

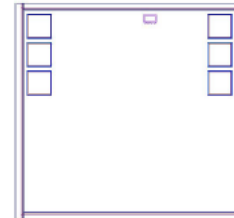
MMIC

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



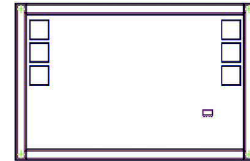
Reflectionless Low Pass Filter Die

XLF-123-D+

50Ω DC to 12200 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
- Satellite
- Radar
- Military & Space

+RoHS Compliant

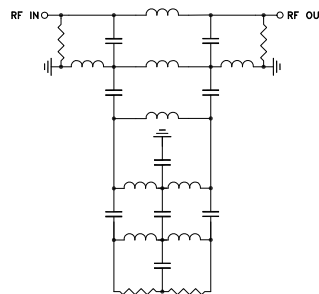
The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

Ordering Information: Refer to Last Page

General Description

Mini-Circuits' XLF-123-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

Note: 1. Bond Pad material - Gold
2. Bottom of Die - Gold plated

Electrical Specifications¹ at 25°C

Parameter		F#	Frequency (MHz)	Min.	Typ.	Max.	Unit
Pass Band	Insertion Loss	DC - F1	DC-12200		1.8		dB
	Frequency Cut-off	F2	15000		3.0		dB
	VSWR	DC - F1	DC-12200		1.3		:1
Stop Band	Rejection	F3 - F4	18100 - 19000		16		dB
		F4 - F5	19000 - 29000		20		dB
	VSWR	F3 - F4	18100 - 19000		1.3		:1
		F4 - F5	19000 - 29000		2.5		:1

¹ Measured on Mini-Circuits Characterization test board. Die packaged in 3mm x 3mm, 12-lead MCLP package and soldered on TB-844-123+

Absolute Maximum Ratings^{1,4}

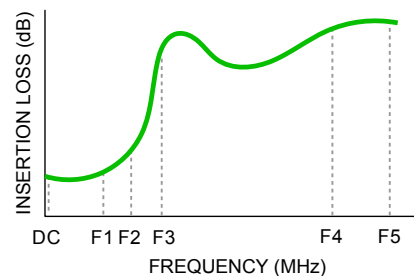
Parameter	Ratings
Operating Temperature	-55°C to +105°C
RF Power Input, Passband (DC-F1) ²	2W at 25°C
RF Power Input, Stopband (F2-F5) ³	50mW at 25°C

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

³ Stopband rating derates linearly to 50mW at 105°C ambient

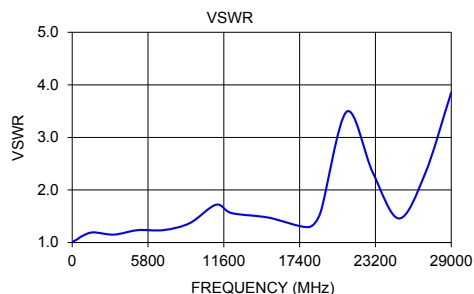
⁴ Permanent damage may occur if any of these limits are exceeded.

Specification Definition



Typical Performance Data at 25°C¹

Frequency (MHz)	Insertion Loss (dB)	VSWR (:1)
10	0.39	1.01
100	0.35	1.02
200	0.37	1.04
400	0.42	1.06
800	0.50	1.13
1600	0.66	1.19
3200	0.83	1.15
5000	0.99	1.24
7000	1.05	1.24
9000	1.19	1.37
11000	1.63	1.72
12200	1.79	1.56
15000	3.04	1.47
18100	15.60	1.29
19000	26.46	1.57
21000	30.52	3.49
23000	21.89	2.33
25000	21.74	1.46
27000	27.66	2.31
29000	21.90	3.86



Die Layout



Fig 1. Die Layout

Bonding Pad Position
(Dimensions in μm , Typical)

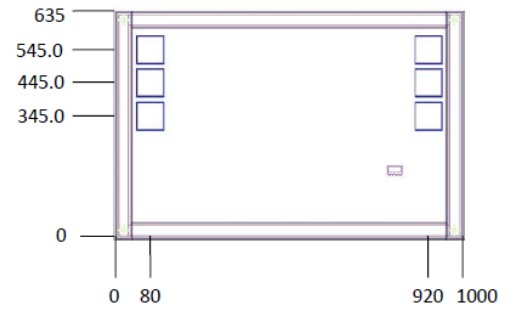


Fig 2. Bonding Pad Positions

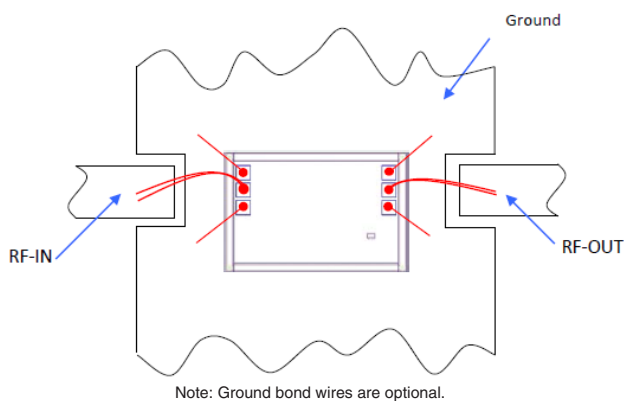
Critical Dimensions

Parameter	Values
Die Thickness, μm	100
Die Width, μm	1000
Die Length, μm	635
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	0.42	0.44	0.44	0.45	0.46	0.05	0.09	0.09	0.05	0.08
50	0.34	0.35	0.38	0.40	0.42	0.05	0.07	0.07	0.05	0.06
100	0.33	0.35	0.38	0.41	0.42	0.05	0.05	0.05	0.05	0.05
200	0.34	0.35	0.39	0.42	0.43	0.05	0.05	0.04	0.04	0.04
300	0.33	0.35	0.41	0.43	0.45	0.05	0.05	0.04	0.04	0.04
400	0.32	0.34	0.39	0.44	0.45	0.04	0.04	0.04	0.04	0.04
500	0.33	0.35	0.41	0.45	0.46	0.04	0.04	0.04	0.04	0.04
1000	0.34	0.36	0.45	0.50	0.52	0.04	0.04	0.04	0.04	0.04
1500	0.37	0.39	0.50	0.56	0.58	0.04	0.04	0.04	0.04	0.04
2000	0.38	0.41	0.53	0.60	0.61	0.04	0.04	0.04	0.04	0.04
2500	0.39	0.42	0.55	0.62	0.64	0.04	0.04	0.04	0.04	0.04
3000	0.39	0.42	0.57	0.64	0.67	0.04	0.04	0.04	0.04	0.04
3500	0.39	0.43	0.59	0.68	0.70	0.04	0.04	0.04	0.04	0.04
4000	0.40	0.45	0.62	0.72	0.75	0.04	0.04	0.04	0.04	0.04
4500	0.41	0.46	0.65	0.76	0.80	0.04	0.04	0.04	0.04	0.04
5000	0.44	0.49	0.69	0.82	0.87	0.04	0.04	0.04	0.04	0.04
5500	0.46	0.51	0.73	0.87	0.91	0.04	0.04	0.04	0.04	0.04
6000	0.48	0.54	0.76	0.90	0.95	0.04	0.04	0.04	0.04	0.04
6500	0.50	0.56	0.79	0.93	0.98	0.05	0.05	0.04	0.04	0.04
7000	0.50	0.56	0.80	0.97	1.02	0.05	0.05	0.04	0.04	0.04
7500	0.48	0.54	0.82	1.01	1.07	0.05	0.05	0.04	0.04	0.04
8000	0.49	0.56	0.86	1.07	1.14	0.05	0.05	0.04	0.04	0.04
8500	0.52	0.59	0.93	1.15	1.23	0.05	0.05	0.04	0.04	0.04
9000	0.60	0.67	1.02	1.25	1.33	0.05	0.05	0.05	0.04	0.04
9500	0.73	0.80	1.14	1.37	1.45	0.05	0.05	0.04	0.04	0.04
10000	0.86	0.94	1.28	1.51	1.59	0.05	0.05	0.05	0.04	0.04
10500	0.98	1.06	1.41	1.66	1.74	0.05	0.05	0.04	0.05	0.05
11000	1.01	1.10	1.52	1.81	1.90	0.05	0.05	0.05	0.05	0.05
11500	1.02	1.12	1.62	1.95	2.06	0.06	0.06	0.05	0.05	0.05
12000	1.05	1.16	1.68	2.03	2.15	0.06	0.06	0.05	0.05	0.05
12200	1.09	1.20	1.71	2.06	2.19	0.06	0.06	0.06	0.06	0.05
12400	1.13	1.24	1.74	2.08	2.22	0.06	0.06	0.06	0.06	0.06
12500	1.16	1.26	1.76	2.11	2.23	0.07	0.06	0.06	0.06	0.06
13000	1.29	1.40	1.85	2.20	2.33	0.07	0.07	0.06	0.06	0.06
13500	1.45	1.56	2.00	2.36	2.48	0.07	0.07	0.07	0.07	0.07
14000	1.61	1.73	2.22	2.61	2.74	0.08	0.08	0.08	0.08	0.08
14500	1.78	1.92	2.54	3.01	3.16	0.08	0.09	0.08	0.08	0.08
15000	2.05	2.22	3.01	3.58	3.78	0.10	0.10	0.09	0.09	0.09
15500	2.58	2.77	3.66	4.36	4.61	0.11	0.11	0.10	0.10	0.10
16000	3.48	3.69	4.63	5.42	5.70	0.12	0.12	0.12	0.11	0.11
16500	4.82	5.07	6.08	6.98	7.29	0.13	0.13	0.12	0.13	0.12
17000	6.71	6.99	8.20	9.24	9.60	0.14	0.14	0.13	0.13	0.13
17500	9.21	9.55	11.04	12.29	12.70	0.14	0.14	0.14	0.13	0.13
18000	12.47	12.89	14.72	16.27	16.79	0.16	0.16	0.15	0.14	0.14
18100	13.25	13.68	15.64	17.21	17.72	0.16	0.16	0.16	0.15	0.14
18200	14.10	14.55	16.55	18.21	18.74	0.17	0.16	0.15	0.14	0.14
18300	15.01	15.49	17.55	19.28	19.84	0.16	0.17	0.15	0.14	0.14
18400	15.99	16.47	18.57	20.40	21.03	0.17	0.17	0.14	0.14	0.13
18500	17.05	17.52	19.72	21.57	22.15	0.17	0.16	0.14	0.14	0.13
18600	18.11	18.66	20.91	22.90	23.44	0.16	0.17	0.14	0.14	0.13
18700	19.38	19.93	22.20	24.19	24.80	0.16	0.16	0.13	0.13	0.11
18800	20.66	21.15	23.56	25.57	26.25	0.15	0.17	0.15	0.11	0.12
18900	21.97	22.54	25.01	27.08	27.57	0.15	0.13	0.10	0.09	0.08
19000	23.45	23.97	26.50	28.58	29.13	0.13	0.12	0.10	0.07	0.08
19500	31.28	31.82	33.76	34.97	35.51	-0.01	0.03	-0.01	0.00	0.01
20000	35.54	35.41	36.12	36.37	36.57	-0.09	-0.02	0.05	0.07	0.13
20500	33.81	33.71	33.82	33.99	34.07	0.16	0.14	0.13	0.12	0.08
21000	31.27	31.27	30.73	30.48	30.60	0.09	0.11	0.09	0.08	0.09
21500	28.46	28.42	27.51	27.22	27.33	0.08	0.09	0.12	0.10	0.10
22000	25.56	25.55	25.20	24.91	24.85	0.08	0.07	0.07	0.09	0.10
22500	23.21	23.24	23.37	23.18	23.13	0.11	0.09	0.10	0.09	0.09
23000	21.19	21.33	22.07	22.11	22.15	0.12	0.12	0.09	0.09	0.10
23500	19.99	20.16	21.27	21.58	21.71	0.13	0.13	0.09	0.08	0.10
24000	19.91	20.07	20.86	21.41	21.70	0.11	0.10	0.11	0.10	0.10
24500	20.21	20.32	21.01	21.86	22.20	0.12	0.12	0.12	0.10	0.12
25000	20.72	20.94	21.77	22.82	23.18	0.14	0.14	0.12	0.13	0.12
25500	21.89	22.14	23.24	24.43	24.98	0.16	0.16	0.15	0.14	0.14
26000	23.72	23.97	25.17	26.55	27.14	0.16	0.18	0.17	0.19	0.21
26500	25.45	25.83	27.07	28.58	28.92	0.21	0.24	0.25	0.23	0.23
27000	26.21	26.39	27.47	28.64	29.22	0.24	0.24	0.25	0.25	0.24
27500	24.64	24.92	26.30	27.07	27.09	0.21	0.21	0.20	0.15	0.20
28000	22.75	23.16	24.54	25.36	25.58	0.17	0.16	0.10	0.11	0.12
28500	21.62	21.89	23.02	24.05	24.36	0.16	0.14	0.09	0.07	0.07
29000	21.49	21.59	21.99	23.22	23.26	0.09	0.08	0.09	0.05	0.07
29500	21.54	21.48	21.29	22.23	22.28	0.08	0.05	0.08	0.07	0.05
30000	21.13	21.29	21.00	21.29	21.33	0.02	0.03	0.05	0.06	0.04

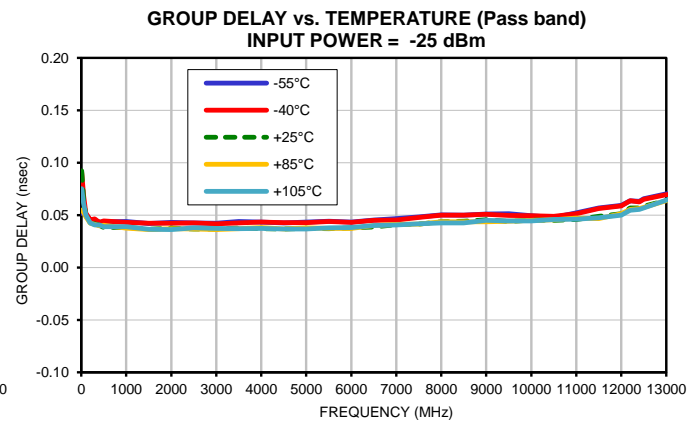
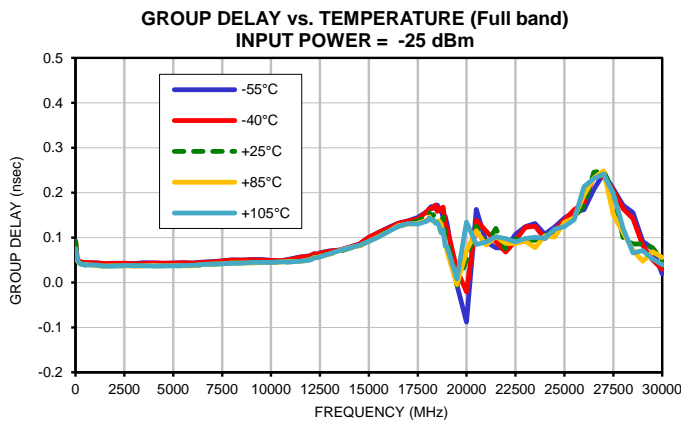
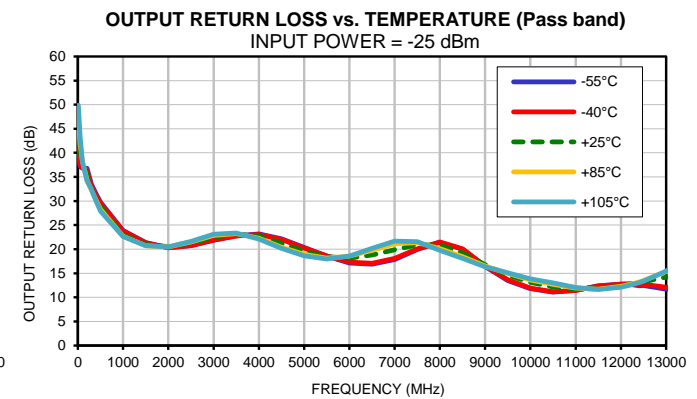
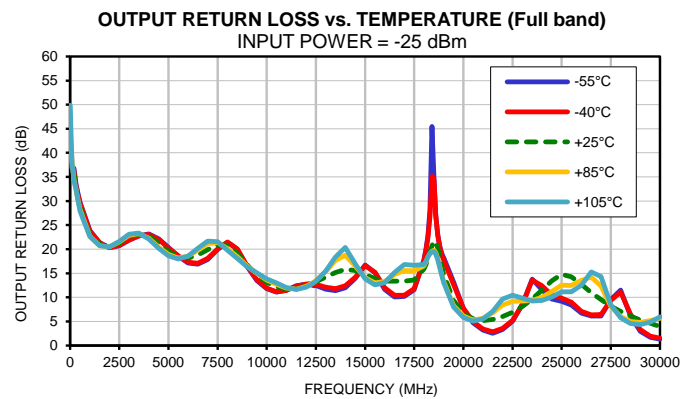
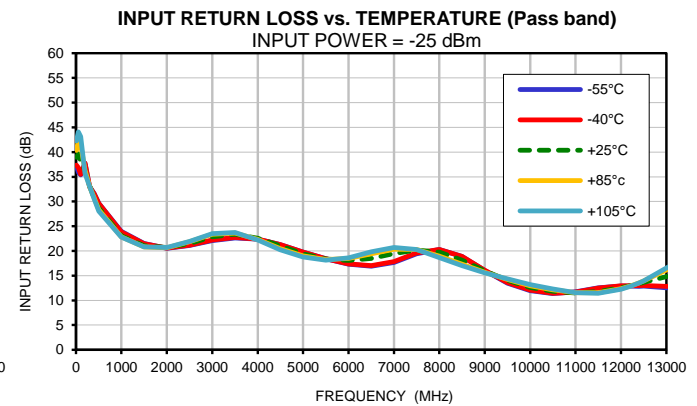
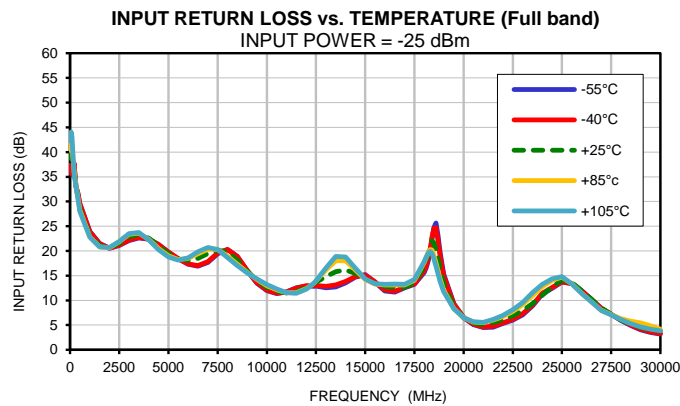
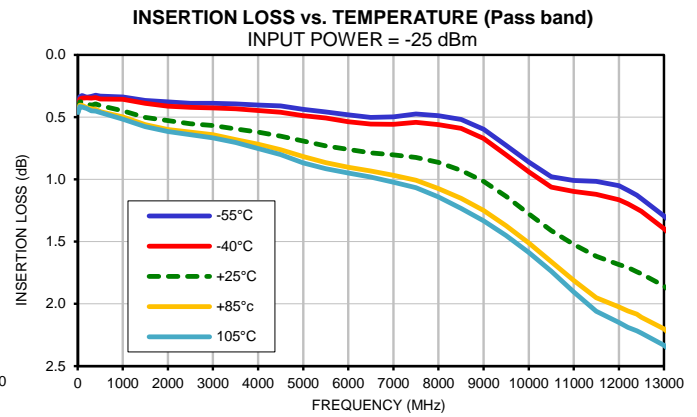
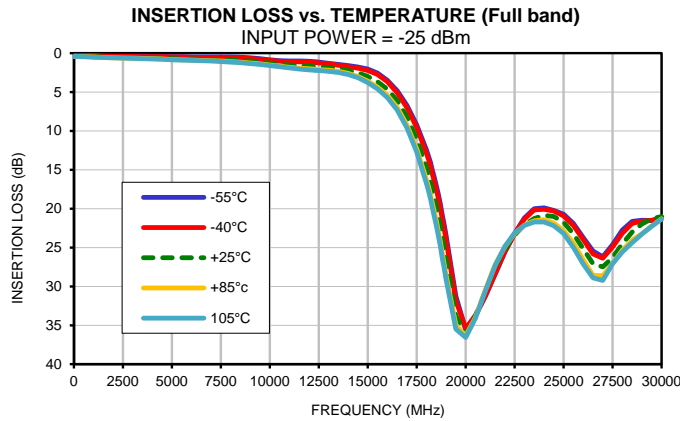


Typical Performance Data

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	37.10	37.34	38.93	40.34	42.24	42.83	41.39	44.25	47.23	49.87
50	35.88	36.85	39.64	42.41	44.08	37.15	37.47	40.47	41.86	43.34
100	35.36	35.51	38.05	41.45	43.13	36.78	36.97	37.78	38.27	38.03
200	37.74	37.76	36.30	36.38	35.68	36.78	36.24	35.46	34.33	34.19
300	33.00	32.97	33.16	33.04	33.04	33.49	33.13	32.60	32.26	32.49
400	31.57	31.53	30.67	30.72	30.50	31.56	31.17	30.31	30.21	30.04
500	29.61	29.63	28.66	28.31	28.06	29.76	29.52	28.79	28.23	27.86
1000	23.94	23.82	23.09	22.83	22.81	23.89	23.75	22.98	22.69	22.60
1500	21.52	21.46	21.06	20.82	20.84	21.39	21.34	20.99	20.72	20.72
2000	20.55	20.58	20.69	20.66	20.69	20.28	20.31	20.53	20.46	20.47
2500	21.10	21.19	21.52	21.86	21.95	20.74	20.81	21.23	21.52	21.61
3000	22.11	22.23	22.83	23.35	23.52	21.86	21.91	22.49	22.86	23.10
3500	22.62	22.73	23.38	23.60	23.73	22.73	22.74	23.14	23.25	23.34
4000	22.37	22.37	22.59	22.34	22.22	23.15	23.04	22.80	22.30	22.10
4500	21.31	21.26	21.02	20.47	20.23	22.16	22.02	21.23	20.44	20.17
5000	19.79	19.78	19.40	18.99	18.75	20.35	20.23	19.57	18.94	18.65
5500	18.42	18.45	18.37	18.28	18.13	18.59	18.65	18.44	18.16	17.95
6000	17.30	17.41	18.10	18.51	18.59	17.14	17.34	18.17	18.55	18.58
6500	16.90	17.05	18.51	19.45	19.82	16.89	17.10	18.80	19.77	20.20
7000	17.64	17.85	19.45	20.33	20.69	17.82	18.06	19.87	21.12	21.68
7500	19.42	19.57	20.19	20.29	20.28	19.92	20.05	20.90	21.39	21.55
8000	20.28	20.30	19.76	18.96	18.63	21.44	21.47	20.84	20.11	19.78
8500	18.92	18.91	18.15	17.33	17.03	20.00	20.06	19.24	18.44	18.08
9000	16.04	16.09	16.00	15.68	15.57	16.40	16.55	16.77	16.53	16.34
9500	13.50	13.62	14.06	14.24	14.35	13.51	13.67	14.65	14.99	15.07
10000	11.93	12.05	12.62	12.97	13.16	11.80	11.95	13.10	13.62	13.84
10500	11.38	11.46	11.82	12.13	12.30	11.09	11.18	12.16	12.71	13.00
11000	11.72	11.69	11.51	11.54	11.55	11.45	11.45	11.73	11.94	12.08
11500	12.55	12.48	11.78	11.56	11.44	12.41	12.33	11.82	11.72	11.62
12000	12.90	12.92	12.56	12.38	12.24	12.70	12.74	12.36	12.27	12.11
12200	12.89	12.97	12.96	12.92	12.81	12.71	12.83	12.75	12.72	12.53
12400	12.85	12.98	13.35	13.54	13.51	12.44	12.65	13.02	13.21	13.08
12500	12.88	13.03	13.62	13.96	13.96	12.46	12.70	13.23	13.47	13.35
13000	12.54	12.86	14.80	16.14	16.55	11.71	12.14	14.22	15.33	15.46
13500	12.73	13.11	15.78	18.00	18.89	11.41	11.84	15.16	17.65	18.41
14000	13.51	13.83	16.15	18.01	18.78	11.98	12.42	15.80	18.77	20.33
14500	14.68	14.80	15.46	16.14	16.49	13.93	14.15	15.57	16.53	16.98
15000	15.20	15.13	14.32	14.26	14.32	16.72	16.60	14.75	14.09	13.83
15500	13.68	13.76	13.39	13.32	13.33	15.13	15.25	13.92	13.03	12.60
16000	11.91	12.11	12.80	13.15	13.26	11.63	11.97	13.39	13.33	13.09
16500	11.64	11.82	12.65	13.13	13.32	10.10	10.41	13.37	14.76	15.18
17000	12.57	12.64	12.68	13.11	13.26	10.20	10.43	13.36	15.59	16.81
17500	13.25	13.38	13.54	14.07	14.24	11.60	11.81	13.60	15.53	16.63
18000	15.63	15.99	16.91	17.68	17.84	17.77	17.62	15.85	16.53	16.82
18100	16.62	17.02	18.12	18.73	18.78	20.02	19.72	16.80	17.35	17.50
18200	18.04	18.48	19.50	19.69	19.54	22.79	22.38	18.01	18.30	18.45
18300	19.96	20.41	20.94	20.27	19.88	28.17	26.74	19.37	19.12	19.11
18400	22.41	22.77	22.05	20.18	19.54	45.48	35.15	20.73	19.61	19.47
18500	24.77	24.59	21.62	19.00	18.33	34.78	34.53	21.64	19.77	19.52
18600	25.68	24.65	20.18	17.56	16.90	27.14	27.08	21.64	19.27	19.01
18700	23.12	22.06	18.31	15.99	15.38	22.96	22.92	20.25	18.01	17.83
18800	19.84	19.08	16.40	14.39	13.88	20.64	20.49	18.33	16.41	16.19
18900	17.27	16.70	14.69	13.09	12.68	19.08	18.78	16.44	14.76	14.56
19000	15.26	14.88	13.30	12.02	11.73	18.18	17.69	14.74	13.24	12.99
19500	9.32	9.25	8.70	8.34	8.27	13.16	12.64	9.33	8.29	7.98
20000	6.51	6.54	6.46	6.46	6.48	7.69	7.73	6.73	6.12	5.83
20500	5.09	5.18	5.42	5.60	5.65	4.71	4.95	5.54	5.33	5.08
21000	4.50	4.62	5.08	5.50	5.56	3.18	3.47	5.16	5.63	5.52
21500	4.58	4.79	5.52	6.00	6.14	2.57	2.85	5.41	6.82	7.07
22000	5.30	5.45	6.08	6.72	6.93	3.33	3.57	6.03	8.41	9.66
22500	6.02	6.19	6.89	7.79	8.13	5.04	5.22	6.92	9.17	10.46
23000	7.09	7.28	7.95	9.14	9.59	8.57	8.52	8.10	9.21	9.85
23500	8.85	9.07	9.33	10.98	11.56	13.80	13.62	9.67	9.38	9.26
24000	11.28	11.45	11.01	12.75	13.24	11.60	12.41	11.49	10.02	9.37
24500	12.45	12.62	12.72	14.06	14.35	9.66	10.51	13.44	11.19	10.05
25000	13.70	13.76	14.10	14.71	14.79	9.16	9.85	14.83	12.54	11.13
25500	13.41	13.37	13.60	13.38	13.29	8.42	8.99	14.25	12.50	11.17
26000	11.93	11.88	11.94	11.42	11.36	6.72	7.10	12.70	13.53	12.54
26500	10.19	10.15	10.21	9.70	9.66	6.11	6.40	10.96	14.22	15.25
27000	8.41	8.38	8.46	7.98	7.96	6.16	6.41	9.55	12.36	14.32
27500	7.20	7.19	7.16	7.11	7.08	9.54	9.37	8.16	8.18	8.45
28000	5.96	5.99	6.00	6.28	6.14	11.54	11.11	7.11	6.03	5.79
28500	4.91	4.98	5.12	5.76	5.28	6.20	6.54	6.12	4.98	4.57
29000	4.05	4.14	4.48	5.42	4.60	2.99	3.30	5.27	4.80	4.35
29500	3.52	3.61	4.05	4.88	4.13	1.68	1.95	4.62	5.15	4.86
30000	3.19	3.28	3.79	4.18	3.85	1.34	1.54	3.94	5.63	5.95



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 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)	