SURFACE MOUNT MMIC

Dual Matched Amplifier PHA-22+

50Ω 0.05 to 1.5 GHz

THE BIG DEAL

- Dual matched amplifier for push-pull & balanced amplifiers
- High IP2 and IP3
- Gain, 16 dB typ. at 0.8 GHz
- P1dB, +22 dBm typ. at 0.8 GHz
- Low noise figure, 1.8 dB typ. at 0.8 GHz
- Two matched amplifiers in one package
- May be used as a replacement to WJ AH22[a,b]

Generic photo used for illustration purposes only

CASE STYLE: DL1020

+RoHS Compliant

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

APPLICATIONS

- CATV
- FTTH
- Optical networks
- Base station infrastructure
- Balanced amplifiers
- 75 Ohm push-pull and balanced amplifiers

PRODUCT OVERVIEW

Mini-Circuits PHA-22+ is a dual matched wideband amplifier fabricated using advanced E-PHEMT technology, offering high dynamic range (High IP3 and Low NF) for use in 50 and 75 ohm applications. Exceptionally high IP2 has been demonstrated in wideband 50 and 75 ohm amplifiers evaluation boards. Combining this with low noise figure to enable it for use in exceptionally high dynamic range amplifiers.

KEY FEATURES

Feature	Advantages
Broadband	Covers Cable TV band and communication bands such as Cellular, Cable TV, PCS, WiMAX etc.
Matched pair for use in exceptionally high IP2 amplifiers	Typical gain match of 0.2 dB and phase match of 1.6 deg. enables it to be used in push-pull amplifiers. Outstanding IP2.
High IP3, up to 43 dBm	Ideal for suppressing unwanted intermods in the presence of multi carriers, which is common in present day communi-cation systems.
Low Noise Figure: 1.8 dB typical	Compare this to the competitors, which is in the range of 4-6 dB. Mini-Circuits amplifier improves the dynamic range.
High P1dB: 22 dBm	High P1dB enables the amplifier to operate in linear region in the presence of strong interfering signals.

a. Suitability for model replacement within a particular system must be determined by and is solely the responsibility of the customer based on, among other things, electrical performance criteria, stimulus conditions, application, compatibility with other components and environmental conditions and stresses.
b. The WJ part number is used for identification and comparison purposes only.

REV. C
ECO-010399
M151107
PHA-22+
MCL NY
211103

Dual Matched Amplifier PHA-22+

ELECTRICAL SPECIFICATIONS[1] AT 25°C, Zo=50Ω AND DEVICE VOLTAGE 5V, UNLESS NOTED

(Specifications (other than Matching or where defined as push-pull) are for each of the two matched amplifiers in the package)

Parameter		Condition (GHz)	Min.	Typ.	Max.	Units
Frequency Range			0.05		1.5	GHz
Gain		0.05 0.8 1.5	— 14.5 —	17.7 16.1 15.4	— 17.7 —	dB
Input Return Loss		0.05 0.8 1.5		11.3 17.0 11.7		dB
Output Return Loss		0.05 0.8 1.5		14.1 18.8 13.1		dB
Output Power @1 dB compression [2]		0.05 0.8 1.5		22.4 22.5 22.5		dBm
Output IP3 [6]		0.05 0.8 1.5	— 37.0 —	41.4 41.5 42.9		dBm
Noise Figure		0.05 0.8 1.5		1.8 1.8 2.0		dB
Matching between A1, A2	Amplitude Unbalance	0.05 0.8 1.5		0.11 0.12 0.22	— 0.6 —	dB
	Phase Unbalance	0.05 0.8 1.5		0.3 1.0 1.6	— 5.0 —	deg.
Device Operating Voltage			4.8	5.0	5.2	V
Device Operating Current (each amplifier)			110	146	180	mA
Device Current Variation vs. Temperature				23		µA/°C
Device Current Variation vs Voltage				0.053		mA/mV
Thermal Resistance, junction-to-ground lead [7]				34		°C/W

MAXIMUM RATINGS (4)

Parameter	Ratings
Operating Temperature[5]	-40°C to 85°C
Storage Temperature	-55°C to 150°C
Operating Current at 5V[6]	200 mA
Power Dissipation[6]	1000 mW
Input Power (CW)	+24 dBm
DC Voltage (pads 5,8)	6V

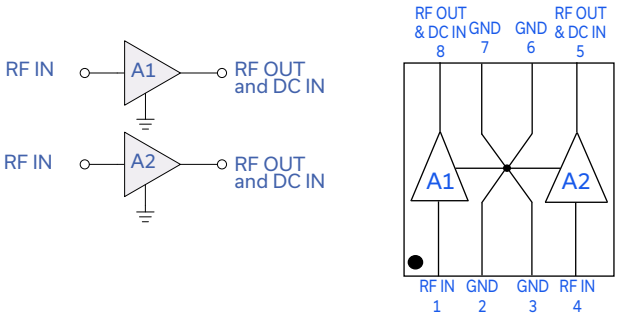
PUSH-PULL AMPLIFIER TYPICAL PERFORMANCE (3)

Frequency (GHZ)	TB-566-75+ (75Ω)			TB-566-50+ (50Ω)		
	Gain (dB)	Output IP3 (dBm)	Output IP2 (dBm)	Gain (dB)	Output IP3 (dBm)	Output IP2 (dBm)
0.05	14.2	45.0	79.0	15.2	45.0	82.0
0.25	13.7	43.0	79.0	13.8	45.0	84.0
0.45	14.0	42.0	81.0	13.8	44.0	81.0
0.85	14.1	43.0	72.0	13.0	44.0	76.0
1.20	13.8	40.6	78.0	12.0	43.0	72.0
1.30	13.5	40.3	78.0	--	--	--

(1) Measured on Mini-Circuits Test Board TB-561-22+ (characterization test circuit, Fig 1a.
(2) Current increases at P1dB
(3) Measured on evaluation boards (push-pull amplifiers) TB-566-50+ (50Ω) and TB-566-75+ (75Ω). See Characterization Test Circuit (Fig. 1b)
(4) Permanent damage may occur if any of these limits are exceeded. These ratings are not intended for continuous normal operation.
(5)Defined with reference to ground pad temperature.
(6) Per single ended amplifier
(7) Θjc= Junction Temperature-85°C / Voltage X sum of current in A1 & A2

Dual Matched Amplifier PHA-22+

SIMPLIFIED SCHEMATIC (EACH OF A1, A2) AND PIN DESCRIPTION



Function	Pin Number	Description
RF IN, A1	1	RF input pin. This pin requires the use of an external DC blocking capacitor chosen for the frequency of operation. (see Application Circuit, Fig 2.)
RF-OUT and DC-IN, A1	8	RF output and bias pin. DC voltage is present on this pin; therefore a DC blocking capacitor is necessary for proper operation. An RF choke is needed to feed DC bias without loss of RF signal due to the bias connection, as shown in "Recommended Application Circuit", Fig 2
RF IN, A2	4	RF input pin. This pin requires the use of an external DC blocking capacitor chosen for the frequency of operation. (see Application Circuit, Fig 2.)
RF-OUT and DC-IN, A2	5	RF output and bias pin. DC voltage is present on this pin; therefore a DC blocking capacitor is necessary for proper operation. An RF choke is needed to feed DC bias without loss of RF signal due to the bias connection, as shown in "Recommended Application Circuit", Fig 2
GND	2,3,6,7 & paddle	Connections to ground. Use via holes as shown in "Suggested Layout for PCB Design" to reduce ground path inductance for best performance.

* Enhancement mode pseudomorphic High Electron Mobility Transistor.

a. Suitability for model replacement within a particular system must be determined by and is solely the responsibility of the customer based on, among other things, electrical performance criteria, stimulus conditions, application, compatibility with other components and environmental conditions and stresses.
b. The WJ part number is used for identification and comparison purposes only.

Dual Matched Amplifier PHA-22+

CHARACTERIZATION TEST CIRCUIT

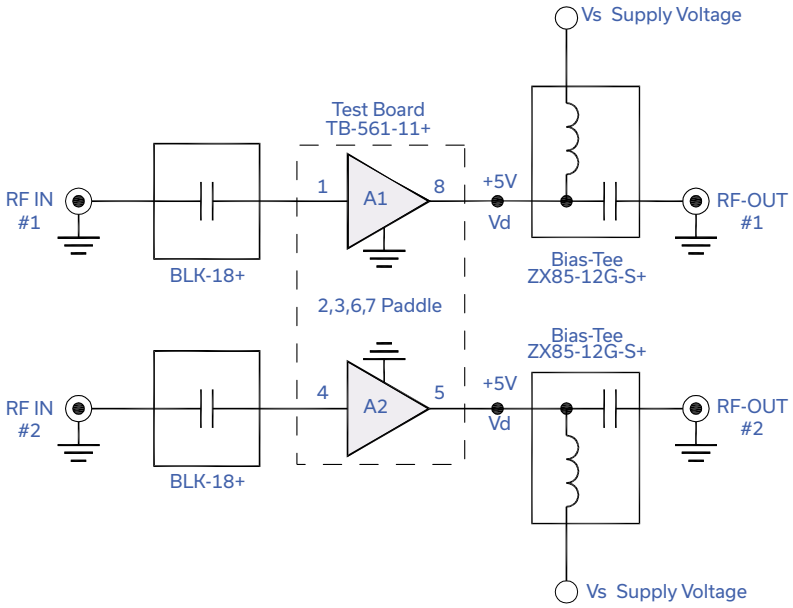


Fig 1a. Block Diagram of Test Circuit used for characterization. (DUT tested in Mini-Circuits Test board TB-561-22+, except for IP2) Gain, Return loss, Output power at 1dB compression (P1 dB) , output IP3 (OIP3) and noise figure measured using Agilent's N5242A PNA-X microwave network analyzer.

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

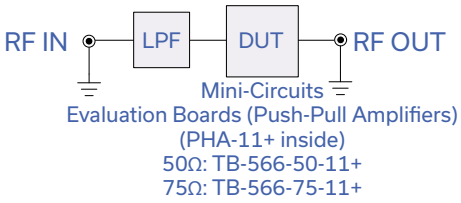


Fig 1b. Block Diagram of Test Set up used for characterization of Gain, IP2, IP3. Measured using Agilent's signal generators E8527D and Spectrum analyzer N9020A.

Conditions:
1. Two tones, spaced 1MHz apart, 5 dBm/tone at output. IP2 is measured at the sum frequency of the tones.

RECOMMENDED APPLICATION CIRCUIT

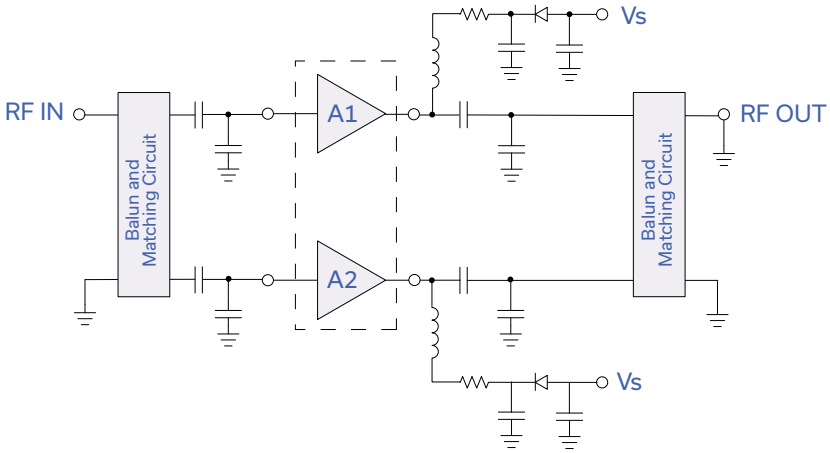


Fig 2. Recommended Application Circuit.
Refer to following Mini-Circuits Evaluation Boards for parts list.
50Ω: TB-566-50-11+
75Ω: TB-566-75-11+

PRODUCT MARKING

index over pin 1

Marking may contain other features or characters for internal lot control

Dual Matched Amplifier PHA-22+

ADDITIONAL DETAILED TECHNICAL INFORMATION IS AVAILABLE ON OUR DASH BOARD. TO ACCESS CLICK HERE

Performance Data	Data Table Swept Graphs S-Parameter (S2P Files) Data Set (.zip file)
Case Style	DL1020 Plastic package, exposed paddle lead finish: tin/silver/nickel
Tape & Reel **Standard quantities available on reel**	F68 7" reels with 20, 50, 100, 200, 500 or 1K devices 13" reels with 2K, 3K, 4K devices
Suggested Layout for PCB Design	PL-322
Evaluation Board	TB-566-50+ (50Ω, 0.05-1.2 GHz) TB-566-75+ (75Ω, 0.05-1.3 GHz)
Environmental Ratings	ENV08T2

ESD RATING

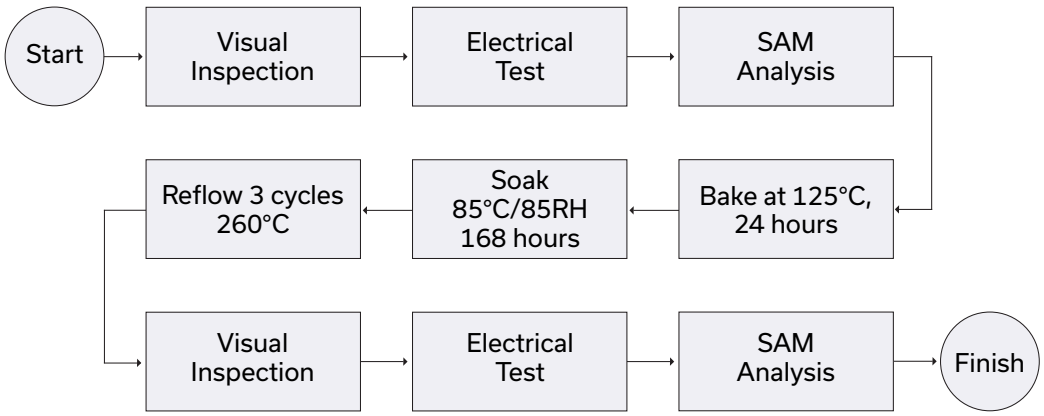
Human Body Model (HBM): Class 1A (250 to <500V) in accordance with ANSI/ESD STM 5.1 - 2001

Machine Model (MM): Class M1 (<100V) in accordance with ANSI/ESD STM5.2-1999; passes 25V

MSL RATING

Moisture Sensitivity: MSL1 in accordance with IPC/JEDEC J-STD-020D

MSL TEST FLOW CHART



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

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, Id1 (A1) = 146.17 mA and Id2 (A2) =138.65 mA @ Temperature = +25degC

FREQ	A1	A2	A1 & A2		A1							
	Gain		Amp Unbal	Phase Unbal	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(Deg)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50.0	17.70	17.61	0.09	0.36	21.61	11.56	13.97	0.98	0.67	43.22	22.44	1.75
100.0	16.79	16.74	0.05	0.39	20.85	15.97	18.28	1.06	0.64	43.05	22.49	1.72
200.0	16.46	16.43	0.03	0.42	20.62	19.40	21.29	1.09	0.63	43.33	22.72	1.63
300.0	16.36	16.34	0.02	0.52	20.56	20.05	21.83	1.10	0.63	43.94	22.79	1.75
400.0	16.30	16.29	0.01	0.60	20.51	19.98	21.53	1.10	0.63	42.76	22.56	1.71
500.0	16.24	16.25	0.01	0.69	20.45	19.46	20.96	1.10	0.63	43.09	22.82	1.77
600.0	16.18	16.20	0.02	0.79	20.37	18.75	20.24	1.09	0.63	43.81	22.76	1.78
700.0	16.12	16.15	0.03	0.90	20.27	17.90	19.52	1.09	0.63	43.18	22.77	1.79
800.0	16.04	16.08	0.04	0.98	20.21	16.97	18.57	1.08	0.63	43.46	22.72	1.80
900.0	15.96	16.02	0.06	1.05	20.12	16.10	17.61	1.08	0.63	44.68	22.92	1.82
1000.0	15.87	15.94	0.07	1.09	20.01	15.22	16.74	1.07	0.63	42.01	22.49	1.88
1100.0	15.77	15.86	0.09	1.15	19.92	14.38	15.96	1.06	0.63	42.90	22.71	1.93
1200.0	15.66	15.77	0.11	1.18	19.81	13.58	15.18	1.06	0.63	44.60	22.83	1.97
1300.0	15.53	15.67	0.14	1.16	19.72	12.84	14.44	1.05	0.63	44.00	22.69	2.01
1400.0	15.41	15.55	0.14	1.17	19.61	12.10	13.75	1.04	0.63	43.41	22.72	2.04
1500.0	15.26	15.43	0.17	1.14	19.53	11.40	13.13	1.04	0.64	44.57	22.81	2.09

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, Id1 (A1) = 132.48 mA and Id2 (A2) = 125.02 mA @ Temperature = +25degC

FREQ	A1	A2	A1 & A2		A1							
	Gain		Amp Unbal	Phase Unbal	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(Deg)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50.0	17.62	17.56	0.06	0.50	21.48	11.51	14.07	0.98	0.67	43.79	21.92	1.76
100.0	16.71	16.70	0.01	0.59	20.75	15.92	18.30	1.06	0.64	43.22	21.97	1.75
200.0	16.37	16.39	0.02	0.61	20.58	19.38	21.35	1.10	0.64	43.94	22.16	1.70
300.0	16.27	16.30	0.03	0.69	20.47	20.01	21.92	1.10	0.63	45.75	22.24	1.76
400.0	16.21	16.25	0.04	0.81	20.46	19.96	21.61	1.10	0.64	43.56	22.03	1.82
500.0	16.16	16.20	0.04	0.93	20.39	19.50	21.08	1.10	0.63	44.44	22.28	1.81
600.0	16.10	16.15	0.05	1.05	20.30	18.83	20.29	1.09	0.63	44.12	22.21	1.85
700.0	16.03	16.10	0.07	1.18	20.25	17.95	19.51	1.09	0.63	43.72	22.24	1.82
800.0	15.95	16.04	0.09	1.29	20.15	17.07	18.60	1.09	0.63	43.90	22.23	1.87
900.0	15.87	15.97	0.10	1.37	20.07	16.20	17.69	1.08	0.63	46.32	22.39	1.84
1000.0	15.79	15.90	0.11	1.46	19.97	15.30	16.84	1.07	0.63	42.59	21.98	1.92
1100.0	15.68	15.81	0.13	1.54	19.88	14.43	16.01	1.07	0.63	43.09	22.18	2.01
1200.0	15.58	15.73	0.15	1.59	19.77	13.64	15.25	1.06	0.63	45.50	22.29	2.02
1300.0	15.46	15.62	0.16	1.61	19.66	12.91	14.53	1.05	0.63	44.05	22.15	2.07
1400.0	15.33	15.50	0.17	1.65	19.56	12.16	13.83	1.04	0.63	43.27	22.20	2.06
1500.0	15.18	15.38	0.20	1.64	19.49	11.45	13.20	1.04	0.64	43.64	22.26	2.11

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, Id1 (A1) = 159.58mA and Id2 (A2) = 151.78 mA @ Temperature = +25degC

FREQ	A1	A2	A1 & A2		A1							
	Gain		Amp Unbal	Phase Unbal	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(Deg)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50.0	17.73	17.69	0.04	0.54	21.33	11.48	13.99	0.97	0.64	42.95	22.97	1.87
100.0	16.83	16.83	0.00	0.61	20.84	16.06	18.35	1.06	0.64	42.47	22.98	1.79
200.0	16.50	16.53	0.03	0.61	20.69	19.53	21.37	1.09	0.63	42.42	23.21	1.73
300.0	16.40	16.44	0.04	0.68	20.56	20.17	21.90	1.10	0.63	43.83	23.31	1.79
400.0	16.34	16.39	0.05	0.81	20.54	20.09	21.66	1.10	0.63	41.70	23.04	1.83
500.0	16.29	16.35	0.06	0.92	20.49	19.62	21.11	1.10	0.63	42.34	23.31	1.85
600.0	16.23	16.30	0.07	1.04	20.43	18.90	20.38	1.10	0.63	42.84	23.25	1.85
700.0	16.16	16.25	0.09	1.15	20.37	18.05	19.61	1.09	0.63	42.32	23.25	1.87
800.0	16.08	16.18	0.10	1.25	20.28	17.15	18.69	1.09	0.63	42.20	23.19	1.88
900.0	16.01	16.12	0.11	1.35	20.17	16.27	17.82	1.08	0.63	43.17	23.42	1.90
1000.0	15.92	16.05	0.13	1.42	20.09	15.37	16.97	1.07	0.63	41.14	22.93	1.97
1100.0	15.81	15.96	0.15	1.50	19.99	14.49	16.14	1.07	0.63	42.11	23.16	2.04
1200.0	15.71	15.87	0.16	1.55	19.91	13.70	15.39	1.06	0.63	43.12	23.30	2.03
1300.0	15.59	15.77	0.18	1.58	19.81	12.97	14.68	1.05	0.63	42.38	23.11	2.08
1400.0	15.47	15.66	0.19	1.60	19.64	12.21	13.97	1.04	0.63	42.39	23.17	2.12
1500.0	15.32	15.53	0.21	1.58	19.63	11.50	13.34	1.04	0.64	43.28	23.26	2.16

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, Id1 (A1) = 140.16 mA and Id2 (A2) = 133.54 mA @ Temperature = -45degC

FREQ	A1	A2	A1 & A2		A1							
	Gain		Amp Unbal	Phase Unbal	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(Deg)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50.0	17.43	17.36	0.07	0.55	21.02	11.79	13.32	0.95	0.65	42.66	22.52	1.63
100.0	16.31	16.30	0.01	0.71	20.30	16.45	16.48	1.05	0.63	40.64	22.67	1.56
200.0	15.88	15.90	0.02	0.70	20.08	20.38	18.43	1.09	0.62	40.34	22.81	1.49
300.0	15.76	15.80	0.04	0.76	19.98	21.10	18.49	1.10	0.62	40.43	22.87	1.53
400.0	15.70	15.75	0.05	0.89	19.96	20.82	18.25	1.10	0.62	39.22	22.73	1.51
500.0	15.66	15.71	0.05	1.02	19.91	20.27	18.08	1.10	0.62	40.08	22.96	1.52
600.0	15.61	15.67	0.06	1.14	19.86	19.37	17.54	1.10	0.61	39.69	22.90	1.51
700.0	15.55	15.63	0.08	1.25	19.80	18.25	16.84	1.10	0.61	39.38	22.95	1.51
800.0	15.49	15.57	0.08	1.37	19.76	17.25	16.30	1.10	0.61	39.46	22.93	1.54
900.0	15.42	15.53	0.11	1.49	19.66	16.35	15.79	1.09	0.61	40.47	23.08	1.54
1000.0	15.35	15.47	0.12	1.59	19.59	15.38	15.07	1.09	0.61	38.69	22.77	1.60
1100.0	15.26	15.39	0.13	1.68	19.55	14.48	14.41	1.08	0.61	39.27	22.96	1.64
1200.0	15.17	15.32	0.15	1.75	19.49	13.68	13.92	1.08	0.61	40.20	23.02	1.68
1300.0	15.07	15.24	0.17	1.79	19.38	12.89	13.32	1.07	0.60	39.63	22.93	1.69
1400.0	14.96	15.13	0.17	1.85	19.31	12.15	12.73	1.06	0.60	39.36	22.99	1.72
1500.0	14.84	15.03	0.19	1.87	19.26	11.49	12.24	1.06	0.61	40.13	23.06	1.78

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, Id1 (A1) = 127.58 mA and Id2 (A2) = 118.02 mA @ Temperature = -45degC

FREQ	A1	A2	A1 & A2		A1							
	Gain		Amp Unbal	Phase Unbal	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(Deg)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50.0	17.37	17.29	0.08	0.44	21.16	11.69	13.46	0.96	0.67	42.17	21.87	1.62
100.0	16.28	16.25	0.03	0.59	20.28	16.36	16.76	1.05	0.63	40.87	21.97	1.55
200.0	15.86	15.86	0.00	0.64	20.05	20.37	18.91	1.09	0.62	40.69	22.12	1.45
300.0	15.75	15.76	0.01	0.71	20.03	21.19	18.97	1.10	0.63	41.38	22.18	1.47
400.0	15.69	15.71	0.02	0.85	19.95	20.97	18.76	1.10	0.62	39.73	22.05	1.48
500.0	15.65	15.68	0.03	0.99	19.88	20.40	18.58	1.10	0.62	40.62	22.29	1.55
600.0	15.60	15.64	0.04	1.12	19.84	19.52	17.99	1.10	0.62	40.56	22.23	1.51
700.0	15.55	15.60	0.05	1.24	19.78	18.39	17.24	1.10	0.61	40.06	22.30	1.50
800.0	15.48	15.54	0.06	1.35	19.72	17.40	16.67	1.09	0.61	40.21	22.27	1.53
900.0	15.42	15.50	0.08	1.48	19.65	16.49	16.12	1.09	0.61	41.40	22.40	1.54
1000.0	15.34	15.44	0.10	1.57	19.57	15.49	15.36	1.08	0.61	39.39	22.13	1.57
1100.0	15.25	15.36	0.11	1.68	19.49	14.56	14.66	1.08	0.61	39.70	22.31	1.68
1200.0	15.17	15.29	0.12	1.73	19.43	13.77	14.13	1.07	0.61	40.70	22.36	1.63
1300.0	15.07	15.20	0.13	1.79	19.34	12.96	13.52	1.07	0.61	40.12	22.30	1.68
1400.0	14.96	15.10	0.14	1.85	19.29	12.22	12.91	1.06	0.61	39.84	22.35	1.70
1500.0	14.83	15.00	0.17	1.87	19.23	11.53	12.40	1.06	0.61	40.74	22.41	1.76

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, Id1 A1) = 156.08 mA and Id2 (A2) =146.41 mA @ Temperature = -45degC

FREQ	A1	A2	A1 & A2		A1							
	Gain		Amp Unbal	Phase Unbal	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(Deg)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50.0	17.50	17.44	0.06	0.43	21.02	11.88	13.50	0.95	0.64	44.48	23.10	1.66
100.0	16.41	16.40	0.01	0.58	20.34	16.45	16.69	1.05	0.62	40.49	23.21	1.59
200.0	15.99	16.01	0.02	0.62	20.17	20.42	18.66	1.09	0.62	40.20	23.36	1.50
300.0	15.88	15.91	0.03	0.69	20.12	21.18	18.67	1.10	0.62	40.58	23.42	1.50
400.0	15.82	15.86	0.04	0.81	20.10	20.89	18.47	1.11	0.62	39.25	23.25	1.56
500.0	15.77	15.82	0.05	0.92	20.00	20.32	18.30	1.10	0.62	39.78	23.47	1.56
600.0	15.72	15.79	0.07	1.05	19.95	19.46	17.74	1.10	0.61	39.97	23.42	1.57
700.0	15.67	15.74	0.07	1.17	19.90	18.31	17.02	1.10	0.61	39.49	23.45	1.53
800.0	15.60	15.68	0.08	1.27	19.82	17.30	16.47	1.09	0.61	39.52	23.42	1.54
900.0	15.54	15.64	0.10	1.38	19.78	16.42	15.96	1.09	0.61	40.43	23.59	1.58
1000.0	15.46	15.58	0.12	1.47	19.69	15.41	15.20	1.08	0.61	38.81	23.24	1.63
1100.0	15.37	15.50	0.13	1.55	19.62	14.50	14.54	1.08	0.61	39.15	23.43	1.65
1200.0	15.29	15.43	0.14	1.62	19.57	13.72	14.02	1.08	0.61	40.36	23.52	1.69
1300.0	15.18	15.34	0.16	1.64	19.45	12.91	13.43	1.07	0.60	39.56	23.40	1.72
1400.0	15.07	15.23	0.16	1.71	19.41	12.17	12.82	1.06	0.60	39.49	23.46	1.75
1500.0	14.94	15.13	0.19	1.70	19.35	11.48	12.33	1.06	0.61	40.05	23.54	1.77

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, Id1(A1) = 144.79 mA and Id2 (A2) = 136.99 mA @ Temperature = +85degC

FREQ	A1	A2	A1 & A2		A1							
	Gain		Amp Unbal	Phase Unbal	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(Deg)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50.0	17.81	17.77	0.04	0.59	21.73	11.26	14.12	0.99	0.66	43.39	22.40	2.10
100.0	17.04	17.06	0.02	0.64	21.19	15.23	19.18	1.07	0.65	44.53	22.42	1.99
200.0	16.76	16.80	0.04	0.61	20.98	17.86	23.13	1.10	0.64	44.27	22.62	1.92
300.0	16.66	16.71	0.05	0.67	20.89	17.87	24.16	1.10	0.64	45.90	22.73	2.05
400.0	16.60	16.66	0.06	0.77	20.82	17.85	24.39	1.10	0.64	43.41	22.43	2.09
500.0	16.54	16.61	0.07	0.89	20.78	17.74	23.32	1.10	0.65	44.93	22.70	2.10
600.0	16.48	16.56	0.08	1.00	20.69	17.30	22.29	1.09	0.65	44.35	22.63	2.11
700.0	16.41	16.50	0.09	1.08	20.57	16.64	21.54	1.08	0.65	44.94	22.63	2.11
800.0	16.32	16.43	0.11	1.20	20.47	16.02	20.49	1.08	0.65	44.28	22.57	2.13
900.0	16.23	16.36	0.13	1.28	20.35	15.41	19.18	1.07	0.65	46.02	22.80	2.19
1000.0	16.14	16.28	0.14	1.34	20.26	14.71	18.12	1.06	0.65	43.06	22.34	2.20
1100.0	16.03	16.18	0.15	1.42	20.13	13.96	17.28	1.05	0.65	44.54	22.60	2.29
1200.0	15.91	16.09	0.18	1.47	20.00	13.27	16.44	1.04	0.65	45.90	22.72	2.31
1300.0	15.78	15.98	0.20	1.46	19.91	12.62	15.55	1.04	0.66	44.96	22.51	2.35
1400.0	15.65	15.85	0.20	1.48	19.77	11.96	14.79	1.03	0.66	44.36	22.59	2.37
1500.0	15.50	15.72	0.22	1.49	19.66	11.30	14.11	1.02	0.66	45.18	22.66	2.46

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, Id1(A1) = 131.62 mA and Id2 (A2) = 124.37 mA @ Temperature = +85degC

FREQ	A1	A2	A1 & A2		A1							
	Gain		Amp Unbal	Phase Unbal	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(Deg)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50.0	17.77	17.71	0.06	0.53	21.46	11.09	14.24	0.98	0.64	42.68	21.88	2.08
100.0	17.01	17.01	0.00	0.53	21.08	15.01	19.16	1.06	0.64	43.83	21.89	2.00
200.0	16.73	16.75	0.02	0.52	20.93	17.50	23.22	1.09	0.64	45.51	22.09	1.87
300.0	16.63	16.67	0.04	0.60	20.90	17.55	24.22	1.10	0.65	46.21	22.17	1.98
400.0	16.58	16.62	0.04	0.72	20.85	17.55	24.44	1.10	0.65	45.09	21.91	2.04
500.0	16.52	16.57	0.05	0.83	20.76	17.43	23.52	1.09	0.65	46.12	22.16	2.07
600.0	16.45	16.51	0.06	0.92	20.67	17.04	22.42	1.09	0.65	46.95	22.10	2.06
700.0	16.38	16.45	0.07	1.02	20.55	16.43	21.66	1.08	0.65	46.24	22.11	2.09
800.0	16.29	16.38	0.09	1.13	20.42	15.83	20.64	1.07	0.65	46.08	22.05	2.11
900.0	16.21	16.31	0.10	1.19	20.33	15.25	19.26	1.07	0.65	48.55	22.25	2.16
1000.0	16.10	16.23	0.13	1.26	20.21	14.59	18.22	1.06	0.65	44.11	21.83	2.18
1100.0	16.00	16.13	0.13	1.36	20.10	13.89	17.37	1.05	0.65	46.64	22.05	2.24
1200.0	15.88	16.04	0.16	1.39	19.97	13.20	16.51	1.04	0.66	46.95	22.18	2.28
1300.0	15.75	15.93	0.18	1.37	19.85	12.57	15.61	1.03	0.66	47.18	22.00	2.34
1400.0	15.62	15.80	0.18	1.39	19.71	11.90	14.84	1.02	0.66	45.84	22.07	2.32
1500.0	15.46	15.67	0.21	1.37	19.62	11.28	14.18	1.02	0.66	49.07	22.15	2.44

Typical Performance Data

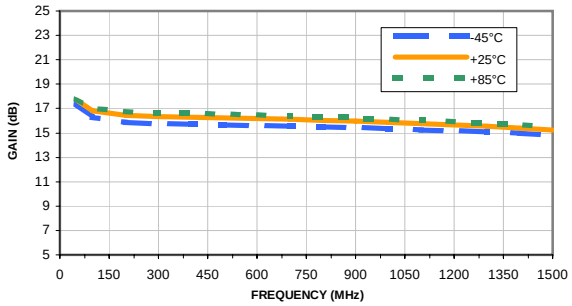
Definitions:
Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 5.25V, Id1(A1) = 157.33 mA and Id2 (A2) = 149.61 mA @ Temperature = +85degC

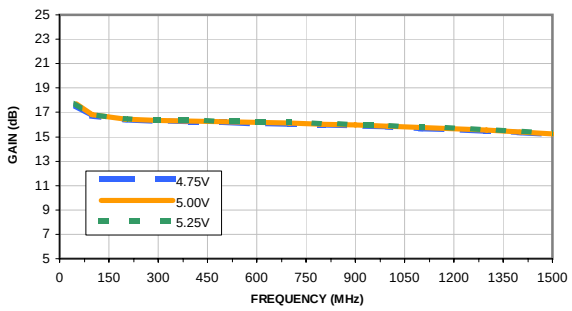
FREQ	A1	A2	A1 & A2		A1							
	Gain		Amp Unbal	Phase Unbal	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(Deg)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50.0	17.87	17.83	0.04	0.53	21.97	11.24	14.31	1.00	0.68	43.71	22.88	2.20
100.0	17.13	17.13	0.00	0.51	21.24	15.11	19.26	1.07	0.65	43.46	22.86	2.07
200.0	16.85	16.88	0.03	0.52	21.07	17.59	23.41	1.10	0.64	44.49	23.05	2.07
300.0	16.76	16.80	0.04	0.58	20.96	17.61	24.47	1.10	0.64	45.65	23.16	2.07
400.0	16.70	16.75	0.05	0.68	20.94	17.59	24.68	1.10	0.65	43.51	22.84	2.09
500.0	16.64	16.70	0.06	0.80	20.85	17.47	23.82	1.09	0.64	43.83	23.10	2.16
600.0	16.57	16.64	0.07	0.91	20.77	17.07	22.70	1.09	0.65	44.39	23.03	2.15
700.0	16.50	16.58	0.08	1.01	20.68	16.45	21.91	1.08	0.65	44.35	23.03	2.12
800.0	16.42	16.52	0.10	1.11	20.56	15.86	20.90	1.08	0.65	43.80	22.97	2.19
900.0	16.33	16.44	0.11	1.18	20.47	15.28	19.50	1.07	0.65	44.41	23.20	2.23
1000.0	16.23	16.36	0.13	1.27	20.36	14.62	18.43	1.06	0.65	42.45	22.72	2.26
1100.0	16.12	16.27	0.15	1.34	20.21	13.90	17.62	1.05	0.65	43.28	22.95	2.32
1200.0	16.01	16.17	0.16	1.36	20.10	13.21	16.73	1.04	0.66	44.32	23.11	2.36
1300.0	15.87	16.06	0.19	1.37	19.99	12.56	15.83	1.04	0.66	43.19	22.91	2.41
1400.0	15.74	15.94	0.20	1.37	19.86	11.90	15.06	1.03	0.66	43.49	22.98	2.46
1500.0	15.59	15.81	0.22	1.38	19.74	11.29	14.36	1.02	0.66	44.19	23.07	2.51

Typical Performance Curves

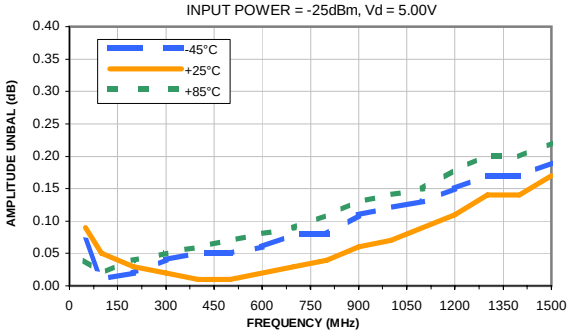
GAIN vs. FREQUENCY & TEMPERATURE
INPUT POWER = -25dBm, Vd = 5.00V



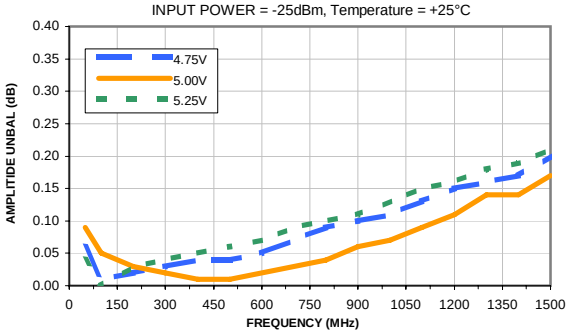
GAIN vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



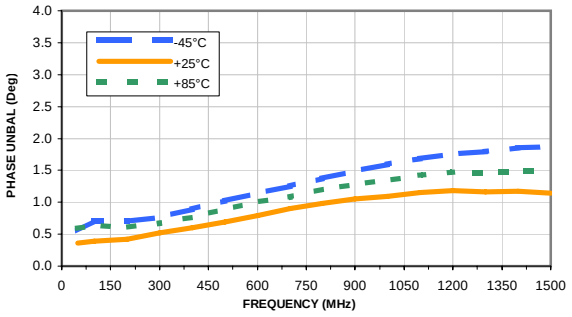
AMPLITUTE UNBALANCE vs. FREQUENCY & TEMPERATURE
INPUT POWER = -25dBm, Vd = 5.00V



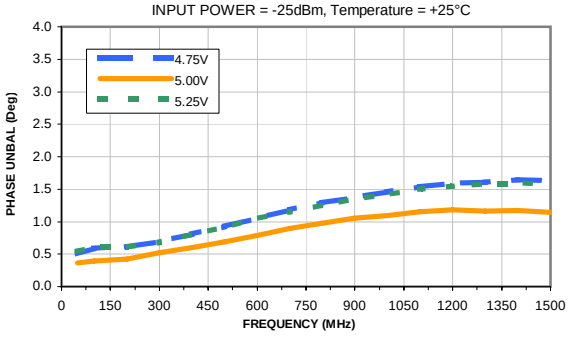
AMPLITUDE UNBALANCE vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



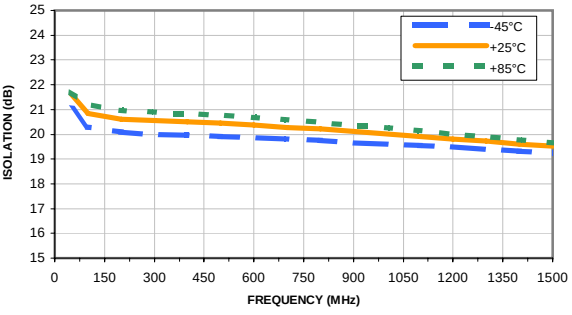
PHASE UNBALANCE vs. FREQUENCY & TEMPERATURE
INPUT POWER = -25dBm, Vd = 5.00V



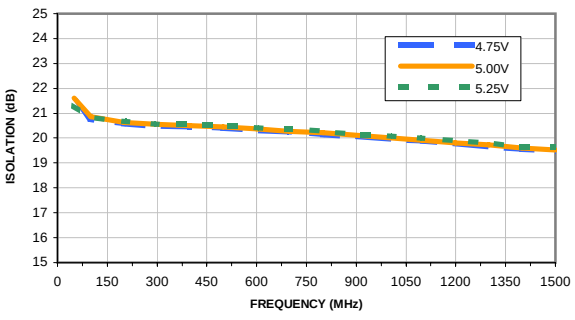
PHASE UNBALANCE vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



ISOLATION vs. FREQUENCY & TEMPERATURE
INPUT POWER = -25dBm, Vd = 5.00V

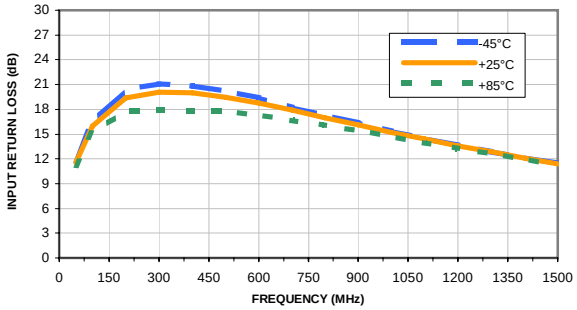


ISOLATION vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C

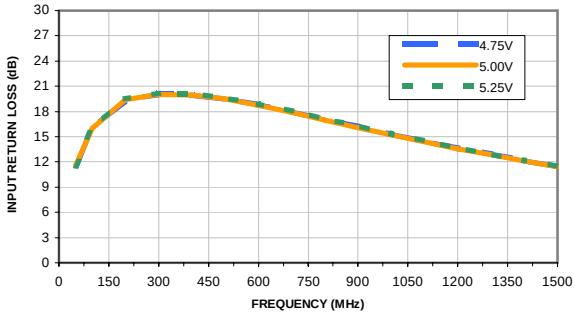


Typical Performance Curves

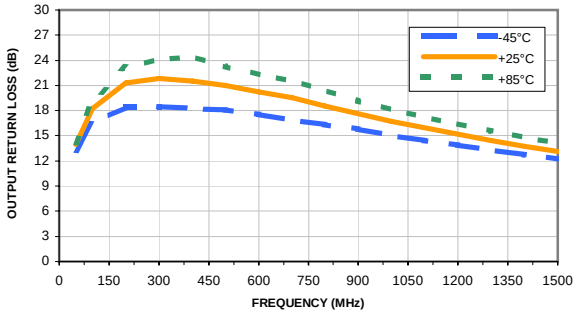
INPUT RETURN LOSS vs. FREQUENCY & TEMPERATURE
INPUT POWER = -25dBm, Vd = 5.00V



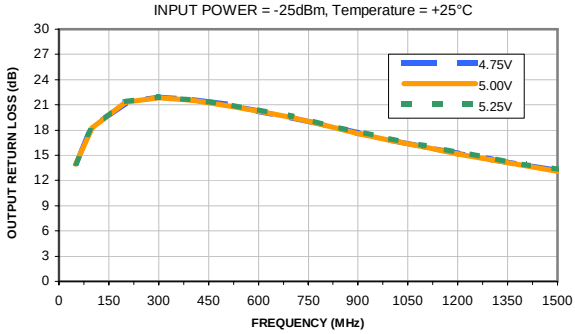
INPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



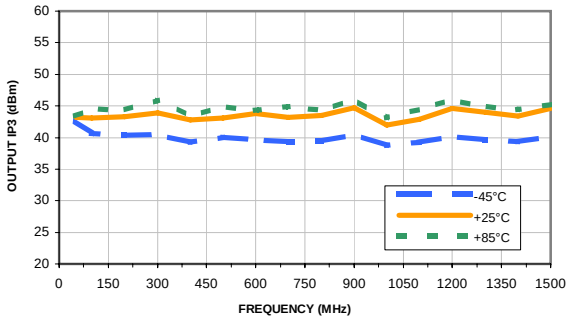
OUTPUT RETURN LOSS vs. FREQUENCY & TEMPERATURE
INPUT POWER = -25dBm, Vd = 5.00V



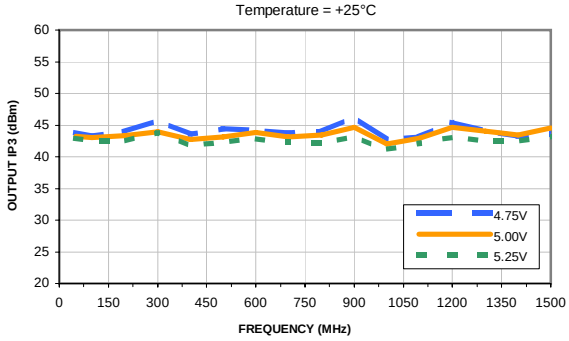
OUTPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



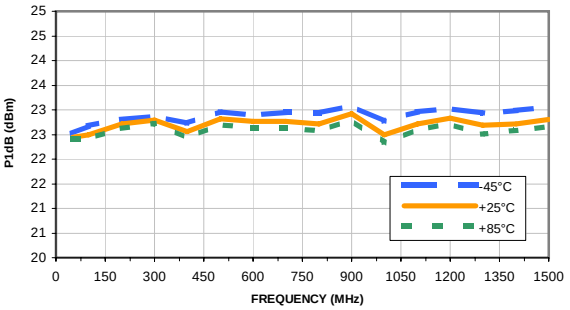
OUTPUT IP3 vs. FREQUENCY & TEMPERATURE
Vd = 5.00V



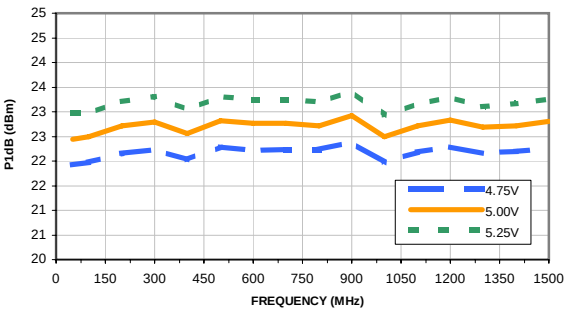
OUTPUT IP3 vs. FREQUENCY & DEVICE VOLTAGE
Temperature = +25°C



P1dB vs. FREQUENCY & TEMPERATURE
Vd = 5.00V

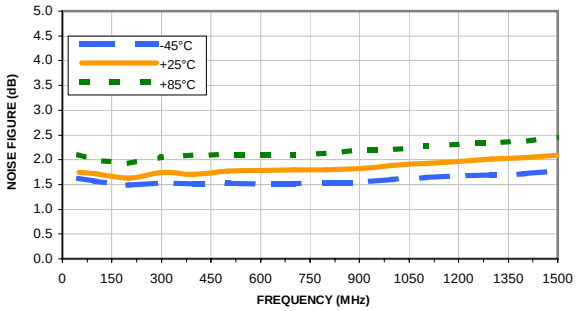


P1dB vs. FREQUENCY & DEVICE VOLTAGE
Temperature = +25°C

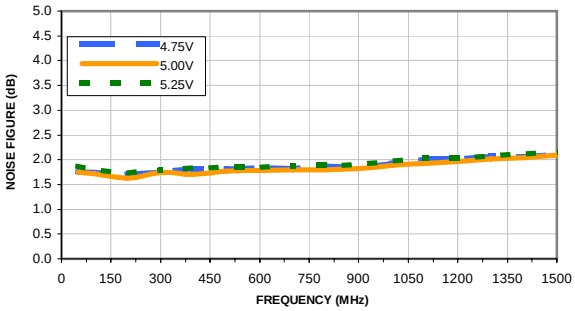


Typical Performance Curves

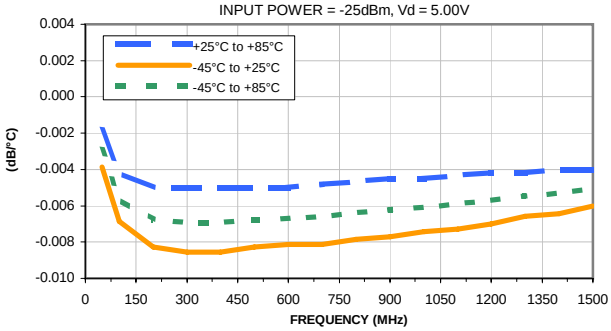
NOISE FIGURE vs. FREQUENCY & TEMPERATURE
INPUT POWER = -25dBm, Vd = 5.00V



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

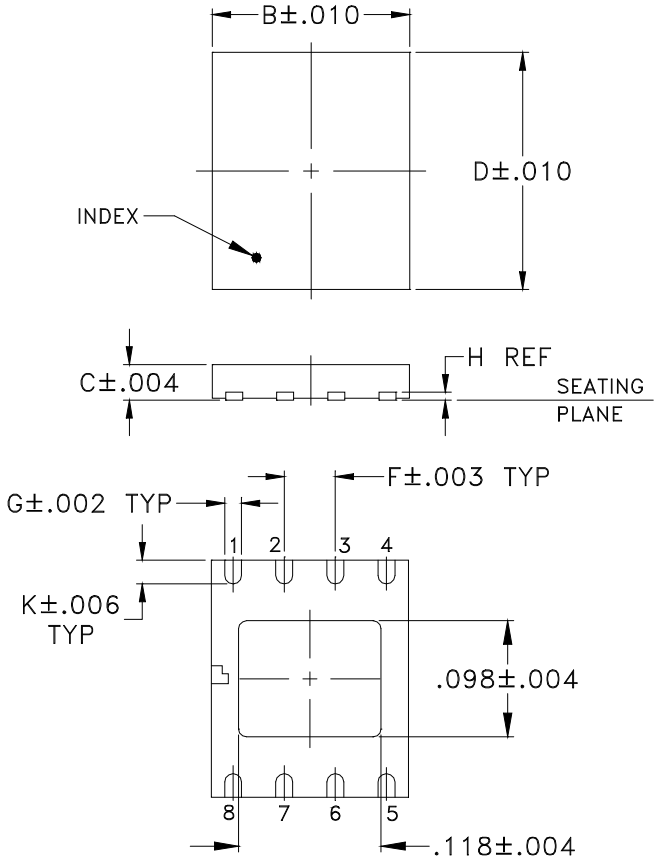


GAIN VARIATION vs. FREQUENCY & TEMPERATURE
INPUT POWER = -25dBm, Vd = 5.00V

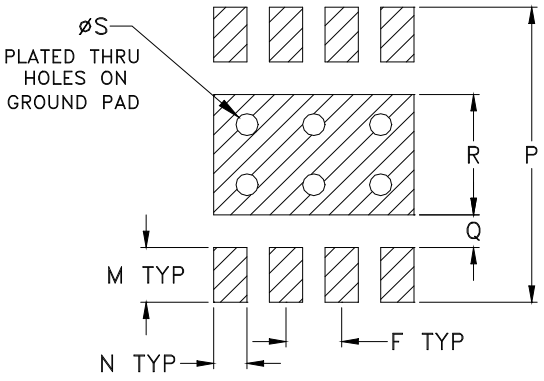


DL1020

Outline Dimensions



PCB Land Pattern



Suggested Layout,
Tolerance to be within ±.002

CASE #	A	B	C	D	E	F	G	H	J	K	L	M	N
DL1020	-- --	.193 (4.90)	.035 (0.90)	.236 (6.00)	-- --	.050 (1.27)	.017 (0.42)	.008 (0.20)	-- --	.024 (0.60)	-- --	.050 (1.27)	.030 (0.76)

CASE #	P	Q	R	S	T	WT. GRAM
DL1020	.270 (6.86)	.030 (0.76)	.110 (2.79)	.020 (0.51)	-- --	.08

Dimensions are in inches (mm). Tolerances: 2 Pl. ± .01; 3Pl. ± .004

Notes:

1. Case material: Plastic.
2. Termination finish:
   For RoHS Case Styles: Tin-Silver alloy plate over Nickel barrier. All models, (+) suffix.
   For RoHS-5 Case Styles: Tin-Lead plate. All models, no (+) suffix.

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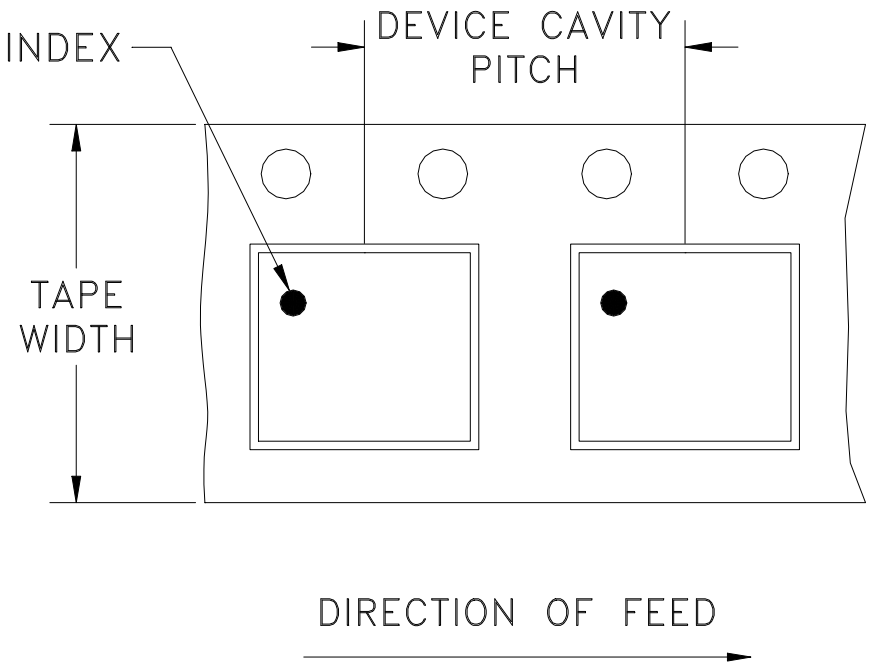
Tape & Reel Packaging TR-F68

DEVICE ORIENTATION IN T&R



Tape Width, mm	Device Cavity Pitch, mm	Reel Size, inches	Devices per Reel see note	
12	8	7	Small quantity standard	20
				50
				100
				200
				500
		7	Standard	1000
		13	Standard	2000
				3000
				4000

Mini-Circuits carrier tape materials provide protection from ESD (Electro-Static Discharge) during handling and transportation. Tapes are static dissipative and comply with industry standards EIA-481/EIA-541.

Go to: www.minicircuits.com/pages/pdfs/tape.pdf

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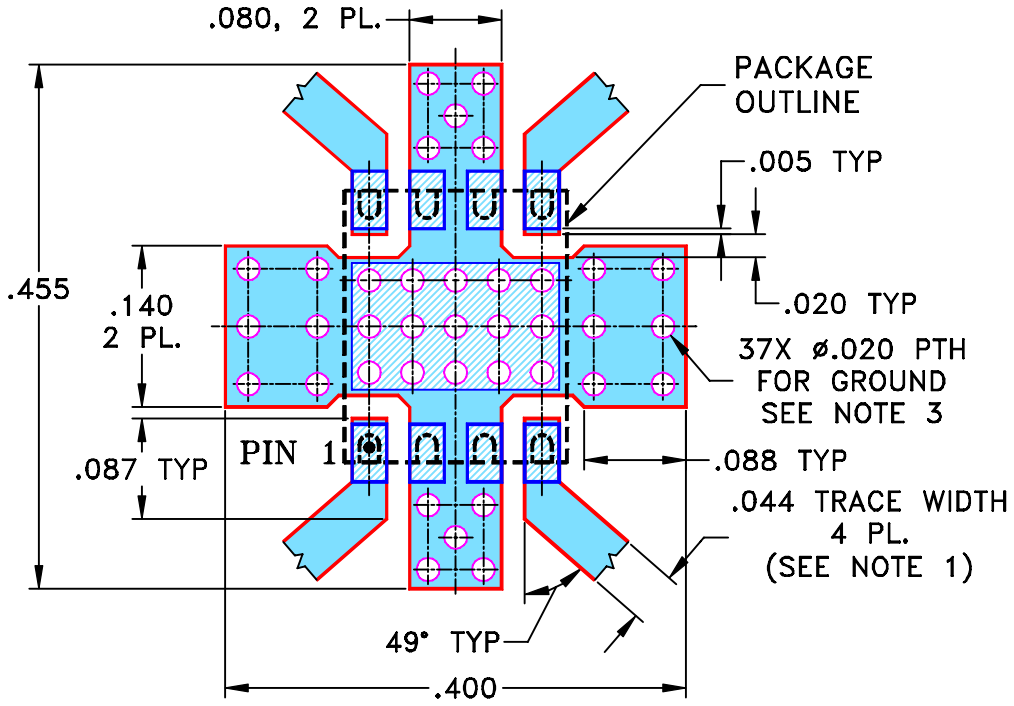
THIRD ANGLE PROJECTION

REVISIONS					
REV	ECN No.	DESCRIPTION	DATE	DR	AUTH
OR	M125629	NEW RELEASE	04/20/10	MMG	RD

SUGGESTED MOUNTING CONFIGURATION FOR DL1020 CASE STYLE, "08AM04" PIN CODE



NOTES:

1. TRACE WIDTH IS SHOWN FOR ROGERS RO4350B WITH DIELECTRIC THICKNESS .020" ± .0015". COPPER: 1/2 OZ. EACH SIDE. FOR OTHER MATERIALS TRACE WIDTH MAY NEED TO BE MODIFIED.
2. BOTTOM SIDE OF THE PCB IS CONTINUOUS GROUND PLANE.
3. RECOMMEND TO PLUG 15 PTH UNDER THE UNIT TO AVOID SOLDER WICKING.

DENOTES PCB COPPER LAYOUT WITH SMOBC (SOLDER MASK OVER BARE COPPER)

DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK

UNLESS OTHERWISE SPECIFIED		INITIALS	DATE
DIMENSIONS ARE IN INCHES	DRAWN	MMG	01/26/10
TOLERANCES ON:	CHECKED	IL	04/20/10
2 PL DECIMALS ±	APPROVED	RD	04/20/10
3 PL DECIMALS ± .005			
ANGLES ±			
FRACTIONS ±			

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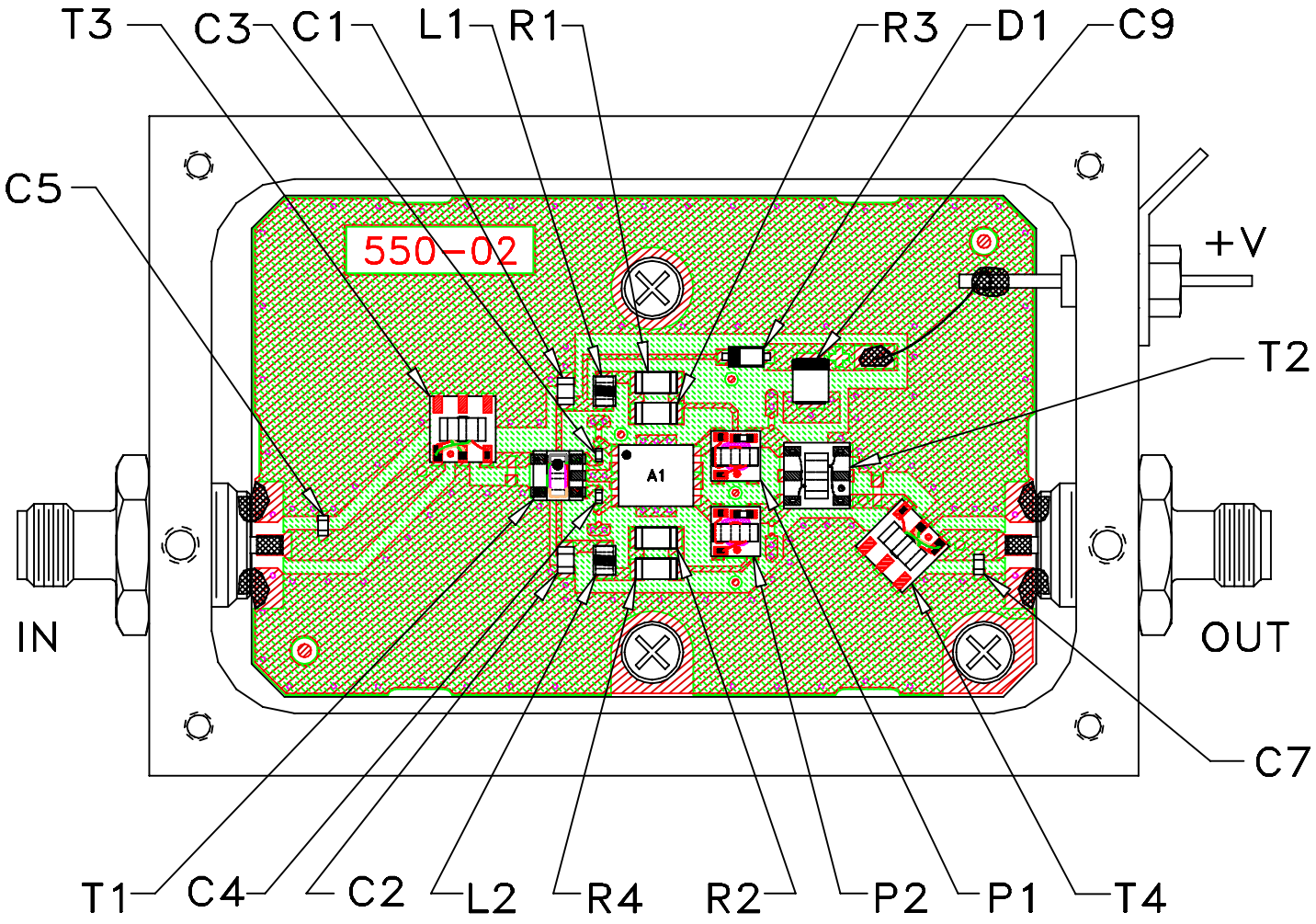
ASHEETA1.DWG REV:A DATE:01/12/95

Mini-Circuits® 13 Neptune Avenue Brooklyn NY 11235

PL, 08AM04, DL1020

SIZE	CODE IDENT	DRAWING NO:	REV:
A	15542	98-PL-322	OR
FILE: 98PL322	SCALE: 6:1	SHEET: 1 OF 1	

Evaluation Board and Circuit



TB-566-50+

Notes:

1. 50 Ohm SMA Female connectors.
2. PCB Material: FR4.
   Dielectric Constant=4.7, Thickness=.059 inch.

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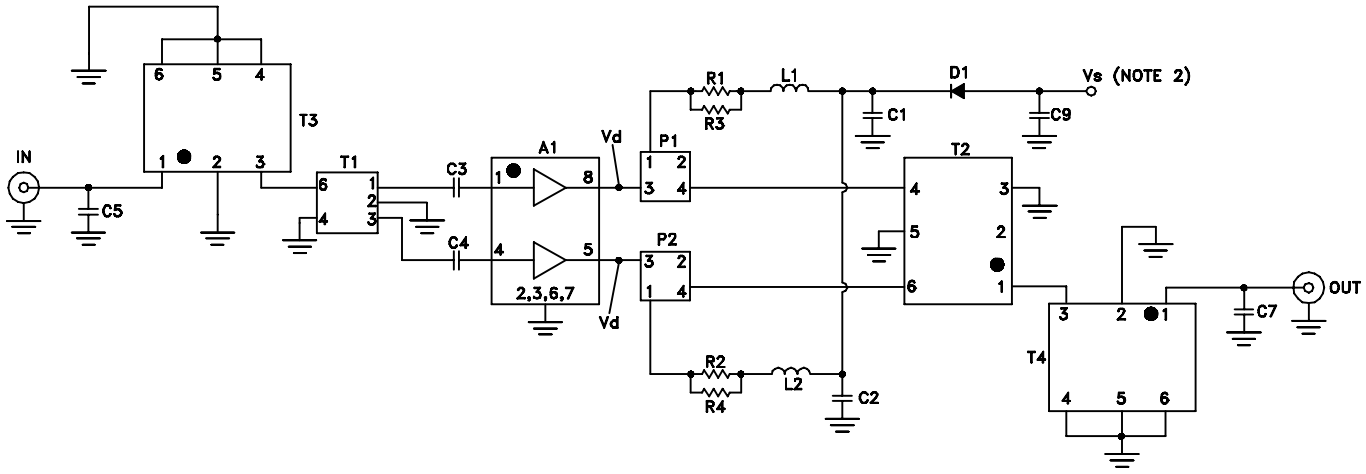
Evaluation Board and Circuit



Note:

1. Numbers inside the boxes indicate Pin Numbers.
2. Set Vs to obtain Vd=5V.

COMPONENT	VALUE
A1	Mini-Circuits PHA-22+
C1,C2	.039 uF
C3,C4	1000 pF
C5	0.8 pF
C7	1.1 pF
C9	1.0 uF
D1	ON Semiconductor: MBR0520LT1G
L1,L2	680 nH
P1,P2	Mini-Circuits TCBT-6G+
R1,R2	11.5 Ohm
R3,R4	7.50 Ohm
T1	Mini-Circuits TC1.33-282+
T2	Mini-Circuits TRS1-23-75+
T3,T4	Mini-Circuits TRS2-252+

Schematic Diagram

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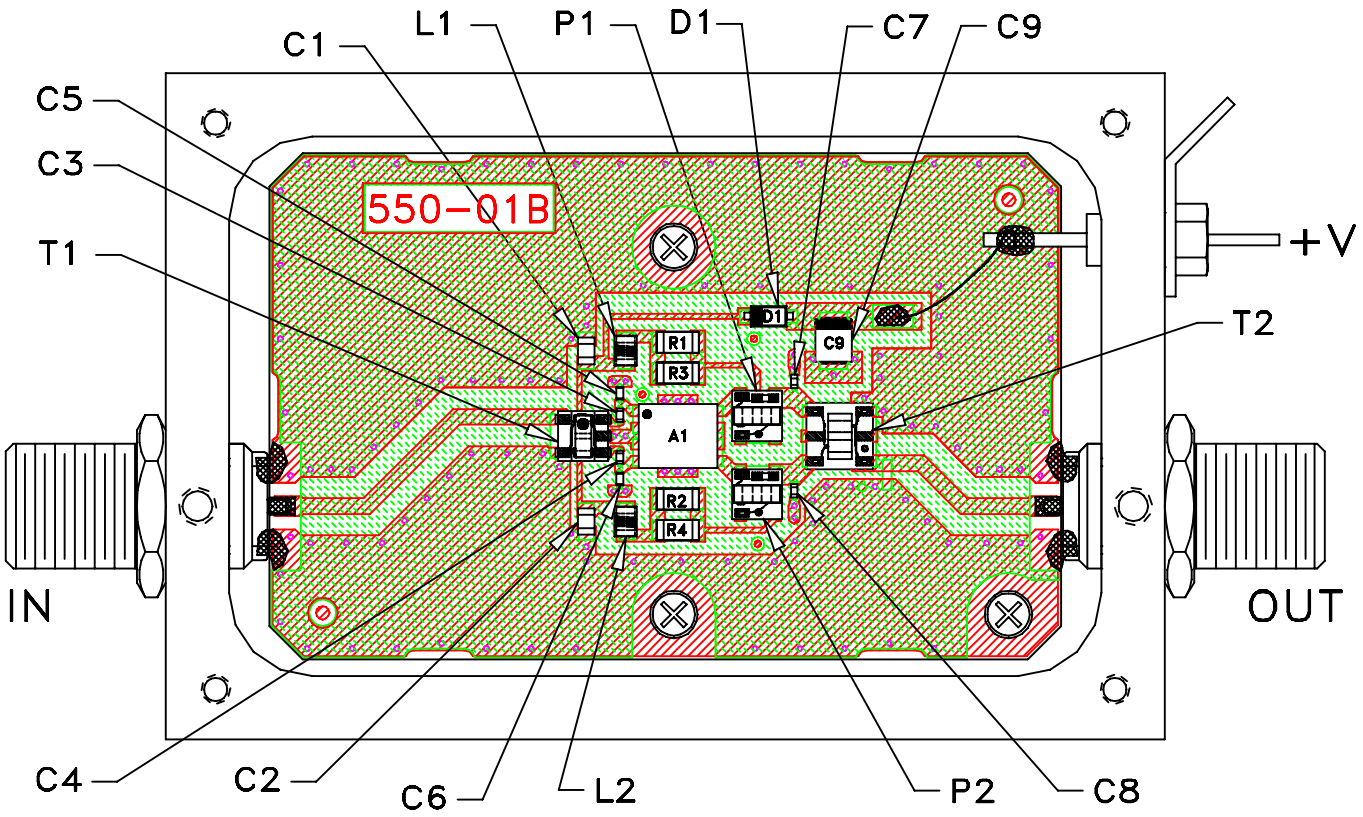
Evaluation Board and Circuit



TB-566-75+

Notes:

1. 75 Ohm F Female connectors.
2. PCB Material: FR4.
   Dielectric Constant=4.7, Thickness=.059 inch.

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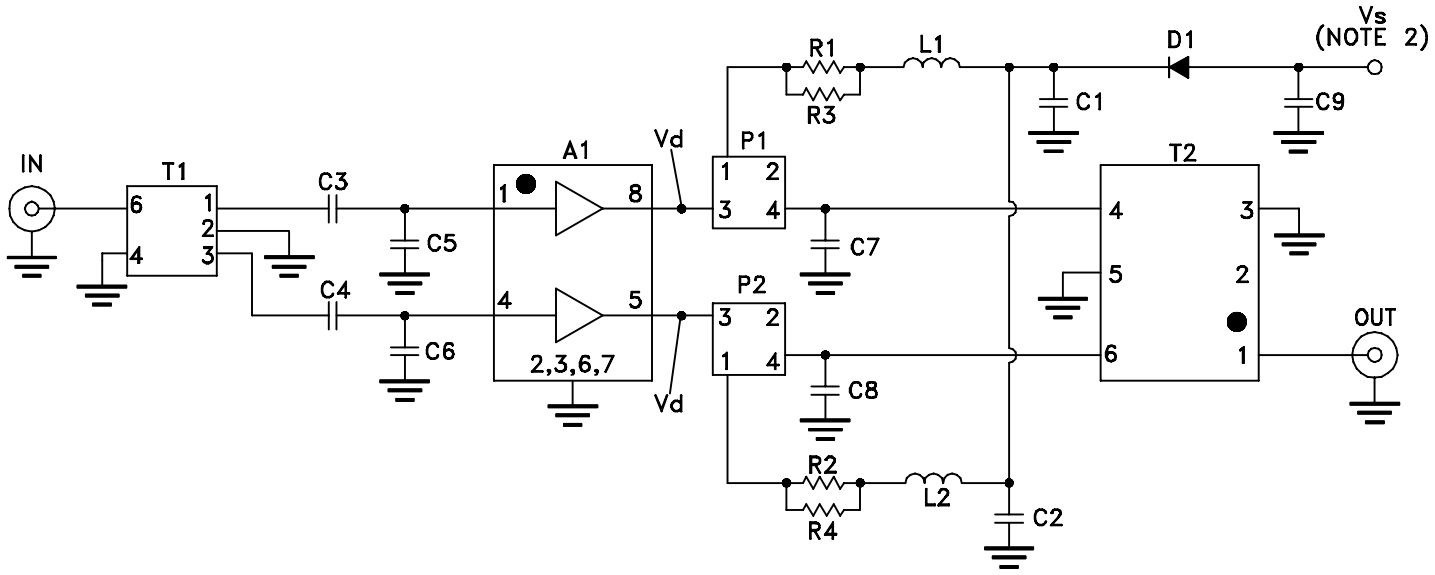
Evaluation Board and Circuit



Note:

1. Numbers inside the boxes indicate Pin Numbers.
2. Set Vs to obtain Vd=5V.

COMPONENT	VALUE
A1	Mini-Circuits PHA-22+
C1,C2	.039 uF
C3,C4	1000 pF
C5,C6	.75 pF
C7,C8	1.6 pF
C9	1.0 uF
D1	ON Semiconductor: MBR0520LT1G
L1,L2	680 nH
P1,P2	Mini-Circuits TCBT-6G+
R1,R2	11.5 Ohm
R3,R4	7.50 Ohm
T1	Mini-Circuits TC1.33-282+
T2	Mini-Circuits TRS1-23-75+

Schematic Diagram

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Mini-Circuits

Environmental Specifications **ENV08T2**

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	-45° to 85°C or -40° to 85°C Ambient Environment	Individual Model Data Sheet
Storage Temperature	-65° to 150° C Ambient Environment	Individual Model Data Sheet
Thermal Shock	-55° to 100°C, 100 cycles	MIL-STD-202, Method 107, Condition A-3, except +100°C
Mechanical Shock	1.5Kg, 0.5 ms, 5 shock pulses, Y1 direction only	MIL-STD-883, Method 2002, Condition B, except Y1 direction only
Vibration (Variable Frequency)	50g peak	MIL-STD-883, Method 2007, Condition B
Autoclave	15 psig, 100% RH, 121°C, 96 hours	JESD22-A102, Condition C
HAST	130°C, 85% RH, 96 hours	JESD22-A110
Solderability	10X Magnification	J-STD-002, Para 4.2.5, Test S, 95% Coverage
Solder Reflow Heat	Sn-Pb Eutetic Process: 240°C peak Pb-Free Process: 260°C peak	J-STD-020, Table 4-1, 4-2 and 5-2; Figure 5-1
Moisture Sensitivity: Level 1	Bake at 125°C for 24 hours Soak at 85°C/85% RH for 168 hours, Reflow 3 cycles at 260°C peak	J-STD-020
Marking Resistance to Solvents	Isopropyl alcohol + mineral spirits at 25°C; terpene defluxer at 25°C; distilled water + proylene glycol monomethyl ether +	MIL-STD-202, Method 215

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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
	monoethanolamine at 63°C to 70°C	

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