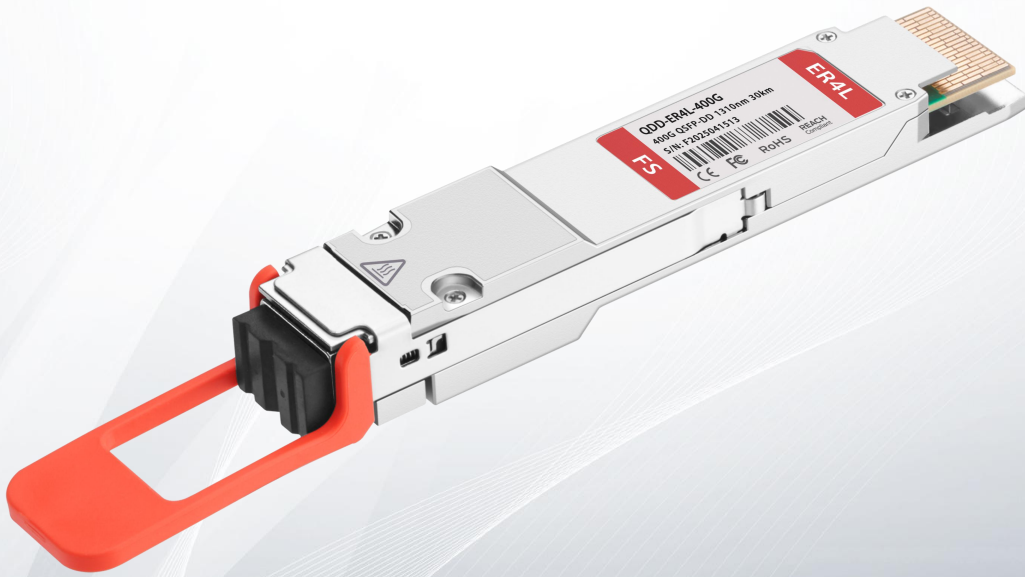


# 400G QSFP-DD ER4 Lite 1310nm 30km Duplex LC/UPC DOM Transceiver

QDD-ER4L-400G



## Application

- Data Center Interconnect
- 400G Ethernet
- Enterprise networking

## Features

- QSFP-DD MSA compliant
- 4 LWDM Lanes MUX/DEMUX design
- Up to 30km transmission on single mode fiber (SMF) with FEC
- Operating case temperature 0°C to 70°C
- 8x53.125Gb/s electrical interface (400GAUI-8)
- Data Rate 106.25Gbps (PAM4) per channel
- Maximum power consumption 12W
- Duplex LC connector
- RoHS compliant

Description

The 400GBASE-ER4L module, Duplex LC connector, up to 30km over parallel single-mode fiber with 400G KP4 FEC. It is compliant to IEEE 802.3bs protocol and 400GAUI-8, QSFP-DD MSA. The module converts 8 channels of 50Gb/s (PAM4) electrical input data into four LAN-WDM optical signals, multiplexed into one channel for 400Gb/s optical transmission.

The 400 Gigabit Ethernet signal is carried over four LAN WDM wavelength grid wavelengths. Multiplexing and demultiplexing of the four wavelengths are managed within the device.It is suitable for Data Center, Enterprise networking.

Product Specifications

I. Absolute Maximum Ratings

| Parameter                            | Symbol          | Min. | Max. | Unit | Condition |
|--------------------------------------|-----------------|------|------|------|-----------|
| Storage Temperature                  | T <sub>S</sub>  | -40  | 85   | degC |           |
| Operating Case Temperature           | T <sub>OP</sub> | 0    | 70   | degC |           |
| Power Supply Voltage                 | V <sub>CC</sub> | -0.5 | 3.6  | V    |           |
| Relative Humidity (Non-condensation) | RH              | 0    | 85   | %    |           |
| Damage Threshold, Each Lane          | TH <sub>d</sub> | -5.0 |      | dBm  |           |

II. Recommended Operating Conditions

| Parameter                  | Symbol          | Min.  | Typical | Max.                 | Unit | Notes |
|----------------------------|-----------------|-------|---------|----------------------|------|-------|
| Operating Case Temperature | T <sub>OP</sub> | 0     |         | 70                   | degC |       |
| Power Supply Voltage       | V <sub>CC</sub> | 3.135 | 3.3     | 3.465                | V    |       |
| Data Rate, Each Lane       |                 |       | 26.5625 |                      | GBd  | PAM4  |
| Data Rate Accuracy         |                 | -100  |         | 100                  | ppm  |       |
| Pre-FEC Bit Error Ratio    |                 |       |         | 2.4x10 <sup>-4</sup> |      |       |
| Post-FEC Bit Error Ratio   |                 |       |         | 1x10 <sup>-12</sup>  |      | 1     |
| Link Distance              | D               | 0.002 |         | 30                   | km   | 2     |

Note 1: FEC provided by host system.

Note 2: Additional attenuation required to support short distance, make sure the receiver input power not exceed the overload point or damage the Receiver(APD).

III. Optical Characteristics

| Parameter                                                                | Symbol           | Min.            | Typ.    | Max.    | Unit  | Notes |
|--------------------------------------------------------------------------|------------------|-----------------|---------|---------|-------|-------|
| Wavelength Assignment                                                    | L0               | 1294.53         | 1295.56 | 1296.59 | nm    |       |
|                                                                          | L1               | 1299.02         | 1300.05 | 1301.09 | nm    |       |
|                                                                          | L2               | 1303.54         | 1304.58 | 1305.63 | nm    |       |
|                                                                          | L3               | 1308.09         | 1309.14 | 1310.19 | nm    |       |
| Transmitter                                                              |                  |                 |         |         |       |       |
| Data Rate, Each Lane                                                     |                  | 53.125 ± 100ppm |         |         | GBd   |       |
| Modulation Format                                                        | PAM4             |                 |         |         |       |       |
| Side-mode Suppression Ratio                                              | SMSR             | 30              |         |         | dB    |       |
| Total Average Launch Power                                               | P <sub>T</sub>   | 14.7            |         |         | dBm   |       |
| Average Launch Power, Each Lane                                          | P <sub>AVG</sub> | 0.4             |         | 6.5     | dBm   |       |
| Outer Optical Modulation Amplitude (OMA <sub>outer</sub> ), Each Lane    | P <sub>OMA</sub> | 3.4             | 9       |         | dBm   |       |
| Launch Powerin OMA <sub>outer</sub> minus TDECQ, Each Lane               |                  | 2               |         |         | dB    |       |
| Transmitter and DispersionEye Closure for PAM4, Each Lane                | TDECQ            | 3.9             |         |         | dB    | TDECQ |
| Extinction Ratio                                                         | ER               | 6               |         |         | dB    |       |
| Difference in Launch Power between any Two Lanes (OMA <sub>outer</sub> ) |                  | 4               |         |         | dB    |       |
| RIN <sub>15.1</sub> OMA                                                  | RIN              | -132            |         |         | dB/Hz |       |
| Optical Return Loss Tolerance                                            | TOL              | 15.6            |         |         | dB    |       |
| Transmitter Reflectance                                                  | R <sub>T</sub>   |                 |         | -26     | dB    |       |

| Parameter                                                    | Symbol    | Min. | Typ.                                  | Max. | Unit | Notes |
|--------------------------------------------------------------|-----------|------|---------------------------------------|------|------|-------|
| Average Launch Power of OFF Transmitter, Each Lane           | $P_{off}$ |      |                                       | -30  | dBm  |       |
| Receiver                                                     |           |      |                                       |      |      |       |
| Data Rate, Each Lane                                         |           |      | $53.125 \pm 100\text{ppm}$            |      | GBd  |       |
| Modulation Format                                            |           |      | PAM4                                  |      |      |       |
| Damage Receiver Power, Each Lane                             |           | -2.4 |                                       |      | dBm  |       |
| Receiver Saturation, Each Lane                               | Overload  | -3.4 |                                       |      |      |       |
| Sensitivity, Each Lane                                       | Sen       |      | $\text{Max}(-12.1, \text{SECQ}-13.5)$ |      | dBm  |       |
| Stressed Conditions for Stress Receiver Sensitivity (Note 8) |           |      |                                       |      |      |       |
| Stressed Eye Closure for PAM4 (SECQ), Lane Under Test        |           |      | 3.4                                   |      | dB   |       |
| $\text{SECQ} - 10 \cdot \log_{10}(C_{eq})$ , Lane Under Test |           |      |                                       |      | dB   |       |
| $\text{OMA}_{outer}$ of Each Aggressor Lane                  |           |      | -8                                    |      | dBm  |       |

IV. Electrical Characteristics

| Parameter                                          | Test Point | Min.                           | Typ. | Max. | Units | Notes |
|----------------------------------------------------|------------|--------------------------------|------|------|-------|-------|
| Power Consumption                                  |            |                                |      | 12   | W     |       |
| Supply Current                                     | Icc        |                                |      | 3.64 | A     |       |
| Transmitter (Each Lane)                            |            |                                |      |      |       |       |
| Signaling Rate, Each Lane                          | TP1        | 26.5625 ± 100ppm               |      |      | GBd   |       |
| Differential pk-pk Input Voltage Tolerance         | TP1a       | 900                            |      |      | mVpp  | 1     |
| Differential Termination Mismatch                  | TP1        |                                |      | 10   | %     |       |
| Differential Input Return Loss                     | TP1        | IEEE802.3-2015 Equation(83E-5) |      |      | dB    |       |
| Differential to Common Mode Input Return Loss      | TP1        | IEEE802.3-2015 Equation(83E-6) |      |      | dB    |       |
| Module Stressed Input Test                         | TP1a       | See IEEE802.3bs 120E.3.4.1     |      |      |       | 2     |
| Single-ended Voltage Tolerance Range (Min)         | TP1a       | -0.4 to 3.3                    |      |      | V     |       |
| DC Common Mode Input Voltage                       | TP1        | -350                           |      | 2850 | mV    | 3     |
| Receiver (Each Lane)                               |            |                                |      |      |       |       |
| Signaling Rate, EachLane                           | TP4        | 26.5625 ± 100ppm               |      |      | GBd   |       |
| Differential Peak-to-Peak Output Voltage           | TP4        |                                |      | 900  | mVpp  |       |
| AC Common Mode Output Voltage, RMS                 | TP4        |                                |      | 17.5 | mV    |       |
| Differential Termination Mismatch                  | TP4        |                                |      | 10   | %     |       |
| Differential Output Return Loss                    | TP4        | IEEE802.3-2015 Equation(83E-2) |      |      |       |       |
| Common to Differential Mode Conversion Return Loss | TP4        | IEEE802.3-2015 Equation(83E-3) |      |      |       |       |
| Transition Time, 20% to 80%                        | TP4        | 9.5                            |      |      | ps    |       |

| Parameter                               | Test Point | Min. | Typ.  | Max. | Units | Notes |
|-----------------------------------------|------------|------|-------|------|-------|-------|
| Near-end Eye Symmetry Mask Width (ESMW) | TP4        |      | 0.265 |      | UI    |       |
| Near-end EyeHeight, Differential        | TP4        | 70   |       |      | mV    |       |
| Far-end EyeSymmetry Mask Width (ESMW)   | TP4        |      | 0.2   |      | UI    |       |
| Far-end EyeHeight, Differential         | TP4        | 30   |       |      | mV    |       |
| Far-end Pre-cursor ISI Ratio            | TP4        | -4.5 |       | 2.5  | %     |       |
| Common Mode Output Voltage (Vcm)        | TP4        | -350 |       | 2850 | mV    | 3     |

Note 1: With the exception to IEEE 802.3bs 120E.3.1.2 that the pattern is PRBS31Q or scrambled idle.

Note 2: Meets BER specified in IEEE 802.3bs 120E.1.1.

Note 3: DC common mode voltage generated by the host. Specification includes effects of ground offset voltage.

V. Pin Definitions

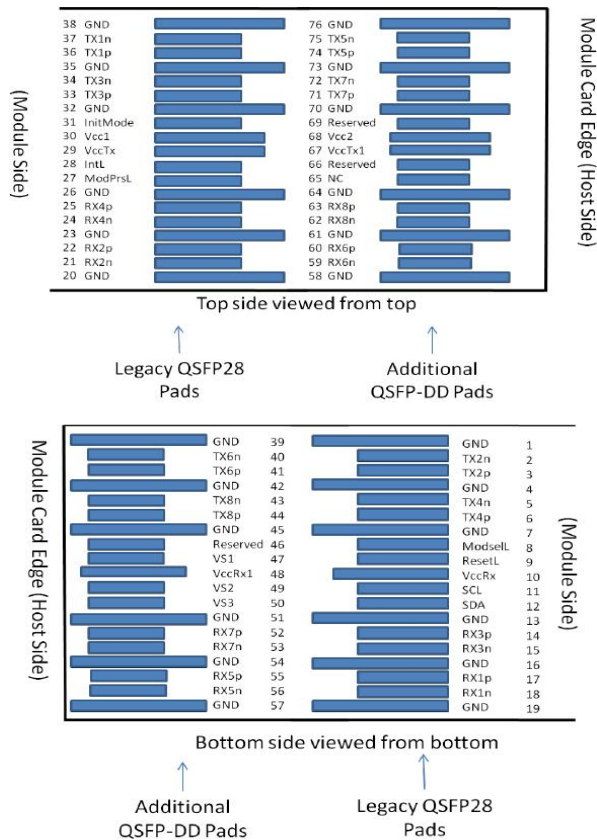


Figure 1. Transceiver Block Diagram

VI. Pin Descriptions

| Pin No. | Logic       | Symbol  | Description                         | Plug Sequence | Notes |
|---------|-------------|---------|-------------------------------------|---------------|-------|
| 1       |             | GND     | Ground                              | 1B            | 1     |
| 2       | CML-I       | Tx2n    | Transmitter Inverted Data Input     | 3B            |       |
| 3       | CML-I       | Tx2p    | Transmitter Non-Inverted Data Input | 3B            |       |
| 4       |             | GND     | Ground                              | 1B            | 1     |
| 5       | CML-I       | Tx4n    | Transmitter Inverted Data Input     | 3B            |       |
| 6       | CML-I       | Tx4p    | Transmitter Non-Inverted Data Input | 3B            |       |
| 7       |             | GND     | Ground                              | 1B            | 1     |
| 8       | LVTTL-I     | ModSelL | Module Select                       | 3B            |       |
| 9       | LVTTL-I     | ResetL  | Module Reset                        | 3B            |       |
| 10      |             | VccRx   | +3.3V Power Supply Receiver         | 2B            | 2     |
| 11      | LVC MOS-I/O | SCL     | 2-wire serial interface clock       | 3B            |       |
| 12      | LVC MOS-I/O | SDA     | 2-wire serial interface data        | 3B            |       |
| 13      |             | GND     | Ground                              | 1B            | 1     |
| 14      | CML-O       | Rx3p    | Receiver Non-Inverted Data Output   | 3B            |       |
| 15      | CML-O       | Rx3n    | Receiver Inverted Data Output       | 3B            |       |
| 16      | GND         | Ground  | 1B                                  |               | 1     |
| 17      | CML-O       | Rx1p    | Receiver Non-Inverted Data Output   | 3B            |       |
| 18      | CML-O       | Rx1n    | Receiver Inverted Data Output       | 3B            |       |
| 19      |             | GND     | Ground                              | 1B            | 1     |
| 20      |             | GND     | Ground                              | 1B            | 1     |
| 21      | CML-O       | Rx2n    | Receiver Inverted Data Output       | 3B            |       |

| Pin No. | Logic   | Symbol   | Description                                                                        | Plug Sequence | Notes |
|---------|---------|----------|------------------------------------------------------------------------------------|---------------|-------|
| 22      | CML-O   | Rx2p     | Receiver Non-Inverted Data Output                                                  | 3B            |       |
| 23      |         | GND      | Ground                                                                             | 1B            | 1     |
| 24      | CML-O   | Rx4n     | Receiver Inverted Data Output                                                      | 3B            |       |
| 25      | CML-O   | Rx4p     | Receiver Non-Inverted Data Output                                                  | 3B            |       |
| 26      |         | GND      | Ground                                                                             | 1B            | 1     |
| 27      | LVTTL-O | ModPrsL  | Module Present                                                                     | 3B            |       |
| 28      | LVTTL-O | IntL     | Interrupt                                                                          | 3B            |       |
| 29      |         | VccTx    | +3.3V Power supply transmitter                                                     | 2B            | 2     |
| 30      |         | Vcc1     | +3.3V Power supply                                                                 | 2B            | 2     |
| 31      | LVTTL-I | InitMode | Initialization mode; Inlegacy QSFP applications, the InitMode pad is called LPMODE | 3B            |       |
| 32      |         | GND      | Ground                                                                             | 1B            | 1     |
| 33      | CML-I   | Tx3p     | Transmitter Non-Inverted Data Input                                                | 3B            |       |
| 34      | CML-I   | Tx3n     | Transmitter Inverted Data Input                                                    | 3B            |       |
| 35      |         | GND      | Ground                                                                             | 1B            | 1     |
| 36      | CML-I   | Tx1p     | Transmitter Non-Inverted Data Input                                                | 3B            |       |
| 37      | CML-I   | Tx1n     | Transmitter Inverted Data Input                                                    | 3B            |       |
| 38      |         | GND      | Ground                                                                             | 1B            | 1     |
| 39      |         | GND      | Ground                                                                             | 1A            | 1     |
| 40      | CML-I   | Tx6n     | Transmitter Inverted Data Input                                                    | 3A            |       |
| 41      | CML-I   | Tx6p     | Transmitter Non-Inverted Data Input                                                | 3A            |       |
| 42      |         | GND      | Ground                                                                             | 1A            | 1     |
| 43      | CML-I   | Tx8n     | Transmitter Inverted Data Input                                                    | 3A            |       |

| Pin No. | Logic | Symbol   | Description                         | Plug Sequence | Notes |
|---------|-------|----------|-------------------------------------|---------------|-------|
| 44      | CML-I | Tx8p     | Transmitter Non-Inverted Data Input | 3A            |       |
| 45      |       | GND      | Ground                              | 1A            | 1     |
| 46      |       | Reserved | For Future Use                      | 3A            | 3     |
| 47      |       | VS1      | Module Vendor Specific1             | 3A            | 3     |
| 48      |       | VccRx1   | 3.3V Power Supply                   | 2A            | 2     |
| 49      |       | VS2      | Module Vendor Specific2             | 3A            | 3     |
| 50      |       | VS3      | Module Vendor Specific3             | 3A            | 3     |
| 51      |       | GND      | Ground                              | 1A            | 1     |
| 52      | CML-O | Rx7p     | Receiver Non-Inverted Data Output   | 3A            |       |
| 53      | CML-O | Rx7n     | Receiver Inverted Data Output       | 3A            |       |
| 54      |       | GND      | Ground                              | 1A            | 1     |
| 55      | CML-O | Rx5p     | Receiver Non-Inverted Data Output   | 3A            |       |
| 56      | CML-O | Rx5n     | Receiver Inverted Data Output       | 3A            |       |
| 57      |       | GND      | Ground                              | 1A            | 1     |
| 58      |       | GND      | Ground                              | 1A            | 1     |
| 59      | CML-O | Rx6n     | Receiver Inverted Data Output       | 3A            |       |
| 60      | CML-O | Rx6p     | Receiver Non-Inverted Data Output   | 3A            |       |
| 61      |       | GND      | Ground                              | 1A            | 1     |
| 62      | CML-O | Rx8n     | Receiver Inverted Data Output       | 3A            |       |
| 63      | CML-O | Rx8p     | Receiver Non-Inverted Data Output   | 3A            |       |
| 64      |       | GND      | Ground                              | 1A            | 1     |
| 65      |       | NC       | No Connect                          | 3A            | 3     |

| Pin No. | Logic | Symbol   | Description                         | Plug Sequence | Notes |
|---------|-------|----------|-------------------------------------|---------------|-------|
| 65      |       | NC       | No Connect                          | 3A            | 3     |
| 66      |       | Reserved | For future use                      | 3A            | 3     |
| 67      |       | VccTx1   | 3.3V Power Supply                   | 2A            | 2     |
| 68      |       | Vcc2     | 3.3V Power Supply                   | 2A            | 2     |
| 69      |       | Reserved | For Future Use                      | 3A            | 3     |
| 70      |       | GND      | Ground                              | 1A            | 1     |
| 71      | CML-I | Tx7p     | Transmitter Non-Inverted Data Input | 3A            |       |
| 72      | CML-I | Tx7n     | Transmitter Inverted Data Input     | 3A            |       |
| 73      |       | GND      | Ground                              | 1A            | 1     |
| 74      | CML-I | Tx5p     | Transmitter Non-Inverted Data Input | 3A            |       |
| 75      | CML-I | Tx5n     | Transmitter Inverted Data Input     | 3A            |       |
| 76      |       | GND      | Ground                              | 1A            | 1     |

VII. Recommended QSFP-DD Host Board Schematic

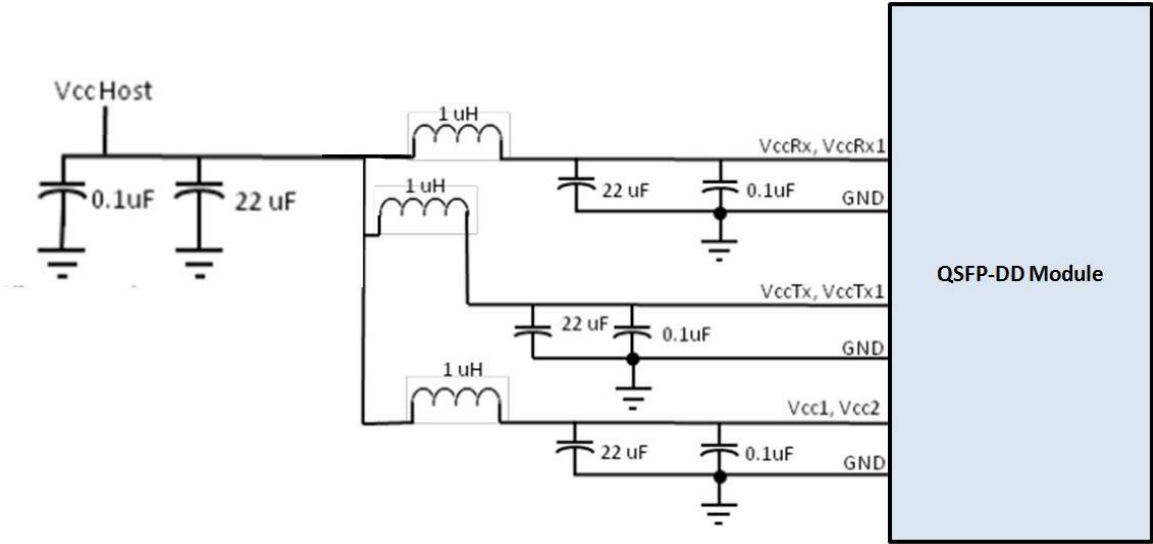


Figure 2. Recommended Power Supply Filter

VIII. Digital Diagnostics

| Parameter                               | Symbol       | Min. | Max. | Unit | Notes                            |
|-----------------------------------------|--------------|------|------|------|----------------------------------|
| Temperature Monitor Absolute Error      | DMI_Temp     | -3   | 3    | degC | Over Operating Temperature Range |
| Supply Voltage Monitor Absolute Error   | DMI_VCC      | -0.1 | 0.1  | V    | Over Full Operating Range        |
| Channel RX Power Monitor Absolute Error | DMI_RX_Ch    | -2   | 2    | dB   | 1                                |
| Channel Bias Current Monitor            | DMI_Ibias_Ch | -10% | 10%  | mA   |                                  |
| Channel TX Power Monitor Absolute Error | DMI_TX_Ch    | -2   | 2    | dB   | 1                                |

IX. Mechanical Diagram

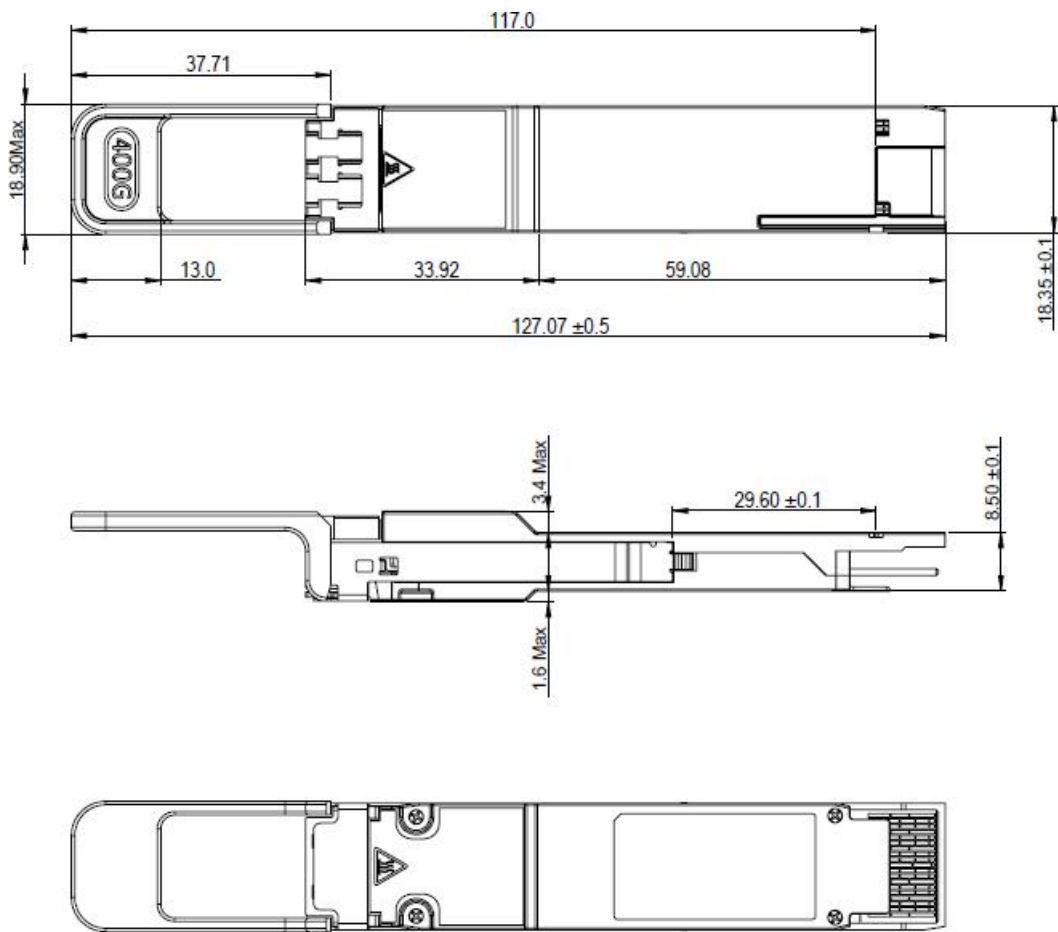


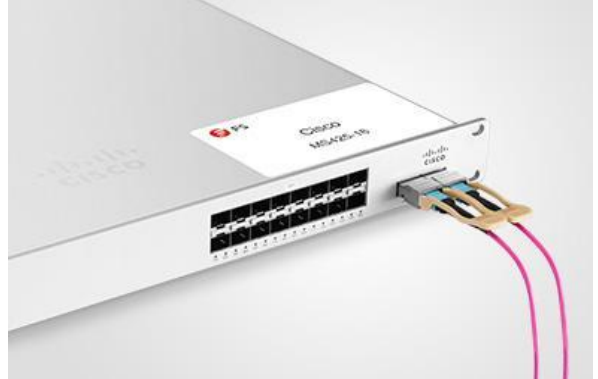
Figure 3. Recommended Power Supply Filter

## Test Center

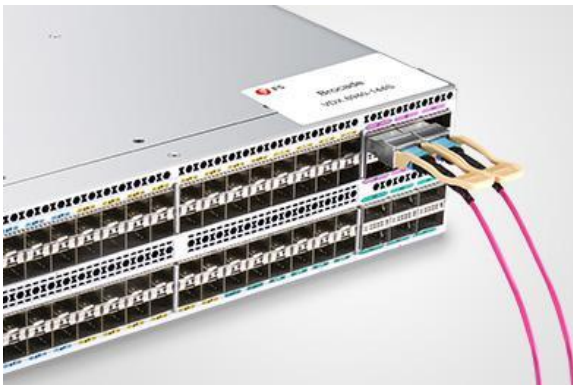
### I. Compatibility Testing



Cisco Catalyst C9500-24Y4C



Cisco MS425-16



Brocade VDX 6940-144S



Dell EMC Networking Z9100-ON



Force10 S60-44T

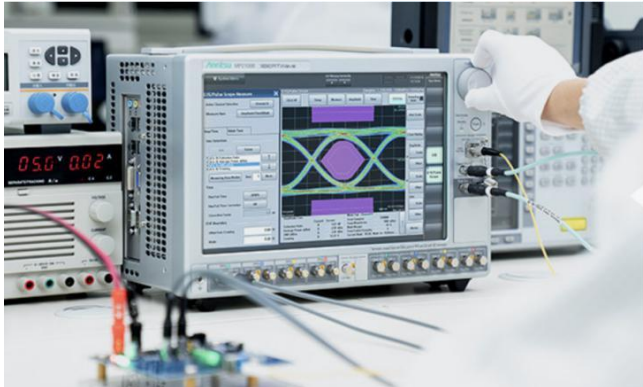


HUAWEI S6720-30L-HI-24S

Above is part of our test bed network equipment. For more information, please click the Test Bed PDF. It will be updated in realtime 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 Signal Quality Testing

Equipped with the all-in-one tester integrated 4ch BERT & sampling oscilloscope, and variable optical attenuator to ensure 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 changes 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

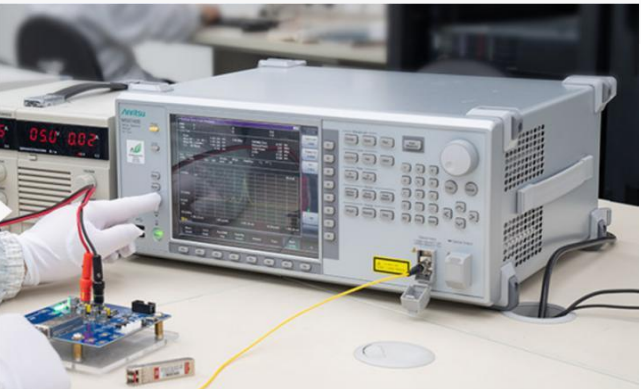
Test the actual transfer data rate and the transmission ability under different protocols with Network Master Pro.

- Ethernet
- Fibre 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                                                            |
|----------------------------------|------------------------------------------------------------------------|
| <a href="#">QDD-SR4-400G</a>     | 400GBASE-SR4 QSFP-DD 850nm 100m Transceiver                            |
| <a href="#">QDD-SR4.2-400G</a>   | 400GBASE-SR4.2 QSFP-DD 850nm 100m Transceiver                          |
| <a href="#">QDD-SR8-400G</a>     | 400GBASE-SR8 QSFP-DD 850nm 100m Transceiver                            |
| <a href="#">QDD-DR4-400G</a>     | 400GBASE-DR4 QSFP-DD 1310nm 500m Transceiver                           |
| <a href="#">QDD-DR4-400G-Si</a>  | 400GBASE-DR4 QSFP-DD 1310nm 500m Silicon Photonics Transceiver         |
| <a href="#">QDD-XDR4-400G</a>    | 400GBASE-XDR4 QSFP-DD 1310nm 2km Transceiver                           |
| <a href="#">QDD-FR-400G</a>      | 400GBASE-FR QSFP-DD 1310nm 2km Transceiver                             |
| <a href="#">QDD-FR4-400G</a>     | 400GBASE-FR4 QSFP-DD 1310nm 2km Transceiver                            |
| <a href="#">QDD-4X100G-FR-Si</a> | 400GBASE-FR4 QSFP-DD 1310nm Silicon Photonics Transceiver              |
| <a href="#">QDD-LR4-400G</a>     | 400GBASE-LR4 QSFP-DD 1310nm 10km Transceiver                           |
| <a href="#">QDD-LR8-400G</a>     | 400GBASE-LR8 QSFP-DD 1310nm 10km Transceiver                           |
| <a href="#">QDD-PLR4-400G</a>    | 400GBASE-PLR4 QSFP-DD 1310nm 10km Transceiver                          |
| <a href="#">QDD-ER4L-400G</a>    | 400GBASE-ER4L QSFP-DD 1310nm 30km Transceiver                          |
| <a href="#">QDD-ER8-400G</a>     | 400GBASE-ER8 QSFP-DD 1310nm 40km Transceiver                           |
| <a href="#">OSFP-SR4-400G-FL</a> | 400GBASE-SR4 OSFP Flat Top 850nm 50m Transceiver                       |
| <a href="#">OSFP-SR8-400G</a>    | 400GBASE-SR8 OSFP Finned Top 850nm 100m Transceiver                    |
| <a href="#">OSFP-DR4-400G-FL</a> | 400GBASE-DR4 OSFP Flat Top 1310nm 500m Transceiver                     |
| <a href="#">OSFP-DR4-400G-Si</a> | 400GBASE-DR4 OSFP Finned Top 1310nm 500m Silicon Photonics Transceiver |
| <a href="#">QSFP112-SR4-400G</a> | 400GBASE-SR4 QSFP112 850nm 50m Transceiver                             |
| <a href="#">QSFP112-DR4-400G</a> | 400GBASE-DR4 QSFP112 1310nm 500m Transceiver                           |
| <a href="#">QSFP112-FR4-400G</a> | 400GBASE-FR4 QSFP112 1310nm 2km Transceiver                            |

Order Information

| Part Number                       | Description                                  |
|-----------------------------------|----------------------------------------------|
| <a href="#">QSFP112-XDR4-400G</a> | 400GBASE-XDR4 QSFP112 1310nm 2km Transceiver |
| <a href="#">QSFP112-LR4-400G</a>  | 400GBASE-LR4 QSFP112 1310nm 10km Transceiver |