

Product Specification

Quadwire® 40 Gb/s Parallel Active Optical Cable

FCCx410QD3Cyy

PRODUCT FEATURES

- Four-channel full-duplex active optical cable
- Multirate capability: 1.06Gb/s to 10.5Gb/s per channel
- Complies with QSFP MSA high-density form factor
- Round, plenum-rated (OFNP) and riser-rated (OFNR), low smoke zero halogen (LSZH) cables
- Connectivity Diagnostics® ready
- Rigid pull-tab with embedded LED light
- Hot Pluggable
- Low power dissipation: <1.3W per cable end
- Commercial operating case temperature range: 0°C to 70°C
- RoHS-6 Compliant



connectivity
diagnostics

APPLICATIONS

- InfiniBand QDR
- 40G Ethernet
- 4G/8G/10G Fibre Channel
- HPC Interconnections
- SATA/SAS3
- PCIe3

PRODUCT SELECTION (Standard Lengths*)

FCCx410QD3Cyy	
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

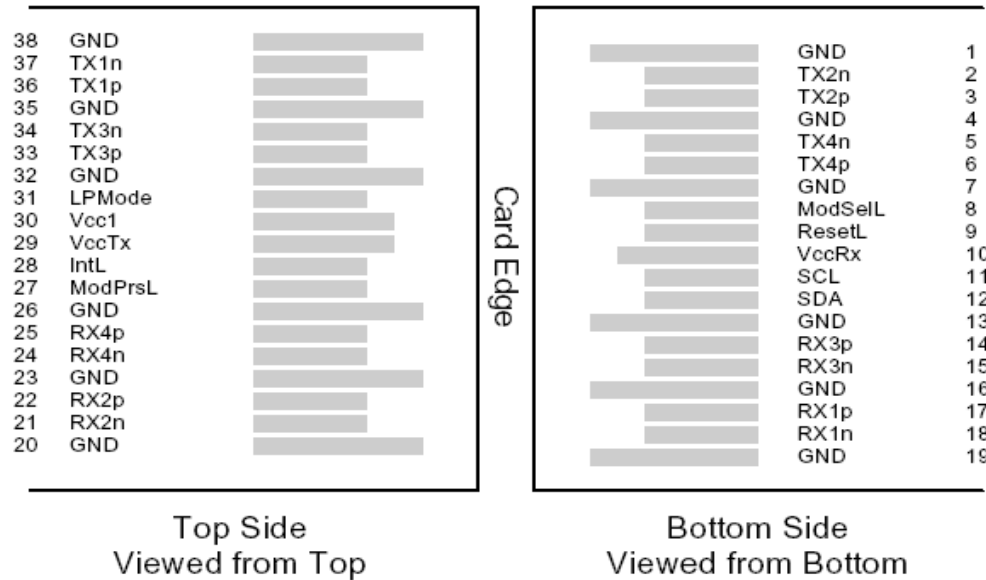


Figure 1 – QSFP MSA-compliant 38-pin connector

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	42.0	Gb/s	
Maximum Data Rate per Lane	10.5	Gb/s	
Standard Cable Lengths	3, 5, 10, 15, 20, 30, 50, 100	meters	Other lengths may be available upon request (<100)
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 fiber cable assembly		
Maximum Power Consumption per End	1.3	Watts	Varies with output voltage swing and pre-emphasis settings (see Figure 5)
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		10500	Mb/sec	1
Bit Error Ratio	BER			10 ⁻¹²		2

Notes:

1. 1/10 Gigabit Ethernet and 1/2/4/8/10G Fibre Channel compatible.
2. Tested with a PRBS 2³¹-1 test pattern.

III. Connectivity Diagnostics® Features

The FCCx410QD3Cxx Quadwire® are equipped with Finisar's Connectivity Diagnostics®, a technology solution enabling real-time performance monitoring and troubleshooting. The following two features are implemented by default:

LynkFind™

By manually pushing in the pull tab, both near- and far-end pull tabs will rapidly blink. To reset the pull tab light off, simply push in the pull tab again on either end of the AOC.

LynkGuardian™

If a digital diagnostic monitor (DDM) triggers an alarm or warning event, or upon a transmitter fault or a receiver loss of signal, the pull tabs of both ends will light up as follows: the near end (where the alarm originates) pull tab will blink slowly, while the far end pull tab will glow solid. Both pull tab lights will alternate blinking and solid in case DDM events occur on both AOCs ends.

IV. Absolute Maximum Ratings

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Maximum Supply Voltage	Vcc1, VccTx, VccRx	-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.

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

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Supply Voltage	Vcc1, VccTx, VccRx	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:

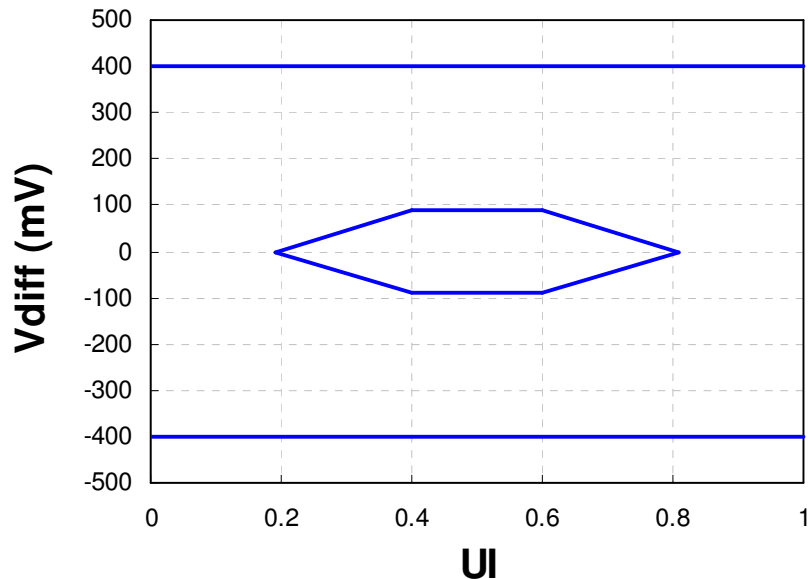
1. From power-on and end of any fault conditions.
2. AC coupled internally. See Figure 2 for input eye mask requirements. Self-biasing 100 Ω differential input.
3. AC coupled with 100 Ω differential output impedance. See Figure 3 for output eye mask.
4. Settable in 4 discrete steps. See Figure 5 for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

VI. 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	
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. See Figure 4.
3. Reflection coefficient given by equation $SDD11(dB) < -6.3 + 13 \log_{10}(f/5.5)$, with f in GHz. See Figure 4.

**Figure 2 – 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	

Notes:

1. Reflection coefficient given by equation $SDD22(dB) < -12 + 2 * \sqrt{f}$, with f in GHz. See Figure 4.
2. Reflection coefficient given by equation $SDD22(dB) < -6.3 + 13 \log_{10}(f/5.5)$, with f in GHz. See Figure 4.
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

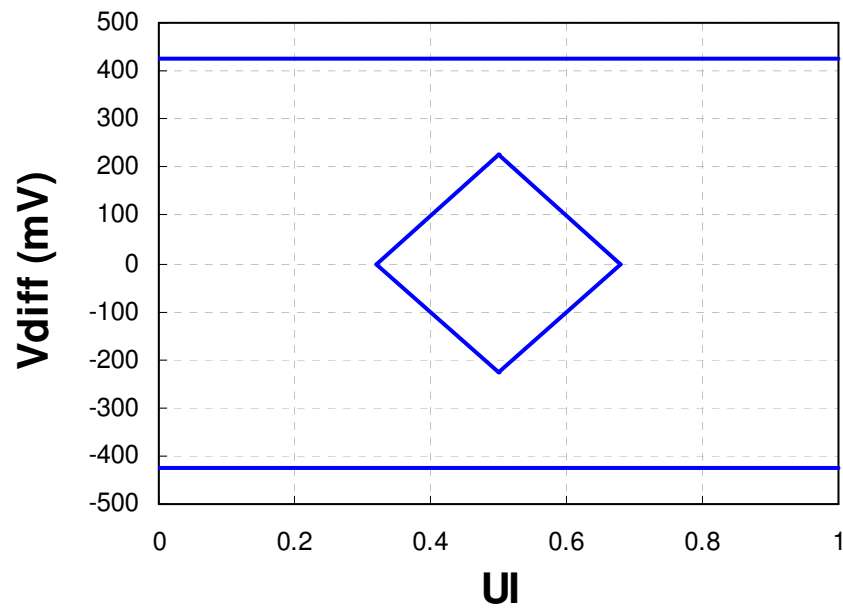
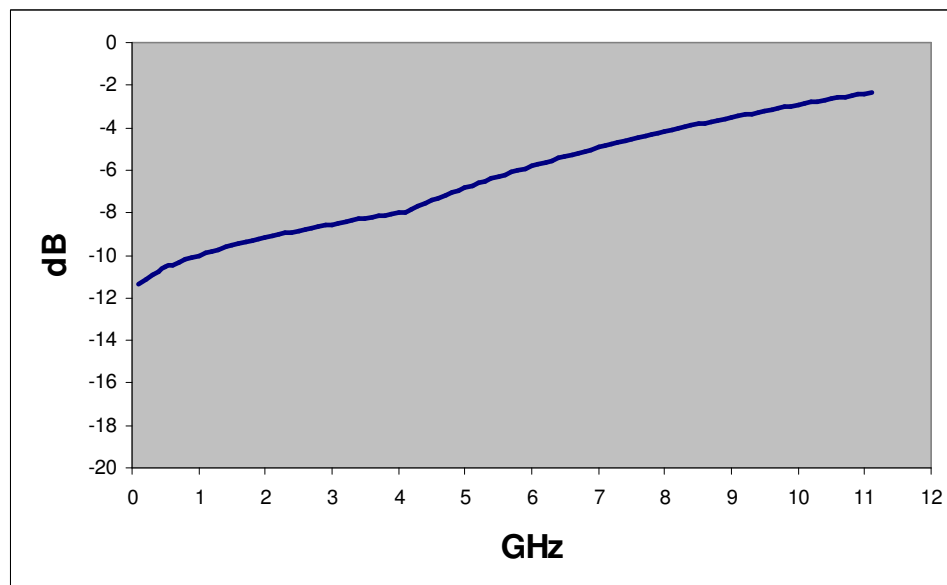
Notes:

1. When transmitter input jitter specs are met.

Other Informational Specifications (not tested)	Symbol	Min	Typ	Max	Units	Ref.
Max Bit Rate NRZ	B			10.5	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-to-channel skew				24	ns	1
Latency		400	495	600	ns	1
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	2
ESD (other pads)				2	kV	2

Notes:

1. For worst-case 100m length.
2. Human Body Model (HBM)

**Figure 3 – Receiver Output Differential Signal Mask****Figure 4 – 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 5 – Power Dissipation (mW, maximum) vs. Rx Output Conditions

VII. Memory Map and Control Registers

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

VIII. 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.

IX. 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.

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

X. Mechanical Specifications

The Quadwire® mechanical specifications are based on QSFP transceiver module specifications, substituting the MPO connectors with a cable connecting both ends. Rigid pull-tab is opaque in non-illuminated mode and amber in illuminated mode.

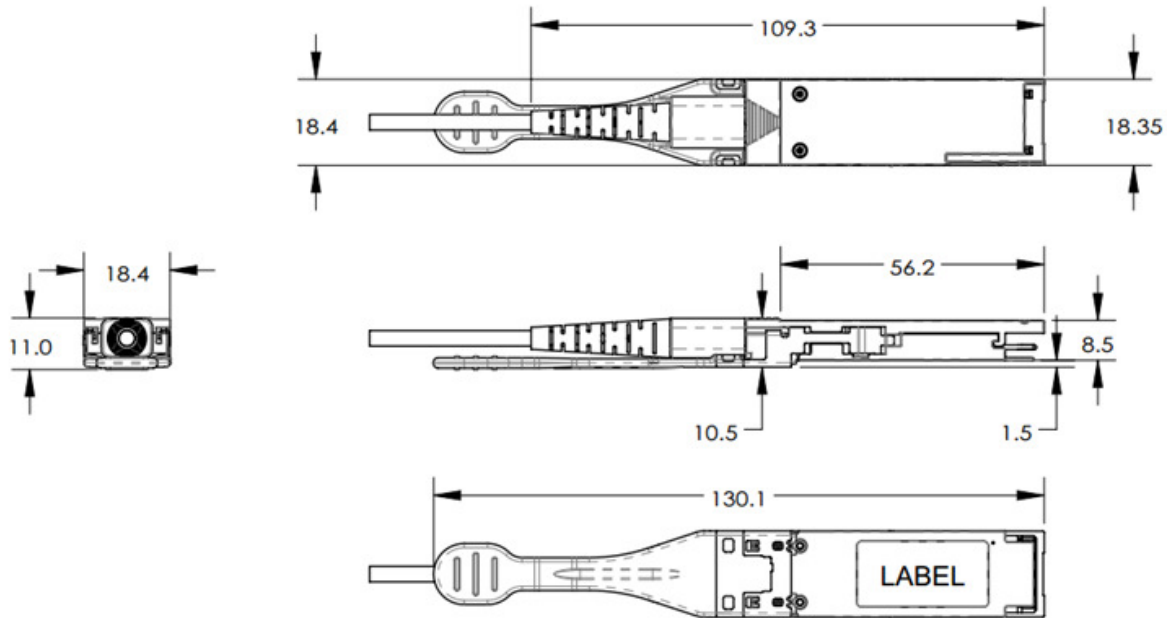


Figure 5 – Quadwire® with Connectivity Diagnostics® mechanical drawing

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 6 – Quadwire® production-level product label

XI. 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
4. Application Note AN-2158: Finisar's Connectivity Diagnostics™ for Active Optical Cables

XII. For More Information

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