

# 10GBASE-ER SFP+ 1310nm 40km DOM Transceiver

SFP-10GER-31



## Application

- 6.144G/9.83G CPRI
- 8.5Gb/s Fibre Channel
- 10G NRZ SONET, SDH
- 10G Ethernet and Fibre Channel
- G.709 OTN FEC bit rates

## Features

- Hot-pluggable SFP+ footprint
- 17dB optical link budget for up to 40km over G.652 single mode fiber
- Supports 6.144, 8.5G and from 9.83 to 11.3 Gb/s bit rates
- Un-cooled 1310nm DFB laser
- Receiver limiting electrical interface
- Power dissipation < 1.5W
- Industrial temperature range: -40°C to 85°C
- Commercial temperature range: 0°C to 70°C
- RoHS-6 compliant (lead-free)
- Single 3.3V power supply
- Duplex LC connector
- Built-in digital diagnostic functions

## Description

10Gb/s Pluggable SFP+ transceivers are compliant with SFF-8431 and SFF-8432, and support 10G SONET, SDH, OTN, IEEE 802.3ae, 8x/10x Fibre Channel and 6.144G/9.83 CPRI. The transceivers have higher optical transmit power and better receiver sensitivity than 1310nm 10GBASE-LR and OC-192 SR-1 transceivers, and they support an optical link budget of 17dB, to compensate for the higher fiber attenuation loss at 1310nm over 40km of G.652 single mode fiber.

Digital diagnostics functions are available via a 2-wire serial interface. The transceivers utilize internal transmitter and receiver re-timer IC's for SONET/SDH jitter compliance and to enhance host cards' signal integrity. The optical transceiver is compliant per the RoHS Directive 2011/65/EU.

## Product Specifications

### I. General Specifications

Data Rate Specifications	Symbol	Min	Typ.	Max	Units	Ref.
<b>Supported Link Length</b>	$L_{MAX}$	10		30	km	1,2,3
		10		40	km	1,2,3,4

#### Notes:

1. Tested with a  $2^{31} - 1$  PRBS pattern and BER of  $1E-12$ , over G.652 single mode fiber.
2. Assuming that the optical link loss due to fiber attenuation is 0.38dB/km.
3. The actual min. link length may differ as it is affected by the receiver overload limit.
4. Assuming this transceivers on both side of the link. If a PIN receiver is on the other side of the link, the optical link budget may not be enough to support 40km of fiber attenuation loss.

## II. Absolute Maximum Ratings

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
<b>Maximum Supply Voltage</b>	V <sub>CC</sub>	-0.5		4.0	V	
<b>Storage Temperature</b>	T <sub>S</sub>	-40		85	°C	
<b>Case Operating Temperature</b>	T <sub>A</sub>	0		70	°C	
	T <sub>A</sub>	-40		85	°C	
<b>Relative Humidity</b>	RH	0		85	%	1
<b>Receiver Optical Damage Threshold</b>	RxDamage	5			dBm	

## III. Electrical Characteristics (TOP = -40 to 85 °C, VCC = 3.14 to 3.46 V)

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
<b>Supply Voltage</b>	V <sub>CC</sub>	3.14	3.30	3.46	V	
<b>Supply Current</b>	I <sub>CC</sub>		300	430	mA	
<b>Power Dissipation</b>	P <sub>diss</sub>			1.5	W	
<b>Transmitter</b>						
<b>Input differential impedance</b>	R <sub>in</sub>		100		V	1
<b>Differential data input swing</b>	V <sub>in,pp</sub>	200		1800	mV <sub>pp</sub>	
<b>Transmit Disable Voltage</b>	V <sub>D</sub>	V <sub>CC</sub> -0.8		V <sub>CC</sub>	V	
<b>Transmit Enable Voltage</b>	V <sub>EN</sub>	V <sub>EE</sub>		V <sub>EE</sub> +0.8	V	

## Receiver

<b>Output differential impedance</b>	V <sub>out,pp</sub>	80	100	120	Ω	
<b>Differential data output swing</b>	V <sub>out,pp</sub>	300		850	mV	2
<b>Output rise time and fall time</b>	T <sub>r</sub> , T <sub>f</sub>	28			ps	3
<b>LOS asserted</b>	V <sub>LOS A</sub>	V <sub>cc</sub> -0.8		V <sub>cc</sub>	V	4
<b>LOS de-asserted</b>	V <sub>LOS D</sub>	0		0.8	V	4
<b>Power Supply Noise Tolerance</b>	V <sub>ccT</sub> /V <sub>ccR</sub>		Per SFF-8431 Rev 3.0		mVpp	5

**Notes:**

1. Measured at 70°C, 3.3V and beginning of life.
2. Internally AC coupled.
3. 20 – 80%. Measured with Module Compliance Test Board and OMA test pattern. Use of four 1's and four 0's sequence in the PRBS 9 is an acceptable alternative. SFF-8431 Rev 4.1.
4. LOS is an open collector output. Should be pulled up with 4.7kΩ– 10k Ω on the host board. Normal operation is logic 0; loss of signal is logic 1.
5. See Section 2.8.3 of SFF-8431 Rev 4.1.

#### IV. Optical Characteristics (TOP = -40 to 85 °C, VCC = 3.14 to 3.46 V)

Parameter	Symbol	Min	Typ.	Max	Unit	Note
<b>Transmitter (Tx)</b>						
<b>Average Launch Power</b>	$P_{AVE}$	-3		+4	dBm	
<b>Optical Wavelength</b>	$\lambda$	1290		1330	nm	
<b>Side-Mode Suppression Ratio</b>	SMSR	30			dB	
<b>Optical Extinction Ratio</b>	ER	6			dB	
<b>Path Penalty</b>	$TDP_S$			1	dB	
<b>Transmitter and Dispersion Penalty</b>	$TDP_F$			3.2	dB	
<b>Average Launch power when Tx is OFF</b>	$P_{OFF}$			-30	dBm	
<b>Tx Jitter 20kHz-80MHz</b>	$T_{XJ1}$			0.3	UI	1,2
<b>Tx Jitter 4MHz – 80MHz</b>	$T_{XJ2}$			0.1	UI	1,2
<b>Relative Intensity Noise</b>	RIN			-128	dB/Hz	
<b>Receiver (Rx)</b>						
<b>Sensitivity (Average Power)</b>	8.5-10.7Gb/s	$R_{SENS1}$		-20	dBm	3,4
	11.1-11.3Gb/s	$R_{SENS2}$		-19	dBm	3,5
<b>Sensitivity (OMA)</b>	9.95-10.3Gb/s	$R_{SENS3}$		-19.2	dBm	3,4
<b>Stressed Sensitivity (OMA)</b>	9.95-10.3Gb/s	$R_{SENS4}$		-11.3	dBm	6
<b>Overload (Average Power)</b>	$P_{AVE}$	-7			dBm	
<b>Optical Center Wavelength</b>	$\lambda_C$	1200		1600	nm	

<b>Receiver Reflectance</b>	$P_{rx}$			-14	dB	
<b>LOS De-Assert</b>	$LOS_D$			-22	dBm	
<b>LOS Assert</b>	$LOS_A$	-42			dBm	
<b>LOS Hysteresis</b>	$LOS_H$	0.5			dB	

**Notes:**

1. For SONET/SDH applications the jitter specifications are defined as per [9].
2. If the CDRs are in bypass mode, the Tx jitter is compliant to the specification defined in [4].
3. Measured with worst ER=6 dB;  $2^{31} - 1$  PRBS.
4. Measured for BER <math>10^{-12}</math>.
5. Measured for BER >math>10^{-5}</math>.
6. As per [4].

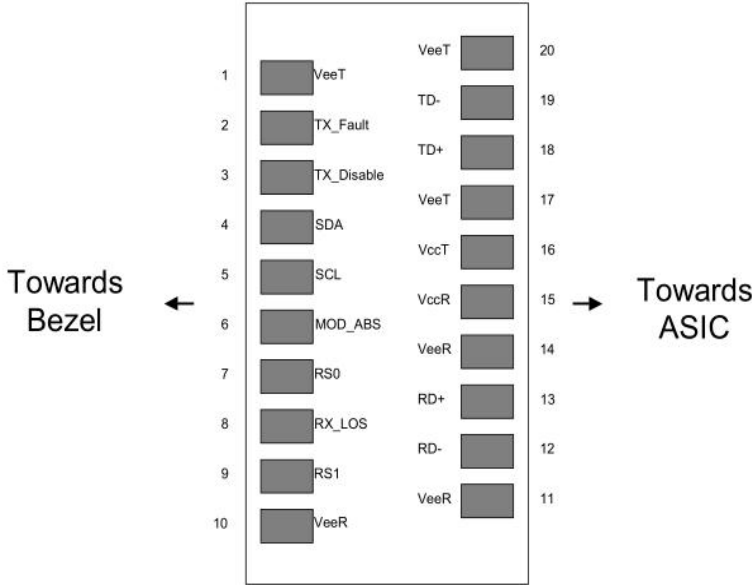
**V. Digital Diagnostic Specifications**

Parameter	Symbol	Units	Min	Max	Accuracy	Ref.
<b>Accuracy</b>						
<b>Transceiver temperature</b>	$\Delta DD_{Temp}$	°C	-40	85	±5°C	1
<b>Transceiver supply voltage</b>	$\Delta DD_{Voltage}$	V	2.8	4.0	±3%	
<b>Transmitter bias current</b>	$\Delta DD_{Bias}$	mA	0	20	±10%	2
<b>Transmitter output power</b>	$\Delta DD_{Tx-Power}$	dBm	-10	+2	±2dB	
<b>Receiver average optical input power</b>	$\Delta DD_{Rx-Power}$	dBm	-22	+2	±2dB	

**Notes:**

1. Internally measured
2. The accuracy of the Tx bias current is 10% of the actual current from the laser driver to the laser

## VI. Pin Description



**Figure 1 – Diagram of Host Board Connector Block Pin Numbers and Names.**

Pin	Symbol	Name/Description	Notes
1	VEET	Transmitter Ground	1
2	TFault	Transmitter Fault	2
3	TDIS	Transmitter Disable. Laser output disabled on high or open.	3
4	SDA	2-wire Serial Interface Data Line	2
5	SCL	2-wire Serial Interface Clock Line	2
6	MOD_ABS	Module Absent. Grounded within the module	2
7	RS0	Rate Select 0.	4
8	RX_LOS	Loss of Signal indication. Logic 0 indicates normal operation.	5
9	RS1	Rate Select 1.	4

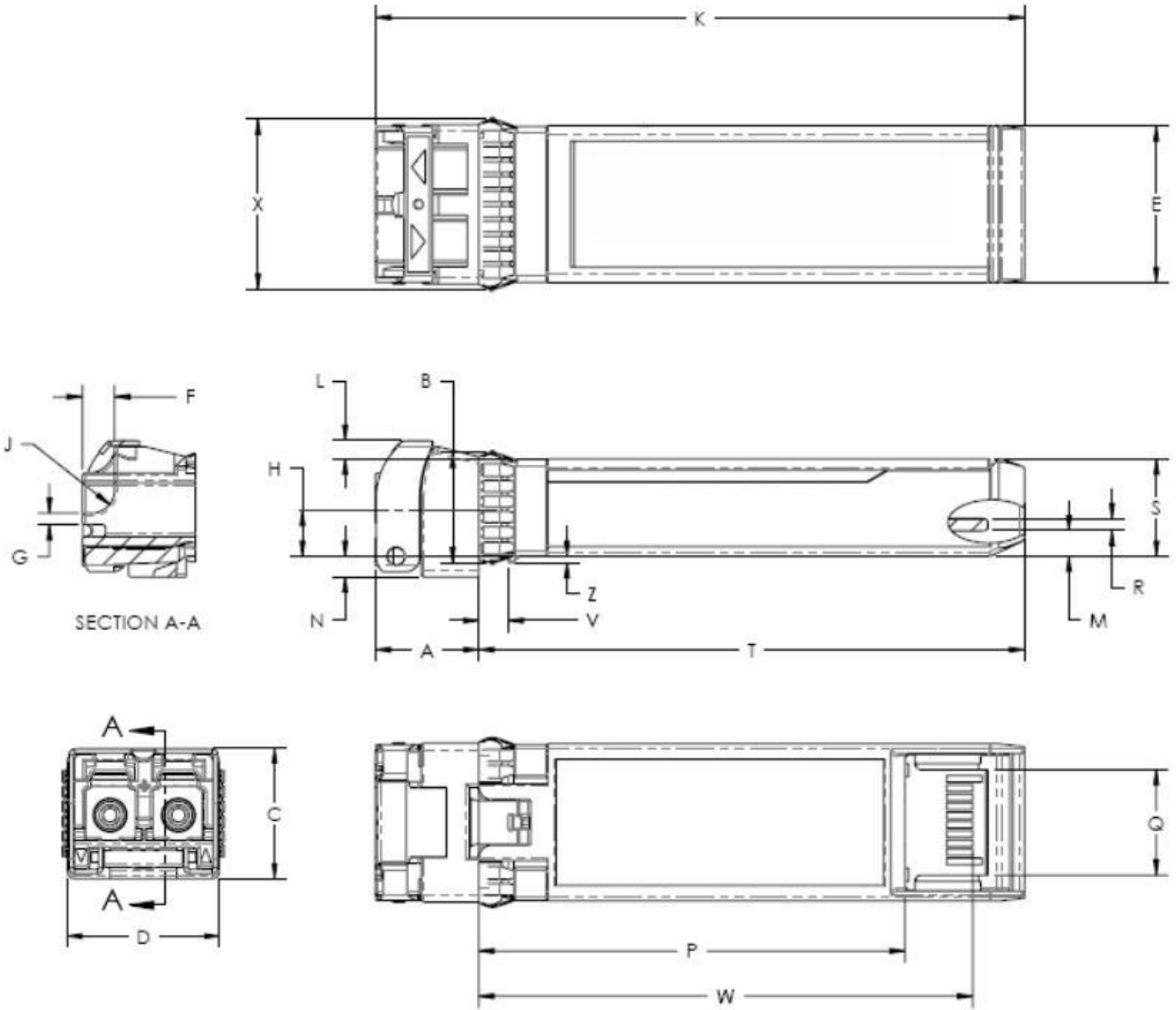
10	VEER	Receiver Ground	1
11	VEER	Receiver Ground	1
12	RD-	Receiver Inverted DATA out. AC Coupled.	
13	RD+	Receiver Non-inverted DATA out. AC Coupled.	
14	VEER	Receiver Ground	1
15	VCCR	Receiver Power Supply	
16	VCCT	Transmitter Power Supply	
17	VEET	Transmitter Ground	1
18	TD+	Transmitter Non-Inverted DATA in. AC Coupled.	
19	TD-	Transmitter Inverted DATA in. AC Coupled.	
20	VEET	Transmitter Ground	1

**Notes:**

1. Circuit ground is internally isolated from chassis ground.
2. TFAULT is an open collector/drain output, which should be pulled up with a 4.7k -10k Ohms resistor on the host board if intended for use. Pull up voltage should be transmitter fault caused by either the TX bias current or the TX output power exceeding the preset alarm thresholds. A low output indicates normal operation. In the low state, the output is pulled to <0.8V.
3. Laser output disabled on TDIS >2.0V or open, enabled on TDIS <0.8V.
4. Internally pulled down per SFF-8431 Rev 2.0. See Sec. X for the logic table to use for the internal CDRs locking modes.
5. LOS is open collector output. Should be pulled up with 4.7kΩ -10kΩ on host board to a voltage between 2.0V and 3.6V. Logic 0 indicates normal operation; logic 1 indicates loss of signal.



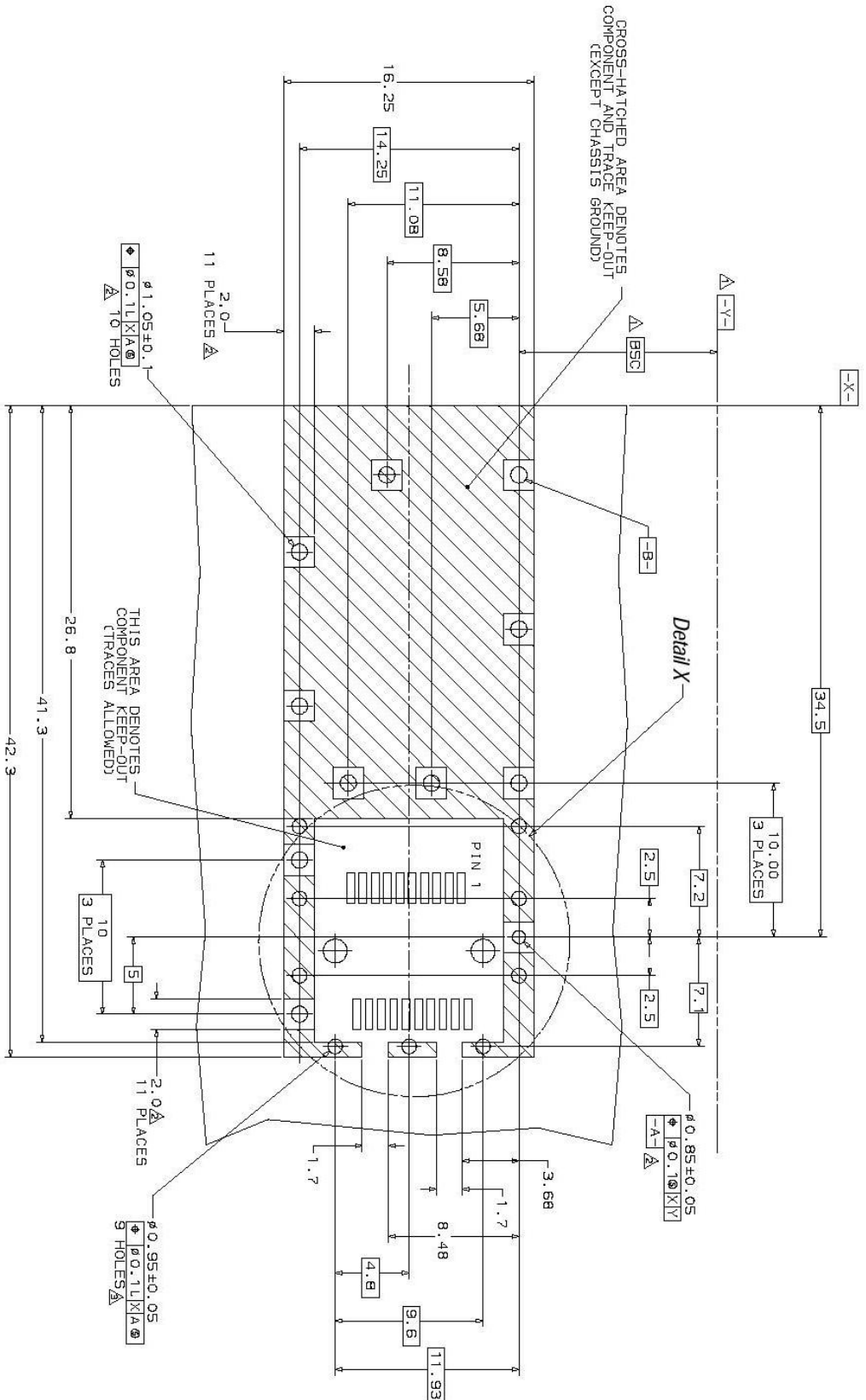
## VII. Mechanical Specifications



**Note:**

The option of the label on the top side of the transceiver is not recommended.

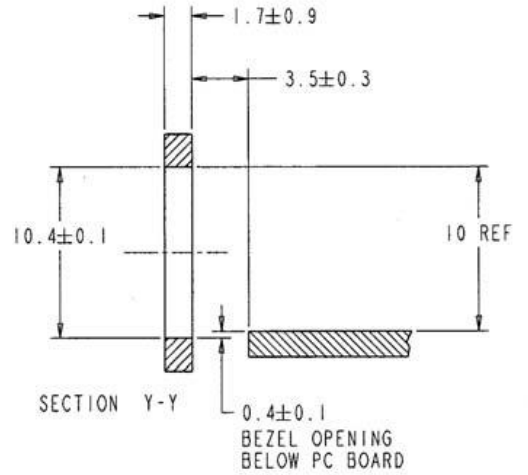
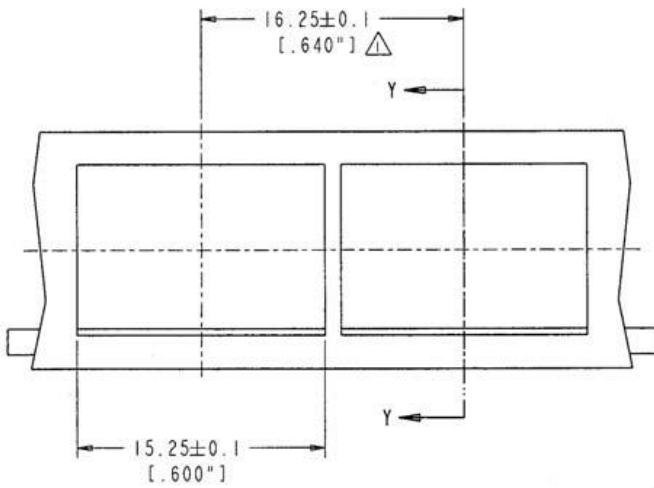
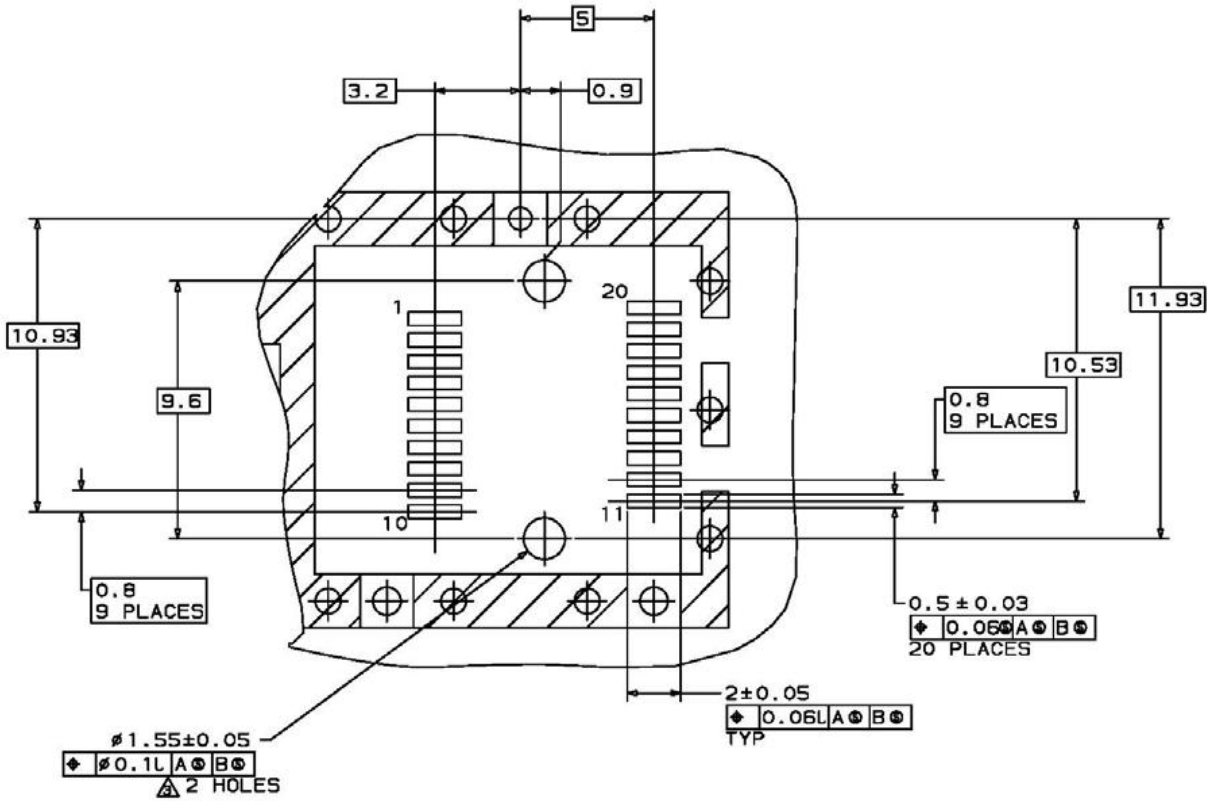
### VIII. Host Board SFP+ Connector Recommendations



△ Datum and Basic Dimension Established by Customer

△ Pads and Vias are Chassis Ground, 11 Places

△ Through Holes are Unplated



NOTES:

△ MINIMUM PITCH ILLUSTRATED, ENGLISH DIMENSIONS ARE FOR REFERENCE ONLY

2. NOT RECOMMENDED FOR PCI EXPANSION CARD APPLICATIONS

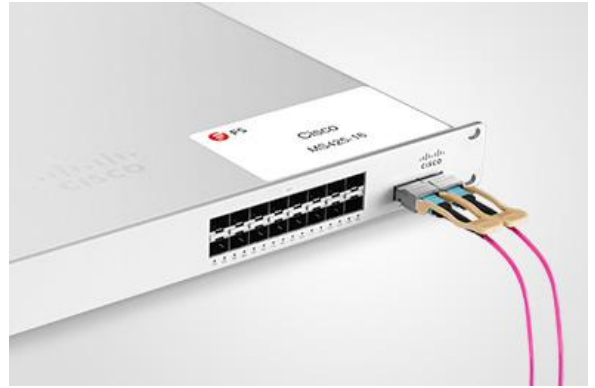
## Test Center

### I. Compatibility Testing

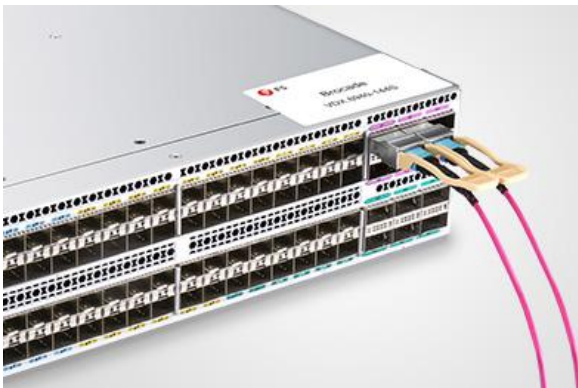
Each fiber optical transceiver has been tested in host device on site in FS Assured Program to ensure full compatibility with over 200 vendors.



Cisco Catalyst C9500-24Y4C



Cisco MS425-16



Brocade VDX 6940-144S



Dell EMC Networking Z9100-ON



Force<sup>10</sup> S60-44T

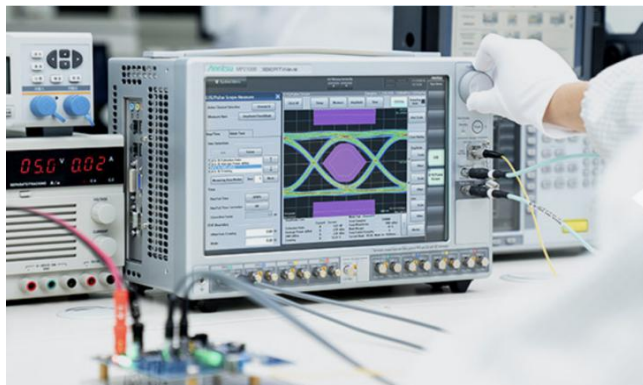


HUAWEI S6720-30L-HI-24S

Above is part of our test bed network equipment. For more information, please click the [Test Bed PDF](#). It will be updated in real time as we expand our portfolio.

## II. Performance Testing

Each fiber optical transceiver has been fully tested in FS Assured Program equipped with world's most advanced analytical equipment to ensure that our transceivers work perfectly on your device.



### 1. TX/RX Single Quality Testing

Equipped with the all-in-one tester integrated 4ch BERT & sampling oscilloscope, and variable optical attenuator the input and output signal quality.

- Eye Pattern Measurements: Jitter, Mask Margin, etc
- Average Output Power
- OMA
- Extinction Ratio
- Receiver Sensitivity
- BER Curve

### 2. Reliability and Stability Testing

Subject the transceivers to dramatic in temperature on the thermal shock chamber to ensure reliability and stability of the transceivers.

- Commercial: 0°C to 70°C
- Extended: -5°C to 85°C
- Industrial: -40°C to 85°C



### 3. Transfer Rate and Protocol Testing

Test the actual transfer data rate and the transmission ability under different protocols with Networks Master Pro.

- Ethernet
- Fiber Channel
- SDH/SONET
- CPRI

### 4. Optical Spectrum Evaluation

Evaluate various important parameters with the Optical Spectrum Analyzer to meet the industry standards.

- Center Wavelength, Level
- OSNR
- SMSR
- Spectrum Width



## Order Information

Part Number	Description
SFP-10GSR-85	10GBASE-SR SFP+ 850nm 300m DOM Transceiver
SFP-10GLRM-31	10G SFP+ 1310nm 2km DOM Transceiver
SFP-10GLR-31	10GBASE-LR SFP+ 1310nm 10km DOM Transceiver
SFP-10GER-55	10GBASE-ER SFP+ 1550nm 40km DOM Transceiver
SFP-10GZR-55	10GBASE-ZR SFP+ 1550nm 80km DOM Transceiver
SFP-10GZRC-55	10G SFP+ 1550nm 100km DOM Transceiver
SFP-10GSR-85	Dual-Rate 1000BASE-SX and 10GBASE-SR SFP+ 850nm 300m DOM Transceiver
SFP-10GLR-31	Dual-Rate 1000BASE-LX and 10GBASE-LR SFP+ 1310nm 10km DOM Transceiver

**Note:**

10G SFP+ transceiver module is individually tested on corresponding equipment such as Cisco, Arista, Juniper, Dell, Brocade and other brands, and passes the monitoring of FS.COM intelligent quality control system.



 <https://www.fs.com>



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