Freescale Semiconductor
Technical Data

Document Number: MMG3014NT1
Rev. 0, 4/2008

Heterojunction Bipolar Transistor Technology (InGaP HBT)

Broadband High Linearity Amplifier

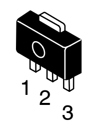
The MMG3014NT1 is a General Purpose Amplifier that is internally input matched and internally output prematched. It is designed for a broad range of Class A, small-signal, high linearity, general purpose applications. It is suitable for applications with frequencies from 40 to 4000 MHz such as Cellular, PCS, BWA, WLL, PHS, CATV, VHF, UHF, UMTS and general small-signal RF.

Features

- Frequency: 40-4000 MHz
- P1dB: 25 dBm @ 900 MHz
- Small-Signal Gain: 19.5 dB @ 900 MHz
- Third Order Output Intercept Point: 40.5 dBm @ 900 MHz
- Single 5 Volt Supply
- Active Bias
- Low Cost SOT-89 Surface Mount Package
- RoHS Compliant
- In Tape and Reel. T1 Suffix = 1,000 Units per 12 mm, 7 inch Reel.

MMG3014NT1

40-4000 MHz, 19.5 dB
25 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	19.5	15	10	dB
Input Return Loss (S11)	IRL	-25	-12	-8	dB
Output Return Loss (S22)	ORL	-11	-13	-19	dB
Power Output @1dB Compression	P1db	25	25.8	25	dBm
Third Order Output Intercept Point	IP3	40.5	40.5	40	dBm

1. V_{CC} = 5 Vdc, T_C = 25°C, 50 ohm system

Table 2. Maximum Ratings

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	6	V
Supply Current	I_{CC}	300	mA
RF Input Power	P_{in}	15	dBm
Storage Temperature Range	T_{stg}	-65 to +150	°C
Junction Temperature (2)	T_J	150	°C

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

Table 3. Thermal Characteristics (V_{CC} = 5 Vdc, I_{CC} = 135 mA, T_C = 25°C)

Characteristic	Symbol	Value (3)	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	27.4	°C/W

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

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Table 4. Electrical Characteristics (V_{CC} = 5 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	18.5	19.5	—	dB
Input Return Loss (S11)	IRL	—	-25	—	dB
Output Return Loss (S22)	ORL	—	-11	—	dB
Power Output @ 1dB Compression	P1dB	—	25	—	dBm
Third Order Output Intercept Point	IP3	—	40.5	—	dBm
Noise Figure	NF	—	5.7	—	dB
Supply Current (1)	I_{CC}	110	135	160	mA
Supply Voltage (1)	V_{CC}	—	5	—	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

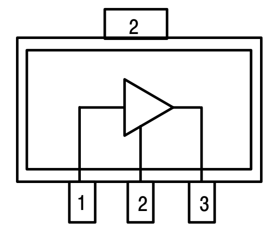


Figure 1. Functional Diagram

Table 6. ESD Protection Characteristics

Test Conditions/Test Methodology	Class
Human Body Model (per JESD 22-A114)	1C (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

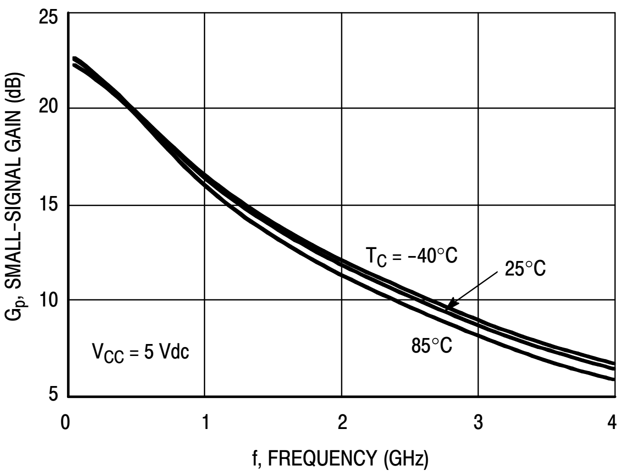


Figure 2. Small-Signal Gain (S21) versus Frequency

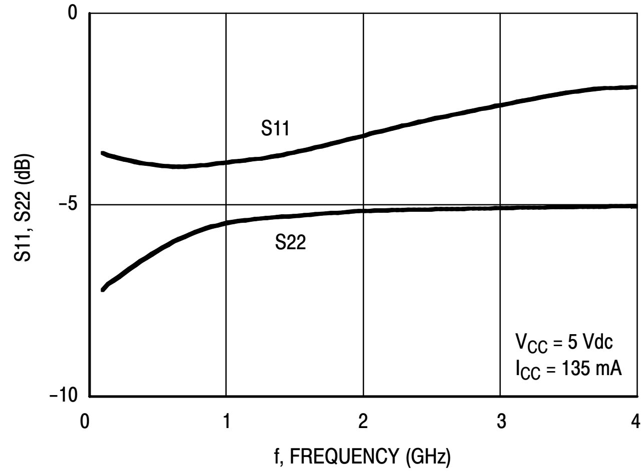


Figure 3. Input/Output Return Loss versus Frequency

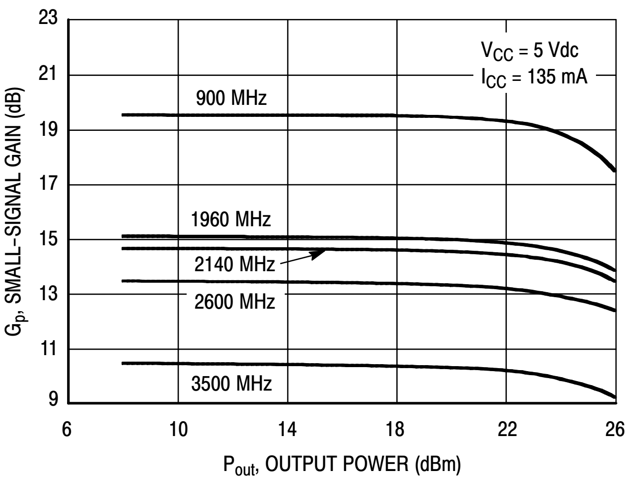


Figure 4. Small-Signal Gain versus Output Power

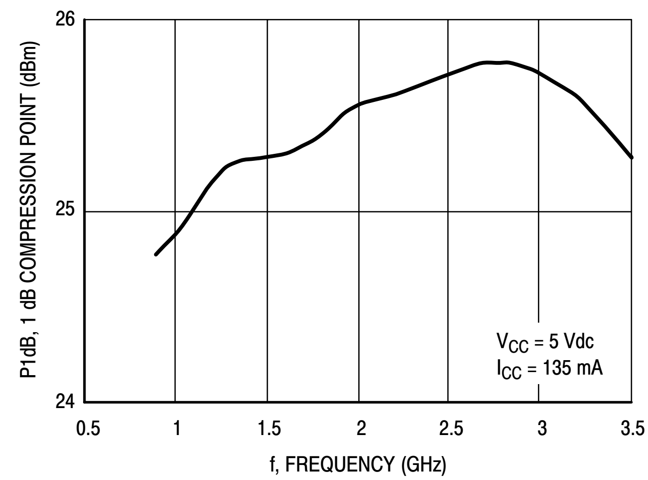


Figure 5. P1dB versus Frequency

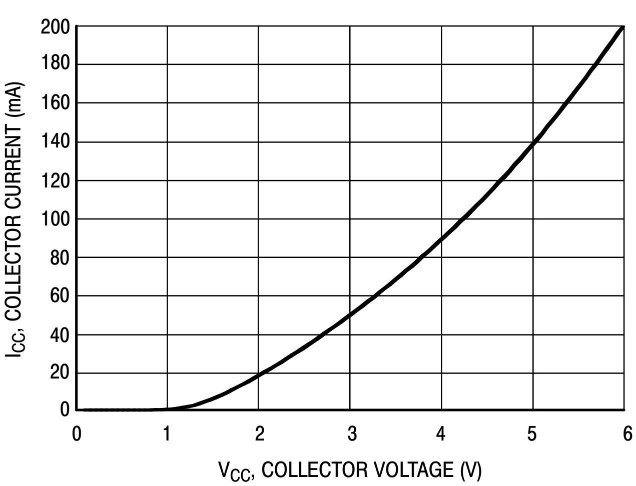


Figure 6. Collector Current versus Collector Voltage

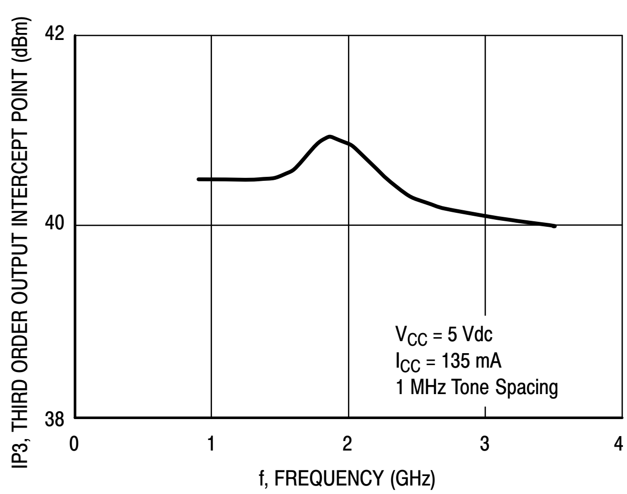


Figure 7. Third Order Output Intercept Point versus Frequency

50 OHM TYPICAL CHARACTERISTICS

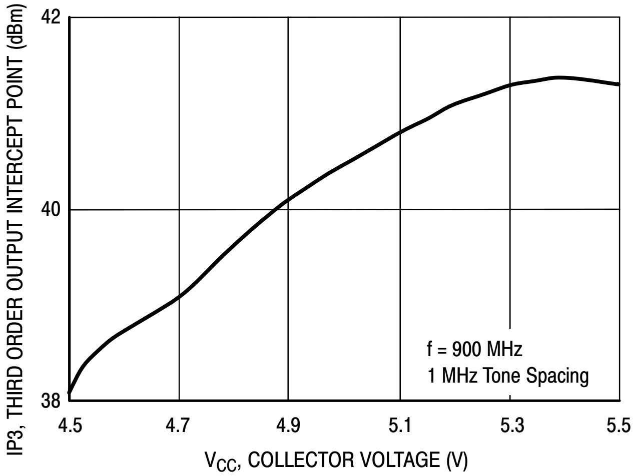


Figure 8. Third Order Output Intercept Point versus Collector Voltage

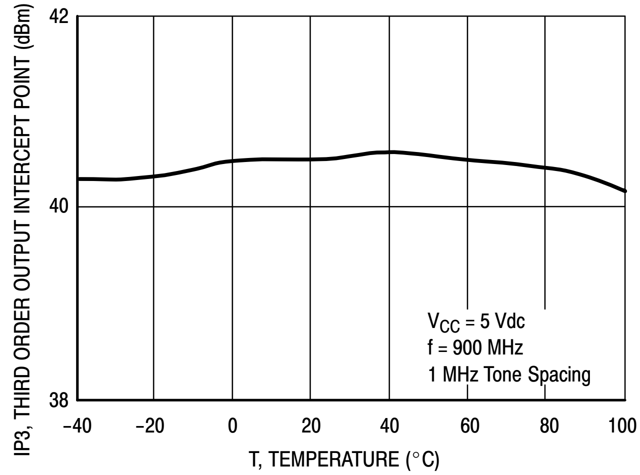


Figure 9. Third Order Output Intercept Point versus Case Temperature

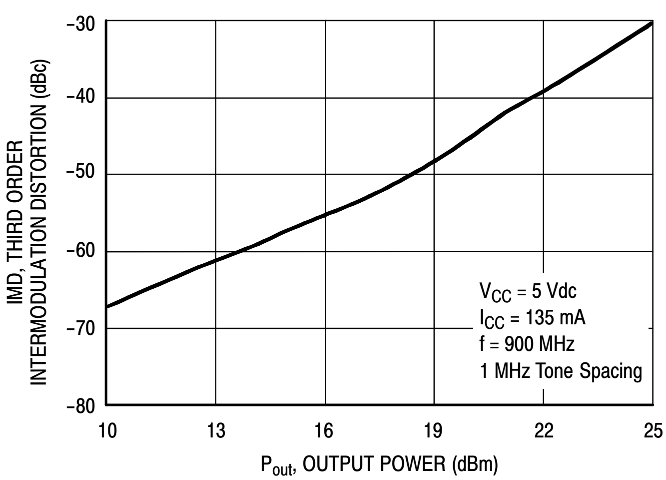
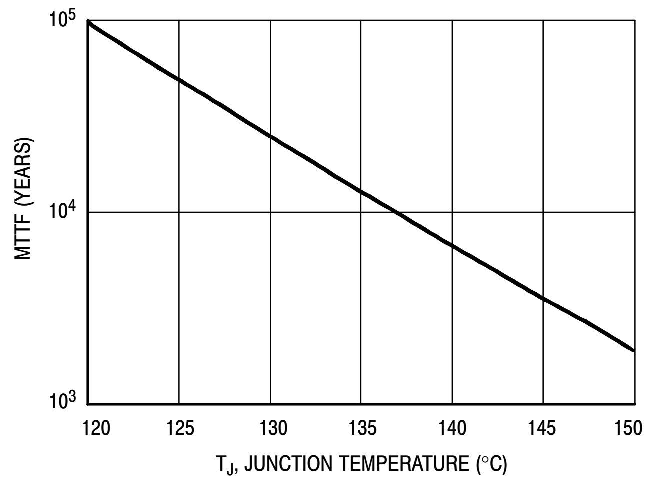


Figure 10. Third Order Intermodulation versus Output Power



NOTE: The MTTF is calculated with V_{CC} = 5 Vdc, I_{CC} = 135 mA

Figure 11. MTTF versus Junction Temperature

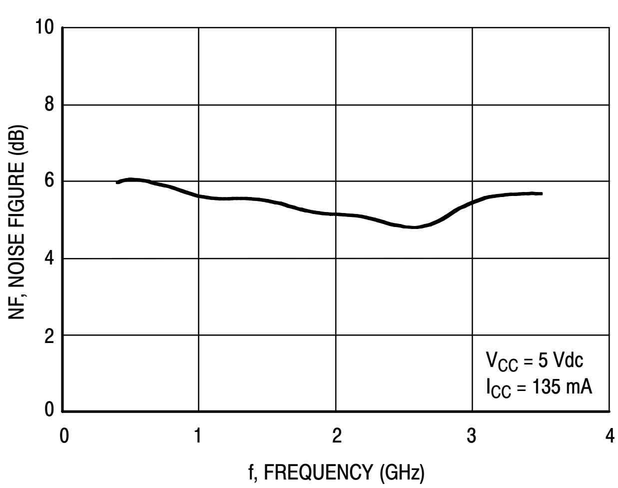


Figure 12. Noise Figure versus Frequency

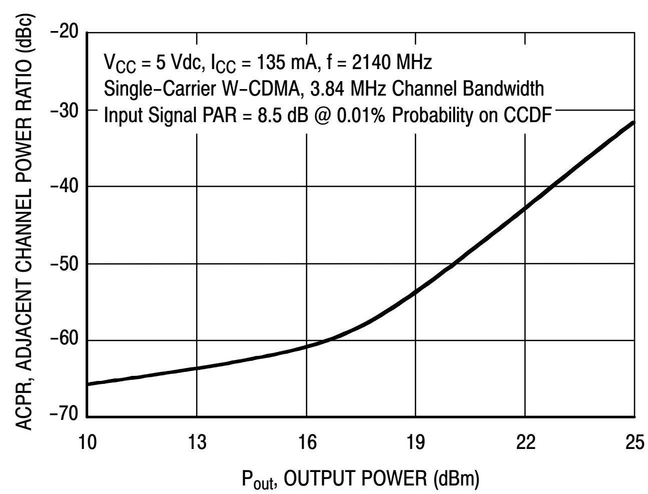
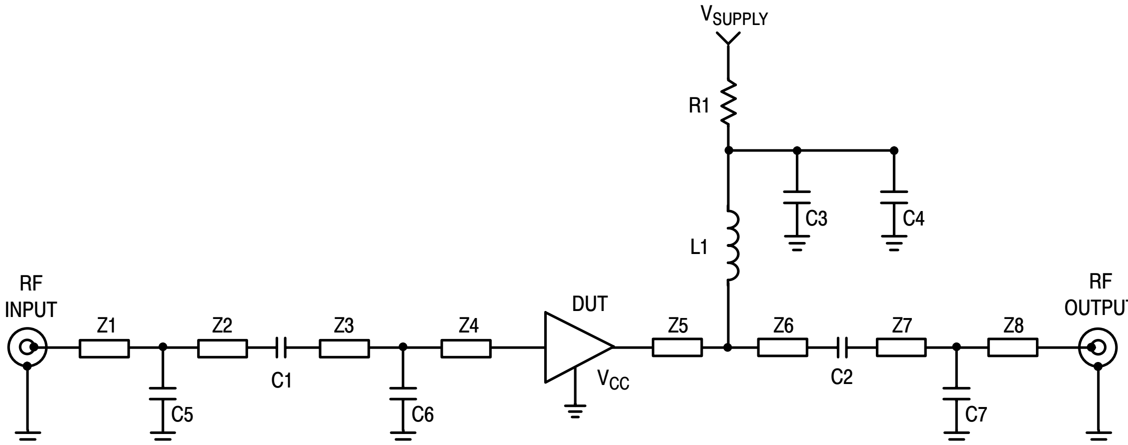


Figure 13. Single-Carrier W-CDMA Adjacent Channel Power Ratio versus Output Power

50 OHM APPLICATION CIRCUIT: 800-1000 MHz



Z1, Z8	0.274″ x 0.058″ Microstrip	Z5	0.172″ x 0.058″ Microstrip
Z2, Z7	0.073″ x 0.058″ Microstrip	Z6	0.403″ x 0.058″ Microstrip
Z3	0.066″ x 0.058″ Microstrip	PCB	Getek Grade ML200C, 0.031″, ε_r = 4.1
Z4	0.509″ x 0.058″ Microstrip		

Figure 14. 50 Ohm Test Circuit Schematic

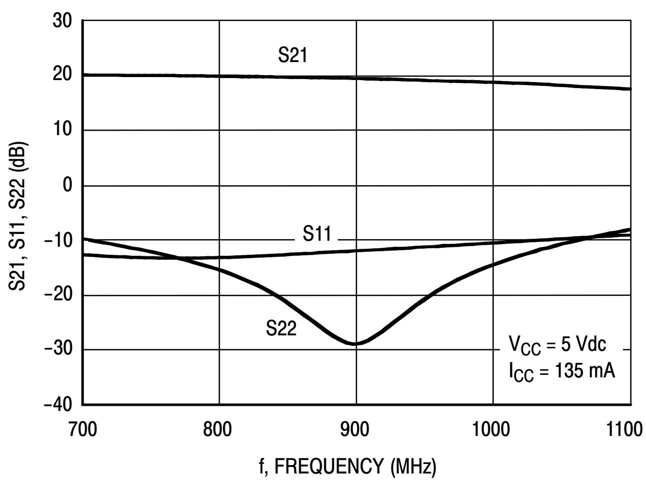


Figure 15. S21, S11 and S22 versus Frequency

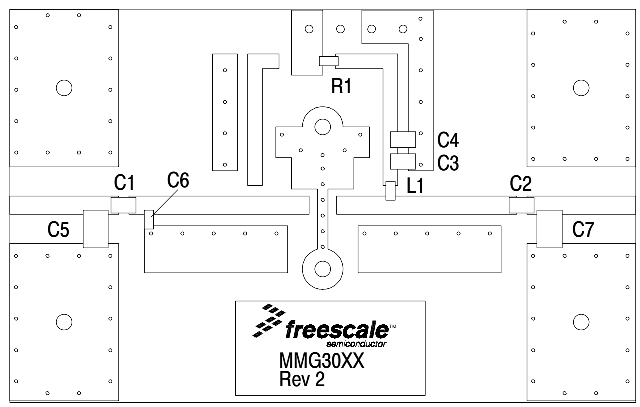
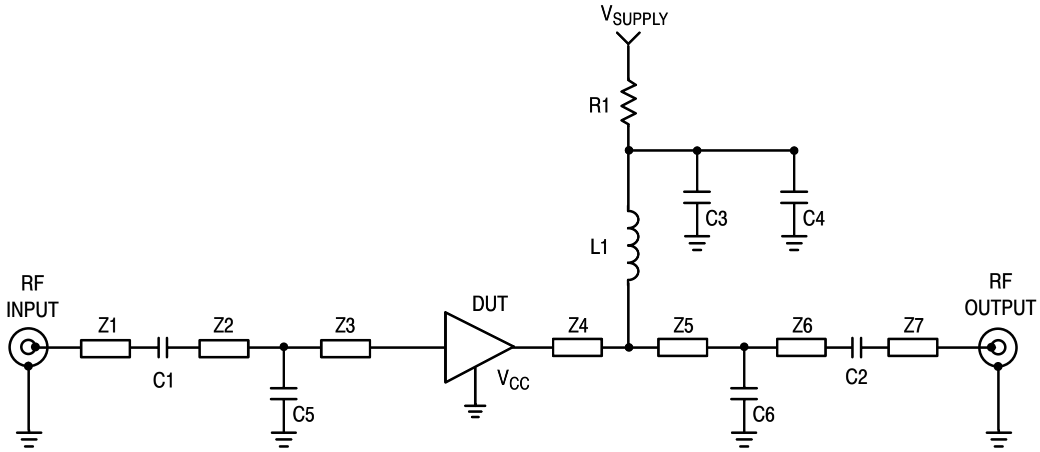


Figure 16. 50 Ohm Test Circuit Component Layout

Table 8. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	220 pF Chip Capacitors	C0805C221J5GAC	Kemet
C3	0.1 μF Chip Capacitor	C0603C104J5RAC	Kemet
C4	2.2 μF Chip Capacitor	C0805C225J4RAC	Kemet
C5	0.2 pF Chip Capacitor	12065J0R2BS	AVX
C6	4.7 pF Chip Capacitor	C0603C479J5GAC	Kemet
C7	1.8 pF Chip Capacitor	C0603C189J5GAC	Kemet
L1	10 nH Chip Inductor	HK160810NJ-T	Taiyo Yuden
R1	0 Ω Chip Resistor	ERJ3GEY0R00V	Panasonic

50 OHM APPLICATION CIRCUIT: 1800-2200 MHz



Z1, Z7	0.347″ x 0.058″ Microstrip	Z5	0.162″ x 0.058″ Microstrip
Z2	0.399″ x 0.058″ Microstrip	Z6	0.241″ x 0.058″ Microstrip
Z3	0.176″ x 0.058″ Microstrip	PCB	Getek Grade ML200C, 0.031″, ε_r = 4.1
Z4	0.172″ x 0.058″ Microstrip		

Figure 17. 50 Ohm Test Circuit Schematic

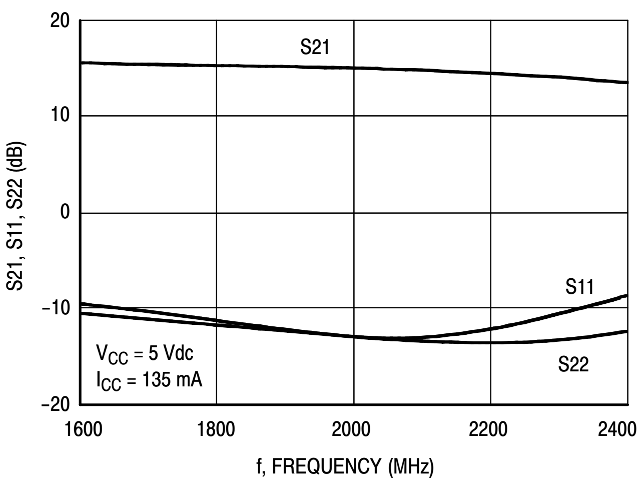


Figure 18. S21, S11 and S22 versus Frequency

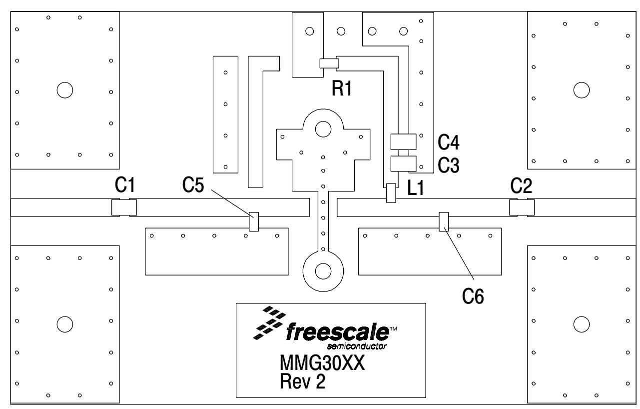
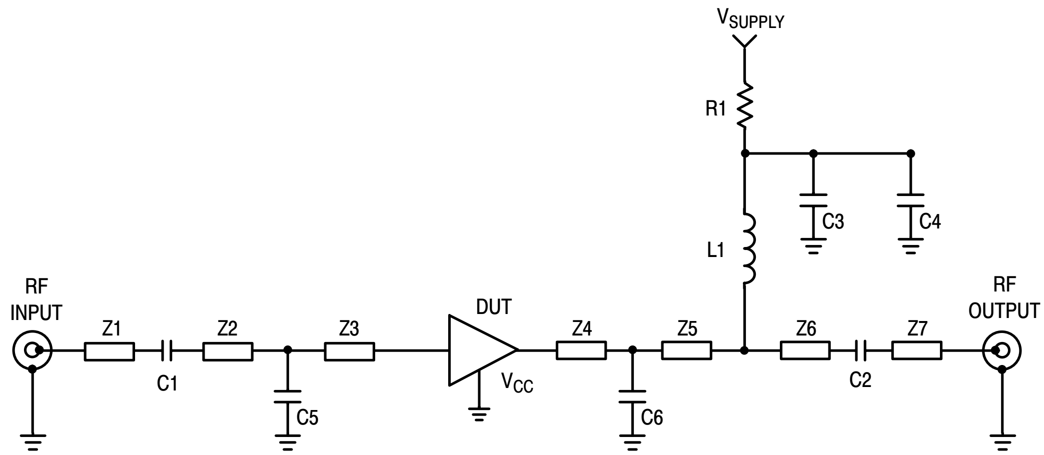


Figure 19. 50 Ohm Test Circuit Component Layout

Table 9. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	22 pF Chip Capacitors	C0805C220J5GAC	Kemet
C3	0.1 μF Chip Capacitor	C0603C104J5RAC	Kemet
C4	2.2 μF Chip Capacitor	C0805C225J4RAC	Kemet
C5	1.5 pF Chip Capacitor	C0603C159J5RAC	Kemet
C6	1.1 pF Chip Capacitor	C0603C119J5GAC	Kemet
L1	15 nH Chip Inductor	HK160815NJ-T	Taiyo Yuden
R1	0 Ω Chip Resistor	ERJ3GEY0R00V	Panasonic

50 OHM APPLICATION CIRCUIT: 2300-2700 MHz



Z1, Z7	0.347″ x 0.058″ Microstrip	Z5	0.036″ x 0.058″ Microstrip
Z2	0.488″ x 0.058″ Microstrip	Z6	0.403″ x 0.058″ Microstrip
Z3	0.087″ x 0.058″ Microstrip	PCB	Getek Grade ML200C, 0.031″, ε_r = 4.1
Z4	0.136″ x 0.058″ Microstrip		

Figure 20. 50 Ohm Test Circuit Schematic

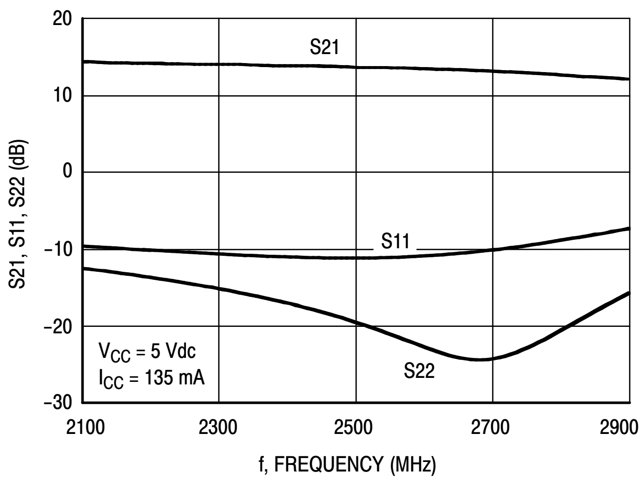


Figure 21. S21, S11 and S22 versus Frequency

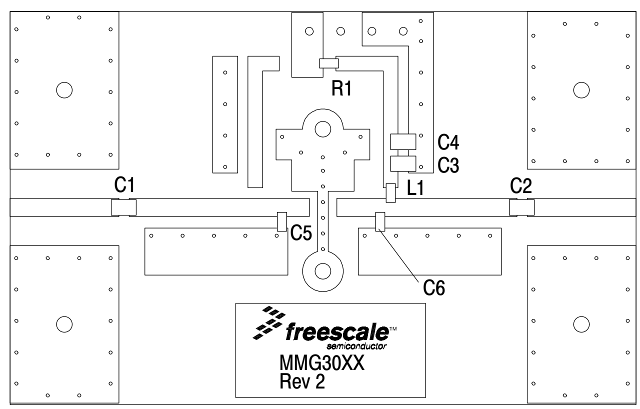
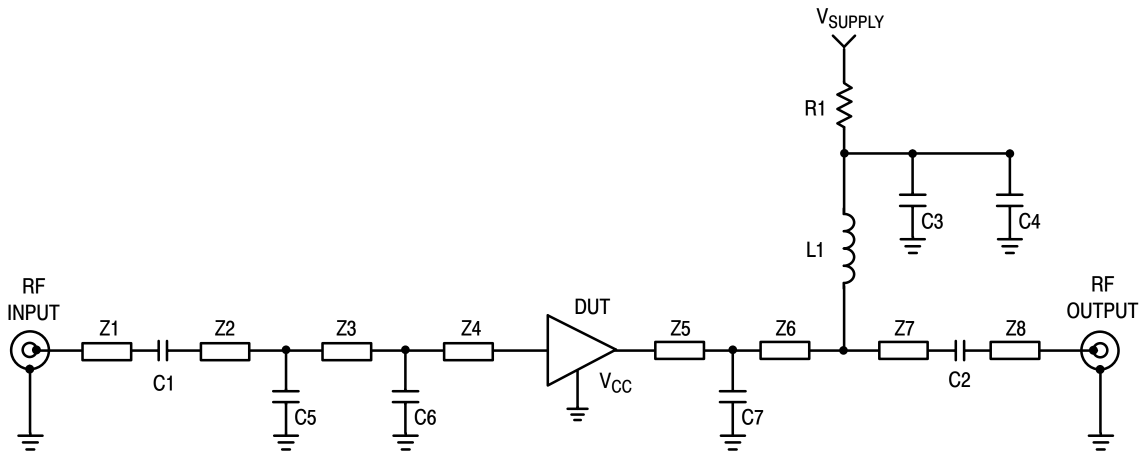


Figure 22. 50 Ohm Test Circuit Component Layout

Table 10. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	22 pF Chip Capacitors	C0805C220J5GAC	Kemet
C3	0.1 μF Chip Capacitor	C0603C104J5RAC	Kemet
C4	2.2 μF Chip Capacitor	C0805C225J4RAC	Kemet
C5, C6	1.1 pF Chip Capacitors	C0603C119J5GAC	Kemet
L1	15 nH Chip Inductor	HK160815NJ-T	Taiyo Yuden
R1	0 Ω Chip Resistor	ERJ3GEY0R00V	Panasonic

50 OHM APPLICATION CIRCUIT: 3400-3600 MHz



Z1, Z8	0.347″ x 0.058″ Microstrip	Z6	0.084″ x 0.058″ Microstrip
Z2	0.068″ x 0.058″ Microstrip	Z7	0.403″ x 0.058″ Microstrip
Z3	0.419″ x 0.058″ Microstrip	PCB	Getek Grade ML200C, 0.031″, ε_r = 4.1
Z4, Z5	0.088″ x 0.058″ Microstrip		

Figure 23. 50 Ohm Test Circuit Schematic

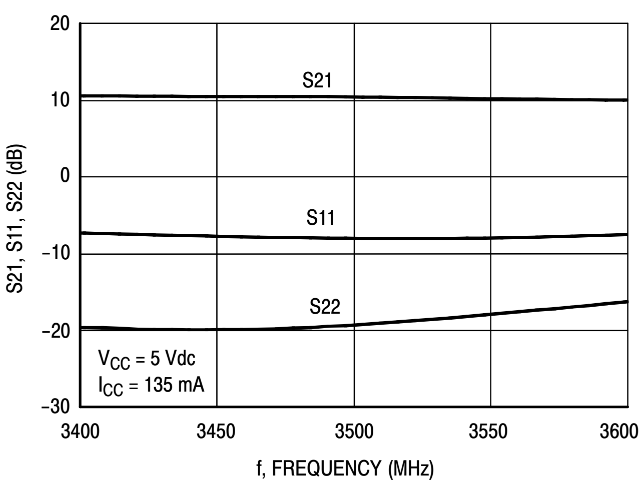


Figure 24. S21, S11 and S22 versus Frequency

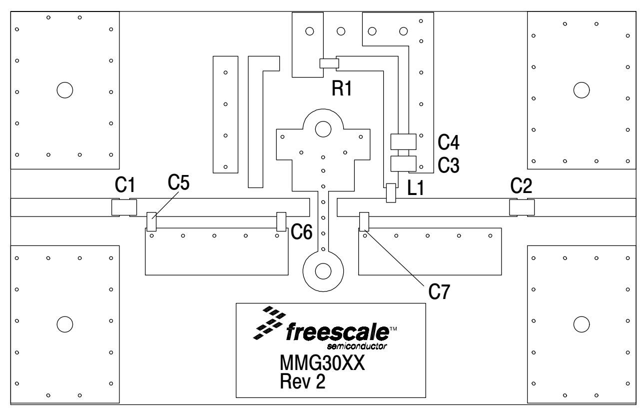


Figure 25. 50 Ohm Test Circuit Component Layout

Table 11. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	3.3 pF Chip Capacitor	C0805C339J5GAC	Kemet
C2	2.0 pF Chip Capacitor	C0805C209J5GAC	Kemet
C3	0.1 μF Chip Capacitor	C0603C104J5RAC	Kemet
C4	2.2 μF Chip Capacitor	C0805C225J4RAC	Kemet
C5	0.6 pF Chip Capacitor	06035J0R6BS	AVX
C6	0.9 pF Chip Capacitor	06035J0R9BS	AVX
C7	0.8 pF Chip Capacitor	06035J0R8BS	AVX
L1	56 nH Chip Inductor	HK160856NJ-T	Taiyo Yuden
R1	0 Ω Chip Resistor	ERJ3GEY0R00V	Panasonic

50 OHM TYPICAL CHARACTERISTICS

Table 12. Common Emitter S-Parameters (V_{CC} = 5 Vdc, I_{CC} = 135 mA, T_C = 25°C, 50 Ohm System)

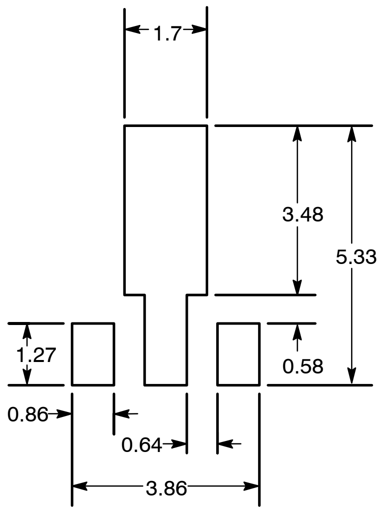
f MHz	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
100	0.653	176.4	13.109	160.2	0.0309	1.8	0.435	-170.7
150	0.650	175.5	12.721	156.3	0.0311	1.4	0.445	-171.0
200	0.648	174.9	12.320	152.2	0.0312	0.9	0.450	-171.5
250	0.643	174.1	11.911	148.2	0.0313	0.5	0.457	-172.2
300	0.642	173.3	11.504	144.3	0.0314	0.1	0.464	-172.9
350	0.639	172.4	11.094	140.4	0.0316	-0.2	0.470	-173.6
400	0.636	171.6	10.690	136.4	0.0317	-0.6	0.478	-174.3
450	0.635	170.9	10.276	132.6	0.0318	-0.9	0.484	-175.1
500	0.631	170.1	9.860	128.7	0.0319	-1.1	0.491	-175.7
550	0.630	169.4	9.450	125.0	0.0319	-1.4	0.498	-176.5
600	0.628	168.6	9.051	121.5	0.0320	-1.5	0.503	-177.4
650	0.628	167.8	8.675	118.2	0.0321	-1.8	0.509	-178.4
700	0.628	167.1	8.321	115.1	0.0321	-1.9	0.513	-179.3
750	0.629	166.7	7.989	112.2	0.0322	-2.1	0.516	179.4
800	0.632	166.1	7.658	109.5	0.0321	-2.3	0.521	178.1
850	0.633	165.4	7.355	106.9	0.0322	-2.4	0.525	177.1
900	0.634	164.6	7.079	104.5	0.0323	-2.6	0.529	176.4
950	0.638	163.9	6.813	102.2	0.0322	-2.6	0.531	175.3
1000	0.639	163.2	6.570	100.0	0.0323	-2.7	0.535	174.5
1050	0.641	164.4	6.349	97.9	0.0323	-2.9	0.536	171.7
1100	0.642	163.6	6.157	95.8	0.0326	-3.0	0.537	171.0
1150	0.644	162.8	5.976	93.7	0.0327	-3.2	0.538	170.2
1200	0.645	162.0	5.805	91.8	0.0329	-3.4	0.539	169.3
1250	0.647	161.0	5.635	89.8	0.0330	-3.7	0.539	168.5
1300	0.648	160.1	5.476	87.9	0.0331	-3.9	0.540	167.4
1350	0.649	159.4	5.326	86.1	0.0333	-4.1	0.541	166.6
1400	0.651	158.5	5.184	84.4	0.0334	-4.3	0.542	165.7
1450	0.656	157.8	5.054	82.7	0.0335	-4.5	0.543	164.7
1500	0.658	157.0	4.924	81.0	0.0337	-4.7	0.544	163.9
1550	0.661	156.3	4.801	79.4	0.0338	-4.9	0.545	162.9
1600	0.664	155.5	4.687	77.8	0.0339	-5.1	0.546	162.1
1650	0.666	154.7	4.573	76.3	0.0340	-5.3	0.546	161.1
1700	0.670	154.0	4.468	74.7	0.0341	-5.5	0.547	160.3
1750	0.674	153.2	4.368	73.2	0.0343	-5.7	0.548	159.4
1800	0.677	152.5	4.269	71.7	0.0344	-6.0	0.549	158.5
1850	0.681	151.8	4.176	70.1	0.0345	-6.3	0.550	157.4
1900	0.684	150.9	4.084	68.6	0.0346	-6.5	0.551	156.4
1950	0.688	150.2	3.999	67.1	0.0347	-6.8	0.552	155.4
2000	0.691	149.3	3.914	65.6	0.0348	-7.2	0.553	154.4
2050	0.696	148.5	3.837	64.2	0.0349	-7.5	0.553	153.5
2100	0.699	147.7	3.761	62.7	0.0350	-7.8	0.553	152.5
2150	0.703	146.8	3.690	61.2	0.0351	-8.2	0.553	151.5
2200	0.707	146.0	3.624	59.6	0.0352	-8.6	0.553	150.6
2250	0.709	145.0	3.555	58.1	0.0353	-9.2	0.554	149.6
2300	0.714	144.0	3.492	56.5	0.0355	-9.6	0.554	148.5

(continued)

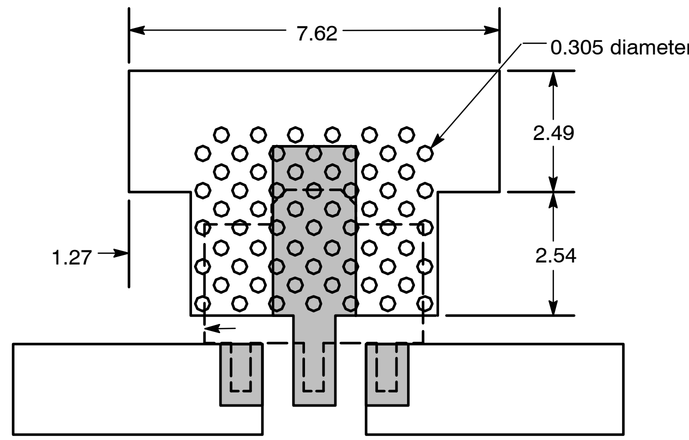
50 OHM TYPICAL CHARACTERISTICS

Table 12. Common Emitter S-Parameters (V_{CC} = 5 Vdc, I_{CC} = 135 mA, T_C = 25°C, 50 Ohm System) **(continued)**

f MHz	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
2350	0.716	142.9	3.430	54.9	0.0356	-10.1	0.554	147.5
2400	0.720	141.8	3.364	53.3	0.0356	-10.7	0.554	146.3
2450	0.724	140.7	3.305	51.7	0.0358	-11.3	0.554	145.1
2500	0.727	139.5	3.244	50.1	0.0359	-11.9	0.555	144.0
2550	0.732	138.4	3.184	48.6	0.0359	-12.4	0.555	142.8
2600	0.734	137.2	3.129	47.0	0.0360	-13.0	0.555	141.8
2650	0.736	135.9	3.070	45.4	0.0360	-13.5	0.555	140.7
2700	0.739	134.6	3.017	43.9	0.0362	-14.1	0.555	139.8
2750	0.742	133.3	2.965	42.4	0.0362	-14.5	0.556	139.1
2800	0.745	132.0	2.913	40.9	0.0362	-15.1	0.556	138.2
2850	0.749	130.7	2.866	39.4	0.0364	-15.6	0.556	137.5
2900	0.753	129.5	2.818	38.0	0.0364	-16.2	0.556	136.5
2950	0.756	128.2	2.771	36.5	0.0365	-16.8	0.556	135.7
3000	0.759	126.9	2.728	35.0	0.0367	-17.3	0.557	134.8
3050	0.761	125.6	2.682	33.6	0.0367	-18.0	0.557	133.9
3100	0.764	124.3	2.639	32.2	0.0368	-18.4	0.557	133.1
3150	0.767	123.1	2.599	30.9	0.0368	-19.0	0.557	132.3
3200	0.770	121.8	2.559	29.5	0.0369	-19.5	0.557	131.7
3250	0.773	120.8	2.522	28.2	0.0370	-19.9	0.557	130.9
3300	0.777	119.7	2.487	26.9	0.0372	-20.5	0.558	130.3
3350	0.779	118.7	2.451	25.6	0.0372	-20.9	0.558	129.7
3400	0.783	117.8	2.421	24.4	0.0374	-21.4	0.558	129.1
3450	0.785	116.9	2.387	23.1	0.0374	-21.8	0.558	128.4
3500	0.788	116.0	2.358	21.9	0.0376	-22.4	0.558	127.7
3550	0.792	115.2	2.329	20.7	0.0378	-22.7	0.559	127.1
3600	0.793	114.4	2.298	19.5	0.0379	-23.2	0.559	126.2
3650	0.797	113.6	2.273	18.3	0.0381	-23.6	0.559	125.4
3700	0.797	112.8	2.244	17.1	0.0382	-24.1	0.559	124.5
3750	0.800	112.0	2.219	15.9	0.0383	-24.6	0.559	123.7
3800	0.800	111.2	2.193	14.8	0.0384	-24.9	0.560	122.9
3850	0.799	110.3	2.167	13.7	0.0385	-25.4	0.560	122.3
3900	0.800	109.3	2.146	12.5	0.0387	-25.8	0.560	121.9
3950	0.800	108.4	2.125	11.4	0.0389	-26.2	0.560	121.3
4000	0.802	107.0	2.092	10.3	0.0388	-26.6	0.560	120.8



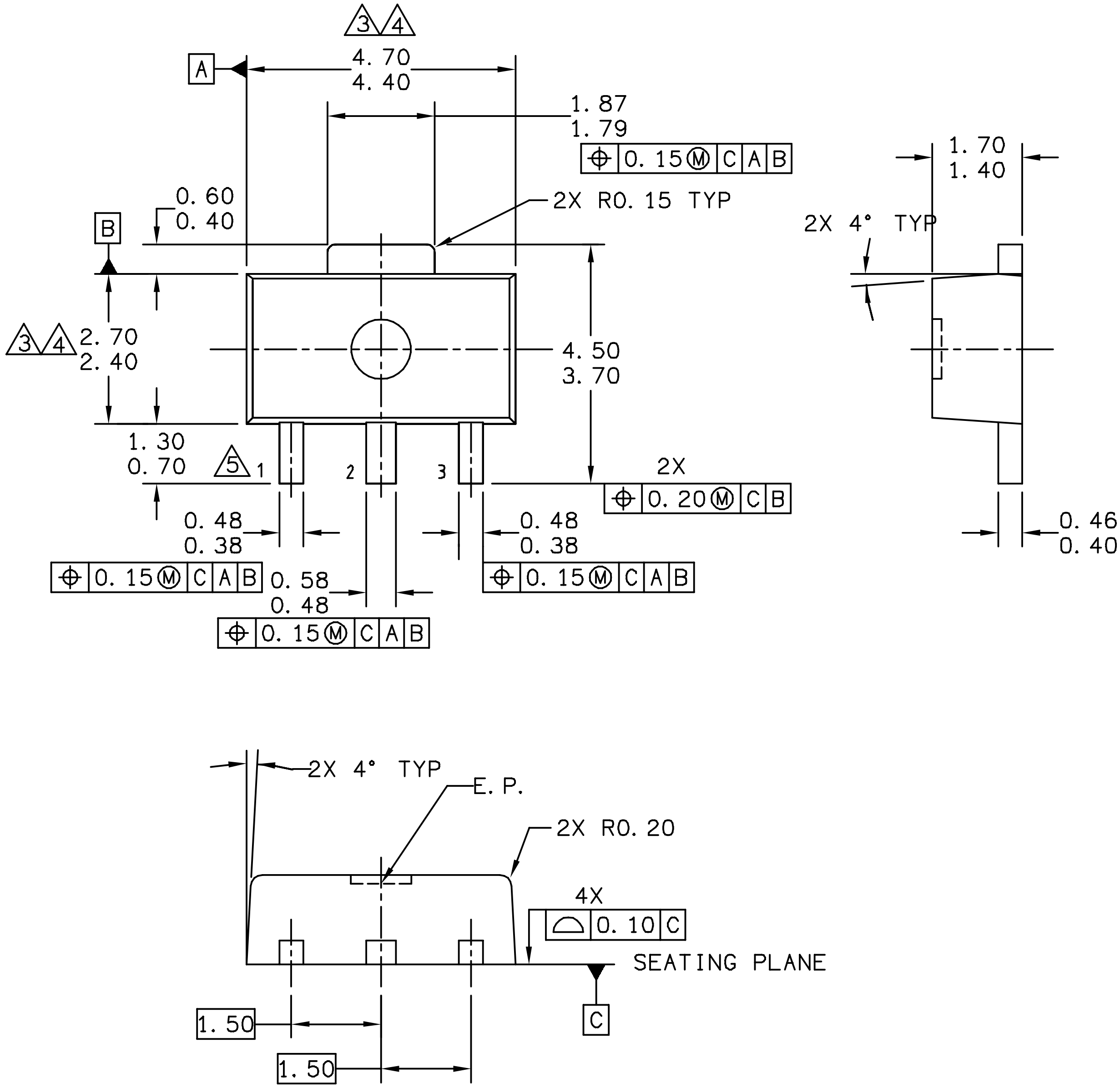
Recommended Solder Stencil



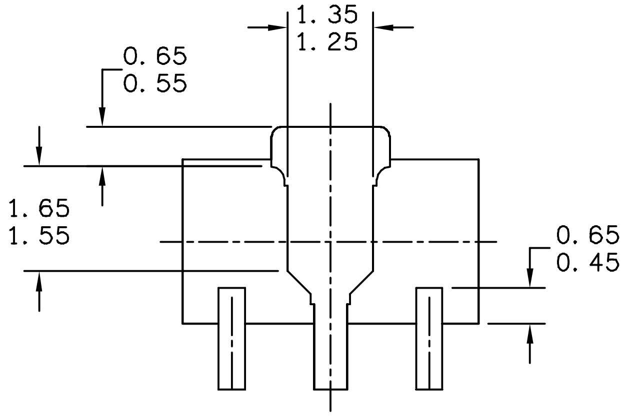
NOTES:
1. THERMAL AND RF GROUNDING CONSIDERATIONS SHOULD BE USED IN PCB LAYOUT DESIGN.
2. DEPENDING ON PCB DESIGN RULES, AS MANY VIAS AS POSSIBLE SHOULD BE PLACED ON THE LANDING PATTERN.
3. IF VIAS CANNOT BE PLACED ON THE LANDING PATTERN, THEN AS MANY VIAS AS POSSIBLE SHOULD BE PLACED AS CLOSE TO THE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

Figure 26. Recommended Mounting Configuration

PACKAGE DIMENSIONS



	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:
PIN 1. RF INPUT
PIN 2. GROUND
PIN 3. RF OUTPUT

STYLE 2:
PIN 1. GATE
PIN 2. SOURCE
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
0	Apr. 2008	• Initial Release of Data Sheet

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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
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