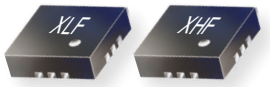
NEW! Two & Three Section Models

MMIC
REFLECTIONLESS FILTERS

50Ω DC to 21 GHz

The Big Deal

- *High Stopband rejection, up to 50 dB*
- *Patented design terminates stopband signals*
- *Pass band cut-off up to 11 GHz*
- *Stop band up to 26 GHz*
- *Excellent repeatability through IPD* process*



X-Series

Available in Low Pass & High Pass designs

Product Overview

Mini-Circuits' ***X-Series*** of reflectionless filters now includes 2- and 3-section models, giving you ultra-high rejection in the stopband – up to 50 dB! Reflectionless filters employ a patented filter topology which absorbs and terminates stopband signals internally rather than reflecting them back to the source. This new capability enables unique applications for filter circuits beyond those suited to traditional approaches. Traditional filters are reflective in the stopband, sending signals back to the source at 100% power. These reflections interact with neighboring components and often result in intermodulation and other interferences. By eliminating stopband reflections, reflectionless filters can readily be paired with sensitive devices and used in applications that otherwise require circuits such as isolation amplifiers or attenuators.

Key Features	Advantages
Easy integration with sensitive reflective components, e.g. mixers, multipliers	Reflectionless filters absorb unwanted signals falling in filter stopband, preventing reflections back to the source. This reduces generation of additional unwanted signals without the need for extra components like attenuators, improving system dynamic range and saving board space.
High stopband rejection, up to 50 dB	Ideal for applications where suppression of strong spurious signals and intermodulation products is needed.
Enables stable integration of wideband amplifiers	Because reflectionless filters maintain good impedance in the stopband; they can be integrated with high gain, wideband amplifiers without the risk of creating instabilities in these out of band regions.
Cascadable	Reflectionless filters can be cascaded in multiple sections to provide sharper and higher attenuation, while also preventing any standing waves that could affect passband signals. Low & highpass filters can be cascaded to realize bandpass filters.
Excellent power handling in a tiny surface mount device up to 7W in passband	High power handling extends the usability of these filters to the transmit path for inter-stage filtering.
Small size, 3x3mm/ 4x4 mm/ 5x5mm QFN	Allows replacement of filter/attenuator pairs with a single reflectionless filter, saving board space.
Excellent repeatability of RF performance	Through semiconductor IPD process, X-series filters are inherently repeatable for large volume production.
Excellent stability over temperature	With ±0.3 dB variation over temperature ideal for use in wide temperature range applications without the need for additional temperature compensation.
Operating temperature up to 105˚C	Suitable for operation close to high power components.

*IPD – Integrated Passive Device, is a GaAs semiconductor process

Reflectionless

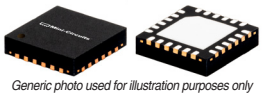
High Pass Filter

XHF-292M+

50Ω 2900 to 8700 MHz

Features

- Match to 50Ω in the stop band, eliminates undesired reflections
- Cascadable
- Good stopband rejection, 36 dB typ.
- Temperature stable, up to 105°C
- Small size, 4 x 4 mm
- Protected by US Patents 8,392,495; 9,705,467, additional patent pending
- Protected by China Patent 201080014266.1
- Protected by Taiwan Patent I581494



Generic photo used for illustration purposes only

CASE STYLE: DG1847

+RoHS Compliant

The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

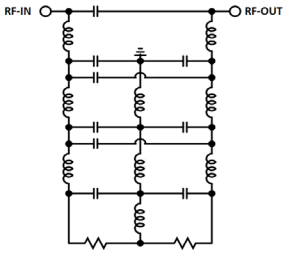
Applications

- Mobile (LTE B42/B43)
- ISM applications
- Satellite
- WiFi WiMAX

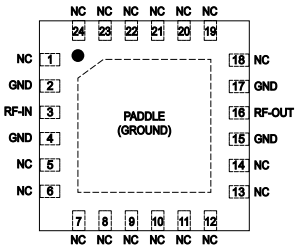
General Description

Mini-Circuits' XHF-292M+ two-section reflectionless filter employs a novel filter topology which absorbs and terminates stop band signals internally rather than reflecting them back to the source. This new capability enables unique applications for filter circuits beyond those suited to traditional approaches. Traditional filters are reflective in the stop band, sending signals back to the source at 100% of the power level. These reflections interact with neighboring components and often result in inter-modulation and other interferences. Reflectionless filters eliminate stop band reflections, allowing them to be paired with sensitive devices and used in applications that otherwise require circuits such as isolation amplifiers or attenuators.

simplified schematic and pad description



(each section)



Function	Pad Number	Description
RF-IN	3	RF Input Pad
RF-OUT	16	RF Output Pad
GND	2,4,15,17 & paddle	Connected to ground
NC (GND Externally)	1, 5-14,18-24	No internal connection

Electrical Specifications[1] at 25°C

Parameter		F#	Frequency (MHz)	Min.	Typ.	Max.	Unit
Stop Band	Rejection	DC-F1	DC - 1950	25	36	—	dB
	Frequency Cut-off	F2	2400	—	3.0	—	dB
	VSWR	DC-F1	DC - 1950	—	1.2	—	:1
Pass Band	Insertion Loss	F3-F5	2900 - 8700	—	0.7	1.7	dB
	VSWR	F3-F4	2900 - 7100	—	1.2	—	:1
		F4-F5	7100 - 8700	—	1.5	—	:1

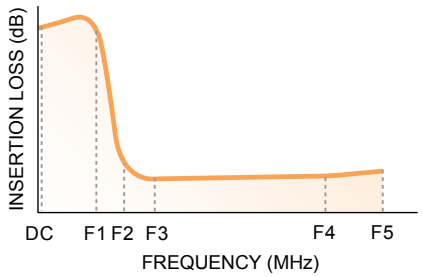
[1] Measured on Mini-Circuits Characterization Test Board TB-952-292M+

Absolute Maximum Ratings[4]

Parameter	Ratings
Operating Temperature	-55°C to +105°C
Storage Temperature	-65°C to +150°C
RF Power Input, Passband (F3-F5)[2]	32 dBm at 25°C
RF Power Input, Stopband (DC-F3)[3]	35 dBm at 25°C

[2] Passband rating derates linearly to 29 dBm at 105°C ambient
[3] Stopband rating derates linearly to 32 dBm at 105°C ambient
[4] Permanent damage may occur if any of these limits are exceeded.

SPECIFICATION DEFINITION

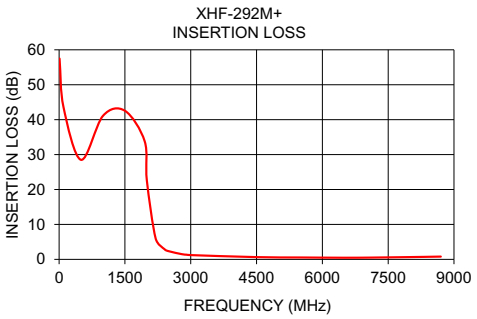


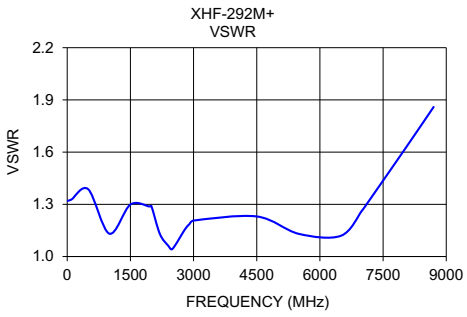
ESD rating

Human body model (HBM): Class 2 (Pass 2000 V) in accordance with ANSI/ESD 5.1-2001

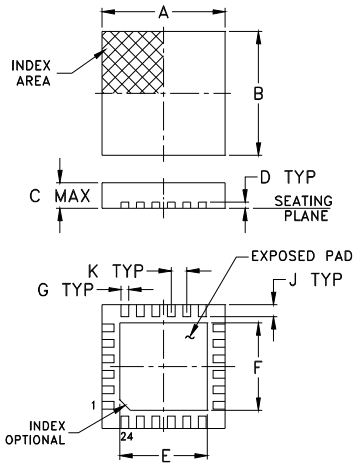
Typical Performance Data at 25°C

Frequency (MHz)	Insertion Loss (dB)	VSWR (:1)
10	57.49	1.32
100	43.57	1.33
500	28.49	1.39
1000	41.10	1.13
1500	42.55	1.30
1950	33.83	1.29
2000	22.54	1.29
2200	6.00	1.13
2400	2.94	1.06
2500	2.33	1.04
2800	1.48	1.16
2900	1.34	1.19
3000	1.22	1.21
4500	0.64	1.23
5500	0.54	1.13
6500	0.47	1.12
7000	0.49	1.26
7100	0.51	1.30
8000	0.65	1.61
8700	0.79	1.86

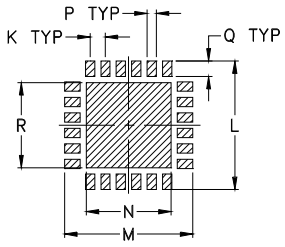




Outline Drawing

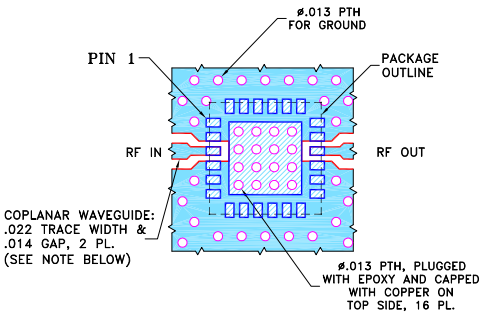


PCB Land Pattern



Suggested Layout,
Tolerance to be within ±.002

Demo Board MCL P/N: TB-952-292M+
Suggested PCB Layout: PL-519



NOTES:
1. TRACE WIDTH & GAP ARE SHOWN FOR ROGERS RO4350B WITH DIELECTRIC THICKNESS .010" ± .001"; COPPER: 1/2 OZ. EACH SIDE. FOR OTHER MATERIALS TRACE WIDTH MAY NEED TO BE MODIFIED.
2. BOTTOM SIDE OF THE PCB IS CONTINUOUS GROUND PLANE.

DENOTES PCB COPPER LAYOUT WITH SMOBC (SOLDER MASK OVER BARE COPPER)

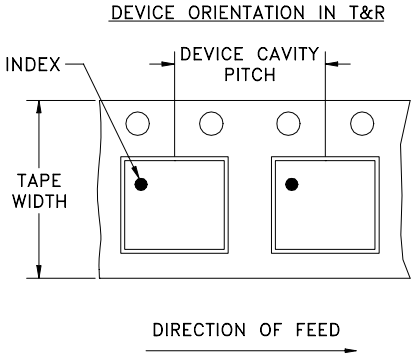
DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK

Outline Dimensions (inch / mm)

A	B	C	D	E	F	G	H	J
.157	.157	.039	.008	.104	.104	.009	--	.016
4.0	4.0	1.0	0.20	2.64	2.64	0.23	--	0.41

K	L	M	N	P	Q	R	wt
.020	.166	.166	.102	.012	.020	.102	grams
0.50	4.22	4.22	2.59	0.30	0.51	2.59	0.04

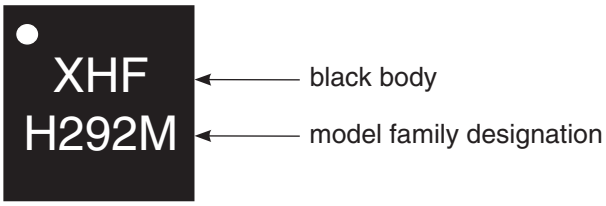
Tape & Reel Packaging, F68



Tape Width, mm	Device Cavity Pitch, mm	Reel Size, inches	Devices per Reel see note	
12	8	7	Small quantity standard	20
				50
				100
				200
				500
		7	Standard	1000
		13	Standard	2000
				4000

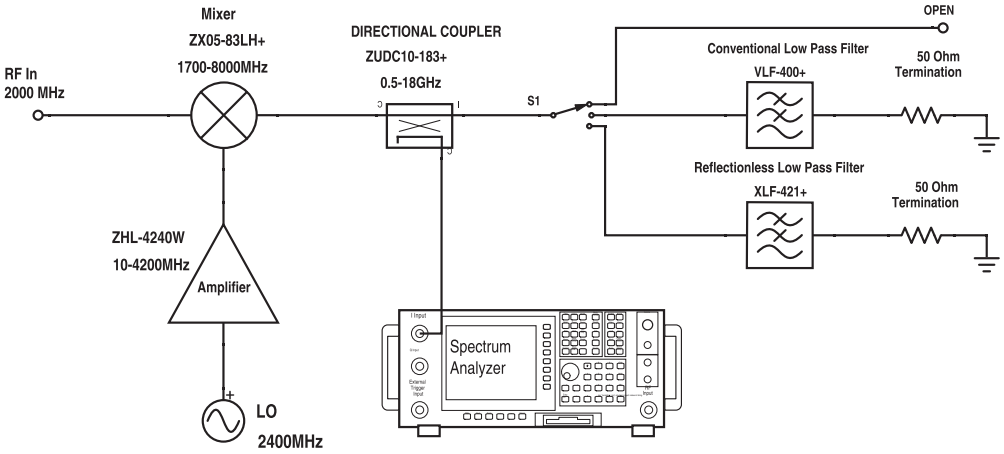
Lead Finish: Matte-Tin

Product Marking



Application Circuit Example

Pairing mixers with reflectionless filters to improve system dynamic range



Test block diagram: IF output reflection spectrum with single input frequency

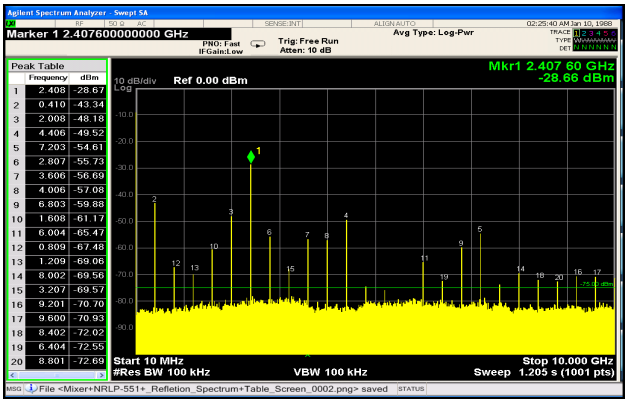


Figure 1. IF output reflection spectrum without filter

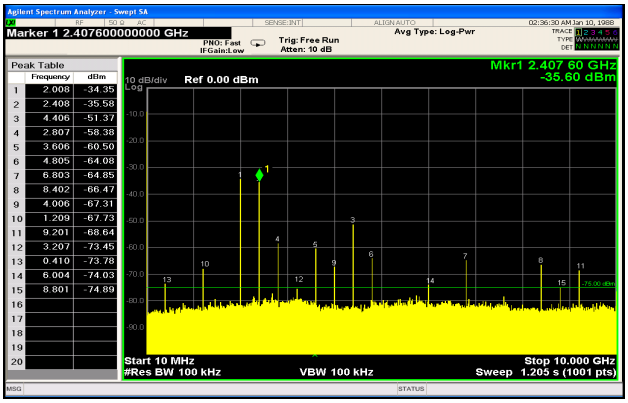


Figure 2. IF output reflection spectrum with conventional filter

An application circuit was assembled to measure the IF reflection spectrum at the output of a mixer when the mixer was paired with a conventional filter versus a reflectionless filter.

While the conventional filter reduces the reflections present when the mixer is used alone (no filter), the reflectionless filter virtually eliminates those reflections altogether.

The reflected signal at marker 1 in the figures above exhibits a reduction of more than 20 dB from -28.7 dBm to -50.3 dBm when the reflectionless filter is used as compared to the conventional filter, thus eliminating unwanted spurious mixing products and improving-system dynamic range.

For more information, refer to application note AN-75-007

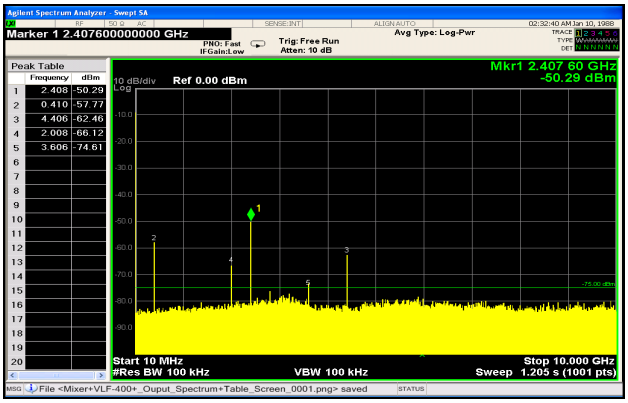


Figure 3. IF output reflection spectrum with reflectionless filter

Additional Notes

A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.

B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.

C. The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the Standard Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at www.minicircuits.com/MCLStore/terms.jsp

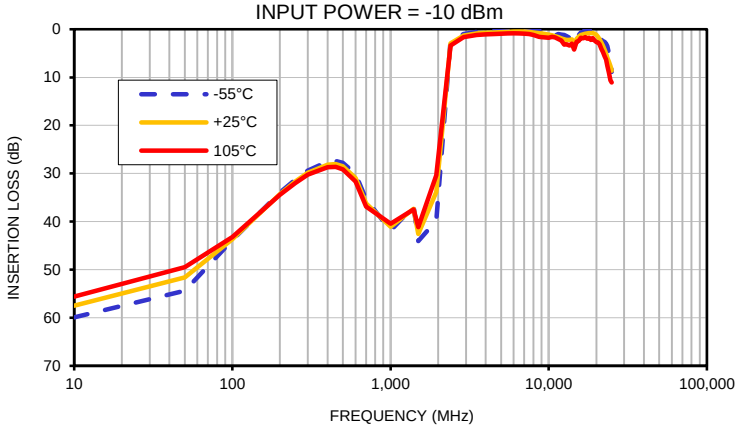
MMIC Reflectionless High Pass Filter XHF-292M+

Typical Performance Data

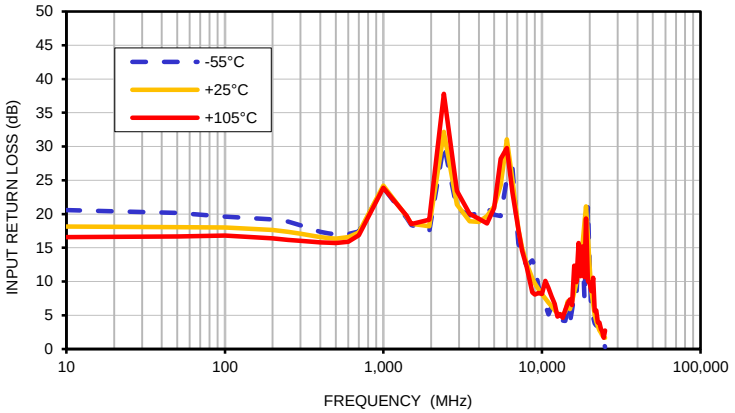
FREQ.	INSERTION LOSS			INPUT RETURN LOSS			OUTPUT RETURN LOSS		
(MHz)	(dB)			(dB)			(dB)		
	@-55˚C	@25°C	@+105°C	@-55°C	@+25˚C	@+105°C	@-55°C	@+25˚C	@+105°C
10	59.91	57.49	55.60	20.60	18.14	16.59	19.08	17.20	15.71
50	54.38	51.60	49.45	20.18	18.04	16.66	18.73	17.14	15.78
100	43.88	43.65	43.23	19.60	18.02	16.81	18.22	17.04	15.90
200	33.97	34.28	34.45	19.22	17.66	16.39	17.91	16.69	15.59
250	31.24	31.65	31.96	18.88	17.35	16.15	17.65	16.49	15.38
300	29.38	29.87	30.25	18.31	17.10	16.01	17.21	16.26	15.27
400	27.54	28.16	28.69	17.38	16.58	15.80	16.47	15.91	15.22
450	27.40	28.07	28.65	17.14	16.43	15.75	16.35	15.82	15.28
500	27.76	28.50	29.12	16.99	16.37	15.73	16.32	15.82	15.32
600	30.11	30.94	31.65	17.04	16.57	15.91	16.49	16.15	15.64
700	35.38	36.21	36.88	17.42	17.26	16.87	17.12	17.03	16.98
1000	41.85	41.10	40.46	23.89	24.20	23.90	26.29	26.31	26.10
1400	36.85	37.34	37.46	19.43	19.68	19.77	17.92	18.38	18.64
1500	44.05	42.55	41.15	18.36	18.54	18.51	17.39	17.73	17.71
1950	39.81	33.83	30.35	17.47	18.19	19.15	17.08	18.01	18.88
2400	2.43	2.94	3.37	30.34	32.18	37.81	28.48	30.45	33.32
2900	0.97	1.34	1.64	20.76	21.42	23.41	20.72	21.55	22.84
3500	0.55	0.90	1.18	19.80	18.93	20.02	19.56	19.01	19.44
4000	0.39	0.74	1.04	20.16	18.86	19.29	19.63	19.03	19.04
4500	0.29	0.64	0.98	20.94	19.72	18.58	20.78	19.97	18.56
5000	0.25	0.60	0.94	19.89	21.13	20.92	19.01	21.60	21.05
5500	0.21	0.54	0.87	19.73	24.27	28.16	19.72	24.91	28.30
6000	0.12	0.48	0.84	25.27	31.05	29.77	25.43	34.69	35.32
6500	0.08	0.47	0.85	26.81	24.99	23.15	27.54	25.34	21.60
7100	0.14	0.51	0.92	15.67	17.76	17.75	15.72	17.97	17.32
7500	0.19	0.56	1.00	13.82	15.01	14.55	13.62	15.26	14.56
8000	0.22	0.65	1.16	12.37	12.62	12.10	12.44	12.86	12.37
8700	0.17	0.79	1.57	13.13	10.44	8.39	13.16	10.68	8.47
9000	0.19	0.86	1.66	12.30	9.74	8.07	12.50	9.97	8.14
9500	0.40	0.98	1.68	9.26	8.85	8.29	9.23	9.01	8.46
10000	0.68	1.12	1.75	7.45	8.10	8.17	7.69	8.22	8.10
10500	0.94	1.27	1.56	6.45	7.49	10.10	6.22	7.55	10.14
11000	1.33	1.45	1.71	5.13	6.89	9.05	5.33	6.90	8.94
11500	1.03	1.66	2.03	6.28	6.32	7.80	6.06	6.26	7.91
12000	1.15	1.89	2.34	5.68	5.73	6.68	5.76	5.66	6.93
12500	1.20	2.10	3.16	5.48	5.32	4.81	5.43	5.21	4.96
13000	1.45	2.23	3.13	4.68	5.05	5.16	5.00	4.98	5.25
13500	1.79	2.24	3.36	4.21	5.08	4.63	4.12	5.02	4.62
14000	1.76	2.11	2.99	4.14	5.48	5.76	4.50	5.63	6.32
14500	2.82	3.25	4.22	5.80	7.06	6.73	6.46	6.76	6.03
15000	2.11	2.03	2.62	3.88	5.90	7.36	3.95	5.97	7.77
15500	1.17	1.52	2.42	5.80	7.08	6.52	5.66	7.24	6.73
16000	0.64	1.22	1.79	7.88	8.43	12.37	7.74	8.68	12.98
16500	0.59	1.03	1.88	7.66	9.89	9.89	7.91	10.22	9.75
17000	0.06	0.93	1.66	14.37	11.24	15.72	16.02	11.64	14.58
17500	0.07	0.86	1.96	12.13	12.92	10.77	12.34	13.36	10.92
18000	0.02	0.82	1.74	16.33	15.11	15.18	16.94	15.90	17.43
18500	0.44	0.80	2.21	7.37	18.72	10.66	7.46	20.44	12.93
19000	0.16	0.81	1.85	14.29	21.15	19.35	14.38	55.80	23.62
19500	0.14	0.93	2.32	21.10	16.68	10.11	21.34	19.12	11.40
20000	0.45	1.17	2.68	11.94	11.94	9.67	12.36	12.84	9.91
20500	1.44	1.56	2.77	5.18	8.83	8.56	5.49	9.23	9.22
21000	1.68	2.08	3.14	4.73	6.63	10.55	5.05	6.93	9.52
21500	2.18	2.77	4.06	3.78	5.04	5.62	3.65	5.27	5.79
22000	2.51	3.45	4.72	3.47	4.10	5.73	3.41	4.26	5.95
22500	2.58	4.23	5.61	3.56	3.38	3.93	3.06	3.49	4.34
23000	2.99	5.04	6.30	3.17	2.81	3.92	3.09	2.94	4.06
23500	3.53	5.88	7.60	2.60	2.43	2.96	2.77	2.47	3.54
24000	4.97	6.74	8.97	1.71	2.06	2.66	1.45	2.11	2.14
24500	6.79	7.63	10.59	0.89	1.84	1.67	1.20	1.84	2.31
25000	8.90	8.59	11.04	0.30	1.66	2.75	0.26	1.67	2.14
25500	10.24	9.57	11.86	0.37	1.61	2.89	0.23	1.61	2.61
26000	11.18	10.84	12.72	0.19	1.66	3.26	0.03	1.72	2.71

Typical Performance Curves

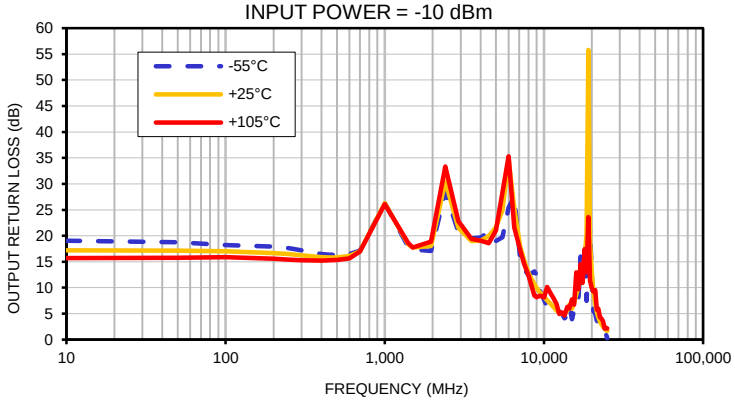
INSERTION LOSS vs. TEMPERATURE
INPUT POWER = -10 dBm



INPUT RETURN LOSS vs. TEMPERATURE
INPUT POWER = -10 dBm



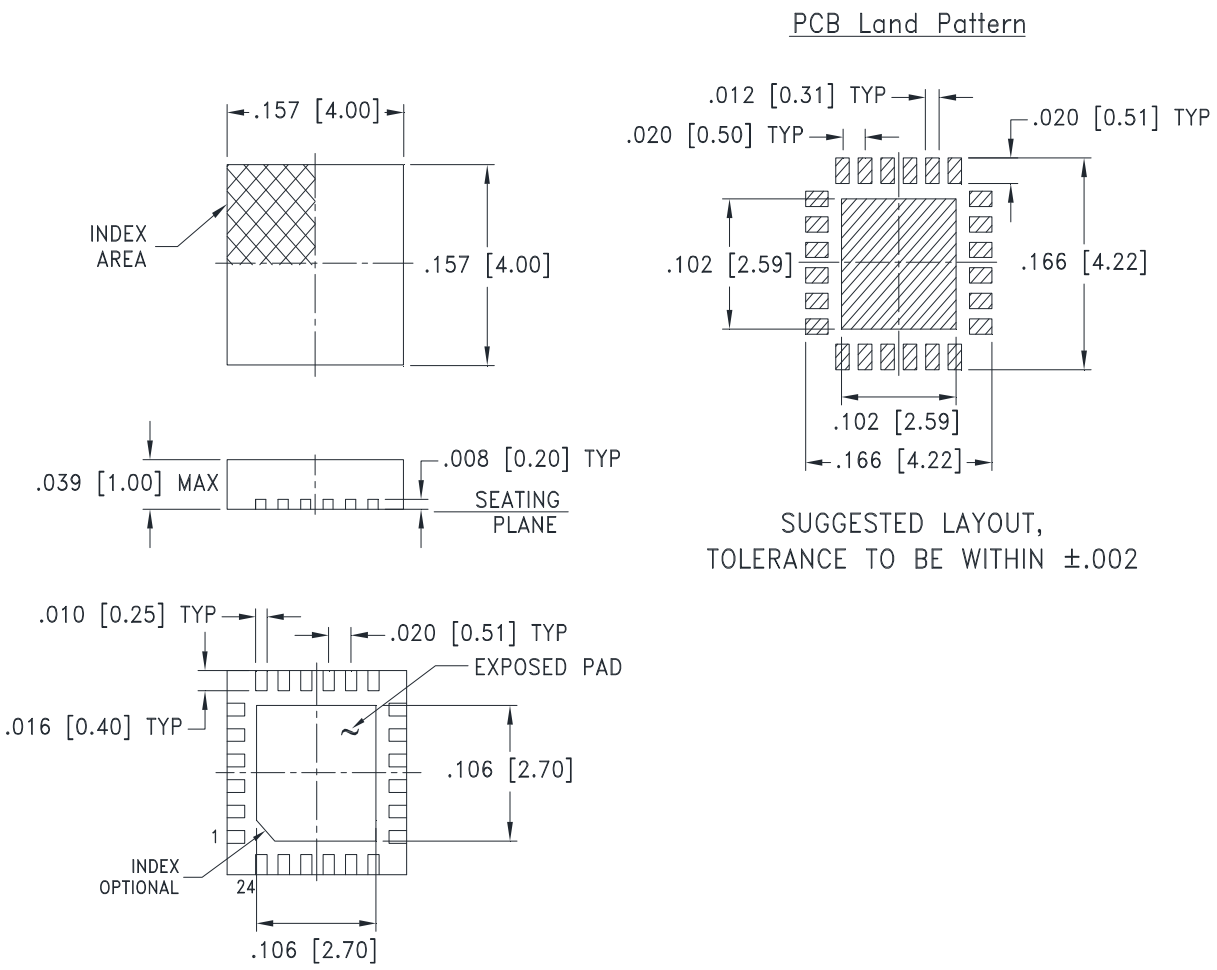
OUTPUT RETURN LOSS vs. TEMPERATURE
INPUT POWER = -10 dBm



Case Style DG

DG1847

Outline Dimensions



Weight: .04 Grams

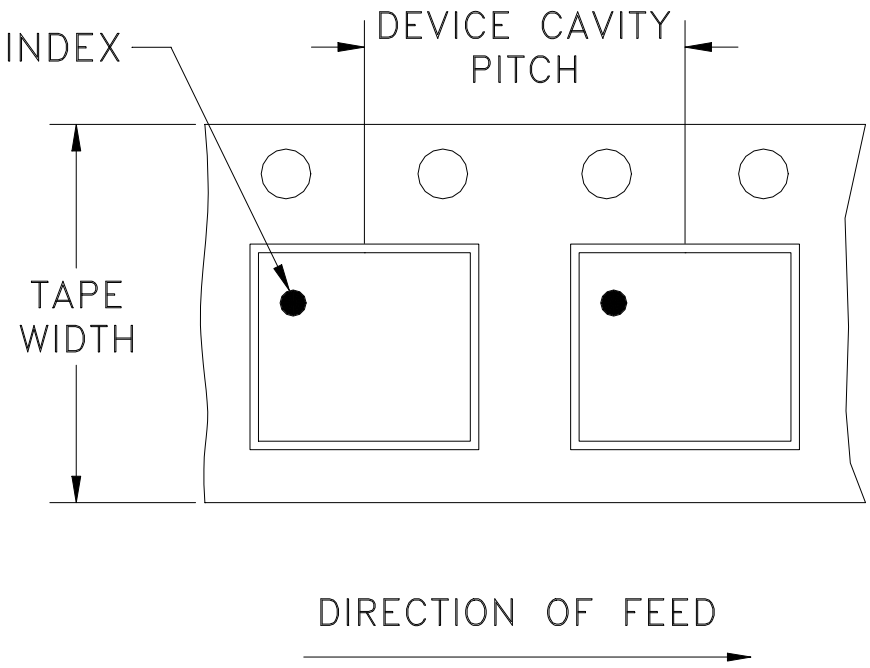
Dimensions are in inches (mm). Tolerances: 2 Pl. ± .01; 3 Pl. ± .005

Notes:

1. Case material: Plastic.
2. Termination finish:
   For RoHS Case Styles: Tin-Silver alloy plate over Nickel barrier or Matte-Tin. All models, (+) suffix. See model Data sheet.
   For RoHS-5 Case Styles: Tin-Lead plate. All models, no (+) suffix.

Tape & Reel Packaging TR-F68

DEVICE ORIENTATION IN T&R



Tape Width, mm	Device Cavity Pitch, mm	Reel Size, inches	Devices per Reel see note	
12	8	7	Small quantity standard	20
				50
				100
				200
				500
		7	Standard	1000
		13	Standard	2000
				3000
				4000

Mini-Circuits carrier tape materials provide protection from ESD (Electro-Static Discharge) during handling and transportation. Tapes are static dissipative and comply with industry standards EIA-481/EIA-541.

Go to: www.minicircuits.com/pages/pdfs/tape.pdf

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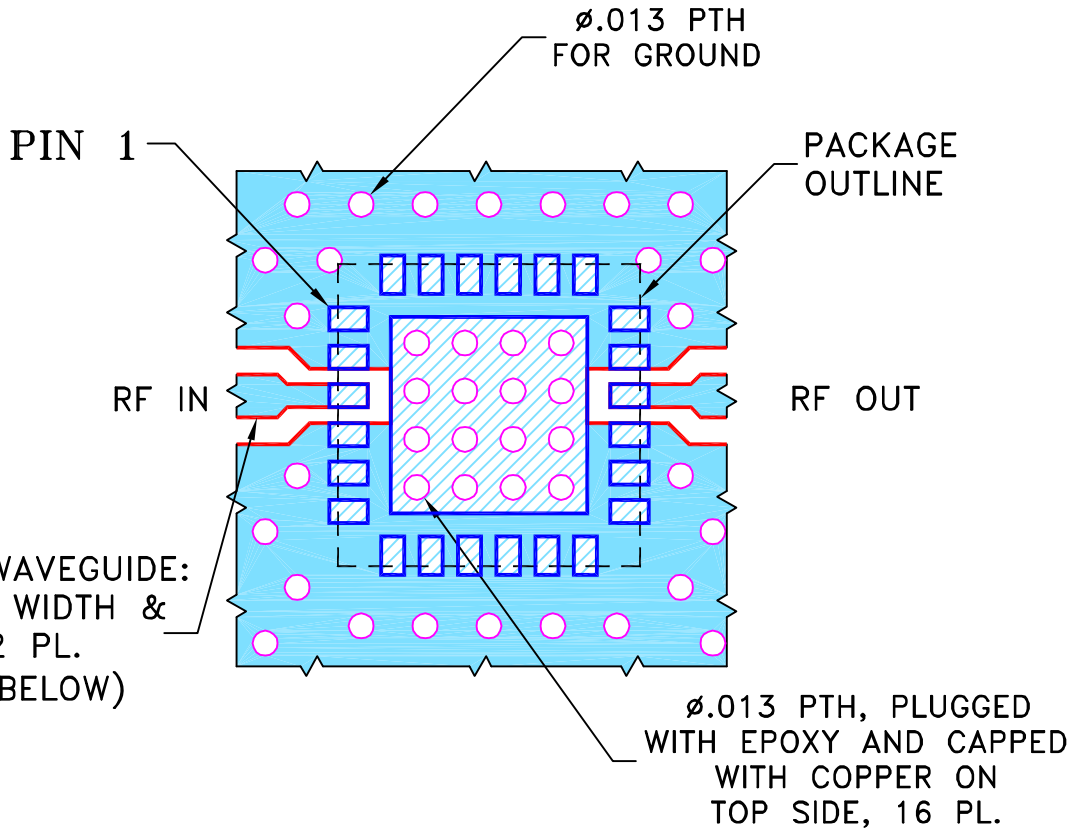
THIRD ANGLE PROJECTION

REVISIONS					
REV	ECN No.	DESCRIPTION	DATE	DR	AUTH
OR	M162496	NEW RELEASE	06/15/17	GF	RS

SUGGESTED MOUNTING CONFIGURATION FOR DG1847 CASE STYLE, "24FL01" PIN CONNECTION



NOTES:

1. TRACE WIDTH & GAP ARE SHOWN FOR ROGERS RO4350B WITH DIELECTRIC THICKNESS .010" ± .001"; COPPER: 1/2 OZ. EACH SIDE.
   FOR OTHER MATERIALS TRACE WIDTH MAY NEED TO BE MODIFIED.
2. BOTTOM SIDE OF THE PCB IS CONTINUOUS GROUND PLANE.

DENOTES PCB COPPER LAYOUT WITH SMOBC (SOLDER MASK OVER BARE COPPER)

DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK

UNLESS OTHERWISE SPECIFIED		INITIALS	DATE
DIMENSIONS ARE IN INCHES	DRAWN	GF	06/14/17
TOLERANCES ON:	CHECKED	IL	06/15/17
2 PL DECIMALS ±	APPROVED	RS	06/15/17
3 PL DECIMALS ± .005			
ANGLES ±			
FRACTIONS ±			

ASHEETA1.DWG REV:A DATE:01/12/95

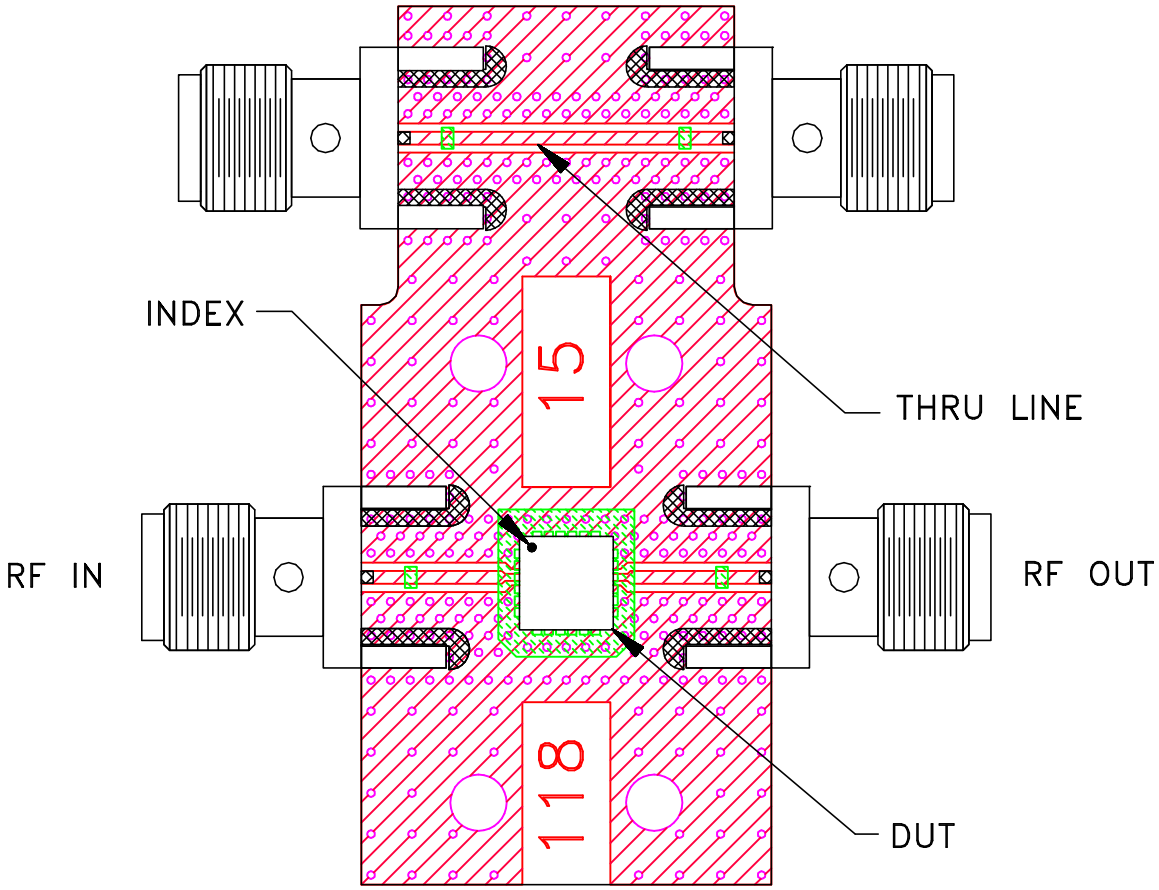
Mini-Circuits® 13 Neptune Avenue Brooklyn NY 11235

PL, 24FL01, DG1847, TB-952+

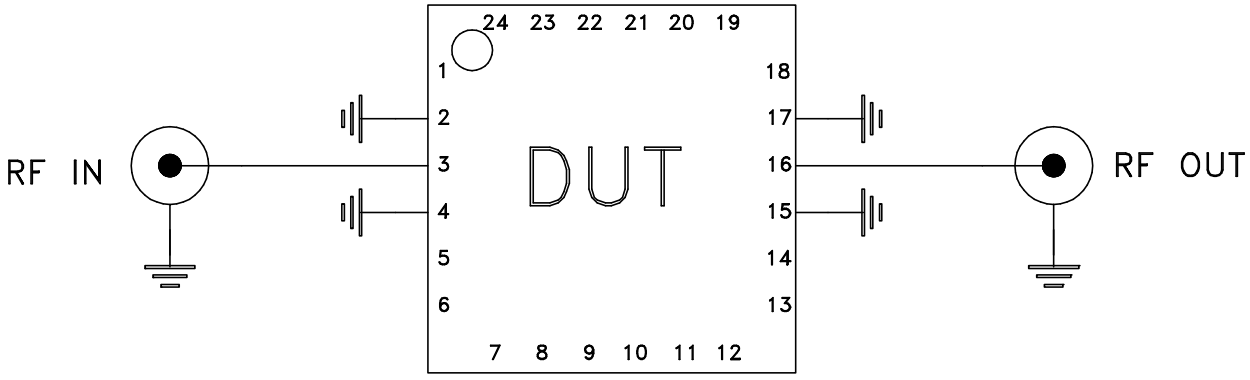
SIZE	CODE IDENT	DRAWING NO:	REV:
A	15542	98-PL-519	OR

FILE:	SCALE:	SHEET:
98PL519	10:1	1 OF 1

Evaluation Board and Circuit



TB-952-292M+



PINS 1,5-14,18-24 - NOT CONNECTED.

Schematic Diagram

Notes:

1. 50 Ohm SMA Female connectors.
2. PCB Material: RO4350 or equivalent, Dielectric Constant=3.5, Thickness=.010 inch.

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Environmental Specifications ENV82

All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

Specification	Test/Inspection Condition	Reference/Spec
Operating Temperature	-55° to 105°C Ambient Environment	Individual Model Data Sheet
Storage Temperature	-65° to 150° C Ambient Environment	Individual Model Data Sheet
Autoclave	15 psig, 100% RH, 121°C, 96 hours	JESD22-A102-C, Condition C
Temperature Cycling	-65° to 150°C, 100 cycles	JESD22-A104
Temperature Humidity	85°C/ 85% RH, 168 hours	JESD22-113
Solder Reflow Heat	Sn-Pb Eutetic Process: 240°C peak Pb-Free Process: 260°C peak	J-STD-020, Table 4-1, 4-2 and 5-2; Figure 5-1
Moisture Sensitivity: Level 1	Bake at 125°C for 24 hours Soak at 85°C/85% RH for 168 hours, Reflow 3 cycles at 240°C peak (Non-RoHS) or 260°C (RoHS)	J-STD-020C
Solderability	10X magnification, 95% coverage	JESD22-B102, Method 1: Dip and Look Test
Marking Resistance to Solvents	Isopropyl alcohol + mineral spirits at 25°C; terpene defluxer at 25°C; distilled water + proylene glycol monomethyl ether + monoethanolamine at 63°C to 70°C	MIL-STD-202, Method 215