 5x10 ⁻⁵
Eye Mask	X2		033	UI	
Eye Mask	Y1	95		mV	
Eye mask	Y2		350	mV	
Receiver electrical output jitter to host at C ³ (detailed specification in SFP+ MSA SFF 8431)					
Differential peak to peak voltage	Vp-p	300	850	mV	Limiting electrical interface; measured at receive overload level
Total Jitter	TJ		0.7	UI(p-p)	

3.7 Timing Requirement of Control and Status I/O

Parameter	Symbol	Min	Max	Unit	Notes
TX_Disable assert time	t _{off}		100	μs	Rising edge of TX_Disable to fall of output signal below 10% of nominal
TX_Disable negate time	t _{on}		2	ms	Falling edge of TX_DIS to rise of output signal above 90% of nominal ¹
Time to initialize 2-wire interface	t _{2w_start_up}		300	ms	From power on or hot plug
Time to initialize	t _{init}		300	ms	From power on or hot plug
Tx_Fault assert	Tx_Fault_on		50	ms	From occurrence of fault to assertion of Tx_Fault
Tx_Fault reset	Tx_Fault_reset	10		μs	Time Tx_Disable must be held high to reset Tx_Fault
RX_LOS Assert Delay	t _{loss_on}		100	μs	From Occurrence of loss of signal to assertion of RX_LOS
RX_LOS Negate Delay	t _{loss_off}		100	μs	From Occurrence of return of signal to negation of RX_LOS

1. The transceiver is stabilized prior to TX_Disable negating event.

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

3.8 SFP+ 2-wire interface protocol and Management Interface

The JDSU SFP+ Optical Transceiver incorporates a 2-wire management interface which is used for serial ID, digital diagnostics, and certain control functions. Details of the protocol and interface are explicitly described in the MSA. Please refer to the MSA for design reference.

3.9 Optical Transmitter Characteristics

Parameter	Symbol	Min	Typ.	Max	Unit	Notes
<i>The following specifications are applicable within the operating case temperature range specified in Section 3.4</i>						
Average Optical Power	Pavg	-8.2		0.5	dBm	
Extinction Ratio	ER	3.5			dB	1
Optical modulation amplitude (OMA)	OMA	-5.2			dBm	
Transmitter Dispersion Penalty				3.2	dB	
OMA minus TDP	OMA-TDP	-6.2			dBm	
Center Wavelength	λ	1260		1355	nm	
Side Mode Suppression Ratio	SMSR	30			dB	
Relative Intensity Noise	RIN ₁₂ OMA			-128	dB/Hz	
1. Tested with PRBS 2 ³¹ - 1 pattern.						

3.10 Optical Receiver Characteristics

Parameter	Symbol	Min	Typ.	Max	Unit	Notes
<i>The following specifications are applicable within the operating case temperature range specified in Section 3.4</i>						
Center Wavelength	λ	1260		1355	nm	
Receiver Sensitivity	Rsen			-14.4	dBm	1
Stressed Receiver Sensitivity (OMA)				-10.3	dBm	2
Receive Overload	Pmax	0.5			dBm	3
LOS Assert	Plos_on	-30			dBm	
LOS Deassert	Plos_off			-16	dBm	
LOS Hysteresis		0.5		4	dB	
1. Guaranteed at 10.52 Gbps. Measured with worst ER; BER<10 ⁻¹² ; PRBS 2 ³¹ - 1 pattern.						
2. Guaranteed at 10.3 Gbps. Measured with worst ER; BER<10 ⁻¹² ; PRBS 2 ³¹ - 1 pattern.						
3. Measured with worst ER; BER<10 ⁻⁴ ; PRBS 2 ³¹ - 1 pattern.						

3.11 Regulatory compliance

The JDSU SFP+ Optical Transceiver is lead-free and RoHS 6/6 compliant.

The JDSU SFP+ Optical Transceiver complies with international Electromagnetic Compatibility (EMC) and international safety requirements and standards. EMC performance is dependent on the overall system design. Information included herein is intended as a figure of merit for designers to use as a basis for design decisions.

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

Table 2 Regulatory Compliance

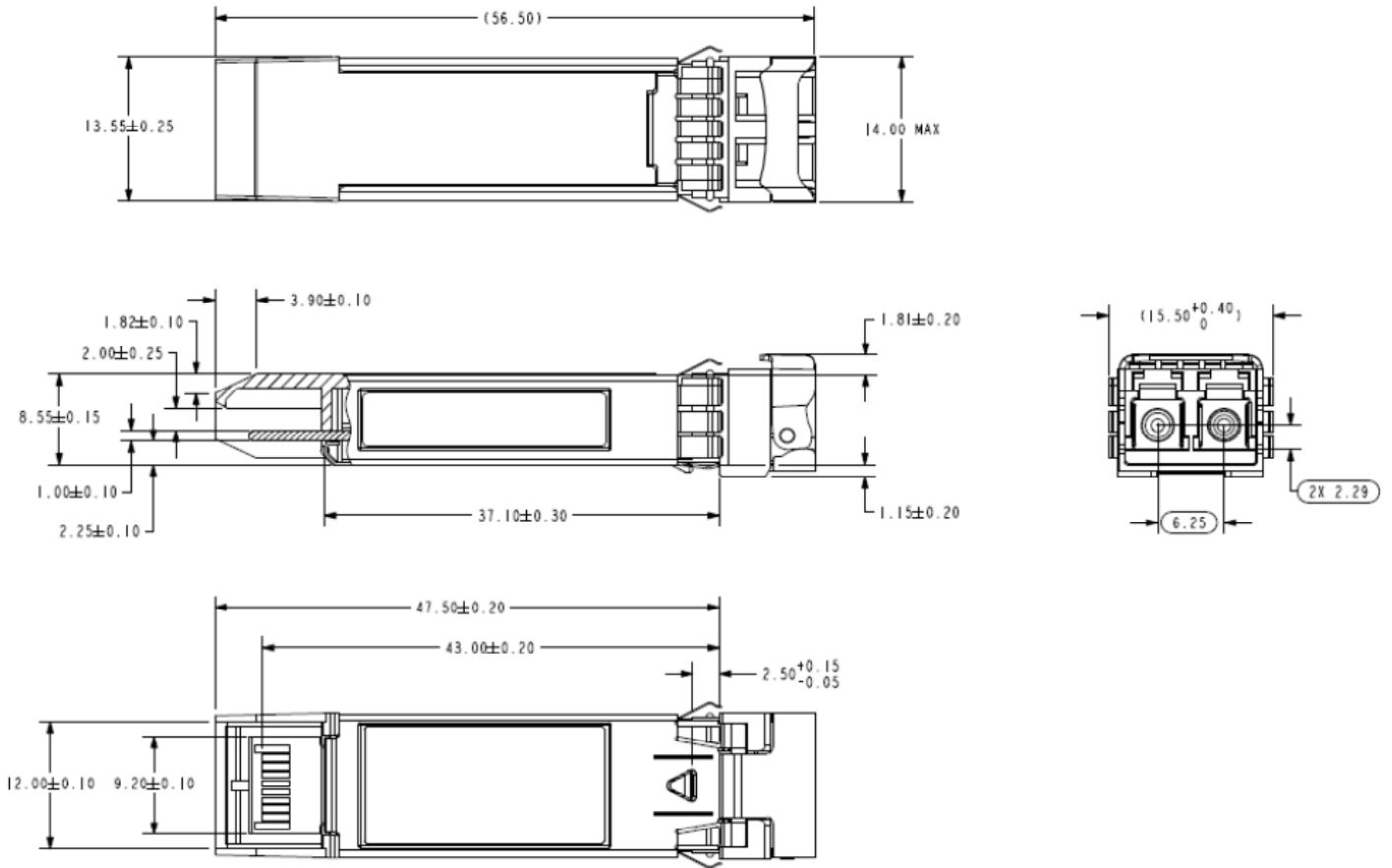
Feature	Test Method	Performance
SAFETY		
Product Safety	UL 60950-1	UL Recognized Component
	CSA C22.2 No. 60950-1	
	UL94-V0	
	EN 60950-1	TUV Bauart certificate
	IEC 60950-1	CB certificate
Laser Safety	EN 60825-1	TUV certificate
	IEC 60825-1	
	U.S. 21 CFR 1040.10	FDA/CDRH certified with accession number, Class 1 laser product
ELECTROMAGNETIC COMPATIBILITY		
Radiated Emissions	EMC Directive 2004/108/EEC	Noise frequency range: 30 MHz to 40 GHz. Good system EMI design practice required to achieve Class B margins.
	FCC 47CFR Part 15	
	CISPR 22	
	AS/NZS CISPR22	
	EN 55022	
	ICES-003, Issue 4	
	VCCI-03	
Immunity	EMC Directive 89/336/EEC	
	IEC /CISPR/24	
	EN 55024	
ESD	EN 61000-4-2	Exceeds Requirements. Withstands discharges of ± 8 kV contact, ± 15 kV air
Radiated Immunity	EN 61000-4-3	Exceeds Requirements. Field strength of 10V/m from 10 MHz to 1 GHz. No effect on transmitter / receiver performance is detectable between these limits.
RESTRICTION OF HAZARDOUS SUBSTANCES (RoHS)		
RoHS	EU Directive 2002/95/EC	Compliant per the Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment. A RoHS Certificate of Conformance (C of C) is available upon request. The product may use certain RoHS component exemptions.

3.12 PCB layout

Recommended PCB layout is given in SFP+ MSA SFF8431 Rev. 4.1.

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

3.13 Module Outline



3.14 Connectors

Fiber

The SFP+ module has a duplex LC receptacle connector.

Electrical

The electrical connector is the 20-way, two row PCB edge connector. Customer connector is Tyco / AMP Part No. 188247 or equivalent.

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

Section 4 Related information

Other information related to the JDSU SFP+ Optical Transceiver includes:

Section 4.1 Packing and handling instructions

Section 4.2 ESD discharge (ESD)

Section 4.3 Eye safety

4.1 Package and handling instructions

Connector covers

The JDSU SFP+ Optical Transceiver is supplied with an LC duplex receptacle. The connector plug supplied protects the connector during standard manufacturing processes and handling by preventing contamination from dust, aqueous solutions, body oils, or airborne particles.

Note: It is recommended that the connector plug remain on whenever the transceiver optical fiber connector is not inserted.

Recommended cleaning and de-greasing chemicals

JDSU recommends the use of methyl, isopropyl and isobutyl alcohols for cleaning.

Do not use halogenated hydrocarbons (e.g. trichloroethane, ketones such as acetone, chloroform, ethyl acetate, MEK, methylene chloride, methylene dichloride, phenol, N-methylpyrrolidone).

This product is not designed for aqueous wash.

Housing

The JDSU SFP+ Optical Transceiver housing is made from zinc.

4.2 ESD discharge (ESD)

Handling

Normal ESD precautions are required during the handling of this module. This transceiver is shipped in ESD protective packaging. It should be removed from the packaging and otherwise handled in an ESD protected environment utilizing standard grounded benches, floor mats, and wrist straps.

Test and operation

In most applications, the optical connector will protrude through the system chassis and be subjected to the same ESD environment as the system. Once properly installed in the system, this transceiver should meet and exceed common ESD testing practices and fulfill system ESD requirements.

Typical of optical transceivers, this module's receiver contains a highly sensitive optical detector and amplifier which may become temporarily saturated during an ESD strike. This could result in a short burst of bit errors. Such an event might require that the application re-acquire synchronization at the higher layers (e.g. Serializer / Deserializer chip).

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach**4.3 Eye Safety**

The JDSU SFP+ Optical Transceiver is certified as a Class 1 laser product per international standard IEC 60825-1:2007 2nd edition and is considered non-hazardous when operated within the limits of this specification.



**INVISIBLE LASER RADIATION
CLASS 1 LASER PRODUCT
 $\lambda = 1260-1355\text{nm}, <15\text{mW}$**

Caution!

Operating this product in a manner inconsistent with intended usage and specifications may result in hazardous radiation exposure.

Use of controls or adjustments or performance of procedures other than these specified in this product datasheet may result in hazardous radiation exposure.

Tampering with this laser product or operating this product outside the limits of this specification may be considered an 'act of manufacturing' and may require recertification of the modified product.

This device complies with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50 dated June 24, 2007.

Change History

Date	Description
October 6, 2011	Version 0.3: Pre-production Release

This Specification may be changed at anytime at the sole discretion of JDSU, without notice.

SFP+ Optical Transceiver with Limiting Electrical Interface for 10 km Reach

Ordering Information

For more information on this or other products and their availability, please contact your local JDSU account manager or JDSU directly at 1-800-498-JDSU (1-800-498-5378) in North America and +800-5378-JDSU (+800-5378-5378) worldwide or via e-mail at customer.service@jdsu.com.

Product Code	Description
JSH-01LWDA1	10GbE, 10km reach, Limiting, 1310nm, Commercial Temperature range, SFP+ Optical transceiver
JSH-01LWDC1	10GbE, 10km reach, Limiting, 1310nm, Extended Temperature range, SFP+ Optical transceiver
JSH-01LWDD1	10GbE, 10km reach, Limiting, 1310nm, Industrial Temperature range, SFP+ Optical transceiver