Freescale Semiconductor
Technical Data

Document Number: MMG3009NT1
Rev. 2, 5/2006

RoHS

Heterojunction Bipolar Transistor (InGaP HBT)

Broadband High Linearity Amplifier

The MMG3009NT1 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 0 to 6000 MHz such as Cellular, PCS, BWA, WLL, PHS, CATV, VHF, UHF, UMTS and general small-signal RF.

Features

- Frequency: 0 to 6000 MHz
- P1dB: 18 dBm @ 900 MHz
- Small-Signal Gain: 15 dB @ 900 MHz
- Third Order Output Intercept Point: 34 dBm @ 900 MHz
- Single 5 Volt 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.

MMG3009NT1

0-6000 MHz, 15 dB
18 dBm
InGaP HBT

CASE 1514-01, 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	15	14	12.5	dB
Input Return Loss (S11)	IRL	-13	-26	-22	dB
Output Return Loss (S22)	ORL	-17	-15	-24	dB
Power Output @1dB Compression	P1db	18	18	17.5	dBm
Third Order Output Intercept Point	IP3	34	32	31	dBm

1. V_{CC} = 5 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. Continuous 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 Vdc, I_{CC} = 70 mA, T_C = 25°C)

Characteristic	Symbol	Value (4)	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	81	°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 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	14.3	15	—	dB
Input Return Loss (S11)	IRL	—	-13	—	dB
Output Return Loss (S22)	ORL	—	-17	—	dB
Power Output @ 1dB Compression	P1dB	—	18	—	dBm
Third Order Output Intercept Point	IP3	—	34	—	dBm
Noise Figure	NF	—	4.2	—	dB
Supply Current (1)	I_{CC}	58	70	82	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

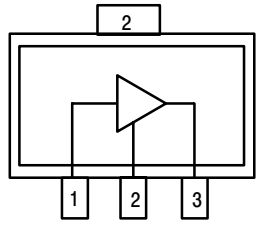


Figure 1. Functional Diagram

Table 6. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD 22-A114)	1A (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

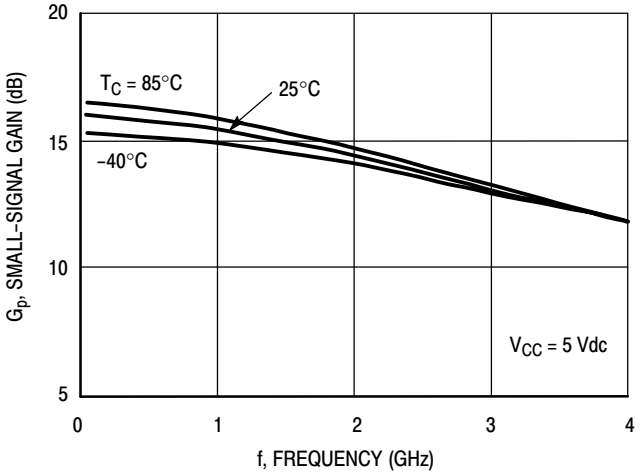


Figure 2. Small-Signal Gain (S21) versus Frequency

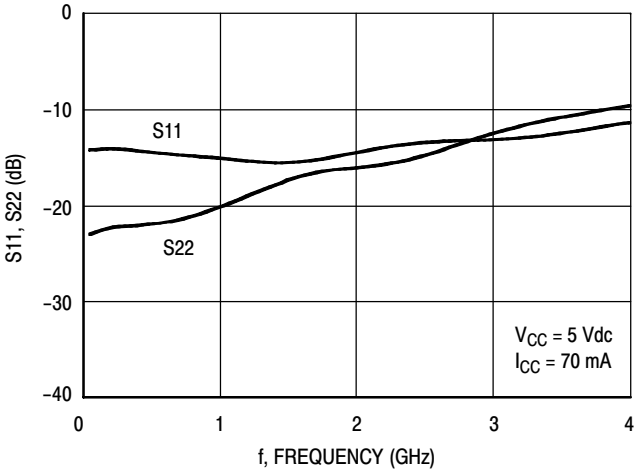


Figure 3. Input/Output Return Loss versus Frequency

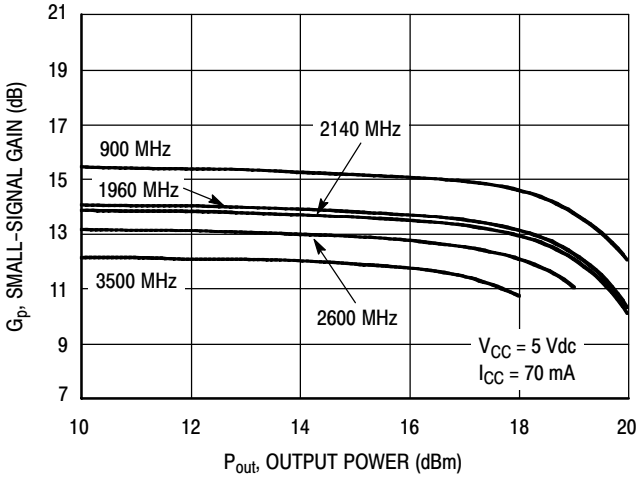


Figure 4. Small-Signal Gain versus Output Power

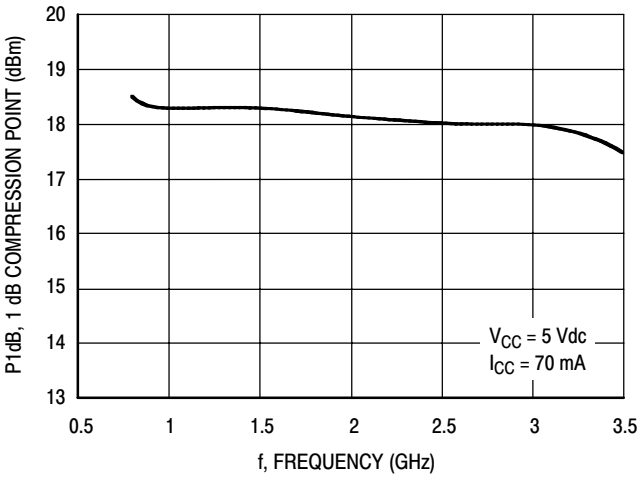


Figure 5. P1dB versus Frequency

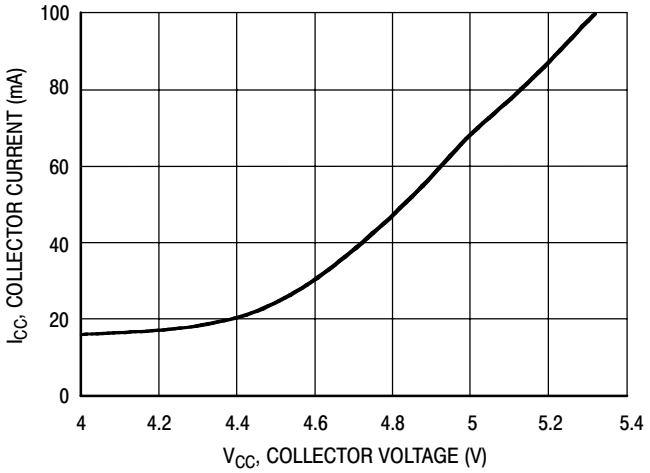


Figure 6. Collector Current versus Collector Voltage

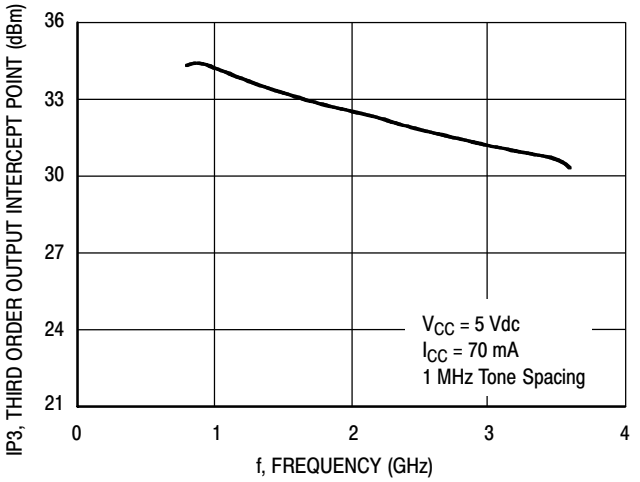


Figure 7. Third Order Output Intercept Point versus Frequency

50 OHM TYPICAL CHARACTERISTICS

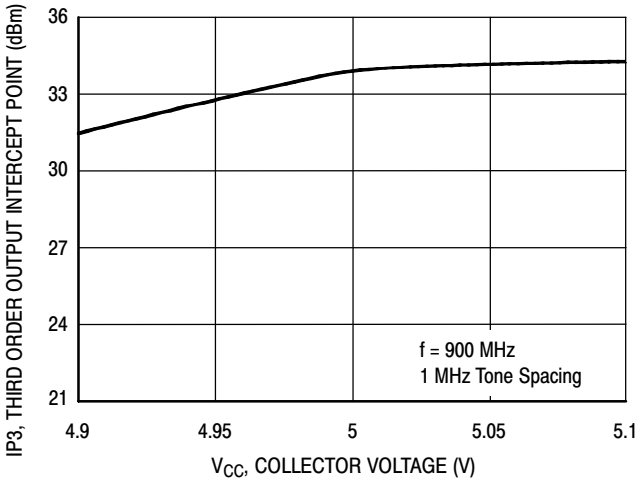


Figure 8. Third Order Output Intercept Point versus Collector Voltage

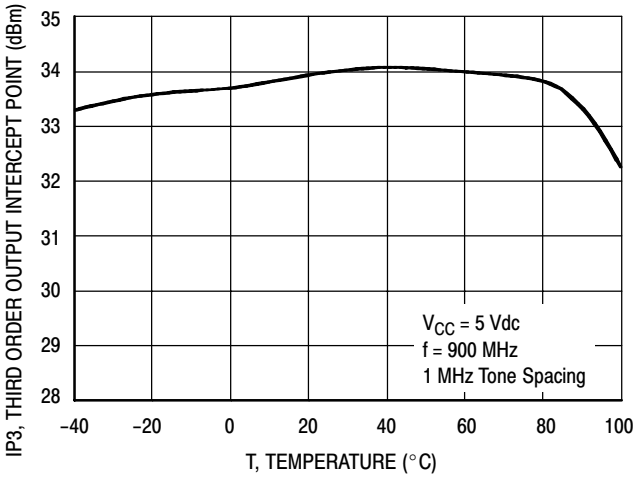


Figure 9. Third Order Output Intercept Point versus Case Temperature

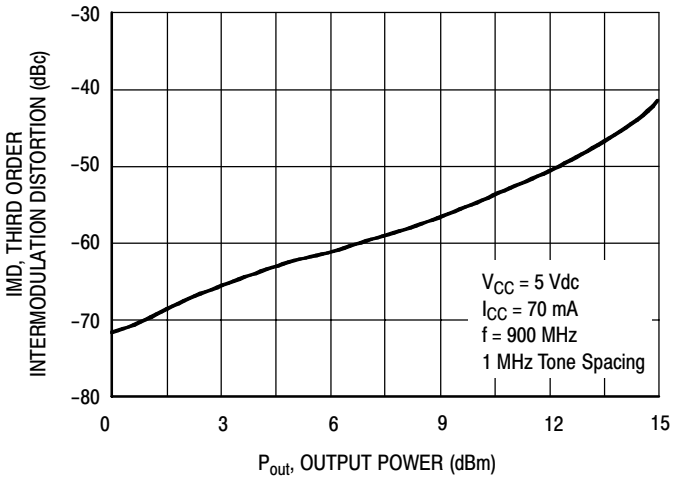
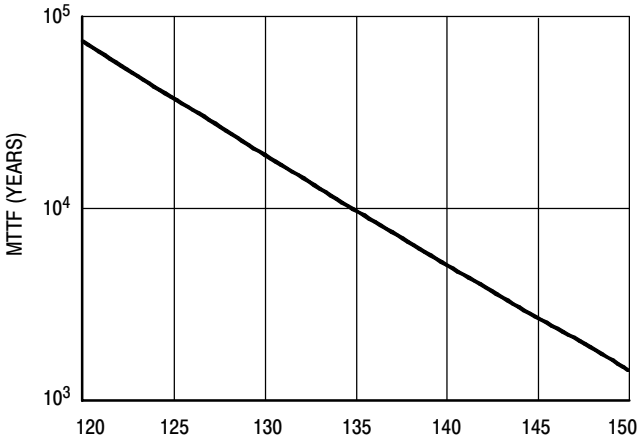


Figure 10. Third Order Intermodulation versus Output Power



NOTE: The MTTF is calculated with V_{CC} = 5 Vdc, I_{CC} = 70 mA

Figure 11. MTTF versus Junction Temperature

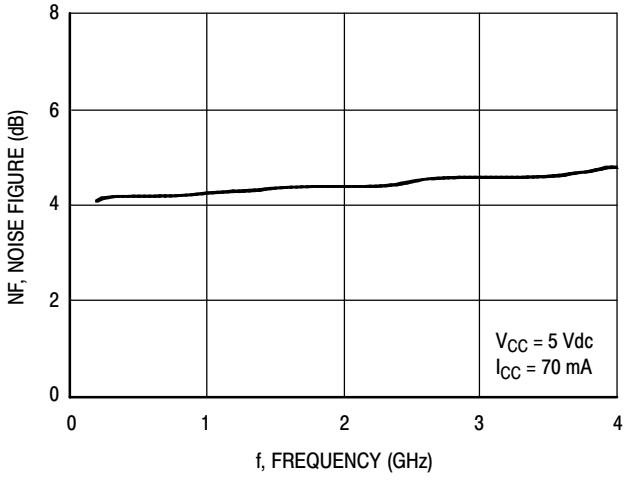


Figure 12. Noise Figure versus Frequency

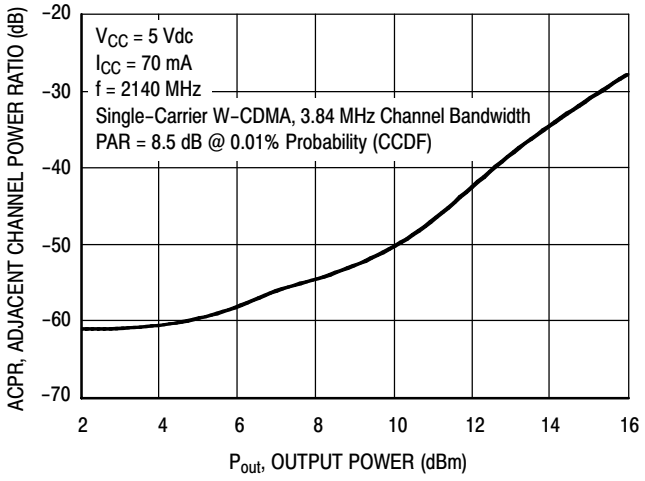
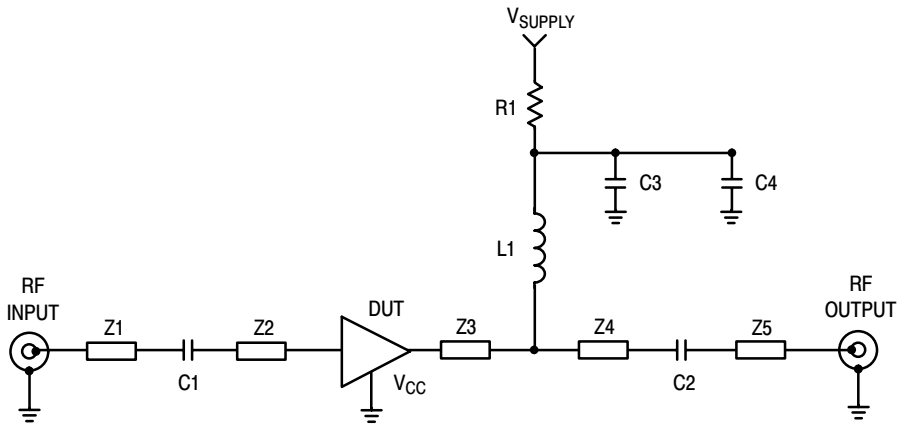


Figure 13. Single-Carrier W-CDMA Adjacent Channel Power Ratio versus Output Power

50 OHM APPLICATION CIRCUIT: 40-300 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

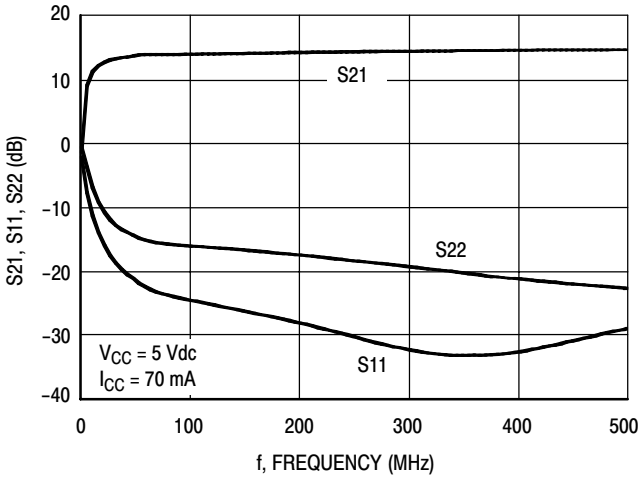


Figure 15. S21, S11 and S22 versus Frequency

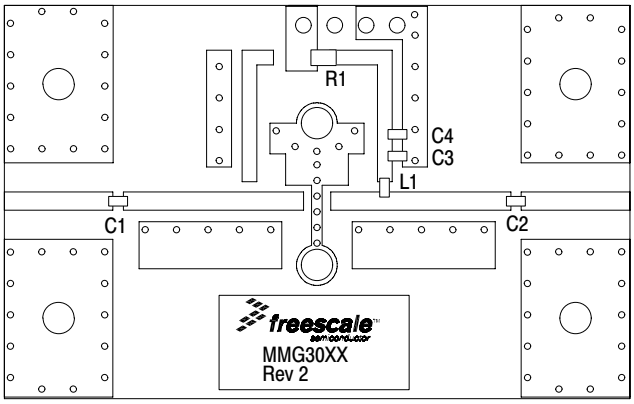
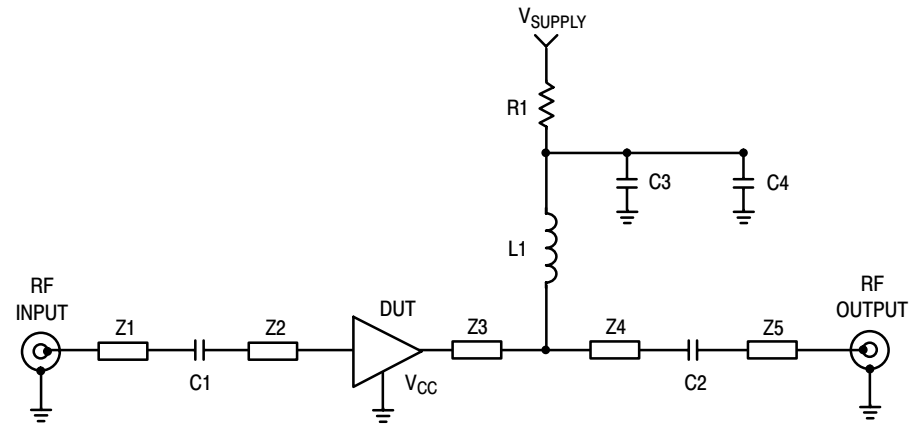


Figure 16. 50 Ohm Test Circuit Component Layout

Table 8. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2, C3	0.01 μF Chip Capacitors	0603A103JAT2A	AVX
C4	1000 pF Chip Capacitor	0603A102JAT2A	AVX
L1	470 nH Chip Inductor	BK2125HM471	Taiyo Yuden
R1	0 Ω Chip Resistor	ERJ3GEY0R00V	Panasonic

50 OHM APPLICATION CIRCUIT: 300 - 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

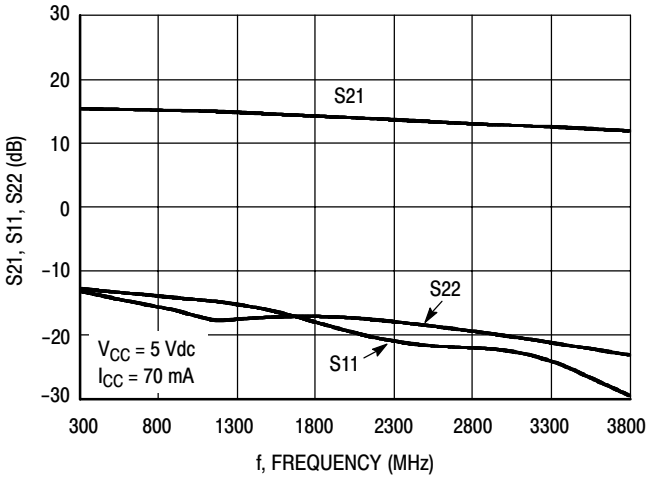


Figure 18. S21, S11 and S22 versus Frequency

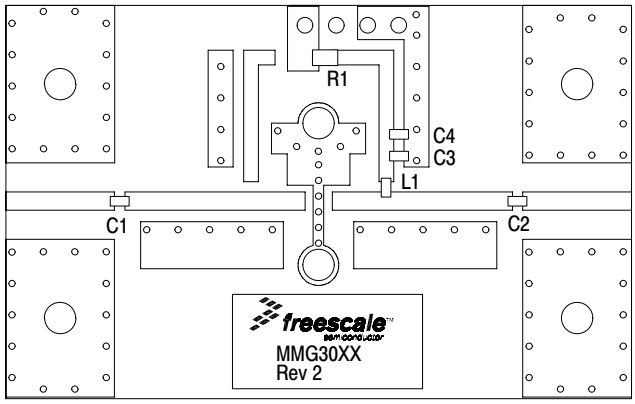


Figure 19. 50 Ohm Test Circuit Component Layout

Table 9. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	150 pF Chip Capacitors	06035A151JAT2A	AVX
C3	0.01 μF Chip Capacitor	0603A103JAT2A	AVX
C4	1000 pF Chip Capacitor	0603A102JAT2A	AVX
L1	56 nH Chip Inductor	HK160856NJ-T	Taiyo Yuden
R1	0 Ω Chip Resistor	ERJ3GEY0R00V	Panasonic

50 OHM TYPICAL CHARACTERISTICS

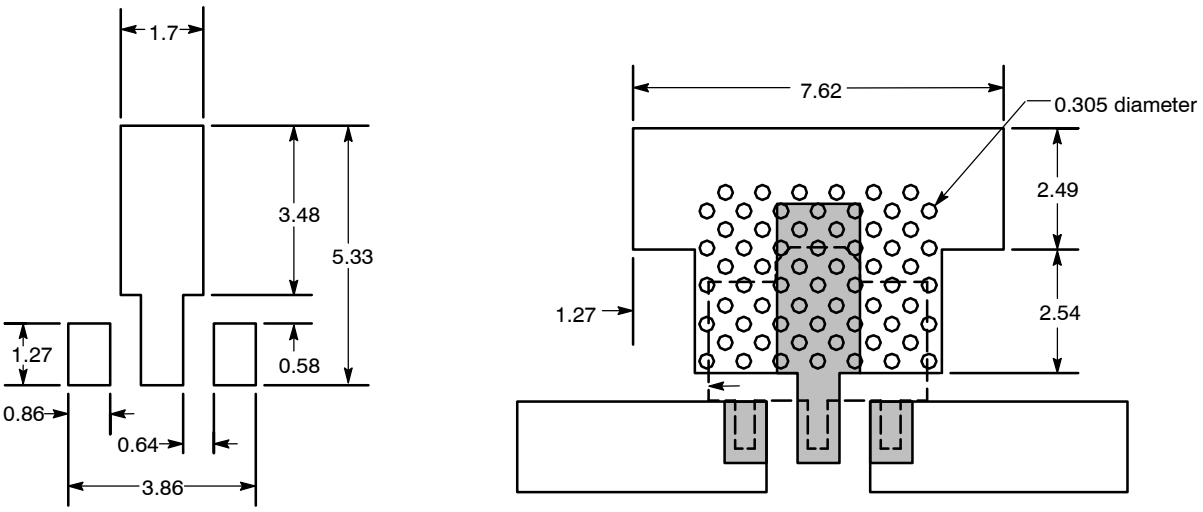
Table 10. Class A Common Emitter S-Parameters at V_{CC} = 5 Vdc, I_{CC} = 70 mA, T_C = 25°C

f	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
0.1	0.19606	-174.964	6.33492	175.897	0.10115	-0.614	0.07282	176.529
0.15	0.19734	-176.357	6.30368	173.26	0.10204	-1.587	0.07571	178.062
0.2	0.19944	169.849	6.27983	171.036	0.10220	-2.173	0.07648	-178.213
0.25	0.20027	168.421	6.24623	169.018	0.10243	-2.498	0.08038	-175.337
0.3	0.19924	166.435	6.22884	166.867	0.10334	-2.998	0.07928	-172.371
0.35	0.19543	164.497	6.22675	164.532	0.10364	-3.636	0.07836	-172.028
0.4	0.19419	162.266	6.21021	162.42	0.10357	-4.18	0.07876	-169.383
0.45	0.19172	160.135	6.19495	160.278	0.10351	-4.669	0.07882	-167.245
0.5	0.18914	158.072	6.18191	158.065	0.10361	-5.256	0.07903	-165.903
0.55	0.18788	156.056	6.16313	155.935	0.10378	-5.746	0.07946	-164.125
0.6	0.18596	154.01	6.14591	153.778	0.10379	-6.277	0.08061	-162.978
0.65	0.18399	152.064	6.12734	151.629	0.10396	-6.756	0.08181	-162.118
0.7	0.18285	150.008	6.10486	149.511	0.10408	-7.313	0.08346	-161.229
0.75	0.18159	148.088	6.08449	147.384	0.10411	-7.817	0.08496	-160.812
0.8	0.18056	146.09	6.06038	145.27	0.10427	-8.376	0.08717	-160.896
0.85	0.17973	144.286	6.03306	143.153	0.10440	-8.885	0.08917	-161.031
0.9	0.17932	142.485	6.00923	141.039	0.10453	-9.38	0.09202	-161.574
0.95	0.17920	140.759	5.98147	138.952	0.10467	-9.995	0.09484	-162.293
1.0	0.17847	139.226	5.95646	136.927	0.10485	-10.462	0.09809	-163.293
1.05	0.17754	137.531	5.92809	134.838	0.10508	-11.017	0.10057	-164.366
1.1	0.17453	136.047	5.89423	132.763	0.10519	-11.541	0.10471	-165.489
1.15	0.17205	134.871	5.86296	130.716	0.10534	-12.012	0.10843	-167.229
1.2	0.17066	133.54	5.83017	128.685	0.10542	-12.612	0.11227	-168.9
1.25	0.16951	132.305	5.79633	126.662	0.10564	-13.155	0.11601	-170.51
1.3	0.16662	131.182	5.76557	124.647	0.10580	-13.654	0.12012	-172.32
1.35	0.16577	130.038	5.73189	122.631	0.10602	-14.194	0.12430	-174.175
1.4	0.16504	128.988	5.69605	120.653	0.10620	-14.728	0.12842	-176.041
1.45	0.16426	128.206	5.65985	118.678	0.10641	-15.283	0.13238	-178.197
1.5	0.16609	122.177	5.63288	116.712	0.10680	-15.856	0.13929	-178.349
1.55	0.16661	120.535	5.60045	114.805	0.10706	-16.422	0.14264	179.292
1.6	0.16797	118.895	5.56701	112.889	0.10732	-16.914	0.14623	176.482
1.65	0.17042	117.389	5.53367	110.947	0.10761	-17.529	0.14778	174.032
1.7	0.17177	116.114	5.50453	109.079	0.10790	-18.111	0.15034	171.358
1.75	0.17361	114.897	5.47270	107.137	0.10818	-18.625	0.15223	168.855
1.8	0.17663	113.75	5.43993	105.194	0.10841	-19.165	0.15382	166.27
1.85	0.17969	112.634	5.40358	103.282	0.10863	-19.761	0.15575	163.924
1.9	0.18333	111.562	5.36970	101.431	0.10919	-20.39	0.15708	161.656
1.95	0.18634	110.534	5.33711	99.484	0.10950	-21.017	0.15722	159.517
2.0	0.18991	109.707	5.30347	97.624	0.10980	-21.621	0.15781	157.67
2.05	0.19272	108.497	5.26942	95.722	0.11012	-22.222	0.15859	156.162
2.1	0.19593	107.602	5.23491	93.803	0.11037	-22.899	0.15951	154.73
2.15	0.19925	106.721	5.19782	91.865	0.11076	-23.629	0.16086	153.761
2.2	0.20272	105.922	5.15894	89.97	0.11107	-24.273	0.16242	152.923
2.25	0.20521	104.933	5.11750	88.119	0.11132	-24.939	0.16412	151.958
2.3	0.20819	103.761	5.07836	86.232	0.11160	-25.64	0.16622	151.355
2.35	0.21027	102.506	5.03981	84.384	0.11177	-26.346	0.16892	150.63

50 OHM TYPICAL CHARACTERISTICS

Table 10. Class A Common Emitter S-Parameters at V_{CC} = 5 Vdc, I_{CC} = 70 mA, T_C = 25°C (continued)

f	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
2.4	0.21179	101.509	4.99976	82.526	0.11206	-26.995	0.17307	150.179
2.45	0.21372	100.321	4.95674	80.649	0.11219	-27.627	0.17696	149.454
2.5	0.21503	99.084	4.91517	78.813	0.11247	-28.368	0.18136	148.699
2.55	0.21607	98.079	4.87557	77.083	0.11260	-29.056	0.18649	147.675
2.6	0.21693	96.937	4.83415	75.317	0.11290	-29.737	0.19209	146.671
2.65	0.21764	95.679	4.79330	73.409	0.11315	-30.261	0.19800	145.149
2.7	0.21800	94.585	4.75322	71.62	0.11317	-31.061	0.20392	144.12
2.75	0.21817	93.428	4.71387	69.917	0.11349	-31.733	0.20970	142.804
2.8	0.21833	92.207	4.67702	68.159	0.11366	-32.454	0.21628	141.065
2.85	0.21805	91.061	4.63817	66.317	0.11402	-33.132	0.22172	139.329
2.9	0.21865	89.888	4.60218	64.555	0.11435	-33.832	0.22856	137.508
2.95	0.21925	88.748	4.56625	62.873	0.11463	-34.552	0.23450	135.667
3.0	0.21915	87.532	4.53210	61.144	0.11512	-35.281	0.24044	133.457
3.05	0.22110	86.342	4.50064	59.382	0.11540	-36.033	0.24561	131.639
3.1	0.22166	85.246	4.46608	57.613	0.11582	-36.792	0.25129	129.229
3.15	0.22283	84.227	4.43647	55.954	0.11604	-37.437	0.25625	127.153
3.2	0.22458	83.152	4.40552	54.104	0.11651	-38.235	0.26146	124.84
3.25	0.22637	82.137	4.37427	52.337	0.11696	-38.955	0.26652	122.578
3.3	0.22771	81.039	4.34455	50.582	0.11740	-39.776	0.27125	120.071
3.35	0.23010	79.979	4.31085	48.824	0.11778	-40.645	0.27548	118.04
3.4	0.23244	78.98	4.28183	47.09	0.11825	-41.441	0.28049	115.642
3.45	0.23531	78.054	4.25137	45.379	0.11856	-42.323	0.28504	113.247
3.5	0.23838	77.028	4.22125	43.528	0.11892	-43.156	0.28907	111.227
3.55	0.24191	76.08	4.19033	41.795	0.11931	-43.953	0.29393	108.97
3.6	0.24470	75.139	4.15822	40.059	0.11966	-44.868	0.29797	106.843

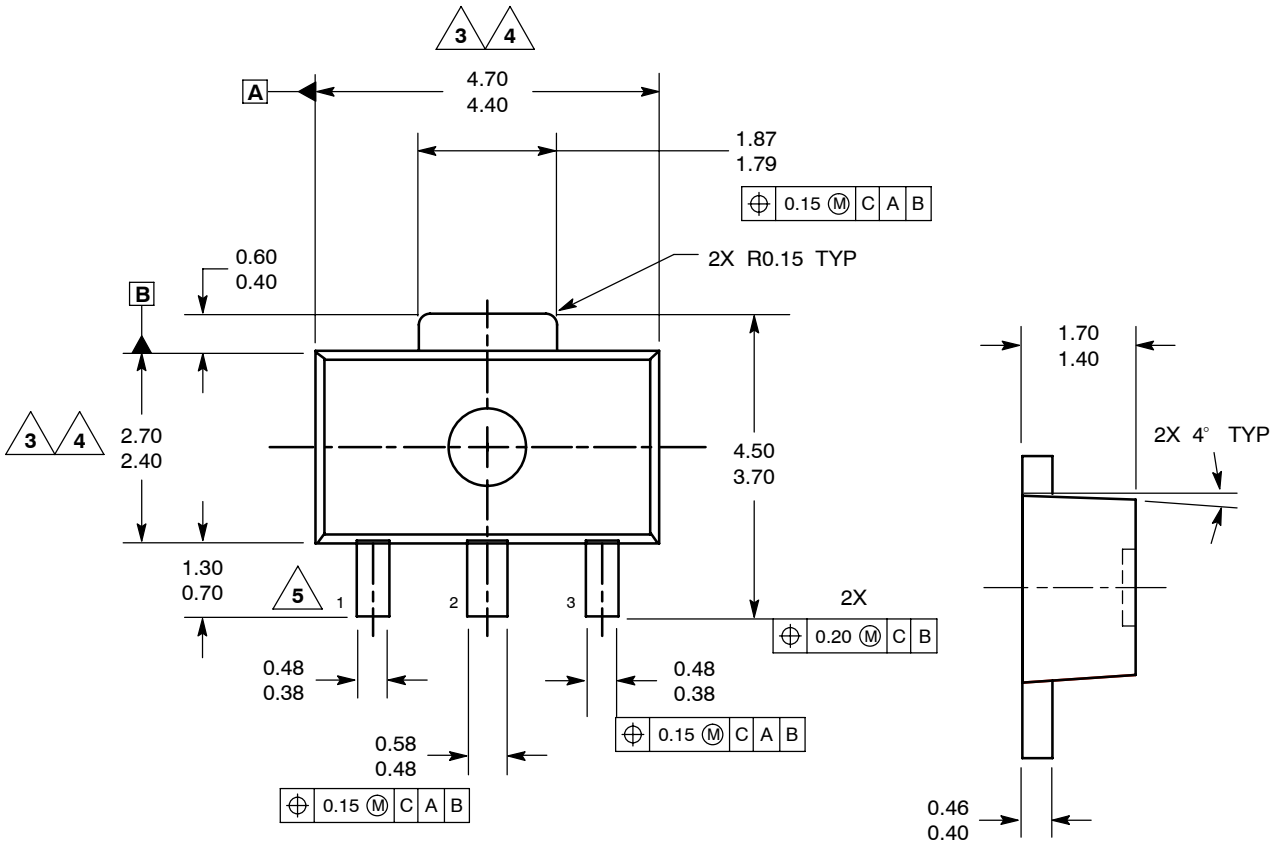


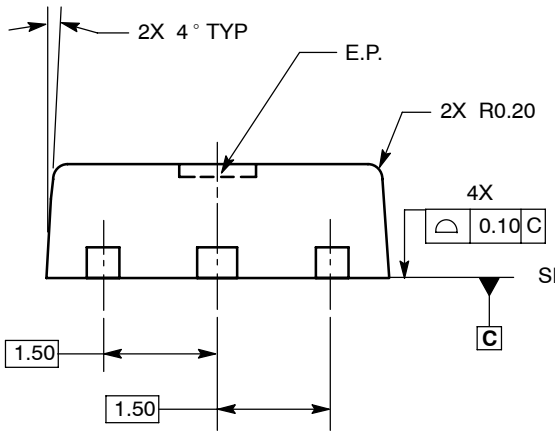
Recommended Solder Stencil

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.

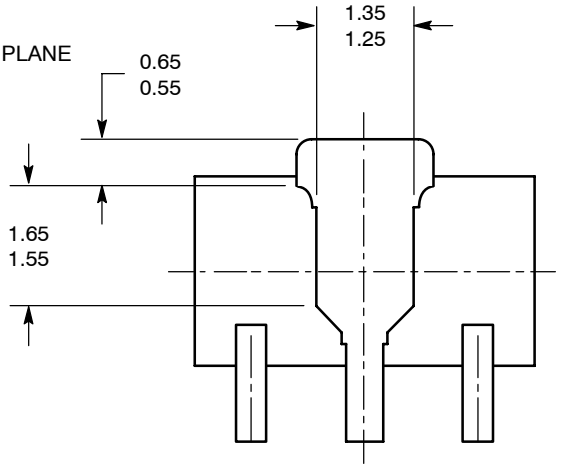
Figure 20. Recommended Mounting Configuration

PACKAGE DIMENSIONS





NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSION 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 0.5MM PER SIDE.
4. DIMENSIONS 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.



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

CASE 1514-01
ISSUE C
SOT-89
PLASTIC

BOTTOM VIEW

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