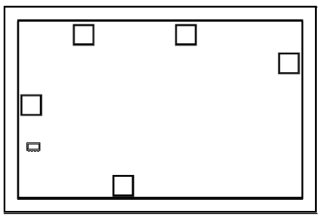
Low Noise, High IP3

Monolithic Amplifier Die PMA-545G1-D+

50Ω 0.4 to 2.2 GHz



The Big Deal

- High Gain, 31.3 dB
- Low Noise Figure, 1.0 dB
- High IP3, 34-36 dBm

Product Overview

Mini-Circuits' PMA-545G1-D+ is a E-PHEMT based Low Noise MMIC Amplifier die operating from 0.4 to 2.2 GHz with a unique combination of low noise high gain and high IP3 making this amplifier ideal for sensitive receiver applications. This design operates on a single +5V supply and is internally matched to 50 Ohms.

Key Features

Feature	Advantages
High Gain: 26-32 dB	Incorporating multiple stages of amplification, the PMA-545G1-D+ provides high gain reducing cost and real estate.
Ultra Low Noise: 1.0 dB at 0.9 GHz	Excellent Noise Figure, measured in a 50 Ohm environment – without any external matching. When combined with high gain of this design, it suppresses second stage NF contribution.
High IP3: +35 dBm IP3 at 0.9 GHz	Combining Low Noise and High IP3 makes this MMIC amplifier ideal for Low Noise Receiver Front End (RFE) giving the user advantages at both ends of the dynamic range: sensitivity & two-tone IM dynamic range.
Output Power: +23 dBm at 0.9 GHz	The PMA-545G1-D+ maintains consistent output power capability over the full operating temperature range making it ideal to be used in remote applications such as LNB's as the L Band driver stage.
Internally Matched: 9-18 dB return loss	No external matching elements required to achieve the advertized noise and output power over the full band.
Max Input Power +25 dBm	Ruggedized design operates up to input powers often seen at Receiver inputs.
High Reliability	Low, small signal operating current of 160 mA nominal maintains junction temperatures typically below 123°C at 85°C at bottom of die.
Unpackaged Die	Enables user to integrate the amplifier directly into hybrids

Low Noise, High IP3

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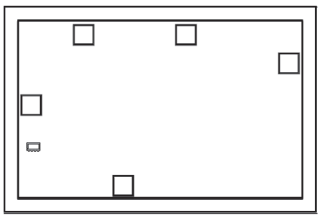


Product Features

- High Gain, 31.3 dB typ. at 0.9 GHz
- Ultra Low Noise Figure, 1.0 dB typ. at 0.9 GHz
- High IP3, 34.6 dBm typ. 0.9 GHz
- Output Power, up to +23dBm typ. at 0.9 GHz
- Single Positive Supply Voltage, 5V

+RoHS Compliant

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

Ordering Information: Refer to Last Page

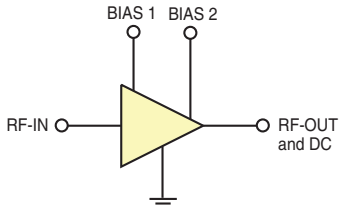
Typical Applications

- Cellular
- ISM
- GSM
- WCDMA
- LTE
- GPS

General Description

PMA-545G1-D+ is a high dynamic range, low noise, high IP3, high output power, monolithic amplifier die. Manufactured using E-PHEMT* technology enables it to work with a single positive supply voltage. Unconditionally stable over the operating frequency.

Simplified Schematic and Pad description



Bonding Pad	Description *(See Application Circuit, Fig. 1)*
RF-IN	RF input pad (connected to RF-IN via C1)
RF-OUT & DC	RF output pad (connected to RF-OUT via blocking external cap C2, and Supply voltage Vs via RF Choke L2)
BIAS 1	Connect to Vs
BIAS 2	Connect to Vs via L1
GROUND	Connected to ground

*Enhancement mode Pseudomorphic High Electron Mobility Transistor.

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

Electrical Specifications[1] at 25°C, Vd=5V, Zo=50Ω | *(refer to characterization circuit)*

Parameter	Condition (GHz)	Min.	Typ.	Max.	Units
Frequency Range		0.4		2.2	GHz
DC Voltage (Vd)		4.8	5.0	5.2	V
DC Current		117	158	186	mA
Noise Figure	0.4	—	1.2	—	dB
	0.9	—	1.0	—	
	1.2	—	1.0	—	
	1.6	—	1.1	—	
	2.2	—	1.3	—	
Gain	0.4	—	32.0	—	dB
	0.9	—	31.3	—	
	1.2	—	31.1	—	
	1.6	—	29.9	—	
	2.2	—	25.8	—	
Input Return Loss	0.4		15.8		dB
	0.9		9.4		
	1.2		10.0		
	1.6		12.9		
	2.2		18.1		
Output Return Loss	0.4		16.9		dB
	0.9		17.3		
	1.2		17.0		
	1.6		16.3		
	2.2		14.9		
Output IP3	0.4		34.5		dBm
	0.9		34.6		
	1.2		36.1		
	1.6		36.6		
	2.2		35.4		
Output Power @ 1 dB compression[2]	0.4	—	22.2	—	dBm
	0.9	—	23.3	—	
	1.2	—	23.4	—	
	1.6	—	23.7	—	
	2.2	—	23.5	—	
DC Current Variation vs. Voltage			0.034		mA/mV
Thermal Resistance			40		°C/W

1. Measured on Mini-Circuits die Characterization test board. See Characterization Test Circuit (Fig. 1)
2. Current increases at P1dB.

Absolute Maximum Ratings[3,5]

Parameter	Ratings
Operating Temperature[4]	-40°C to 85°C
Channel Temperature	150°C
DC Voltage (Pads Bias, RF-OUT & DC)	6V
Power Dissipation	1.35W
Input Power	25dBm

3. Permanent damage may occur if any of these limits are exceeded. These maximum ratings are not intended for continuous normal operation.
4. Defined with reference to ground pad temperature.
5. Measured in industry standard 8-lead 3x3 MCLP package.

Characterization Test Circuit

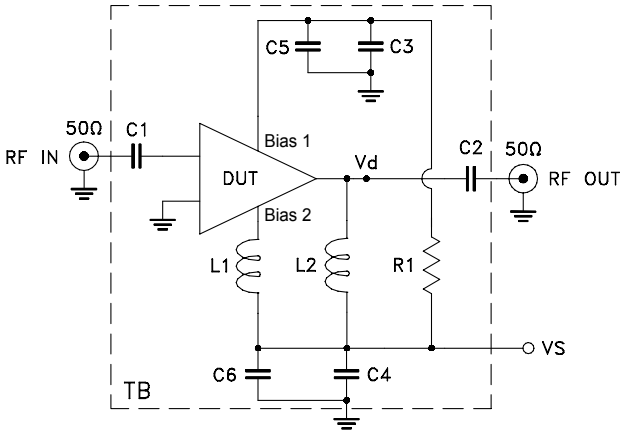
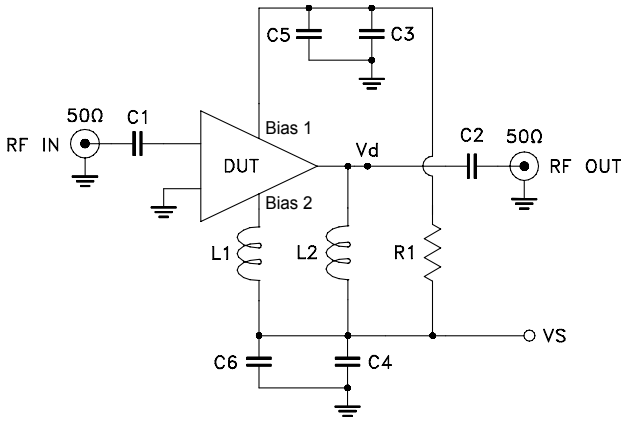


Fig 1. Block Diagram of Test Circuit used for characterization. Gain, Output power at 1dB compression (P1dB), Output IP3 (OIP3), Noise Figure are measured using Agilent's N5242A PNA-X microwave network analyzer.

Conditions:
1. Gain: Pin=-25 dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, 0 dBm/tone at output.
3. Vs adjusted for 5V at device (Vd), compensating loss of bias tee.

Recommended Application Circuit



Component	Description
DUT	PMA-545G1-D+ Die
C1, C2, C5, C6	100 pF
C3, C4	1µF
R1	0 ⊃
L1	36 nH
L2	47 nH

Die Layout

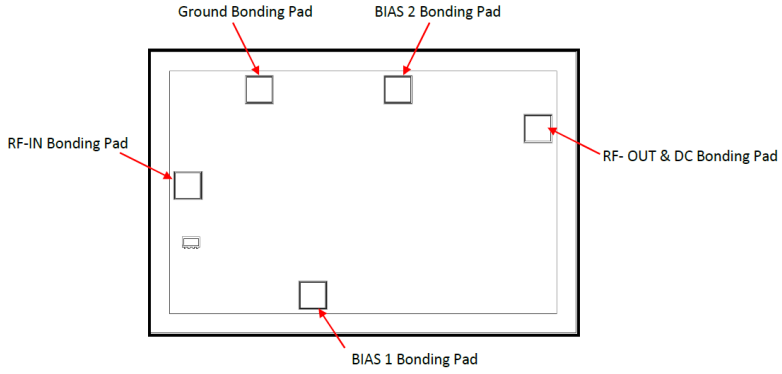


Fig 2. Die Layout

Bonding Pad Position

(Dimensions in µm, Typical)

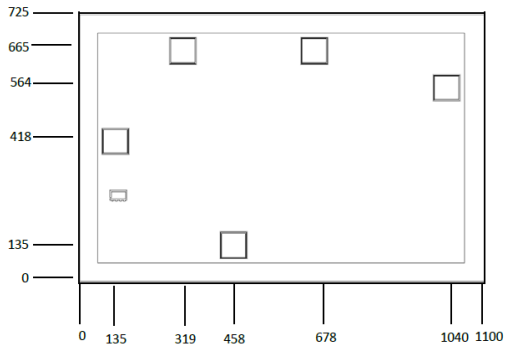


Fig 3. Bonding Pad Positions

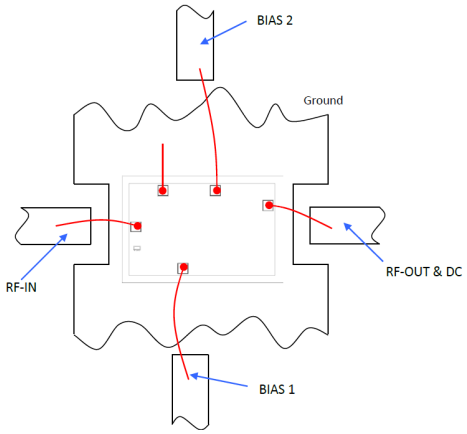
Critical Dimensions

Parameter	Values
Die Thickness, µm	100
Die Width, µm	725
Die Length, µm	1100
Bond Pad Size, 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) 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 worksta tion. 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.

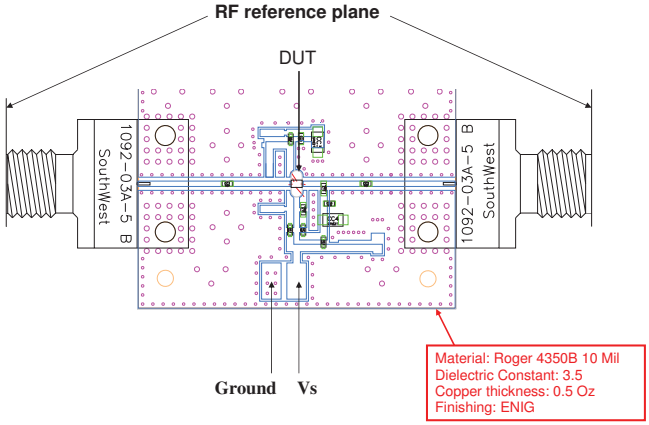
Assembly Diagram



Recommended Wire Length, Typical

Wire	Wire Length (mm)	Wire Loop Height (mm)
RF-IN, RF-OUT & DC	0.8	0.15
BIAS 1, BIAS 2	1.2	0.15
GROUND	0.50	0.15

RF Reference Plane - No port extension



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: 10,50,100 KGD*	PMA-545G1-DG+
	Medium†, Partial wafer: KGD*<1655	PMA-545G1-DP+
	Large†, Full Wafer	PMA-545G1-DF+
	†*Available upon request contact sales representative*	
	Refer to AN-60-067	
Environmental Ratings	ENV-80	

*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 1B (500 to <1000V) in accordance with ANSI/ESD STM 5.1 - 2001

** Tested in industry standard 3x3mm, 8-lead, MCLP 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.

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MMIC Amplifier Die PMA-545G1-D+

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 = 5V, Id = 159mA @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	24.23	86.28	1.41	13.74	167.55	1.65	28.03	15.55	5.29
300	30.63	73.60	6.09	17.39	52.19	1.22	34.18	20.57	1.64
350	31.73	68.21	10.83	18.17	30.16	1.06	34.73	21.58	1.36
400	32.09	70.52	16.55	18.32	40.21	1.01	35.81	22.34	1.19
450	32.16	70.69	17.73	18.47	40.93	1.00	37.27	22.79	1.16
500	32.06	70.62	15.11	18.44	40.45	1.02	35.49	22.68	1.16
550	31.94	74.59	13.11	18.47	63.58	1.03	35.64	22.96	1.16
600	31.84	69.14	11.89	18.42	33.76	1.05	35.94	23.10	1.16
650	31.74	67.24	11.09	18.43	27.06	1.06	35.92	23.02	1.08
700	31.65	67.87	10.58	18.51	29.08	1.07	34.71	23.14	1.08
750	31.56	64.40	10.23	18.57	19.53	1.08	36.60	23.22	1.07
800	31.50	63.46	10.03	18.59	17.58	1.08	34.94	23.40	1.03
850	31.45	63.88	9.93	18.64	18.51	1.09	36.86	23.28	0.98
900	31.40	62.44	9.90	18.67	15.76	1.09	36.37	23.41	0.98
950	31.36	64.80	9.90	18.67	20.77	1.09	35.57	23.58	0.99
1000	31.32	63.30	9.99	18.61	17.61	1.09	36.63	23.50	1.01
1050	31.28	60.73	10.08	18.55	13.19	1.08	36.34	23.36	1.02
1100	31.23	59.62	10.24	18.46	11.72	1.08	36.32	23.68	1.02
1150	31.18	58.47	10.43	18.39	10.38	1.07	36.12	23.59	1.01
1200	31.12	58.53	10.67	18.27	10.57	1.07	37.03	23.49	1.01
1250	31.04	57.74	10.93	18.23	9.79	1.06	36.35	23.77	1.04
1300	30.95	57.54	11.23	18.12	9.72	1.06	37.76	23.72	1.06
1350	30.84	56.77	11.59	18.08	9.07	1.05	37.01	23.62	1.03
1400	30.71	56.42	11.98	18.06	8.91	1.05	35.36	23.77	1.06
1450	30.55	57.43	12.35	18.03	10.24	1.04	37.21	23.84	1.00
1500	30.38	55.89	12.82	18.06	8.81	1.03	37.50	23.62	1.06
1600	29.95	56.02	13.75	18.20	9.50	1.03	37.13	23.79	1.11
1700	29.43	54.67	14.82	18.25	8.71	1.02	36.26	23.69	1.08
1800	28.84	53.31	15.94	18.24	8.04	1.01	36.91	23.82	1.12
1900	28.23	53.47	16.98	17.79	8.82	1.00	37.14	23.68	1.12
2000	27.48	53.08	17.92	17.84	9.22	1.00	39.84	23.76	1.14
2100	26.72	52.77	18.76	17.47	9.74	0.99	36.52	23.75	1.18
2200	25.93	53.81	19.42	16.82	11.99	0.99	36.30	23.67	1.23
2300	25.14	52.82	19.81	16.02	11.69	0.98	37.36	23.54	1.24
2400	24.32	54.00	20.01	15.13	14.62	0.98	35.35	23.35	1.28
2500	23.51	53.34	20.00	14.18	14.76	0.97	35.73	23.11	1.32
2600	22.69	53.62	19.90	13.22	16.58	0.96	36.76	22.93	1.39
2700	21.86	53.99	19.72	12.31	18.80	0.95	32.41	22.64	1.54
2800	21.04	54.25	19.51	11.36	20.97	0.94	35.44	22.23	1.56
2900	20.23	55.52	19.19	10.43	26.11	0.92	35.65	21.74	1.63
3000	19.44	55.40	18.82	9.52	27.51	0.90	34.47	21.36	1.68

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 = 150mA @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	24.08	73.44	1.38	13.69	38.15	1.65	27.73	15.44	5.32
300	30.47	69.88	6.07	17.08	34.52	1.22	34.00	20.72	1.65
350	31.58	71.93	10.79	17.90	46.96	1.06	35.62	21.60	1.37
400	31.94	71.11	16.46	17.96	43.74	1.01	37.37	22.12	1.21
450	31.98	66.75	17.62	18.02	26.48	1.00	34.70	22.53	1.17
500	31.90	73.51	15.02	17.98	57.36	1.02	35.40	22.31	1.16
550	31.79	66.10	13.07	18.01	24.30	1.03	33.04	22.45	1.16
600	31.69	66.47	11.84	18.00	25.20	1.05	35.42	22.64	1.18
650	31.58	67.18	11.04	18.00	27.30	1.06	35.70	22.49	1.10
700	31.50	67.15	10.54	18.11	27.19	1.07	34.08	22.61	1.07
750	31.42	64.65	10.20	18.17	20.41	1.08	34.90	22.69	1.09
800	31.36	61.07	9.99	18.20	13.52	1.08	34.66	22.94	1.01
850	31.32	63.06	9.89	18.26	17.06	1.09	35.70	22.82	1.05
900	31.27	60.20	9.84	18.29	12.32	1.09	36.25	22.96	0.99
950	31.23	63.11	9.86	18.32	17.32	1.09	34.76	23.13	0.98
1000	31.19	61.96	9.94	18.27	15.26	1.09	35.61	22.99	1.00
1050	31.16	60.75	10.04	18.24	13.37	1.08	34.70	22.92	1.01
1100	31.11	60.74	10.20	18.17	13.48	1.08	36.65	23.25	1.03
1150	31.06	58.30	10.39	18.13	10.29	1.08	35.22	23.15	1.03
1200	31.00	58.58	10.63	18.01	10.75	1.07	37.09	23.05	1.03
1250	30.93	56.80	10.90	17.97	8.89	1.06	36.99	23.34	1.04
1300	30.84	57.38	11.19	17.84	9.64	1.06	36.22	23.29	1.06
1350	30.73	56.89	11.55	17.82	9.29	1.05	36.06	23.14	1.03
1400	30.60	55.90	11.94	17.82	8.49	1.05	35.66	23.35	1.06
1450	30.45	54.31	12.36	17.78	7.23	1.04	36.31	23.43	1.02
1500	30.28	55.63	12.78	17.77	8.64	1.03	35.23	23.19	1.08
1600	29.86	54.60	13.73	17.88	8.14	1.02	36.25	23.38	1.12
1700	29.35	53.40	14.82	17.85	7.60	1.01	35.96	23.27	1.10
1800	28.77	53.93	15.94	17.75	8.69	1.01	35.99	23.41	1.10
1900	28.14	53.60	16.98	17.47	9.04	1.00	35.25	23.28	1.12
2000	27.41	53.41	18.01	17.47	9.66	1.00	36.67	23.36	1.14
2100	26.66	53.21	18.85	17.07	10.30	0.99	35.26	23.30	1.17
2200	25.88	53.42	19.56	16.41	11.51	0.99	36.67	23.28	1.23
2300	25.08	52.11	19.95	15.68	10.83	0.98	35.12	23.14	1.26
2400	24.27	53.26	20.16	14.88	13.48	0.98	36.46	22.97	1.30
2500	23.46	53.17	20.22	13.99	14.53	0.97	35.20	22.73	1.32
2600	22.65	54.55	20.08	13.07	18.52	0.96	35.57	22.55	1.38
2700	21.82	53.35	19.91	12.18	17.53	0.95	36.91	22.27	1.57
2800	21.00	54.16	19.72	11.25	20.82	0.94	32.34	21.79	1.58
2900	20.19	55.53	19.38	10.33	26.22	0.92	34.17	21.37	1.61
3000	19.41	55.38	19.03	9.45	27.49	0.90	33.63	20.98	1.68

Typical Performance Data

Definitions:

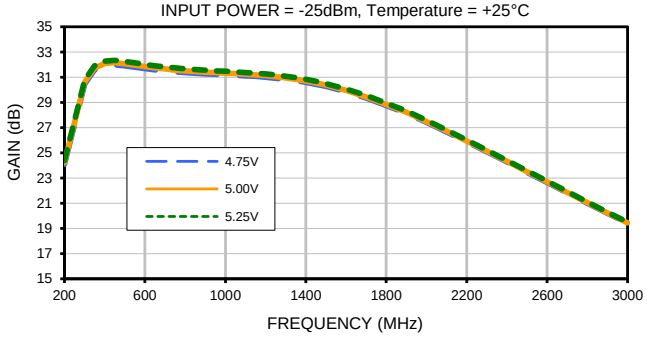
Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 5.25V, Id = 167mA @Temperature = +25°C

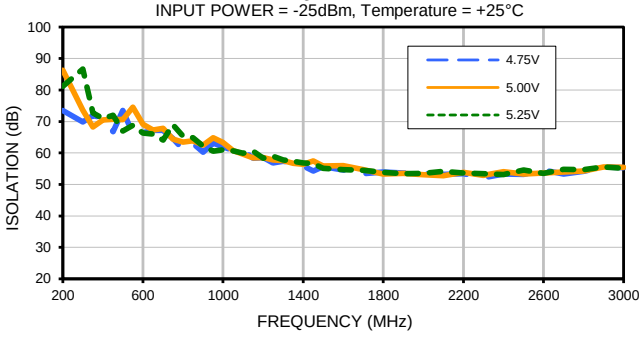
FREQ.	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
200	24.38	81.14	1.44	13.71	93.05	1.64	27.63	15.37	5.27
300	30.78	86.66	6.12	17.81	231.18	1.22	34.59	20.19	1.64
350	31.90	72.70	10.84	18.74	49.64	1.07	34.24	21.46	1.38
400	32.27	70.91	16.59	18.98	41.28	1.01	35.41	22.29	1.23
450	32.34	71.97	17.85	19.20	46.56	1.00	36.13	22.90	1.18
500	32.25	67.00	15.17	19.19	26.18	1.02	35.49	22.89	1.17
550	32.13	68.82	13.17	19.19	32.09	1.04	36.62	23.17	1.17
600	32.02	66.28	11.91	19.21	23.86	1.05	36.83	23.32	1.18
650	31.91	66.00	11.11	19.16	23.04	1.07	36.63	23.30	1.10
700	31.82	64.06	10.61	19.22	18.46	1.07	36.97	23.42	1.08
750	31.73	69.00	10.28	19.25	32.66	1.08	35.55	23.50	1.09
800	31.67	65.32	10.07	19.29	21.44	1.09	36.64	23.73	1.03
850	31.61	64.87	9.97	19.28	20.43	1.09	36.40	23.56	1.03
900	31.56	62.13	9.92	19.29	14.97	1.09	36.65	23.69	0.98
950	31.51	60.59	9.94	19.24	12.61	1.09	37.12	23.90	1.00
1000	31.47	60.97	10.01	19.14	13.26	1.09	36.32	23.77	1.01
1050	31.42	60.70	10.12	19.07	12.97	1.08	35.39	23.69	1.03
1100	31.37	59.96	10.28	18.93	12.02	1.08	35.99	23.99	1.03
1150	31.32	60.53	10.47	18.88	12.97	1.08	36.72	23.91	1.05
1200	31.25	58.28	10.70	18.70	10.13	1.07	36.33	23.81	0.99
1250	31.17	58.93	10.96	18.62	11.08	1.07	36.04	24.02	1.05
1300	31.08	57.78	11.26	18.55	9.88	1.06	36.85	24.02	1.06
1350	30.97	57.32	11.62	18.47	9.54	1.05	35.05	23.88	1.03
1400	30.83	56.83	12.01	18.50	9.22	1.05	37.42	24.02	1.07
1450	30.68	56.58	12.41	18.50	9.17	1.04	36.93	24.08	1.01
1500	30.50	55.14	12.83	18.52	7.98	1.04	37.70	23.92	1.09
1600	30.07	54.73	13.77	18.69	8.10	1.03	37.57	24.03	1.12
1700	29.55	54.45	14.82	18.81	8.40	1.02	38.18	23.98	1.13
1800	28.95	53.89	15.92	18.89	8.50	1.01	37.22	24.05	1.12
1900	28.33	53.41	16.96	18.52	8.69	1.00	38.04	23.96	1.14
2000	27.57	53.48	17.84	18.60	9.58	1.00	36.54	24.04	1.15
2100	26.80	54.15	18.62	18.15	11.32	1.00	37.45	23.97	1.20
2200	26.01	53.59	19.24	17.44	11.61	0.99	37.49	23.95	1.24
2300	25.21	53.45	19.60	16.53	12.49	0.99	37.33	23.81	1.25
2400	24.39	53.14	19.79	15.57	13.16	0.98	34.48	23.63	1.33
2500	23.57	54.55	19.82	14.56	16.90	0.98	37.26	23.39	1.34
2600	22.75	53.50	19.65	13.53	16.28	0.97	36.83	23.20	1.41
2700	21.92	54.77	19.48	12.56	20.48	0.96	31.82	22.90	1.59
2800	21.10	54.65	19.26	11.57	21.86	0.94	36.60	22.43	1.59
2900	20.28	55.59	18.92	10.62	26.24	0.93	35.34	21.94	1.65
3000	19.50	55.12	18.60	9.68	26.56	0.91	35.34	21.55	1.72

Typical Performance Curves

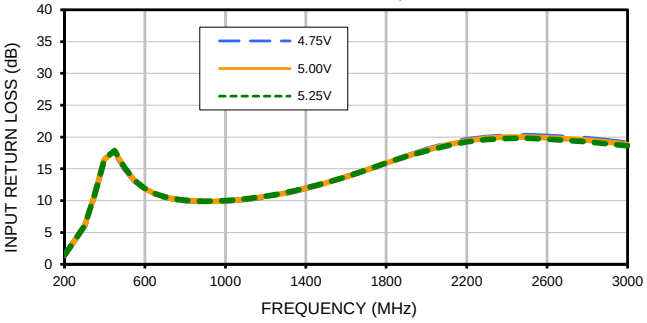
GAIN vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



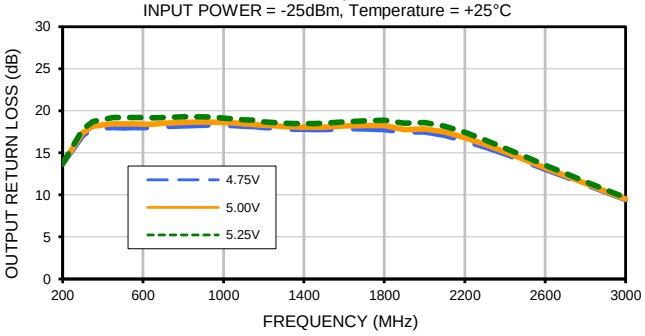
ISOLATION vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



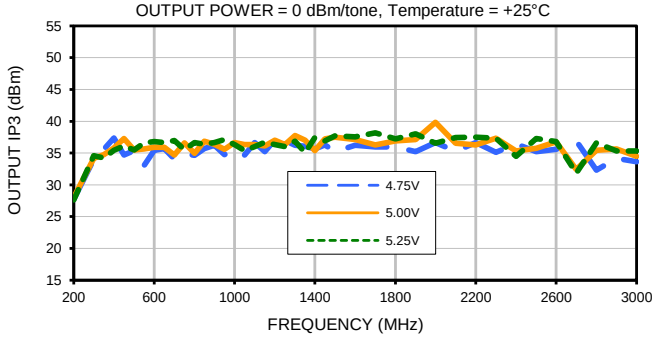
INPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



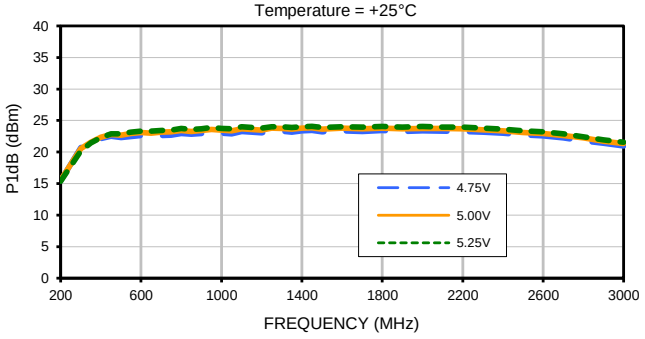
OUTPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



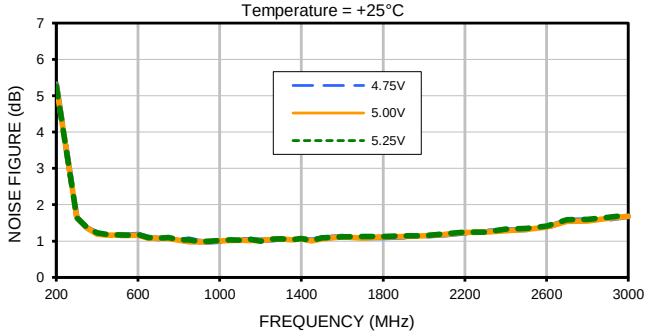
OUTPUT IP3 vs. DEVICE VOLTAGE
OUTPUT POWER = 0 dBm/tone, Temperature = +25°C



P1dB vs. DEVICE VOLTAGE
Temperature = +25°C



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



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)	