Finisar

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: 0ºC to 70ºC
- 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

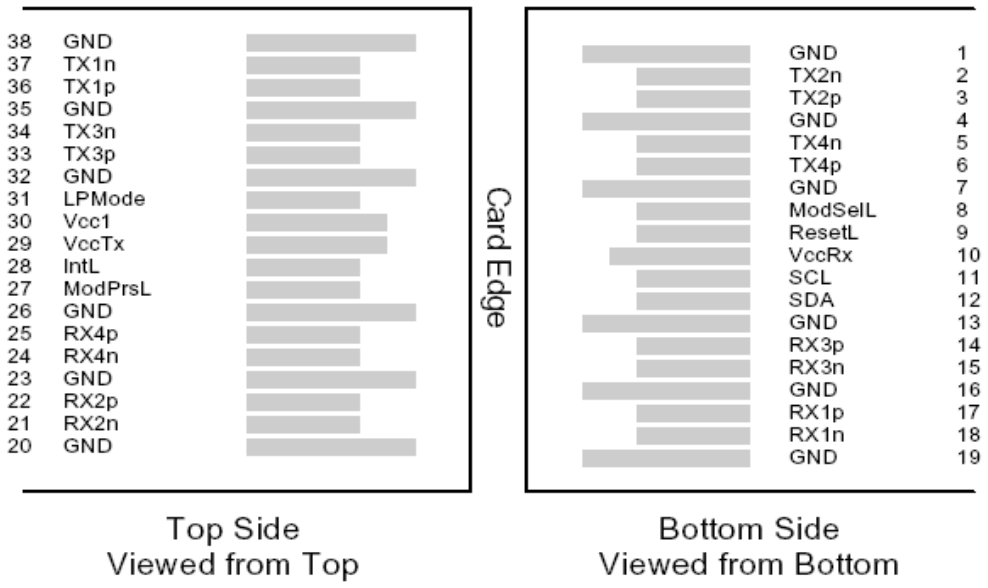

Figure 1 – QSFP MSA-compliant 38-pin connector

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.

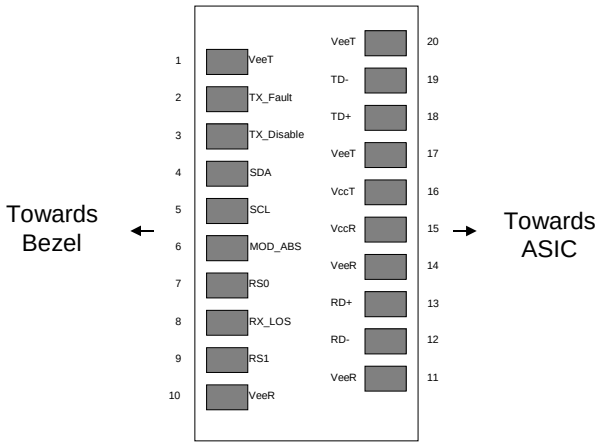

Figure 2. Diagram of Host Board Connector Block Pin Numbers and Names on the SFP+ ends.

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 2^{31}-1 test pattern.

III. 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	-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	Vcc1, VccTx, VccRx	3.15		3.45	V	
Supply Current	Icc			350 (QSFP) 250 (SFP+)	mA	
Link Turn-On Time						
Transmit Turn-On Time				2000	ms	1
Transmitter (per Lane)						
Differential data input swing	Vin,pp	180		1200 (QSFP) 700 (SFP+)	mVpp	2
Differential input threshold			50		mV	
Receiver (per Lane)						
Differential data output swing	Vout,pp	0		850	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 Vo settings

V. High-Speed Electrical Characteristics per Lane

(T_{OP} = 0 to 70°C, V_{CC} = 3.3 ± 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(dB)< -12+2*SQRT(f), with f in GHz.
3. Reflection coefficient given by equation SDD11(dB)< -6.3+13Log10(f/5.5), with f in GHz.
4. Hit ratio $5x10^{-5}$. See Figure 3 for transmitter input eye mask definitions.

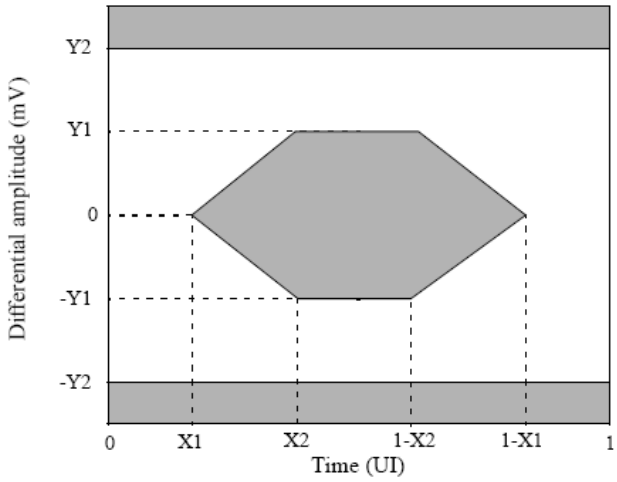

Figure 3 – Transmitter Input Differential Signal Mask

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+13Log10(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 $5x10^{-5}$. 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

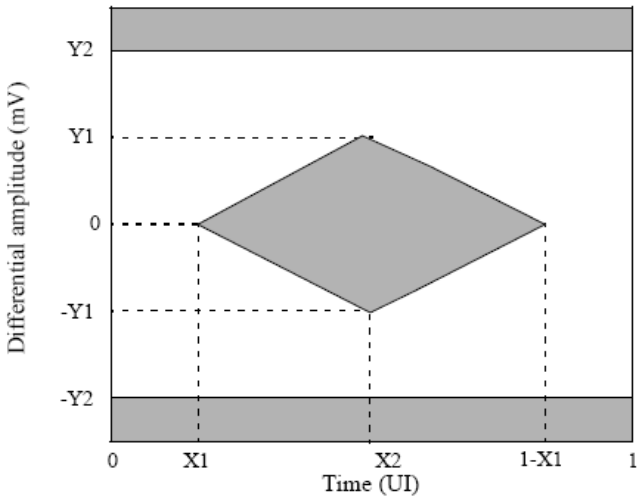

Figure 4 – Receiver Output Differential Signal Mask

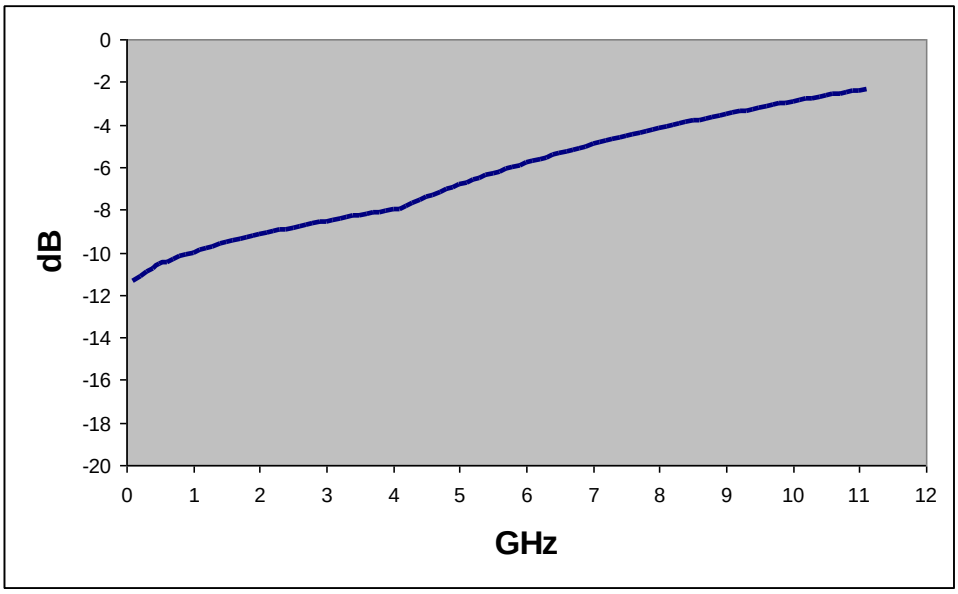

Figure 5 – Maximum Transmitter Input and Receiver Output Differential Return Loss

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.

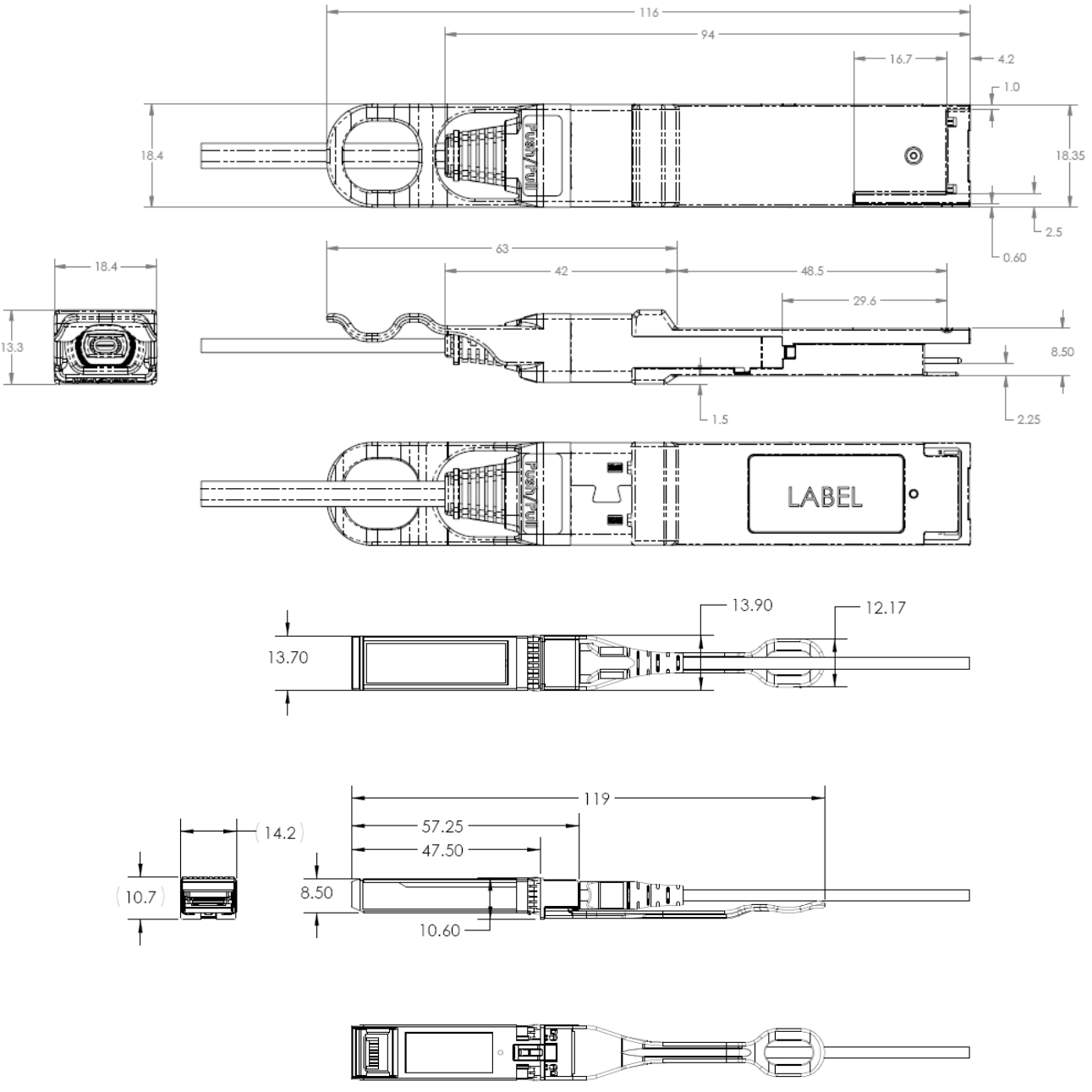

Figure 5 –Mechanical drawing of Quadwire QSFP+ and SFP+ ends

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^o)		44.0	Newtons	
Cable Proof (Tensile) Test (90^o)		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

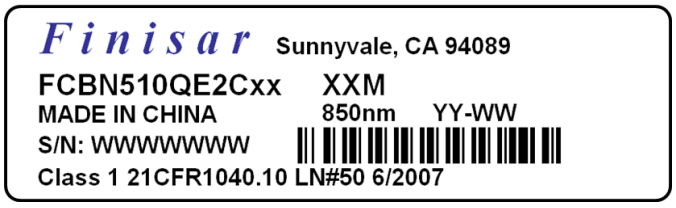

Figure 6 – Quadwire product labels: QSFP end (top) and SFP+ ends (bottom)

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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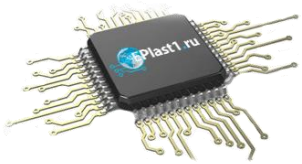

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