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## Product Specification

### C.wire® 120 Gb/s Parallel Active Optical Cable

#### FCBGD10CD1Cxx

#### PRODUCT FEATURES

- 12-channel full-duplex active optical cable
- Electrical interface only
- Multirate capability: 1.06Gb/s to 10.5Gb/s per channel
- Complies with CXP high-density form factor requirements
- Low power dissipation: <3.5W per cable end
- Requires 3.3V power supply only
- Reliable VCSEL array technology using multimode fiber
- Available in standard lengths of 3, 5, 10, 20, 30, 50 and 100m\*
- Hot Pluggable
- Built-in digital diagnostic functions
- Commercial operating temperature range: 0°C to 70°C
- RoHS-6 Compliant (lead-free)



#### APPLICATIONS

- Infiniband 12xQDR
- 100G Ethernet
- 4G/8G/10G Fibre Channel
- Proprietary Interconnections
- SATA/SAS3

#### PRODUCT SELECTION

<b>FCBGD10CD1C03</b>	3-meter cable
<b>FCBGD10CD1C05</b>	5-meter cable
<b>FCBGD10CD1C10</b>	10-meter cable
<b>FCBGD10CD1C20</b>	20-meter cable
<b>FCBGD10CD1C30</b>	30-meter cable
<b>FCBGD10CD1C50</b>	50-meter cable
<b>FCBGD10CD1CX0</b>	100-meter cable

\*For availability of additional cable lengths, please contact Finisar.



**I. Pin Descriptions**

Bottom side			Top Side		
I/O #	Name	Contact Length	Contact Length	Name	I/O #
<b>Receiver -- Top Card</b>					
C1	GND			GND	D1
C2	RX1p			RX0p	D2
C3	RX1n			RX0n	D3
C4	GND			GND	D4
C5	RX3p			RX2p	D5
C6	RX3n			RX2n	D6
C7	GND			GND	D7
C8	RX5p			RX4p	D8
C9	RX5n			RX4n	D9
C10	GND			GND	D10
C11	RX7p			RX6p	D11
C12	RX7n			RX6n	D12
C13	GND			GND	D13
C14	RX9p			RX8p	D14
C15	RX9n			RX8n	D15
C16	GND			GND	D16
C17	RX11p			RX10p	D17
C18	RX11n			RX10n	D18
C19	GND			GND	D19
C20	PRSNT_L			Vcc3.3-RX	D20
C21	Int_L/Reset_L			Vcc12-RX	D21
<b>Transmitter -- Bottom Card</b>					
A1	GND			GND	B1
A2	TX1p			TX0p	B2
A3	TX1n			TX0n	B3
A4	GND			GND	B4
A5	TX3p			TX2p	B5
A6	TX3n			TX2n	B6
A7	GND			GND	B7
A8	TX5p			TX4p	B8
A9	TX5n			TX4n	B9
A10	GND			GND	B10
A11	TX7p			TX6p	B11
A12	TX7n			TX6n	B12
A13	GND			GND	B13
A14	TX9p			TX8p	B14
A15	TX9n			TX8n	B15
A16	GND			GND	B16
A17	TX11p			TX10p	B17
A18	TX11n			TX10n	B18
A19	GND			GND	B19
A20	SCL			VCC3.3-TX	B20
A21	SDA			VCC12-TX	B21

**Figure 1 – CXP-compliant 84-pin connector**

Pin	Symbol	Name/Description	Notes
A1	GND	Ground	1
A2	Tx1p	Transmitter Non-Inverted Data Input	
A3	Tx1n	Transmitter Inverted Data Input	
A4	GND	Ground	1
A5	Tx3p	Transmitter Non-Inverted Data Input	
A6	Tx3n	Transmitter Inverted Data Input	
A7	GND	Ground	1
A8	Tx5p	Transmitter Non-Inverted Data Input	
A9	Tx5n	Transmitter Inverted Data Input	
A10	GND	Ground	1
A11	Tx7p	Transmitter Non-Inverted Data Input	
A12	Tx7n	Transmitter Inverted Data Input	
A13	GND	Ground	1
A14	Tx9p	Transmitter Non-Inverted Data Input	
A15	Tx9n	Transmitter Inverted Data Input	
A16	GND	Ground	1
A17	Tx11p	Transmitter Non-Inverted Data Input	
A18	Tx11n	Transmitter Inverted Data Input	
A19	GND	Ground	1
A20	SCL	2-wire serial interface clock	
A21	SDA	2-wire serial interface data	
B1	GND	Ground	1
B2	Tx0p	Transmitter Non-Inverted Data Input	
B3	Tx0n	Transmitter Inverted Data Input	
B4	GND	Ground	1
B5	Tx2p	Transmitter Non-Inverted Data Input	
B6	Tx2n	Transmitter Inverted Data Input	
B7	GND	Ground	1
B8	Tx4p	Transmitter Non-Inverted Data Input	
B9	Tx4n	Transmitter Inverted Data Input	
B10	GND	Ground	1
B11	Tx6p	Transmitter Non-Inverted Data Input	
B12	Tx6n	Transmitter Inverted Data Input	
B13	GND	Ground	1
B14	Tx8p	Transmitter Non-Inverted Data Input	
B15	Tx8n	Transmitter Inverted Data Input	
B16	GND	Ground	1
B17	Tx10p	Transmitter Non-Inverted Data Input	
B18	Tx10n	Transmitter Inverted Data Input	
B19	GND	Ground	1
B20	VCC3.3-TX	+3.3 V Power supply transmitter	
B21	VCC12-TX	+12.0 V Power supply transmitter - <b>NOT CONNECTED</b>	2
C1	GND	Ground	1
C2	Rx1p	Receiver Non-Inverted Data Output	
C3	Rx1n	Receiver Inverted Data Output	
C4	GND	Ground	1
C5	Rx3p	Receiver Non-Inverted Data Output	
C6	Rx3n	Receiver Inverted Data Output	
C7	GND	Ground	1
C8	Rx5p	Receiver Non-Inverted Data Output	

C9	Rx5n	Receiver Inverted Data Output	
C10	GND	Ground	1
C11	Rx7p	Receiver Non-Inverted Data Output	
C12	Rx7n	Receiver Inverted Data Output	
C13	GND	Ground	1
C14	Rx9p	Receiver Non-Inverted Data Output	
C15	Rx9n	Receiver Inverted Data Output	
C16	GND	Ground	1
C17	Rx11p	Receiver Non-Inverted Data Output	
C18	Rx11n	Receiver Inverted Data Output	
C19	GND	Ground	1
C20	PRSNT_L	Module Present	
C21	Int_L/Reset_L	Interrupt / Reset	
D1	GND	Ground	1
D2	Rx0p	Receiver Non-Inverted Data Output	
D3	Rx0n	Receiver Inverted Data Output	
D4	GND	Ground	1
D5	Rx2p	Receiver Non-Inverted Data Output	
D6	Rx2n	Receiver Inverted Data Output	
D7	GND	Ground	1
D8	Rx4p	Receiver Non-Inverted Data Output	
D9	Rx4n	Receiver Inverted Data Output	
D10	GND	Ground	1
D11	Rx6p	Receiver Non-Inverted Data Output	
D12	Rx6n	Receiver Inverted Data Output	
D13	GND	Ground	1
D14	Rx8p	Receiver Non-Inverted Data Output	
D15	Rx8n	Receiver Inverted Data Output	
D16	GND	Ground	1
D17	Rx10p	Receiver Non-Inverted Data Output	
D18	Rx10n	Receiver Inverted Data Output	
D19	GND	Ground	1
D20	Vcc3.3-RX	+3.3 V Power supply receiver	
D21	Vcc12-RX	+12.0 V Power supply receiver - <b>NOT CONNECTED</b>	2

Notes

1. Circuit ground is internally isolated from chassis ground.
2. 12V power supply not required.

**II. General Product Characteristics**

Parameter	Value	Unit	Notes
Module Form Factor	CXP		
Number of Lanes	12 Tx and 12 Rx		
Maximum Aggregate Data Rate	126	Gb/s	
Maximum Data Rate per Lane	10.5	Gb/s	
Standard Cable Lengths	3, 5, 10, 20, 30, 50, 100	meters	Other lengths may be available upon request, up to 300 meters
Protocols Supported	Typical applications include Infiniband, Fibre Channel, 100G Ethernet, SATA/SAS3		
Electrical Interface and Pin-out	84-pin edge connector		Pin-out as defined in the CXP Specification by the IBTA
Standard Optical Cable Type	Multimode fiber ribbon, flat cable assembly, LSZH/riser-rated		
Maximum Power Consumption per End	3.5	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 CXP Specification

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:

- Infiniband SDR/DDR/QDR, 1/10 Gigabit Ethernet, 1/2/4/8/10G Fibre Channel.
- Tested with a PRBS  $2^{31}-1$  test pattern.

**III. Absolute Maximum Ratings**

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Maximum Supply Voltage	V <sub>cc1</sub> , V <sub>ccTx</sub> , V <sub>ccRx</sub>	-0.5		3.6	V	
Storage Temperature	T <sub>s</sub>	-40		85	°C	
Case Operating Temperature	T <sub>OP</sub>	0		70	°C	
Relative Humidity	RH	0		85	%	1

Notes:

- Non-condensing.

**IV. Electrical Characteristics (T<sub>OP</sub> = 0 to 70°C, V<sub>CC</sub> = 3.3 ± 5% Volts)**

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Supply Voltage	Vcc1, VccTx, VccRx	3.15		3.45	V	
Supply Current	Icc		850	1000	mA	
<b>Link Turn-On Time</b>						
Transmit Turn-On Time				2000	ms	1
<b>Transmitter (per Lane)</b>						
Single-ended input voltage tolerance	VinT	-0.3		4.0	V	
Differential data input swing	Vin,pp	120		1200	mVpp	2
Differential input threshold			50		mV	
<b>Receiver (per Lane)</b>						
Differential data output swing	Vout,pp	0		800	mVpp	3,4
Power Supply Ripple Tolerance	PSR	50			mVpp	

**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 Vout settings

**V. High-Speed Electrical Characteristics per Lane**(T<sub>OP</sub> = 0 to 70°C, V<sub>CC</sub> = 3.3 ± 5% Volts)

Parameter –Inputs	Symbol	Conditions	Min	Typ	Max	Units	Ref.
Reference Differential Input Impedance	Z <sub>d</sub>			100		Ω	
Termination Mismatch	ΔZ <sub>M</sub>				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 (Deterministic)	DJ				0.15	UI	
Jitter Tolerance (Total)	TJ				0.30	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.

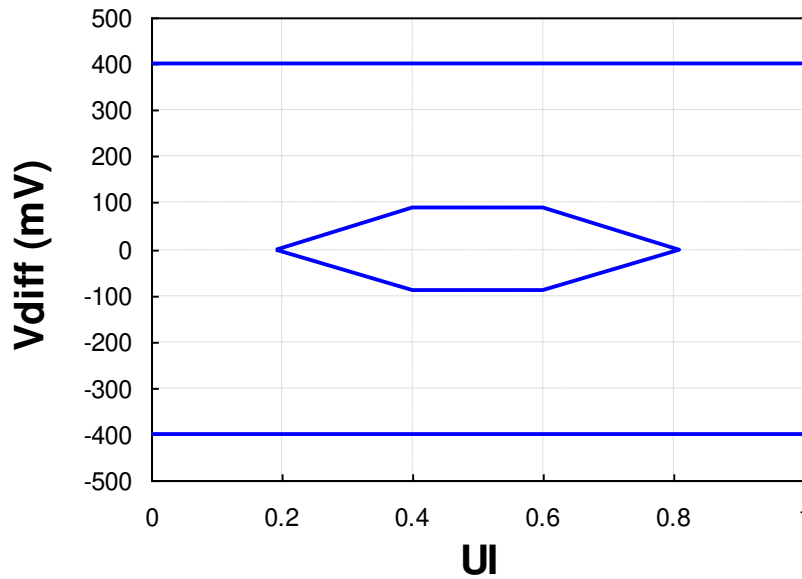


Figure 2 – Transmitter Input Differential Signal Mask

Parameter –Outputs	Symbol	Conditions	Min	Typ	Max	Units	Ref.
Reference Differential Output Impedance	$Z_d$			100		$\Omega$	
Termination Mismatch	$\Delta Z_M$				5	%	
Output AC Common Mode Voltage					15	mV <sub>RMS</sub>	
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 <sub>OUT</sub>			0.40	UI	1
Total Jitter	TJ <sub>OUT</sub>			0.72	UI	1

Notes:

1. When transmitter input jitter specs are met. Typical Total Jitter contribution for C.wire is 30 UI (typ).



Other Informational Specifications (not tested)	Symbol	Min	Typ	Max	Units	Ref.
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			f(L)		ps	1
Channels Skew				220	ps	2
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

Notes:

1. Channel latency is a function of cable length L [m]. The typical value is given by the formula  $L/(0.7*c)$ , where  $c = 3*10E+8$  [m/s].
2. The shown maximum skew value corresponds to a cable length of 100 meters. The typical skew in a 5-meter cable is 100 ps and in a 100-meter cable is 200 ps.

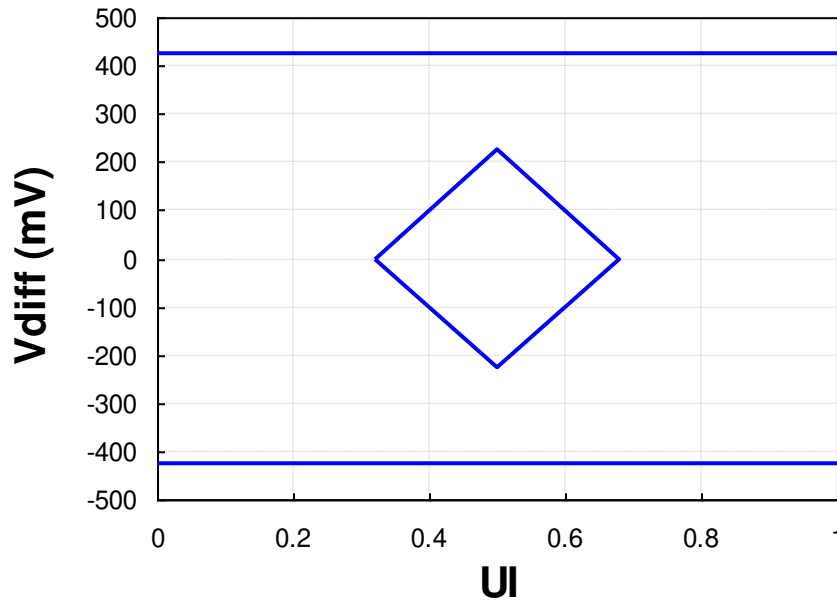


Figure 3 – Receiver Output Differential Signal Mask

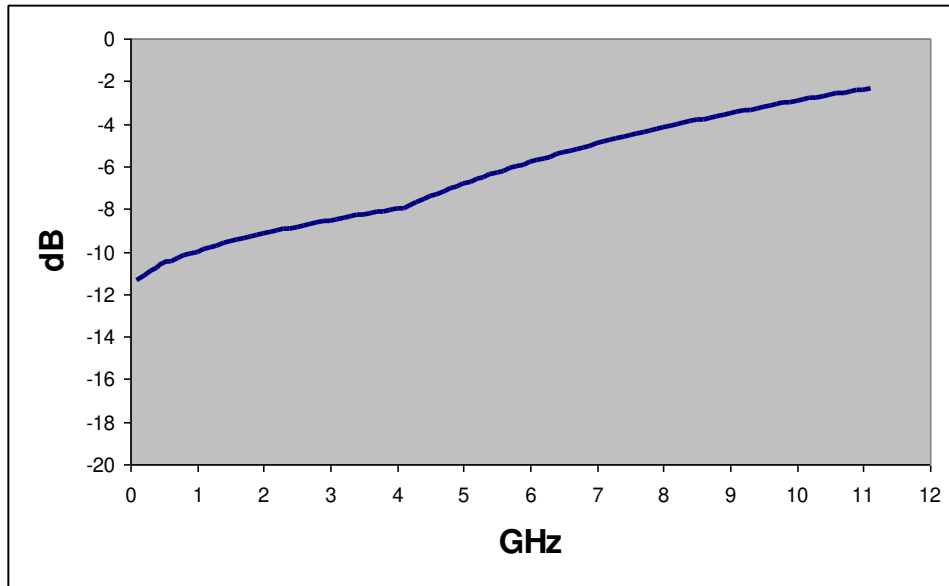


Figure 4 – Maximum Transmitter Input and Receiver Output Differential Return Loss

Power (mW)	Vo (mV)	Pre-Emphasis into 100ohms (mV)			
		0	125	175	325
0	0	1189			
317	317	1645	2197	2305	2617
422	422	1753	2305	2413	2725
739	739	2041	2557	2701	2962

Figure 5 – Power Dissipation (mW, typical) vs. Rx Output Conditions

## VI. Memory Map and Control Registers

Compatible with the CXP Specification. Please see Finisar Application Note AN-2077.

**VII. Environmental Specifications**

Finisar C.wire 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 <sub>op</sub>	0		70	°C	
Storage Temperature	T <sub>sto</sub>	-40		85	°C	

**VIII. Regulatory Compliance**

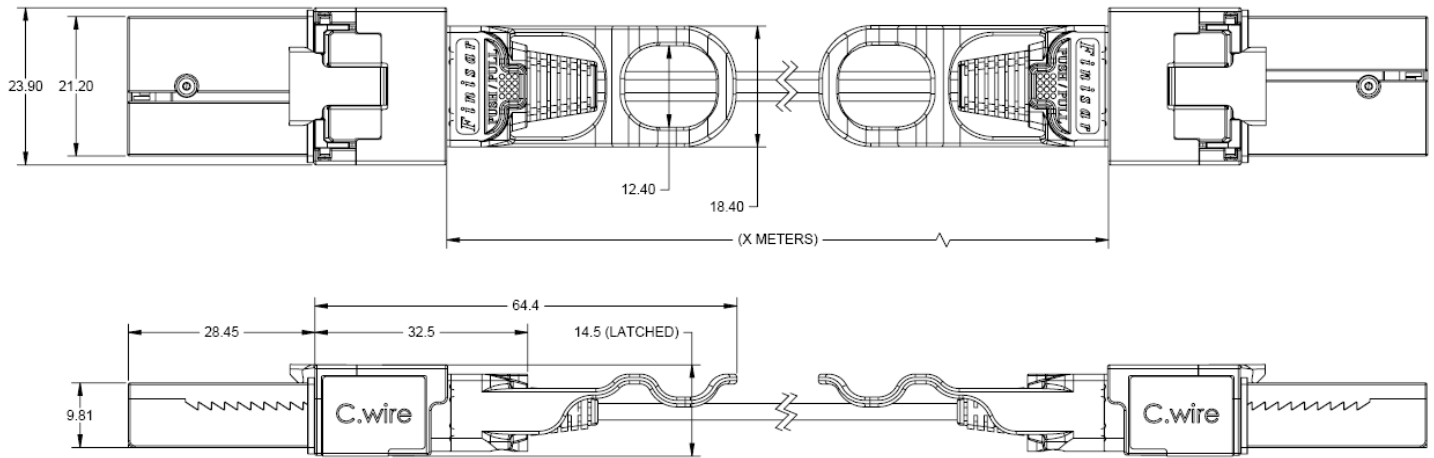
Finisar C.wire active optical cables are RoHS-6 Compliant. Copies of certificates are available at Finisar Corporation upon request.

C.wire active optical cables are laser eye safe so long as the fiber cable is intact. In case of a broken cable, the C.wire active optical cable should be treated as Class 1 per EN 60825-2.

Fiber cable type is s LSZH/riser-rated, flat ribbon construction. Other cable types are available upon request.

**IX. Mechanical Specifications**

The C.wire active optical cable mechanical specifications are based on the CXP Specification, substituting the MPO connectors with a cable connecting both ends.



DIMENSIONS SUBJECT TO CHANGES

**Figure 5 – C.wire mechanical drawing**

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 – C.wire production-level product label (20-meter cable shown)



**X. References**

1. Supplement to Infiniband Architecture Specification, Volume 2, Release 1.2.1., Annex A6: "120 Gb/s 12x Small Form-factor Pluggable (CXP) - Interface Specification for Cables, Active Cables, & Transceivers", September 10, 2009
2. SFF-8431 Rev 3.2 (SFP+ Specification)

**XI. For More Information**

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