

Preliminary Product Specification

Quadwire® 40 Gb/s Parallel Breakout Active Optical Cable FCBN510QE2Cxx

PRODUCT FEATURES

- Four-channel full-duplex active optical cable with breakout from QSFP+ to four SFP+
- 10.3125 Gb/s per channel
- Complies with QSFP+ and SFP+ MSA form factors
- Round, plenum-rated cable
- Reliable VCSEL array technology using multimode fiber
- Hot Pluggable
- Low power dissipation: <1.3W on QSFP end, <1W on SFP+ ends
- Commercial operating case temperature range: 0°C to 70°C
- RoHS-6 Compliant



APPLICATIONS

- 4x10G Ethernet

PRODUCT SELECTION (Standard Lengths*)

| | |
|-----------------------|----------------|
| FCBN510QE2C01 | 1-meter cable |
| FCBN510Q E2C02 | 2-meter cable |
| FCBN510Q E2C03 | 3-meter cable |
| FCBN510Q E2C05 | 5-meter cable |
| FCBN510Q E2C07 | 7-meter cable |
| FCBN510Q E2C10 | 10-meter cable |
| FCBN510Q E2C15 | 15-meter cable |
| FCBN510Q E2C20 | 20-meter cable |
| FCBN510Q E2C30 | 30-meter cable |

*For availability of additional cable lengths, please contact Finisar. For breakout location, see Section IX.

I. Pin Descriptions
a. QSFP+ end

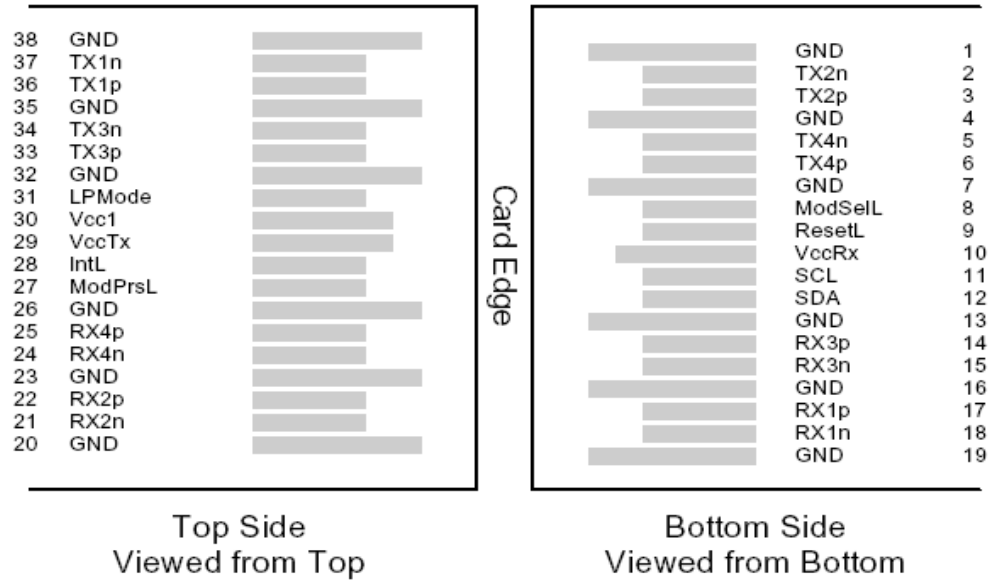


Figure 1 – QSFP MSA-compliant 38-pin connector

| Pin | Symbol | Name/Description | Notes |
|-----|---------|-------------------------------------|-------|
| 1 | GND | Ground | 1 |
| 2 | Tx2n | Transmitter Inverted Data Input | |
| 3 | Tx2p | Transmitter Non-Inverted Data Input | |
| 4 | GND | Ground | 1 |
| 5 | Tx4n | Transmitter Inverted Data Input | |
| 6 | Tx4p | Transmitter Non-Inverted Data Input | |
| 7 | GND | Ground | 1 |
| 8 | ModSelL | Module Select | |
| 9 | ResetL | Module Reset | |
| 10 | Vcc Rx | +3.3 V Power supply receiver | |
| 11 | SCL | 2-wire serial interface clock | |
| 12 | SDA | 2-wire serial interface data | |
| 13 | GND | Ground | 1 |
| 14 | Rx3p | Receiver Non-Inverted Data Output | |
| 15 | Rx3n | Receiver Inverted Data Output | |
| 16 | GND | Ground | 1 |
| 17 | Rx1p | Receiver Non-Inverted Data Output | |
| 18 | Rx1n | Receiver Inverted Data Output | |
| 19 | GND | Ground | 1 |
| 20 | GND | Ground | 1 |
| 21 | Rx2n | Receiver Inverted Data Output | |
| 22 | Rx2p | Receiver Non-Inverted Data Output | |
| 23 | GND | Ground | 1 |
| 24 | Rx4n | Receiver Inverted Data Output | |

| | | | |
|----|---------|-------------------------------------|---|
| 25 | Rx4p | Receiver Non-Inverted Data Output | |
| 26 | GND | Ground | 1 |
| 27 | ModPrsL | Module Present | |
| 28 | IntL | Interrupt | |
| 29 | Vcc Tx | +3.3 V Power supply transmitter | |
| 30 | Vcc1 | +3.3 V Power Supply | |
| 31 | LPMode | Low Power Mode | |
| 32 | GND | Ground | 1 |
| 33 | Tx3p | Transmitter Non-Inverted Data Input | |
| 34 | Tx3n | Transmitter Inverted Data Input | |
| 35 | GND | Ground | 1 |
| 36 | Tx1p | Transmitter Non-Inverted Data Input | |
| 37 | Tx1n | Transmitter Inverted Data Input | |
| 38 | GND | Ground | 1 |

Notes

1. Circuit ground is internally isolated from chassis ground.

b. SFP+ ends

| Pin | Symbol | Name/Description | Ref. |
|-----|--------------------|--|------|
| 1 | V _{EET} | Transmitter Ground (Common with Receiver Ground) | 1 |
| 2 | T _{FAULT} | Transmitter Fault. | 2 |
| 3 | T _{DIS} | Transmitter Disable. Laser output disabled on high or open. | 3 |
| 4 | SDA | 2-wire Serial Interface Data Line | 4 |
| 5 | SCL | 2-wire Serial Interface Clock Line | 4 |
| 6 | MOD_ABS | Module Absent. Grounded within the module | 4 |
| 7 | RS0 | No connection required | |
| 8 | RX_LOS | Loss of Signal indication. Logic 0 indicates normal operation. | 5 |
| 9 | RS1 | No connection required | |
| 10 | V _{EER} | Receiver Ground (Common with Transmitter Ground) | 1 |
| 11 | V _{EER} | Receiver Ground (Common with Transmitter Ground) | 1 |
| 12 | RD- | Receiver Inverted DATA out. AC Coupled | |
| 13 | RD+ | Receiver Non-inverted DATA out. AC Coupled | |
| 14 | V _{EER} | Receiver Ground (Common with Transmitter Ground) | 1 |
| 15 | V _{CCR} | Receiver Power Supply | |
| 16 | V _{CCT} | Transmitter Power Supply | |
| 17 | V _{EET} | Transmitter Ground (Common with Receiver Ground) | 1 |
| 18 | TD+ | Transmitter Non-Inverted DATA in. AC Coupled. | |
| 19 | TD- | Transmitter Inverted DATA in. AC Coupled. | |
| 20 | V _{EET} | Transmitter Ground (Common with Receiver Ground) | 1 |

Notes:

1. Circuit ground is internally isolated from chassis ground.
2. T_{FAULT} is an open collector/drain output, which is pulled up with a 4.7k – 10k Ohms resistor on the host board, but is grounded inside the SFP+ cable plug.
3. Laser output disabled on T_{DIS} >2.0V or open, enabled on T_{DIS} <0.8V.
4. Should be pulled up with 4.7kΩ – 10kΩ on host board to a voltage between 2.0V and 3.6V. MOD_ABS pulls line low to indicate module is plugged in.
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.

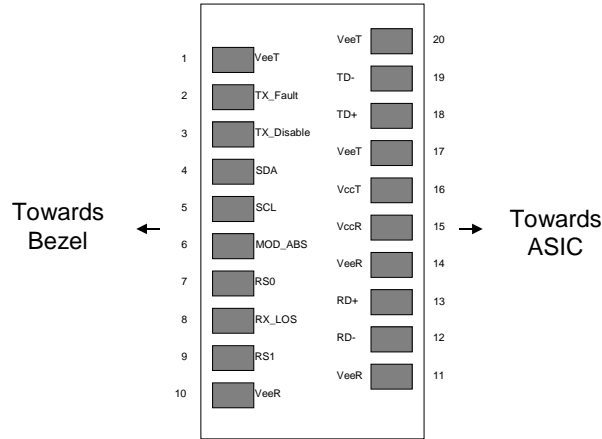


Figure 2. Diagram of Host Board Connector Block Pin Numbers and Names on the SFP+ ends.

II. General Product Characteristics

| Parameter | Value | Unit | Notes |
|-----------------------------------|--|--------|--|
| Module Form Factor | QSFP+ and SFP+ | | |
| Number of Lanes | 4 Tx and 4 Rx | | |
| Maximum Aggregate Data Rate | 42.0 | Gb/s | |
| Maximum Data Rate per Lane | 10.3125 | Gb/s | |
| Standard Cable Lengths | 1, 2, 3, 5, 7, 10, 15, 20, 30 | meters | Other lengths may be available upon request |
| Protocols Supported | 10G Ethernet | | |
| Electrical Interface and Pin-out | 38-pin edge connector (QSFP+) and 20-pin edge connector (SFP+) | | Pin-out as defined by the QSFP+ and SFP+ MSAs |
| Standard Optical Cable Type | Multimode fiber cable assembly, plenum-rated | | OFNP |
| Maximum Power Consumption per End | 1.3 (QSFP+) and 1 (SFP+) | Watts | Varies with output voltage swing and pre-emphasis settings |
| Management Interface | Serial, I2C-based, 400 kHz maximum frequency | | As defined by the QSFP MSA |

| Data Rate Specifications | Symbol | Min | Typ | Max | Units | Ref. |
|--------------------------|--------|------|-----|-------------------|--------|------|
| Bit Rate per Lane | BR | 1000 | | 103125 | Mb/sec | |
| Bit Error Ratio | BER | | | 10 ⁻¹² | | 1 |

Notes:

1. Tested with a PRBS 2³¹-1 test pattern.

III. Absolute Maximum Ratings

| Parameter | Symbol | Min | Typ | Max | Unit | Ref. |
|----------------------------|--|------|-----|-----|------|------|
| Maximum Supply Voltage | V _{cc1} , V _{ccTx} , V _{ccRx} | -0.5 | | 3.6 | V | |
| Storage Temperature | T _S | -10 | | 75 | °C | |
| Case Operating Temperature | T _{OP} | 0 | | 70 | °C | |
| Relative Humidity | RH | 0 | | 85 | % | 1 |

Notes:

1. Non-condensing.

IV. Electrical Characteristics (T_{OP} = 0 to 70°C, V_{CC} = 3.3 ± 5% Volts)

| Parameter | Symbol | Min | Typ | Max | Unit | Ref. |
|--------------------------------|--|------|-----|---------------------------|------------------|------|
| Supply Voltage | V _{cc1} , V _{ccTx} , V _{ccRx} | 3.15 | | 3.45 | V | |
| Supply Current | I _{cc} | | | 350 (QSFP) 250 (SFP+) | mA | |
| Link Turn-On Time | | | | | | |
| Transmit Turn-On Time | | | | 2000 | ms | 1 |
| Transmitter (per Lane) | | | | | | |
| Differential data input swing | V _{in,pp} | 180 | | 1200 (QSFP) 700 (SFP+) | mV _{pp} | 2 |
| Differential input threshold | | | 50 | | mV | |
| Receiver (per Lane) | | | | | | |
| Differential data output swing | V _{out,pp} | 0 | | 850 | mV _{pp} | 3,4 |
| Power Supply Ripple Tolerance | PSR | 50 | | | mV _{pp} | |

Notes:

1. From power-on and end of any fault conditions.
2. AC coupled internally. See Figure 2 for input eye mask requirements. Self-biasing 100Ω differential input.
3. AC coupled with 100Ω differential output impedance. See Figure 3 for output eye mask.
4. Settable in 4 discrete steps. See Figure 5 for V_o settings

V. High-Speed Electrical Characteristics per Lane

($T_{OP} = 0$ to 70°C , $V_{CC} = 3.3 \pm 5\%$ Volts)

| Parameter –Inputs | Symbol | Conditions | Min | Typ | Max | Units | Ref. |
|--|--------------|----------------|-----|-----|------|----------|------|
| Reference Differential Input Impedance | Z_d | | | 100 | | Ω | |
| Termination Mismatch | ΔZ_M | | | | 5 | % | 1 |
| Input AC Common Mode Voltage | | | | | 25 | mV (RMS) | |
| Differential Input Return Loss | SDD11 | 0.01-4.1 GHz | | | | dB | 2 |
| | | 4.1 – 11.1 GHz | | | | dB | 3 |
| Differential to Common Mode Loss | SCD11 | 0.01-11.1 GHz | | | -10 | dB | |
| Eye Mask Coordinates: | X1, X2 | 0.29, 0.5 | | | | UI | 4 |
| | Y1, Y2 | 150, 425 | | | | mV | |
| Jitter Tolerance (Total) | TJ | | | | 0.40 | UI | |
| Jitter Tolerance (Deterministic) | DJ | | | | 0.15 | UI | |

Notes:

1. See SFF-8431 Rev 3.2 (SFP+) section D.15 Termination Mismatch for definition & test recommendations
2. Reflection coefficient given by equation $SDD11(\text{dB}) < -12 + 2 * \text{SQRT}(f)$, with f in GHz.
3. Reflection coefficient given by equation $SDD11(\text{dB}) < -6.3 + 13 \text{Log}_{10}(f/5.5)$, with f in GHz.
4. Hit ratio 5×10^{-5} . See Figure 3 for transmitter input eye mask definitions.

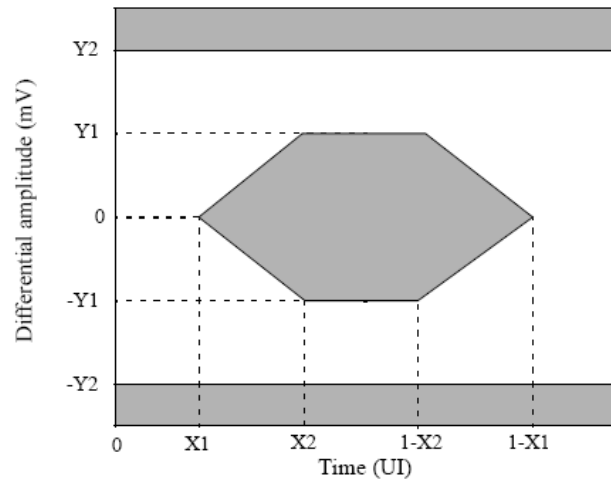


Figure 3 – Transmitter Input Differential Signal Mask

| Parameter –Outputs | Symbol | Conditions | Min | Typ | Max | Units | Ref. |
|---|-------------------|----------------|-----|-----|------|-------------------|------|
| Reference Differential Output Impedance | Z_d | | | 100 | | Ω | |
| Termination Mismatch | ΔZ_M | | | | 5 | % | |
| Output AC Common Mode Voltage | | | | | 15 | mV _{RMS} | |
| Output Rise and Fall time (20% to 80%) | t_{RH}, t_{FH} | | 24 | | | ps | |
| Differential Output Return Loss | SDD22 | 0.01-4.1 GHz | | | | dB | 1 |
| | | 4.1 – 11.1 GHz | | | | dB | 2 |
| Common Mode Output Return Loss | SCC22 | 0.01-2.5 GHz | | | | dB | 3 |
| | | 2.5-11.1 GHz | | | -3 | dB | |
| Eye Mask Coordinates: | X1, X2 | 0.29, 0.5 | | | | UI | 4 |
| | Y1, Y2 | 150, 425 | | | | mV | |
| Deterministic Jitter | DJ _{OUT} | | | | 0.38 | UI | 1 |
| Total Jitter | TJ _{OUT} | | | | 0.64 | UI | 1 |

Notes:

1. Reflection coefficient given by equation $SDD22(dB) < -12 + 2 * \sqrt{f}$, with f in GHz. See Figure 5.
2. Reflection coefficient given by equation $SDD22(dB) < -6.3 + 13 \log_{10}(f/5.5)$, with f in GHz. See Figure 5.
3. Reflection coefficient given by equation $SCC22(dB) < -7 + 1.6 * f$, with f in GHz.
4. Hit ratio 5×10^{-5} . See Figure 4 for receiver output eye mask definitions.
5. When transmitter input jitter specs are met

| Other Informational Specifications (not tested) | Symbol | Min | Typ | Max | Units | Ref. |
|---|--------|-----|-----|------|-------|------|
| Max Bit Rate NRZ | B | | | 12.5 | Gb/s | |
| Low Frequency 3dB Cutoff | f_c | 175 | | | kHz | |
| Ch / Ch crosstalk | | | | -26 | dB | |
| Output Pre-emphasis settings (user selectable) | PE | | 0 | | mV | |
| | | | 125 | | mV | |
| | | | 175 | | mV | |
| | | | 325 | | mV | |
| Pre-Emphasis pulse width | | 60 | | 90 | ps | |
| Channel Latency | | | TBD | | | |
| Digital clock to data delay | | | | 25 | ns | |
| Digital output rise/fall times | | | | 5 | ns | |
| Digital input / output Cap | | | | 1 | pF | |
| Digital input logic High | | 2 | | | V | |
| Digital input logic Low | | | | 1 | V | |
| ESD Signal pads | | | | 500 | V | HBM |
| ESD (other pads) | | | | 2 | kV | HBM |

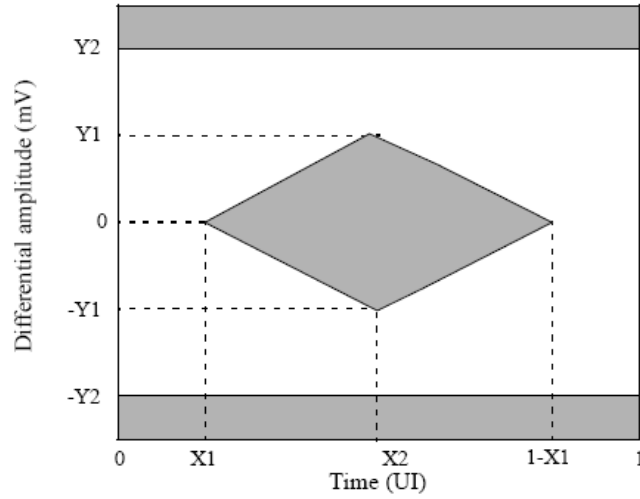


Figure 4 – Receiver Output Differential Signal Mask

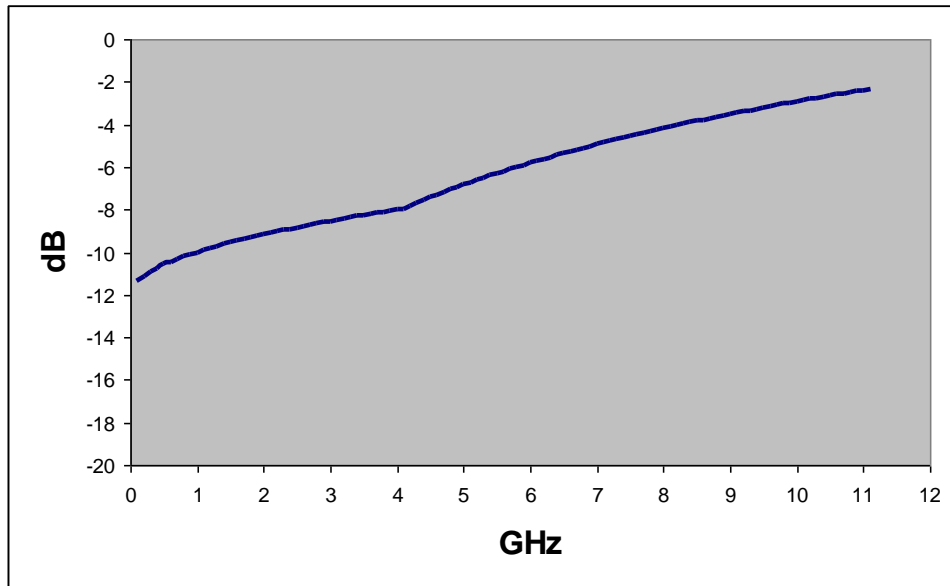


Figure 5 – Maximum Transmitter Input and Receiver Output Differential Return Loss

| Power (mW) | | Pre-Emphasis into 100ohms (mV) | | | |
|------------|-----|--------------------------------|------|------|------|
| | | 0 | 125 | 175 | 325 |
| Vo (mV) | 0 | 599 | | | |
| | 317 | 751 | 935 | 971 | 1075 |
| | 422 | 787 | 971 | 1007 | 1111 |
| | 739 | 883 | 1055 | 1103 | 1190 |

Figure 6 – Power Dissipation (mW, maximum) vs. Rx Output Conditions

VI. Memory Map and Control Registers

Compatible with SFF-8436. More details to be provided in a future revision of this document.

VII. Environmental Specifications

Finisar Quadwire active optical cables have an operating temperature range from 0°C to +70°C case temperature.

| Environmental Specifications | Symbol | Min | Typ | Max | Units | Ref. |
|------------------------------|------------------|-----|-----|-----|-------|------|
| Case Operating Temperature | T _{op} | 0 | | 70 | °C | |
| Storage Temperature | T _{sto} | -10 | | 75 | °C | |

VIII. Regulatory Compliance

Finisar Quadwire active optical cables are RoHS-6 Compliant. Copies of certificates are available at Finisar Corporation upon request.

Quadwire active optical cables are Class 1 laser eye safety compliant per IEC 60825-1.

Standard fiber cable type is OFNP plenum rated, round construction. Other cable types may be supported upon request.

IX. Mechanical Specifications

The Quadwire mechanical specifications are based on QSFP+ and SFP+ transceiver module specifications, substituting the optical connectors with a cable connecting both ends.

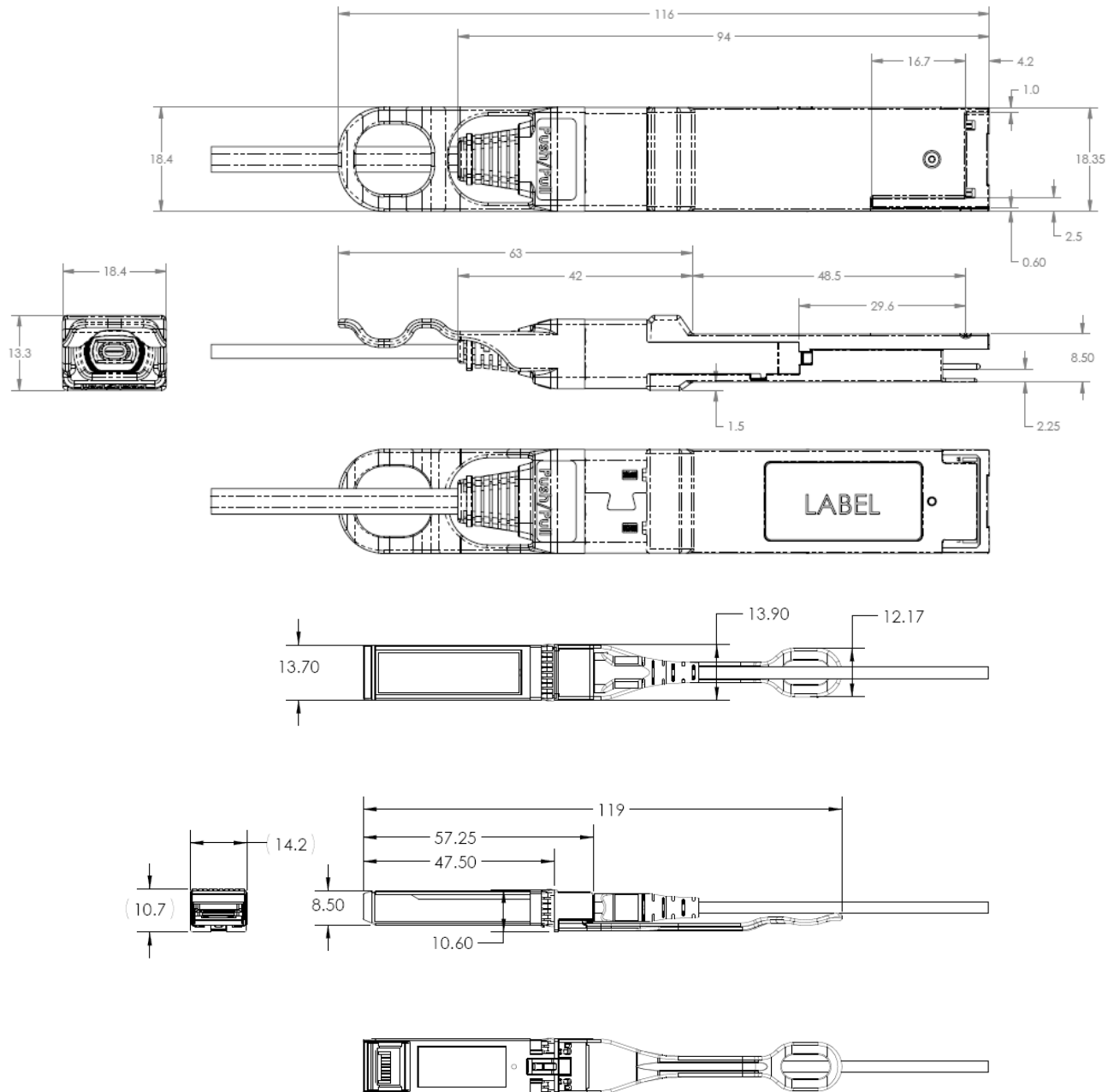



Figure 5 –Mechanical drawing of Quadwire QSFP+ and SFP+ ends

| Quadwire length | Breakout point (measured from QSFP) | Breakout point (measured from SFP+) |
|-----------------|-------------------------------------|-------------------------------------|
| 1m | 33cm | 67cm |
| 2m | 67cm | 1.33m |
| 3m | 1m | 2m |
| 5m | 2m | 3m |
| 7m | 4m | 3m |
| 10m | 7m | 3m |
| 15m | 12m | 3m |
| 20m | 17m | 3m |
| 30m | 27m | 3m |

| Cable Mechanical Specifications | Min | Typical | Max | Units |
|---|-----|---------|-----|-------|
| Minimum bend radius | 60 | | | mm |
| Minimum bend radius within 100 mm of a module end | 105 | | | mm |
| Diameter of common (non-broken-out) cable jacket | 3.0 | 3.3 | 3.6 | mm |
| Diameter of broken-out cable jacket | 1.8 | 2.0 | 2.2 | mm |

| Insertion, Extraction and Retention Forces | Min | Max | Units | Notes |
|--|-----|------|---------|----------------------|
| Cable Proof (Tensile) Test (0°) | | 44.0 | Newtons | |
| Cable Proof (Tensile) Test (90°) | | 33.0 | Newtons | |
| Impact Test | | 8 | Cycles | 1.5m drop |
| Flex Test | | 8.9 | Newtons | |
| Twist Test | | 13.0 | Newtons | |
| Module retention | 90 | N/A | Newtons | No damage below 90N |
| Host Connector Retention | 180 | N/A | Newtons | No damage below 180N |

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FCBN510QE2Cxx
 QSFP-40G-SR4 XX M
 MADE IN CHINA
 Class 1 21CFR1040.10 LN#50 6/2007
 S/N: WWWWWWWW
 01-01


Finisar Sunnyvale, CA 94089
FCBN510QE2Cxx XXM
 MADE IN CHINA 850nm YY-WW
 S/N: WWWWWWWW 
 Class 1 21CFR1040.10 LN#50 6/2007

Figure 6 – Quadwire product labels: QSFP end (top) and SFP+ ends (bottom)**X. References**

1. SFF-8436 – Specification for QSFP+ Copper and Optical Transceiver, Rev 4.8, October 2013.
2. “Specifications for Enhanced 8.5 and 10 Gigabit Small Form Factor Pluggable Module ‘SFP+’, SFF Document Number SFF-8431, Revision 4.1.
3. Directive 2011/65/EC of the European Council Parliament and of the Council, “on the restriction of the use of certain hazardous substances in electrical and electronic equipment,” June 8, 2011 which supercedes the previous RoHS Directive 2002/95/EC.
4. “Application Note AN-2038: Finisar Implementation of RoHS Compliant Transceivers”, Finisar Corporation, January 21, 2005.
5. “Application Note AN-2079: QSFP Module EEPROM Mapping”, Rev. G, Finisar Corporation, May, 2013.

XI. For More Information

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