

### Features:

- 1.25 Gbps to 4.25 Gbps duplex data links
- 1310nm Fabry-Perot laser transmitter and PIN receiver
- Class 1 Laser Int. Safety Std. IEC-60825 compliant
- Industry standard MSA 2x5 footprint
- MSA 2x7 option available providing Digital Diagnostics per SFF-8472
- Rugged LC connector housing
- -40 to 85°C operating temperature, -40 to 95°C option
- Option for RoHS compliant and lead free per Directive 2002/95/EC
- Single 3.3V power supply
- AC coupled transmitter and receiver data
- Conformal coated for harsh environment use
- Pigtail Assembly option is available



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



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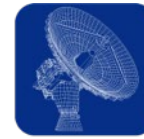
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MILITARY  
TACTICAL



SUBSEA  
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RADAR &  
SENSING



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EXPLORATION

### Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Notes
Maximum Supply Voltage	$V_{CC}$	-0.5	4.5	V	
Storage Temperature	$T_{sto}$	-55	100	°C	
Case Operating Temperature	$T_{OP}$	-40	85	°C	
Relative Humidity	RH	0	85	%	Based on conformal coating
Lead Soldering Temperature	-	-	260	°C	10 seconds on leads only
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) The components should not undergo Reflow Soldering under any circumstances.

### General Specifications

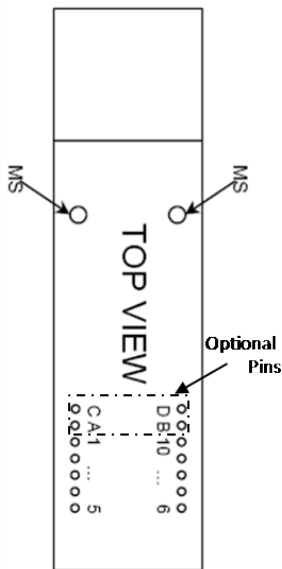
Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Data Rate	BR	1.25	-	4.25	Gbps	
Supply Voltage	$V_{CC}$	3.14	-	3.47	V	
Power Dissipation	$P_{DIS}$	-	-	1.2	W	1.32W for $T_{OP} > 85^{\circ}C$

**Electrical Specifications** ( $T_{OP} = -40$  to  $85^{\circ}C$ ,  $V_{CC} = 3.14$  to  $3.47$  Volts)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Total Module Power Dissipation	$P_{DISS}$	-	-	1.2	W	1.32W for $T_{OP} > 85^{\circ}C$
<b>Transmitter</b>						
Supply Current	$I_{CC}$	-	-	275	mA	
Input Differential Impedance	$R_{in}$	-	100	-	$\Omega$	
TX Single-Ended Input Voltage Swing	$V_{D_{TX}}$	200	-	2400	mV	(1)
TX Disable Input Voltage	$V_D$	2.0	-	$V_{CC}$	V	(2)
TX Enable Input Voltage	$V_{EN}$	0	-	0.8	V	
<b>Receiver</b>						
Supply Current	$I_{CC}$	-	-	80	mA	
Output Differential Impedance	$R_{out}$	-	100	-	$\Omega$	
Rx Single-Ended Output Voltage Swing	$V_{D_{RX}}$	600	-	900	mV	
Data Output Rise Time	$t_r$	-	-	130	ps	(3)
Data Output Fall Time	$t_f$	-	-	130	ps	(3)
Total Contributed Jitter	$RX_{\Delta TJ}$	-	-	0.4	UI	(4)
Signal Detect Assert	$SD_{norm}$	2.0	-	$V_{CC}$	V	(2)
Signal Detect De-Assert	$SD_{fault}$	0	-	0.8	V	(2)
<b>Notes:</b>						
1) LVPECL.						
2) LVTTTL.						
3) 20% – 80%.						
4) Peak to Peak.						

**Pin Configuration**

PIN #	Symbol	Description	Notes
1	$V_{EER}$	Receiver Ground (Common with Transmitter Ground)	N/A
2	$V_{CCR}$	Receiver Power Supply	N/A
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	$V_{CCT}$	Transmitter Power Supply	N/A
7	$V_{EET}$	Transmitter Ground (Common with Rx Ground)	N/A
8	$T_{DIS}$	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	-	N/A
D	TX_FAULT	Transmitter Fault Indication – High Indicates a fault condition	LVTTTL
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.	N/A



**Optical Characteristics** ( $T_{OP} = -40$  to  $85^{\circ}\text{C}$ ,  $V_{CC} = 3.14$  to  $3.47$  Volts)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
<b>Transmitter</b>						
Average Output Optical Power (SMF)	$P_{OUT}$	-5	-	1	dBm	(1)
Optical Wavelength	$\lambda$	1270	1310	1355	nm	(2)
Spectral Width (RMS)	$\sigma$	-	-	2.5	nm	(2)
Extinction Ratio	ER	9	-	-	dB	(3)
Rise Time	$t_r$	-	-	150	ps	180ps for $T_{OP} > 85^{\circ}\text{C}$ (3)(4)(6)
Fall Time	$t_f$	-	-	150	ps	(3)(4)(6)
Relative Intensity Noise	RIN	-	-	-120	dB/Hz	(3) FCPI-4 ( $\delta_R - \gamma_R$ )
Total Jitter Contribution	$TX_{TJ}$	-	-	0.4	UI	pk-pk
<b>Receiver</b>						
Receiver Sensitivity (1.25 Gbps)	$RX_{SENS1G}$	-	-	-22	dBm	(1)(4)(5)
Receiver Sensitivity (4.25 Gbps)	$RX_{SENS4G}$	-	-	-20	dBm	(1)(4)(5)
Receiver Overload	$RX_{MAX}$	0	-	-	dBm	(1)(4)(5)
Optical Center Wavelength	$\lambda_C$	1200	1310	1600	nm	
Return Loss	RL	12	-	-	dB	
Signal Detect Assert	$SD_A$	-	-	-22	dBm	(1)(5)
Signal Detect De-Assert	$SD_D$	-35	-	-	dBm	(1)(5)
Signal Detect Hysteresis	$SD_H$	1	-	-	dB	

**Notes:**

- 1) Measured using a broad area detector optical power meter.
- 2) Measured using an optical spectrum analyzer at  $25^{\circ}\text{C}$  per IEEE 802.3 1000BASE-LX.
- 3) Measured using a high-speed oscilloscope.
- 4) Measured using a BERT set running PRBS  $2^7-1$  at 4.25Gbps.
- 5) Measured using a  $9\mu\text{m}$  single-mode variable optical attenuator.
- 6) 20% – 80%.

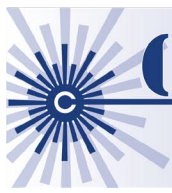
**Digital Diagnostics Information**

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.

<https://cotsworks.com/support-documents/digital-diagnostic-overviews/>

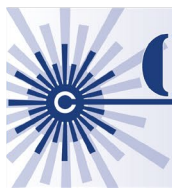
**Address A0h Data Fields**

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	04
04				12
05				00
06				02
07				22
08				00
09				01
10				05
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	0F
15	1	Length (SMF)	Link length supported for single mode fiber, units of 100 m	96
16	1	Length (50um)	Link length supported for 50 um OM2 fiber, units of 10 m	00
17	1	Length (62.5um)	Link length supported for 62.5 um OM1 fiber, units of 10 m	00
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	00
19	1	Length (OM3)	Link length supported for 50 um OM3 fiber, units of 10 m	00
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				34
44				47
45				4C
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	05
61				1E





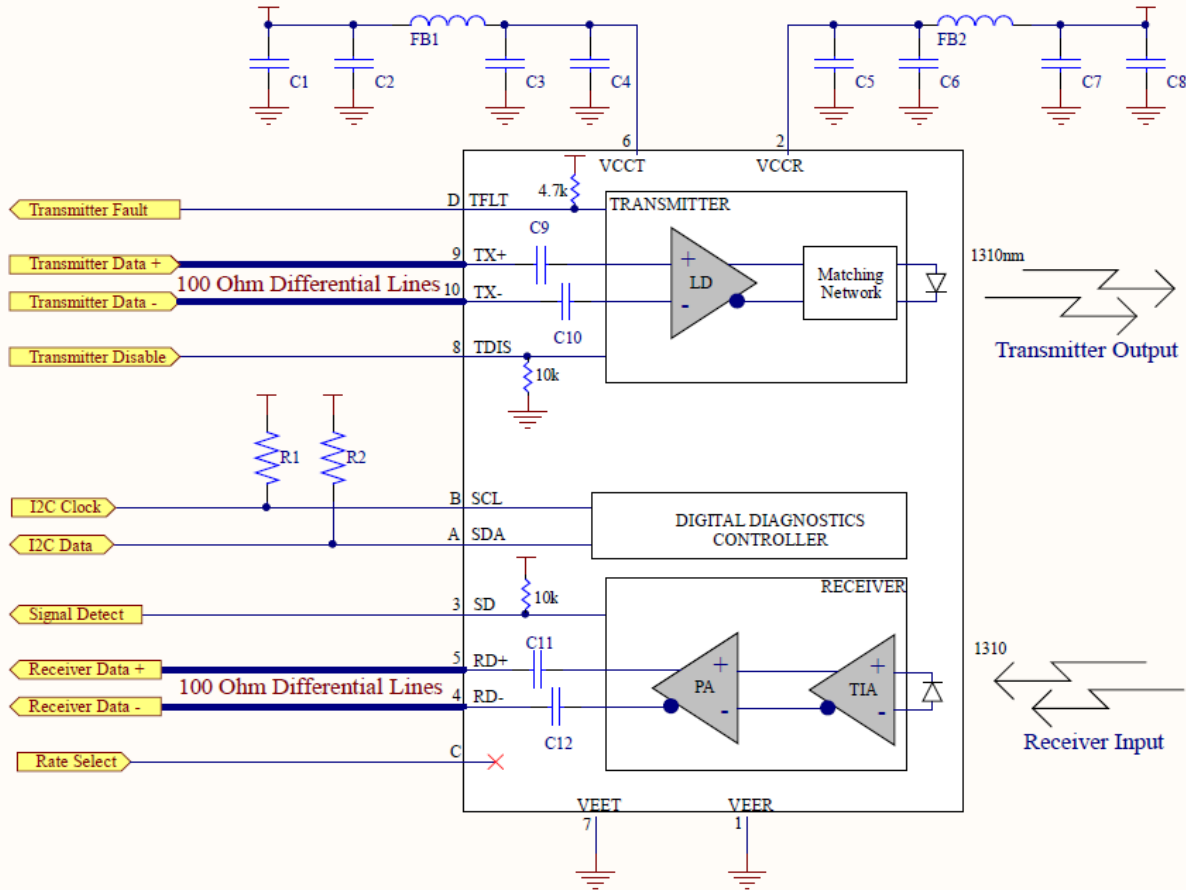
62	1	Unallocated		00
63	1	CC_BASE	Check code for Base ID Fields (addresses 0 to 62)	XX
<b>Extended ID Fields</b>				
64	2	Options	Indicates which optional transceiver signals are implemented	10
65				14
66	1	BR, max	Upper bit rate margin, units of %	00
67	1	BR, min	Lower bit rate margin, units of %	00
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

### HOST BOARD APPLICATION SCHEMATIC



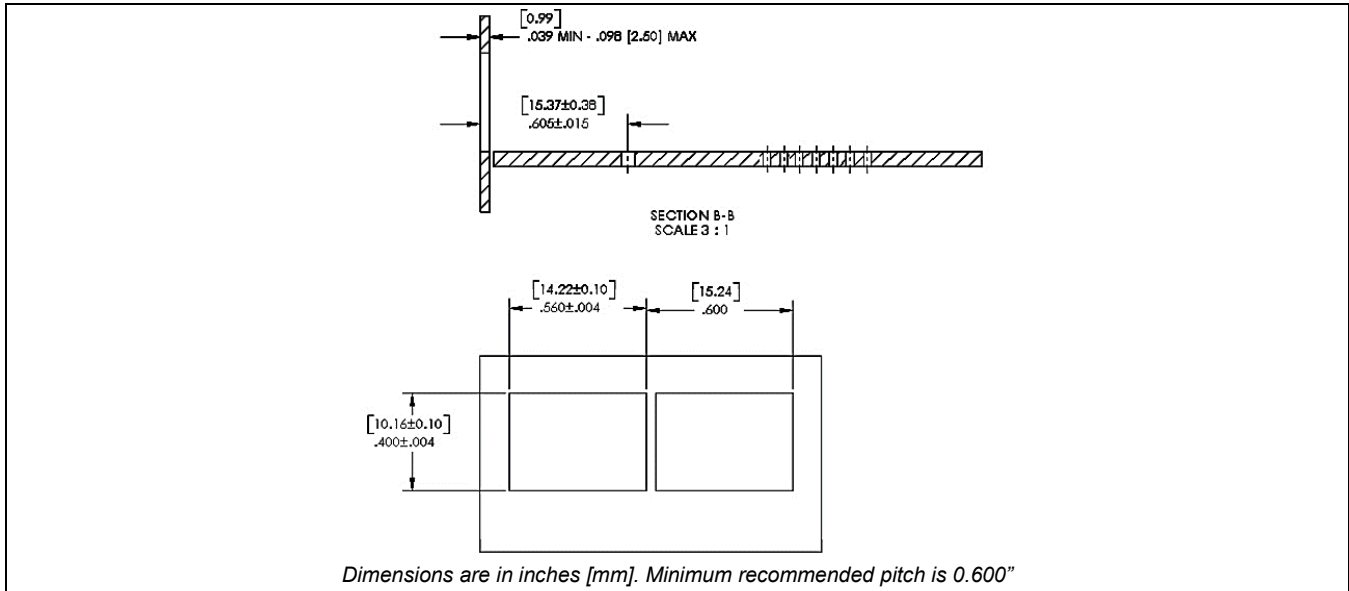
#### Notes:

- 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.
- R1/R2 2-wire bus pull-up resistors required on host for implementing optional digital diagnostics; 4.7kΩ to 10kΩ.
- Screw or solder posts are not internally connected to signal ground. Recommend screw or solder posts be connected to chassis ground if available, otherwise they should be tied to local signal ground.
- For host with LVPECL electrical interface contact COTSWORKS' applications engineering.

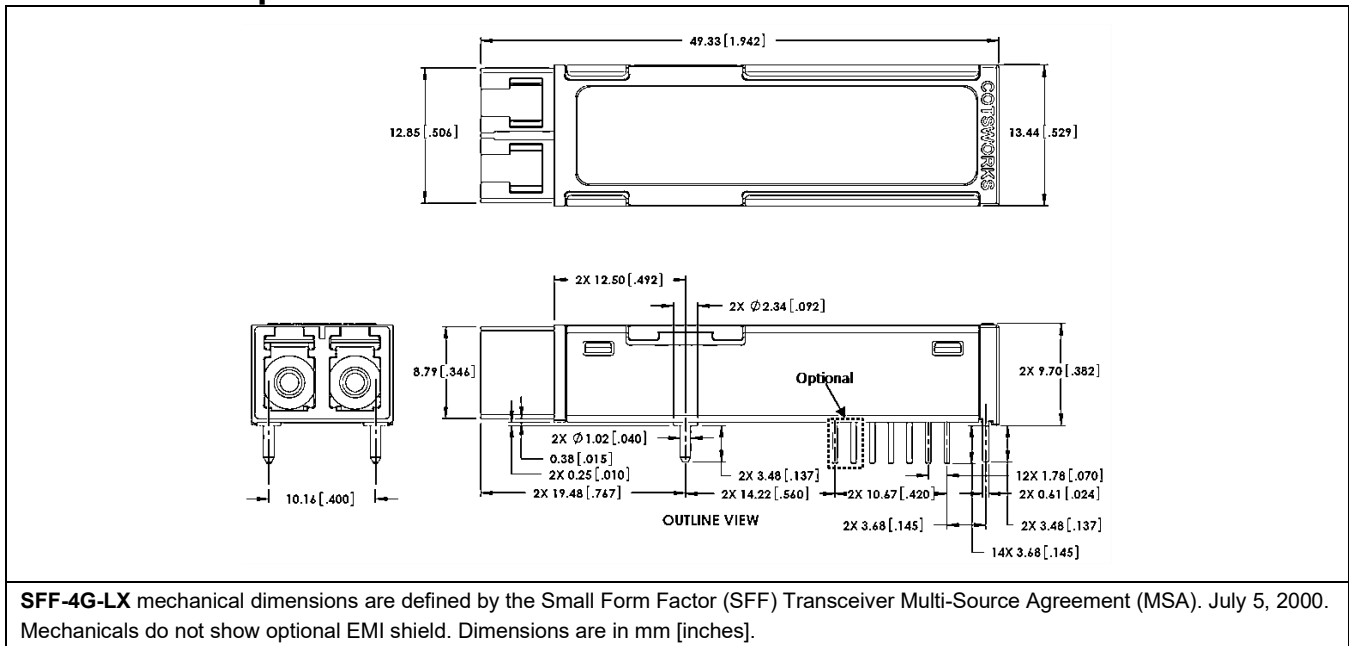




## Panel Cutout



## Mechanical Specifications





## Ruggedization Notes

- Parylene Type C coating can be used for conformal coating with a 1.0 mil ± 0.2 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.
- Contact COTSWORKS for all MSDS and case composition information.

## Reference Information

- 1) IEEE Standard 802.3, 2002 Edition, 1000BASE-LX. 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.
- 4) 3.125 Gb/s XAU1 specification, IEEE 802.3ae, section 47.
- 5) ARINC 818 specification at 3.1875Gb/s, <https://www.arinc818.com/>
- 6) Directive 2002/95/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." January 27, 2003.

## Regulatory Compliance

- COTSWORKS transceivers are Class 1 Laser Products and are 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 2002/95/EC covering restriction on certain hazardous substances (RoHS). Contact COTSWORKS for more information.

## 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-LX	-x	-DPLX-LC	-x	-x	-x	-x	-x
<b>SFF Form Factor</b>	<b>Pins and Diagnostics</b>		<b>Ruggedized Coating</b>	<b>Operating Temp Range</b>	<b>EMI Shield</b>	<b>RoHS Level</b>	<b>Posts</b>
<b>4.25 Gbps MAX Data Rate</b>	( <i>:</i> ): 2x5 <i>No Diagnostics</i>	Duplex LC Receptacles	( <i>:</i> ): <i>Non-coated</i>	A: -40 to 85°C	( <i>:</i> ): <i>No Shield</i>	( <i>:</i> ): <i>Level 5</i>	( <i>:</i> ): <i>Posts</i>
<b>1310nm Long Reach</b>	D: 2x7 <i>Digital Diagnostics</i>		R: <i>Parylene</i>	M: -40 to 95°C.	E: <i>Shield</i>	6: <i>Level 6</i>	NP: <i>No Posts</i>

### Example part number: SFF-4G-LX-D-DPLX-LC-R-A

[Small Form Factor Transceiver, 4.25 Gbps Max Data Rate, 1310nm Long Reach, Digital Diagnostics, Duplex LC Receptacles, Parylene Coated, -40 to 85°C Operating Temperature Range, No EMI Shield, RoHS 5(6), Solder Posts]

Contact COTSWORKS for mechanical dimensional information, lead times, and other configuration options.

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