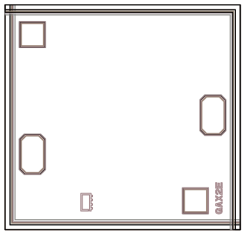
Low Noise, Wideband, Low Current

Monolithic Amplifier Die PMA2-123LN5-D+

50Ω 0.5 to 12 GHz



The Big Deal

- Ultra wideband, 0.5 to 12 GHz
- Excellent noise figure, 1.8 dB at 12 GHz
- Low Current, 30mA

Product Overview

The PMA2-123LN5-D+ is a E-PHEMT based wideband, low noise MMIC amplifier die with a unique combination of low noise, high IP3, and low current making it ideal for sensitive, high-dynamic-range receiver applications. This design operates on a single 5V supply, is well matched for 50Ω.

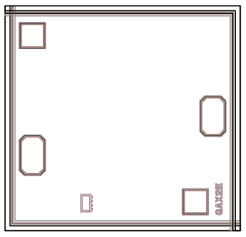
Key Features

Feature	Advantages
Excellent Noise Figure up to 18 GHz • 1.8 dB typ. at 12 GHz • 2.4 dB typ. at 18 GHz	Enables lower system noise figure performance.
High IP3 • +23.4 dBm at 0.5 GHz • +24.1 dBm at 12 GHz	Combination of low noise figure and high IP3 makes this MMIC amplifier ideal for use in low noise receiver front end (RFE) as it gives the user advantages of sensitivity and two-tone IM performance at both ends of the dynamic range.
Low operating voltage & current 5V & 30mA	Low voltage & current consumption is ideal for use in amplifier chain.
Unpackaged die	Enables user to integrate it directly into hybrids.

Low Noise, Wideband, Low Current

Monolithic Amplifier Die PMA2-123LN5-D+

50Ω 0.5 to 12 GHz



Product Features

- Ultra wideband, 0.5 to 12 GHz
- Excellent Noise figure, 1.8 dB at 12 GHz
- Low current, 30mA
- Usable to 18 GHz

Typical Applications

- WiFi
- WLAN
- UMTS
- LTE
- WiMAX
- S-band Radar
- C-band Satcom

+RoHS Compliant

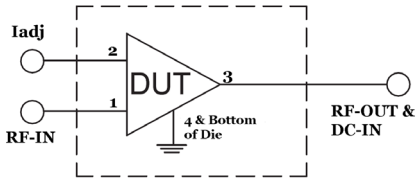
The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

Ordering Information: Refer to Last Page

General Description

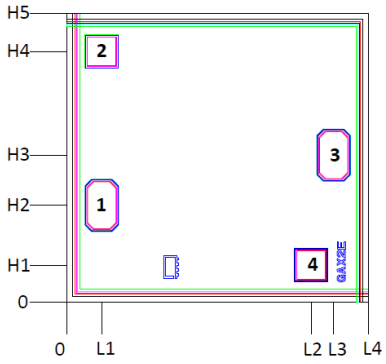
The PMA2-123LN5-D+ is a E-PHEMT based wideband, low noise MMIC amplifier die with a unique combination of low noise, high IP3, and low current making it ideal for sensitive, high-dynamic-range receiver applications. This design operates on a single 5V supply, is well matched for 50Ω.

Simplified Schematic and Pad description



Pad#	Function
1	RF-IN
2	Iadj Pin (Current Adjust)
3	RF OUT and DC-IN
4	Ground

Bonding Pad Position



Dimensions in µm, Typical

L1	L2	L3	L4	H1	H2	H3	H4	H5	Thickness	Die size	Pad size 1 & 3	Pad size 2 & 4
85	594	648	733	90	235	357	608	701	100	733 x 701	81 x 126	81 x 81

Electrical Specifications[1] at 25°C, unless noted

Parameter	Condition (GHz)	V_{DD}=5.0			Units
		Min.	Typ.	Max.	
Frequency Range		0.5		12	GHz
Noise Figure	0.5		1.4		dB
	5		1.2		
	10		1.6		
	12		1.8		
	18		2.4		
Gain	0.5		17.7		dB
	5		15.1		
	10		11.6		
	12		10.7		
	18		7.6		
Reverse Isolation	10	—	24.4	—	dB
Input Return Loss	0.5		6		dB
	5		10		
	10		10		
	12		10		
	18		7		
Output Return Loss	0.5		12		dB
	5		17		
	10		12		
	12		11		
	18		6		
Output Power at 1dB Compression[2]	0.5		12.3		dBm
	5		12.2		
	10		11.6		
	12		11.5		
	18		9.6		
Output IP3	0.5		24.0		dBm
	5		23.4		
	10		23.5		
	12		24.1		
	18		21.6		
Device Operating Voltage (V_{DD})			5		V
Device Operating Current (I_{DD})		—	30	47	mA
Device Current Variation vs. Temperature[2]			7.69		µA/°C
Device Current Variation vs. Voltage			0.008		mA/mV
Thermal Resistance, junction-to-junction			69.8		°C/W

1. Measured on Mini-Circuits Characterization test board with tested board loss being deducted. Die is packaged in 2X2 mm, 8-lead MCL package and soldered on TB-PMA2-123LN5+. See Characterization Test Circuit (Fig. 1)
2. (Current at 85°C - Current at -45°C)/130

Absolute Maximum Ratings[1,3]

Parameter	Ratings
Operating Temperature (ground lead)	-40°C to 85°C
Junction Temperature	131°C
Total Power Dissipation	0.65W
Input Power (CW), Vd=5V	+24 dBm (5 minutes max.) +7 dBm (continuous)
DC Voltage	7V

3. Permanent damage may occur if any of these limits are exceeded.
Electrical maximum ratings are not intended for continuous normal operation.

Characterization Test Circuit

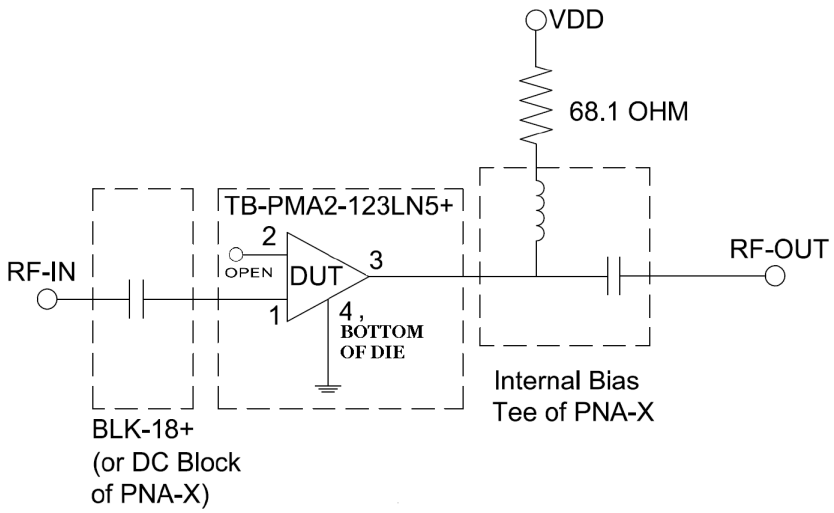
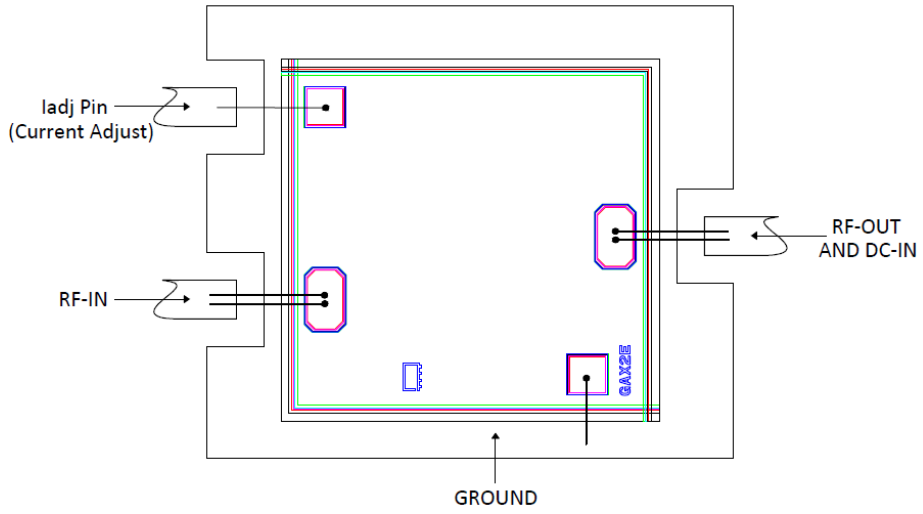


Fig 1. Application and Characterization Circuit
Note: This block diagram is used for characterization. (Die is packaged in 2x2mm, 8-lead MCLP package and soldered on Mini-Circuits Characterization test board TB-PMA2-123LN5+) Gain, Return loss, Output power at 1dB compression (P1dB), output IP3 (OIP3) 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, -5 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. Dice 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*	PMA2-123LN5-DG+
	Medium†, Partial wafer: KGD*<2162	PMA2-123LN5-DP+
	Large†, Full Wafer	PMA2-123LN5-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 1A (250 to <500V) in accordance with ANSI/ESD STM 5.1 - 2001

** Tested in industry standard MCLP 2x2 mm, 8-lead package.

Additional Notes

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

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

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

D. Mini-Circuits does not warrant the accuracy or completeness of the information, text, graphics and other items contained within this document and same are provided as an accommodation and on an "As is" basis, with all faults.

E. Purchasers of this part are solely responsible for proper storing, handling, assembly and processing of Known Good Dice (including, without limitation, proper ESD preventative measures, die preparation, die attach, wire bond ing and related assembly and test activities), and Mini-Circuits assumes no responsibility therefor or for environmental effects on Known Good Dice.

F. Mini-Circuits and the Mini-Circuits logo are registered trademarks of Scientific Components Corporation d/b/a Mini-Circuits. All other third-party trademarks are the property of their respective owners. A reference to any third-party trademark does not constitute or imply any endorsement, affiliation, sponsorship, or recommendation by any such third-party of Mini-Circuits or its products.

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 = 5.00V, Id = 30mA @ 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)
200	14.83	28.54	2.47	7.48	1.23	1.13	25.97	12.75	2.65
400	17.27	25.37	4.92	10.80	1.13	0.95	25.51	12.56	1.56
600	17.85	24.56	6.49	13.43	1.12	0.88	24.74	12.49	1.37
800	18.00	24.25	7.43	15.42	1.12	0.85	24.52	12.54	1.25
1000	18.01	24.09	8.03	16.92	1.13	0.84	24.17	12.33	1.14
1200	17.95	23.98	8.41	18.00	1.14	0.83	24.28	12.29	1.18
1400	17.84	23.91	8.66	18.76	1.14	0.84	24.52	12.41	1.21
1600	17.72	23.85	8.86	19.30	1.15	0.84	23.84	12.50	1.20
1800	17.58	23.79	8.98	19.63	1.16	0.84	23.92	12.21	1.16
2000	17.43	23.76	9.05	19.81	1.18	0.85	24.76	12.14	1.12
2200	17.26	23.71	9.11	19.84	1.19	0.85	23.49	12.18	1.14
2400	17.10	23.69	9.15	19.75	1.20	0.86	24.42	12.55	1.11
2600	16.94	23.65	9.18	19.61	1.21	0.86	23.53	12.01	1.21
2800	16.78	23.62	9.22	19.32	1.22	0.87	24.49	12.24	1.19
3000	16.62	23.59	9.26	19.02	1.23	0.87	23.99	12.08	1.09
4000	15.88	23.44	9.71	17.87	1.30	0.88	24.11	12.09	1.22
5000	15.16	23.38	10.47	17.60	1.38	0.89	23.96	12.34	1.21
6000	14.40	23.65	10.32	17.41	1.50	0.93	24.34	12.28	1.29
7000	13.62	23.79	9.62	17.62	1.61	0.97	24.50	12.08	1.42
8000	12.88	23.98	9.07	16.65	1.71	1.00	23.91	12.09	1.51
9000	12.24	24.13	9.18	14.46	1.83	1.00	24.84	12.16	1.53
10000	11.69	24.19	9.86	12.98	1.95	0.97	23.64	11.76	1.61
11000	11.12	24.54	10.88	12.10	2.17	0.95	23.46	11.63	1.91
12000	10.86	24.81	9.91	11.10	2.20	0.96	24.33	11.57	1.70
13000	10.36	24.90	9.21	10.59	2.28	0.97	24.24	11.27	1.73
14000	9.85	25.13	8.50	10.51	2.40	0.99	23.79	11.02	1.93
15000	9.34	25.45	7.99	10.27	2.56	1.01	23.82	11.11	2.18
16000	8.74	25.97	7.79	9.00	2.77	0.99	23.18	10.29	2.40
17000	8.19	26.67	8.02	7.25	2.99	0.91	22.05	10.05	2.62
18000	7.72	27.09	7.50	6.18	3.07	0.86	21.99	9.78	2.29
19000	7.22	27.79	7.34	5.62	3.35	0.82	22.89	9.41	2.55
20000	6.56	28.87	6.91	5.24	3.86	0.81	21.25	8.93	3.06

Note: Test data of Die packaged in industry standard 2x2 8-lead MCL 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 = 28mA @ 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)
200	14.72	28.39	2.48	7.63	1.23	1.14	25.22	12.14	2.66
400	17.14	25.24	4.90	10.98	1.13	0.95	24.17	11.94	1.58
600	17.70	24.49	6.44	13.62	1.12	0.89	23.86	11.86	1.35
800	17.85	24.18	7.35	15.60	1.13	0.86	24.08	11.90	1.29
1000	17.85	24.01	7.91	17.09	1.13	0.85	23.62	11.69	1.16
1200	17.79	23.90	8.28	18.16	1.14	0.84	23.40	11.77	1.18
1400	17.69	23.83	8.52	18.91	1.15	0.84	23.64	11.77	1.21
1600	17.56	23.77	8.71	19.43	1.16	0.85	23.11	11.85	1.20
1800	17.42	23.73	8.82	19.74	1.17	0.85	23.17	11.69	1.17
2000	17.27	23.69	8.90	19.90	1.18	0.86	23.85	11.62	1.12
2200	17.11	23.65	8.95	19.90	1.19	0.86	22.75	11.66	1.13
2400	16.94	23.60	8.99	19.79	1.20	0.86	23.65	11.90	1.12
2600	16.78	23.55	9.02	19.63	1.21	0.87	22.57	11.38	1.23
2800	16.62	23.54	9.05	19.32	1.22	0.87	23.59	11.60	1.24
3000	16.46	23.50	9.09	19.02	1.23	0.88	23.09	11.44	1.11
4000	15.73	23.37	9.54	17.91	1.30	0.89	23.59	11.46	1.25
5000	15.02	23.30	10.29	17.74	1.39	0.90	23.19	11.71	1.19
6000	14.27	23.56	10.16	17.62	1.51	0.93	23.72	11.65	1.33
7000	13.48	23.72	9.48	17.83	1.61	0.98	23.71	11.57	1.43
8000	12.74	23.94	8.93	16.75	1.72	1.01	22.91	11.58	1.53
9000	12.10	24.09	9.02	14.50	1.84	1.00	24.45	11.53	1.57
10000	11.55	24.13	9.69	13.01	1.96	0.98	23.13	11.01	1.64
11000	10.98	24.52	10.69	12.11	2.19	0.96	22.80	10.88	1.91
12000	10.72	24.75	9.73	11.11	2.21	0.97	23.87	10.93	1.79
13000	10.22	24.88	9.05	10.60	2.29	0.98	23.07	10.63	1.78
14000	9.71	25.14	8.36	10.52	2.43	1.00	22.92	10.50	1.96
15000	9.20	25.42	7.86	10.27	2.58	1.02	22.81	10.47	2.21
16000	8.60	25.99	7.67	8.99	2.80	0.99	22.30	9.64	2.48
17000	8.05	26.64	7.92	7.24	3.01	0.91	21.11	9.41	2.64
18000	7.59	27.08	7.42	6.18	3.09	0.86	21.08	9.14	2.27
19000	7.09	27.77	7.28	5.62	3.38	0.83	21.91	8.78	2.58
20000	6.43	28.80	6.86	5.23	3.87	0.81	20.40	8.19	3.01

Note: Test data of Die packaged in industry standard 2x2 8-lead MCL package

Typical Performance Data

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

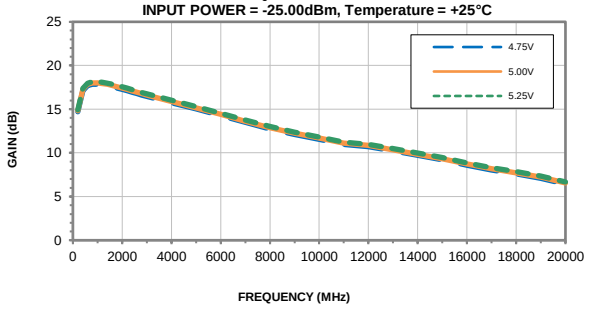
TEST CONDITIONS: Vd = 5.25, Id = 32mA @ Temperature = +25°C

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)
200	14.92	28.63	2.46	7.34	1.23	1.12	27.01	13.33	2.65
400	17.39	25.47	4.93	10.63	1.13	0.94	25.69	13.05	1.57
600	17.98	24.68	6.54	13.26	1.12	0.87	25.33	13.00	1.34
800	18.14	24.33	7.51	15.24	1.12	0.84	25.26	13.05	1.24
1000	18.15	24.17	8.13	16.73	1.13	0.83	25.02	12.84	1.15
1200	18.08	24.05	8.52	17.83	1.13	0.83	24.78	12.79	1.15
1400	17.98	23.97	8.78	18.61	1.14	0.83	25.03	12.91	1.19
1600	17.86	23.91	8.99	19.15	1.15	0.83	24.37	13.00	1.19
1800	17.72	23.89	9.12	19.51	1.16	0.83	24.89	12.71	1.16
2000	17.56	23.84	9.20	19.72	1.17	0.84	25.10	12.64	1.09
2200	17.40	23.79	9.26	19.76	1.18	0.84	24.40	12.68	1.12
2400	17.24	23.75	9.30	19.67	1.20	0.85	25.34	13.05	1.10
2600	17.08	23.73	9.33	19.56	1.21	0.85	24.35	12.51	1.20
2800	16.92	23.72	9.36	19.29	1.22	0.86	25.24	12.62	1.20
3000	16.76	23.68	9.41	18.98	1.23	0.86	24.36	12.58	1.10
4000	16.02	23.54	9.88	17.81	1.30	0.87	25.01	12.59	1.22
5000	15.28	23.45	10.64	17.47	1.38	0.88	24.50	12.83	1.18
6000	14.52	23.70	10.45	17.21	1.50	0.92	25.77	12.77	1.29
7000	13.74	23.84	9.74	17.43	1.60	0.96	25.10	12.56	1.42
8000	13.00	24.04	9.20	16.53	1.71	1.00	24.65	12.58	1.48
9000	12.37	24.16	9.33	14.42	1.82	0.99	26.08	12.65	1.55
10000	11.82	24.22	10.03	12.97	1.94	0.97	24.63	12.13	1.61
11000	11.24	24.56	11.06	12.09	2.15	0.95	24.22	12.00	1.90
12000	10.98	24.80	10.07	11.09	2.18	0.96	25.47	12.06	1.76
13000	10.48	24.94	9.35	10.56	2.27	0.97	24.53	11.88	1.73
14000	9.97	25.14	8.62	10.49	2.38	0.99	24.62	11.63	1.93
15000	9.46	25.46	8.11	10.27	2.54	1.01	24.33	11.61	2.17
16000	8.86	25.99	7.88	9.01	2.75	0.98	23.92	10.79	2.43
17000	8.31	26.65	8.10	7.26	2.96	0.91	22.85	10.55	2.53
18000	7.84	27.11	7.57	6.19	3.05	0.86	22.80	10.28	2.28
19000	7.34	27.81	7.40	5.62	3.33	0.82	23.60	9.91	2.51
20000	6.67	28.89	6.95	5.24	3.83	0.81	22.42	9.42	2.97

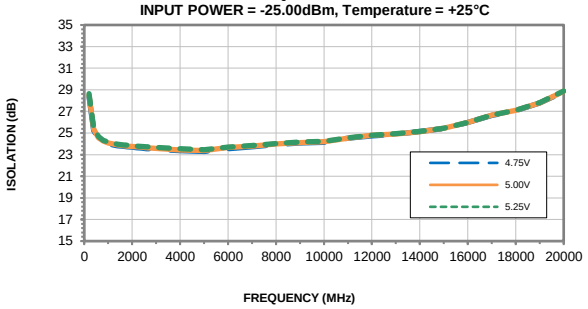
Note: Test data of Die packaged in industry standard 2x2 8-lead MCL package

Typical Performance Curves

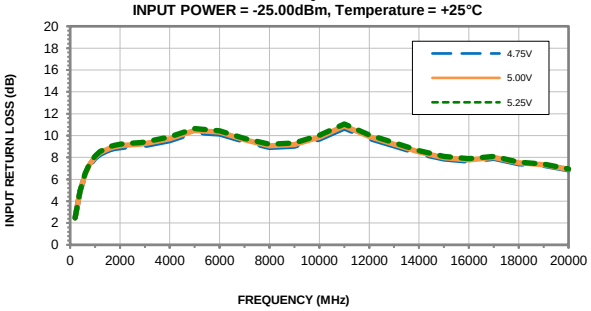
GAIN vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25.00dBm, Temperature = +25°C



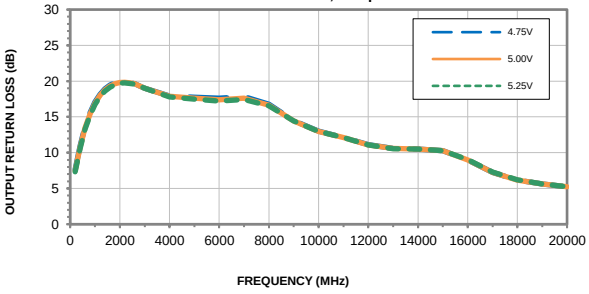
ISOLATION vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25.00dBm, Temperature = +25°C



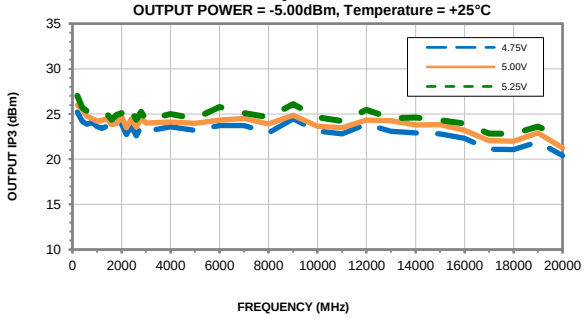
INPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25.00dBm, Temperature = +25°C



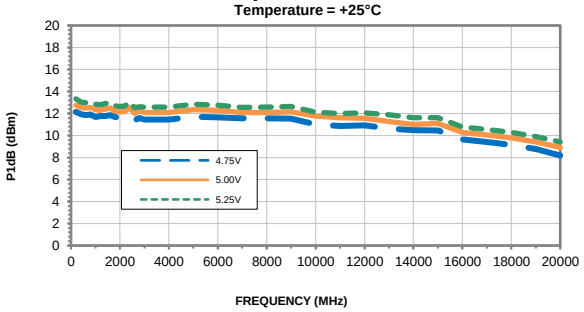
OUTPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25.00dBm, Temperature = +25°C



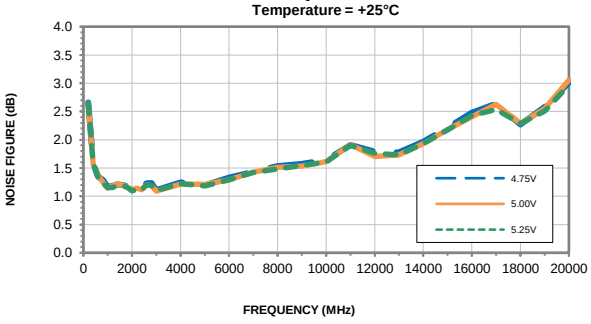
OUTPUT IP3 vs. FREQUENCY & DEVICE VOLTAGE
OUTPUT POWER = -5.00dBm, Temperature = +25°C



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 8-lead MCL 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)	