

MMIC

# REFLECTIONLESS FILTER DICE

50Ω DC to 21 GHz

## The Big Deal

- Patented design eliminates in band spurs
- Pass band cut-off up to 21 GHz
- Stop band up to 35 GHz
- Excellent repeatability through IPD\* process
- Unpackaged Die Form



**X-Series**

Available in Low Pass, High Pass and Band Pass designs

## Product Overview

Mini-Circuits' X-Series reflectionless filters employ 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 which interact with neighboring components and often result in intermodulation 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 isolators, isolation amplifiers or attenuators.

### Key Features

Easy integration with sensitive reflective components, e.g. mixers, multipliers

Enables stable integration of wideband amplifiers

Cascadable

Excellent power handling in a tiny surface mount device

Excellent repeatability of RF performance

Excellent stability over temperature

Operating Temperature up to 105°C

Unpackaged Die form

### Advantages

Reflectionless filters absorb unwanted signals, 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.

Because reflectionless filters maintain good impedance in the stop band; they can be integrated with high gain, wideband amplifiers without the risk of creating instabilities in these out of band regions.

Reflectionless filters can be cascaded in multiple sections to provide sharper and higher attenuation, while also preventing any standing waves that could affect pass band signals.

High power handling extends the usability of these filters to the transmit path for inter-stage filtering.

Through semiconductor IPD process, X-series filters are inherently repeatable for large volume production.

With  $\pm 0.3$  dB variation over temperature ideal for use in wide temperature range applications without the need for additional temperature compensation.

Suitable for operation close to high power components

Enables direct integration into customer hybrids

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



# Reflectionless Low Pass Filter Die

## XLF-861-D+

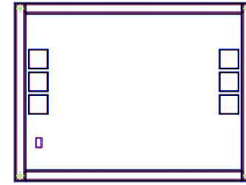
50Ω DC to 860 MHz

### Features

- Match to 50Ω in the stop band, eliminates undesired reflections
- Cascadable
- Excellent Power handling
- Protected by US Patent No. 8,392,495

### Applications

- Harmonics Rejection
- Wideband Matching
- Transmitters / Receivers



#### +RoHS Compliant

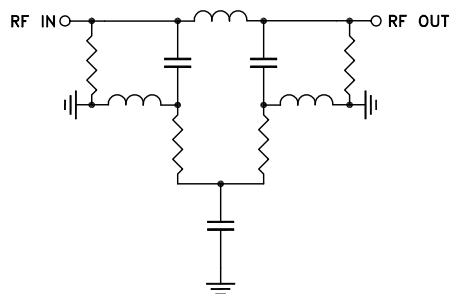
The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

Ordering Information: Refer to Last Page

### General Description

Mini-Circuits' XLF-861-D+ reflectionless filter die 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



Pad	Description
RF-IN	RF Input Pad
RF-OUT	RF Output Pad
Ground	Ground Bonding Pad

**Electrical Specifications<sup>1</sup> at 25°C**

Parameter		F#	Frequency (MHz)	Min.	Typ.	Max.	Unit
Pass Band	Insertion Loss	DC - F1	DC - 860		1.4		dB
	Frequency Cut-off	F2	1150		3.0		dB
	VSWR	DC - F1	DC - 860		1.2		:1
Stop Band	Rejection	F3 - F4	1700 - 7500		15		dB
		F4 - F5	7500 - 25000		24		dB
	VSWR	F3 - F4	1700 - 7500		1.2		:1
		F4 - F5	7500 - 25000		2.3		:1

<sup>1</sup> Measured on Mini-Circuits Characterization test board. Die packaged in 3mm x 3mm, 12-lead MCLP package and soldered on TB-844-861+

**Absolute Maximum Ratings<sup>1,4</sup>**

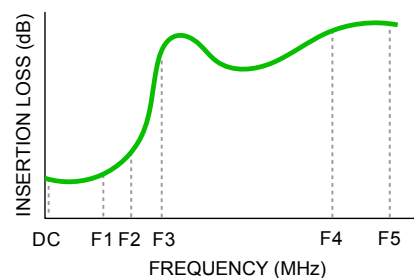
Parameter	Ratings
Operating Temperature	-55°C to +105°C
RF Power Input, Passband (DC-F1) <sup>2</sup>	2W at 25°C
RF Power Input, Stopband (F2-F5) <sup>3</sup>	0.2W at 25°C

<sup>2</sup> Passband rating derates linearly to 1W at 105°C ambient

<sup>3</sup> Stopband rating derates linearly to 0.1W at 105°C ambient

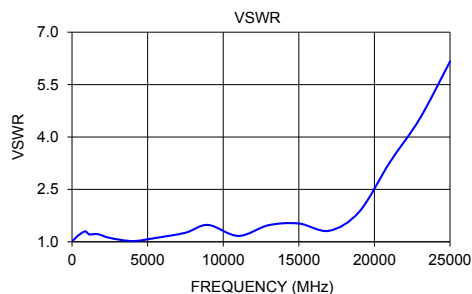
<sup>4</sup> Permanent damage may occur if any of these limits are exceeded.

**Specification Definition**



**Typical Performance Data at 25°C<sup>1</sup>**

Frequency (MHz)	Insertion Loss (dB)	VSWR (:1)
10	0.67	1.02
100	0.65	1.06
200	0.67	1.09
400	0.76	1.18
860	1.38	1.30
1150	2.97	1.21
1700	15.26	1.22
2500	16.70	1.11
4000	15.03	1.02
5500	16.44	1.11
7500	16.09	1.26
9000	12.17	1.48
11000	26.57	1.17
13000	27.34	1.48
15000	25.78	1.52
17000	23.91	1.32
19000	22.50	1.86
21000	23.63	3.26
23000	24.92	4.53
25000	27.04	6.16



**Die Layout**

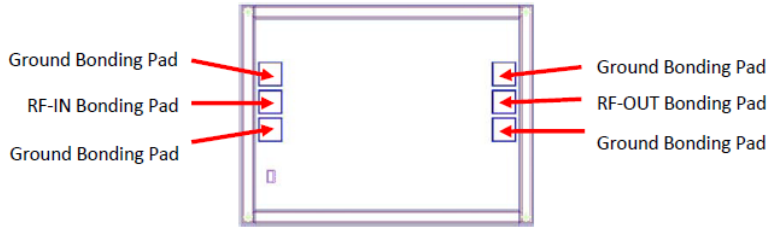


Fig 1. Die Layout

**Bonding Pad Position**  
(Dimensions in  $\mu\text{m}$ , Typical)

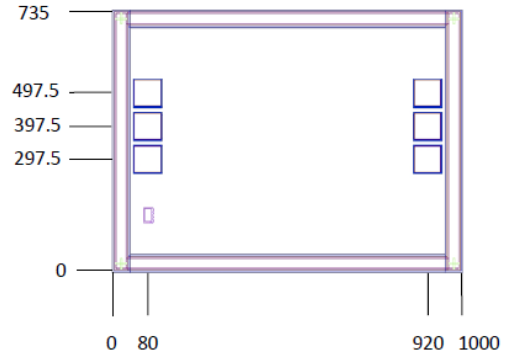


Fig 2. Bonding Pad Positions

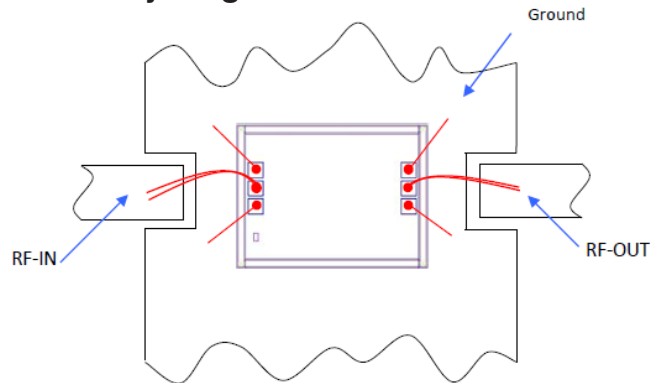
**Critical Dimensions**

Parameter	Values
Die Thickness, $\mu\text{m}$	100
Die Width, $\mu\text{m}$	1000
Die Length, $\mu\text{m}$	735
Bond Pad Size (Ground pad), $\mu\text{m}$	75 x 75

## Assembly and Handling Procedure

1. Storage  
Dice should be stored in a dry nitrogen purged desiccators or equivalent.
2. ESD  
MMIC Gallium Arsenide (GaAs) filter dice are susceptible to electrostatic and mechanical damage. Die are supplied in antistatic protected material, which should be opened in clean room conditions at an appropriately grounded anti-static workstation. Devices need careful handling using correctly designed collets, vacuum pickup tips or sharp antistatic tweezers to deter ESD damage to dice.
3. Die Attach  
The die mounting surface must be clean and flat. Using conductive silver filled epoxy, recommended epoxies are DieMat DM6030Hk-PT/H579/H579 or Ablestik 84-1LMISR4. Apply sufficient epoxy to meet required epoxy bond line thickness, epoxy fillet height and epoxy coverage around total die periphery. Parts shall be cured in a nitrogen filled atmosphere per manufacturer's cure condition. It is recommended to use antistatic die pick up tools only.
4. Wire Bonding  
Bond pad openings in the surface passivation above the bond pads are provided to allow wire bonding to the dice gold bond pads. Thermosonic bonding is used with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. Suggested wire is pure gold, 1 mil diameter. Bonds must be made from the bond pads on the die to the package or substrate. All bond wires should be kept as short as low as reasonable to minimize performance degradation due to undesirable series inductance.

## Assembly Diagram



### Recommended Wire Length, Typical

Wire	Wire Length (mm)	Wire Loop Height (mm)
All wires	1.0	0.15

Note: Use double bond wire at RF IN & RF OUT

<b>Additional Detailed Technical Information</b> <i>additional information is available on our dash board.</i>	
<b>Performance Data</b>	Data Table
	Swept Graphs
	S-Parameter (S2P Files) Data Set with and without port extension(.zip file)
<b>Case Style</b>	Die
<b>Die Ordering and packaging information</b>	Quantity, Package                      Model No. Small, Gel - Pak: 10,50,100 KGD*    XLF-861-DG+ Medium†, Partial wafer: KGD*<1745   XLF-861-DP+
	†Available upon request contact sales representative
	Refer to <a href="#">AN-60-067</a>
<b>Environmental Ratings</b>	ENV-80

\*Known Good Dice ("KGD") means that the dice are taken from PCM good wafer and visually inspected according to Mini-Circuits inspection criteria. While this is not definitive, it does help to provide a higher degree of confidence that dice are capable of meeting typical RF electrical parameters specified by Mini-Circuits.

## ESD Rating\*\*

Human Body Model (HBM): Class 1A (250V) in accordance with ANSI/ESD STM 5.1 - 2001

\*\* Tested in industry standard MCLP 3x3mm 12 lead package.

### Additional Notes

- 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.
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Typical Performance Data

FREQ.  (MHz)	INSERTION LOSS					GROUP DELAY				
	(dB)					(nsec)				
	@-55°C	@-40°C	@+25°C	@+85°C	@+105°C	@-55°C	@-40°C	@+25°C	@+85°C	@+105°C
10	0.54	0.57	0.68	0.73	0.77	0.18	0.21	0.21	0.21	0.18
50	0.54	0.56	0.65	0.72	0.75	0.19	0.21	0.20	0.21	0.19
100	0.52	0.55	0.64	0.72	0.74	0.20	0.20	0.20	0.20	0.20
120	0.53	0.55	0.65	0.72	0.75	0.20	0.20	0.20	0.20	0.20
140	0.53	0.55	0.65	0.73	0.75	0.20	0.20	0.20	0.20	0.20
160	0.54	0.56	0.66	0.74	0.76	0.20	0.20	0.20	0.20	0.20
180	0.53	0.56	0.66	0.73	0.77	0.20	0.20	0.20	0.20	0.20
200	0.54	0.56	0.66	0.75	0.77	0.20	0.20	0.20	0.20	0.20
250	0.55	0.58	0.69	0.77	0.80	0.20	0.20	0.20	0.20	0.20
300	0.56	0.59	0.71	0.79	0.82	0.20	0.20	0.20	0.20	0.20
350	0.58	0.61	0.73	0.81	0.85	0.20	0.21	0.20	0.20	0.20
400	0.59	0.62	0.74	0.83	0.87	0.21	0.21	0.21	0.21	0.21
450	0.61	0.66	0.78	0.88	0.90	0.21	0.21	0.21	0.21	0.21
500	0.64	0.68	0.81	0.91	0.95	0.22	0.22	0.21	0.21	0.21
550	0.68	0.71	0.86	0.96	1.00	0.22	0.22	0.22	0.22	0.22
600	0.72	0.76	0.91	1.01	1.05	0.23	0.23	0.22	0.22	0.22
650	0.77	0.81	0.97	1.08	1.12	0.23	0.24	0.23	0.23	0.23
700	0.83	0.87	1.04	1.16	1.20	0.24	0.24	0.24	0.24	0.24
750	0.89	0.94	1.12	1.24	1.29	0.25	0.25	0.25	0.25	0.25
800	0.98	1.03	1.22	1.35	1.40	0.26	0.26	0.26	0.26	0.26
850	1.09	1.13	1.33	1.48	1.53	0.27	0.27	0.27	0.27	0.27
860	1.11	1.16	1.37	1.51	1.56	0.27	0.27	0.27	0.27	0.27
880	1.17	1.22	1.43	1.57	1.62	0.28	0.28	0.27	0.27	0.27
900	1.22	1.27	1.48	1.63	1.69	0.29	0.28	0.28	0.28	0.28
920	1.28	1.33	1.55	1.71	1.76	0.29	0.29	0.28	0.28	0.28
940	1.34	1.40	1.62	1.79	1.84	0.29	0.29	0.29	0.29	0.29
960	1.41	1.47	1.70	1.87	1.93	0.30	0.30	0.29	0.29	0.29
980	1.50	1.56	1.80	1.97	2.03	0.30	0.30	0.30	0.30	0.30
1000	1.58	1.64	1.89	2.06	2.13	0.31	0.31	0.31	0.30	0.30
1050	1.84	1.90	2.16	2.36	2.42	0.32	0.32	0.31	0.31	0.31
1100	2.16	2.22	2.51	2.72	2.79	0.34	0.33	0.33	0.32	0.32
1150	2.54	2.62	2.93	3.15	3.23	0.34	0.34	0.33	0.33	0.33
1200	3.02	3.10	3.43	3.68	3.76	0.35	0.35	0.34	0.34	0.33
1300	4.28	4.37	4.75	5.02	5.12	0.35	0.35	0.34	0.33	0.33
1400	6.03	6.13	6.53	6.85	6.95	0.33	0.33	0.31	0.30	0.29
1500	8.27	8.38	8.83	9.16	9.26	0.28	0.28	0.25	0.24	0.23
1600	11.07	11.19	11.65	11.99	12.10	0.20	0.20	0.17	0.15	0.14
1700	14.51	14.62	15.09	15.42	15.53	0.08	0.07	0.03	-0.01	-0.02
1800	18.76	18.86	19.29	19.54	19.58	-0.18	-0.20	-0.26	-0.32	-0.33
1900	23.76	23.80	23.73	23.54	23.45	-0.81	-0.82	-0.85	-0.83	-0.83
2000	26.00	25.80	24.92	24.21	23.97	-1.16	-1.11	-0.96	-0.85	-0.81
2500	16.68	16.68	16.70	16.62	16.61	0.07	0.07	0.06	0.05	0.05
3000	14.78	14.81	14.93	14.97	14.97	0.08	0.08	0.07	0.07	0.07
3500	14.51	14.55	14.71	14.78	14.78	0.07	0.07	0.07	0.06	0.06
4000	14.74	14.80	14.99	15.05	15.08	0.07	0.07	0.06	0.06	0.06
4500	15.17	15.21	15.42	15.51	15.56	0.06	0.07	0.05	0.06	0.06
5000	15.62	15.68	15.90	15.99	16.06	0.06	0.06	0.05	0.06	0.05
5500	16.06	16.11	16.33	16.47	16.51	0.06	0.05	0.05	0.05	0.05
6000	16.38	16.47	16.69	16.80	16.86	0.05	0.06	0.05	0.06	0.05
6500	16.54	16.59	16.86	16.95	16.98	0.06	0.06	0.05	0.06	0.06
7000	16.42	16.46	16.66	16.74	16.77	0.07	0.06	0.06	0.06	0.06
7500	15.72	15.78	15.92	15.94	15.96	0.07	0.07	0.07	0.08	0.08
8000	14.12	14.15	14.26	14.20	14.19	0.11	0.11	0.12	0.13	0.13
8500	11.15	11.19	11.41	11.54	11.62	0.25	0.25	0.27	0.29	0.30
9000	10.73	10.99	12.19	13.20	13.54	0.36	0.35	0.31	0.28	0.27
10000	21.05	21.23	22.11	22.76	22.95	0.08	0.07	0.06	0.05	0.07
11000	25.85	25.97	26.52	26.84	27.00	0.04	0.03	0.03	0.03	0.02
12000	27.09	27.22	27.70	27.92	28.00	0.04	0.05	0.03	0.04	0.03
13000	26.82	26.95	27.41	27.64	27.76	0.03	0.04	0.03	0.02	0.03
14000	26.17	26.33	26.62	26.84	26.83	0.04	0.05	0.03	0.04	0.04
15000	25.31	25.37	25.61	25.69	25.76	0.04	0.04	0.04	0.03	0.04
16000	24.18	24.25	24.54	24.70	24.76	0.04	0.04	0.05	0.04	0.04
17000	23.07	23.20	23.65	23.90	23.96	0.05	0.04	0.05	0.04	0.05
18000	22.58	22.68	23.02	23.28	23.34	0.05	0.05	0.06	0.04	0.05
19000	22.34	22.45	22.96	23.41	23.36	0.05	0.06	0.04	0.05	0.05
20000	22.53	22.68	23.70	24.29	24.50	0.06	0.06	0.04	0.04	0.04
21000	24.10	23.98	23.64	24.31	24.63	-0.04	-0.03	0.05	0.04	0.03
22000	24.42	24.51	24.32	24.55	24.66	0.00	-0.01	0.03	0.04	0.04
23000	24.59	24.72	24.98	24.97	24.87	0.02	0.02	0.04	0.04	0.04
24000	23.69	23.94	25.44	25.89	26.00	0.06	0.07	0.03	0.02	0.02
25000	25.33	25.41	26.04	26.72	27.11	0.03	0.04	0.02	0.01	-0.01
26000	27.27	27.19	26.68	27.04	27.23	-0.03	-0.01	0.01	0.01	0.03
27000	26.60	26.68	27.04	26.73	26.70	0.00	0.00	-0.02	0.02	0.02
28000	22.69	22.69	23.24	23.81	24.20	0.11	0.10	0.16	0.17	0.21
29000	20.52	21.00	23.81	28.14	29.52	0.31	0.32	0.39	0.41	0.54
30000	23.90	24.20	24.34	24.09	24.17	0.35	0.36	0.31	0.26	0.23



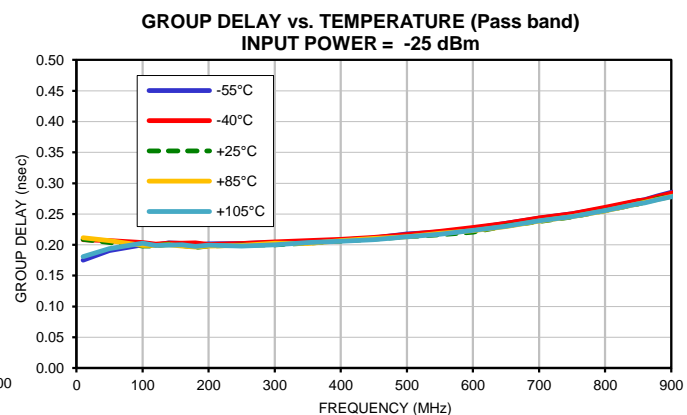
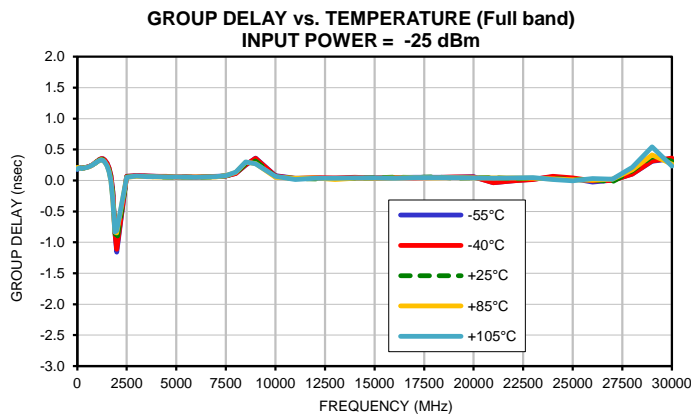
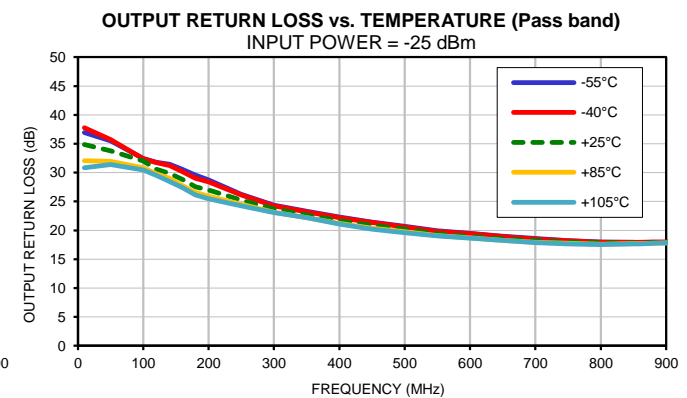
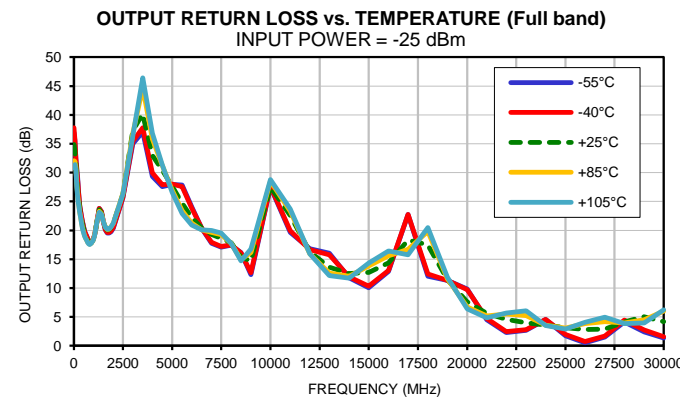
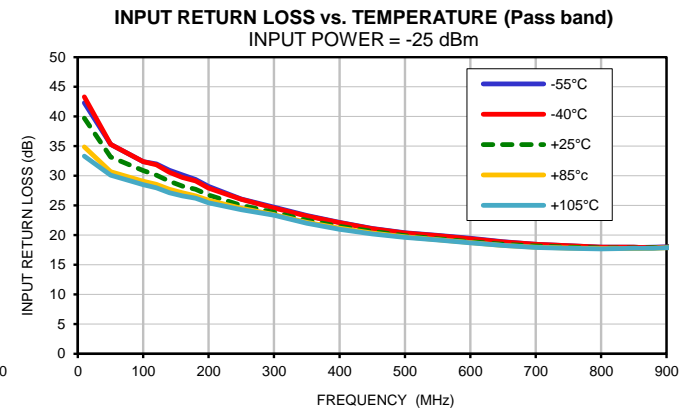
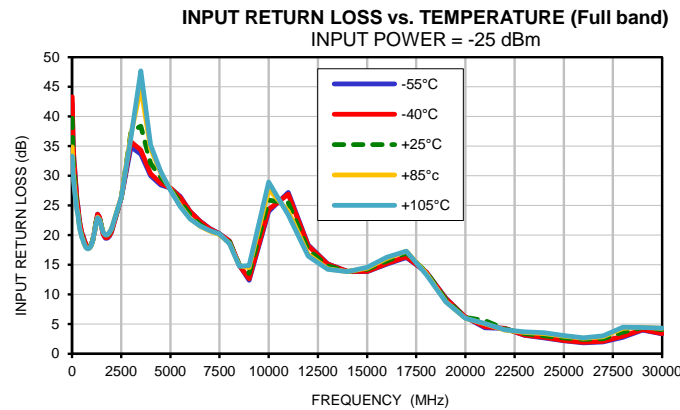
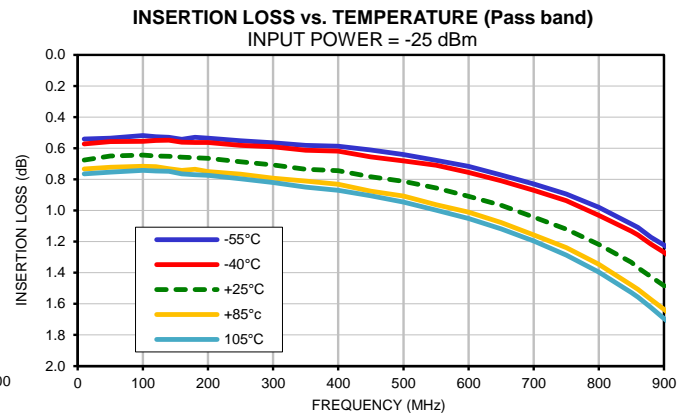
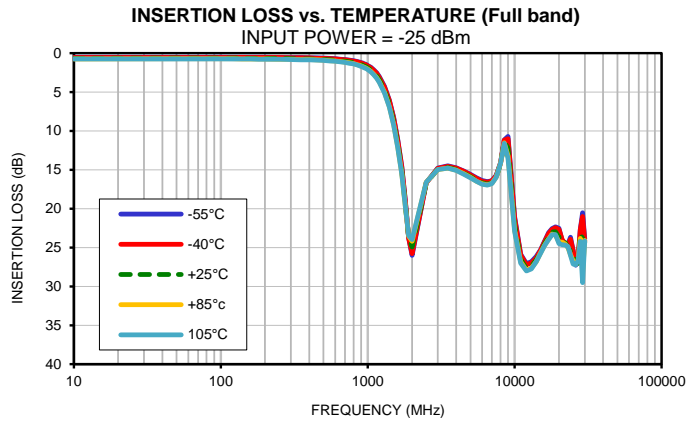
Typical Performance Data

FREQ.  (MHz)	INPUT RETURN LOSS					OUTPUT RETURN LOSS				
	(dB)					(dB)				
	@-55°C	@-40°C	@+25°C	@+85°C	@+105°C	@-55°C	@-40°C	@+25°C	@+85°C	@+105°C
10	42.30	43.31	39.73	34.87	33.33	36.92	37.77	34.87	32.04	30.84
50	35.29	35.29	33.16	30.71	30.11	35.47	35.70	33.77	31.94	31.42
100	32.38	32.40	30.87	29.09	28.54	32.47	32.41	32.00	30.86	30.44
120	32.01	31.86	30.14	28.54	27.96	31.79	31.74	30.59	29.79	29.51
140	30.96	30.61	29.12	27.75	27.17	31.44	31.21	29.87	29.00	28.46
160	30.16	29.73	28.26	27.16	26.64	30.59	30.17	28.82	27.74	27.38
180	29.40	29.14	27.72	26.61	26.23	29.57	29.02	27.55	26.57	26.12
200	28.22	27.92	26.77	25.89	25.47	28.70	28.43	26.97	25.89	25.46
250	26.09	26.03	25.03	24.52	24.30	26.26	26.14	25.26	24.49	24.25
300	24.70	24.56	23.84	23.45	23.34	24.35	24.24	23.71	23.16	23.09
350	23.30	23.22	22.49	22.17	22.03	23.31	23.18	22.64	22.17	22.17
400	22.17	22.11	21.49	21.19	21.00	22.32	22.19	21.63	21.22	21.08
450	21.16	21.07	20.67	20.38	20.21	21.39	21.34	20.84	20.38	20.20
500	20.42	20.37	19.91	19.72	19.62	20.68	20.58	20.18	19.75	19.59
550	19.97	19.90	19.38	19.25	19.21	19.92	19.80	19.40	19.09	19.02
600	19.46	19.39	18.88	18.75	18.71	19.48	19.42	18.91	18.72	18.67
650	18.88	18.84	18.45	18.28	18.25	18.97	18.93	18.48	18.28	18.23
700	18.48	18.45	18.18	17.97	17.95	18.57	18.49	18.18	17.94	17.86
750	18.22	18.20	17.99	17.85	17.78	18.20	18.20	17.97	17.73	17.63
800	18.00	17.99	17.85	17.72	17.69	17.96	17.94	17.78	17.60	17.53
850	17.96	17.96	17.86	17.76	17.76	17.90	17.91	17.78	17.67	17.63
860	17.93	17.93	17.84	17.74	17.77	17.88	17.91	17.79	17.68	17.64
880	17.96	17.95	17.88	17.80	17.78	17.94	17.97	17.87	17.78	17.73
900	18.02	18.00	17.96	17.86	17.87	17.95	17.97	17.91	17.84	17.78
920	18.09	18.09	18.06	17.95	17.95	18.05	18.06	18.00	17.93	17.90
940	18.16	18.17	18.14	18.04	18.03	18.17	18.17	18.13	18.07	18.03
960	18.31	18.31	18.30	18.17	18.17	18.24	18.29	18.24	18.16	18.13
980	18.42	18.43	18.44	18.32	18.30	18.39	18.42	18.39	18.32	18.25
1000	18.53	18.56	18.57	18.45	18.43	18.57	18.62	18.59	18.50	18.43
1050	19.04	19.09	19.14	19.04	19.03	19.03	19.12	19.15	19.06	18.98
1100	19.82	19.87	19.97	19.86	19.83	19.87	19.92	20.04	19.94	19.88
1150	20.71	20.72	20.83	20.72	20.69	20.84	20.88	21.02	20.90	20.87
1200	21.80	21.82	21.88	21.70	21.63	21.93	21.95	22.02	21.87	21.79
1300	23.57	23.52	23.37	23.04	22.94	23.78	23.79	23.60	23.29	23.11
1400	22.97	22.98	22.86	22.62	22.54	23.25	23.22	23.03	22.87	22.74
1500	21.29	21.30	21.43	21.35	21.30	21.43	21.50	21.50	21.52	21.53
1600	20.06	20.13	20.43	20.45	20.45	20.08	20.15	20.48	20.56	20.54
1700	19.49	19.59	19.96	20.04	20.04	19.52	19.62	20.06	20.17	20.21
1800	19.47	19.57	19.97	20.06	20.05	19.54	19.62	20.14	20.22	20.24
1900	19.82	19.94	20.36	20.45	20.44	19.76	19.90	20.49	20.63	20.60
2000	20.48	20.55	20.93	21.05	21.06	20.35	20.50	21.09	21.19	21.24
2500	26.23	26.30	26.27	26.40	26.32	25.62	25.75	26.28	26.42	26.31
3000	34.87	35.73	37.47	37.04	36.50	34.99	35.42	37.20	36.82	36.38
3500	33.65	34.32	38.34	44.87	47.69	37.05	37.77	40.17	44.69	46.43
4000	30.03	30.37	32.13	34.59	35.21	29.35	29.95	32.93	35.83	36.81
4500	28.45	28.77	29.83	30.56	30.74	27.56	27.88	30.36	31.24	31.32
5000	27.94	27.92	27.85	27.67	27.54	27.96	27.99	27.62	26.97	26.57
5500	26.52	26.39	25.61	24.98	24.85	27.86	27.55	24.72	23.43	22.91
6000	24.00	23.98	23.47	22.83	22.71	24.05	23.85	22.20	21.24	20.94
6500	22.38	22.34	21.82	21.54	21.55	20.36	20.40	20.47	20.11	20.07
7000	21.12	21.06	20.72	20.72	20.81	17.77	17.92	19.30	19.66	19.99
7500	20.27	20.23	20.15	20.10	20.19	17.10	17.23	18.59	19.23	19.55
8000	18.99	18.97	18.87	18.63	18.54	17.45	17.50	17.83	17.73	17.75
8500	14.95	14.92	15.00	14.86	14.78	16.16	16.08	15.34	14.95	14.72
9000	12.39	12.62	13.54	14.54	14.89	12.32	12.66	14.69	16.15	16.76
10000	24.00	24.36	25.88	27.75	28.95	27.52	27.61	27.55	28.49	28.81
11000	27.19	26.91	25.48	24.07	23.40	19.66	19.94	22.63	23.32	23.66
12000	18.37	18.21	17.52	16.78	16.47	16.79	16.65	16.23	15.94	15.91
13000	15.18	15.11	14.83	14.34	14.22	16.05	15.75	13.60	12.60	12.18
14000	13.88	13.89	13.92	13.83	13.86	11.76	11.94	12.52	12.04	11.74
15000	13.83	13.91	14.25	14.44	14.59	10.06	10.31	12.73	13.80	14.32
16000	15.10	15.21	15.65	16.07	16.26	12.89	13.02	14.34	15.61	16.42
17000	16.23	16.37	17.03	17.28	17.31	22.74	22.76	18.32	16.69	15.77
18000	13.78	13.76	13.78	13.56	13.36	12.04	12.45	17.49	19.78	20.45
19000	9.38	9.33	9.12	8.82	8.75	11.32	11.31	11.42	11.58	11.85
20000	6.16	6.17	6.11	5.99	6.00	9.82	9.70	7.64	6.75	6.37
21000	4.38	4.57	5.58	5.07	5.09	4.49	4.72	5.63	5.19	4.83
22000	4.27	4.29	4.17	4.02	4.06	2.27	2.48	4.56	5.52	5.68
23000	3.13	3.19	3.43	3.61	3.71	2.66	2.77	3.96	5.24	6.04
24000	2.69	2.78	3.05	3.40	3.54	4.55	4.59	3.60	3.55	3.54
25000	2.18	2.26	2.69	2.97	3.06	1.71	1.97	3.15	3.08	2.88
26000	1.85	1.95	2.44	2.62	2.70	0.53	0.74	2.81	3.87	4.07
27000	1.99	2.10	2.53	2.86	3.02	1.51	1.67	2.87	4.18	4.94
28000	2.78	2.97	3.66	4.31	4.49	4.14	4.47	4.14	3.95	3.84
29000	4.02	4.07	4.45	4.49	4.44	2.43	2.74	5.02	4.51	3.93
30000	3.36	3.43	4.10	4.30	4.33	1.37	1.59	4.18	5.99	6.23





## Typical Performance Curves



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.

<b>Specification</b>	<b>Test/Inspection Condition</b>	<b>Reference/Spec</b>
Operating Temperature	-40° to 85° C or -40° to 105° C or -55° to 105° C or -45° to 105° C Ambient Environment	Refer to Individual Model Data Sheet
Storage Environment (Die)	-65° to 150°C	Individual Model Data Sheet
Storage Environment(Packaging)	-40° to 70°C and 40 to 60% humidity (In Factory Shipped Package)	