

**Product Specification**

**Quadwire® 100 Gb/s Parallel Breakout Active Optical Cable  
FCBN525QE1Cxx**

**PRODUCT FEATURES**

- Four-channel full-duplex active optical cable with breakout from QSFP28 to four SFP28
- Complies with QSFP28 and SFP28 MSA form factors
- Round, plenum-rated cable
- Reliable VCSEL array technology using multimode fiber
- Hot Pluggable
- Low power dissipation: <2.5W on QSFP28 end, <1W on SFP28 end
- Commercial operating case temperature range: 0 °C to 70 °C
- RoHS-6 Compliant



**APPLICATIONS**

- 25/100G Ethernet

**PRODUCT SELECTION (Standard Lengths\*)**

FCBN525QE1C01	1-meter cable
FCBN525QE1C02	2-meter cable
FCBN525QE1C03	3-meter cable
FCBN525QE1C05	5-meter cable
FCBN525QE1C07	7-meter cable
FCBN525QE1C10	10-meter cable
FCBN525QE1C15	15-meter cable
FCBN525QE1C20	20-meter cable
FCBN525QE1C30	30-meter cable

\*For availability of additional cable lengths, please contact II-VI. For breakout location, see Section VIII.

I. Pin Descriptions

a. QSFP28 end

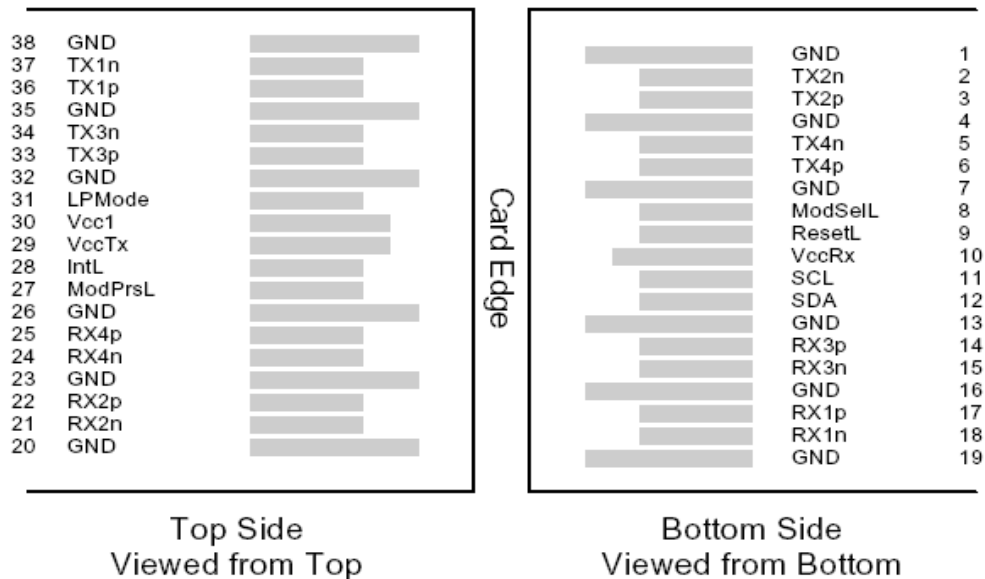


Figure 1 – QSFP MSA-compliant 38-pin connector

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. SFP28 ends**

Pin	Symbol	Name/Description	Ref.
1	V <sub>EET</sub>	Transmitter Ground (Common with Receiver Ground)	1
2	T <sub>FAULT</sub>	Transmitter Fault.	2,3
3	T <sub>DIS</sub>	Transmitter Disable. Laser output disabled on high or open.	4
4	SDA	2-wire Serial Interface Data Line	2
5	SCL	2-wire Serial Interface Clock Line	2
6	MOD_ABS	Module Absent. Grounded within the module	5
7	RS0	No connection required	
8	RX_LOS	Loss of Signal indication. Logic 0 indicates normal operation.	6
9	RS1	No connection required	
10	V <sub>EER</sub>	Receiver Ground (Common with Transmitter Ground)	1
11	V <sub>EER</sub>	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 <sub>EER</sub>	Receiver Ground (Common with Transmitter Ground)	1
15	V <sub>CCR</sub>	Receiver Power Supply	7
16	V <sub>CCT</sub>	Transmitter Power Supply	7
17	V <sub>EET</sub>	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 <sub>EET</sub>	Transmitter Ground (Common with Receiver Ground)	1

**Notes:**

1. Circuit ground is internally isolated from chassis ground.
2. Open collector/drain output, which should be pulled up with a 4.7k – 10k Ohms resistor on the host board if intended for use. Pull up voltage should be between 2.0V to Vcc + 0.3V.
3. A high output indicates a transmitter fault caused by either the TX bias current or the TX output power exceeding the preset alarm thresholds. A low output indicates normal operation. In the low state, the output is pulled to <0.8V.
4. Laser output disabled on TDIS >2.0V or open, enabled on TDIS <0.8V.
5. Internally pulled down per SFF-8431 Rev 4.1.

- 6. LOS is open collector output. Should be pulled up with 4.7k – 10k on host board to a voltage between 2.0V and 3.6V. Logic 0 indicates normal operation; logic 1 indicates loss of signal.
- 7. Internally connected.

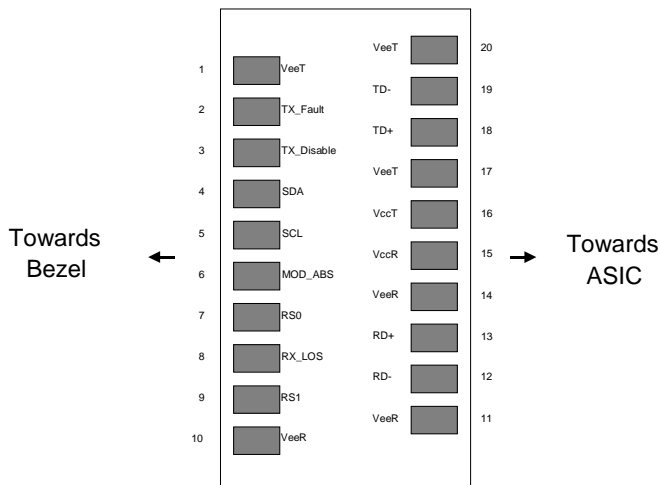


Figure 2. Diagram of Host Board Connector Block Pin Numbers and Names on the SFP28 ends.

## 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	103.125	Gb/s	
Maximum Data Rate per Lane	25.781	Gb/s	
Standard Cable Lengths	1, 2, 3, 5, 7, 10, 15, 20, 30	meters	Other lengths may be available upon request
Protocols Supported	25/100G 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	2.5 (QSFP28) and 1 (SFP28)	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		25.781		Gb/sec	1
Pre-FEC Bit Error Ratio	BER			10 <sup>-8</sup>		2
Post FEC Bit Error Ratio	BER			10 <sup>-12</sup>		3

Notes:

- 1. Supports 25/100 Gigabit Ethernet applications.
- 2. Pre-FEC, tested with a PRBS 2<sup>31</sup>-1 test pattern.
- 3. Assumes FEC provided by host system.
- 4. Better BER spec may be available through customization, as a premium product.

### 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	1
Case Operating Temperature	T <sub>OP</sub>	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 >70 mm.
- 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	V <sub>cc1</sub> , V <sub>ccTx</sub> , V <sub>ccRx</sub>	3.15		3.45	V	
Supply Current	I <sub>cc</sub>			750 (QSFP28) 310 (SFP28)	mA	
<b>Link Turn-On Time</b>						
Transmit Turn-On Time				2000	ms	1
<b>Input electrical specifications (per Lane), QSFP+ end</b>						
Differential Voltage pk-pk				900	mV	
Common Mode Noise RMS				17.5	mV	
Differential Termination Resistance Mismatch				10	%	
Differential Return Loss	SDD22	Per OIF CEI-28G-VSR and CAUI-4 requirements				
Common Mode to Differential conversion and Differential to Common Mode Conversion	SDC22, SCD22					
Common Mode Return Loss	SCC22					
Transition Time, 20 to 80%	Tr, Tf	10			ps	
Common Mode Voltage	V <sub>cm</sub>	-0.3		2.8	V	
Eye Width at 1E-15 probability	EW15	0.46			UI	
Eye Height at 1E-15 probability	EH15	94			mV	
<b>Output electrical specifications (per Lane), QSFP+ end</b>						
Differential Voltage pk-pk				900	mV	
Common Mode Voltage	V <sub>cm</sub>	-350		2850	mV	
Common Mode Noise RMS				17.5	mV	
Differential Termination Resistance Mismatch				10	%	
Differential Return Loss	SDD22	Per OIF CEI-28G-VSR and CAUI-4 requirements				
Common Mode to Differential conversion and Differential to Common Mode Conversion	SDC22, SCD22					
Common Mode Return Loss	SCC22					

Transition Time, 20 to 80%	Tr, Tf	9.5			ps	
Vertical Eye Closure	VEC			5.5	dB	
Eye Width at 1E-15 probability	EW15	0.57			UI	
Eye Height at 1E-15 probability	EH15	228			mV	
<b>Input electrical specifications (per Lane), SFP+ end</b>						
Input differential impedance	R <sub>in</sub>		100		Ω	2
Differential data input swing	V <sub>in,pp</sub>	180		700	mV	
Transmit Disable Voltage	V <sub>D</sub>	2		V <sub>cc</sub>	V	
Transmit Enable Voltage	V <sub>EN</sub>	V <sub>ee</sub>		V <sub>ee</sub> + 0.8	V	
<b>Output electrical specifications (per Lane), SFP+ end</b>						
Differential data output swing	V <sub>out,pp</sub>	300		850	mV	3
Data output rise time, fall time	t <sub>r</sub>			28	ps	4
LOS Fault	V <sub>LOS fault</sub>	2		V <sub>cc,host</sub>	V	5
LOS Normal	V <sub>LOS norm</sub>	V <sub>ee</sub>		V <sub>ee</sub> +0.8	V	5
Power Supply Noise Tolerance	V <sub>ccT/VccR</sub>	Per SFF-8431 Rev 4.1			mVpp	6

**Notes:**

1. From power-on and end of any fault conditions.
2. Connected directly to TX data input pins. AC coupling from pins into laser driver IC.
3. Into 100Ω differential termination.
4. 20 – 80% . Measured with Module Compliance Test Board and OMA test pattern. Use of four 1's and four 0's in sequence in the PRBS<sup>9</sup> is an acceptable alternative [1].
5. LOS is an open collector output. Should be pulled up with 4.7kΩ– 10kΩ on the host board. Normal operation is logic 0; loss of signal is logic 1. Maximum pull-up voltage is 5.5V.
6. Testing methodology per [1]

**V. Memory Map and Control Registers**

Compatible with SFF-8636. Please see II-VI Application Note AN-21506.

**VI. Environmental Specifications**

II-VI 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 <sub>op</sub>	0		70	°C	
Storage Temperature	T <sub>sto</sub>	-40		85	°C	

**VII. Regulatory Compliance**

II-VI Quadwire active optical cables are RoHS-6 Compliant. Copies of certificates are available at II-VI Incorporated 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. OFNR riser rated cable type is available upon request, under the part number FCB525QE1Cxx.

**VIII. Mechanical Specifications**

The Quadwire mechanical specifications are based on QSFP28 and SFP28 transceiver module specifications, substituting the optical connectors with a cable connecting both ends.

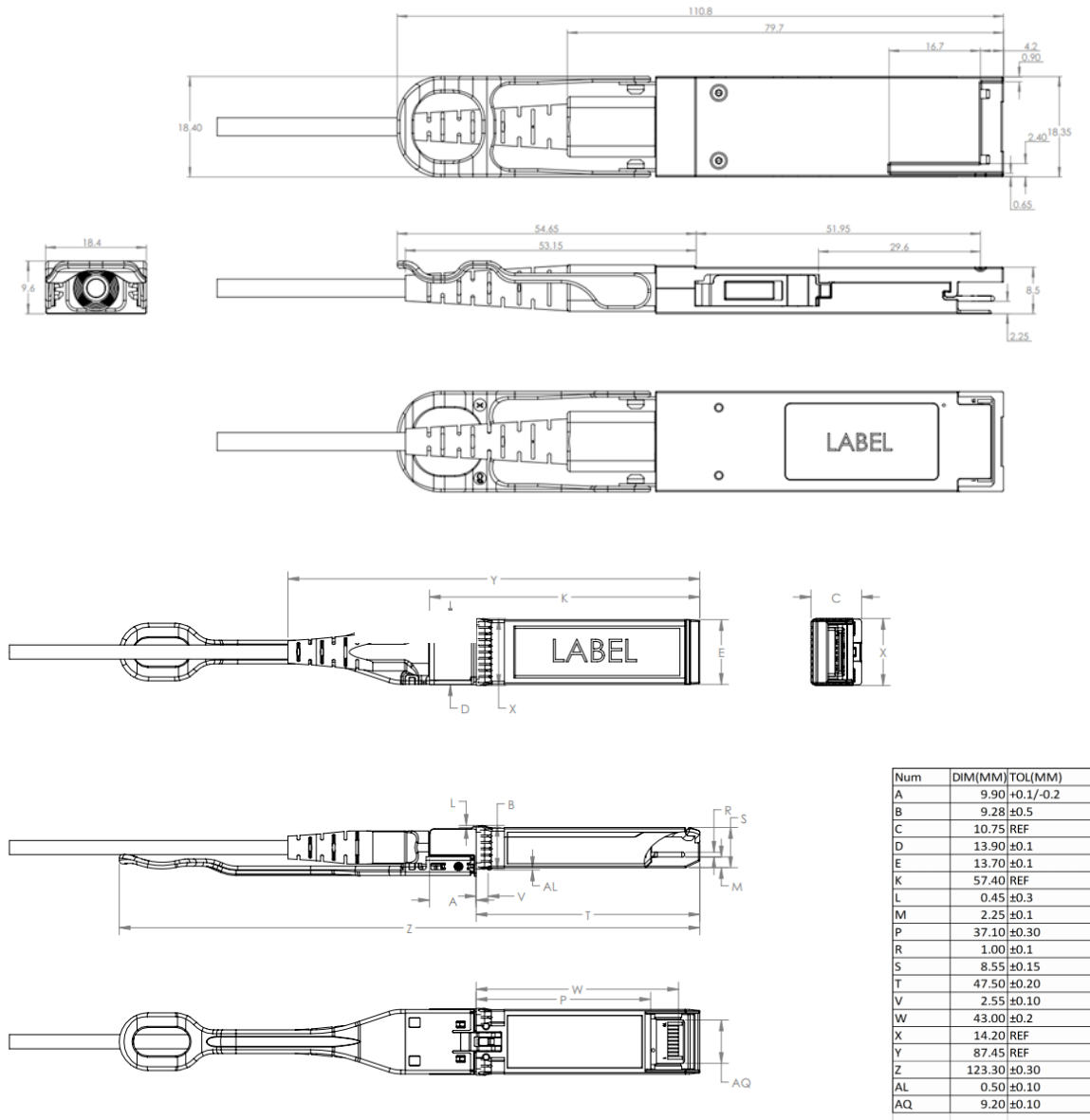


Figure 3 –Mechanical drawing of Quadwire QSFP28 and SFP28 ends

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	2.85	3.0	3.15	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

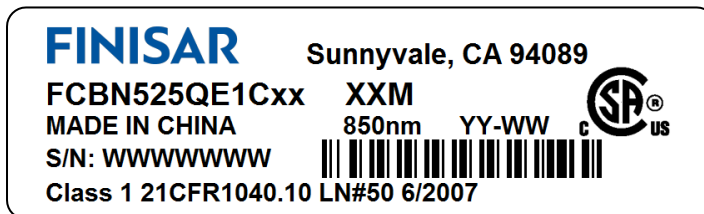
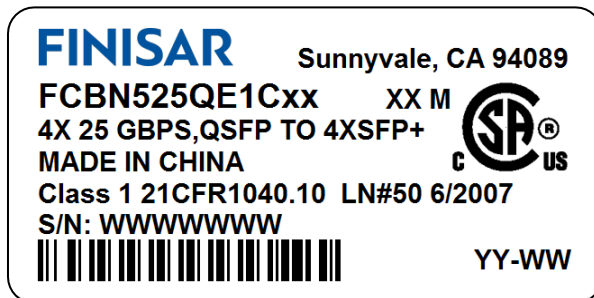


Figure 4 – Quadwire product labels: QSFP28 end (top) and SFP28 ends (bottom)



**IX. References**

1. “Specifications for Enhanced 8.5 and 10 Gigabit Small Form Factor Pluggable Module ‘SFP+ ‘”, SFF Document Number SFF-8431, Revision 4.1.
2. SFF-8636 – Specification for Management Interface for Cabled Environments, Rev 2.9, April 2017.
3. CEI-28G-VSR Implementation Agreement, per OIF 2012.290.00
4. 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.
5. “Application Note AN-2038: Finisar Implementation of RoHS Compliant Transceivers”, Finisar Corporation, January 21, 2005.
6. “Application Note AN-2150: EDR Quadwire EEPROM Mapping.”

**X. For More Information, Pls. contact:**

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