

# 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
- 0° C to 70° C temperature range
- 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. |
|-----------------------------------|----------|------|------|-----|------|------|
| Maximum Supply Voltage            | Vcc      | -0.5 |      | 4.0 | V    |      |
| Storage Temperature               | Ts       | -40  |      | 85  | ° C  |      |
| Case Operating Temperature        | Top      | 0    |      | 70  | ° C  |      |
| Relative Humidity                 | RH       | 0    |      | 85  | %    | 1    |
| Receiver Optical Damage Threshold | RxDamage | 5    |      |     | dBm  |      |

## III. Electrical Characteristics (TOP = 0 to 70 °C, VCC = 3.14 to 3.46 V)

| Parameter                     | Symbol | Min     | Typ. | Max     | Unit | Ref. |
|-------------------------------|--------|---------|------|---------|------|------|
| Supply Voltage                | Vcc    | 3.14    | 3.30 | 3.46    | V    |      |
| Supply Current                | Icc    |         | 300  | 430     | mA   |      |
| Power Dissipation             | Pdiss  |         |      | 1.5     | W    |      |
| <b>Transmitter</b>            |        |         |      |         |      |      |
| Input differential impedance  | Rin    |         | 100  |         | V    | 1    |
| Differential data input swing | Vin,pp | 200     |      | 1800    | mVpp |      |
| Transmit Disable Voltage      | VD     | Vcc-0.8 |      | Vcc     | V    |      |
| Transmit Enable Voltage       | VEN    | Vee     |      | Vee+0.8 | v    |      |

### Receiver

|                                       |                    |         |                      |     |          |   |
|---------------------------------------|--------------------|---------|----------------------|-----|----------|---|
| <b>Output differential impedance</b>  | Vout,pp            | 80      | 100                  | 120 | $\Omega$ |   |
| <b>Differential data output swing</b> | Vout,pp            | 300     |                      | 850 | mV       | 2 |
| <b>Output rise time and fall time</b> | Tr, Tf             | 28      |                      |     | ps       | 3 |
| <b>LOS asserted</b>                   | V <sub>LOS A</sub> | Vcc-0.8 |                      | Vcc | V        | 4 |
| <b>LOS de-asserted</b>                | V <sub>LOS D</sub> | 0       |                      | 0.8 | V        | 4 |
| <b>Power Supply Noise Tolerance</b>   | VccT/VccR          |         | 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 4.7k $\Omega$ – 10k  $\Omega$  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 = 0 to 70 °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> | Prx              |     |  | -14 | dB  |  |
| <b>LOS De-Assert</b>        | LOS <sub>D</sub> |     |  | -22 | dBm |  |
| <b>LOS Assert</b>           | LOS <sub>A</sub> | -42 |  |     | dBm |  |
| <b>LOS Hysteresis</b>       | LOS <sub>H</sub> | 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<sup>31</sup> – 1 PRBS.
4. Measured for BER<10<sup>-12</sup>.
5. Measured for BER>10<sup>-5</sup>.
6. As per [4].

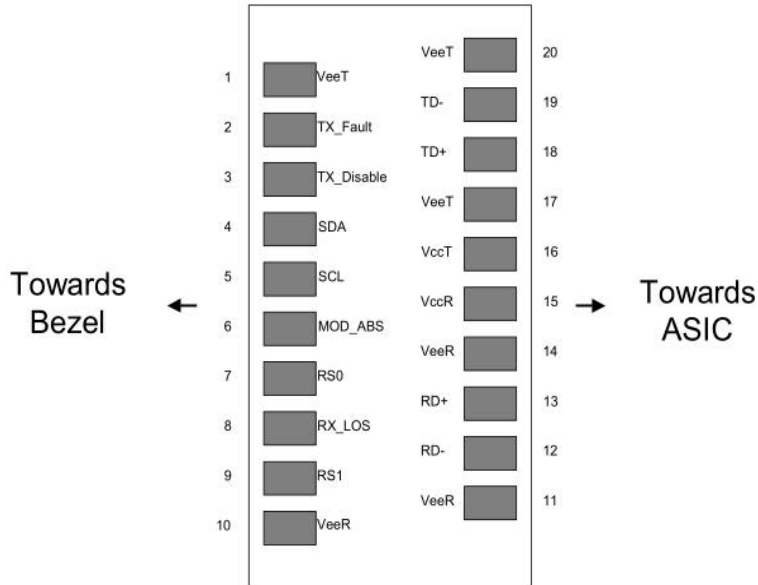
**V. Digital Diagnostic Specifications**

| Parameter                                   | Symbol                 | Units | Min | Max | Accuracy | Ref. |
|---|------------------------|-------|-----|-----|----------|------|
| <b>Accuracy</b>                             |                        |       |     |     |          |      |
| <b>Transceiver temperature</b>              | $\Delta DD_{Temp}$     | °C    | -10 | 80  | ± 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     |

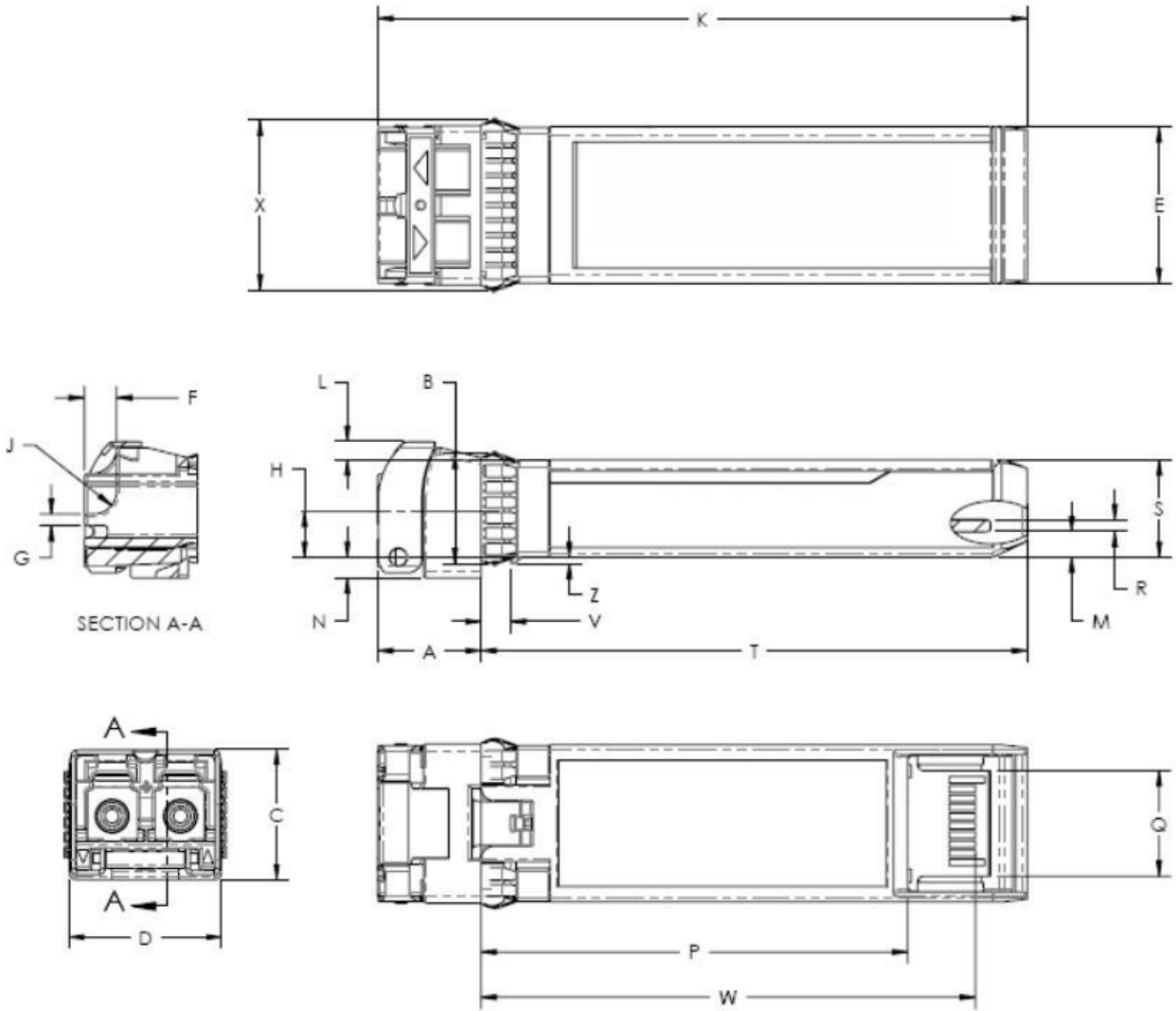
|    |      |  |   |
|----|------|--|---|
| 10 | VEER | Receiver Ground                                  | 1 |
| 11 | VEER | Receiver Ground                                  | 1 |
| 12 | RD-  | Receiver Inverted DATA out.<br>AC Coupled.       |   |
| 13 | RD+  | Receiver Non-inverted DATA out.<br>AC 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.<br>AC Coupled. |   |
| 19 | TD-  | Transmitter Inverted DATA in.<br>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 4.7k $\Omega$  -10k $\Omega$  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.





## Test Center

FS.COM transceivers are tested to ensure connectivity and compatibility in our test center before shipped out. FS.COM test center is supported by a variety of mainstream original brand switches and groups of professional staff, helping our customers make the most efficient use of our products in their systems, network designs and deployments.

The original switches could be found nowhere but at FS.COM test center, eg: Juniper MX960 & EX 4300 series, Cisco Nexus 9396PX & Cisco ASR 9000 Series, HP 5900 Series & HP 5406R ZL2 V3(J9996A), Arista 7050S-64, Brocade ICX7750-26Q & ICX6610-48, Avaya VSP 7000 MDA 2, etc.



Cisco ASR 9000 Series(A9K-MPA-1X40GE)



ARISTA 7050S-64(DCS-7050S-64)



Juniper MX960



Brocade ICX 7750-26Q



Extreme Networks X670V VIM-40G4X



Mellanox M3601Q



Dell N4032F



HP 5406R ZL2 V3(J9996A)



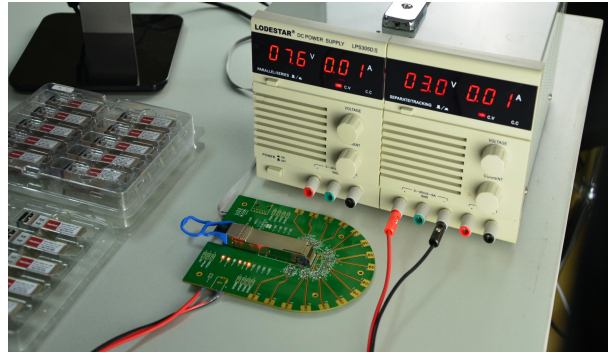
AVAYA 7024XLS(7002QQ-MDA)

## Test Assured Program

FS.COM truly understands the value of compatibility and interoperability to each optics. Every module FS.COM provides must run through programming and an extensive series of platform diagnostic tests to prove its performance and compatibility. In our test center, we care of every detail from staff to facilities—professionally trained staff, advanced test facilities and comprehensive original-brand switches, to ensure our customers to receive the optics with superior quality.



Our smart data system allows effective product management and quality control according to the unique serial number, properly tracking the order, shipment and every part.



Our in-house coding facility programs all of our parts to standard OEM specs for compatibility on all major vendors and systems such as Cisco, Juniper, Brocade, HP, Dell, Arista and so on.



With a comprehensive line of original-brand switches, we can recreate an environment and test each optics in practical application to ensure quality and distance.



The last test assured step to ensure our products to be shipped with perfect package.

## Excellent Quality Control System

FS innovated a self-developed automated and integrated test system, and also equipped with complete sets of advanced testing equipment to ensure modules quality and high performance.



### Performance Testing

One-Click operation, including centre-wavelength, extinction ratio, optical eye diagram, TX power, receiver sensitivity, DDM etc.

### Environmental Testing

Low temp test, storage in 85° C and -40° C for 12 hours. ESD test,  $\pm 8$  and  $\pm 15$  kV discharges as per GR-78-CORE. Connector durability - pull test, min of 10 connections, no more than 30% pullouts.



### Compatibility and Connectivity Testing

Equipped with a variety of mainstream original brand switches, like Cisco, Juniper, Arista, HPE etc. Each transceiver will be tested before delivery.

## 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.





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