HIGH DIRECTIVITY

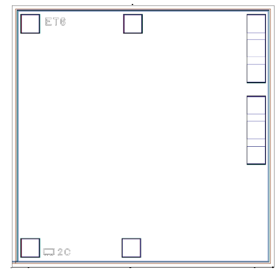
Monolithic Amplifier Die

MNA-5A-D+

50Ω 0.5 to 4.5 GHz

THE BIG DEAL

- Choice of Supply Voltage, +2.8 V to +5 V
- Internal DC Blocking at RF Input and Output
- High Directivity, 17-23 dB Typ.
- Output Power, Up to +14 dBm Typ.



+RoHS Compliant
The +Suffix identifies RoHS Compliance.
See our website for methodologies and qualifications

SEE ORDERING INFORMATION ON THE LAST PAGE

APPLICATIONS

- Buffer Amplifier
- Cellular Infrastructure
- Communications Satellite
- Defense

PRODUCT OVERVIEW

MNA-5A-D+ is a wideband pHEMT based MMIC amplifier die with high active directivity. MNA-5A-D+ integrates the entire matching network and majority of the bias circuit inside the die, reducing the need for complicated external circuits. This approach makes the MNA-5A-D+ amplifier die extremely straightforward to use. This design operates on a single +2.8 V to +5 V supply, is well matched for 50Ω. MNA series models are available in Die and packaged form.

KEY FEATURES

Features	Advantages
Excellent Active Directivity (Isolation - Gain) 17-23 dB	Ideal for use as a buffer amplifier minimizing interaction of adjacent circuits.
Integrates DC Blocks and RF Choke	Minimizes external components, component count and circuit area.
Single +2.8 V to +5 V Operation	Amplifier can be used at low voltage such as +3 V or standard +5 V. +5 V operation results in higher P1dB and OIP3.
Unpackaged Die	Enables the user to integrate the amplifier directly into hybrids.

REV. C
ECO-024931
MNA-5A-D+
MCL NY
250319

ELECTRICAL SPECIFICATIONS[1] AT +25°C

Parameter	Condition (GHz)	V_S=+5 V Min.	V_S=+5 V Typ.	V_S=+5 V Max.	V_S=+2.8 V Typ.	Units
Frequency Range		0.5		4.5	0.5-4.5	GHz
Gain	0.5		21.6		20.5	dB
	1.0		23.5		21.9	
	2.0		21.3		19.4	
	2.5		19.2		17.4	
	3.5		14.5		13.1	
	4.5		10.3		9.1	
Input Return Loss	0.5		5.4		5.6	dB
	1.0		14.9		15.3	
	2.0		21.6		21.1	
	2.5		17.1		17.2	
	3.5		10.3		10.4	
	4.5		6.5		6.6	
Output Return Loss	0.5		14.5		14.4	dB
	1.0		12.8		17.4	
	2.0		12.2		15.3	
	2.5		12.8		15.7	
	3.5		13.9		17.1	
	4.5		13.7		16.8	
Output Power at P1dB	0.5		+12.6		+11.0	dBm
	1.0		+11.1		+10.1	
	2.0		+9.6		+8.4	
	2.5		+8.7		+7.5	
	3.5		+7.2		+5.8	
	4.5		+5.5		+4.1	
Output IP3	0.5		+23.8		+21.8	dBm
	1.0		+22.3		+20.6	
	2.0		+20.1		+18.5	
	2.5		+19.1		+17.5	
	3.5		+17.8		+15.9	
	4.5		+16.0		+14.1	
Noise Figure	0.5		3.2		3.3	dB
	1.0		3.0		3.0	
	2.0		3.1		3.2	
	2.5		3.2		3.2	
	3.5		3.4		3.6	
	4.5		4.3		4.6	
Directivity (Isolation - Gain)	0.5		20.3		22.5	dB
	1.0		19.7		19.3	
	2.0		16.6		16.2	
	2.5		17.3		16.6	
	3.5		20.0		18.9	
	4.5		22.9		21.7	
DC Current			34	43	32	mA
Device Current Variation vs. Temperature[2]			15		5	µA/°C
Device Current Variation vs. Voltage			0.0004[3]		0.0014[4]	mA/mV
Thermal Resistance at +85°C (Junction to Lead)			64		64	°C/W

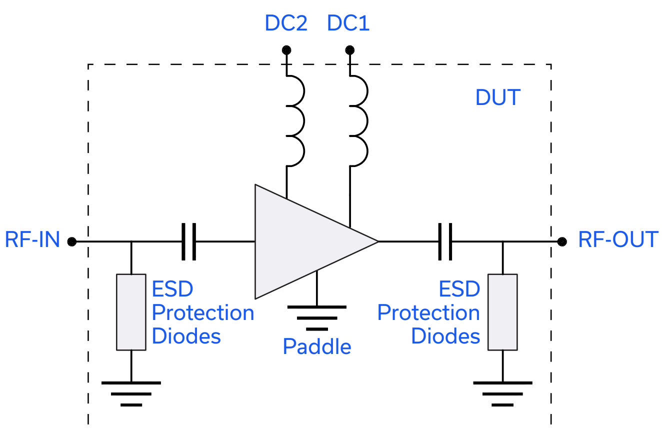
1. Measured on Mini-Circuits characterization test board. Die packaged in 3x3 mm 8-Lead QFN-Style Package and soldered on test board TB-186-5A+.
2. (Current at +85°C - Current at -45°C)/130
3. (Current at +5.25 V - Current at +3.9 V)/1.35
4. (Current at +3.9 V - Current at +2.66 V)/1.24

ABSOLUTE MAXIMUM RATINGS

Parameter	Ratings
Operating Temperature	-40°C to +85°C
DC Voltage	+7 V at DC1 (DC2 connected to DC1 via 33.2Ω) +1 V at RF IN & RF OUT
Power Dissipation	700 mW
Input Power	+5 dBm at +5 V (continuous operation) +28 dBm (5 minutes max)

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

SIMPLIFIED SCHEMATIC AND PAD DESCRIPTION



Function	Description
RF-IN	RF input pad.
RF-OUT	RF output pad.
DC1 & DC2	DC Supply pad. Connect DC2 to DC1 via 33.2Ω resistor

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

CHARACTERIZATION CIRCUIT

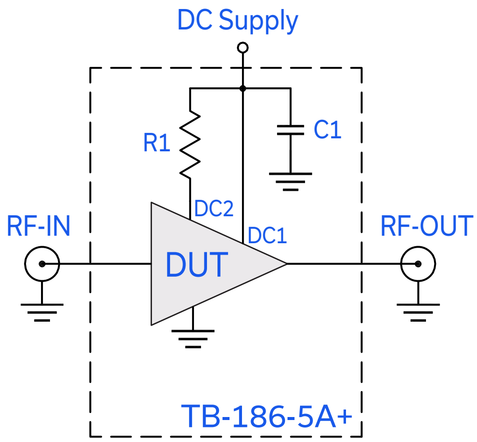


Fig 1. Block Diagram of Test Circuit used for characterization. (Die packaged in 3x3 mm 8-Lead QFN-Style Package and soldered on Mini-Circuits Characterization test board TB-186-5A+) Gain, Return Loss, Output Power at 1 dB Compression (P1dB), Output IP3 (OIP3) and Noise Figure measured using Agilent's N5242A PNA-X microwave network analyzer.

Conditions:
1. Gain and Return Loss: P_{IN}= -25 dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, 0 dBm/tone at output.

Component	Size	Value	Units
R1	0805	33.2	Ω
C1	0402	1000	ρF

RECOMMENDED APPLICATION CIRCUIT

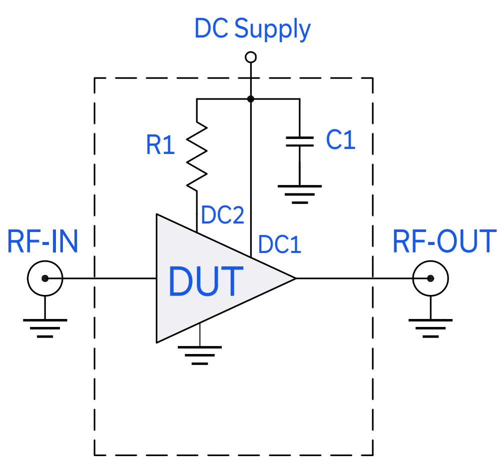


Fig 2. Test Board includes case, connectors, and components soldered to PCB

Component	Value	Units
R1	33.2	Ω
C1	1000	ρF

DIE LAYOUT

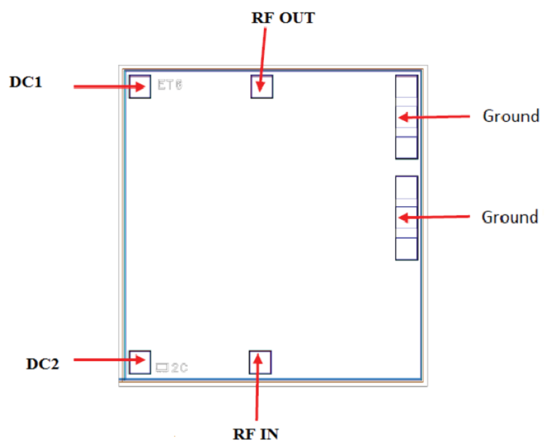


Fig 3. Die Layout

BONDING PAD POSITION

(Dimensions in µm, Typical)

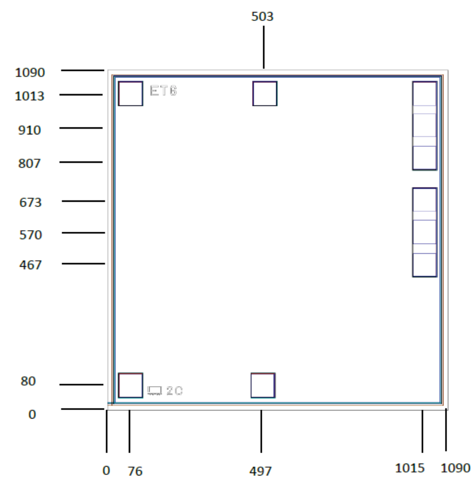
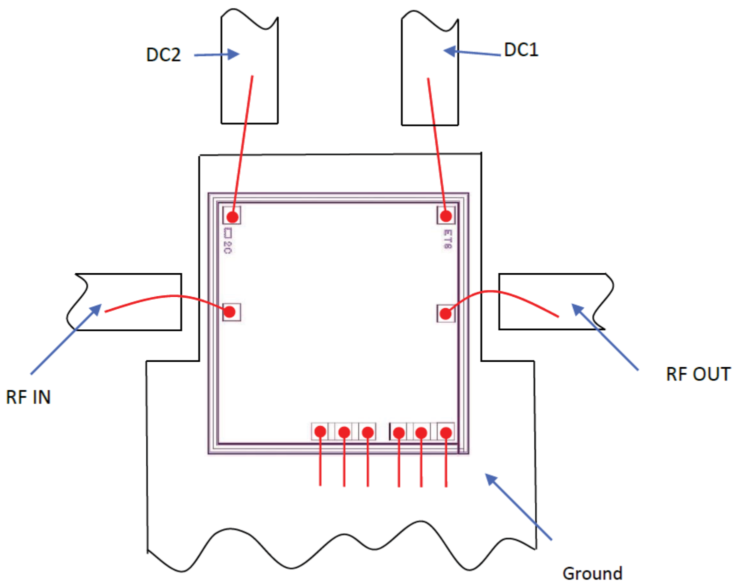


Fig 4. Bonding Pad Positions

CRITICAL DIMENSIONS

Parameter	Values
Die Thickness, µm	100
Die Width, µm	1090
Die Length, µm	1090
Bond Pad Size (RF IN, RF OUT, DC1, DC2), µm	80 x 80
Bond Pad Size (Ground), µm	80 x 286

ASSEMBLY DIAGRAM



Note: Ground bond wires are optional.

RECOMMENDED WIRE LENGTH, TYPICAL

Wire	Wire Length (mm)	Wire Loop Height (mm)
RF IN, RF OUT	1.20	0.15
DC1, DC2	1.00	0.15
Ground	0.35	0.15

ASSEMBLY PROCEDURE

1. Storage
   Die should be stored in a dry nitrogen purged desiccators or equivalent.
2.  ESD
   MMIC PHEMT amplifier Die are susceptible to electrostatic and mechanical damage. Die are supplied in antistatic protected material, which should be open in clean room conditions at an appropriately grounded anti-static workstation.
3. Die Handling and Attachment
   Devices need careful handling using correctly designed collets, it is recommended to handle the chip along the edges with a custom design collet. The die mounting surface must be clean and flat. Using conductive silver filled epoxy, recommended epoxies are Ablestik 84-1 LMISR4 or equivalents. Apply sufficient epoxy to meet required epoxy bond line thickness, epoxy fillet height and epoxy coverage around total periphery. Parts shall be cured in a nitrogen filled atmosphere per manufacturer's cure condition. The surface of the chip has exposed air bridges and should not be touched with vacuum collet, tweezers or fingers.
4. Wire Bonding
   Bond pad openings in the surface passivation above the bond pads are provided to allow wire bonding to the Die gold bond pads. Thermo-sonic bonding is used with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. Suggested wire is pure gold, 1mil diameter. Bonds must be made from the bond pads on the die to the packaged or substrate. All bond wire length and bond wire height should be kept as short as possible unless specified by the Assembly Drawing to minimize performance degradation due to undesirable series inductance.

ADDITIONAL DETAILED TECHNICAL 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 Small, Gel - Pak: 5,10,50,100 KGD* Medium†, Partial wafer: KGD*<1295 Large†, Full Wafer † Available upon request contact sales representative Refer to AN-60-067	Model No. MNA-5A-DG+ MNA-5A-DP+ MNA-5A-DF+
Environmental Ratings	ENV-80	

*Known Good Die ('KGD') means that the die in question have been subjected to Mini-Circuits DC test performance criteria and measurement instructions and that the parametric data of such die fall within a predefined range. While DC testing is not definitive, it does provide a higher degree of confidence that die are capable of meeting typical RF electrical performance specified by Mini-Circuits.

ESD RATING**

Human Body Model (HBM): Class 1A (250 V to < 500 V) in accordance with ANSI/ESD STM 5.1 - 2001

**Tested in 3x3 mm 8-Lead QFN-Style Package

MMIC Amplifier Die

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 = 3.9V, Id = 33.77 mA @ Temperature = +25degC

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	4.46	45.30	1.75	2.32	7.36	0.69	9.45	1.65	5.54
300	14.54	41.54	2.22	5.87	2.97	1.22	19.87	9.06	4.13
400	19.14	41.31	3.56	9.76	3.04	1.32	23.26	12.24	3.51
500	21.26	42.74	5.44	14.49	4.03	1.25	24.20	13.17	3.58
600	22.27	43.43	7.49	20.63	4.66	1.17	24.79	13.35	3.08
700	22.75	43.95	9.49	23.64	5.11	1.10	24.60	13.19	3.06
800	23.06	44.49	11.44	19.41	5.48	1.05	24.16	12.88	3.08
900	23.06	43.34	13.40	18.26	4.92	1.02	23.46	12.40	2.98
1000	23.09	42.78	15.08	16.61	4.65	0.99	23.30	12.20	2.99
1100	23.05	41.91	16.76	15.81	4.26	0.98	23.15	12.08	2.99
1200	22.97	41.28	18.32	15.29	4.02	0.96	23.19	11.96	2.97
1300	22.84	40.52	19.70	14.86	3.75	0.96	22.56	11.70	2.91
1400	22.69	40.10	20.91	14.48	3.63	0.95	22.26	11.43	2.91
1500	22.49	39.77	22.12	14.18	3.58	0.94	22.27	11.40	2.93
1600	22.32	39.10	22.07	14.32	3.39	0.94	22.02	11.30	2.99
1700	22.06	38.60	22.75	14.17	3.30	0.94	21.56	10.93	2.96
1800	21.81	38.51	22.60	13.99	3.35	0.94	21.42	10.73	3.03
1900	21.53	37.80	22.12	13.96	3.20	0.94	20.93	10.41	3.01
2000	21.23	37.56	22.15	13.68	3.21	0.93	20.94	10.42	3.04
2100	20.91	37.26	21.05	13.84	3.22	0.94	20.94	10.37	2.97
2200	20.55	37.17	20.09	14.17	3.32	0.94	20.69	10.18	3.01
2300	20.19	36.45	19.57	14.06	3.19	0.94	20.43	9.94	3.02
2400	19.81	36.40	18.67	14.18	3.30	0.95	20.37	9.81	2.93
2500	19.43	36.46	17.30	14.41	3.46	0.95	19.85	9.43	3.05
2600	19.07	35.88	16.78	14.27	3.36	0.95	19.99	9.46	3.10
2700	18.59	35.68	15.77	14.63	3.46	0.96	19.95	9.35	3.15
2800	18.17	35.62	14.89	14.56	3.58	0.97	19.68	9.06	3.14
2900	17.72	35.96	14.01	15.17	3.90	0.98	19.45	9.03	3.23
3000	17.30	35.26	13.30	14.83	3.75	0.99	19.32	8.71	3.21
3100	16.92	34.63	12.76	14.69	3.62	0.99	19.37	8.83	3.24
3200	16.45	34.78	11.96	15.19	3.85	1.01	18.61	8.60	3.35
3300	16.05	34.47	11.45	15.07	3.86	1.01	18.68	8.50	3.24
3400	15.50	34.61	10.70	15.94	4.13	1.04	18.59	8.33	3.43
3500	15.12	34.21	10.33	15.66	4.08	1.04	18.25	8.13	3.45
3600	14.79	33.87	9.98	15.38	4.03	1.04	18.29	7.87	3.52
3700	14.31	33.67	9.52	15.92	4.12	1.06	17.99	7.86	3.55
3800	13.86	33.94	8.96	16.08	4.40	1.08	18.01	7.58	3.67
3900	13.37	33.66	8.65	16.15	4.45	1.09	17.52	7.41	3.70
4000	12.92	34.20	8.02	16.10	4.85	1.11	17.50	7.25	3.83

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 = 2.8V, Id =32.63 mA @ Temperature = +25degC

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	4.21	45.11	1.79	2.39	7.68	0.71	9.05	1.18	5.63
300	14.09	42.07	2.28	5.93	3.45	1.21	18.47	8.14	4.18
400	18.54	41.78	3.66	9.71	3.52	1.30	21.58	10.79	3.56
500	20.54	42.91	5.61	14.33	4.53	1.24	22.53	11.71	3.65
600	21.47	44.30	7.72	20.87	5.71	1.16	22.89	11.89	3.15
700	21.88	44.13	9.78	34.56	5.83	1.10	22.77	11.79	3.15
800	22.12	43.78	11.75	26.61	5.69	1.06	22.43	11.60	3.12
900	22.09	42.28	13.70	23.33	4.94	1.03	22.05	11.38	3.04
1000	22.07	41.84	15.38	20.64	4.75	1.01	21.78	11.17	3.02
1100	21.98	40.67	17.04	19.31	4.24	0.99	21.74	11.08	3.03
1200	21.85	40.13	18.57	18.30	4.06	0.98	21.76	10.95	3.04
1300	21.69	39.41	19.87	17.72	3.82	0.97	21.22	10.76	2.97
1400	21.51	38.61	20.96	17.17	3.57	0.97	20.96	10.45	2.98
1500	21.28	38.45	22.05	16.81	3.59	0.96	20.98	10.43	3.00
1600	21.07	37.70	22.04	16.80	3.38	0.96	20.69	10.33	3.03
1700	20.79	37.35	22.56	16.56	3.35	0.96	20.28	10.01	3.01
1800	20.52	36.83	22.42	16.27	3.26	0.96	20.15	9.80	3.12
1900	20.23	36.49	21.99	16.19	3.24	0.95	19.77	9.54	3.11
2000	19.92	36.02	21.95	15.93	3.18	0.95	19.78	9.48	3.09
2100	19.60	35.72	20.92	15.90	3.18	0.95	19.68	9.51	3.04
2200	19.25	35.67	20.02	16.23	3.29	0.96	19.45	9.22	3.08
2300	18.89	35.13	19.47	16.08	3.22	0.96	19.25	8.95	3.11
2400	18.53	35.03	18.63	16.26	3.31	0.96	19.12	8.85	3.05
2500	18.15	35.01	17.38	16.45	3.43	0.97	18.74	8.57	3.16
2600	17.81	34.18	16.83	16.31	3.24	0.97	18.79	8.46	3.19
2700	17.35	34.27	15.84	16.88	3.44	0.98	18.72	8.37	3.25
2800	16.95	34.05	14.97	16.75	3.49	0.98	18.48	8.10	3.26
2900	16.52	34.32	14.11	17.24	3.75	1.00	18.23	8.00	3.36
3000	16.12	33.81	13.40	17.26	3.68	1.00	18.09	7.78	3.31
3100	15.77	33.07	12.83	17.16	3.51	1.00	18.11	7.76	3.35
3200	15.32	33.21	12.06	17.73	3.71	1.02	17.38	7.61	3.47
3300	14.93	32.91	11.54	17.63	3.72	1.03	17.34	7.55	3.42
3400	14.41	33.11	10.79	18.46	3.98	1.05	17.27	7.35	3.54
3500	14.05	32.66	10.42	18.49	3.91	1.05	17.00	7.19	3.55
3600	13.73	32.33	10.06	18.34	3.88	1.06	16.94	6.82	3.67
3700	13.26	32.25	9.59	19.00	4.01	1.07	16.68	6.91	3.74
3800	12.82	32.47	9.03	19.26	4.24	1.09	16.65	6.74	3.82
3900	12.35	32.38	8.68	19.21	4.38	1.10	16.20	6.42	3.89
4000	11.92	32.88	8.06	19.04	4.74	1.13	16.16	6.28	4.02

Typical Performance Data

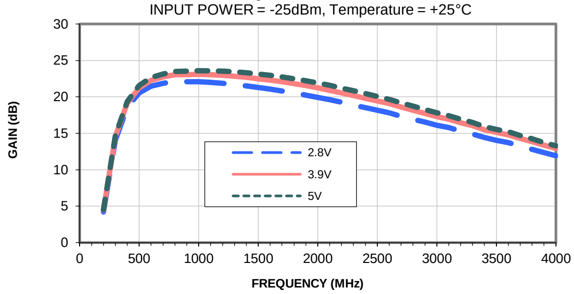
Definitions:
Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 5V, Id = 34.20 mA @ Temperature = +25degC

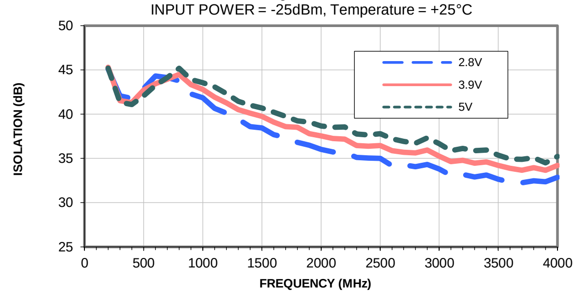
FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
200	4.51	45.20	1.74	2.27	7.12	0.68	9.55	1.77	5.52
300	14.69	41.33	2.21	5.83	2.82	1.21	20.40	9.39	4.11
400	19.37	41.08	3.53	9.77	2.85	1.32	23.83	12.65	3.49
500	21.56	42.07	5.38	14.33	3.57	1.25	24.82	13.55	3.53
600	22.63	43.27	7.41	18.91	4.36	1.17	25.49	13.76	3.08
700	23.15	44.12	9.40	19.26	4.93	1.09	25.35	13.59	3.05
800	23.50	45.18	11.35	16.27	5.56	1.04	24.77	13.29	3.06
900	23.54	43.91	13.38	15.52	4.92	1.00	24.12	12.73	3.20
1000	23.59	43.54	15.09	14.28	4.71	0.98	23.91	12.55	2.96
1100	23.58	43.07	16.86	13.68	4.50	0.96	23.78	12.44	2.96
1200	23.53	42.34	18.57	13.29	4.18	0.95	23.79	12.35	2.94
1300	23.43	41.44	20.08	12.96	3.82	0.94	23.11	12.00	2.90
1400	23.31	41.01	21.43	12.65	3.69	0.93	22.84	11.76	2.89
1500	23.13	40.70	22.88	12.43	3.63	0.93	22.79	11.68	2.92
1600	22.98	40.21	22.86	12.58	3.50	0.93	22.59	11.65	2.94
1700	22.73	39.76	23.60	12.50	3.42	0.92	22.09	11.29	2.90
1800	22.48	39.25	23.56	12.39	3.32	0.92	21.92	11.13	3.01
1900	22.21	39.10	23.00	12.39	3.37	0.92	21.38	10.75	3.01
2000	21.91	38.67	23.06	12.14	3.31	0.92	21.45	10.74	3.01
2100	21.59	38.52	21.77	12.33	3.37	0.92	21.37	10.74	2.94
2200	21.22	38.54	20.68	12.67	3.53	0.93	21.19	10.55	2.96
2300	20.85	37.76	20.08	12.59	3.37	0.93	20.90	10.24	2.98
2400	20.46	37.64	19.14	12.71	3.47	0.93	20.85	10.17	2.96
2500	20.05	37.81	17.58	12.93	3.70	0.94	20.27	9.85	3.04
2600	19.68	37.23	17.01	12.85	3.60	0.94	20.45	9.81	3.05
2700	19.18	36.93	15.89	13.08	3.68	0.95	20.44	9.73	3.11
2800	18.74	36.71	14.98	13.05	3.74	0.95	20.16	9.50	3.11
2900	18.27	37.34	14.02	13.69	4.23	0.97	19.97	9.38	3.19
3000	17.82	36.67	13.31	13.26	4.08	0.97	19.81	9.14	3.17
3100	17.43	35.86	12.75	13.09	3.87	0.97	19.89	9.24	3.20
3200	16.93	36.12	11.90	13.52	4.18	0.99	19.16	8.90	3.27
3300	16.51	35.86	11.38	13.43	4.21	1.00	19.29	8.93	3.21
3400	15.93	35.94	10.59	14.22	4.49	1.03	19.16	8.66	3.38
3500	15.54	35.37	10.22	13.83	4.36	1.03	18.80	8.47	3.37
3600	15.21	34.94	9.85	13.54	4.27	1.03	18.89	8.29	3.47
3700	14.70	34.90	9.38	14.00	4.45	1.05	18.59	8.24	3.51
3800	14.24	35.08	8.83	14.10	4.70	1.07	18.63	8.09	3.60
3900	13.74	34.50	8.51	14.20	4.61	1.08	18.12	7.82	3.64
4000	13.27	35.23	7.88	14.21	5.13	1.10	18.11	7.70	3.78

Typical Performance Curves

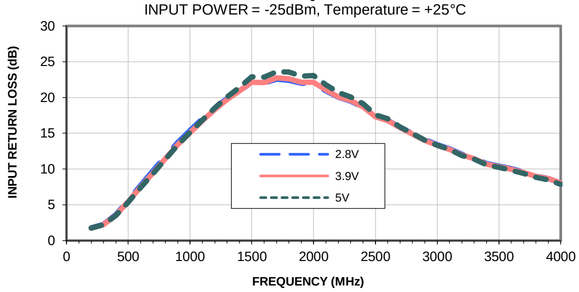
GAIN vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



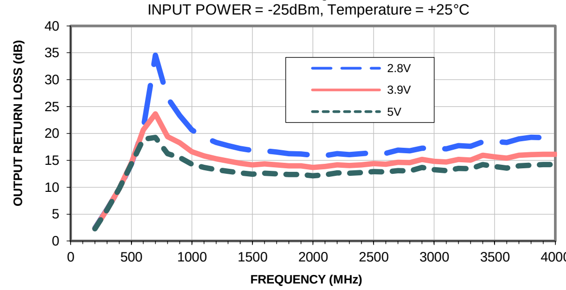
ISOLATION vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



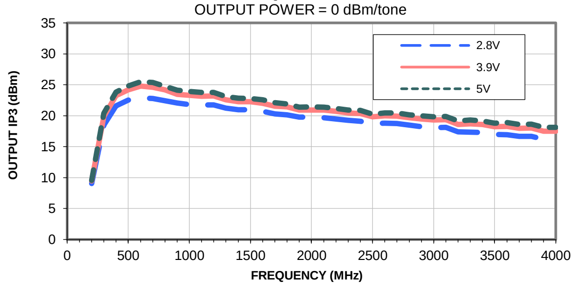
INPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



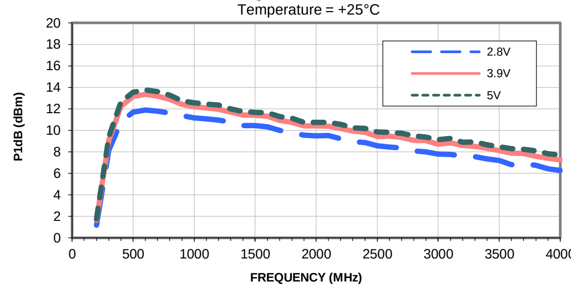
OUTPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



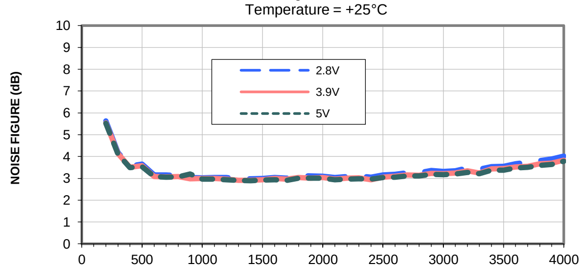
OUTPUT IP3 vs. FREQUENCY & DEVICE VOLTAGE
OUTPUT POWER = 0 dBm/tone



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



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



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)	