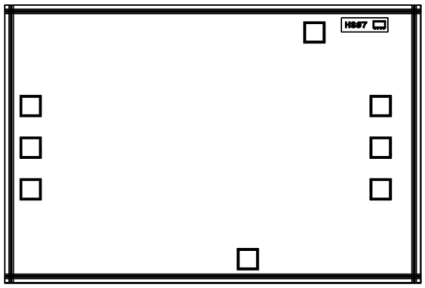
SUPER WIDEBAND, HIGH GAIN

Monolithic Amplifier Die PMA3-453-D+

50Ω 10 to 45 GHz

THE BIG DEAL

- Wideband, 10 to 45 GHz
- Usable down to 9 GHz
- High Gain, 25.5 dB typ. at 20 GHz
- Low NF, 1.6 dB typ. at 20 GHz
- P1dB, 10 dBm typ. at 20 GHz
- OIP3, 22 dBm typ. at 20 GHz
- Built-in Bias Tee and DC Blocks
- Patent Pending



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

SEE ORDERING INFORMATION ON THE LAST PAGE

APPLICATIONS

- 5G
- Lab Instrument
- Satellite

PRODUCT OVERVIEW

The PMA3-453-D+ is a PHEMT based wideband, low noise MMIC amplifier die with a unique combination of high gain and low noise figure over a very board bandwidth making it ideal for using as the first stage driver amplifier of receiver applications. This design operates on a single 4V supply, and is matched to 50 Ohm.

KEY FEATURES

Feature	Advantages
Low NF (<3.0dB typ.) up to 30GHz	Enables lower system noise figure performance.
High Gain 20dB typ. up to 30GHz	Enables signal amplification without the need for multiple gain stage, minimizing the effect of subsequent stages on noise figure.
Built-in Bias Tee & DC Blocks	Minimizes the external component count & PC board space, making it less expensive and user friendly for system designers.
Unpackaged Die	Enables users to integrates it directly into hybrids.

REV. A
ECO-011060
PMA3 -453-D+
MCLNY
211213

ELECTRICAL SPECIFICATIONS[1] AT 25°C, 50Ω, UNLESS NOTED

Parameter	Condition (GHz)	Vs=4.0V			Units
		Min.	Typ.	Max.	
Frequency Range	—	10		45	GHz
Noise Figure	10		1.9		dB
	20		1.6		
	30		2.4		
	40		3.8		
	45		5.2		
Gain	10		25.3		dB
	20		25.5		
	30		18.2		
	40		14.1		
	45		9.1		
Input Return Loss	10		13		dB
	20		21		
	30		8		
	40		5		
	45		5		
Output Return Loss	10		12		dB
	20		10		
	30		9		
	40		15		
	45		7		
Output Power @ 1 dB compression	10		8.5		dBm
	20		10.0		
	30		11.0		
	40		11.7		
	45		10.1		
Output IP3	10		18.6		dBm
	20		22.0		
	30		23.4		
	40		21.9		
	45		21.4		
Supply Voltage (Vs)		3.75	4.0	4.25	V
Device Operating Current (I_{DD})			68	112	mA
Device Current Variation vs. Temperature[2]			-50		µA/°C
Device Current Variation vs. Voltage			0.02		mA/mV
Thermal Resistance, junction-to-ground lead			106		°C/W

1. Die is packaged in 3x3mm 12L MCLP and soldered on Mini-Circuits Characterization test board TB-PMA3-453+ with thru-line loss being deducted. See Characterization Test Circuit (Fig. 1)
2. Device Current Variation vs. Temperature = (Current at 85°C - Current at -45°C)/130°C

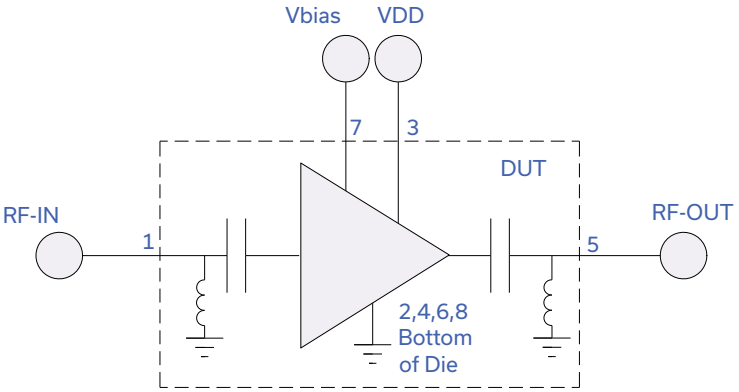
MAXIMUM RATINGS[3]

Parameter	Ratings
Operating temperature (ground lead)	-40°C to 85°C
Junction Temperature	146°C
Total Power Dissipation	0.65W
Input Power (CW), Vs=4V	+23 dBm (5 minutes max.) +13 dBm (continuous)
DC Voltage (RF-IN & RF-OUT)	2V
DC voltage (Vs)	6V

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

Monolithic Amplifier Die PMA3-453-D+

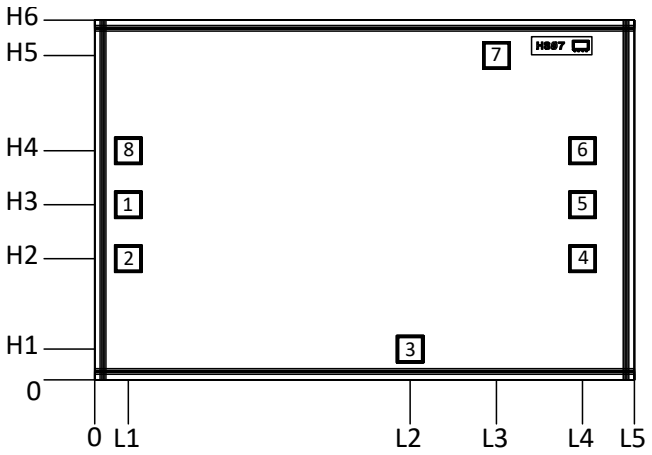
SIMPLIFIED SCHEMATIC



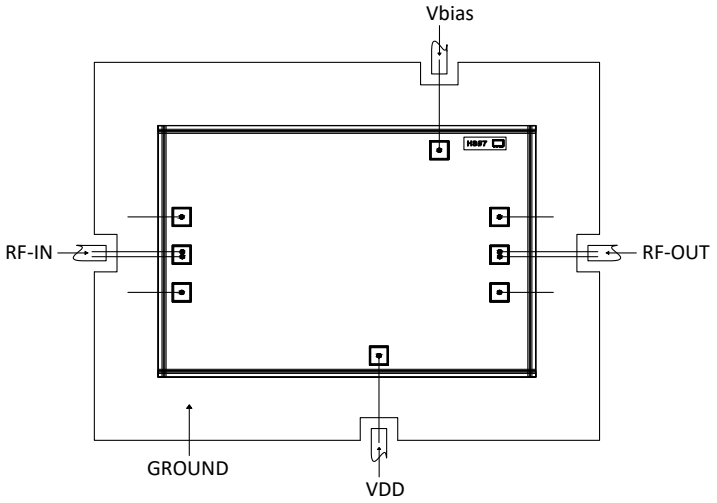
PAD DESCRIPTION

Function	Pad Number	Description
RF-IN	1	RF Input Pad. Connects to RF input
RF-OUT	5	RF Output Pad. Connects to RF output
VDD	3	DC Power Supply Pad. Connects to Voltage Source Vs via R1
VBias	7	Connects to VDD
Ground	2,4,6,8 & Bottom of Die	Connects to ground

BONDING PAD POSITION



ASSEMBLY DIAGRAM



DIMENSION IN µM, TYPICAL

L1	L2	L3	L4	L5	H1	H2	H3	H4	H5	H6	Thick-ness	Die Size	Pad Size 1,2,3,4,5 6,7 & 8
93.0	877.0	1117.0	1356.0	1500.0	85.0	337.0	487.0	637.0	902.0	1000.0	100	1500 x 1000	64 x 64

RECOMMENDED APPLICATION AND CHARACTERIZATION TEST CIRCUIT

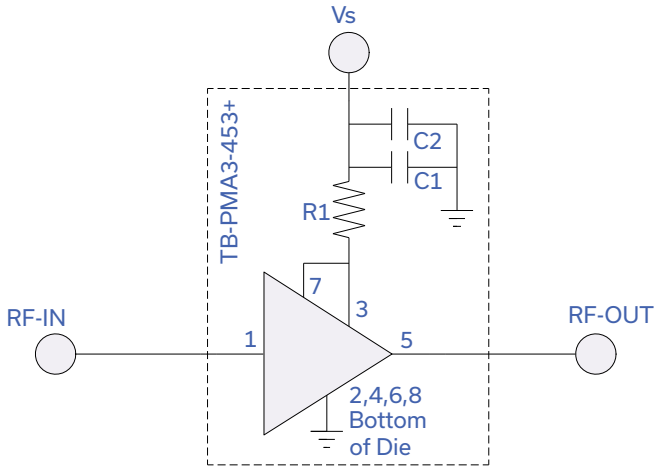


Fig 1. Application and Characterization Circuit

Note: This block diagram is used for characterization. (Die is packaged in 3x3mm 12L MCLP and soldered on Mini-Circuits Characterization Test Board TB-PMA3-453+) Gain, Return Loss, Output Power at 1dB Compression (P1dB), Ouptut IP3(OIP3), and Noise Figure are measured using Agilent's N4245A microwave network analyzer.

Conditions:
1. Gain and Return loss: Pin= -25dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, -5dBm/tone at output.

Component	Size	Value	Part Number	Manufacturer
R1	0603	18 Ohm	SG73G1JTTD18R0C	Koa
C1	0402	5pF	GJM1555C1H5R0CB01D	Murata
C2	0402	0.1uF	GRM155R71C104KA88D	Murata

ASSEMBLY PROCEDURE

1. Storage
   Dice should be stored in a dry nitrogen purged desiccators or equivalent.
2. ESD
   MMIC PHEMT amplifier dice 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.
5. 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. 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 wires should be kept as short as low as reasonable 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 — Model No. Small, Gel - Pak: 5,10,50,100 KGD* — PMA3-453-DG+ Medium†, Partial wafer: KGD*<1102 — PMA3-453-DP+ Full Wafer — PMA3-453-DF+ †Available upon request contact sales representative Refer to AN-60-067
Environmental Ratings	ENV80

*Known Good Die ("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 provide a higher degree of confidence that die are capable of meeting typical RF electrical parameters specified by Mini-Circuits.

ESD RATING**

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

**Tested in 3x3 12L MCLP package

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

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

TEST CONDITIONS: Vd = 3.75V, Id = 63mA @ 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)
7000	6.72	66.69	4.00	5.41	229.36	1.00	1.77	-5.07	7.38
8000	18.93	64.83	9.50	9.82	84.65	1.00	12.47	2.55	3.48
9000	22.62	69.03	10.61	12.09	97.34	1.02	16.77	5.68	2.29
10000	25.07	58.79	12.08	12.24	23.53	1.00	17.26	7.51	1.79
11000	26.69	60.80	10.21	12.69	23.91	1.04	18.50	7.58	1.81
12000	27.87	61.71	8.21	15.65	22.40	1.12	18.09	8.12	1.84
13000	28.47	57.87	8.16	18.25	13.64	1.14	18.55	8.06	1.93
14000	28.43	54.72	10.16	12.70	9.85	1.04	19.01	8.14	1.85
15000	27.95	52.49	13.35	10.63	8.31	0.95	19.76	8.69	1.75
16000	27.42	51.84	16.15	10.85	8.46	0.93	20.52	8.81	1.63
17000	26.86	49.85	15.83	11.89	7.31	0.95	20.86	8.73	1.61
18000	26.32	48.56	14.38	12.32	6.72	0.97	20.19	8.45	1.59
19000	25.83	48.32	14.04	11.64	6.88	0.96	19.62	8.19	1.58
20000	25.46	46.87	15.08	10.96	6.12	0.94	19.09	8.83	1.55
21000	24.91	46.06	16.61	10.48	5.95	0.92	19.04	9.31	1.54
22000	23.79	46.98	14.85	9.31	7.23	0.90	20.51	10.07	1.49
23000	23.02	47.30	12.32	8.90	7.89	0.91	21.02	9.90	1.56
24000	22.22	47.73	10.87	8.78	8.86	0.93	21.33	10.47	1.65
25000	21.45	48.31	10.29	8.43	10.11	0.93	22.13	10.61	1.69
26000	20.65	47.95	9.39	7.79	10.13	0.92	20.99	10.49	1.80
27000	19.77	46.74	8.51	7.24	9.25	0.92	21.02	10.58	1.95
28000	19.04	47.45	7.94	7.35	10.68	0.95	20.85	10.59	2.18
29000	18.55	45.02	7.78	8.20	8.79	1.00	21.39	10.33	2.14
30000	18.13	45.16	8.08	9.29	9.91	1.03	20.69	10.58	2.25
31000	17.62	46.59	8.21	9.90	12.74	1.04	21.48	10.41	2.43
32000	16.98	47.12	7.69	9.49	14.10	1.04	20.92	9.99	2.65
33000	16.14	47.52	6.33	8.81	14.75	1.08	20.86	9.89	2.96
34000	15.28	46.77	4.98	8.29	13.16	1.13	21.47	9.75	3.36
35000	14.61	46.42	4.19	8.06	12.52	1.16	21.60	9.48	3.82
36000	13.69	46.42	3.74	7.89	13.15	1.18	21.00	9.42	3.95
37000	13.31	46.45	3.72	8.43	14.11	1.21	22.28	9.33	4.16
38000	12.93	45.12	4.12	9.04	13.67	1.21	20.68	9.85	4.04
39000	12.97	47.36	4.66	10.44	19.57	1.22	21.20	10.33	3.94
40000	13.36	44.39	4.90	11.97	14.27	1.24	21.32	11.15	3.84
41000	12.94	45.29	4.78	10.92	16.33	1.22	21.38	10.27	3.87
42000	11.81	43.80	4.46	9.13	14.42	1.19	20.57	9.89	4.25
43000	10.17	46.40	4.26	8.11	21.70	1.17	22.22	9.26	4.53
44000	8.30	54.38	4.39	7.74	67.56	1.14	20.93	8.76	4.58
45000	7.68	53.78	4.06	7.86	65.49	1.17	20.43	9.97	5.07
46000	7.50	49.77	3.73	8.38	41.40	1.22	20.84	10.15	4.74
47000	7.88	49.30	3.80	8.83	39.42	1.23	20.26	9.67	5.08
48000	9.54	45.75	4.56	8.06	23.72	1.14	19.04	10.11	4.79
49000	10.80	43.42	6.78	7.06	18.59	0.97	21.39	11.19	4.78
50000	10.51	42.55	12.09	6.98	20.83	0.84	18.84	12.01	5.69

Note: Test data of Die packaged in industry standard 3x3mm 12L 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 = 4.00V, Id = 68mA @ 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)
7000	7.38	66.16	4.18	5.42	205.54	0.99	2.49	-4.39	7.36
8000	19.18	62.70	9.27	9.75	63.74	1.00	13.28	3.34	3.62
9000	22.92	67.81	10.44	11.99	81.23	1.02	17.62	6.34	2.23
10000	25.39	60.57	12.03	12.15	27.79	1.00	18.22	8.15	1.81
11000	27.02	60.08	10.36	12.65	21.27	1.03	19.26	8.11	1.70
12000	28.20	61.13	8.44	15.64	20.35	1.11	18.58	8.65	1.77
13000	28.77	59.85	8.41	17.94	16.68	1.13	19.02	8.68	1.83
14000	28.70	56.31	10.46	12.54	11.52	1.03	19.73	8.62	1.79
15000	28.20	54.41	13.69	10.53	10.07	0.95	20.49	9.15	1.69
16000	27.68	51.56	16.58	10.77	7.96	0.93	21.06	9.41	1.61
17000	27.13	50.77	16.15	11.78	7.88	0.95	21.38	9.21	1.56
18000	26.59	49.29	14.63	12.22	7.08	0.96	20.90	8.94	1.57
19000	26.11	48.93	14.29	11.55	7.14	0.96	19.54	8.68	1.55
20000	25.73	47.20	15.35	10.87	6.16	0.93	20.34	9.44	1.59
21000	25.16	46.32	16.74	10.38	5.95	0.92	19.21	9.91	1.51
22000	24.01	46.70	14.76	9.21	6.80	0.90	20.96	10.65	1.54
23000	23.23	47.32	12.27	8.81	7.69	0.91	22.11	10.48	1.59
24000	22.43	47.48	10.86	8.69	8.39	0.92	21.63	11.05	1.65
25000	21.65	48.14	10.30	8.35	9.66	0.92	22.93	11.19	1.59
26000	20.86	48.38	9.42	7.72	10.38	0.92	21.22	11.06	1.81
27000	19.97	48.01	8.52	7.20	10.41	0.92	21.83	11.15	1.99
28000	19.25	46.14	7.97	7.34	8.98	0.95	22.33	11.16	2.16
29000	18.76	45.49	7.85	8.18	9.10	0.99	21.06	10.91	2.18
30000	18.34	45.90	8.17	9.27	10.56	1.02	20.56	11.16	2.27
31000	17.84	46.16	8.32	9.90	11.87	1.04	21.01	10.99	2.40
32000	17.21	46.83	7.76	9.49	13.33	1.04	21.75	10.56	2.70
33000	16.37	46.96	6.41	8.85	13.55	1.08	21.03	10.36	3.01
34000	15.53	46.49	5.04	8.37	12.50	1.13	21.29	10.24	3.39
35000	14.88	46.66	4.24	8.19	12.63	1.17	20.15	10.01	3.80
36000	13.96	47.31	3.78	8.01	14.28	1.19	21.30	9.83	3.98
37000	13.58	45.79	3.75	8.57	12.83	1.21	21.70	9.71	4.19
38000	13.19	44.82	4.16	9.15	12.93	1.21	22.13	10.31	4.10
39000	13.20	46.60	4.69	10.53	17.57	1.22	21.22	10.79	3.97
40000	13.59	44.74	4.93	12.17	14.53	1.24	22.37	11.68	3.86
41000	13.18	44.17	4.83	11.04	14.06	1.22	22.59	10.80	3.81
42000	12.05	44.69	4.50	9.22	15.66	1.19	22.72	10.40	4.16
43000	10.40	45.36	4.28	8.12	18.82	1.17	21.10	9.74	4.58
44000	8.52	52.61	4.40	7.75	53.79	1.14	21.79	9.25	5.12
45000	7.88	52.63	4.07	7.87	56.17	1.17	20.48	10.27	5.12
46000	7.69	49.10	3.74	8.36	37.46	1.22	19.38	10.38	4.97
47000	8.06	47.43	3.80	8.83	31.12	1.23	20.71	9.90	5.04
48000	9.73	45.19	4.53	8.03	21.64	1.14	19.56	10.44	4.73
49000	10.99	42.74	6.74	6.97	16.68	0.97	20.51	11.59	4.81
50000	10.73	42.82	12.03	6.87	20.79	0.84	20.31	12.44	5.56

Note: Test data of Die packaged in industry standard 3x3mm 12L MCLP package

Typical Performance Data

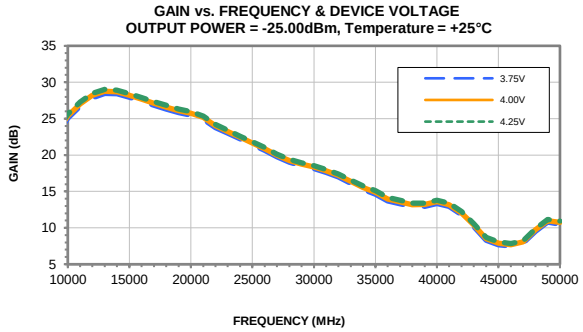
Definitions:
Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

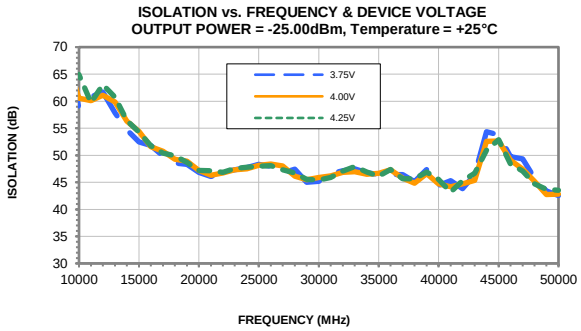
TEST CONDITIONS: Vd = 4.25V, Id = 73mA @ Temperature = +25°C

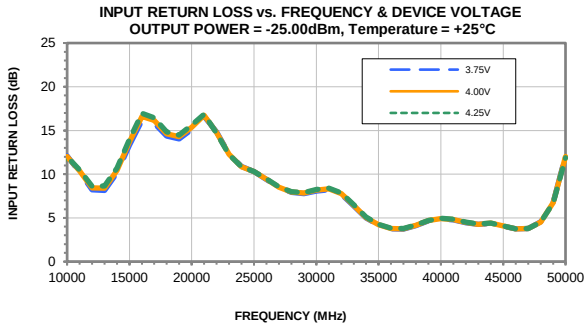
FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
7000	7.94	72.53	4.35	5.43	411.03	0.98	2.76	-3.80	7.29
8000	19.39	61.47	9.09	9.68	53.60	1.00	14.08	4.07	3.47
9000	23.16	63.93	10.31	11.90	50.30	1.02	18.43	6.94	2.24
10000	25.64	64.95	11.98	12.07	44.52	1.00	18.54	8.62	1.80
11000	27.30	59.77	10.49	12.61	19.91	1.03	19.54	8.58	1.75
12000	28.48	63.04	8.63	15.65	24.72	1.11	19.37	9.24	1.80
13000	29.02	60.77	8.65	17.67	18.17	1.12	19.69	9.13	1.88
14000	28.92	56.45	10.72	12.39	11.46	1.02	20.17	9.04	1.79
15000	28.41	54.31	13.99	10.46	9.74	0.94	21.39	9.69	1.73
16000	27.89	51.75	16.96	10.71	7.95	0.93	21.65	9.83	1.65
17000	27.35	50.42	16.43	11.71	7.38	0.95	22.03	9.77	1.54
18000	26.82	49.92	14.84	12.16	7.41	0.96	21.20	9.51	1.57
19000	26.33	48.70	14.49	11.48	6.79	0.95	21.13	9.12	1.58
20000	25.95	47.19	15.60	10.79	6.00	0.93	20.60	9.86	1.59
21000	25.37	47.13	16.84	10.28	6.36	0.91	20.01	10.32	1.57
22000	24.19	46.84	14.70	9.12	6.75	0.90	21.01	11.05	1.50
23000	23.41	47.58	12.22	8.73	7.74	0.91	23.43	10.87	1.53
24000	22.60	47.81	10.85	8.61	8.51	0.92	21.75	11.57	1.62
25000	21.81	47.98	10.32	8.28	9.30	0.92	22.88	11.71	1.70
26000	21.02	48.09	9.44	7.65	9.84	0.91	21.31	11.59	1.82
27000	20.13	47.29	8.55	7.14	9.44	0.91	22.38	11.68	1.92
28000	19.42	46.74	8.00	7.28	9.42	0.94	22.08	11.68	2.15
29000	18.93	45.56	7.90	8.17	9.00	0.99	21.89	11.45	2.21
30000	18.52	45.42	8.24	9.26	9.82	1.02	21.58	11.60	2.31
31000	18.03	45.92	8.38	9.90	11.33	1.03	21.78	11.51	2.44
32000	17.40	47.07	7.84	9.53	13.47	1.04	21.35	11.10	2.68
33000	16.57	47.93	6.48	8.87	14.90	1.07	21.50	10.93	3.08
34000	15.75	46.88	5.09	8.46	12.84	1.13	21.91	10.82	3.43
35000	15.12	46.16	4.27	8.34	11.72	1.17	21.20	10.54	3.78
36000	14.19	47.36	3.81	8.14	14.14	1.19	20.63	10.39	4.01
37000	13.81	45.68	3.78	8.70	12.48	1.22	23.23	10.27	4.21
38000	13.40	45.63	4.18	9.23	13.93	1.21	21.24	10.85	4.10
39000	13.40	46.93	4.71	10.62	17.86	1.22	23.14	11.22	3.92
40000	13.80	45.55	4.95	12.26	15.65	1.24	22.59	12.14	3.86
41000	13.39	43.19	4.84	11.17	12.30	1.22	22.62	11.26	3.90
42000	12.26	45.33	4.51	9.26	16.46	1.19	22.28	10.86	4.11
43000	10.59	46.69	4.29	8.14	21.51	1.16	24.06	10.18	4.52
44000	8.71	50.95	4.42	7.75	43.54	1.14	21.75	9.68	5.08
45000	8.06	52.86	4.10	7.85	56.69	1.16	21.41	10.61	5.23
46000	7.84	48.39	3.75	8.34	33.98	1.22	20.31	10.68	4.90
47000	8.22	47.10	3.80	8.81	29.34	1.23	19.94	10.11	5.06
48000	9.89	44.72	4.52	7.95	20.00	1.14	19.16	10.72	4.70
49000	11.16	43.73	6.70	6.85	18.16	0.96	22.14	11.89	4.85
50000	10.92	43.53	11.89	6.75	21.88	0.84	19.89	12.92	5.48

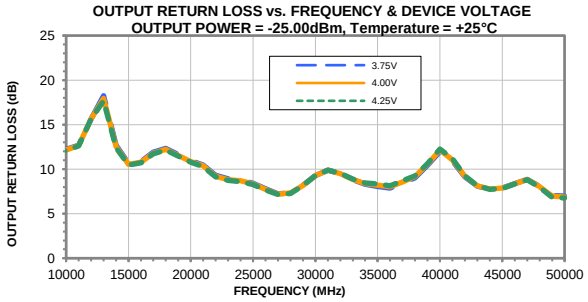
Note: Test data of Die packaged in industry standard 3x3mm 12L MCLP package

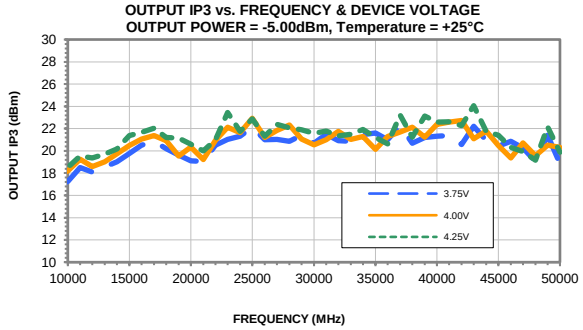
Typical Performance Curves

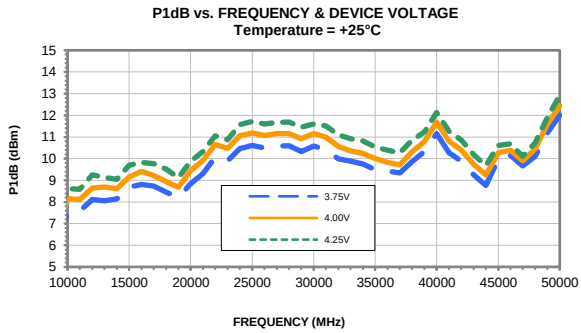


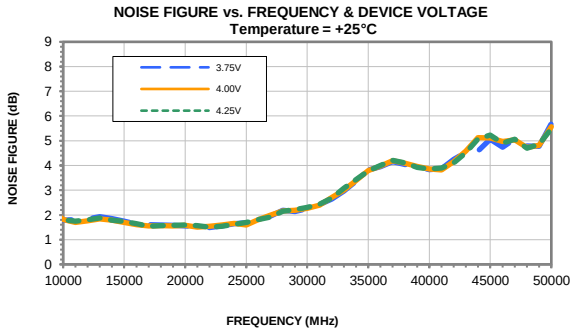












Note: Test data of Die packaged in industry standard 3x3mm 12L MCLP package

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 Ambient Environment	Refer to Individual Model Data Sheet
Storage Environment	20° to 35° C and 40 to 60% humidity (In Factory Shipped Package)	Individual Model Data Sheet

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