

#### Features:

- 1.25Gb/s to 4.25 Gb/s duplex data links
- 850 nm VCSEL laser transmitter and PIN receiver
- Class 1 Laser Int. Safety Std. IEC-825 compliant
- Standard reach of 500 m on 50/125 and 250 m on 62.5/125  $\mu$ m MMF
- Industry Standard MSA 2x5 footprint
- MSA 2x7 option available providing Digital Diagnostics per SFF-8472
- Rugged LC connector housing including screw mounted OSAs
- -40 to +85 C operating temperature, wider option available
- Option for RoHS 6/6 compliant and lead free per Directive 2011/65/EU
- Single +3.3V power supply
- AC Coupled Transmitter & Receiver Data
- Conformal coated for harsh environment use
- Pigtail Assembly option is available



The SFF-4G-SX is ideal for harsh environment connectivity because of its low cost, availability, and wide operating parameters



Commercial Aerospace



Military Aerospace



Military Tactical



Industrial Oil & Gas



Military Sensing



Undersea Networking

#### Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Note
Maximum Supply Voltage	V <sub>CC</sub>	-0.3	4.0	V	
Storage Temperature	T <sub>sto</sub>	-55	100	°C	
Case Operating Temperature	T <sub>OP</sub>	-40	85	°C	(2)
Relative Humidity	RH	0	85	%	Based on conformal coating
Hot Bar Soldering Temperature			260	°C	10 seconds, leads only, (2)(3)
Hand Lead Soldering Temperature			260	°C	10 seconds, leads only, (2)(3)
Conformal Coating		0.8	1.2	mil	See ruggedization notes

#### Notes:

- 1) SFF transceivers may be water washed. The process must be followed by an 80°C bake for one hour to ensure the drying of any water inside the shell.
- 2) Standard SFF operating temperature, wider options available
- 3) Mounting Studs do not transmit data and do not need a complete solder fill.
- 4) The components should not undergo Wave Soldering under any circumstances.

#### General Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Data Rate	BR	1.25		4.25	Gb/s	(1)

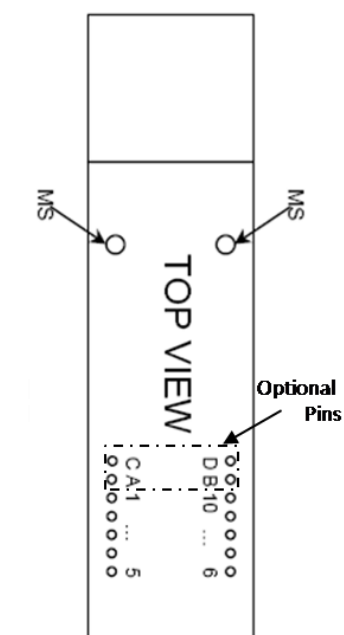
#### Notes:

- 1) SFF-4G-SX supports all the same data rates as the SFF-2G-SX, as well as XAUI, ARINC 818, & 4G FC

**Electrical Specifications** (TOP = -40 to 85°C, VCC = 3.14 to 3.47 Volts)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Supply Voltage	V <sub>CC</sub>	3.14		3.47	V	
Total Module Power Dissipation	P <sub>DISS</sub>			1	W	
<b>Transmitter</b>						
Supply Current	I <sub>CC</sub>		85	120	mA	
Input differential Impedance	R <sub>in</sub>		100		Ω	LVPECL
Data Input Range	V <sub>DTX</sub>	200		2400	mV	CML
Transmit Disable Voltage	V <sub>TD</sub>	2.0		V <sub>CC</sub>	V	LVTTTL
Transmit Enable Voltage	V <sub>EN</sub>	V <sub>EE</sub>		0.8	V	LVTTTL
<b>Receiver</b>						
Supply Current	I <sub>CC</sub>			120	mA	
Differential Output Voltage Swing	V <sub>DRX</sub>	200		1000	mV	CML
Data Rise Time	t <sub>RX</sub>		70	100	ps	20%-80%
Data Fall Time	t <sub>RX</sub>		70	100	ps	20%-80%
Total Contributed Jitter	T <sub>JRX</sub>			0.32	UI	
Signal Detect Assert	SD <sub>norm</sub>	2		V <sub>CC</sub>	V	LVTTTL
Signal Detect De-assert	SD <sub>fault</sub>	V <sub>EE</sub>		0.5	V	LVTTTL

**Pin Configuration**



**TOP VIEW**

Optional Pins

PIN #	Symbol	Description	Logic Family
MS	MS	Mounting studs are for mechanical attachment and are connected to chassis ground. Chassis ground is internally isolated from circuit grounds. Connection to user's ground planes is recommended.	NA
1	VEER	Receiver Ground (Common with Transmitter Ground)	NA
2	VCCR	Receiver Power Supply	NA
3	SD	Signal Detect. Logic 1 indicates normal operation.	LVTTTL
4	RD-	Receiver Inverted DATA out. AC Coupled	See Rx
5	RD+	Receiver Non-inverted DATA out. AC Coupled	See Rx
6	VCC1	Transmitter Power Supply	NA
7	VEET	Transmitter Ground (Common with Rx Ground)	NA
8	T <sub>DIS</sub>	Transmitter Disable	LVTTTL
9	TD+	Transmitter Non-Inverted DATA in, AC Coupled	See Tx
10	TD-	Transmitter Inverted DATA in. AC Coupled	See Tx
A	SDA	Two Wire Digital Diagnostics Data Interface	LVTTTL
B	SCL	Two Wire Digital Diagnostics Clock Interface	LVTTTL
C	Reserved		NA
D	TX_FAULT	Transmitter Fault Indication – High Indicates a fault condition	LVTTTL

**Optical Characteristics (TOP = -40 to 85°C, VCC = 3.14 to 3.47 Volts)**

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
<b>Transmitter</b>						
Output Optical Power	P <sub>OUT</sub>	-5		-1	dBm	
Optical Wavelength	λ	830	850	860	nm	
Spectral Width	σ			2	nm	
Extinction Ratio	ER	9			dB	802.3 Specification
Optical Rise Time	t <sub>RTX</sub>			100	ps	(1)
Optical Fall Time	t <sub>FTX</sub>			100	ps	(1)
Relative Intensity Noise	RIN			-122	dB/Hz	
Total Contributed Jitter	TJ <sub>TX</sub>			.36	UI	
<b>Receiver</b>						
Receiver Sensitivity @ 4.25 Gb/s	P <sub>IN42</sub>			-15	dBm	
Receiver Sensitivity @ 2.125 Gb/s	P <sub>IN21</sub>			-18	dBm	
Receiver Sensitivity @ 1.25 Gb/s	P <sub>IN12</sub>			-20	dBm	
Overload	RX <sub>MAX</sub>	0			dBm	
Optical Center Wavelength	λ <sub>c</sub>	830	850	860	nm	
Return Loss	RL	12			dB	
Signal Detect Assert	P <sub>A</sub>			-15	dBm	
Signal Detect De-Assert	P <sub>D</sub>	-31			dBm	
Signal Detect Hysteresis	P <sub>A</sub> - P <sub>D</sub>	1		5	dB	
<b>NOTES:</b>						
1) Unfiltered, 20-80%. For Fibre Channel data rates, complies with FC 1x and 2x eye mask when filtered						

**Digital Diagnostics Information**

COTSWORKS' SFF parts include additional pins to read and write I2C information per the MSA SFF 8472 specification. While typically implemented in pluggable modules such as SFPs, all that is required to enable this functionality is two additional pins and internal circuitry in the transceiver. The circuitry in the COTSWORKS' SFF is a microcontroller providing EEPROM storage and accessing optical and electrical information from the laser and receiver.

**Address A0h Data Fields**

A0h Address (dec)	# Bytes	Name	Description	Value (hex)
<b>Base ID Fields</b>				
00	1	Identifier	Type of transceiver	02
01	1	Ext. Identifier	Extended identifier of type of transceiver	04
02	1	Connector	Code for connector type	07
03	8	Transceiver	Code for electronic or optical compatibility	08
04				00
05				00
06				01
07				40
08				40
09				0C
10				15
11	1	Encoding	Code for high speed serial encoding algorithm	01
12	1	BR, Nominal	Nominal signaling rate, units of 100 MBd	2A
13	1	Rate Identifier	Type of rate select functionality	00
14	1	Length (SMF, km)	Link length supported for single mode fiber, units of km	00



15	1	Length (SMF)	Link length supported for single mode fiber, units of 100 m	00
16	1	Length (50um)	Link length supported for 50 um OM2 fiber, units of 10 m	37
17	1	Length (62.5um)	Link length supported for 62.5 um OM1 fiber, units of 10 m	1C
18	1	Length (OM4 or copper cable)	Link length supported for 50um OM4 fiber, units of 10m. Alternatively copper or direct attach cable, units of m	64
19	1	Length (OM3)	Link length supported for 50 um OM3 fiber, units of 10 m	37
20	16	Vendor Name	SFP vendor name (ASCII)	43
21				4F
22				54
23				53
24				57
25				4F
26				52
27				4B
28				53
29				20
30				20
31				20
32				20
33				20
34				20
35				20
36	1	Transceiver	Code for electronic or optical compatibility	00
37	3	Vendor OUI	SFP vendor IEEE company ID	00
38				00
39				00
40	16	Vendor PN	Part number provided by SFP vendor (ASCII)	53
41				46
42				46
43				XX
44				47
45				53
46				58
47				XX
48				XX
49				XX
50				XX
51				XX
52				XX
53				XX
54				XX
55				XX
56	4	Vendor rev	Revision level for part number provided by vendor (ASCII)	30
57				30
58				30
59				30
60	2	Wavelength	Laser wavelength	03
61				52

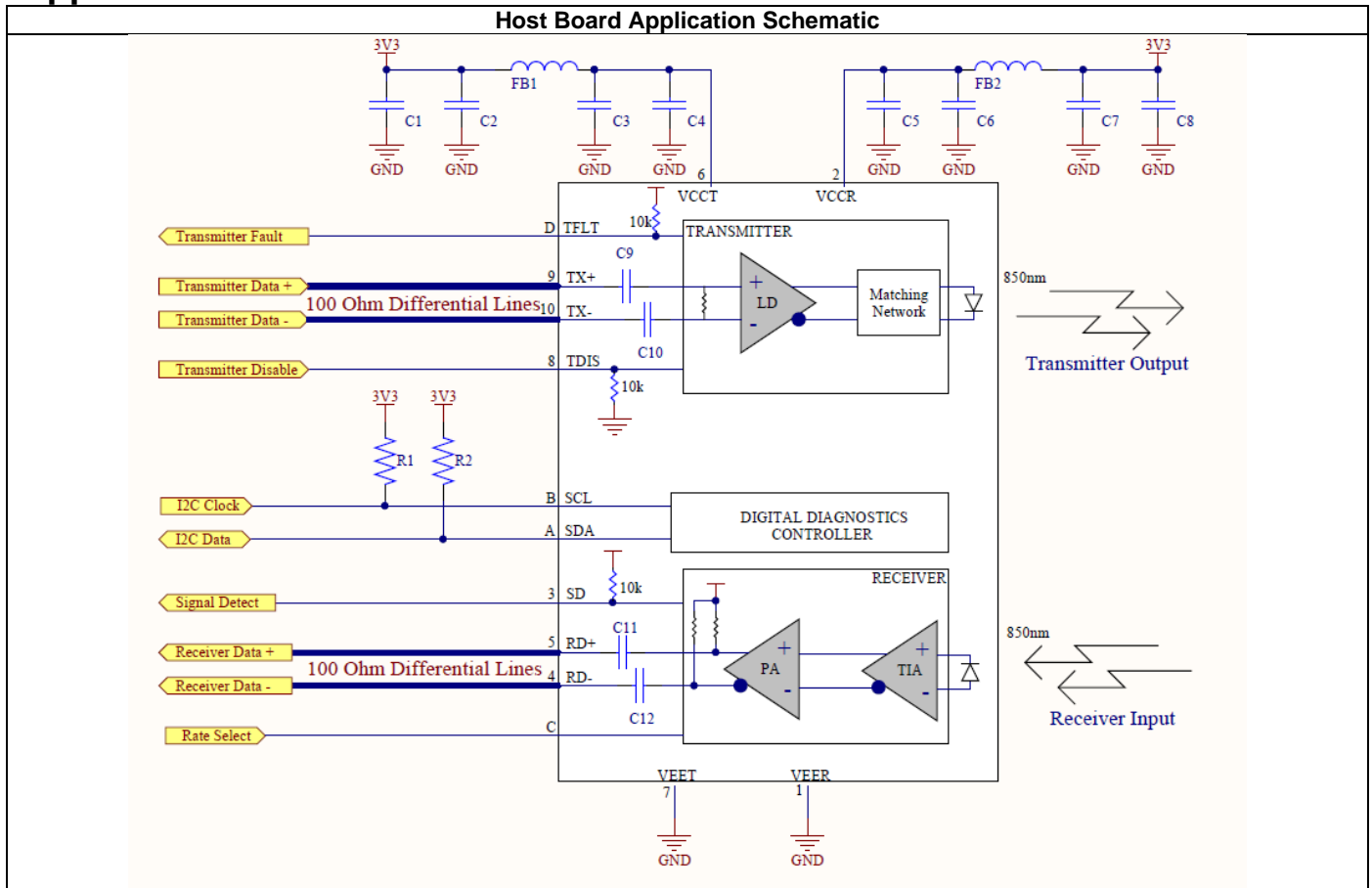




62	1	Unallocated		00
63	1	CC_BASE	Check code for Base ID Fields (addresses 0 to 62)	XX
<b>Extended ID Fields</b>				
64	2	Options	Indicates which optional transceiver signals are implemented	10
65				14
66	1	BR, max	Upper bit rate margin, units of %	00
67	1	BR, min	Lower bit rate margin, units of %	00
68	16	Vendor SN	Serial number provided by vendor (ASCII)	XX
69				XX
70				XX
71				XX
72				XX
73				XX
74				XX
75				XX
76				XX
77				XX
78				XX
79				XX
80				XX
81				XX
82				XX
83				XX
84	8	Date code	Vendor's manufacturing date code	XX
85				XX
86				XX
87				XX
88				XX
89				XX
90				20
91				20
92	1	Diagnostic Monitoring Type	Indicates which type of diagnostic monitoring is implemented (if any) in the transceiver	68
93	1	Enhanced Options	Indicates which optional enhanced features are implemented (if any) in the transceiver	70
94	1	SFF-8472 Compliance	Indicates which revision of SFF-8472 the transceiver complies with	08
95	1	CC_EXT	Check code for the Extended ID Fields (addresses 64 to 94)	XX



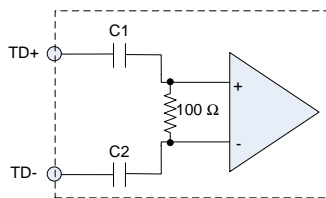
### Application Schematics



**Notes:**

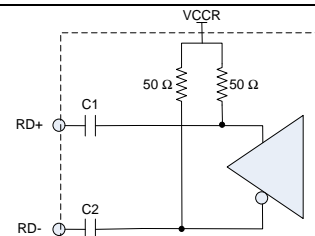
- Recommend host routes separate supply voltages and filtering for SFF-module transmitter and receiver as shown in the schematic above
  - FB1/FB2 ferrite bead for power supply noise suppression; Murata BLM18KG601SN1, 0603, 600Ω @ 100MHz, 1300mA
  - C1/C4/C5/C8 bulk capacitance; Murata GRM21BR61C106KE15L, 0805, 10μF, 16V
  - C2/C3/C6/C7 de-coupling capacitors; Murata GRM155R71C104KA88D, 0402, 0.1μF, 16V
  - C9/C10/C11/C12 X7R 0.1μF, 16V coupling capacitors
- Mounting studs/solder posts must be connected to chassis ground in a bezel mounted application
- Recommend mounting studs/solder posts be connected to chassis ground if available in embedded applications. Otherwise they should be tied to local signal ground

#### Equivalent Input Circuit



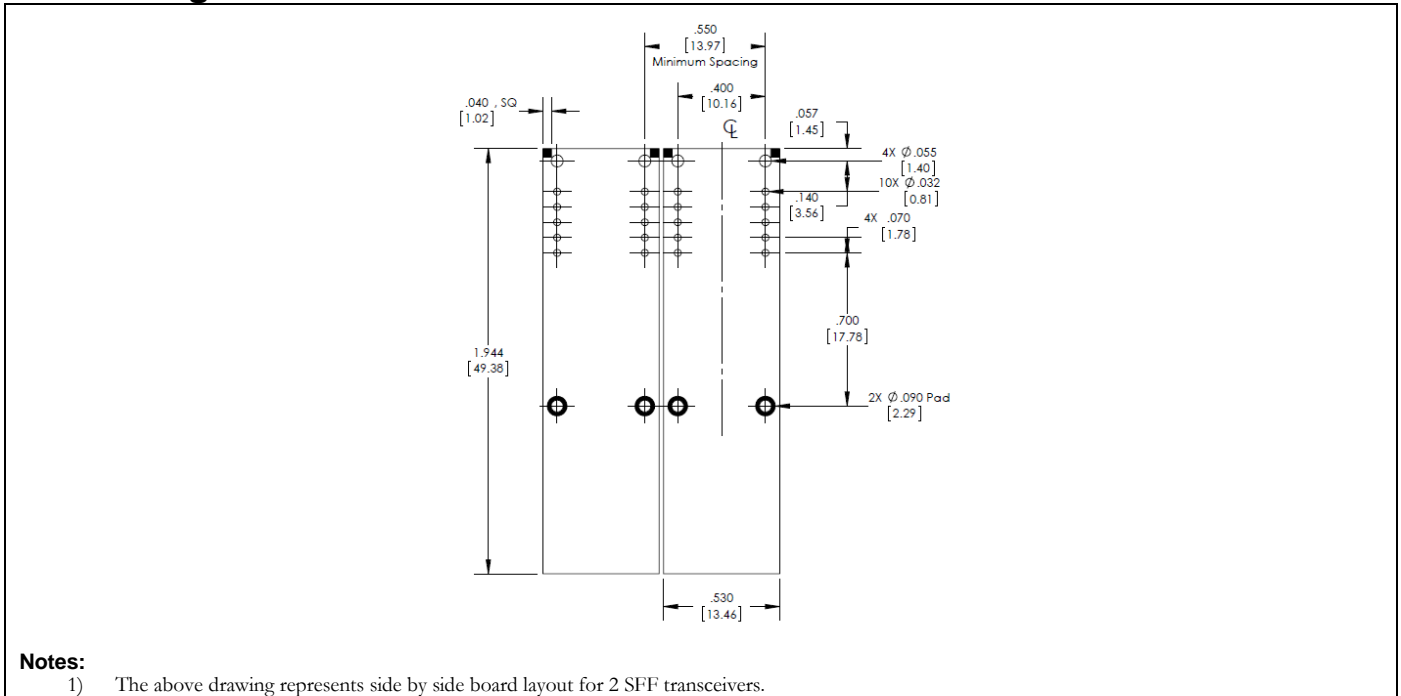
Optical Transmit Input Equivalent Circuit  
100 ohm differential input, AC coupled, CML compatibility  
C1,C2 = 0.1uF

#### Equivalent Output Circuit

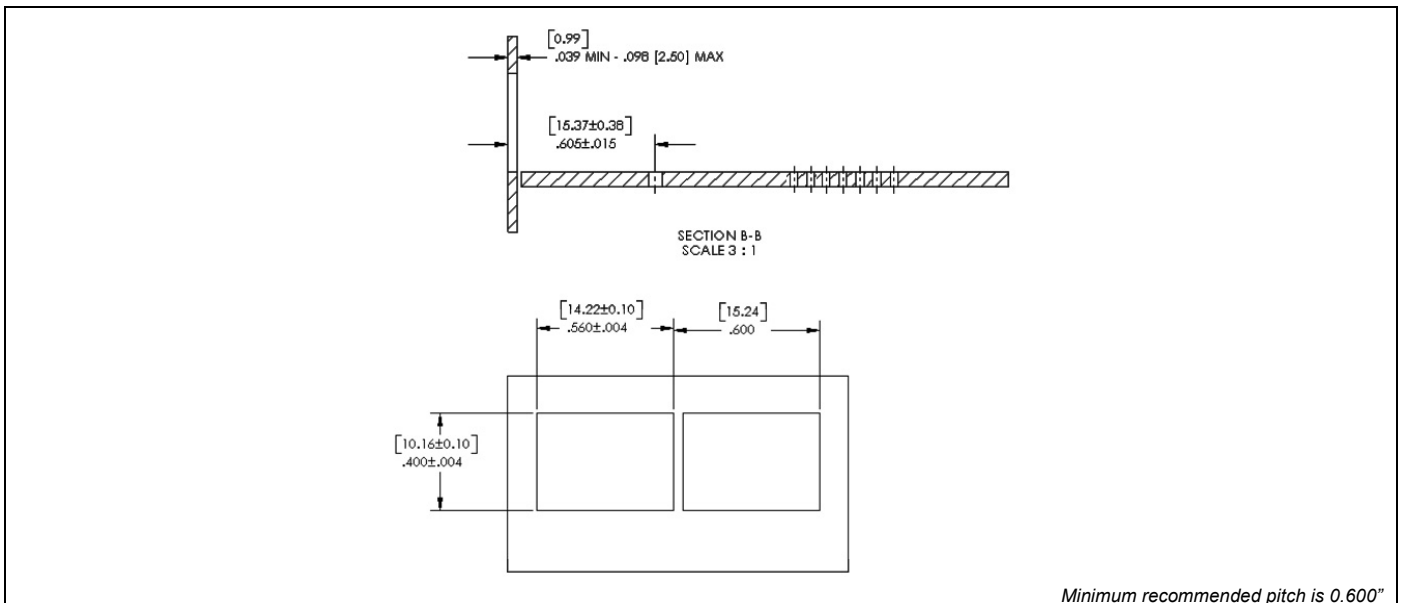


Optical Receive Output Equivalent Circuit  
50 ohm single-ended output, AC coupled, CML compatibility  
C1,C2 = 0.1uF

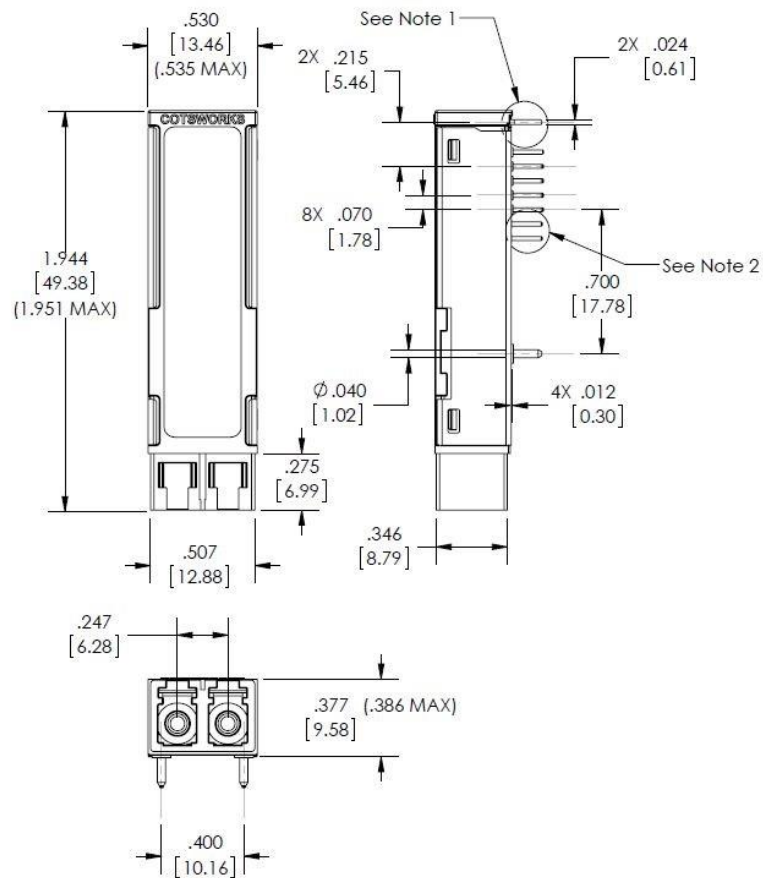
### PCB Design Guidelines



### Panel Cutout



### Mechanical Specifications



#### Notes:

1. Available with and without back pin
2. 7 pin configuration supports DDMI
3. Conforms to the SFF MSA specifications

### Ruggedization Notes

- Parylene C coating can be used for conformal coating with a  $1.0 \text{ mil} \pm 0.2 \text{ mil}$  thickness through a deposition process.
  - Parylene Type C has a 5600 VPM rating, withstands high temperatures, and is extremely resistant to oil/dirt, and object impact.
- This part is also available in a pigtail fiber optic version.
- Contact COTSWORKS for all MSDS, case composition, and burn analysis.



### Reference Information

- 1) IEEE Standard 802.3, 2002 Edition, 1000BASE-X. IEEE Standards Department, 2002
- 2) "Fibre Channel Draft Physical Interface Specification (FC-PI-2 Rev. 10.0)". American National Standard for Information Systems
- 3) Infiniband 1.2.1 specification, [www.infinibandta.org](http://www.infinibandta.org)
- 4) 3.125 Gb/s XAU specification, IEEE 802.3ae, section 47
- 5) ARINC 818 specification at 3.1875Gb/s, <https://www.arinc818.com/>
- 6) Directive 2011/65/EU of the European Parliament and of the Council, "on the restriction of the use of certain hazardous substances in electrical and electronic equipment." June 8th, 2011

### Regulatory Compliance

- COTSWORKS transceivers are Class 1 Laser Products and designed to comply with US FDA regulations.
- These products are designed to comply with Class 1 eye safety requirements of EN (IEC) 60825 and the electrical safety requirements of EN (IEC) 60950.
- This part has an option for compliance with Directive 2011/65/EU covering restriction on certain hazardous substances (RoHS) Contact COTSWORKS support for a product compliance matrix

### Warnings:

**Handling Precautions:** This device is susceptible to damage as a result of electrostatic discharge (ESD). A static free environment is highly recommended.

**Laser Safety:** Radiation emitted by laser devices can be dangerous to human eyes. Avoid eye exposure to direct or indirect radiation.

### Ordering Information

SFF-4G-SX-	x	DPLX	-LC-	x	-x-	x	-x-	x
<i>SFF Form Factor</i>	<i>Pins and Diagnostics</i>			<i>Ruggedized Coating</i>	<i>Operating Temp Range</i>	<i>EMI Shield</i>	<i>RoHS Level</i>	<i>Posts</i>
<i>4Gbps Max Data Rate</i>	(): 2x5 <i>No Diagnostics</i>	<i>Duplex</i>		(): <i>Non-coated</i>	A: -40 to 85°C	(): <i>No Shield</i>	(): <i>Lvl 5</i>	(): <i>Posts</i>
<i>Short Reach (MMF)</i>	D: 2x7 <i>Digital Diagnostics</i>	<i>LC Connector</i>		R: <i>Parylene</i>	M: -40 to 95°C	E: <i>Shield</i>	6: <i>Lvl 6</i>	NP: <i>No Posts</i>

**Example part number:** SFF-4G-SX-D-DPLX-LC-R-A

[4G SFF Duplex LC transceiver, Digital Diagnostics, Parylene-coated, Industrial temperature range, posts]

Contact COTSWORKS for mechanical dimensional information and other configuration options.

