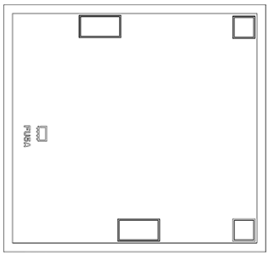
Ultra Low Noise, Low Current, Shutdown

Monolithic Amplifier Die PMA2-133LN-D+

50Ω 10 to 13 GHz



The Big Deal

- Ultra-low noise figure, 1.3 dB
- Low Current, 13 mA at 3V and 29mA at 5V
- Excellent ESD protection, Class 1C
- Shutdown feature

Product Overview

Mini-Circuits' PMA2-133LN-D+ is an E-PHEMT based, ultra-low noise MMIC amplifier die. The model offers a unique combination of low current consumption, low noise and high IP3, making it an ideal for sensitive, high-dynamic-range receiver applications. This design operates at both 3V & 5V supply, is well matched for 50Ω systems.

Key Features

Feature	Advantages
Ultra-low noise, 1.3 dB at 11 GHz	Enables lower system noise figure performance.
High IP3, 28.6 dBm typ. at 11 GHz	The combination of low noise and high IP3 makes the PMA2-133LN-D+ ideal for use in low noise receiver front end (RFE) as it gives the user the advantages of sensitivity and two-tone IM performance at both ends of the dynamic range.
Support Low operating voltage, 3V&5V	Usable in battery operated systems.
Low current consumption, 13 mA at 3V 29 mA at 5V	Enables prolonged battery life.
Shutdown feature (Ven=0V, V_{DD}=3/5V)	Saves DC power consumption when it is not reguired.
Separate pads for V_{DD} and RF-OUT	Built-in RF-choke separates V_{DD} and RF-OUT ports, minimizing external components, cost and saving PCB space.
Excellent ESD protection, Class 1C	Robust ESD performance eliminates the need for external ESD protection circuits, saving PCB space, minimizing noise figure degradation, and reducing cost.
Unpackaged Die	Enables the user to integrate the amplifier directly into hybrids

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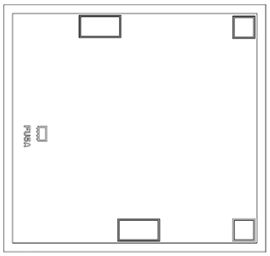
Monolithic Amplifier Die

PMA2-133LN-D+

50Ω 10 to 13 GHz



Product Features

- Low noise figure, 1.3 dB at 11 GHz
- Low current, 13 mA at 3V, 29 mA typ. at 5V
- Excellent ESD protection Class 1C
- Shutdown feature

Typical Applications

- Satellite communication
- Military Radar
- VSAT
- Point to Point
- Radio Astronomy

+RoHS Compliant

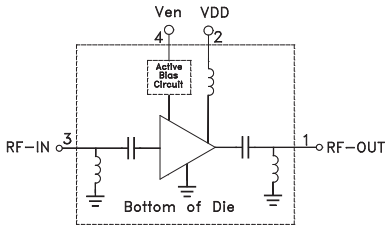
The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

Ordering Information: Refer to Last Page

General Description

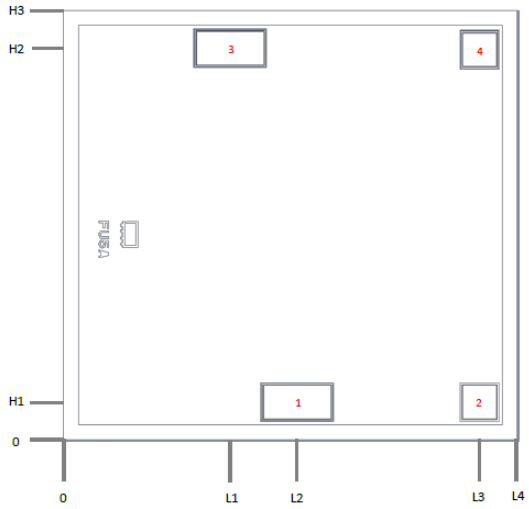
Mini-Circuits' PMA2-133LN-D+ is an E-PHEMT based, ultra-low noise MMIC amplifier die. The model offers a unique combination of low current consumption, low noise and high IP3, making it an ideal for sensitive, high-dynamic-range receiver applications. This design operates at both 3V & 5V supply, is well matched for 50Ω systems.

Simplified Schematic and Pad description



Pad #	Function	Description
1	RF-OUT	RF Output pad. This pad requires the use of an external DC blocking capacitor.
2	V_{DD}	DC Supply pad, Connect to external DC power supply.
3	RF-IN	RF Input pad. This pad requires the use of an external DC blocking capacitor.
4	Ven	Gain or shutdown model enable voltage pad. Connect to VDD for Gain mode operation. Connect to Ground to shutdown the amplifier.
Bottom of Die	GND	Connections to Ground.

Bonding Pad Position



Dimensions in µm, Typical

L1	L2	L3	L4	H1	H2	H3	
345	484	862	940	78	812	890	
Thickness		Die size		Bond pad #1 and #3 Size		Bond pad #2 and #4 Size	
100		940 x 890		139 x 69		69 x 69	

Electrical Specifications[1] at 25°C, 3V&5V, and 50 ohms unless noted

Parameter	Condition (GHz)	3V			5V	Units
		Min.	Typ.	Max.	Typ.	
Frequency Range		10		13		GHz
Noise Figure	10.0		1.4		1.5	dB
	10.7		1.4		1.3	
	11.0		1.4		1.3	
	12.0		1.5		1.4	
	13.0		1.6		1.5	
Gain	10.0		14.1		15.3	dB
	10.7		14.1		15.3	
	11.0		14.1		15.3	
	12.0		14.1		15.6	
	13.0		14.0		15.8	
Reverse Isolation	11.0		22.7		23.3	dB
Input Return Loss	10.0		13		16	dB
	10.7		14		17	
	11.0		14		17	
	12.0		17		21	
	13.0		27		24	
Output Return Loss	10.0		18		14	dB
	10.7		16		12	
	11.0		16		12	
	12.0		26		18	
	13.0		13		18	
Output Power at 1dB Compression	10.0		8.4		13.3	dBm
	10.7		9.4		14.4	
	11.0		8.9		13.5	
	12.0		8.5		13.1	
	13.0		7.1		11.5	
Output IP3 Pout=-10 dBm/tone	10.0		23.4		27.9	dBm
	10.7		23.7		29.3	
	11.0		23.6		28.6	
	12.0		23.8		28.8	
	13.0		23.5		28.9	
Device Operating Voltage (V_{DD})[3]			3.0		5.0	V
Device Operating Current (I_{DD})			13		29	mA
Device Current Variation vs. Temperature[2]			-10		-53	µA/°C
Device Current Variation vs. Voltage			0.0079		0.0076	mA/mV
Thermal Resistance, junction-to-ground lead			124		118	°C/W

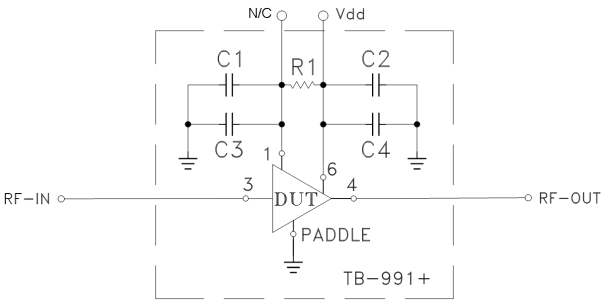
[1] Measured on Mini-Circuits Characterization test board. Die is packaged in 2x2 MCLP and soldered on TB-991+. See Characterization Test Circuit (Fig. 1)
[2] (Current at 85°C - Current at -45°C)/130
[3] V_{DD} is connected to Ven.

Absolute Maximum Ratings[4]

Parameter	Ratings
Operating Temperature (ground lead)	-40°C to 85°C
Total Power Dissipation	0.31W
Input Power (CW)	+19 dBm (5minutes max) +10 dBm (continuous)
DC Voltage	+7.7V

Note:
[4] Permanent damage may occur if any of these limits are exceeded.
Electrical maximum ratings are not intended for continuous normal operation.

Recommended Application and Characterization Test Circuit



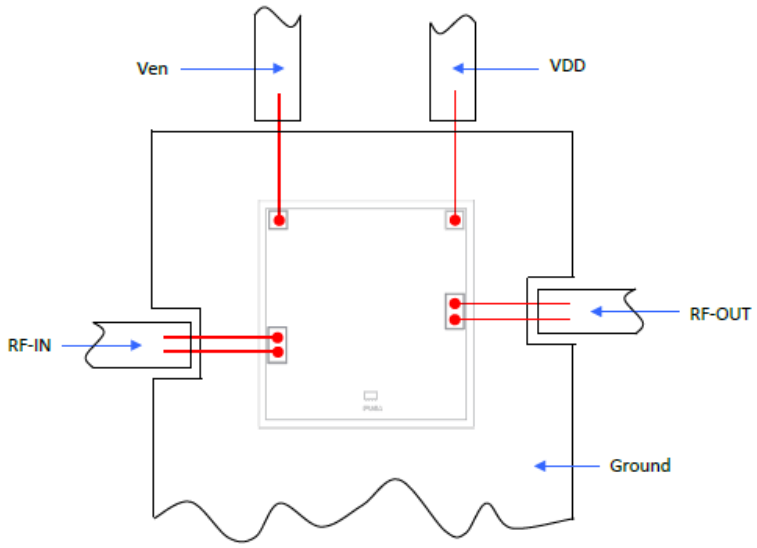
For Gain Mode Operation:

Component	Size	Value	Manufacturer	P/N
C1, C2	0402	0.1uF	Murata	GRM155R71C104KA88D
C3, C4	0402	100pF	Murata	GRM1555C1H101J01D
R1	0402	0 ohms	KOA	RK73Z1JTTD

Fig 1. Application and Characterization Circuit
This block diagram is used for DUT characterization in Gain Mode operation. (Die is packaged in 2x2mm MCLP and soldered on Mini-Circuits Characterization test board TB-991+). For DUT pad description, please see PMA2-133LN+ data sheet.
Gain, Return loss, Output power at 1dB compression (P1dB), Output IP3 (OIP3) and noise figure measured using Agilent's N5242A PNA-X microwave network analyzer.

Conditions:
1. Gain and Return loss: Pin= -25dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, -10 dBm/tone at output.

Assembly Diagram



Assembly and Handling Procedure

1. Storage
   Dice should be stored in a dry nitrogen purged desiccators or equivalent.
2. ESD
   MMIC E-PHEMT amplifier 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 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.

Additional Detailed Technical Information

additional information is available on our dash board.

Performance Data	Data Table	
	Swept Graphs	
	S-Parameter (S2P Files) Data Set with and without port extension(.zip file)	
Case Style	Die	
Die Ordering and packaging information	Quantity, Package	Model No.
	Small, Gel - Pak: 5,10,50,100 KGD*	PMA2-133LN-DG+
	Medium†, Partial wafer: KGD*<800	PMA2-133LN-DP+
	Large†, Full Wafer	PMA2-133LN-DF+
	†*Available upon request contact sales representative*	
	Refer to AN-60-067	
Environmental Ratings	ENV80	

*Known Good Dice ("KGD") means that the dice in question have been subjected to Mini-Circuits DC test performance criteria and measurement instructions and that the parametric data of such dice fall within a predefined range. While DC testing 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 1C (pass 1000V) in accordance with ANSI/ESD STM 5.1 - 2001

** Tested in industry standard 2mm x 2mm MCLP

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.

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Typical Performance Data

NOTE: Use PDF Bookmarks to view DATA at required conditions

Definitions:

Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 3.00V, Id = 13.16mA @ Temperature = +25°C

FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
9000	12.75	26.36	9.61	7.32	1.83	0.87	25.26	6.48	1.37
9500	13.91	24.28	11.52	12.64	1.64	0.90	27.56	7.86	1.36
10000	14.24	23.32	13.13	17.14	1.53	0.88	28.29	8.82	1.39
10100	14.25	23.21	13.36	17.20	1.52	0.88	27.54	9.26	1.42
10200	14.25	23.12	13.53	17.03	1.50	0.88	28.19	9.34	1.37
10300	14.25	23.04	13.70	16.82	1.49	0.88	28.06	8.98	1.41
10400	14.25	22.97	13.84	16.53	1.48	0.87	28.51	9.58	1.41
10500	14.24	22.91	13.91	16.29	1.47	0.87	28.02	9.28	1.43
10600	14.23	22.87	14.00	16.10	1.46	0.87	28.29	9.30	1.44
10700	14.23	22.82	14.09	16.03	1.45	0.87	28.53	9.40	1.38
10800	14.22	22.79	14.18	16.03	1.44	0.87	28.22	8.95	1.44
10900	14.22	22.76	14.29	16.13	1.44	0.87	30.25	9.12	1.41
11000	14.22	22.74	14.42	16.34	1.44	0.88	30.17	8.88	1.41
11100	14.22	22.72	14.55	16.66	1.44	0.88	30.59	8.75	1.42
11200	14.23	22.71	14.75	17.09	1.44	0.88	29.87	8.73	1.40
11300	14.23	22.70	14.97	17.67	1.44	0.88	29.90	8.50	1.40
11400	14.24	22.70	15.21	18.40	1.44	0.88	29.29	8.83	1.44
11500	14.26	22.70	15.49	19.31	1.45	0.88	30.36	8.63	1.43
11600	14.27	22.71	15.85	20.47	1.45	0.88	29.92	8.14	1.43
11700	14.28	22.72	16.20	21.94	1.46	0.88	29.21	8.27	1.47
11800	14.29	22.75	16.64	23.77	1.47	0.88	28.48	8.15	1.46
11900	14.31	22.78	17.15	26.14	1.48	0.88	27.48	7.99	1.47
12000	14.32	22.81	17.68	28.80	1.49	0.88	28.13	8.53	1.43
12100	14.32	22.86	18.29	30.09	1.50	0.87	26.41	8.05	1.47
12200	14.33	22.92	19.00	28.26	1.51	0.87	27.20	8.28	1.43
12300	14.32	22.99	19.71	25.30	1.53	0.87	26.66	7.87	1.43
12400	14.32	23.07	20.59	22.60	1.54	0.87	25.59	8.04	1.42
12500	14.31	23.16	21.54	20.30	1.55	0.86	27.09	8.77	1.47
12600	14.29	23.27	22.64	18.45	1.56	0.86	25.54	7.60	1.47
12700	14.26	23.39	23.94	16.86	1.57	0.86	24.61	7.35	1.48
12800	14.23	23.52	25.39	15.49	1.59	0.85	24.82	7.19	1.45
12900	14.20	23.67	27.14	14.28	1.60	0.85	24.06	6.92	1.51
13000	14.15	23.84	29.53	13.19	1.61	0.84	23.70	7.16	1.56
13500	13.78	24.91	37.98	9.09	1.72	0.80	21.43	5.95	1.48
14000	13.12	26.45	25.34	6.35	1.91	0.71	18.65	4.37	1.63
14500	12.16	28.41	20.01	4.48	2.20	0.61	16.53	3.53	1.71
15000	10.94	30.50	16.47	3.26	2.51	0.53	15.84	2.71	1.79

Note: Test data of Die packaged in industry standard 2x2 MCLP package

Typical Performance Data

Definitions:
Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 2.70V, Id = 10.86mA @ Temperature = +25°C

FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
9000	12.41	26.02	9.06	7.49	1.81	0.89	22.72	5.49	1.42
9500	13.51	24.01	10.92	13.00	1.65	0.92	24.14	6.85	1.41
10000	13.82	23.10	12.40	18.25	1.55	0.90	24.53	7.79	1.46
10100	13.82	23.00	12.61	18.42	1.54	0.90	24.82	8.21	1.48
10200	13.83	22.91	12.75	18.30	1.53	0.90	24.90	8.29	1.41
10300	13.82	22.83	12.90	18.10	1.51	0.90	25.17	7.97	1.46
10400	13.82	22.77	13.01	17.81	1.50	0.89	24.96	8.52	1.43
10500	13.81	22.71	13.06	17.57	1.49	0.89	24.83	8.25	1.46
10600	13.80	22.67	13.16	17.37	1.49	0.89	24.59	8.26	1.48
10700	13.79	22.63	13.23	17.32	1.48	0.89	24.67	8.36	1.42
10800	13.78	22.60	13.31	17.33	1.47	0.89	24.59	7.96	1.46
10900	13.78	22.57	13.41	17.47	1.47	0.90	24.80	8.10	1.44
11000	13.78	22.55	13.52	17.73	1.47	0.90	25.15	7.87	1.46
11100	13.78	22.54	13.67	18.11	1.47	0.90	24.91	7.76	1.47
11200	13.78	22.54	13.83	18.63	1.47	0.90	24.91	7.72	1.49
11300	13.78	22.53	14.03	19.31	1.48	0.90	24.13	7.51	1.48
11400	13.79	22.53	14.24	20.19	1.48	0.90	23.94	7.81	1.50
11500	13.80	22.54	14.50	21.26	1.49	0.90	24.32	7.63	1.46
11600	13.80	22.55	14.82	22.61	1.49	0.90	24.00	7.15	1.50
11700	13.81	22.57	15.12	24.24	1.50	0.90	23.42	7.27	1.50
11800	13.81	22.60	15.51	26.06	1.51	0.90	23.44	7.14	1.52
11900	13.82	22.64	15.97	27.54	1.52	0.89	23.09	6.97	1.51
12000	13.82	22.68	16.42	27.68	1.53	0.89	23.50	7.49	1.48
12100	13.82	22.73	16.94	26.00	1.55	0.89	22.52	7.01	1.53
12200	13.81	22.80	17.52	23.78	1.56	0.88	22.49	7.23	1.49
12300	13.80	22.87	18.09	21.67	1.57	0.88	22.22	6.82	1.48
12400	13.78	22.96	18.83	19.76	1.59	0.88	21.92	6.95	1.46
12500	13.77	23.05	19.55	18.06	1.60	0.87	22.40	7.62	1.48
12600	13.74	23.16	20.40	16.62	1.61	0.87	21.32	6.53	1.49
12700	13.70	23.29	21.38	15.33	1.63	0.86	20.59	6.23	1.50
12800	13.66	23.42	22.39	14.19	1.64	0.86	20.44	6.06	1.49
12900	13.62	23.58	23.49	13.17	1.66	0.85	20.03	5.77	1.57
13000	13.56	23.74	24.85	12.23	1.67	0.84	20.08	5.96	1.61
13500	13.14	24.81	32.00	8.60	1.79	0.79	17.83	4.61	1.58
14000	12.43	26.30	26.08	6.11	1.98	0.71	15.28	2.96	1.61
14500	11.46	28.15	20.20	4.38	2.25	0.61	13.39	1.99	1.76
15000	10.24	30.05	16.45	3.24	2.54	0.53	12.80	1.08	1.83

Note: Test data of Die packaged in industry standard 2x2 MCLP package

Typical Performance Data

Definitions:
Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 3.30V, Id = 15.62mA @ Temperature = +25°C

FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
9000	13.01	26.63	10.11	7.19	1.85	0.85	27.95	7.36	1.38
9500	14.21	24.49	12.06	12.35	1.64	0.88	31.40	8.73	1.35
10000	14.56	23.50	13.79	16.30	1.52	0.87	32.34	9.71	1.42
10100	14.57	23.39	14.07	16.29	1.50	0.87	31.97	10.17	1.39
10200	14.57	23.29	14.25	16.09	1.48	0.86	30.75	10.25	1.32
10300	14.58	23.21	14.45	15.87	1.47	0.86	32.73	9.88	1.38
10400	14.57	23.14	14.60	15.59	1.46	0.86	30.99	10.50	1.35
10500	14.57	23.07	14.68	15.35	1.44	0.86	34.63	10.18	1.40
10600	14.56	23.03	14.79	15.17	1.44	0.86	31.74	10.20	1.41
10700	14.56	22.99	14.88	15.09	1.43	0.86	32.76	10.29	1.35
10800	14.55	22.95	14.98	15.08	1.42	0.86	33.13	9.85	1.41
10900	14.55	22.92	15.10	15.15	1.42	0.86	33.51	10.02	1.37
11000	14.56	22.89	15.26	15.33	1.41	0.86	33.10	9.77	1.34
11100	14.56	22.88	15.38	15.60	1.41	0.86	31.58	9.64	1.39
11200	14.57	22.86	15.61	15.98	1.41	0.86	31.02	9.62	1.36
11300	14.58	22.85	15.84	16.49	1.41	0.86	29.95	9.38	1.40
11400	14.59	22.84	16.09	17.13	1.42	0.87	32.52	9.72	1.41
11500	14.61	22.84	16.41	17.91	1.42	0.87	30.72	9.52	1.37
11600	14.63	22.85	16.81	18.91	1.43	0.87	28.89	8.99	1.40
11700	14.64	22.86	17.19	20.19	1.43	0.87	29.85	9.15	1.41
11800	14.66	22.88	17.71	21.78	1.44	0.87	29.77	9.02	1.45
11900	14.68	22.90	18.28	23.93	1.45	0.87	28.84	8.85	1.40
12000	14.70	22.94	18.89	26.83	1.46	0.86	30.25	9.43	1.41
12100	14.71	22.98	19.58	30.84	1.47	0.86	28.42	8.92	1.43
12200	14.72	23.05	20.38	33.96	1.48	0.86	28.81	9.18	1.38
12300	14.73	23.11	21.22	30.32	1.49	0.86	29.11	8.76	1.39
12400	14.73	23.18	22.31	25.99	1.50	0.86	28.58	8.95	1.38
12500	14.72	23.27	23.46	22.72	1.51	0.86	30.39	9.73	1.41
12600	14.72	23.38	24.83	20.28	1.53	0.86	28.36	8.50	1.39
12700	14.70	23.50	26.51	18.31	1.54	0.85	28.05	8.24	1.41
12800	14.67	23.62	28.42	16.67	1.55	0.85	27.31	8.09	1.41
12900	14.65	23.77	30.62	15.27	1.56	0.85	27.33	7.84	1.48
13000	14.61	23.94	33.36	14.02	1.57	0.85	26.48	8.12	1.49
13500	14.28	25.02	29.14	9.49	1.67	0.81	25.31	7.03	1.44
14000	13.64	26.61	22.93	6.54	1.86	0.72	22.21	5.48	1.54
14500	12.70	28.69	19.05	4.55	2.16	0.61	19.77	4.76	1.66
15000	11.47	30.94	16.13	3.27	2.51	0.52	18.85	4.00	1.72

Note: Test data of Die packaged in industry standard 2x2 MCLP package

Typical Performance Data

Definitions:
Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 5.00V, Id = 13.16mA @ Temperature = +25°C

FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
9000	12.75	26.36	9.61	7.32	1.83	0.87	25.26	6.48	1.37
9500	13.91	24.28	11.52	12.64	1.64	0.90	27.56	7.86	1.36
10000	14.24	23.32	13.13	17.14	1.53	0.88	28.29	8.82	1.39
10100	14.25	23.21	13.36	17.20	1.52	0.88	27.54	9.26	1.42
10200	14.25	23.12	13.53	17.03	1.50	0.88	28.19	9.34	1.37
10300	14.25	23.04	13.70	16.82	1.49	0.88	28.06	8.98	1.41
10400	14.25	22.97	13.84	16.53	1.48	0.87	28.51	9.58	1.41
10500	14.24	22.91	13.91	16.29	1.47	0.87	28.02	9.28	1.43
10600	14.23	22.87	14.00	16.10	1.46	0.87	28.29	9.30	1.44
10700	14.23	22.82	14.09	16.03	1.45	0.87	28.53	9.40	1.38
10800	14.22	22.79	14.18	16.03	1.44	0.87	28.22	8.95	1.44
10900	14.22	22.76	14.29	16.13	1.44	0.87	30.25	9.12	1.41
11000	14.22	22.74	14.42	16.34	1.44	0.88	30.17	8.88	1.41
11100	14.22	22.72	14.55	16.66	1.44	0.88	30.59	8.75	1.42
11200	14.23	22.71	14.75	17.09	1.44	0.88	29.87	8.73	1.40
11300	14.23	22.70	14.97	17.67	1.44	0.88	29.90	8.50	1.40
11400	14.24	22.70	15.21	18.40	1.44	0.88	29.29	8.83	1.44
11500	14.26	22.70	15.49	19.31	1.45	0.88	30.36	8.63	1.43
11600	14.27	22.71	15.85	20.47	1.45	0.88	29.92	8.14	1.43
11700	14.28	22.72	16.20	21.94	1.46	0.88	29.21	8.27	1.47
11800	14.29	22.75	16.64	23.77	1.47	0.88	28.48	8.15	1.46
11900	14.31	22.78	17.15	26.14	1.48	0.88	27.48	7.99	1.47
12000	14.32	22.81	17.68	28.80	1.49	0.88	28.13	8.53	1.43
12100	14.32	22.86	18.29	30.09	1.50	0.87	26.41	8.05	1.47
12200	14.33	22.92	19.00	28.26	1.51	0.87	27.20	8.28	1.43
12300	14.32	22.99	19.71	25.30	1.53	0.87	26.66	7.87	1.43
12400	14.32	23.07	20.59	22.60	1.54	0.87	25.59	8.04	1.42
12500	14.31	23.16	21.54	20.30	1.55	0.86	27.09	8.77	1.47
12600	14.29	23.27	22.64	18.45	1.56	0.86	25.54	7.60	1.47
12700	14.26	23.39	23.94	16.86	1.57	0.86	24.61	7.35	1.48
12800	14.23	23.52	25.39	15.49	1.59	0.85	24.82	7.19	1.45
12900	14.20	23.67	27.14	14.28	1.60	0.85	24.06	6.92	1.51
13000	14.15	23.84	29.53	13.19	1.61	0.84	23.70	7.16	1.56
13500	13.78	24.91	37.98	9.09	1.72	0.80	21.43	5.95	1.48
14000	13.12	26.45	25.34	6.35	1.91	0.71	18.65	4.37	1.63
14500	12.16	28.41	20.01	4.48	2.20	0.61	16.53	3.53	1.71
15000	10.94	30.50	16.47	3.26	2.51	0.53	15.84	2.71	1.79

Note: Test data of Die packaged in industry standard 2x2 MCLP package

Typical Performance Data

Definitions:
Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 4.75V, Id = 10.86mA @ Temperature = +25°C

FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
9000	12.41	26.02	9.06	7.49	1.81	0.89	22.72	5.49	1.42
9500	13.51	24.01	10.92	13.00	1.65	0.92	24.14	6.85	1.41
10000	13.82	23.10	12.40	18.25	1.55	0.90	24.53	7.79	1.46
10100	13.82	23.00	12.61	18.42	1.54	0.90	24.82	8.21	1.48
10200	13.83	22.91	12.75	18.30	1.53	0.90	24.90	8.29	1.41
10300	13.82	22.83	12.90	18.10	1.51	0.90	25.17	7.97	1.46
10400	13.82	22.77	13.01	17.81	1.50	0.89	24.96	8.52	1.43
10500	13.81	22.71	13.06	17.57	1.49	0.89	24.83	8.25	1.46
10600	13.80	22.67	13.16	17.37	1.49	0.89	24.59	8.26	1.48
10700	13.79	22.63	13.23	17.32	1.48	0.89	24.67	8.36	1.42
10800	13.78	22.60	13.31	17.33	1.47	0.89	24.59	7.96	1.46
10900	13.78	22.57	13.41	17.47	1.47	0.90	24.80	8.10	1.44
11000	13.78	22.55	13.52	17.73	1.47	0.90	25.15	7.87	1.46
11100	13.78	22.54	13.67	18.11	1.47	0.90	24.91	7.76	1.47
11200	13.78	22.54	13.83	18.63	1.47	0.90	24.91	7.72	1.49
11300	13.78	22.53	14.03	19.31	1.48	0.90	24.13	7.51	1.48
11400	13.79	22.53	14.24	20.19	1.48	0.90	23.94	7.81	1.50
11500	13.80	22.54	14.50	21.26	1.49	0.90	24.32	7.63	1.46
11600	13.80	22.55	14.82	22.61	1.49	0.90	24.00	7.15	1.50
11700	13.81	22.57	15.12	24.24	1.50	0.90	23.42	7.27	1.50
11800	13.81	22.60	15.51	26.06	1.51	0.90	23.44	7.14	1.52
11900	13.82	22.64	15.97	27.54	1.52	0.89	23.09	6.97	1.51
12000	13.82	22.68	16.42	27.68	1.53	0.89	23.50	7.49	1.48
12100	13.82	22.73	16.94	26.00	1.55	0.89	22.52	7.01	1.53
12200	13.81	22.80	17.52	23.78	1.56	0.88	22.49	7.23	1.49
12300	13.80	22.87	18.09	21.67	1.57	0.88	22.22	6.82	1.48
12400	13.78	22.96	18.83	19.76	1.59	0.88	21.92	6.95	1.46
12500	13.77	23.05	19.55	18.06	1.60	0.87	22.40	7.62	1.48
12600	13.74	23.16	20.40	16.62	1.61	0.87	21.32	6.53	1.49
12700	13.70	23.29	21.38	15.33	1.63	0.86	20.59	6.23	1.50
12800	13.66	23.42	22.39	14.19	1.64	0.86	20.44	6.06	1.49
12900	13.62	23.58	23.49	13.17	1.66	0.85	20.03	5.77	1.57
13000	13.56	23.74	24.85	12.23	1.67	0.84	20.08	5.96	1.61
13500	13.14	24.81	32.00	8.60	1.79	0.79	17.83	4.61	1.58
14000	12.43	26.30	26.08	6.11	1.98	0.71	15.28	2.96	1.61
14500	11.46	28.15	20.20	4.38	2.25	0.61	13.39	1.99	1.76
15000	10.24	30.05	16.45	3.24	2.54	0.53	12.80	1.08	1.83

Note: Test data of Die packaged in industry standard 2x2 MCLP package

Typical Performance Data

Definitions:
Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

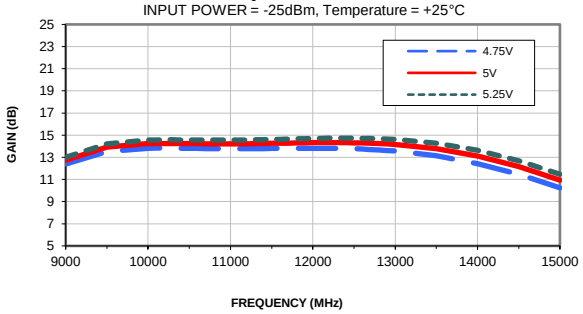
TEST CONDITIONS: Vd = 5.25V, Id = 15.62mA @ Temperature = +25°C

FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
9000	13.01	26.63	10.11	7.19	1.85	0.85	27.95	7.36	1.38
9500	14.21	24.49	12.06	12.35	1.64	0.88	31.40	8.73	1.35
10000	14.56	23.50	13.79	16.30	1.52	0.87	32.34	9.71	1.42
10100	14.57	23.39	14.07	16.29	1.50	0.87	31.97	10.17	1.39
10200	14.57	23.29	14.25	16.09	1.48	0.86	30.75	10.25	1.32
10300	14.58	23.21	14.45	15.87	1.47	0.86	32.73	9.88	1.38
10400	14.57	23.14	14.60	15.59	1.46	0.86	30.99	10.50	1.35
10500	14.57	23.07	14.68	15.35	1.44	0.86	34.63	10.18	1.40
10600	14.56	23.03	14.79	15.17	1.44	0.86	31.74	10.20	1.41
10700	14.56	22.99	14.88	15.09	1.43	0.86	32.76	10.29	1.35
10800	14.55	22.95	14.98	15.08	1.42	0.86	33.13	9.85	1.41
10900	14.55	22.92	15.10	15.15	1.42	0.86	33.51	10.02	1.37
11000	14.56	22.89	15.26	15.33	1.41	0.86	33.10	9.77	1.34
11100	14.56	22.88	15.38	15.60	1.41	0.86	31.58	9.64	1.39
11200	14.57	22.86	15.61	15.98	1.41	0.86	31.02	9.62	1.36
11300	14.58	22.85	15.84	16.49	1.41	0.86	29.95	9.38	1.40
11400	14.59	22.84	16.09	17.13	1.42	0.87	32.52	9.72	1.41
11500	14.61	22.84	16.41	17.91	1.42	0.87	30.72	9.52	1.37
11600	14.63	22.85	16.81	18.91	1.43	0.87	28.89	8.99	1.40
11700	14.64	22.86	17.19	20.19	1.43	0.87	29.85	9.15	1.41
11800	14.66	22.88	17.71	21.78	1.44	0.87	29.77	9.02	1.45
11900	14.68	22.90	18.28	23.93	1.45	0.87	28.84	8.85	1.40
12000	14.70	22.94	18.89	26.83	1.46	0.86	30.25	9.43	1.41
12100	14.71	22.98	19.58	30.84	1.47	0.86	28.42	8.92	1.43
12200	14.72	23.05	20.38	33.96	1.48	0.86	28.81	9.18	1.38
12300	14.73	23.11	21.22	30.32	1.49	0.86	29.11	8.76	1.39
12400	14.73	23.18	22.31	25.99	1.50	0.86	28.58	8.95	1.38
12500	14.72	23.27	23.46	22.72	1.51	0.86	30.39	9.73	1.41
12600	14.72	23.38	24.83	20.28	1.53	0.86	28.36	8.50	1.39
12700	14.70	23.50	26.51	18.31	1.54	0.85	28.05	8.24	1.41
12800	14.67	23.62	28.42	16.67	1.55	0.85	27.31	8.09	1.41
12900	14.65	23.77	30.62	15.27	1.56	0.85	27.33	7.84	1.48
13000	14.61	23.94	33.36	14.02	1.57	0.85	26.48	8.12	1.49
13500	14.28	25.02	29.14	9.49	1.67	0.81	25.31	7.03	1.44
14000	13.64	26.61	22.93	6.54	1.86	0.72	22.21	5.48	1.54
14500	12.70	28.69	19.05	4.55	2.16	0.61	19.77	4.76	1.66
15000	11.47	30.94	16.13	3.27	2.51	0.52	18.85	4.00	1.72

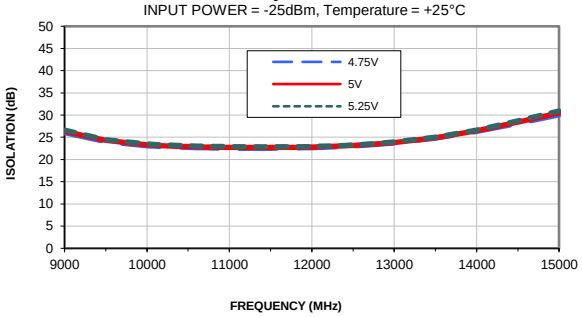
Note: Test data of Die packaged in industry standard 2x2 MCLP package

Typical Performance Curves

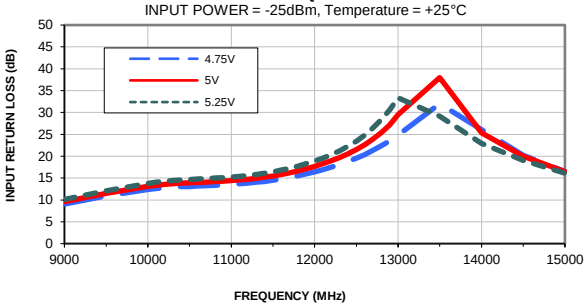
GAIN vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



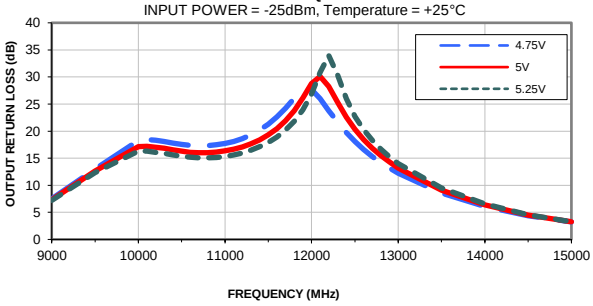
ISOLATION vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



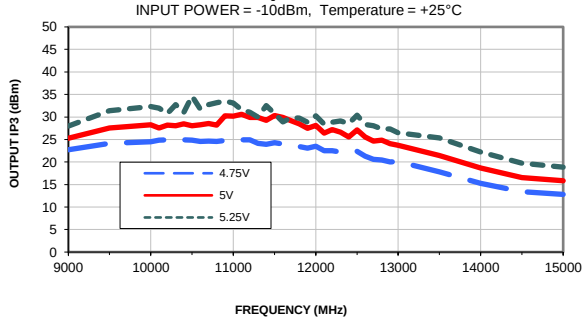
INPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



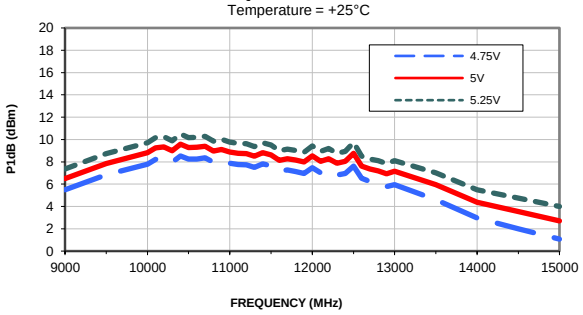
OUTPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



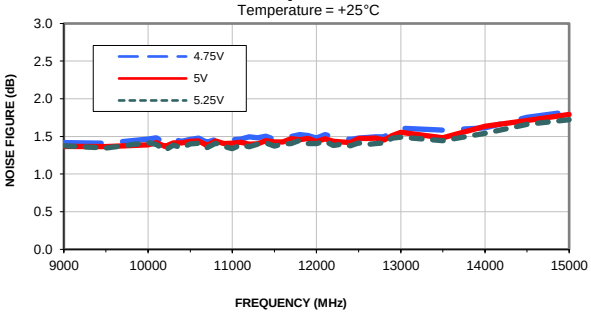
OUTPUT IP3 vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -10dBm, Temperature = +25°C



P1dB vs. FREQUENCY & DEVICE VOLTAGE
Temperature = +25°C



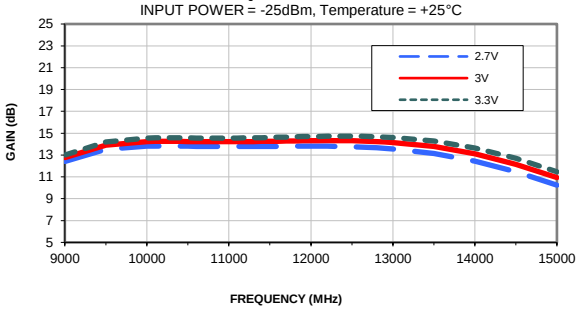
NOISE FIGURE vs. FREQUENCY & DEVICE VOLTAGE
Temperature = +25°C



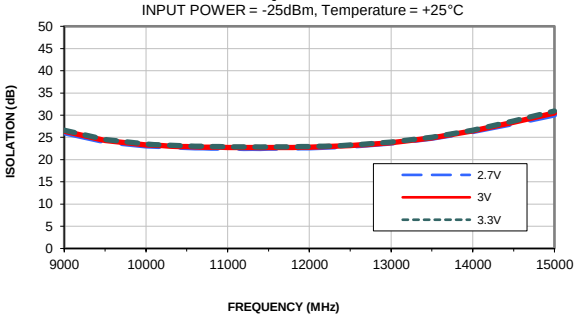
Note: Test data of Die packaged in industry standard 2x2 MCLP package

Typical Performance Curves

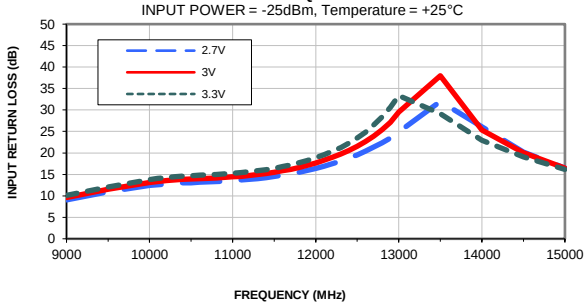
GAIN vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



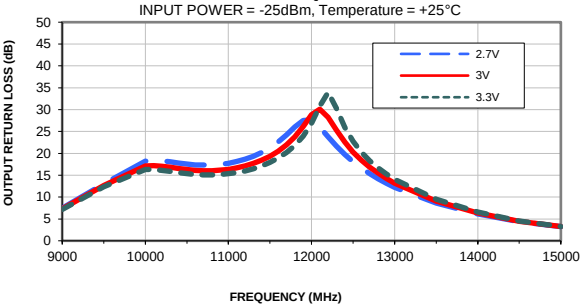
ISOLATION vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



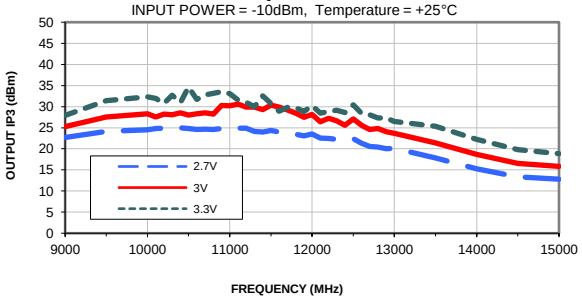
INPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



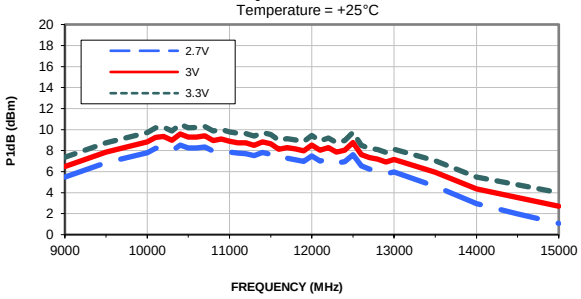
OUTPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



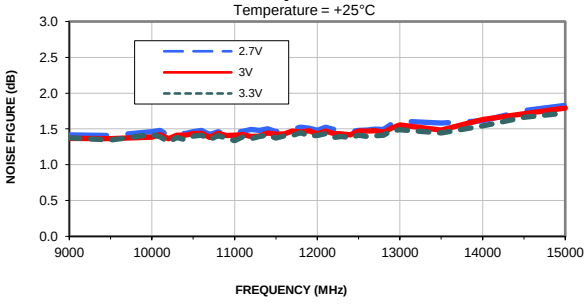
OUTPUT IP3 vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -10dBm, Temperature = +25°C



P1dB vs. FREQUENCY & DEVICE VOLTAGE
Temperature = +25°C



NOISE FIGURE vs. FREQUENCY & DEVICE VOLTAGE
Temperature = +25°C



Note: Test data of Die packaged in industry standard 2x2 MCLP package

Mini-Circuits

Environmental Specifications ENV80

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)	