

Product Specification

Quadwire® FDR Parallel Active Optical Cable FCBx414QD3Cyy

PRODUCT FEATURES

- Four-channel full-duplex active optical cable
- Multirate capability: 1.06Gb/s to 14.025Gb/s per channel
- Complies with QSFP MSA high-density form factor
- Reliable VCSEL array technology using multimode fiber
- Round, plenum-rated (OFNP) and riser-rated (OFNR), low smoke zero halogen (LSZH) cables
- Hot Pluggable
- Built-in digital diagnostic functions
- Low power dissipation: <1.3W per cable end
- Commercial operating case temperature range: 0°C to 70°C
- RoHS-6 Compliant (lead-free)



APPLICATIONS

- Infiniband 4xFDR, 4xQDR
- 40G Ethernet
- 4G/8G/10G/14G Fibre Channel
- HPC Interconnections
- SATA/SA

PRODUCT SELECTION (Standard Lengths*)

| FCBx414QD3Cyy | |
|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| x: | N = Plenum-rated (OFNP) cable jacket R = Riser-rated (OFNR) low smoke zero halogen (LSZH) cable jacket |
| yy*: | 03 = 3m length 05 = 5m length 10 = 10m length 15 = 15m length 20 = 20m length 30 = 30m length 50 = 50m length X0 = 100m length |
| *Please contact Finisar for availability of additional cable lengths. | |

I. Pin Descriptions



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.

II. General Product Characteristics

| Parameter | Value | Unit | Notes |
|-----------------------------------|---------------------------------------------------------------------------------|--------|---------------------------------------------------------------------------|
| Module Form Factor | QSFP | | |
| Number of Lanes | 4 Tx and 4 Rx | | |
| Maximum Aggregate Data Rate | 56.25 | Gb/s | |
| Maximum Data Rate per Lane | 14.0625 | Gb/s | |
| Standard Cable Lengths | 3, 5, 10, 15, 20, 30, 50, 100 | meters | Other lengths may be available upon request (< 300m) |
| Protocols Supported | Typical applications include Infiniband, Fibre Channel, 40G Ethernet, SATA/SAS3 | | |
| Electrical Interface and Pin-out | 38-pin edge connector | | Pin-out as defined by the QSFP MSA |
| Standard Optical Cable Type | Multimode ribbon fiber cable assembly, riser-rated | | |
| Maximum Power Consumption per End | 1.3 | Watts | Varies with output voltage swing and pre-emphasis settings (see Figure 2) |
| 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 | | 14062.5 | Mb/sec | 1 |
| Bit Error Ratio | BER | | | 10 ⁻¹² | | 2 |

Notes:

1. 1/10 Gigabit Ethernet and 1/2/4/8/10/16G Fibre Channel compatible.
2. 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 | -40 | | 85 | °C | 1 |
| Case Operating Temperature | T _{OP} | 0 | | 70 | °C | |
| Relative Humidity | RH | 0 | | 85 | % | 2 |

Notes:

- Assumes no mechanical load force on the unit. Ensuring no mechanical load force requires a cable bend radius of >105 mm within 100 mm of either cable end module and >60 mm on the rest of the cable.
- 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 | mA | |
| Link Turn-On Time | | | | | | |
| Transmit Turn-On Time | | | | 2000 | ms | 1 |
| Transmitter (per Lane) | | | | | | |
| Differential data input swing | V _{in,pp} | 180 | | 1200 | mV _{pp} | 2 |
| Differential input threshold | | | 50 | | mV | |
| Receiver (per Lane) | | | | | | |
| Differential data output swing | V _{out,pp} | 0 | | 800 | mV _{pp} | 3,4 |
| Power Supply Ripple Tolerance | PSR | 50 | | | mV _{pp} | |

Notes:

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

V. High-Speed Electrical Characteristics per Lane

($T_{OP} = 0$ to $70^{\circ}C$, $V_{CC} = 3.3 \pm 5\%$ 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 | |
| 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 $SDD11(dB) < -12 + 2 * \sqrt{f}$, with f in GHz.
3. Reflection coefficient given by equation $SDD11(dB) < -6.3 + 13 \log_{10}(f/5.5)$, with f in GHz.

| 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} | 14 Gbps | 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 | |

Notes:

1. Reflection coefficient given by equation $SDD22(dB) < -12 + 2 * \sqrt{f}$, with f in GHz.
2. Reflection coefficient given by equation $SDD22(dB) < -6.3 + 13 \log_{10}(f/5.5)$, with f in GHz.
3. Reflection coefficient given by equation $SCC22(dB) < -7 + 1.6 * f$, with f in GHz.

| Receiver Output Jitter Specification | Symbol | Min | Typ | Max | Units | Ref. |
|--------------------------------------|------------|-----|-----|------|-------|------|
| Deterministic Jitter | DJ_{OUT} | | | 0.38 | UI | 1 |
| Total Jitter | TJ_{OUT} | | | 0.64 | UI | 1 |

Notes:

1. When transmitter input jitter specs are met.

| Other Informational Specifications (not tested) | Symbol | Min | Typ | Max | Units | Ref. |
|-------------------------------------------------|--------|-----|-----|-------------|-------|------|
| Max Bit Rate NRZ | B | | | 14.0625 | 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 | |
| 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 |
| Channel-to-channel skew | | | | 913 | ps | 1 |
| Latency | | | | 1086+4990/m | ps | |

Notes:

1. For cable lengths $\leq 7m$. For longer cable lengths, the maximum channel-to-channel skew = 1204ps + (cable length – 8m) * 992ps.

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

Figure 2 – Power Dissipation (mW, maximum) vs. Rx Output Conditions

VI. Memory Map and Control Registers

Compatible with SFF-8436.² Please see Finisar Application Note AN-2075: Quadwire[®] EEPROM Mapping³ for details.

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} | -40 | | 85 | °C | 1 |

1. Assumes no mechanical load force on the unit. Ensuring no mechanical load force requires a cable bend radius of >105 mm within 100 mm of either cable end module and >60 mm on the rest of the cable.

VIII. Regulatory Compliance

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

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

The round cable jacket is available in both plenum-rated (OFNP) and riser-rated (OFNR) low smoke zero-halogen (LSZH).

IX. Mechanical Specifications

Finisar FDR Quadwire® mechanical specifications are based on QSFP transceiver module specifications, substituting the MPO connectors with a cable connecting both ends.



Figure 3 – Quadwire® mechanical drawing

| Cable Mechanical Specifications | Min | Typical | Max | Units |
|---------------------------------------------------------------|-----|---------|-----|-------|
| Minimum bend radius | 60 | | | mm |
| Minimum bend radius within 100 mm of the Quadwire® module end | 105 | | | mm |
| Diameter | 3.0 | 3.3 | 3.6 | 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 |



Figure 4 – Quadwire[®] production-level product label

X. References

1. INF-8438i – Specification for QSFP (Quad Small Formfactor Pluggable) Transceiver, Rev 1.0, November 2006
2. SFF-8636 – Specification for QSFP+ Copper and Optical Transceiver, Rev 2.7, January, 2016
3. Application Note AN-2075: Quadwire[®] EEPROM Mapping, Rev E

XI. For More Information

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