

Freescale Semiconductor
Technical Data

Document Number: MMG3003NT1
Rev. 3, 8/2005

Heterojunction Bipolar Transistor Technology (InGaP HBT)

Broadband High Linearity Amplifier

The MMG3003NT1 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 3600 MHz such as Cellular, PCS, BWA, WLL, PHS, CATV, VHF, UHF, UMTS and general small-signal RF.

Features

- Frequency: 40-3600 MHz
- P1dB: 24 dBm @ 900 MHz
- Small-Signal Gain: 20 dB @ 900 MHz
- Third Order Output Intercept Point: 40.5 dBm @ 900 MHz
- Single Voltage Supply
- Internally Matched to 50 Ohms
- Low Cost SOT-89 Surface Mount Package
- Pb-Free and RoHS Compliant
- In Tape and Reel. T1 Suffix = 1000 Units per 12 mm, 7 inch Reel.

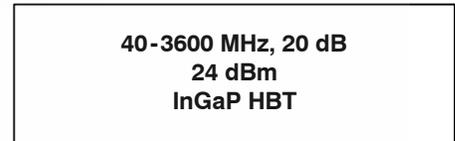


Table 1. Typical Performance (1)

Characteristic	Symbol	900 MHz	2140 MHz	3500 MHz	Unit
Small-Signal Gain (S21)	G _p	20	16.9	12	dB
Input Return Loss (S11)	IRL	-15	-14.1	-11.2	dB
Output Return Loss (S22)	ORL	-9.3	-14.5	-10.2	dB
Power Output @1dB Compression	P1db	24	23.3	20.5	dBm
Third Order Output Intercept Point	IP3	40.5	40	37	dBm

1. V_{CC} = 6.2 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}	400	mA
RF Input Power	P _{in}	15	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} = 6.2 Vdc, I_{CC} = 180 mA, T_C = 25°C)

Characteristic	Symbol	Value (4)	Unit
Thermal Resistance, Junction to Case	R _{θJC}	31.6	°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.



Table 4. Electrical Characteristics ($V_{CC} = 6.2$ Vdc, 900 MHz, $T_C = 25^\circ\text{C}$, 50 ohm system, in Freescale Application Circuit)

Characteristic	Symbol	Min	Typ	Max	Unit
Small-Signal Gain (S21)	G_p	19.3	20	—	dB
Input Return Loss (S11)	IRL	—	-15	—	dB
Output Return Loss (S22)	ORL	—	-9.3	—	dB
Power Output @ 1dB Compression	P1dB	—	24	—	dBm
Third Order Output Intercept Point	IP3	—	40.5	—	dBm
Noise Figure	NF	—	4	—	dB
Supply Current (1)	I_{CC}	160	180	205	mA
Supply Voltage (1)	V_{CC}	—	6.2	—	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

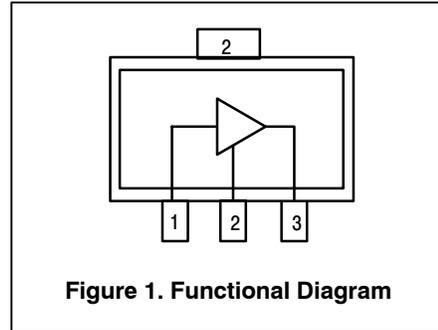


Table 6. ESD Protection Characteristics

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

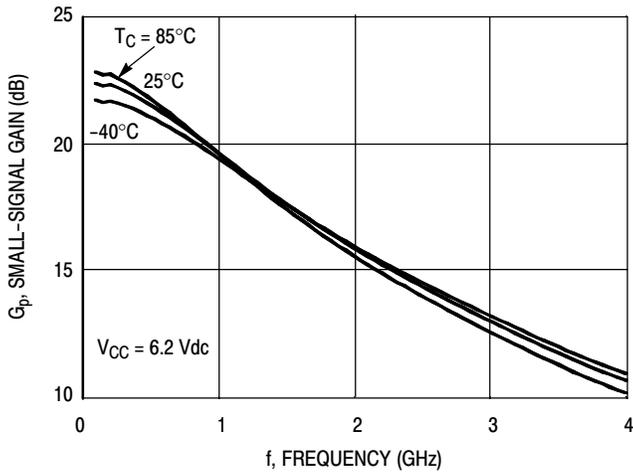


Figure 2. Small-Signal Gain (S21) versus Frequency

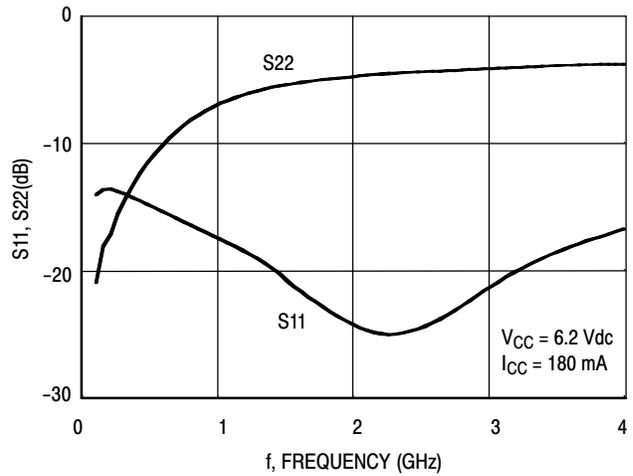


Figure 3. Input/Output Return Loss versus Frequency

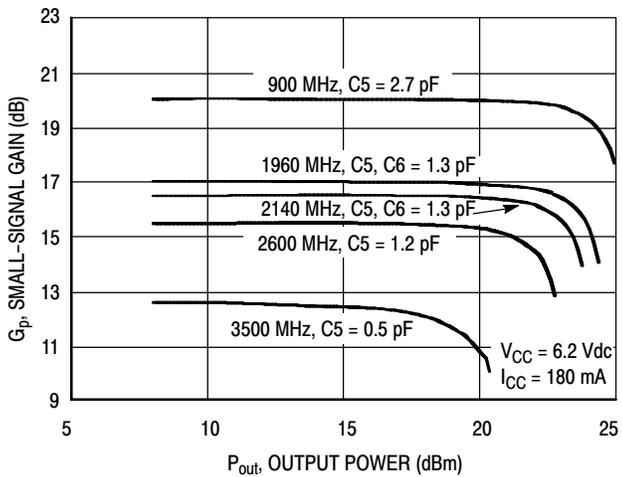


Figure 4. Small-Signal Gain versus Output Power

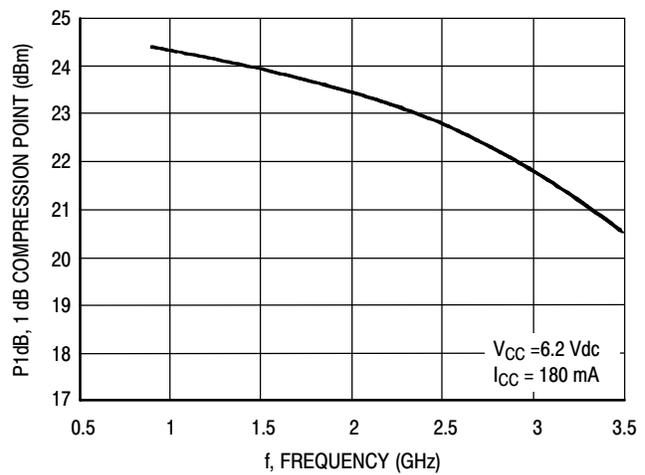


Figure 5. P1dB versus Frequency

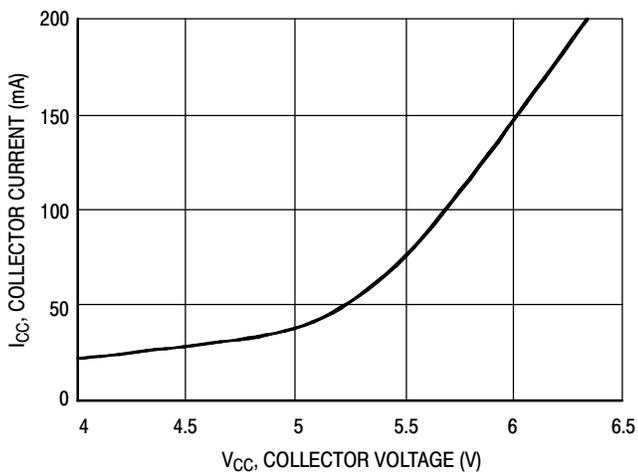


Figure 6. Collector Current versus Collector Voltage

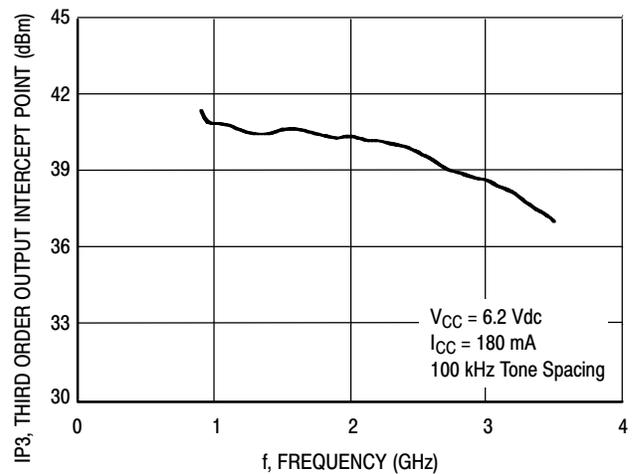


Figure 7. Third Order Output Intercept Point versus Frequency

50 OHM TYPICAL CHARACTERISTICS

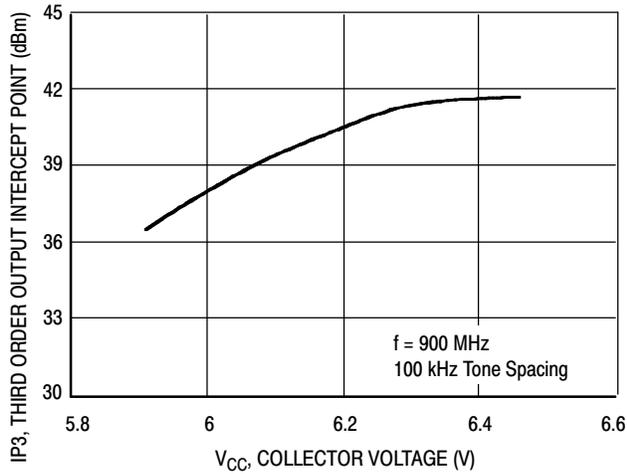


Figure 8. Third Order Output Intercept Point versus Collector Voltage

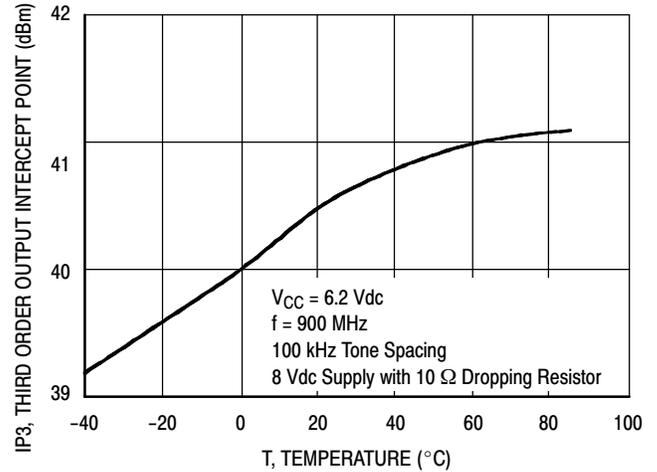


Figure 9. Third Order Output Intercept Point versus Case Temperature

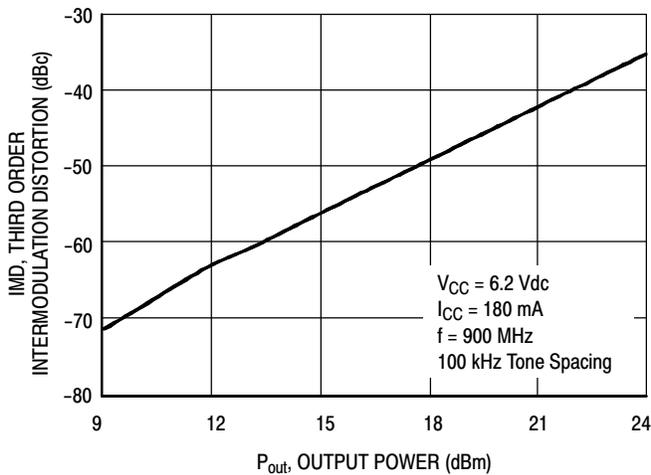
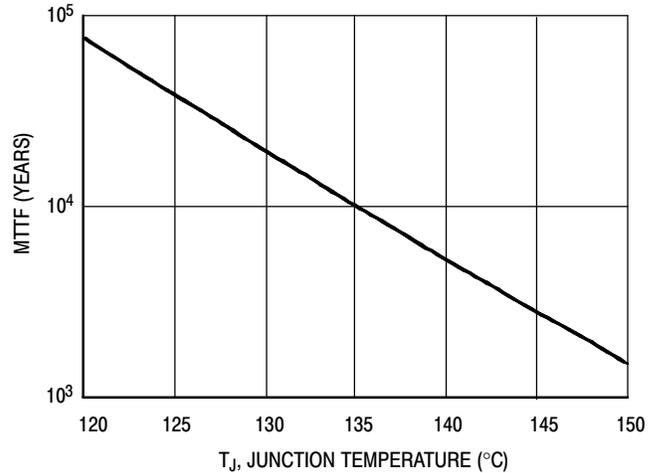


Figure 10. Third Order Intermodulation versus Output Power



NOTE: The MTTF is calculated with $V_{CC} = 6.2$ Vdc, $I_{CC} = 180$ mA

Figure 11. MTTF versus Junction Temperature

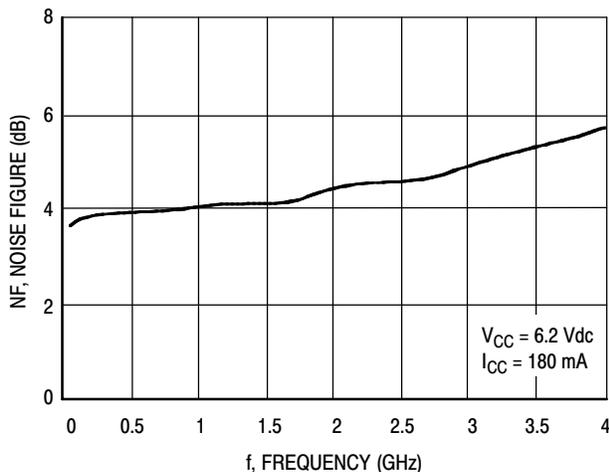


Figure 12. Noise Figure versus Frequency

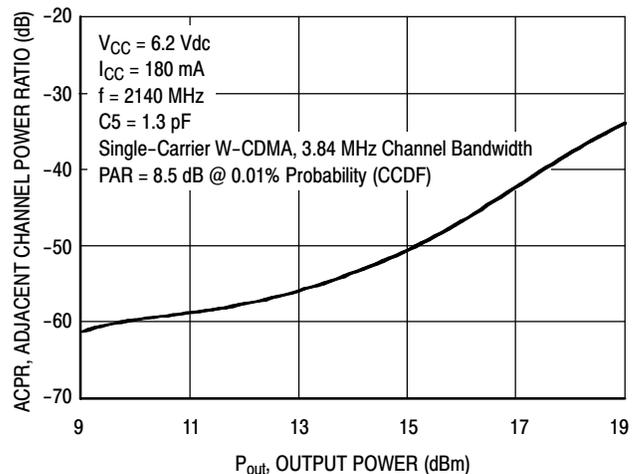


Figure 13. Single-Carrier W-CDMA Adjacent Channel Power Ratio versus Output Power

50 OHM APPLICATION CIRCUIT: 40-800 MHz

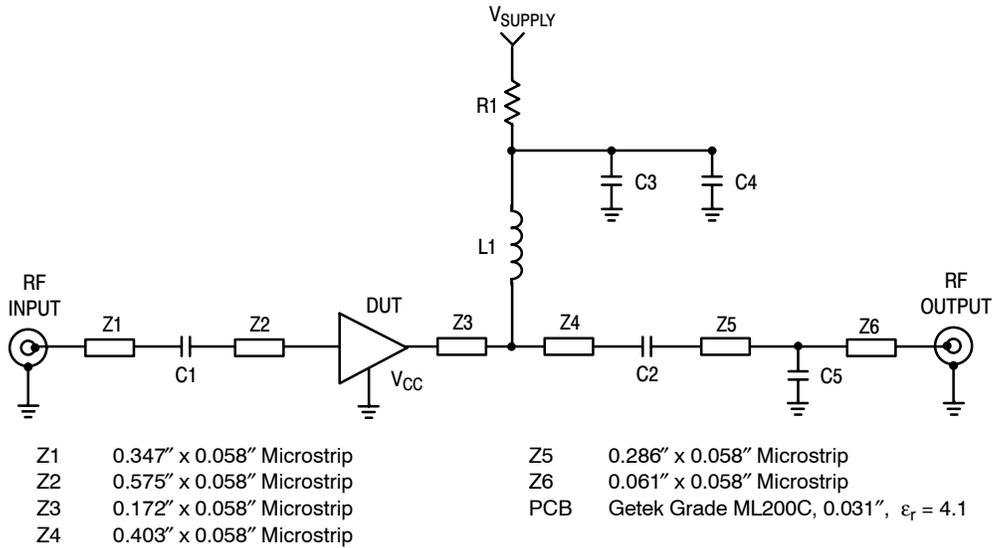


Figure 14. 50 Ohm Test Circuit Schematic

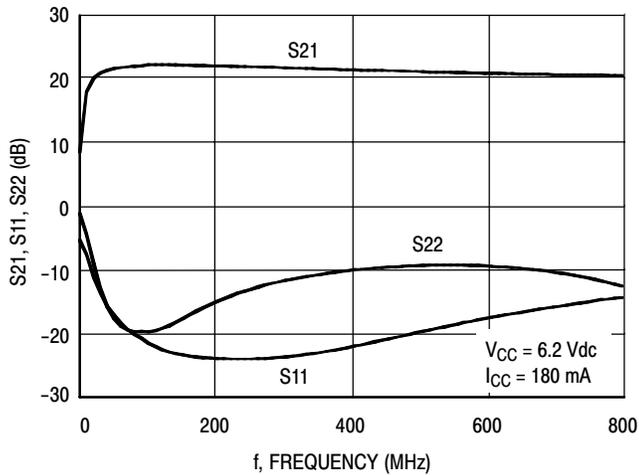


Figure 15. S21, S11 and S22 versus Frequency

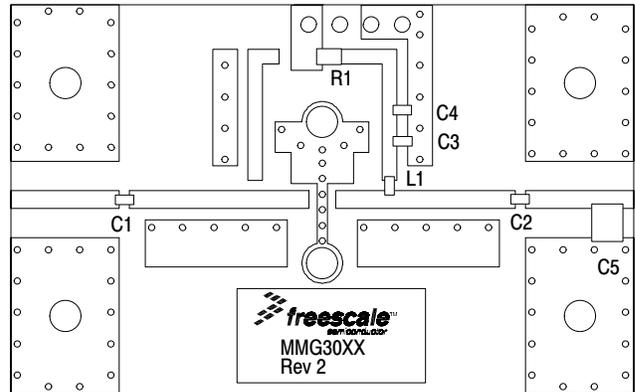


Figure 16. 50 Ohm Test Circuit Component Layout

Table 8. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2, C4	0.01 μ F Chip Capacitors	0603A103JAT2A	AVX
C3	68 pF Chip Capacitor	0805K680JBT	AVX
C5 (1)	2.7 pF Chip Capacitor for 40-800 MHz	12105J2R7BBT	AVX
L1	470 nH Chip Inductor	BK2125HM471	Taiyo Uden
R1	7.5 Ω Chip Resistor	RK73B2AT7R5J	KOA Speer

1. Tuning capacitor: Capacitor value and location on the transmission line are varied for different frequencies.

Table 9. Supply Voltage versus R1 Values

Supply Voltage	7	8	9	10	11	12	V
R1 Value	4.4	10	15.6	21	27	32	Ω

Note: To provide $V_{CC} = 6.2$ Vdc and $I_{CC} = 180$ mA at the device.

50 OHM APPLICATION CIRCUIT: 800-1100 MHz

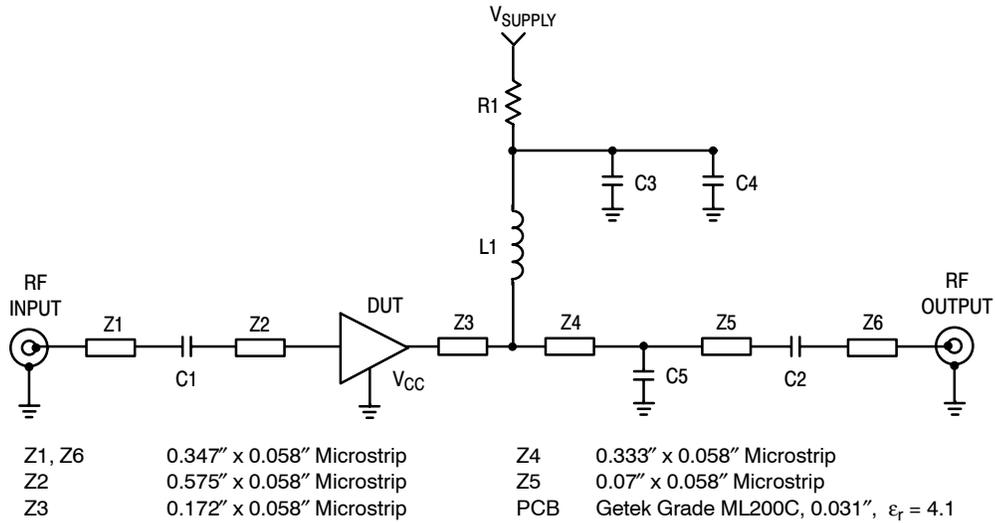


Figure 17. 50 Ohm Test Circuit Schematic

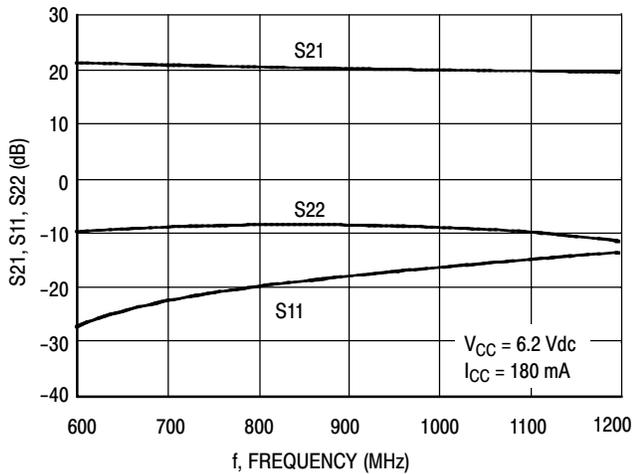


Figure 18. S21, S11 and S22 versus Frequency

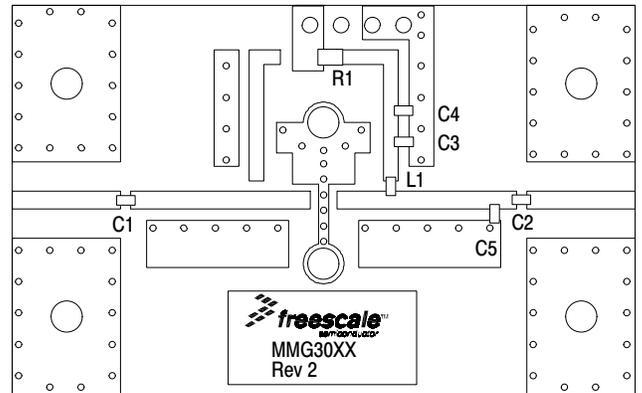


Figure 19. 50 Ohm Test Circuit Component Layout

Table 10. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	47 pF Chip Capacitors	0805K470JBT	AVX
C3	68 pF Chip Capacitor	0805K680JBT	AVX
C4	0.01 μ F Chip Capacitor	0603A103JAT2A	AVX
C5 (1)	2.7 pF Chip Capacitor for 800 - 1100 MHz	06035J2R7BBT	AVX
L1	22 nH Chip Inductor	HK160822NJ-T	Taiyo Uden
R1	7.5 Ω Chip Resistor	RK73B2AT7R5J	KOA Speer

1. Tuning capacitor: Capacitor value and location on the transmission line are varied for different frequencies.

50 OHM APPLICATION CIRCUIT: 1800-2400 MHz

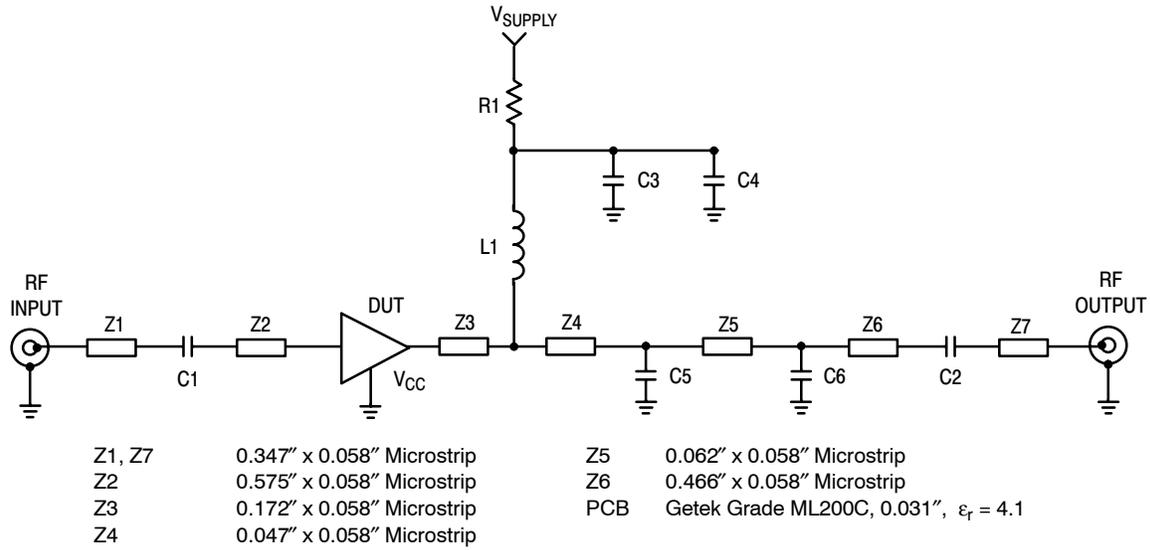


Figure 20. 50 Ohm Test Circuit Schematic

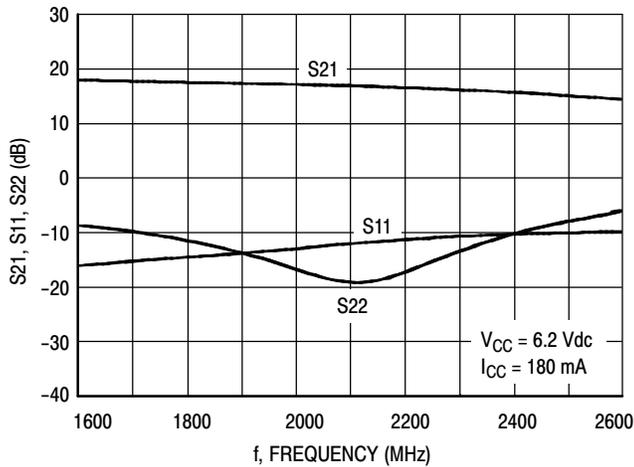


Figure 21. S21, S11 and S22 versus Frequency

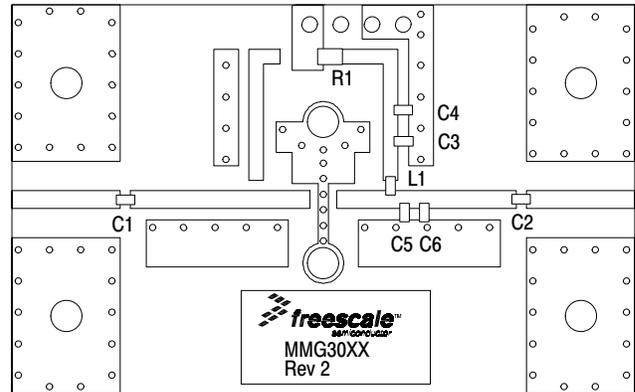


Figure 22. 50 Ohm Test Circuit Component Layout

Table 11. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	47 pF Chip Capacitors	0805K470JBT	AVX
C3	68 pF Chip Capacitor	0805K680JBT	AVX
C4	0.01 μ F Chip Capacitor	0603A103JAT2A	AVX
C5 (1)	1.2 pF Chip Capacitor for 1800-2400 MHz	06035J1R2BBT	AVX
C6 (1)	0.1 pF Chip Capacitor for 1800-2400 MHz	06035J0R1BBT	AVX
L1	22 nH Chip Inductor	HK160822NJ-T	Taiyo Uden
R1	7.5 Ω Chip Resistor	RK73B2AT7R5J	KOA Speer

1. Tuning capacitor: Capacitor value and location on the transmission line are varied for different frequencies.

50 OHM APPLICATION CIRCUIT: 2500-2700 MHz

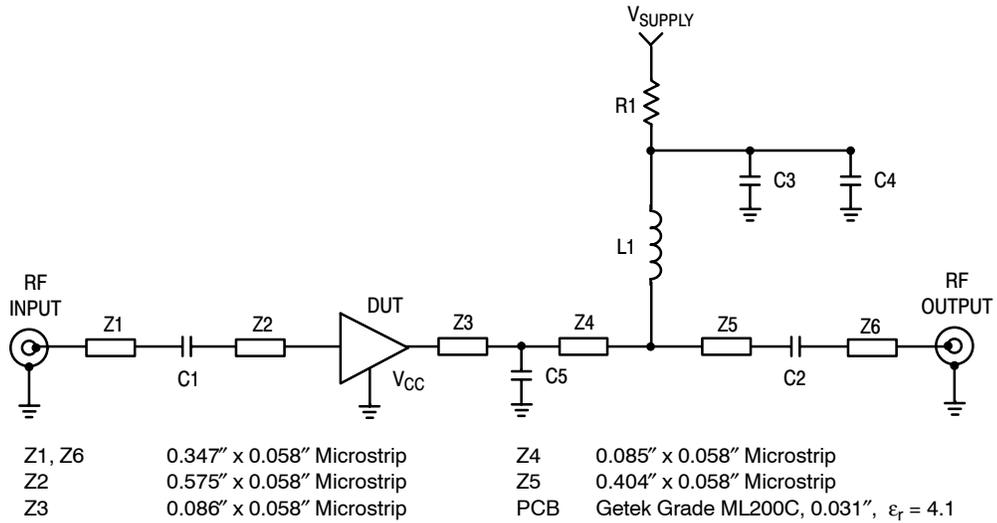


Figure 23. 50 Ohm Test Circuit Schematic

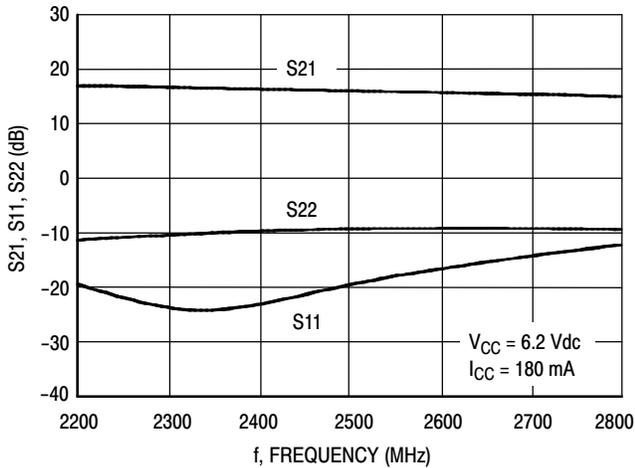


Figure 24. S21, S11 and S22 versus Frequency

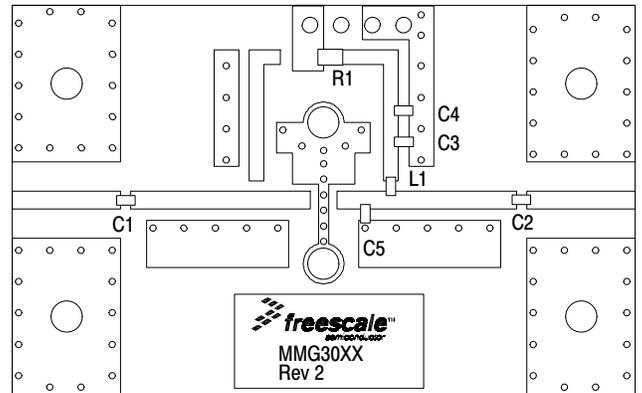


Figure 25. 50 Ohm Test Circuit Component Layout

Table 12. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	2.2 pF Chip Capacitors	0603A5J2R2BBT	AVX
C3	68 pF Chip Capacitor	0805K680JBT	AVX
C4	0.01 μ F Chip Capacitor	0603A103JAT2A	AVX
C5 (1)	1.2 pF Chip Capacitor for 2500-2700 MHz	06035J1R2BBT	AVX
L1	39 nH Chip Inductor	HK160839NJ-T	Taiyo Uden
R1	7.5 Ω Chip Resistor	RK73B2AT7R5J	KOA Speer

1. Tuning capacitor: Capacitor value and location on the transmission line are varied for different frequencies.

50 OHM APPLICATION CIRCUIT: 3400-3600 MHz

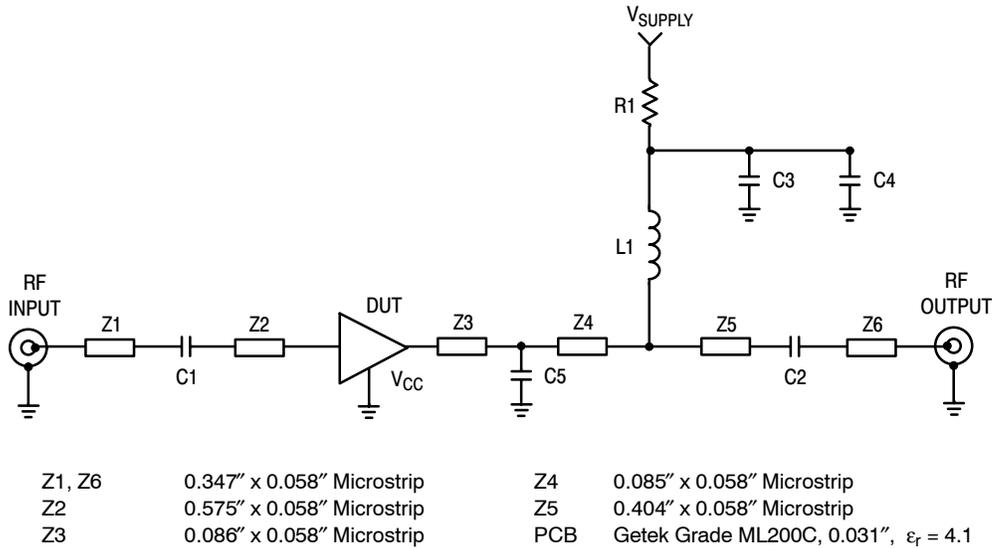


Figure 26. 50 Ohm Test Circuit Schematic

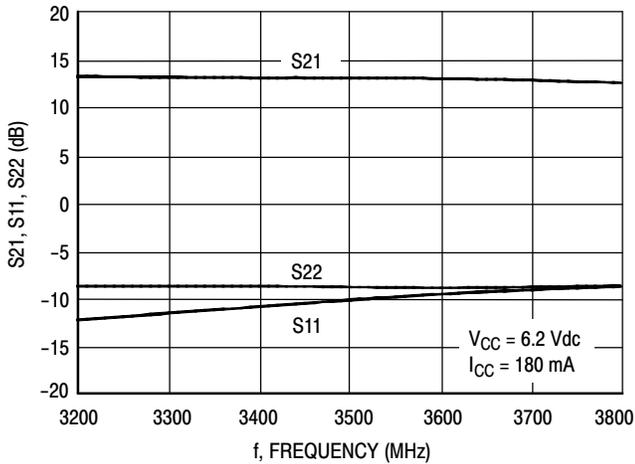


Figure 27. S21, S11 and S22 versus Frequency

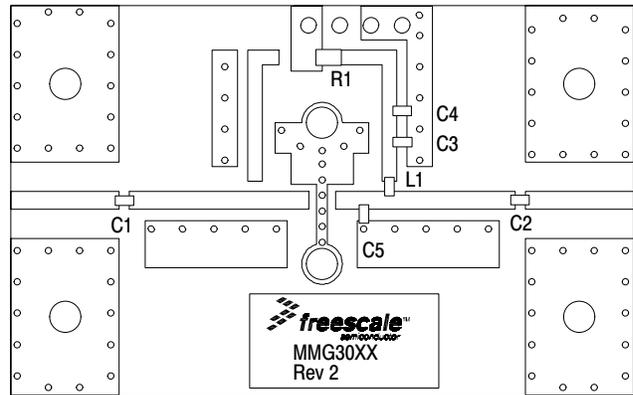


Figure 28. 50 Ohm Test Circuit Component Layout

Table 13. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	2.2 pF Chip Capacitors	0603A5J2R2BBT	AVX
C3	68 pF Chip Capacitor	0805K680JBT	AVX
C4	0.01 μ F Chip Capacitor	0603A103JAT2A	AVX
C5 (1)	0.5 pF Chip Capacitor for 3400-3600 MHz	06035J0R5BBT	AVX
L1	39 nH Chip Inductor	HK160839NJ-T	Taiyo Uden
R1	7.5 Ω Chip Resistor	RK73B2AT7R5J	KOA Speer

1. Tuning capacitor: Capacitor value and location on the transmission line are varied for different frequencies.

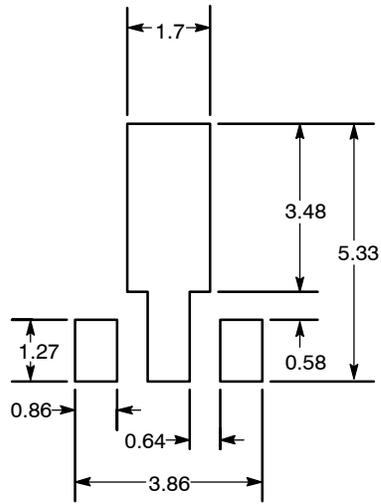
50 OHM TYPICAL CHARACTERISTICS

Table 14. Class A Common Emitter S-Parameters at $V_{CC} = 6.2$ Vdc, $I_{CC} = 180$ mA, $T_C = 25^\circ\text{C}$

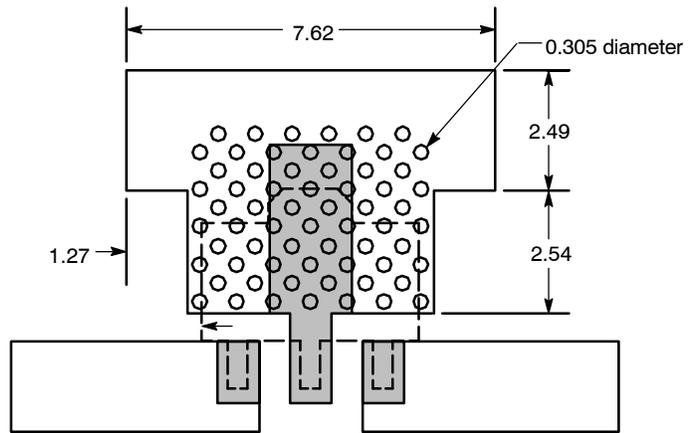
f GHz	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	S ₁₁	∠φ	S ₂₁	∠φ	S ₁₂	∠φ	S ₂₂	∠φ
0.1	0.141	178.297	12.985	173.850 0	0.057	0.785 0	0.087	-167.704
0.15	0.153	175.556	12.654	168.9	0.057	-0.913	0.136	-137.479
0.2	0.155	160.177	13.067	164.046	0.059	-2.423	0.125	-131.397
0.25	0.152	159.068	12.851	160.334	0.058	-2.897	0.159	-130.233
0.3	0.147	156.309	12.685	156.518	0.058	-3.227	0.187	-128.649
0.35	0.139	153.853	12.519	152.664	0.058	-3.971	0.212	-128.651
0.4	0.135	150.838	12.327	149.087	0.057	-4.471	0.239	-129.263
0.45	0.129	148.378	12.124	145.521	0.057	-4.799	0.263	-130.237
0.5	0.123	145.160	11.915	142.009	0.057	-5.285	0.285	-131.637
0.55	0.117	142.332	11.694	138.634	0.057	-5.623	0.306	-133.294
0.6	0.112	139.364	11.470	135.366	0.057	-6.012	0.326	-135.284
0.65	0.106	136.769	11.238	132.093	0.057	-6.295	0.345	-137.146
0.7	0.101	133.592	11.004	128.948	0.057	-6.705	0.362	-139.07
0.75	0.096	131.187	10.770	125.882	0.057	-7.044	0.378	-141.171
0.8	0.090	128.979	10.532	122.88	0.056	-7.277	0.394	-143.273
0.85	0.086	126.711	10.298	119.942	0.056	-7.495	0.408	-145.372
0.9	0.081	124.541	10.066	117.117	0.056	-7.847	0.422	-147.618
0.95	0.076	122.189	9.841	114.276	0.056	-8.05	0.435	-149.849
1	0.073	121.191	9.611	111.625	0.056	-8.311	0.447	-151.947
1.05	0.069	119.451	9.393	108.992	0.056	-8.582	0.458	-154.142
1.1	0.065	118.827	9.170	106.412	0.056	-8.89	0.470	-156.289
1.15	0.062	118.851	8.957	103.879	0.056	-9.079	0.480	-158.481
1.2	0.059	118.882	8.742	101.417	0.056	-9.405	0.490	-160.544
1.25	0.056	119.703	8.541	99.039	0.056	-9.615	0.498	-162.608
1.3	0.054	120.919	8.340	96.664	0.056	-9.805	0.507	-164.561
1.35	0.051	123.223	8.143	94.364	0.056	-10.198	0.515	-166.501
1.4	0.048	125.019	7.957	92.107	0.056	-10.536	0.522	-168.351
1.45	0.046	128.063	7.774	89.892	0.056	-10.724	0.530	-170.229
1.5	0.033	135.869	7.640	87.599	0.057	-11.197	0.529	-172.918
1.55	0.030	139.127	7.475	85.482	0.057	-11.434	0.536	-174.487
1.6	0.027	142.585	7.322	83.442	0.057	-11.649	0.541	-175.93
1.65	0.024	146.640	7.170	81.444	0.057	-11.993	0.546	-177.394
1.7	0.023	152.580	7.040	79.397	0.058	-12.335	0.552	-179.018
1.75	0.021	158.266	6.890	77.439	0.058	-12.616	0.555	179.899
1.8	0.021	166.196	6.756	75.477	0.058	-12.879	0.560	178.582
1.85	0.022	171.633	6.621	73.576	0.058	-13.16	0.563	177.318
1.9	0.023	177.431	6.495	71.695	0.058	-13.445	0.566	176.139
1.95	0.025	-176.142	6.371	69.952	0.059	-13.806	0.570	175.08
2	0.027	-173.137	6.251	67.988	0.059	-14.176	0.573	173.812
2.05	0.029	-170.367	6.135	66.175	0.059	-14.413	0.577	172.704
2.1	0.031	-168.467	6.025	64.385	0.060	-14.882	0.580	171.566
2.15	0.033	-168.388	5.921	62.595	0.060	-15.338	0.583	170.426
2.2	0.036	-169.515	5.815	60.823	0.060	-15.659	0.586	169.283
2.25	0.039	-170.197	5.716	59.079	0.061	-16.136	0.589	168.164
2.3	0.042	-171.944	5.618	57.331	0.061	-16.513	0.591	167.003
2.35	0.045	-173.747	5.525	55.573	0.061	-16.98	0.593	165.803

Table 14. Class A Common Emitter S-Parameters at $V_{CC} = 6.2$ Vdc, $I_{CC} = 180$ mA, $T_C = 25^\circ\text{C}$ (continued)

f GHz	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	S ₁₁	$\angle \phi$	S ₂₁	$\angle \phi$	S ₁₂	$\angle \phi$	S ₂₂	$\angle \phi$
2.4	0.048	-175.268	5.431	53.848	0.062	-17.435	0.595	164.669
2.45	0.052	-177.409	5.345	52.136	0.062	-17.955	0.597	163.447
2.5	0.056	-178.703	5.258	50.405	0.062	-18.404	0.598	162.182
2.55	0.060	179.650	5.173	48.736	0.063	-19.004	0.600	160.854
2.6	0.063	177.705	5.096	47.012	0.063	-19.505	0.602	159.516
2.65	0.067	175.894	5.015	45.266	0.063	-20.1	0.603	158.1
2.7	0.071	174.932	4.938	43.452	0.064	-20.75	0.605	156.649
2.75	0.074	172.453	4.861	41.831	0.064	-21.297	0.607	155.174
2.8	0.079	170.595	4.788	40.113	0.065	-21.999	0.609	153.675
2.85	0.083	168.962	4.715	38.402	0.065	-22.577	0.610	152.104
2.9	0.087	167.373	4.643	36.711	0.065	-23.239	0.612	150.539
2.95	0.091	165.543	4.573	35.036	0.066	-23.942	0.614	148.941
3	0.095	164.513	4.506	33.356	0.066	-24.652	0.616	147.251
3.05	0.099	163.309	4.438	31.684	0.066	-25.269	0.618	145.747
3.1	0.103	162.077	4.373	29.98	0.067	-26.085	0.620	144.105
3.15	0.107	161.249	4.308	28.307	0.067	-26.717	0.622	142.483
3.2	0.110	160.222	4.244	26.653	0.067	-27.483	0.624	140.894
3.25	0.114	159.057	4.182	25.007	0.068	-28.223	0.626	139.31
3.3	0.117	158.018	4.121	23.381	0.068	-29.013	0.629	137.737
3.35	0.119	156.94	4.061	21.791	0.068	-29.779	0.631	136.267
3.4	0.122	155.757	4.004	20.196	0.069	-30.535	0.633	134.76
3.45	0.126	154.754	3.949	18.618	0.069	-31.29	0.635	6
3.5	0.12826	153.898	3.895	17.049	0.06938	-31.957	0.6367	131.951
3.55	0.13168	152.875	3.84045	15.491	0.06971	-32.814	0.6392	130.655
3.6	0.13497	152.157	3.78882	13.97	0.07016	-33.474	0.64031	129.412



Recommended Solder Stencil



NOTES:

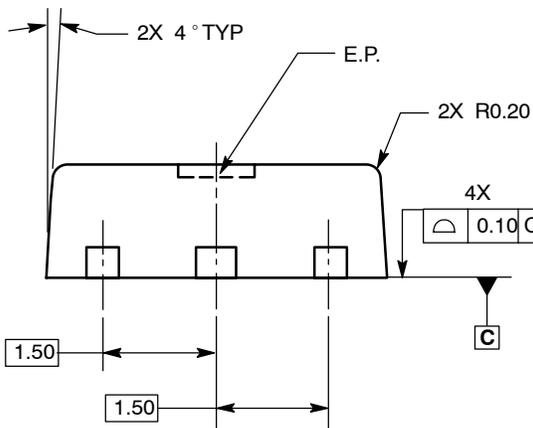
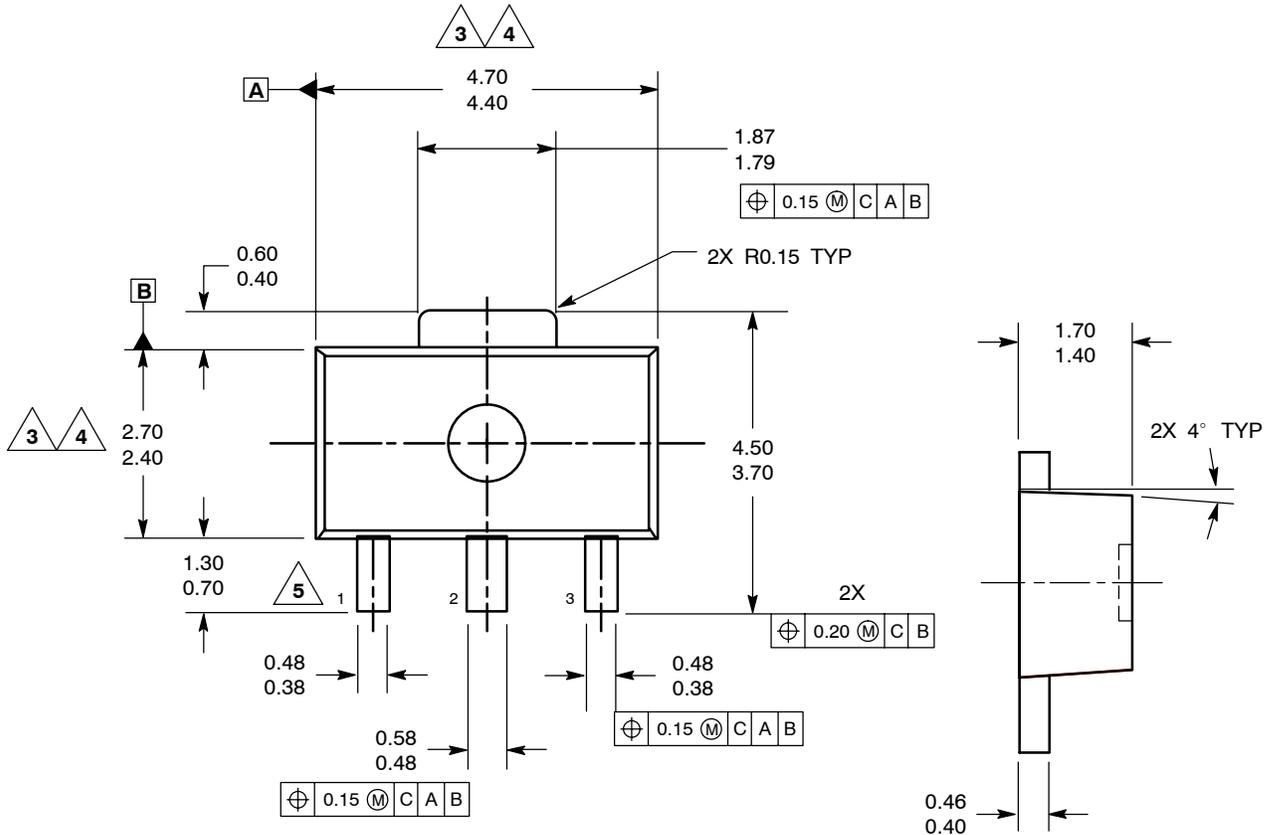
1. THERMAL AND RF GROUNDING CONSIDERATIONS SHOULD BE USED IN PCB LAYOUT DESIGN.
2. DEPENDING ON PCB DESIGN RULES, AS MANY VIAS AS POSSIBLE SHOULD BE PLACED ON THE LANDING PATTERN.
3. IF VIAS CANNOT BE PLACED ON THE LANDING PATTERN, THEN AS MANY VIAS AS POSSIBLE SHOULD BE PLACED AS CLOSE TO THE LANDING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

Figure 29. Recommended Mounting Configuration

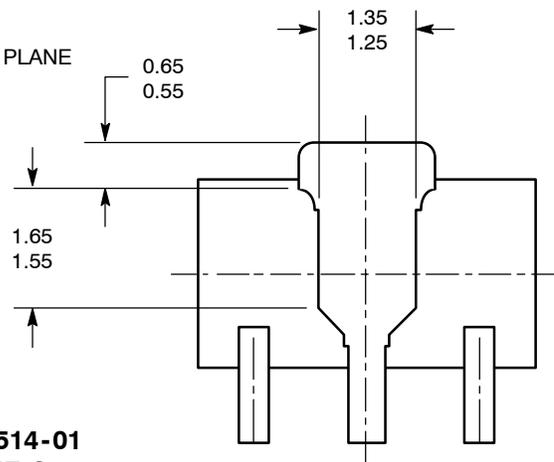


NOTES

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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