Freescale Semiconductor
Technical Data

Document Number: MMG3004NT1
Rev. 0, 11/2005

RoHS

Heterojunction Bipolar Transistor Technology (InGaP HBT)

Broadband High Linearity Amplifier

The MMG3004NT1 is a General Purpose Amplifier that is internally prematched and designed for a broad range of Class A, small-signal, high linearity, general purpose applications. It is suitable for applications with frequencies from 400 to 2200 MHz such as Cellular, PCS, WLL, PHS, VHF, UHF, UMTS and general small-signal RF.

Features

- Frequency: 400-2200 MHz
- P1dB: 27 dBm @ 2140 MHz
- Small-Signal Gain: 16 dB @ 2140 MHz
- Third Order Output Intercept Point: 44 dBm @ 2140 MHz
- Single 5 Volt Supply
- Internally Prematched to 50 Ohms
- Pb-Free Leads. RoHS Compliant.
- In Tape and Reel. T1 Suffix = 1000 Units per 12 mm, 7 inch Reel.

MMG3004NT1

400-2200 MHz, 16 dB
27 dBm
InGaP HBT

CASE 1543-02
PQFN 5x5
PLASTIC

Table 1. Typical Performance (1)

Characteristic	Symbol	900 MHz	1960 MHz	2140 MHz	Unit
Small-Signal Gain (S21)	G_p	19.5	16.5	16	dB
Input Return Loss (S11)	IRL	-7.5	-8	-8	dB
Output Return Loss (S22)	ORL	-10	-12	-12	dB
Power Output @1dB Compression	P1db	27	27	27	dBm
Third Order Output Intercept Point	IP3	44	44	44	dBm

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

Table 2. Maximum Ratings

Rating	Symbol	Value	Unit
Supply Voltage (2)	V_{DC}	6	V
Supply Current (2)	I_{DC}	400	mA
RF Input Power	P_{in}	18	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_{DC} = 5 Vdc, I_{DC} = 250 mA, T_C = 25°C)

Characteristic	Symbol	Value (4)	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	33	°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_{DC} = 5 Vdc, 2140 MHz, T_C = 25°C, 50 ohm system, in Freescale Application Circuit)

Characteristic	Symbol	Min	Typ	Max	Unit
Small-Signal Gain (S21)	G_p	15	16	—	dB
Input Return Loss (S11)	IRL	—	-8	—	dB
Output Return Loss (S22)	ORL	—	-12	—	dB
Power Output @ 1dB Compression	P1dB	—	27	—	dBm
Third Order Output Intercept Point	IP3	—	44	—	dBm
Noise Figure	NF	—	3.4	—	dB
Supply Current (1)	I_{DC}	225	250	275	mA
Supply Voltage (1)	V_{DC}	—	5	—	V

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

Table 5. Functional Pin Description

Name	Pin Number	Description
RF_{in}	2, 3, 4	RF input for the power amplifier. This pin is DC-coupled and requires a DC-blocking series capacitor.
RF_{OUT}/ V_{CC}	10, 11, 12	RF output for the power amplifier. This pin is DC-coupled and requires a DC-blocking series capacitor.
V_{CC}	14	Collector voltage supply.
V_{BA}	16	Bias voltage supply.
GND	Backside Center Metal	The center metal base of the PQFN package provides both DC and RF ground as well as heat sink contact for the power amplifier.

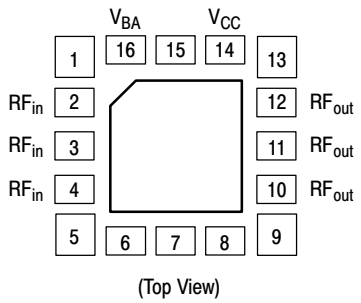


Figure 1. Pin Connections

Table 6. ESD Protection Characteristics

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)	III (Minimum)

Table 7. Moisture Sensitivity Level

Test Methodology	Rating	Package Peak Temperature	Unit
Per JESD 22-A113, IPC/JEDEC J-STD-020	3	260	°C

50 OHM TYPICAL CHARACTERISTICS

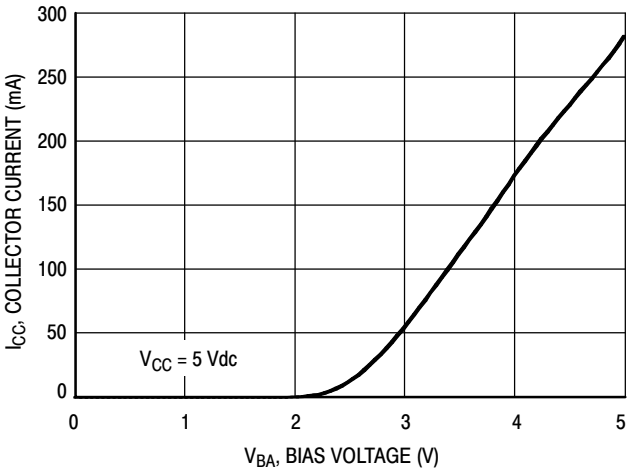
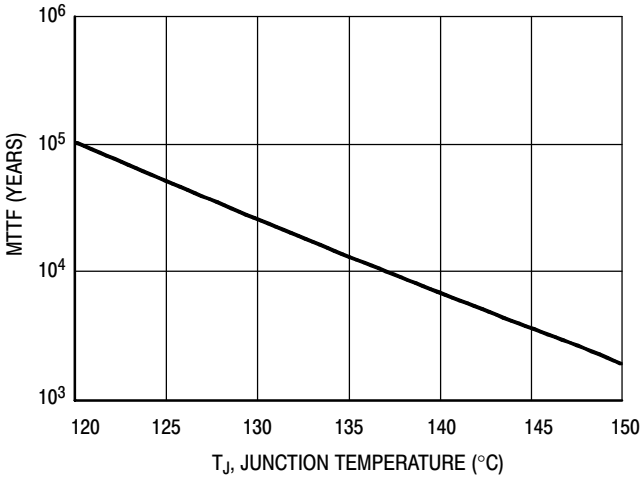


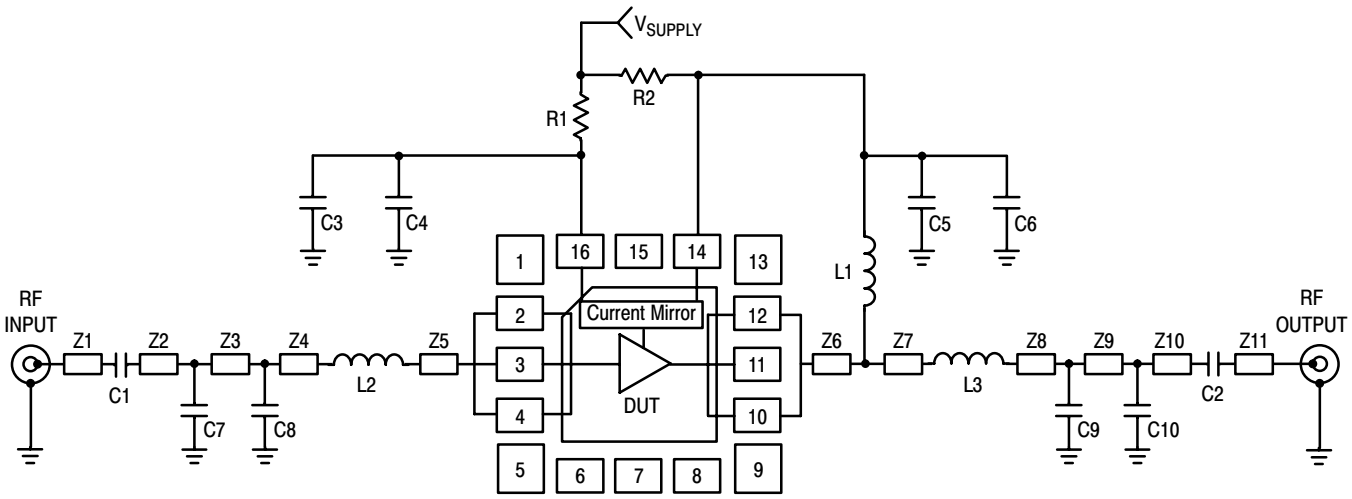
Figure 2. Collector Current versus Bias Voltage



NOTE: The MTTF is calculated with V_{DC} = 5 Vdc, I_{DC} = 250 mA

Figure 3. MTTF versus Junction Temperature

50 OHM APPLICATION CIRCUIT: 900 MHz



Z1, Z11	0.140″ x 0.028″ Microstrip	Z6	0.089″ x 0.028″ Microstrip
Z2, Z10	0.060″ x 0.028″ Microstrip	Z7	0.051″ x 0.028″ Microstrip
Z3	0.192″ x 0.028″ Microstrip	Z8	0.055″ x 0.028″ Microstrip
Z4	0.055″ x 0.028″ Microstrip	Z9	0.112″ x 0.028″ Microstrip
Z5	0.084″ x 0.028″ Microstrip	PCB	Isola FR408, 0.014″, ε_r = 3.7

Figure 4. 50 Ohm Test Circuit Schematic

Table 8. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	15 pF Chip Capacitors	ECUV1H150JCV	Panasonic
C3, C5	0.01 μF Chip Capacitors	0603A103JAT2A	AVX
C4, C6	0.1 μF Chip Capacitors	0603A102JAT2A	AVX
C7, C8	2.2 pF Chip Capacitors	06035J2R2BBT	AVX
C9, C10	1.8 pF Chip Capacitors	06035J1R8BBT	AVX
L1	33 nH Chip Inductor	LL1608-FH33NJ	Toko
L2, L3	3.9 nH Chip Inductors	LL1608-FH3N9S	Toko
R1	22 Ω Chip Resistor		
R2	0 Ω Chip Resistor		

50 OHM APPLICATION CIRCUIT: 900 MHz

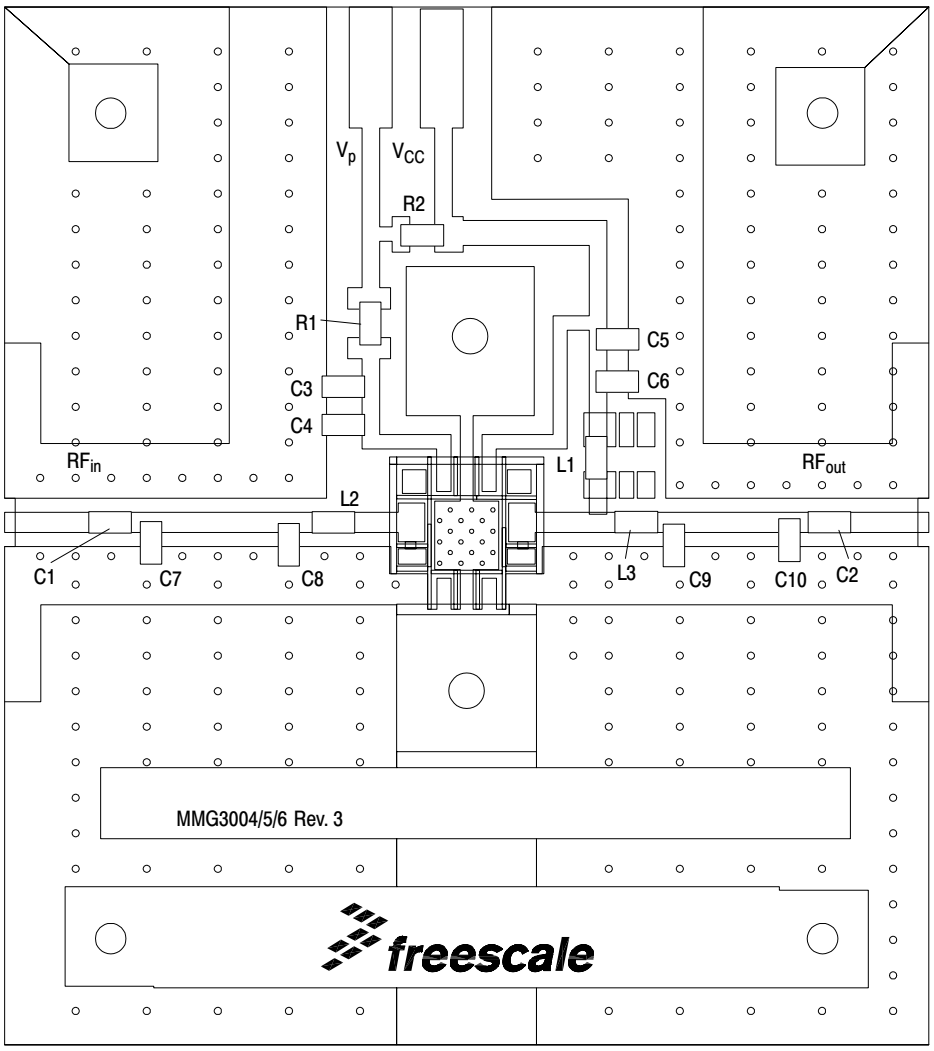


Figure 5. 50 Ohm Test Circuit Component Layout

50 OHM TYPICAL CHARACTERISTICS: 900 MHz

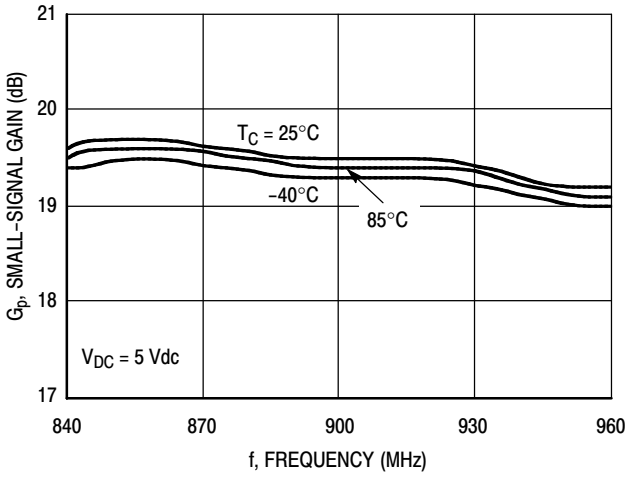


Figure 6. Small-Signal Gain (S21) versus Frequency

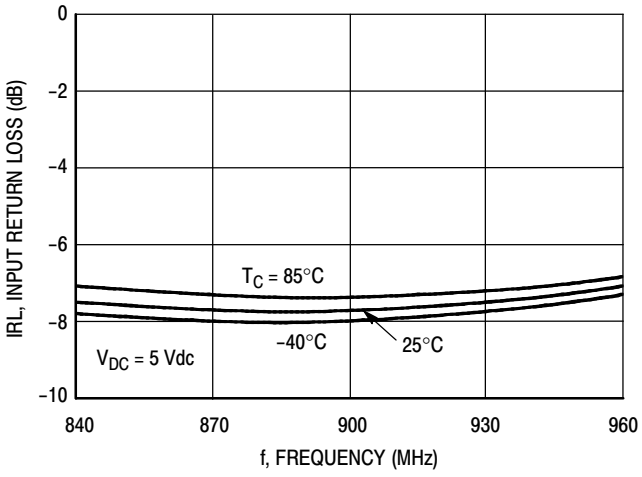


Figure 7. Input Return Loss (S11) versus Frequency

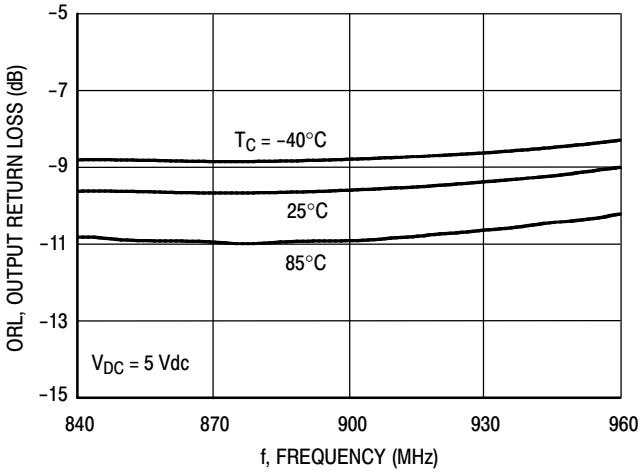


Figure 8. Output Return Loss (S22) versus Frequency

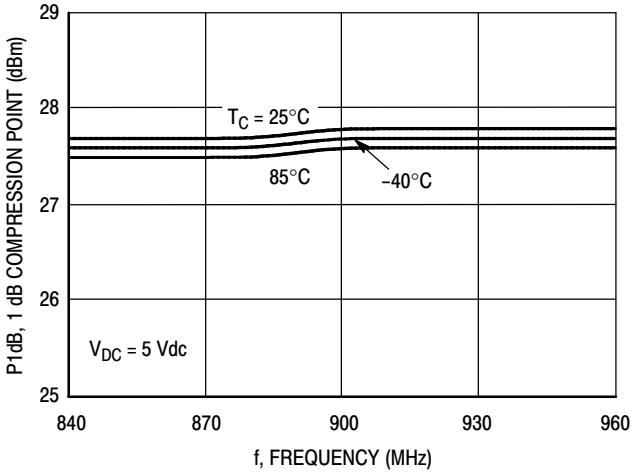


Figure 9. P1dB versus Frequency

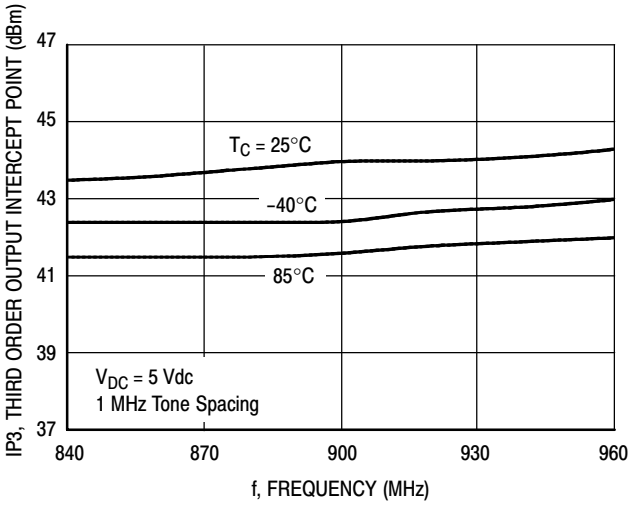


Figure 10. Third Order Output Intercept Point versus Frequency

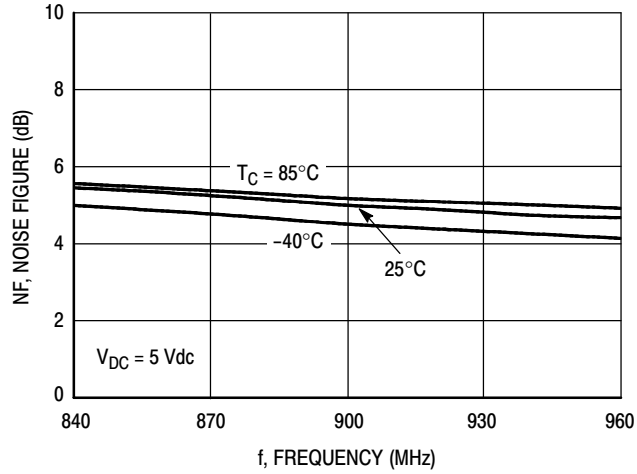


Figure 11. Noise Figure versus Frequency

50 OHM TYPICAL CHARACTERISTICS: 900 MHz

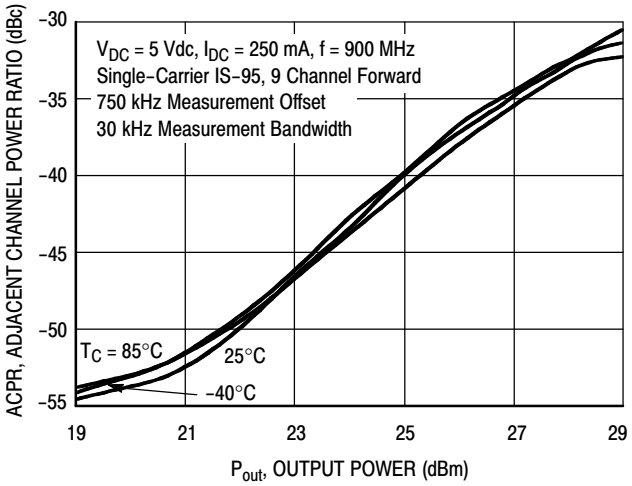


Figure 12. IS-95 Adjacent Channel Power Ratio versus Output Power

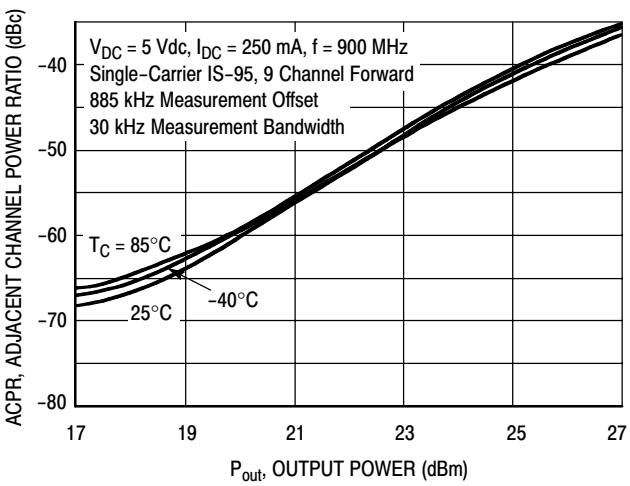
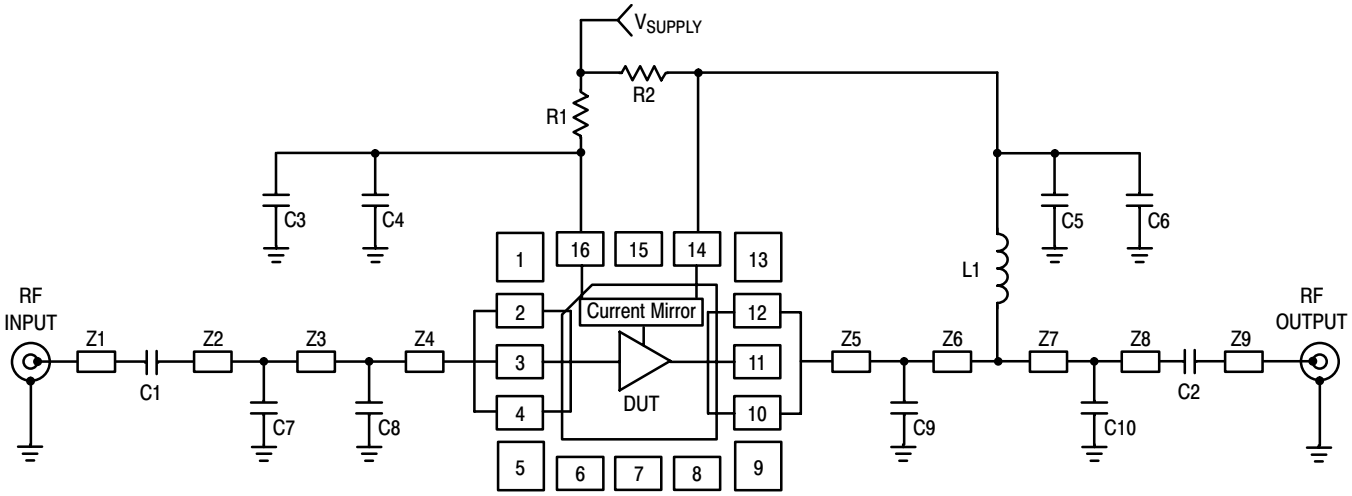


Figure 13. IS-95 Adjacent Channel Power Ratio versus Output Power

50 OHM APPLICATION CIRCUIT: 1900 - 2200 MHz



Z1, Z9	0.140″ x 0.028″ Microstrip	Z5	0.049″ x 0.028″ Microstrip
Z2, Z8	0.060″ x 0.028″ Microstrip	Z6	0.036″ x 0.028″ Microstrip
Z3	0.259″ x 0.028″ Microstrip	Z7	0.254″ x 0.028″ Microstrip
Z4	0.080″ x 0.028″ Microstrip	PCB	Isola FR408, 0.014″, ε_r = 3.7

Figure 14. 50 Ohm Test Circuit Schematic

Table 9. 50 Ohm Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	15 pF Chip Capacitors	ECUV1H150JCV	Panasonic
C3, C5	0.01 μF Chip Capacitors	0603A103JAT2A	AVX
C4, C6	0.1 μF Chip Capacitors	0603A102JAT2A	AVX
C7, C10	0.5 pF Chip Capacitors	06035J0R5BBT	AVX
C8	2.7 pF Chip Capacitor	06035J2R7BBT	AVX
C9	0.8 pF Chip Capacitor	06035J0R8BBT	AVX
L1	33 nH Chip Inductor	LL1608 - FH33NJ	Toko
R1	22 Ω Chip Resistor		
R2	0 Ω Chip Resistor		

50 OHM APPLICATION CIRCUIT: 1900 - 2200 MHz

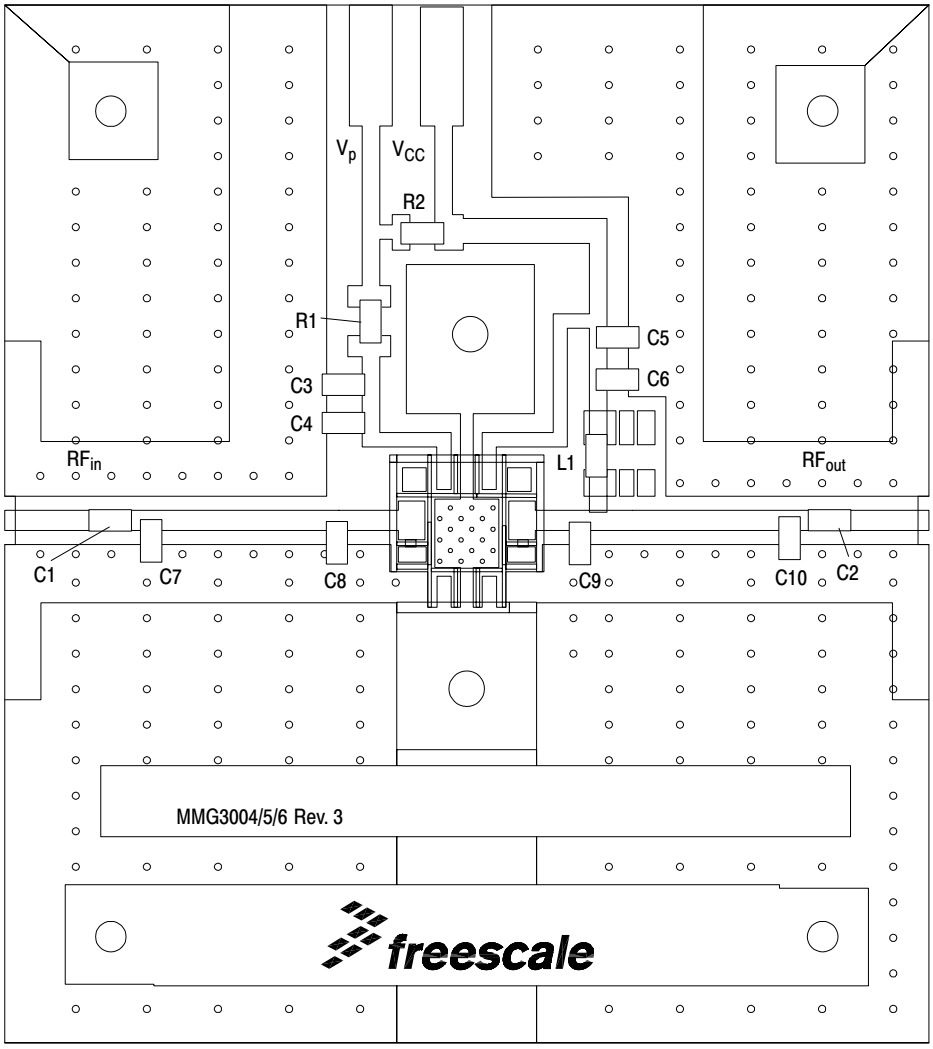


Figure 15. 50 Ohm Test Circuit Component Layout

50 OHM TYPICAL CHARACTERISTICS: 1900 - 2200 MHz

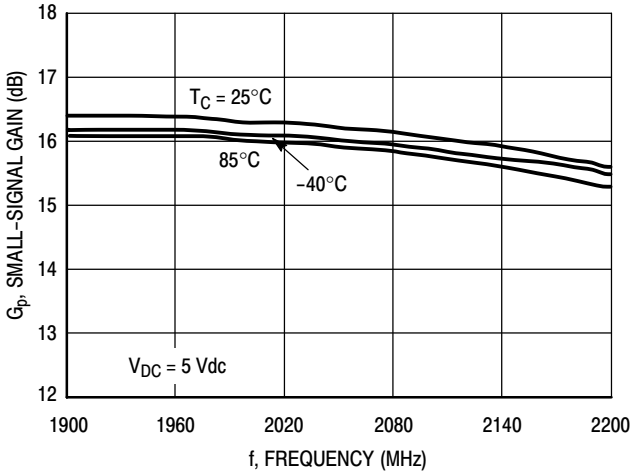


Figure 16. Small-Signal Gain (S21) versus Frequency

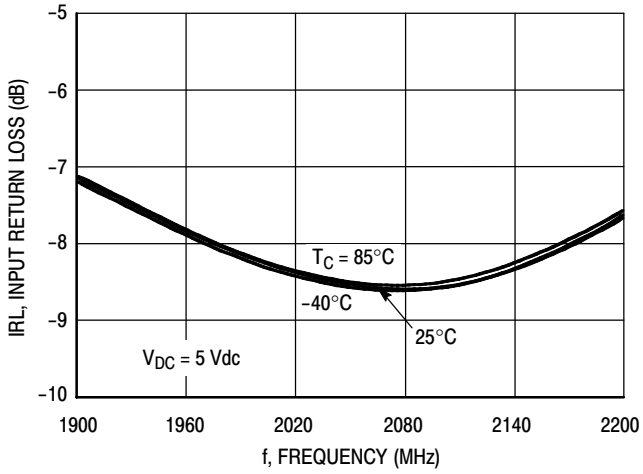


Figure 17. Input Return Loss (S11) versus Frequency

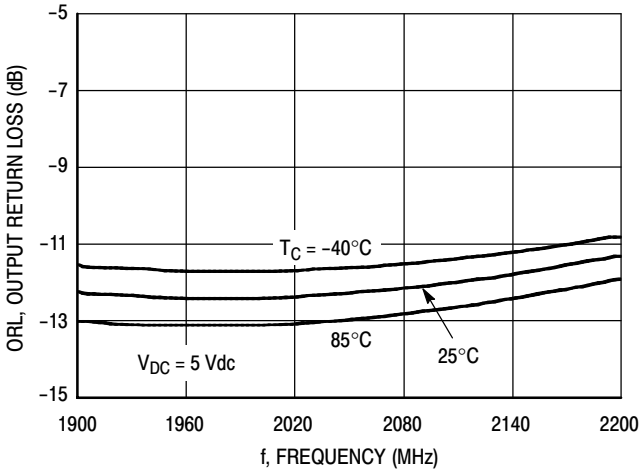


Figure 18. Output Return Loss (S22) versus Frequency

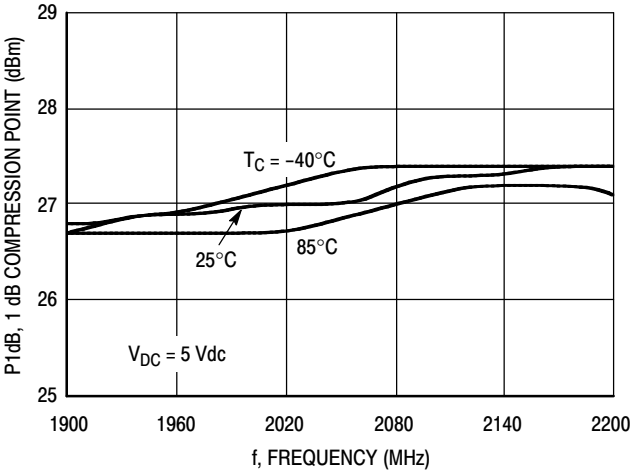


Figure 19. P1dB versus Frequency

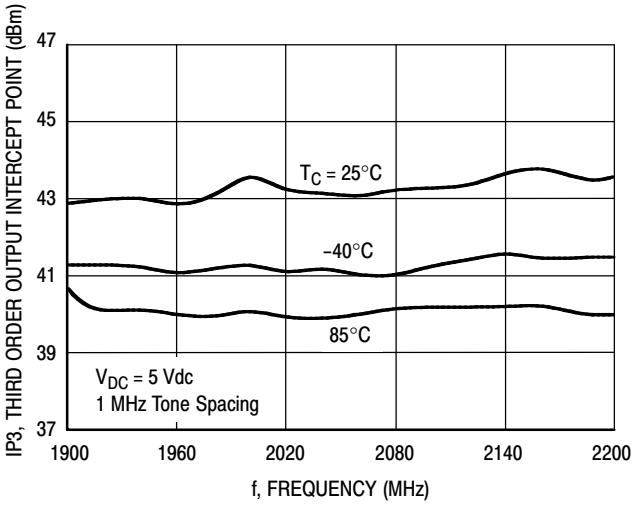


Figure 20. Third Order Output Intercept Point versus Frequency

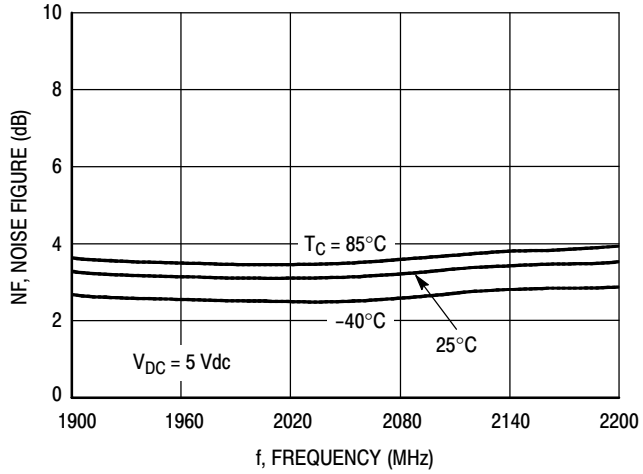


Figure 21. Noise Figure versus Frequency

50 OHM TYPICAL CHARACTERISTICS: 1900 - 2200 MHz

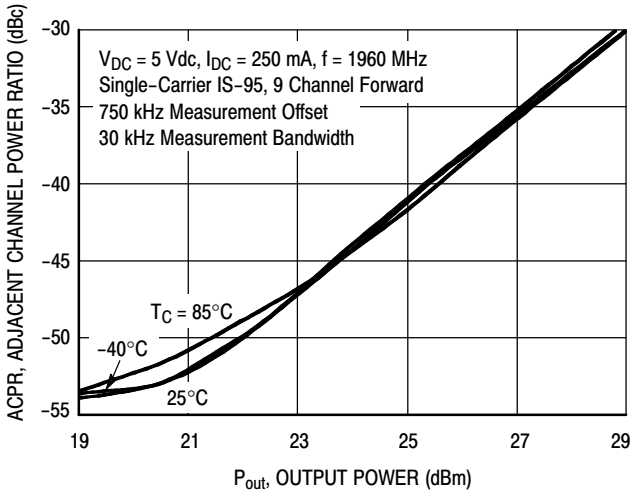


Figure 22. IS-95 Adjacent Channel Power Ratio versus Output Power

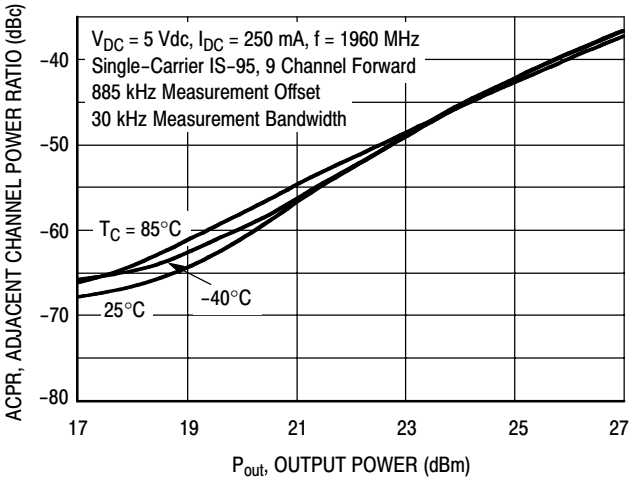


Figure 23. IS-95 Adjacent Channel Power Ratio versus Output Power

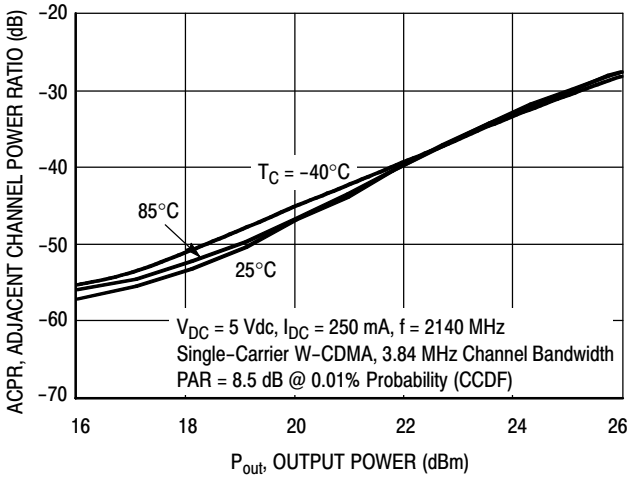


Figure 24. Single-Carrier W-CDMA Adjacent Channel Power Ratio versus Output Power

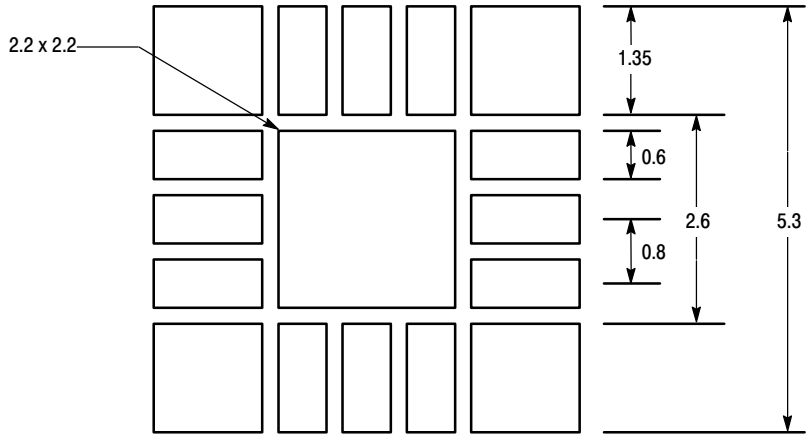
50 OHM TYPICAL CHARACTERISTICS

Table 10. Class A Common Emitter S-Parameters at V_{DC} = 5 Vdc, I_{DC} = 250 mA, T_C = 25°C

f	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
0.25	0.47850	-144.63	9.45303	155.76	0.01650	-37.55	0.72316	-177.17
0.30	0.52079	-147.32	9.03153	149.91	0.01507	-32.08	0.72165	-179.65
0.35	0.56232	-150.13	8.58464	144.58	0.01400	-27.65	0.72111	178.58
0.40	0.60124	-152.97	8.14110	139.74	0.01312	-23.56	0.72123	177.23
0.45	0.63724	-155.74	7.71607	135.24	0.01238	-19.64	0.72227	176.23
0.50	0.67062	-158.39	7.30892	131.03	0.01178	-15.72	0.72607	175.49
0.55	0.69942	-160.88	6.89268	127.12	0.01127	-11.78	0.72827	174.79
0.60	0.72531	-163.15	6.49002	123.55	0.01089	-7.87	0.73132	174.32
0.65	0.74778	-165.23	6.11441	120.27	0.01059	-3.96	0.73450	173.93
0.70	0.76805	-167.12	5.76070	117.18	0.01038	-0.12	0.73738	173.62
0.75	0.78656	-168.87	5.45265	114.30	0.01026	3.42	0.74039	173.40
0.80	0.80272	-170.48	5.15936	111.47	0.01020	6.89	0.74323	173.19
0.85	0.81645	-171.90	4.88436	108.89	0.01021	10.11	0.74517	173.02
0.90	0.82822	-173.17	4.62846	106.51	0.01027	13.05	0.74685	172.87
0.95	0.83744	-174.28	4.39398	104.33	0.01040	15.81	0.74824	172.75
1.00	0.84657	-175.33	4.19167	102.27	0.01057	18.21	0.74859	172.62
1.05	0.85407	-176.30	4.02364	100.34	0.01077	20.46	0.74854	172.44
1.10	0.86090	-177.20	3.94135	98.55	0.01104	22.47	0.74717	172.28
1.15	0.86535	-178.01	3.91900	96.85	0.01133	24.29	0.74526	172.02
1.20	0.86886	-178.83	3.85851	95.17	0.01170	25.89	0.74174	171.79
1.25	0.87175	-179.63	3.79219	93.55	0.01213	27.37	0.73677	171.52
1.30	0.87371	179.54	3.72665	91.87	0.01260	28.59	0.72983	171.23
1.35	0.87541	178.70	3.67139	90.24	0.01314	29.59	0.72142	171.00
1.40	0.87551	177.79	3.61378	88.58	0.01374	30.35	0.71266	170.74
1.45	0.87377	176.80	3.54706	86.86	0.01441	31.03	0.70274	170.34
1.50	0.87157	175.77	3.49666	85.07	0.01515	31.39	0.68899	169.84
1.55	0.86970	174.61	3.43623	83.27	0.01593	31.55	0.67338	169.39
1.60	0.87145	173.30	3.37777	81.56	0.01667	31.82	0.65921	168.89
1.65	0.87360	172.88	3.29315	79.82	0.01704	32.13	0.64230	168.30
1.70	0.87554	171.27	3.23698	78.19	0.01742	32.44	0.63500	167.61
1.75	0.87801	170.47	3.18392	76.44	0.01787	32.72	0.62803	166.69
1.80	0.87960	169.84	3.12886	74.79	0.01827	33.03	0.62082	165.48
1.85	0.88138	168.45	3.07394	73.09	0.01868	33.51	0.61361	164.62
1.90	0.88346	167.07	3.02285	70.94	0.01909	33.93	0.60658	163.92
1.95	0.88598	166.55	2.96910	69.97	0.01943	34.35	0.59945	162.22
2.00	0.88778	165.97	2.91830	68.84	0.01979	34.80	0.59252	160.49
2.05	0.88960	164.20	2.86794	67.75	0.02016	35.21	0.58583	158.82
2.10	0.89142	163.32	2.82292	66.45	0.02056	35.61	0.57935	155.15
2.15	0.89304	162.24	2.77684	64.77	0.02099	35.94	0.57343	153.51
2.20	0.89418	161.03	2.72905	63.07	0.02145	36.24	0.56807	150.95
2.25	0.89508	160.65	2.68145	61.37	0.02191	36.53	0.56323	147.48
2.30	0.89600	159.14	2.63323	59.64	0.02243	36.76	0.55888	144.06
2.35	0.89634	158.47	2.58664	57.91	0.02297	36.91	0.55599	141.76
2.40	0.89699	157.61	2.54289	56.14	0.02356	37.09	0.55378	138.51
2.45	0.89702	155.66	2.50232	54.31	0.02424	37.17	0.55279	137.25

Table 10. Class A Common Emitter S-Parameters at V_{DC} = 5 Vdc, I_{DC} = 250 mA, T_C = 25°C (continued)

f	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
2.50	0.89704	153.55	2.46083	52.48	0.02497	37.10	0.55229	136.08
2.55	0.89673	151.36	2.41952	50.63	0.02577	36.86	0.55220	134.93
2.60	0.89666	149.04	2.37843	48.76	0.02662	36.46	0.55253	133.86
2.65	0.89604	147.95	2.33835	46.85	0.02748	35.86	0.55292	132.84
2.70	0.89565	146.13	2.29930	44.91	0.02839	35.08	0.55313	131.90
2.75	0.89574	144.58	2.26245	42.98	0.02929	34.17	0.55301	131.05
2.80	0.89516	142.97	2.22577	41.05	0.03020	33.15	0.55285	130.28
2.85	0.89417	141.35	2.18910	39.16	0.03111	32.05	0.55271	129.61
2.90	0.89358	139.74	2.15463	37.28	0.03203	30.83	0.55189	128.97
2.95	0.89313	137.08	2.12107	35.40	0.03295	29.56	0.55130	128.44
3.00	0.89241	135.52	2.09065	33.50	0.03387	28.22	0.55001	127.89



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 BACKSIDE CENTER METAL GROUND LANDING PATTERN.
3. REFER TO FREESCALE APPLICATION NOTE AN2467 FOR ADDITIONAL PQFN PCB GUIDELINES.

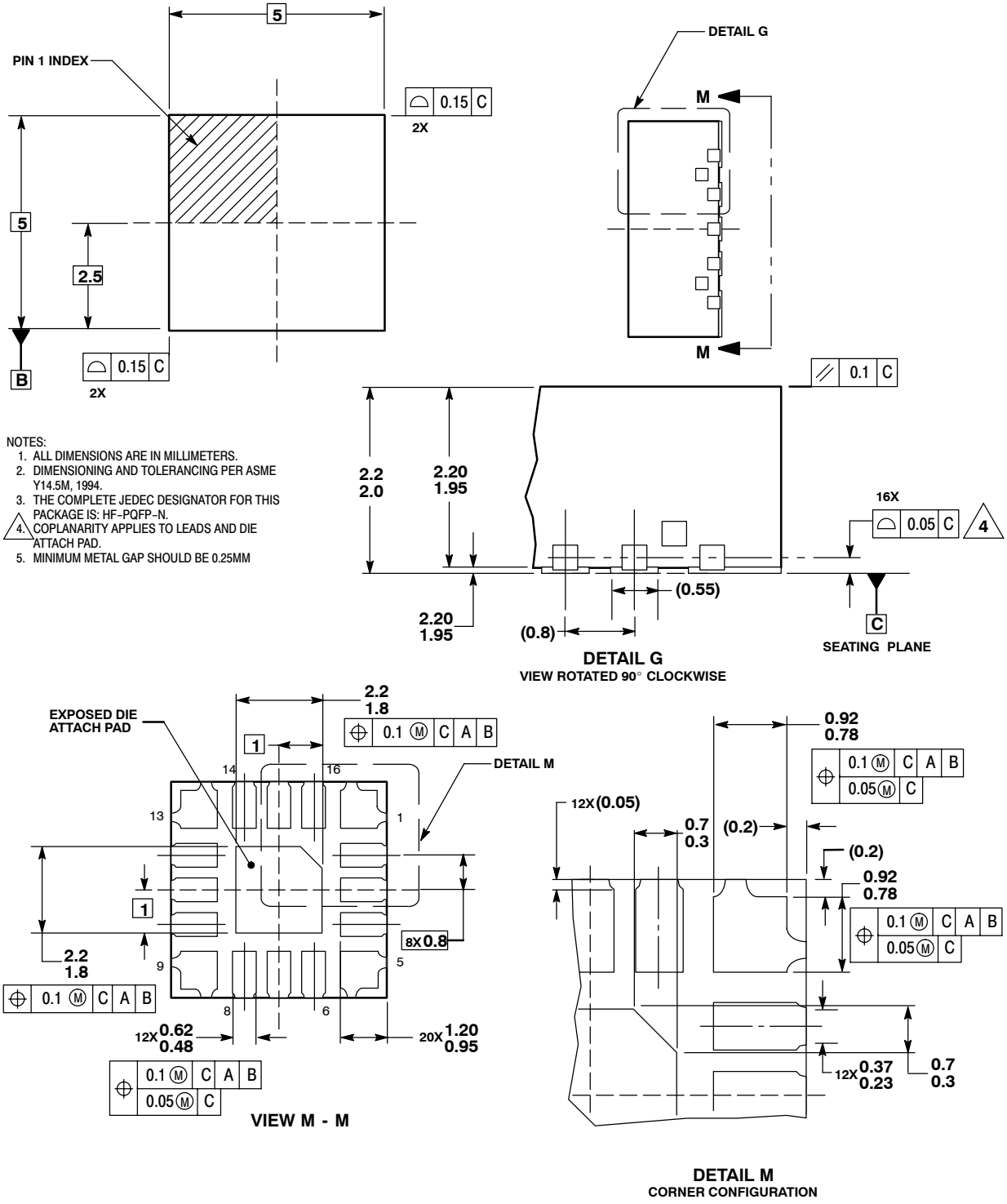
Figure 25. Recommended Mounting Configuration

NOTES

NOTES

NOTES

PACKAGE DIMENSIONS



NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
3. THE COMPLETE JEDEC DESIGNATOR FOR THIS PACKAGE IS: HF-PQFP-N.
4. COPLANARITY APPLIES TO LEADS AND DIE ATTACH PAD.
5. MINIMUM METAL GAP SHOULD BE 0.25MM

CASE 1543-02
ISSUE B
PQFN 5x5
PLASTIC

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Document Number: MMG3004NT1
Rev. 0, 11/2005