Document Number: MMG3001NT1
Rev. 6, 7/2007

RoHS

Heterojunction Bipolar Transistor Technology (InGaP HBT)

Broadband High Linearity Amplifier

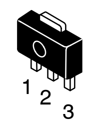
The MMG3001NT1 is a General Purpose Amplifier that is internally input and output matched. It is designed for a broad range of Class A, small-signal, high linearity, general purpose applications. It is suitable for applications with frequencies from 40 to 3600 MHz such as Cellular, PCS, BWA, WLL, PHS, CATV, VHF, UHF, UMTS and general small-signal RF.

Features

- Frequency: 40-3600 MHz
- P1dB: 18.5 dBm @ 900 MHz
- Small-Signal Gain: 20 dB @ 900 MHz
- Third Order Output Intercept Point: 32 dBm @ 900 MHz
- Single Voltage Supply
- Internally Matched to 50 Ohms
- Low Cost SOT-89 Surface Mount Package
- RoHS Compliant
- In Tape and Reel. T1 Suffix = 1000 Units per 12 mm, 7 inch Reel.

MMG3001NT1

40-3600 MHz, 20 dB
18.5 dBm
InGaP HBT



CASE 1514-02, STYLE 1
SOT-89
PLASTIC

Table 1. Typical Performance (1)

Characteristic	Symbol	900 MHz	2140 MHz	3500 MHz	Unit
Small-Signal Gain (S21)	G_p	20	18	16	dB
Input Return Loss (S11)	IRL	-25	-25	-19	dB
Output Return Loss (S22)	ORL	-22	-18	-17	dB
Power Output @1dB Compression	P1db	18.5	18	15.5	dBm
Third Order Output Intercept Point	IP3	32	31	28.5	dBm

1. V_{CC} = 5.6 Vdc, T_C = 25°C, 50 ohm system

Table 2. Maximum Ratings

Rating	Symbol	Value	Unit
Supply Voltage (2)	V_{CC}	7	V
Supply Current (2)	I_{CC}	300	mA
RF Input Power	P_{in}	10	dBm
Storage Temperature Range	T_{stg}	-65 to +150	°C
Junction Temperature (3)	T_J	150	°C

2. Voltage and current applied to device.
3. For reliable operation, the junction temperature should not exceed 150°C.

Table 3. Thermal Characteristics (V_{CC} = 5.6 Vdc, I_{CC} = 58 mA, T_C = 25°C)

Characteristic	Symbol	Value (4)	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	92.0	°C/W

4. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1955.

freescale™ semiconductor

Table 4. Electrical Characteristics (V_{CC}= 5.6 Vdc, 900 MHz, T_C = 25°C, 50 ohm system, in Freescale Application Circuit)

Characteristic	Symbol	Min	Typ	Max	Unit
Small-Signal Gain (S21)	G_p	18	20	—	dB
Input Return Loss (S11)	IRL	—	-25	—	dB
Output Return Loss (S22)	ORL	—	-22	—	dB
Power Output @ 1dB Compression	P1dB	—	18.5	—	dBm
Third Order Output Intercept Point	IP3	—	32	—	dBm
Noise Figure	NF	—	4.1	—	dB
Supply Current (1)	I_{CC}	40	58	75	mA
Supply Voltage (1)	V_{CC}	—	5.6	—	V

1. For reliable operation, the junction temperature should not exceed 150°C.

Table 5. Functional Pin Description

Pin Number	Pin Function
1	RF_{in}
2	Ground
3	RF_{out}/DC Supply

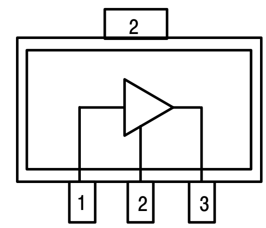


Figure 1. Functional Diagram

Table 6. ESD Protection Characteristics

Test Conditions/Test Methodology	Class
Human Body Model (per JESD 22-A114)	0 (Minimum)
Machine Model (per EIA/JESD 22-A115)	A (Minimum)
Charge Device Model (per JESD 22-C101)	IV (Minimum)

Table 7. Moisture Sensitivity Level

Test Methodology	Rating	Package Peak Temperature	Unit
Per JESD 22-A113, IPC/JEDEC J-STD-020	1	260	°C

50 OHM TYPICAL CHARACTERISTICS

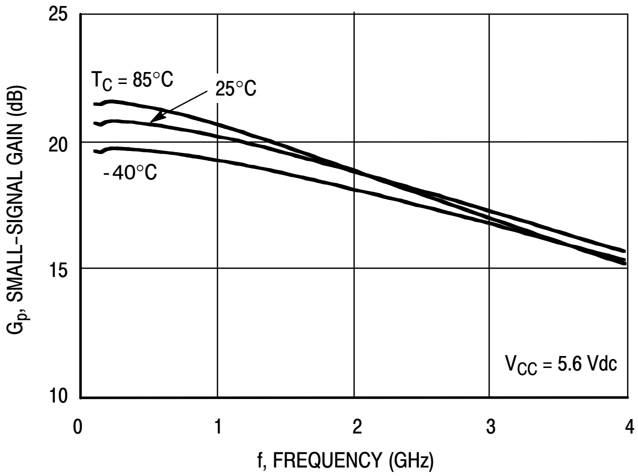


Figure 2. Small-Signal Gain (S21) versus Frequency

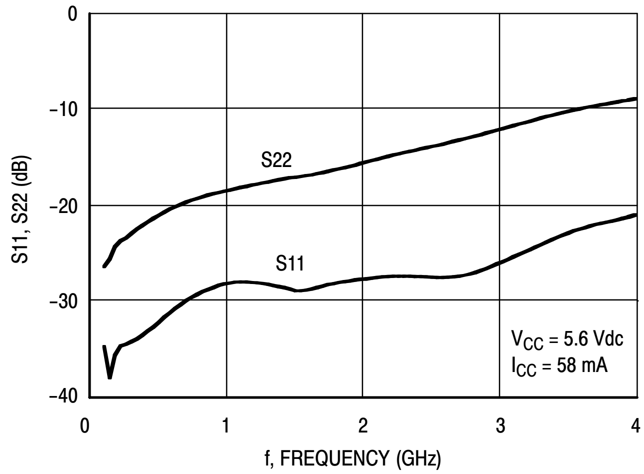


Figure 3. Input/Output Return Loss versus Frequency

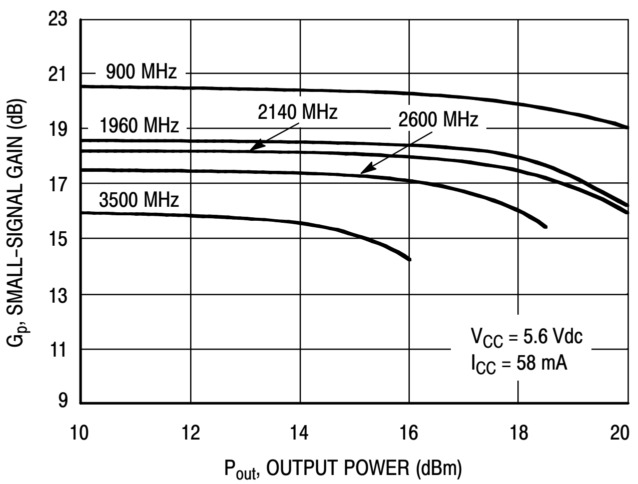


Figure 4. Small-Signal Gain versus Output Power

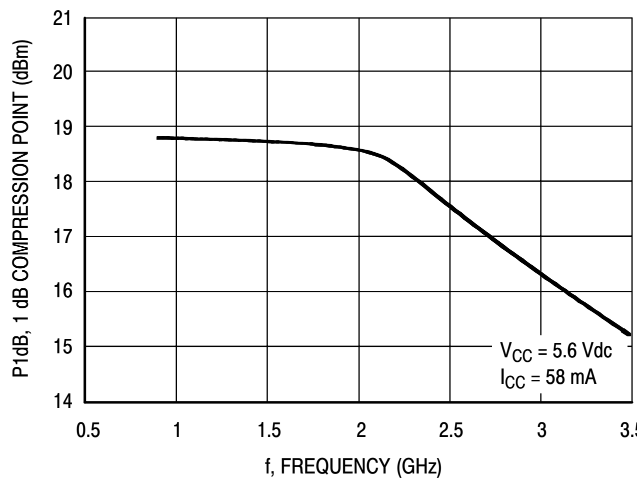


Figure 5. P1dB versus Frequency

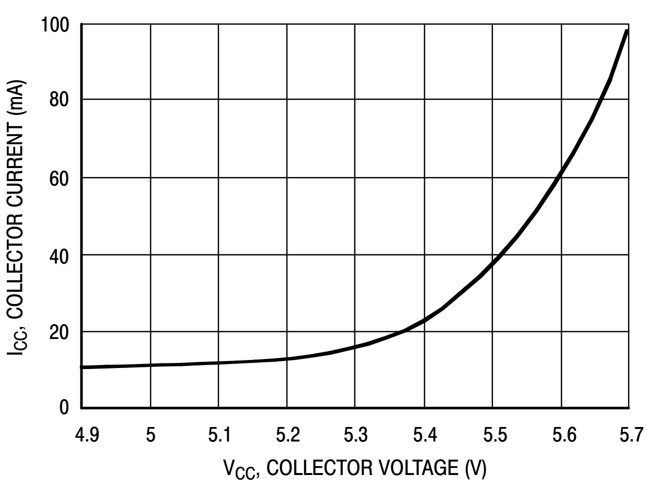


Figure 6. Collector Current versus Collector Voltage

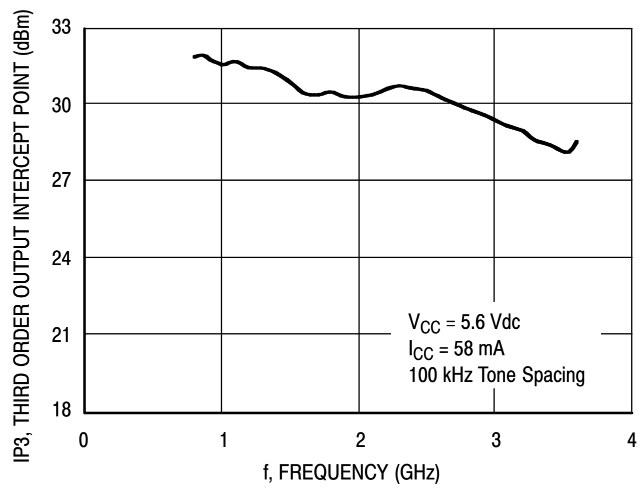


Figure 7. Third Order Output Intercept Point versus Frequency

50 OHM TYPICAL CHARACTERISTICS

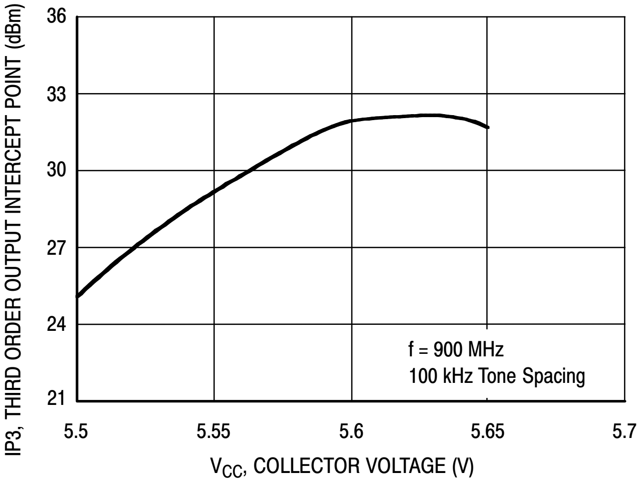


Figure 8. Third Order Output Intercept Point versus Collector Voltage

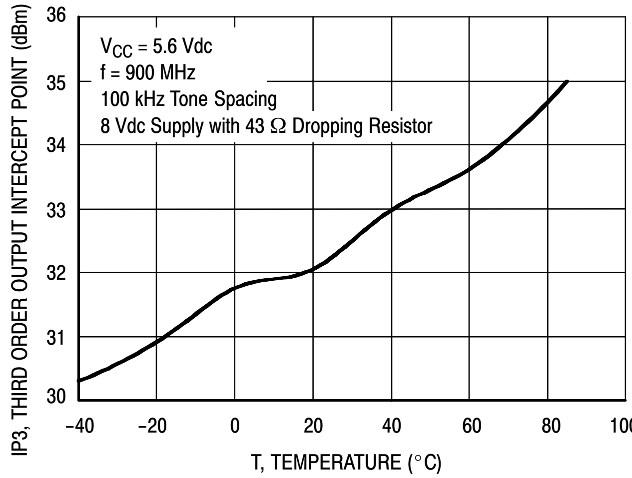


Figure 9. Third Order Output Intercept Point versus Case Temperature

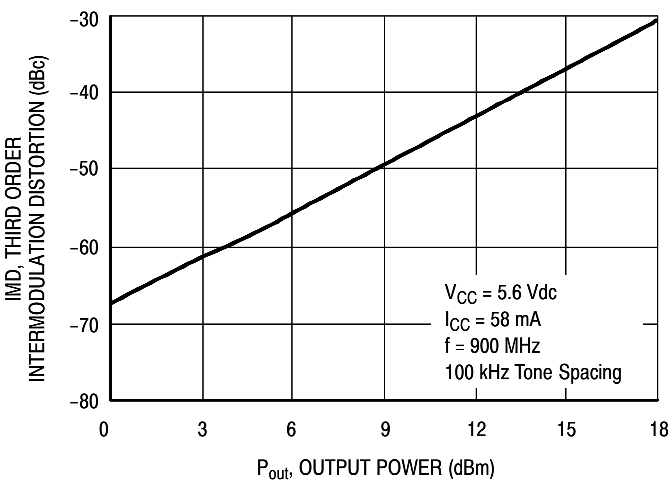
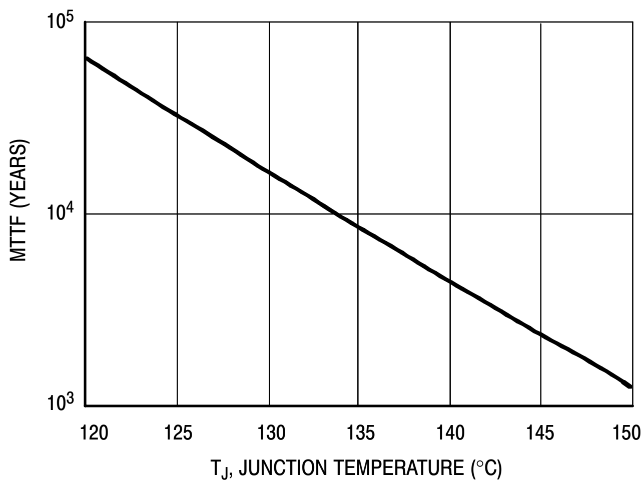


Figure 10. Third Order Intermodulation versus Output Power



NOTE: The MTTF is calculated with V_{CC} = 5.6 Vdc, I_{CC} = 58 mA

Figure 11. MTTF versus Junction Temperature

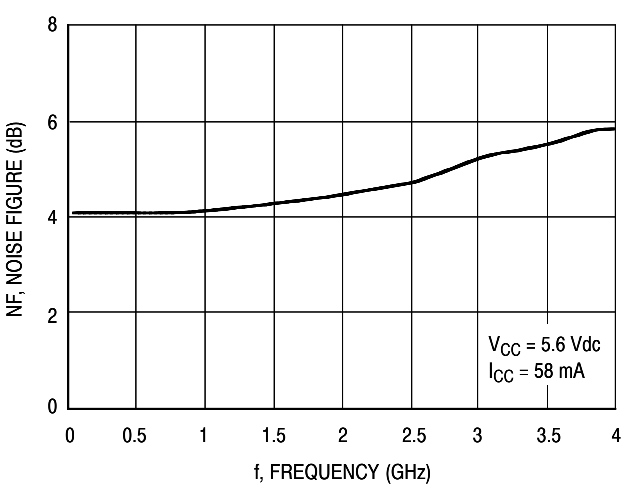


Figure 12. Noise Figure versus Frequency

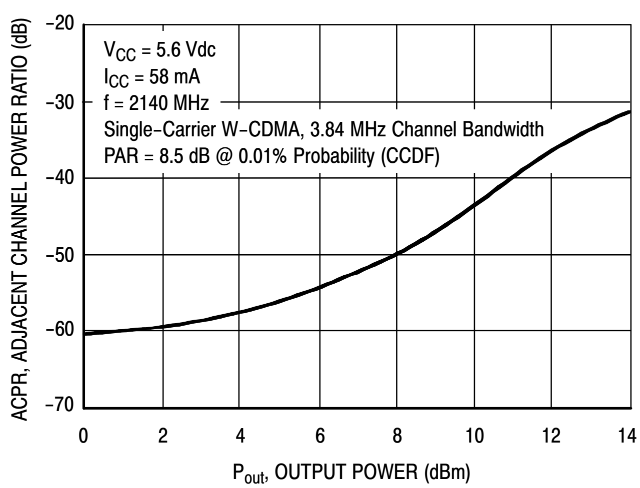
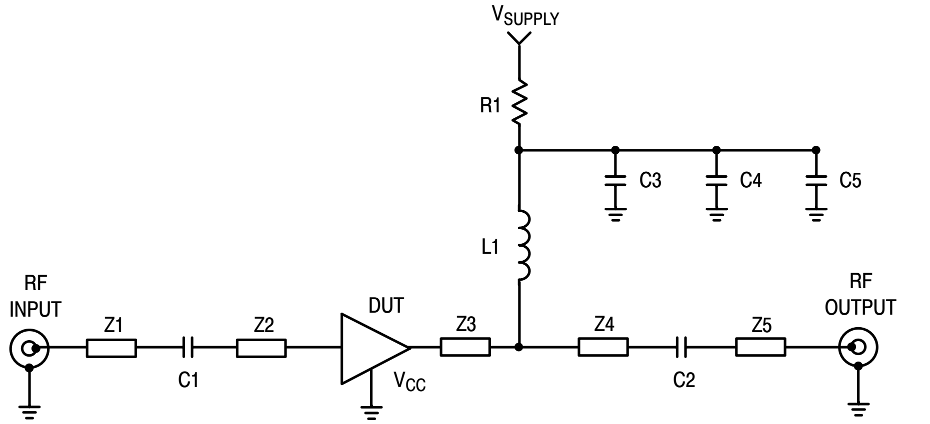


Figure 13. Single-Carrier W-CDMA Adjacent Channel Power Ratio versus Output Power

50 OHM APPLICATION CIRCUIT: 40-800 MHz



Z1, Z5	0.347″ x 0.058″ Microstrip	Z4	0.403″ x 0.058″ Microstrip
Z2	0.575″ x 0.058″ Microstrip	PCB	Getek Grade ML200C, 0.031″, ε_r = 4.1
Z3	0.172″ x 0.058″ Microstrip		

Figure 14. 50 Ohm Test Circuit Schematic

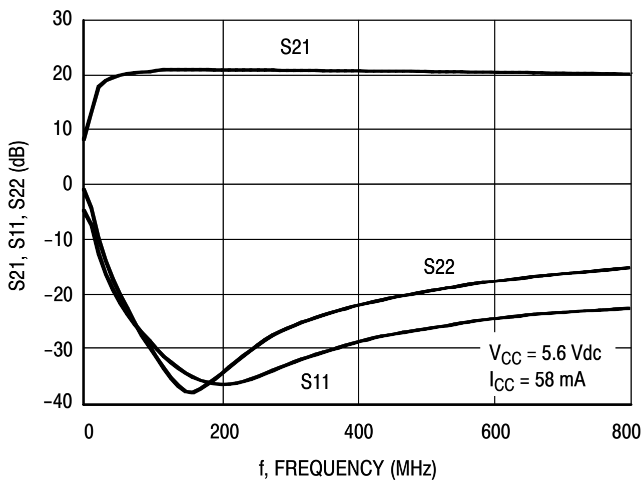


Figure 15. S21, S11 and S22 versus Frequency

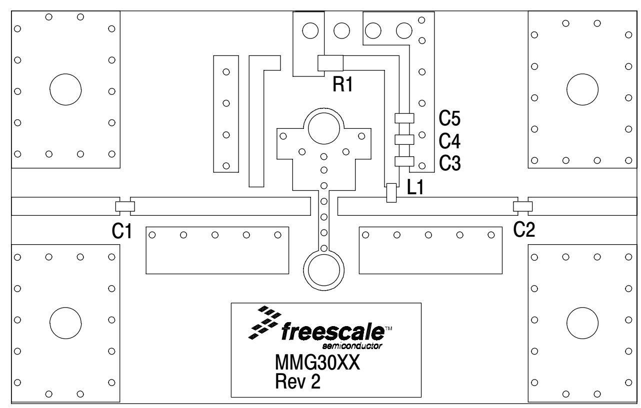


Figure 16. 50 Ohm Test Circuit Component Layout

Table 8. 50 Ohm Test Circuit Component Designations and Values

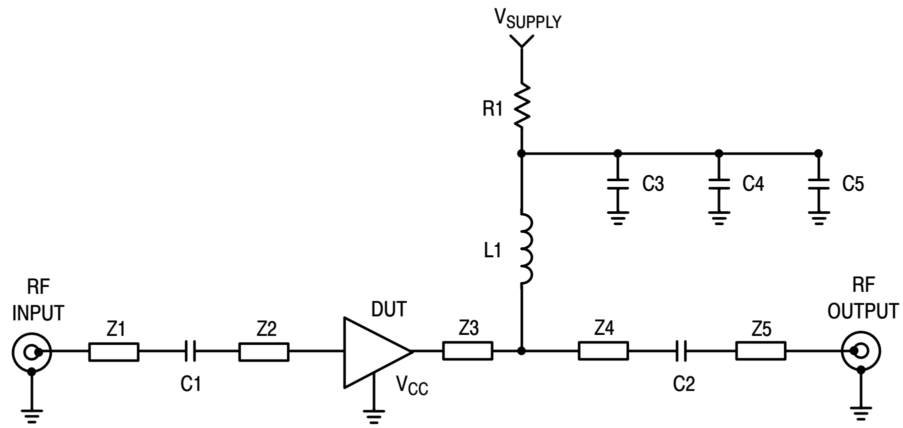
Part	Description	Part Number	Manufacturer
C1, C2, C3	0.01 μF Chip Capacitors	C0603C103J5RAC	Kemet
C4	1000 pF Chip Capacitor	C0603C102J5RAC	Kemet
C5	47 pF Chip Capacitor	C0805C470J5RAC	Kemet
L1	470 nH Chip Inductor	BK2125HM471-T	Taiyo Yuden
R1	8.2 Ω Chip Resistor	RK73B2ATTE8R2J	KOA Speer

Table 9. Supply Voltage versus R1 Values

Supply Voltage	6	7	8	9	10	11	12	V
R1 Value	6.9	24	41	59	76	93	110	Ω

Note: To provide V_{CC} = 5.6 Vdc and I_{CC} = 58 mA at the device.

50 OHM APPLICATION CIRCUIT: 800-3600 MHz



Z1, Z5	0.347″ x 0.058″ Microstrip	Z4	0.403″ x 0.058″ Microstrip
Z2	0.575″ x 0.058″ Microstrip	PCB	Getek Grade ML200C, 0.031″, ε_r = 4.1
Z3	0.172″ x 0.058″ Microstrip		

Figure 17. 50 Ohm Test Circuit Schematic

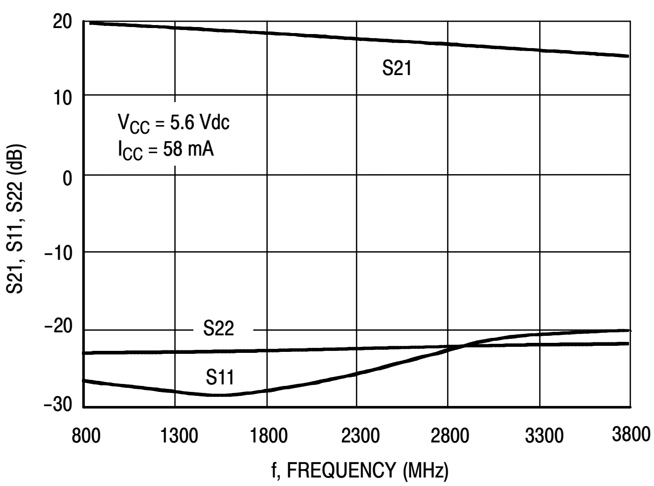


Figure 18. S21, S11 and S22 versus Frequency

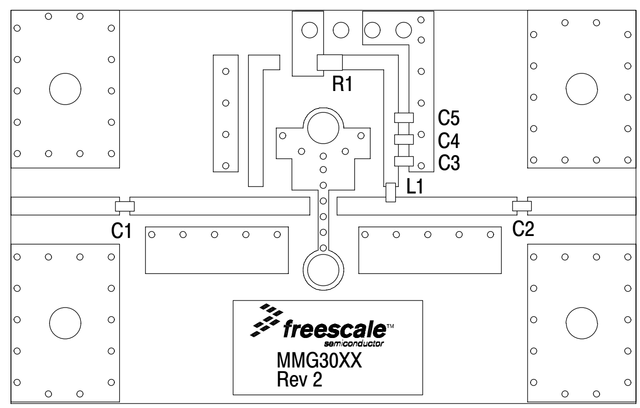


Figure 19. 50 Ohm Test Circuit Component Layout

Table 10. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	39 pF Chip Capacitors	C0805C390J5RAC	Kemet
C3	0.01 μF Chip Capacitor	C0603C103J5RAC	Kemet
C4	1000 pF Chip Capacitor	C0603C102J5RAC	Kemet
C5	47 pF Chip Capacitor	C0805C470J5RAC	Kemet
L1	56 nH Chip Inductor	HK160856NJ-T	Taiyo Yuden
R1	8.2 Ω Chip Resistor	RK73B2ATTE8R2J	KOA Speer

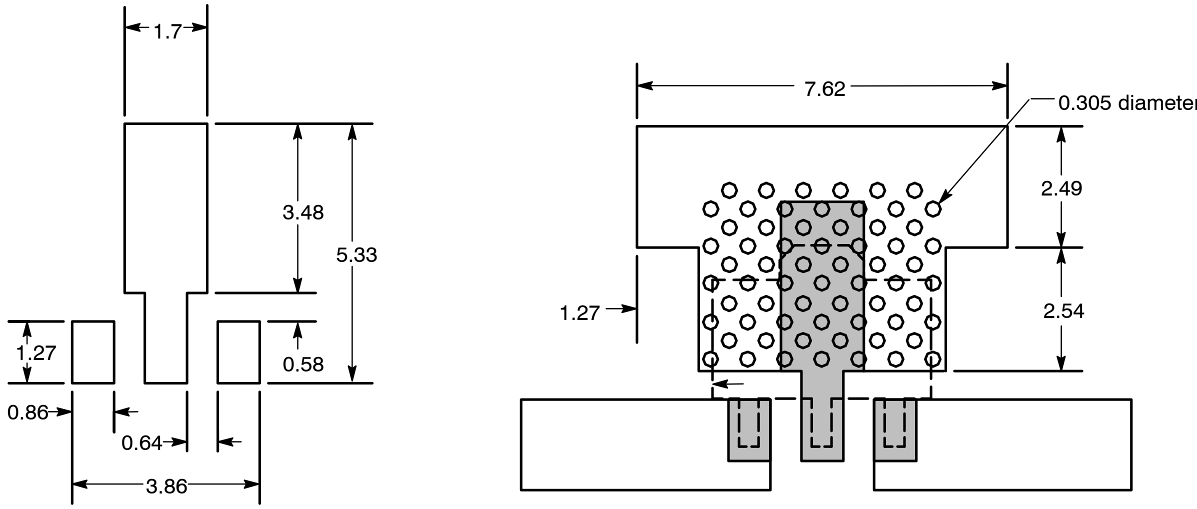
50 OHM TYPICAL CHARACTERISTICS

Table 11. Class A Common Emitter S-Parameters at V_{CC} = 5.6 Vdc, I_{CC} = 58 mA, T_C = 25°C

f GHz	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
0.1	0.01837	0.158	10.80154	176.164	0.06918	0.196	0.04789	11.134
0.15	0.00937	-92.445	10.61985	173.508	0.06785	-0.796	0.05071	-49.334
0.2	0.02263	96.518	11.06276	170.083	0.07095	-2.253	0.07322	-17.196
0.25	0.02049	101.715	10.97614	167.952	0.07046	-2.513	0.06689	-28.31
0.3	0.02015	91.299	10.93416	165.552	0.07052	-2.899	0.07111	-35.935
0.35	0.01939	77.961	10.89886	163.145	0.07044	-3.499	0.07696	-41.106
0.4	0.0212	71.36	10.85777	160.903	0.07055	-3.885	0.08093	-47.831
0.45	0.02169	63.516	10.81348	158.599	0.07053	-4.455	0.08609	-52.772
0.5	0.02447	55.112	10.76682	156.269	0.07056	-4.766	0.09084	-57.016
0.55	0.02643	49.889	10.71841	154.026	0.07058	-5.297	0.09479	-60.897
0.6	0.02857	47.303	10.67367	151.767	0.07057	-5.783	0.09752	-65.139
0.65	0.03094	43.937	10.61782	149.477	0.07066	-6.195	0.1016	-69.112
0.7	0.03356	42.055	10.56473	147.215	0.07064	-6.702	0.10489	-72.747
0.75	0.03495	40.001	10.50489	144.98	0.07073	-7.082	0.10746	-76.469
0.8	0.03599	38.298	10.44613	142.748	0.07084	-7.625	0.11046	-80.336
0.85	0.03675	36.713	10.38955	140.536	0.07089	-8.108	0.11345	-84.309
0.9	0.0378	34.449	10.32195	138.333	0.07106	-8.539	0.11524	-88.629
0.95	0.04014	35.697	10.26867	136.075	0.07101	-8.95	0.11712	-93.045
1	0.03975	34.93	10.19351	133.939	0.07128	-9.497	0.11971	-97.401
1.05	0.04101	35.048	10.13374	131.742	0.07142	-10.015	0.12057	-101.389
1.1	0.0413	34.972	10.05555	129.606	0.07148	-10.588	0.12293	-106.494
1.15	0.04078	36.31	9.98381	127.42	0.07156	-10.989	0.12475	-111.339
1.2	0.04045	38.732	9.90685	125.299	0.07171	-11.51	0.12702	-115.996
1.25	0.04005	39.914	9.83535	123.178	0.07179	-12.025	0.12882	-120.553
1.3	0.03952	43.011	9.76304	121.077	0.07197	-12.554	0.13202	-125.245
1.35	0.03786	44.538	9.68157	118.951	0.07208	-13.057	0.13502	-129.596
1.4	0.03796	46.354	9.60628	116.874	0.07224	-13.606	0.13836	-133.849
1.45	0.03675	48.792	9.52474	114.777	0.07243	-14.151	0.14227	-138.332
1.5	0.03229	27.259	9.45514	112.739	0.07269	-14.685	0.13499	-140.027
1.55	0.03309	25.231	9.36984	110.697	0.0728	-15.204	0.13808	-143.203
1.6	0.03475	23.271	9.29518	108.724	0.07296	-15.823	0.14111	-146.041
1.65	0.0367	22.494	9.2159	106.764	0.07327	-16.372	0.14376	-149.267
1.7	0.03803	21.485	9.15729	104.763	0.07341	-16.955	0.14728	-152.506
1.75	0.03976	21.793	9.07502	102.811	0.07361	-17.538	0.14882	-155.031
1.8	0.04035	21.332	9.00137	100.821	0.07373	-18.047	0.15301	-157.889
1.85	0.04093	21.941	8.92666	98.873	0.07383	-18.59	0.15553	-160.786
1.9	0.0409	20.661	8.84934	96.931	0.07407	-19.216	0.1587	-163.24
1.95	0.04127	17.824	8.75854	95.008	0.07433	-19.75	0.1617	-165.666
2	0.04055	20.129	8.69148	93.046	0.07451	-20.324	0.1659	-168.355
2.05	0.04148	18.841	8.6161	91.185	0.07482	-20.966	0.16929	-170.838
2.1	0.04198	18.596	8.5446	89.293	0.07498	-21.435	0.17351	-173.6
2.15	0.04249	18.599	8.47505	87.398	0.07512	-22.217	0.17715	-176.054
2.2	0.04309	19.388	8.39794	85.501	0.07543	-22.79	0.18032	-178.865
2.25	0.04316	19.789	8.32788	83.624	0.0756	-23.41	0.18422	178.51
2.3	0.04326	21.542	8.24837	81.777	0.07591	-24.034	0.1871	175.803
2.35	0.04285	23.93	8.17883	79.926	0.0761	-24.632	0.19081	173.166

Table 11. Class A Common Emitter S-Parameters at V_{CC} = 5.6 Vdc, I_{CC} = 58 mA, T_C = 25°C (continued)

f GHz	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
2.4	0.0428	25.661	8.10402	78.094	0.07638	-25.226	0.19358	170.371
2.45	0.04222	28.349	8.0349	76.296	0.07665	-25.841	0.19769	167.872
2.5	0.04157	30.594	7.96381	74.438	0.07693	-26.474	0.20079	164.997
2.55	0.04062	32.718	7.89112	72.648	0.07715	-27.199	0.20422	162.204
2.6	0.04117	35.498	7.83503	70.815	0.07744	-27.904	0.20869	159.371
2.65	0.0407	39.668	7.76263	69.011	0.07768	-28.528	0.21293	156.39
2.7	0.04099	40.736	7.68838	67.13	0.07806	-29.281	0.21614	153.567
2.75	0.04248	44.129	7.62088	65.378	0.07826	-29.943	0.22114	150.373
2.8	0.04329	47.509	7.55264	63.561	0.0785	-30.741	0.226	147.517
2.85	0.04466	51.043	7.48275	61.767	0.07867	-31.392	0.23048	144.417
2.9	0.04661	53.041	7.41535	60.019	0.07893	-32.182	0.23581	141.675
2.95	0.04876	57.415	7.34593	58.235	0.07915	-32.903	0.24106	138.661
3	0.04991	59.701	7.28251	56.493	0.07945	-33.641	0.24698	136.002
3.05	0.05208	61.593	7.21536	54.703	0.07976	-34.4	0.25213	133.272
3.1	0.05426	64.102	7.1502	52.913	0.07989	-35.181	0.25854	130.712
3.15	0.05536	65.235	7.08162	51.15	0.08017	-35.962	0.26426	128.119
3.2	0.05758	65.884	7.01653	49.405	0.08027	-36.771	0.27078	125.669
3.25	0.06021	66.564	6.94732	47.655	0.08054	-37.539	0.27729	123.284
3.3	0.06243	66.702	6.88222	45.916	0.08071	-38.36	0.28468	120.844
3.35	0.06498	65.787	6.81808	44.235	0.08097	-39.051	0.29005	118.633
3.4	0.06832	65.869	6.75612	42.521	0.08112	-39.867	0.29718	116.391
3.45	0.07049	65.731	6.69433	40.809	0.08128	-40.621	0.3026	114.187
3.5	0.07294	65.097	6.63494	39.085	0.08144	-41.453	0.30819	112.291
3.55	0.07565	65.299	6.57111	37.382	0.08171	-42.369	0.31389	110.431
3.6	0.07682	64.978	6.51018	35.707	0.08186	-43.091	0.31878	108.662

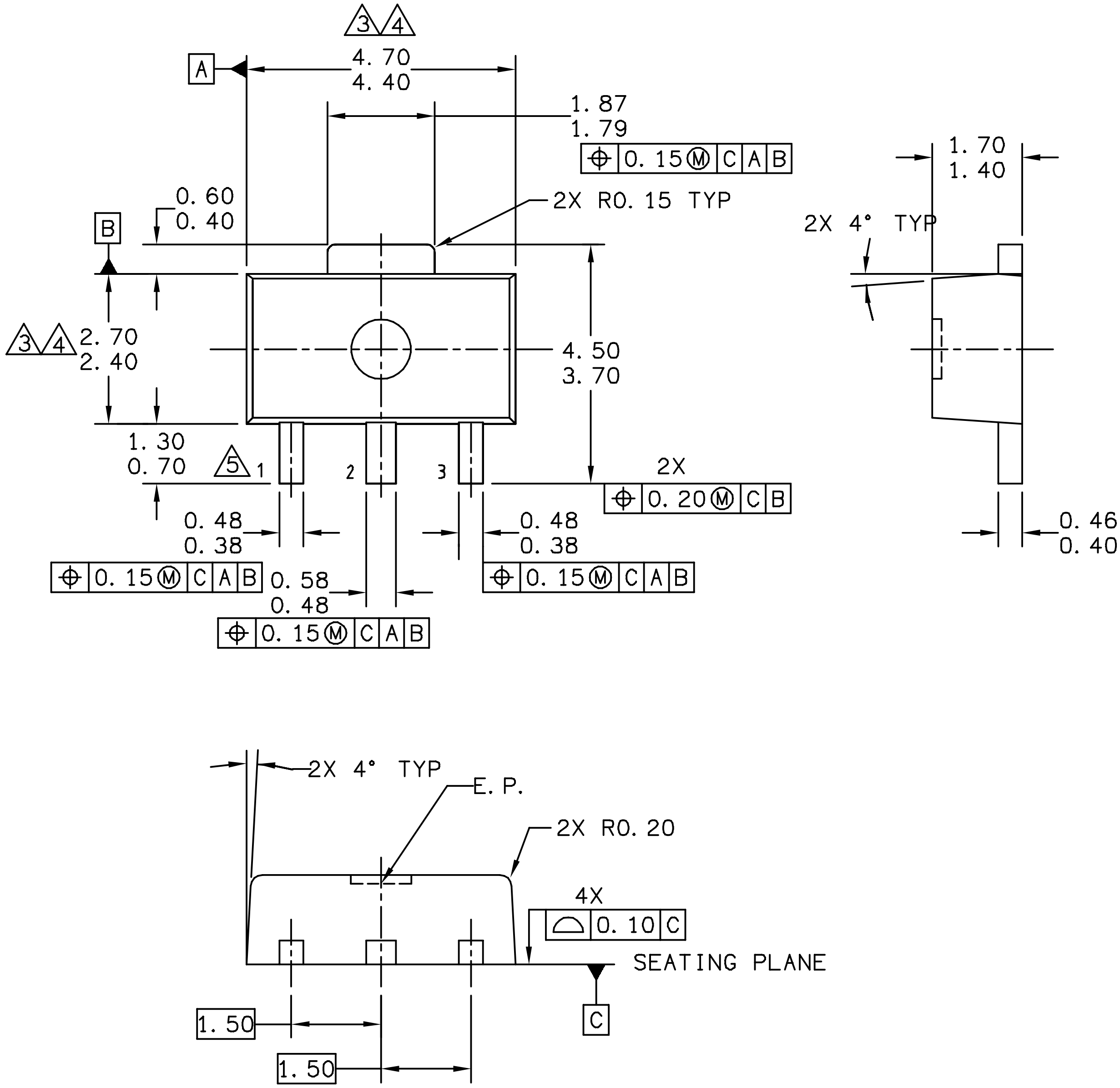


Recommended Solder Stencil

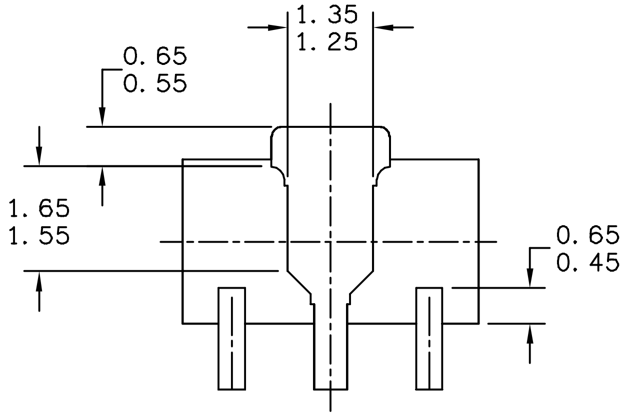
NOTES:
1. THERMAL AND RF GROUNDING CONSIDERATIONS SHOULD BE USED IN PCB LAYOUT DESIGN.
2. DEPENDING ON PCB DESIGN RULES, AS MANY VIAS AS POSSIBLE SHOULD BE PLACED ON THE LANDING PATTERN.
3. IF VIAS CANNOT BE PLACED ON THE LANDING PATTERN, THEN AS MANY VIAS AS POSSIBLE SHOULD BE PLACED AS CLOSE TO THE LANDING PATTERN AS POSSIBLE FOR OPTIMAL THERMAL AND RF PERFORMANCE.
4. RECOMMENDED VIA PATTERN SHOWN HAS 0.381 x 0.762 MM PITCH.

Figure 20. Recommended Mounting Configuration

PACKAGE DIMENSIONS



© FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED.	**MECHANICAL OUTLINE**	PRINT VERSION NOT TO SCALE
TITLE: SOT−89, 4 LEAD, 4.5 X 2.5 PKG, 1.5 MM PITCH	DOCUMENT NO: 98ASA10586D	REV: D
	CASE NUMBER: 1514−02	27 JUN 2007
	STANDARD: NON−JEDEC	



BOTTOM VIEW

CASE STYLE:

STYLE 1:		STYLE 2:	
PIN 1.	RF INPUT	PIN 1.	GATE
PIN 2.	GROUND	PIN 2.	SOURCE
PIN 3.	RF OUTPUT	PIN 3.	DRAIN

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
TITLE: SOT-89, 4 LEAD, 4.5 X 2.5 PKG, 1.5 MM PITCH	DOCUMENT NO: 98ASA10586D	REV: D
	CASE NUMBER: 1514-02	27 JUN 2007
	STANDARD: NON-JEDEC	

NOTES:

1 DIMENSIONING AND TOLERANCING PER ASME Y14.5M — 1994.

2 ALL DIMENSIONS ARE IN MILLIMETERS.

3 DIMENSIONS DOES NOT INCLUDE MOLD FLASH. PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.5mm PER END. DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.5 mm PER SIDE.

4 DIMENSION ARE DETERMINED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY EXCLUSIVE OF MOLD FLASH, TIE BAR BURRS, GATE BURRS AND INTERLEAD FLASH, BUT INCLUDING ANY MISMATCH BETWEEN THE TOP AND BOTTOM OF THE PLASTIC BODY.

5 TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE	
TITLE: SOT–89, 4 LEAD, 4.5 X 2.5 PKG, 1.5 MM PITCH	DOCUMENT NO: 98ASA10586D		REV: D
	CASE NUMBER: 1514–02		27 JUN 2007
	STANDARD: NON-JEDEC		

PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers
- AN3100: General Purpose Amplifier Biasing

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
5	Mar. 2007	• Corrected and updated Part Numbers in Tables 8 and 10, Component Designations and Values, to RoHS compliant part numbers, p. 6, 7
6	July 2007	• Replaced Case Outline 1514-01 with 1514-02, Issue D, p. 1, 11-13. Case updated to add missing dimension for Pin 1 and Pin 3.

How to Reach Us:

Home Page:
www.freescale.com

Web Support:
http://www.freescale.com/support

USA/Europe or Locations Not Listed:
Freescale Semiconductor, Inc.
Technical Information Center, EL516
2100 East Elliot Road
Tempe, Arizona 85284
+1-800-521-6274 or +1-480-768-2130
www.freescale.com/support

Europe, Middle East, and Africa:
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
www.freescale.com/support

Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor Hong Kong Ltd.
Technical Information Center
2 Dai King Street
Tai Po Industrial Estate
Tai Po, N.T., Hong Kong
+800 2666 8080
support.asia@freescale.com

For Literature Requests Only:
Freescale Semiconductor Literature Distribution Center
P.O. Box 5405
Denver, Colorado 80217
1-800-441-2447 or 303-675-2140
Fax: 303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com

freescale™ semiconductor

Document Number: MMG3001NT1
Rev. 6, 7/2007