

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 ± 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



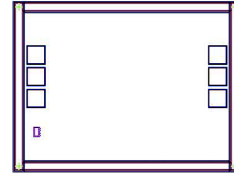
Reflectionless Low Pass Filter Die

XLF-122-D+

50Ω DC to 1150 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

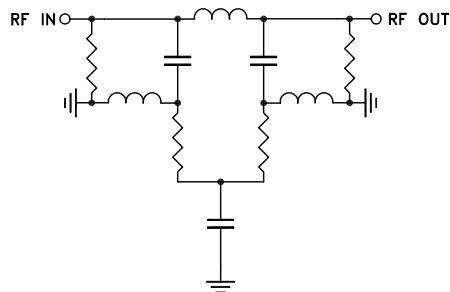
The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

Ordering Information: Refer to Last Page

General Description

Mini-Circuits' XLF-122-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 Specifications¹ at 25°C

Parameter		F#	Frequency (MHz)	Min.	Typ.	Max.	Unit
Pass Band	Insertion Loss	DC - F1	DC-1150		1.4		dB
	Frequency Cut-off	F2	1510		3.0		dB
	VSWR	DC - F1	DC-1150		1.2		:1
Stop Band	Rejection	F3 - F4	2190 - 10000		14		dB
		F4 - F5	10000 - 21000		21		dB
	VSWR	F3 - F4	2190 - 10000		1.2		:1
		F4 - F5	10000 - 21000		1.5		:1

¹ Measured on Mini-Circuits Characterization test board. Die packaged in 3mm x 3mm, 12-lead MCLP package and soldered on TB-844-122+

Absolute Maximum Ratings^{1,4}

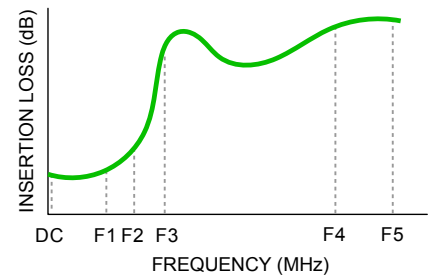
Parameter	Ratings
Operating Temperature	-55°C to +105°C
RF Power Input, Passband (DC-F1) ²	2W at 25°C
RF Power Input, Stopband (F2-F5) ³	0.5W at 25°C

² Passband rating derates linearly to 1W at 105°C ambient

³ Stopband rating derates linearly to 0.25W at 105°C ambient

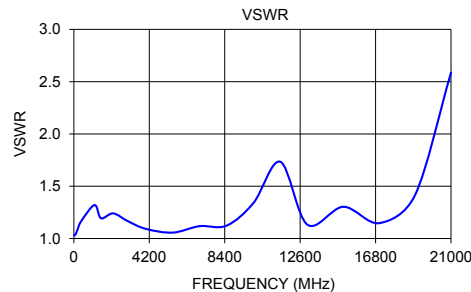
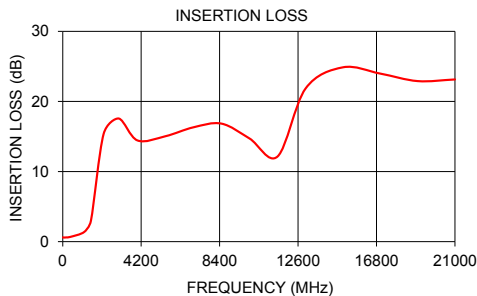
⁴ Permanent damage may occur if any of these limits are exceeded.

Specification Definition



Typical Performance Data at 25°C¹

Frequency (MHz)	Insertion Loss (dB)	VSWR (:1)
10	0.62	1.03
50	0.59	1.03
100	0.59	1.04
200	0.61	1.08
400	0.67	1.16
1150	1.38	1.32
1510	2.99	1.19
2190	15.37	1.24
3000	17.56	1.17
4000	14.44	1.09
5500	15.04	1.06
7000	16.31	1.12
8500	16.84	1.12
10000	14.72	1.34
11500	12.15	1.73
13000	21.84	1.13
15000	24.87	1.30
17000	23.97	1.15
19000	22.90	1.42
21000	23.14	2.59



Die Layout

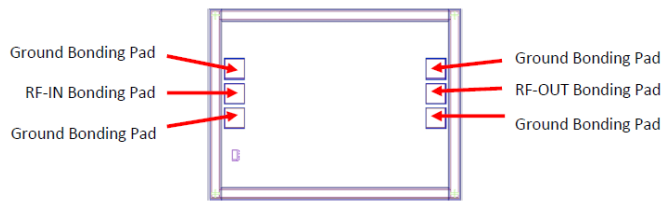


Fig 1. Die Layout

Bonding Pad Position
(Dimensions in μm , Typical)

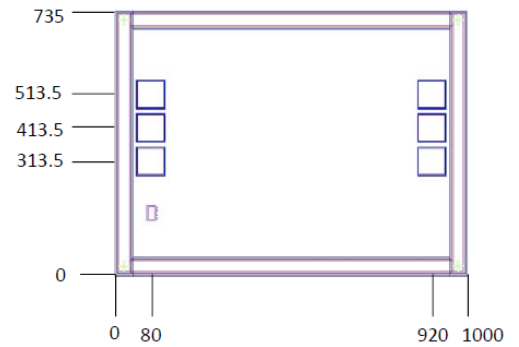


Fig 2. Bonding Pad Positions

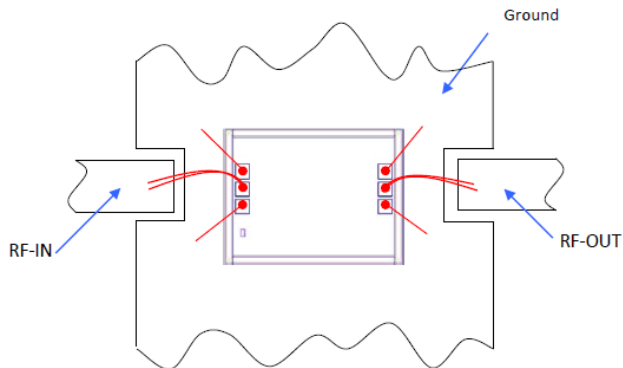
Critical Dimensions

Parameter	Values
Die Thickness, μm	100
Die Width, μm	1000
Die Length, μm	735
Bond Pad Size (Ground pad), μm	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

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	0.53	0.56	0.61	0.66	0.71	0.17	0.20	0.20	0.19	0.20
50	0.48	0.50	0.58	0.65	0.67	0.17	0.18	0.18	0.18	0.18
100	0.49	0.51	0.59	0.66	0.68	0.16	0.16	0.16	0.16	0.16
200	0.50	0.52	0.61	0.68	0.71	0.15	0.15	0.15	0.16	0.16
300	0.52	0.54	0.63	0.72	0.74	0.15	0.15	0.15	0.16	0.16
400	0.55	0.57	0.66	0.74	0.78	0.16	0.16	0.16	0.16	0.16
500	0.58	0.60	0.70	0.79	0.82	0.16	0.16	0.16	0.16	0.16
600	0.62	0.64	0.76	0.85	0.88	0.16	0.16	0.16	0.17	0.17
700	0.66	0.69	0.81	0.92	0.95	0.17	0.17	0.17	0.17	0.17
800	0.73	0.76	0.89	1.00	1.03	0.18	0.18	0.17	0.18	0.18
900	0.82	0.85	0.99	1.10	1.14	0.19	0.19	0.19	0.19	0.19
1000	0.92	0.95	1.11	1.24	1.28	0.20	0.20	0.19	0.20	0.20
1100	1.07	1.11	1.27	1.42	1.47	0.21	0.21	0.21	0.21	0.21
1150	1.16	1.20	1.37	1.52	1.58	0.22	0.22	0.22	0.22	0.22
1200	1.28	1.32	1.50	1.66	1.72	0.22	0.22	0.22	0.23	0.23
1250	1.41	1.45	1.65	1.82	1.87	0.23	0.23	0.23	0.23	0.24
1300	1.56	1.61	1.82	2.00	2.06	0.24	0.24	0.24	0.24	0.24
1350	1.75	1.81	2.03	2.22	2.28	0.25	0.25	0.25	0.25	0.25
1400	1.97	2.03	2.27	2.47	2.54	0.26	0.26	0.26	0.26	0.26
1450	2.24	2.30	2.55	2.77	2.85	0.27	0.27	0.26	0.26	0.26
1500	2.56	2.63	2.89	3.12	3.20	0.27	0.27	0.27	0.27	0.27
1510	2.63	2.70	2.97	3.20	3.28	0.27	0.28	0.27	0.27	0.27
1550	2.93	3.01	3.29	3.54	3.62	0.28	0.28	0.27	0.27	0.27
1600	3.37	3.45	3.75	4.01	4.10	0.28	0.28	0.27	0.27	0.27
1650	3.88	3.96	4.28	4.55	4.65	0.28	0.28	0.27	0.27	0.27
1700	4.46	4.54	4.88	5.17	5.26	0.28	0.28	0.27	0.27	0.27
1750	5.11	5.20	5.56	5.86	5.96	0.27	0.27	0.26	0.26	0.26
1800	5.85	5.95	6.32	6.63	6.74	0.27	0.26	0.25	0.25	0.25
1850	6.68	6.77	7.16	7.49	7.59	0.25	0.25	0.24	0.23	0.23
1900	7.59	7.69	8.09	8.42	8.53	0.24	0.23	0.22	0.21	0.21
1950	8.58	8.69	9.10	9.45	9.56	0.22	0.21	0.20	0.19	0.19
2000	9.67	9.78	10.21	10.56	10.68	0.20	0.19	0.16	0.16	0.16
2050	10.86	10.97	11.40	11.76	11.89	0.17	0.16	0.15	0.13	0.13
2100	12.15	12.26	12.71	13.08	13.19	0.14	0.13	0.11	0.09	0.09
2150	13.56	13.67	14.12	14.50	14.61	0.10	0.09	0.06	0.04	0.04
2190	14.76	14.89	15.34	15.71	15.83	0.06	0.05	0.02	-0.01	-0.02
2200	15.09	15.20	15.66	16.03	16.14	0.05	0.04	0.00	-0.02	-0.03
2400	22.82	22.89	23.03	23.02	23.01	-0.53	-0.55	-0.61	-0.63	-0.63
2600	25.13	24.92	24.10	23.44	23.25	-0.74	-0.70	-0.59	-0.52	-0.49
2800	20.34	20.28	19.96	19.70	19.63	-0.08	-0.08	-0.07	-0.07	-0.07
3000	17.69	17.66	17.56	17.46	17.44	0.03	0.03	0.03	0.03	0.03
3500	15.02	15.04	15.10	15.12	15.13	0.07	0.06	0.06	0.06	0.06
4000	14.30	14.33	14.43	14.51	14.53	0.06	0.06	0.06	0.06	0.06
4500	14.24	14.26	14.39	14.49	14.53	0.06	0.06	0.05	0.06	0.06
5000	14.45	14.49	14.64	14.75	14.79	0.05	0.05	0.05	0.05	0.05
5500	14.82	14.86	15.03	15.15	15.20	0.05	0.05	0.05	0.05	0.05
6000	15.23	15.28	15.46	15.59	15.65	0.05	0.05	0.04	0.05	0.05
6500	15.66	15.71	15.90	16.04	16.08	0.04	0.04	0.04	0.04	0.05
7000	16.05	16.11	16.30	16.43	16.47	0.04	0.04	0.04	0.04	0.04
7500	16.39	16.44	16.63	16.76	16.80	0.04	0.04	0.04	0.04	0.04
8000	16.58	16.64	16.83	16.95	16.99	0.04	0.04	0.04	0.04	0.05
8500	16.61	16.66	16.84	16.95	16.98	0.04	0.04	0.04	0.04	0.05
9000	16.39	16.44	16.59	16.67	16.71	0.05	0.05	0.05	0.05	0.05
10000	14.64	14.67	14.72	14.69	14.70	0.08	0.08	0.09	0.09	0.10
11000	10.13	10.21	10.59	10.97	11.13	0.26	0.26	0.27	0.28	0.28
12000	14.86	15.11	16.14	17.01	17.30	0.15	0.15	0.13	0.13	0.13
13000	21.00	21.15	21.78	22.33	22.53	0.07	0.07	0.07	0.07	0.08
14000	23.65	23.77	24.19	24.59	24.71	0.06	0.06	0.06	0.06	0.06
15000	24.42	24.52	24.83	25.05	25.15	0.05	0.05	0.05	0.05	0.06
16000	24.23	24.32	24.62	24.75	24.83	0.05	0.05	0.05	0.04	0.05
17000	23.65	23.70	23.94	24.11	24.19	0.05	0.05	0.04	0.05	0.06
18000	22.91	22.99	23.28	23.46	23.49	0.04	0.04	0.05	0.05	0.06
19000	22.46	22.55	22.89	23.10	23.22	0.06	0.05	0.04	0.05	0.05
20000	22.33	22.41	22.78	23.12	23.25	0.05	0.05	0.04	0.05	0.05
21000	22.61	22.65	22.97	23.43	23.53	0.03	0.04	0.04	0.03	0.03
22000	22.76	22.91	23.33	23.50	23.59	0.04	0.03	0.03	0.03	0.03
23000	23.11	23.22	23.60	23.86	23.90	0.04	0.04	0.04	0.03	0.03
24000	23.31	23.23	23.27	23.47	23.57	0.02	0.05	0.05	0.05	0.06
25000	23.12	23.23	23.55	23.74	23.80	0.03	0.04	0.03	0.04	0.04
26000	23.28	23.38	23.84	24.13	24.23	0.04	0.03	0.03	0.02	0.03
27000	23.18	23.33	23.96	24.41	24.58	0.04	0.04	0.03	0.05	0.05
28000	23.31	23.42	24.04	24.70	24.96	0.05	0.05	0.04	0.06	0.05
29000	24.14	24.25	24.96	25.66	25.97	0.05	0.05	0.05	0.05	0.05
30000	25.89	26.09	27.05	27.56	27.72	0.06	0.06	0.03	0.04	0.06

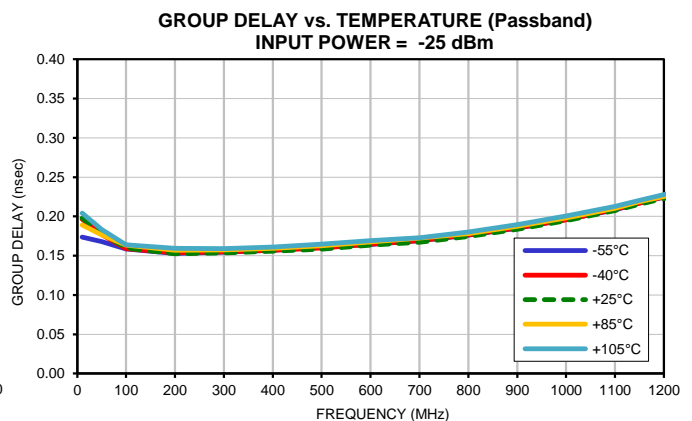
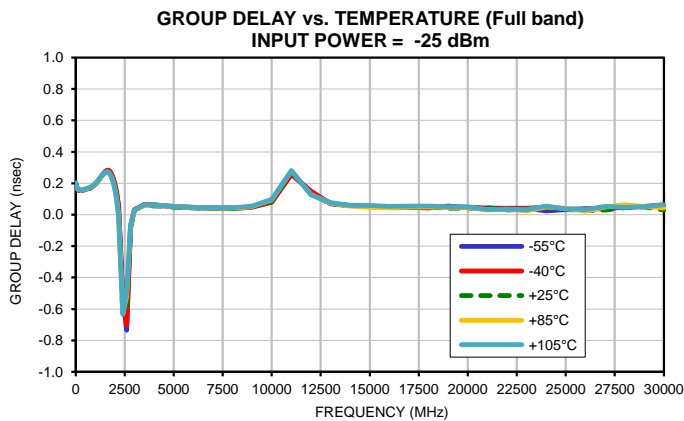
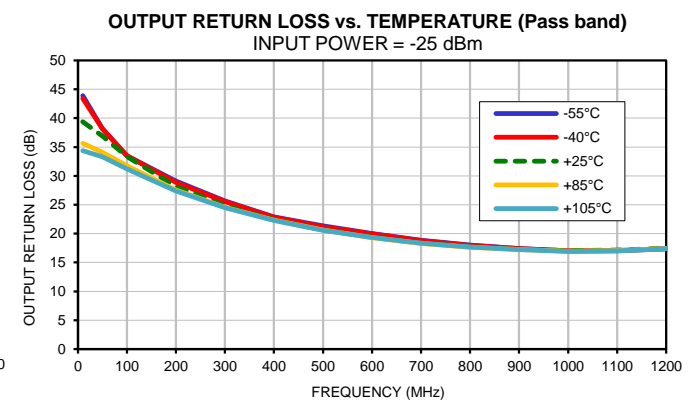
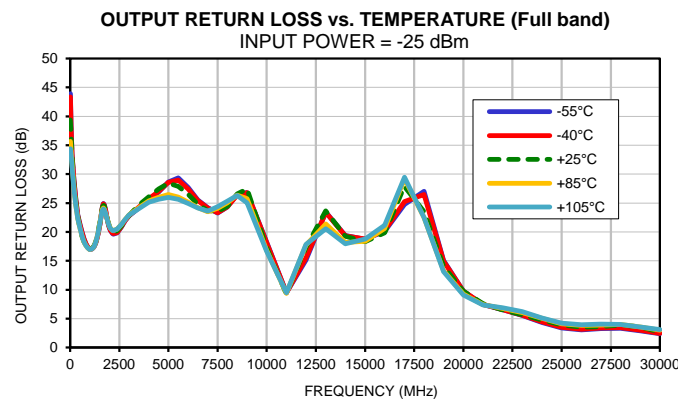
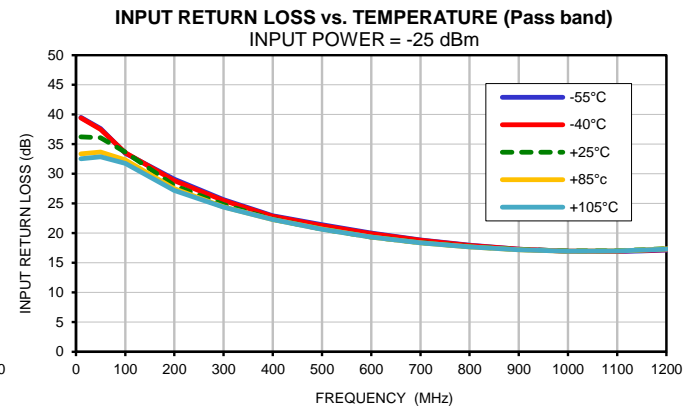
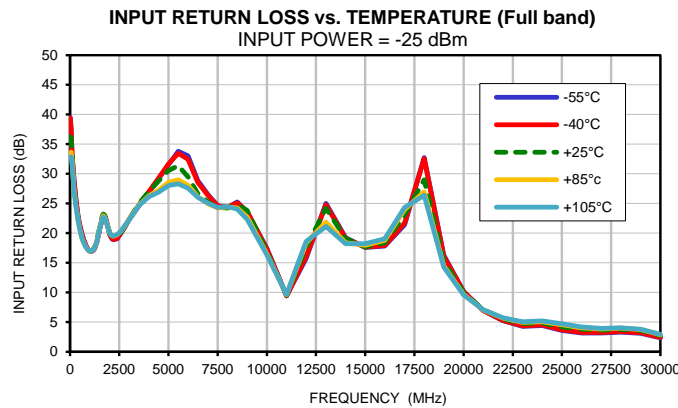
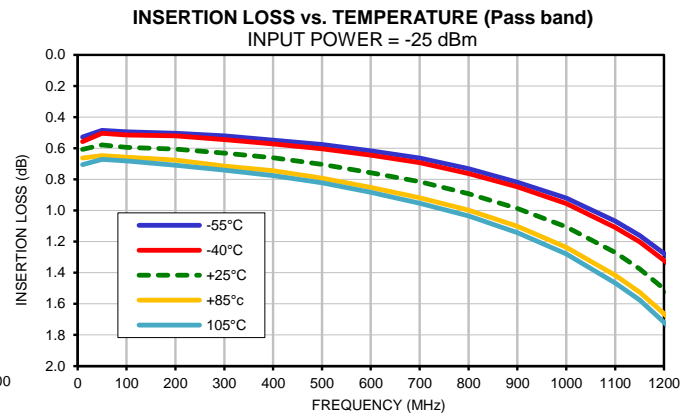
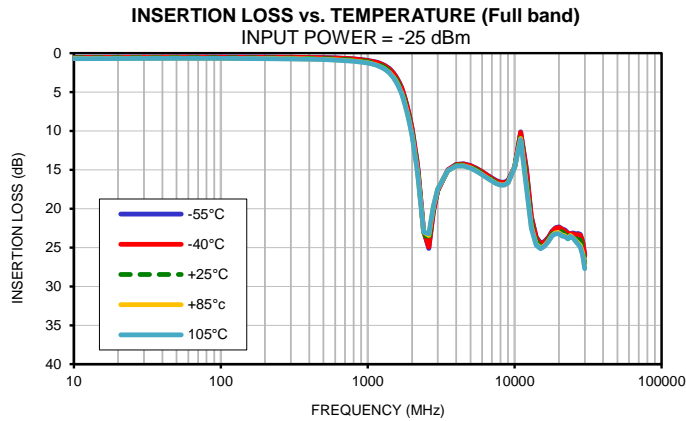


Typical Performance Data

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	39.51	39.42	36.23	33.35	32.53	43.92	43.38	39.38	35.67	34.37
50	37.63	37.50	36.10	33.68	32.87	38.20	38.21	36.94	34.10	33.31
100	33.48	33.57	33.66	32.36	31.74	33.46	33.49	33.37	31.77	31.19
200	29.07	28.86	28.03	27.48	27.21	29.09	28.86	28.11	27.57	27.38
300	25.63	25.49	24.80	24.45	24.36	25.65	25.54	24.82	24.54	24.50
400	22.91	22.82	22.36	22.29	22.28	22.91	22.84	22.39	22.33	22.27
500	21.41	21.28	20.72	20.68	20.66	21.32	21.18	20.63	20.60	20.59
600	19.99	19.89	19.35	19.32	19.32	20.03	19.94	19.36	19.32	19.32
700	18.87	18.79	18.43	18.36	18.38	18.87	18.81	18.38	18.32	18.33
800	17.97	17.94	17.74	17.67	17.69	18.02	17.98	17.73	17.65	17.66
900	17.31	17.30	17.27	17.20	17.20	17.39	17.40	17.40	17.23	17.21
1000	16.96	16.96	17.03	16.96	16.95	17.01	17.01	17.04	16.95	16.93
1100	16.92	16.97	17.07	17.01	17.00	17.03	17.08	17.15	17.05	17.04
1150	17.03	17.09	17.22	17.16	17.14	17.17	17.23	17.14	17.24	17.21
1200	17.17	17.21	17.38	17.33	17.31	17.33	17.39	17.48	17.41	17.40
1250	17.46	17.49	17.70	17.63	17.60	17.65	17.71	17.84	17.80	17.77
1300	17.88	17.92	18.12	18.06	18.02	18.04	18.11	18.26	18.24	18.21
1350	18.38	18.44	18.62	18.55	18.51	18.59	18.67	18.86	18.83	18.82
1400	19.02	19.10	19.30	19.20	19.15	19.25	19.34	19.60	19.56	19.55
1450	19.70	19.78	20.04	19.93	19.87	19.98	20.08	20.41	20.34	20.31
1500	20.47	20.54	20.91	20.76	20.66	20.98	21.08	21.45	21.35	21.29
1510	20.63	20.69	21.08	20.94	20.84	21.14	21.25	21.63	21.50	21.45
1550	21.21	21.27	21.72	21.54	21.42	21.97	22.07	22.43	22.24	22.16
1600	21.96	22.02	22.47	22.23	22.10	23.24	23.30	23.49	23.23	23.09
1650	22.59	22.62	23.00	22.71	22.54	24.35	24.36	24.29	23.90	23.76
1700	23.01	23.02	23.23	22.92	22.75	24.93	24.86	24.59	24.15	24.00
1750	22.99	22.96	23.02	22.74	22.59	24.67	24.62	24.40	23.93	23.81
1800	22.62	22.60	22.58	22.36	22.28	23.74	23.73	23.66	23.28	23.18
1850	22.05	22.01	21.96	21.83	21.76	22.76	22.80	22.90	22.64	22.55
1900	21.34	21.33	21.31	21.24	21.18	21.92	21.96	22.17	21.99	21.95
1950	20.63	20.65	20.72	20.68	20.67	21.18	21.23	21.48	21.41	21.36
2000	19.98	20.01	20.19	20.20	20.18	20.67	20.73	20.98	21.00	20.95
2050	19.51	19.57	19.82	19.87	19.87	20.21	20.28	20.57	20.63	20.61
2100	19.17	19.22	19.56	19.63	19.64	19.99	20.07	20.36	20.50	20.45
2150	18.98	19.03	19.42	19.53	19.53	19.74	19.81	20.12	20.29	20.28
2190	18.89	18.97	19.39	19.49	19.53	19.64	19.72	20.04	20.23	20.22
2200	18.88	18.96	19.37	19.49	19.52	19.62	19.71	20.02	20.23	20.22
2400	19.06	19.16	19.57	19.73	19.77	19.82	19.89	20.22	20.50	20.52
2600	20.06	20.10	20.20	20.39	20.39	20.84	20.88	21.02	21.27	21.28
2800	21.17	21.19	21.23	21.39	21.36	21.92	21.98	21.95	22.15	22.17
3000	22.24	22.29	22.26	22.25	22.18	22.74	22.82	22.83	22.94	22.92
3500	24.59	24.72	24.96	24.74	24.62	24.16	24.30	24.64	24.19	24.03
4000	26.88	27.01	27.03	26.30	26.12	25.66	25.74	26.09	25.35	25.14
4500	29.20	29.28	28.81	27.24	26.89	26.86	26.99	27.43	25.95	25.67
5000	31.52	31.68	30.56	28.54	28.04	28.61	28.57	28.40	26.45	26.00
5500	33.81	33.44	31.36	28.99	28.32	29.36	28.98	27.89	26.05	25.64
6000	33.05	32.43	29.49	28.08	27.58	27.68	27.41	26.53	25.14	24.90
6500	28.84	28.55	26.69	26.13	26.04	25.54	25.41	24.79	24.22	24.15
7000	26.52	26.38	25.25	24.95	25.04	24.23	24.13	23.69	23.51	23.60
7500	24.61	24.58	24.34	24.25	24.32	23.28	23.33	23.52	24.09	24.35
8000	24.34	24.38	24.23	24.45	24.50	24.30	24.30	24.46	25.02	25.29
8500	25.24	25.12	24.74	24.24	24.03	26.47	26.36	26.59	26.36	26.31
9000	23.62	23.64	23.85	22.74	22.33	26.80	26.83	27.43	25.77	25.01
10000	17.42	17.32	16.81	16.47	16.31	18.30	18.15	17.26	16.85	16.68
11000	9.43	9.42	9.51	9.61	9.66	9.49	9.47	9.31	9.39	9.45
12000	15.75	16.10	17.65	18.39	18.58	15.15	15.52	17.38	17.73	17.83
13000	25.00	24.79	24.20	21.86	21.15	23.45	23.39	23.64	21.36	20.55
14000	19.24	19.16	19.09	18.38	18.24	19.38	19.35	19.26	18.16	17.95
15000	17.59	17.62	17.67	17.96	18.21	18.73	18.76	18.30	18.40	18.76
16000	17.84	17.93	18.37	18.80	19.05	20.12	20.21	19.86	20.62	21.15
17000	21.41	21.69	23.13	24.02	24.35	24.74	25.24	27.87	29.21	29.45
18000	32.72	32.58	29.01	26.96	26.40	27.02	26.44	23.54	22.47	22.46
19000	16.27	16.08	15.28	14.49	14.30	15.10	14.94	13.99	13.28	13.14
20000	10.16	10.12	9.97	9.66	9.59	9.75	9.75	9.75	9.25	9.08
21000	6.94	6.97	7.11	7.07	7.09	7.44	7.49	7.62	7.45	7.40
22000	5.27	5.31	5.55	5.69	5.75	6.52	6.55	6.51	6.76	6.87
23000	4.31	4.37	4.76	4.96	5.06	5.55	5.61	5.64	6.04	6.20
24000	4.44	4.53	4.85	5.07	5.19	4.31	4.42	4.78	5.05	5.12
25000	3.60	3.71	4.19	4.58	4.74	3.37	3.48	3.93	4.14	4.23
26000	3.17	3.28	3.79	4.07	4.17	3.08	3.18	3.53	3.81	3.93
27000	3.15	3.26	3.67	3.87	3.94	3.29	3.38	3.64	3.91	4.04
28000	3.31	3.42	3.78	3.98	4.07	3.34	3.45	3.93	4.02	4.02
29000	3.14	3.24	3.58	3.74	3.78	2.89	3.00	3.55	3.56	3.54
30000	2.35	2.42	2.74	2.89	2.94	2.40	2.46	2.68	2.99	3.12



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.

Specification	Test/Inspection Condition	Reference/Spec
Operating Temperature	-40° to 85° C or -40° to 105° C or -55° to 105° C Ambient Environment	Refer to Individual Model Data Sheet
Storage Environment	20° to 35° C and 40 to 60% humidity (In Factory Shipped Package)	Individual Model Data Sheet