Document Number: MW6IC2240N
Rev. 1, 1/2006

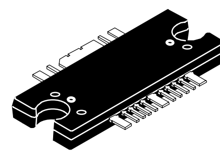
RoHS

RF LDMOS Wideband Integrated Power Amplifiers

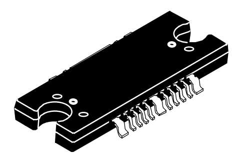
MW6IC2240NBR1
MW6IC2240GNBR1

The MW6IC2240N wideband integrated circuit is designed with on-chip matching that makes it usable from 2110 to 2170 MHz. This multi-stage structure is rated for 26 to 32 Volt operation and covers all typical cellular base station modulation formats.

2110-2170 MHz, 4.5 W AVG., 28 V
2 x W-CDMA
RF LDMOS WIDEBAND
INTEGRATED POWER AMPLIFIERS



CASE 1329-09
TO-272 WB-16
PLASTIC
MW6IC2240NBR1



CASE 1329A-03
TO-272 WB-16 GULL
PLASTIC
MW6IC2240GNBR1

Final Application

- Typical 2-Carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQ1} = 210 mA, I_{DQ2} = 370 mA, P_{out} = 4.5 Watts Avg., Full Frequency Band (2110-2170 MHz), Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
  Power Gain — 28 dB
  Power Added Efficiency — 15%
  IM3 @ 10 MHz Offset — -43 dBc in 3.84 MHz Bandwidth
  ACPR @ 5 MHz Offset — -46 dBc in 3.84 MHz Bandwidth

Driver Application

- Typical 2-Carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQ1} = 300 mA, I_{DQ2} = 320 mA, P_{out} = 25 dBm, Full Frequency Band (2110-2170 MHz), Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
  Power Gain — 29 dB
  IM3 @ 10 MHz Offset — -59 dBc in 3.84 MHz Bandwidth
  ACPR @ 5 MHz Offset — -62 dBc in 3.84 MHz Bandwidth
- Capable of Handling 3:1 VSWR, @ 28 Vdc, 2170 MHz, 20 Watts CW Output Power
- Stable into a 3:1 VSWR. All Spurs Below -60 dBc @ 100 mW to 10 W CW P_{out}.
- Characterized with Series Equivalent Large-Signal Impedance Parameters and Common Source Scattering Parameters
- On-Chip Matching (50 Ohm Input, DC Blocked, >3 Ohm Output)
- Integrated Quiescent Current Temperature Compensation with Enable/Disable Function
- Integrated ESD Protection
- 200°C Capable Plastic Package
- N Suffix Indicates Lead-Free Terminations. RoHS Compliant.
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel

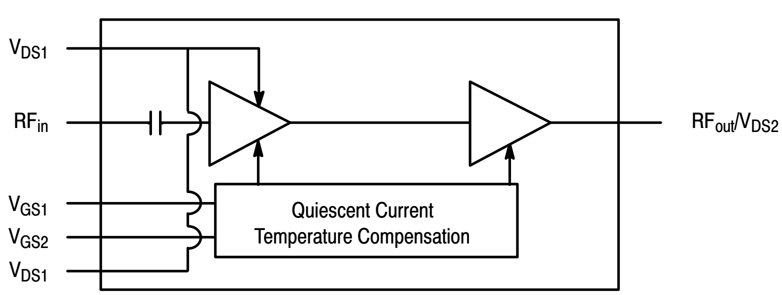
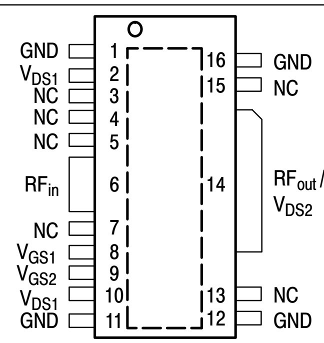


Figure 1. Functional Block Diagram



(Top View)
Note: Exposed backside flag is source terminal for transistors.

Figure 2. Pin Connections

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +68	Vdc
Gate-Source Voltage	V_{GS}	-0.5, +6	Vdc
Storage Temperature Range	T_{stg}	-65 to +200	°C
Operating Junction Temperature	T_J	200	°C
Input Power	P_{in}	23	dBm

Table 2. Thermal Characteristics

Characteristic		Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case		$R_{\theta JC}$		°C/W
W-CDMA Application (P_{out} = 4.5 W Avg.)	Stage 1, 28 Vdc, I_{DQ} = 210 mA		1.8	
	Stage 2, 28 Vdc, I_{DQ} = 370 mA		1.0	
W-CDMA Application (P_{out} = 40 W CW)	Stage 1, 28 Vdc, I_{DQ} = 110 mA		2.0	
	Stage 2, 28 Vdc, I_{DQ} = 370 mA		0.87	

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	1A (Minimum)
Machine Model (per EIA/JESD22-A115)	A (Minimum)
Charge Device Model (per JESD22-C101)	III (Minimum)

Table 4. Moisture Sensitivity Level

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

Table 5. Electrical Characteristics (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit

Functional Tests (In Freescale Wideband 2110-2170 MHz Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ1} = 210 mA, I_{DQ2} = 370 mA, P_{out} = 4.5 W Avg., f1 = 2112.5 MHz, f2 = 2122.5 MHz and f1 = 2157.5 MHz, f2 = 2167.5 MHz, 2-Carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset. IM3 measured in 3.84 MHz Channel Bandwidth @ ±10 MHz Offset. PAR = 8.5 dB @ 0.01% Probability on CCDF.

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain	G_{ps}	25.5	28	30	dB
Power Added Efficiency	PAE	13.7	15	—	%
Intermodulation Distortion	IM3	—	-43	-40	dBc
Adjacent Channel Power Ratio	ACPR	—	-46	-43	dBc
Input Return Loss	IRL	—	-15	-10	dB

1. MTTF calculator available at http://www.freescale.com/rf. Select Tools/Software/Application Software/Calculators to access the MTTF calculators by product.
2. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1955.

(continued)

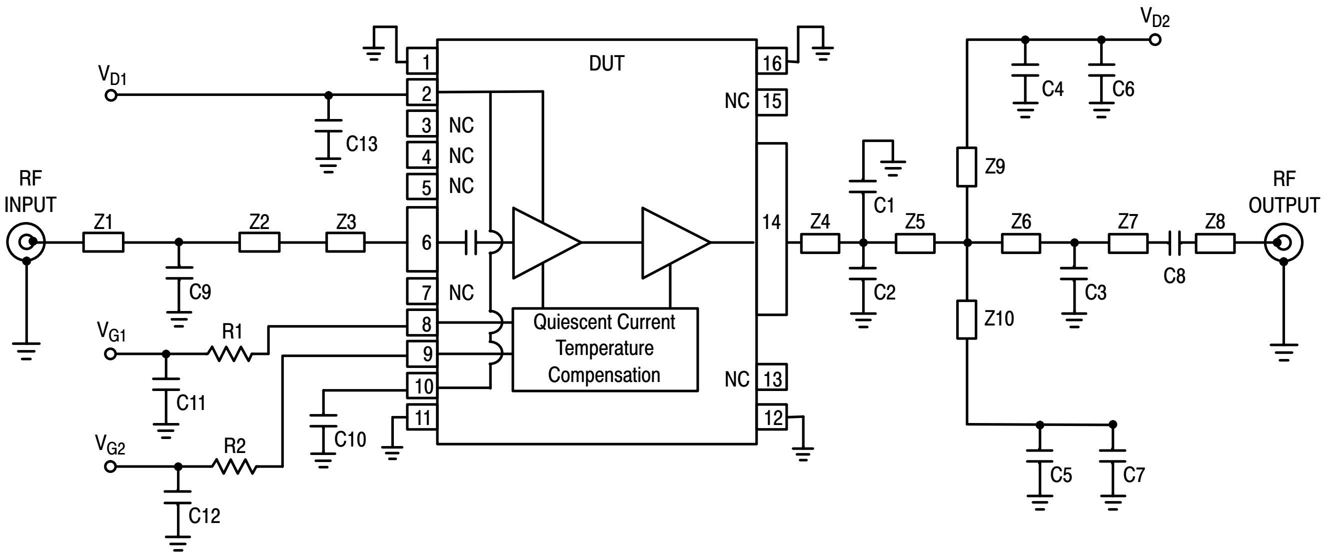
Table 5. Electrical Characteristics (T_C = 25°C unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Typical Performances (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ1} = 210 mA, I_{DQ2} = 370 mA, 2110 MHz<Frequency<2170 MHz					
Video Bandwidth (Tone Spacing from 100 kHz to VBW) ΔIMD3 = IMD3 @ VBW frequency - IMD3 @ 100 kHz <1 dBc (both sidebands)	VBW	—	30	—	MHz
Quiescent Current Accuracy over Temperature with 18 kΩ Gate Feed Resistors (-10 to 85°C) (1)	ΔI_{QT}	—	±5	—	%
Gain Flatness in 30 MHz Bandwidth @ P_{out} = 1 W CW	G_F	—	0.2	—	dB
Deviation from Linear Phase in 30 MHz Bandwidth @ P_{out} = 1 W CW	Φ	—	±1	—	°
Delay @ P_{out} = 1 W CW Including Output Matching	Delay	—	2.8	—	ns
Part-to-Part Phase Variation @ P_{out} = 1 W CW	ΔΦ	—	±9	—	°

Table 6. Electrical Characteristics (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Typical Performances (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ1} = 110 mA, I_{DQ2} = 370 mA, 2110 MHz<Frequency<2170 MHz					
Saturated Pulsed Output Power (8 μsec(on), 1 msec(off))	P_{sat}	—	60	—	W

1. Refer to AN1977, *Quiescent Current Thermal Tracking Circuit in the RF Integrated Circuit Family.* Go to http://www.freescale.com/rf. Select Documentation/ApplicationNotes - AN1977.



Z1*	1.73″ x 0.090″ Microstrip
Z2*	0.47″ x 0.090″ Microstrip
Z3	0.13″ x 0.040″ Microstrip
Z4*	0.22″ x 0.315″ Microstrip
Z5*	0.34″ x 0.315″ Microstrip
Z6*	0.34″ x 0.090″ Microstrip
Z7*	0.94″ x 0.090″ Microstrip
Z8	0.34″ x 0.090″ Microstrip
Z9, Z10	1.00″ x 0.080″ Microstrip
PCB	Taconic TLX8-0300, 0.030″, $\varepsilon_r = 2.55$

* Variable for tuning

Figure 3. MW6IC2240NBR1(GNBR1) Test Circuit Schematic

Table 7. MW6IC2240NBR1(GNBR1) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	1.5 pF 100B Chip Capacitors	100B1R5BW	ATC
C3	1.8 pF 100B Chip Capacitor	100B1R8BW	ATC
C4, C5	6.8 pF 100B Chip Capacitors	100B6R8CW	ATC
C6, C7, C10, C11, C12, C13	4.7 μF Chip Capacitors (1812)	C4532X5R1H475MT	TDK
C8	8.2 pF 100B Chip Capacitor	100B8R2CW	ATC
C9	0.5 pF 100B Chip Capacitor	100B0R5BW	ATC
R1	18 kΩ, 1/4 W Chip Resistor (1206)		
R2	8.2 kΩ, 1/4 W Chip Resistor (1206)		

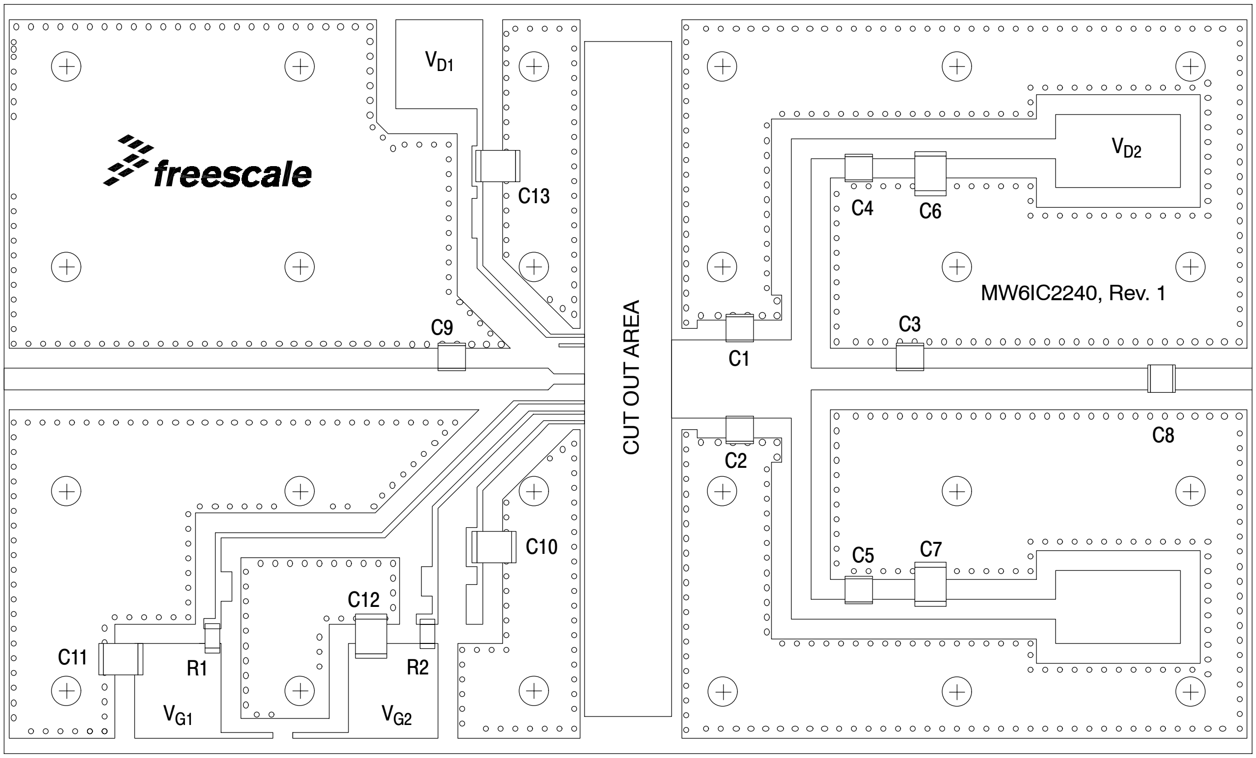


Figure 4. MW6IC2240NBR1(GNBR1) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

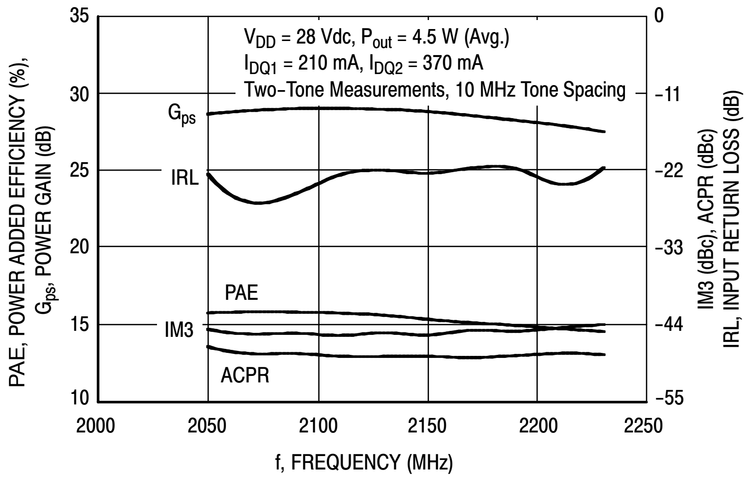


Figure 5. 2-Carrier W-CDMA Wideband Performance @ P_{out} = 4.5 Watts Avg.

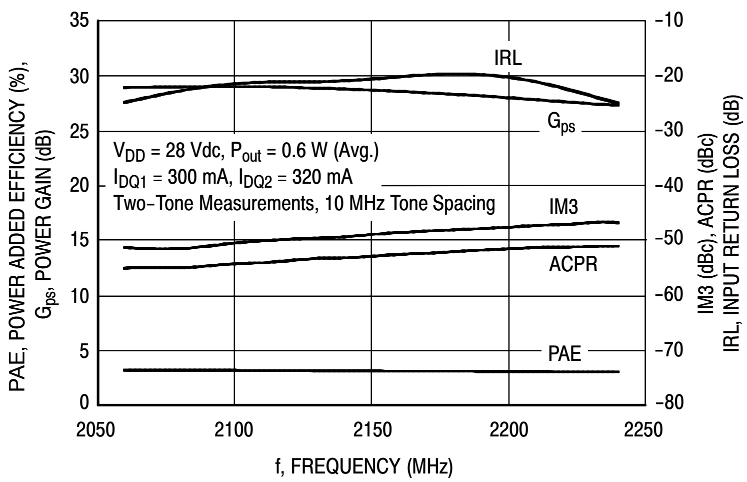


Figure 6. 2-Carrier W-CDMA Wideband Performance @ P_{out} = 0.6 Watts Avg.

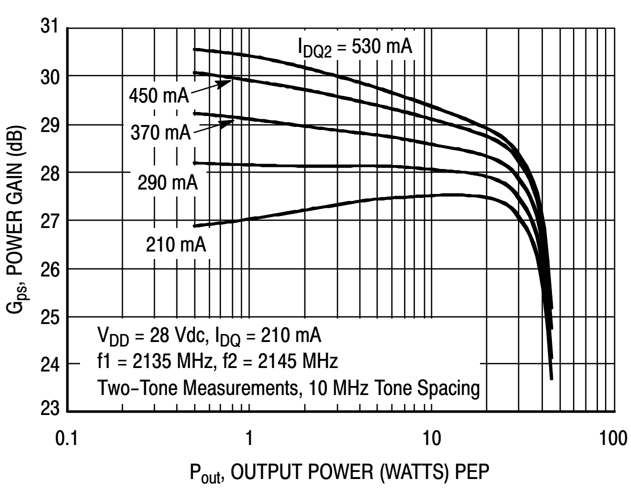


Figure 7. Two-Tone Power Gain versus Output Power

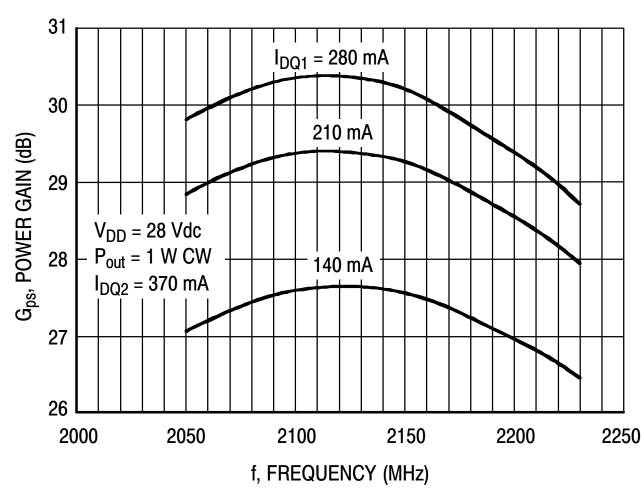


Figure 8. Frequency Response versus Current

TYPICAL CHARACTERISTICS

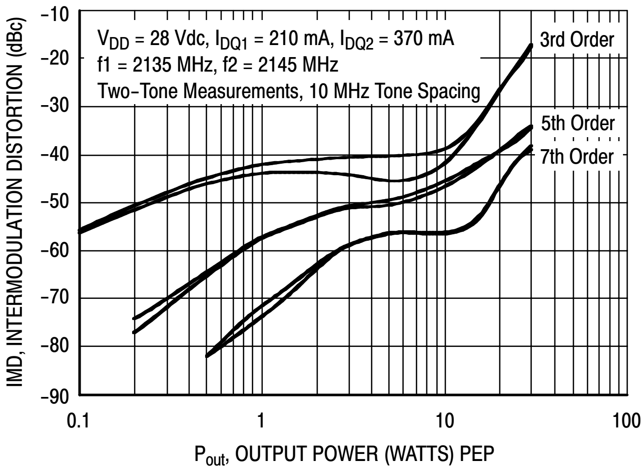


Figure 9. Intermodulation Distortion Products versus Output Power

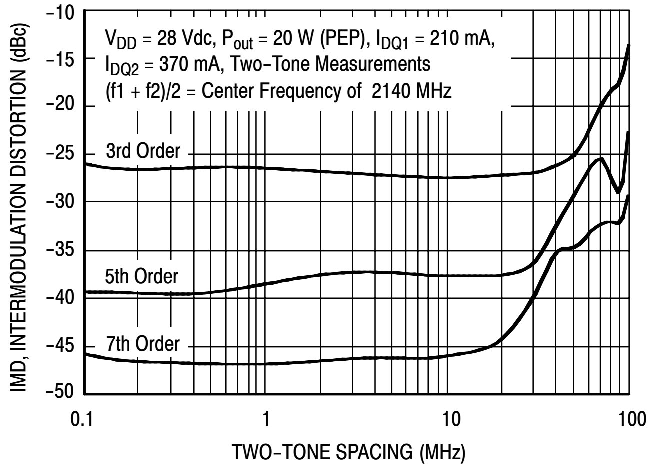


Figure 10. Intermodulation Distortion Products versus Tone Spacing

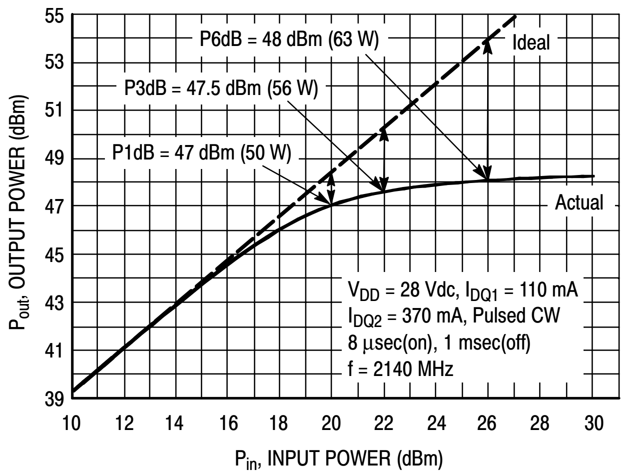


Figure 11. Pulse CW Output Power versus Input Power

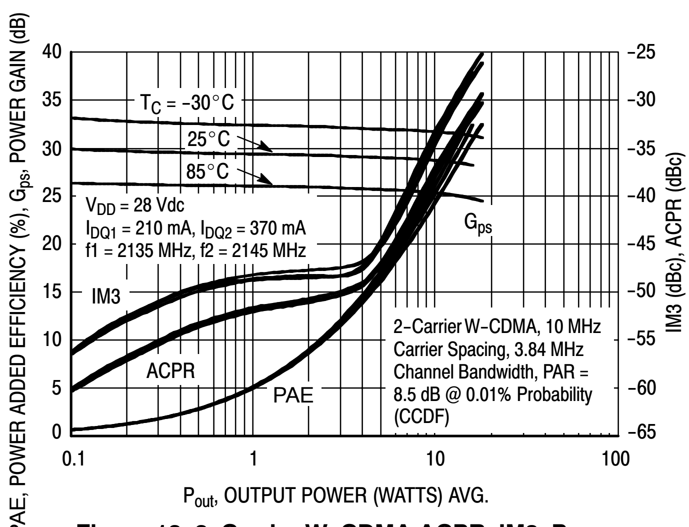


Figure 12. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Power Added Efficiency versus Output Power

TYPICAL CHARACTERISTICS

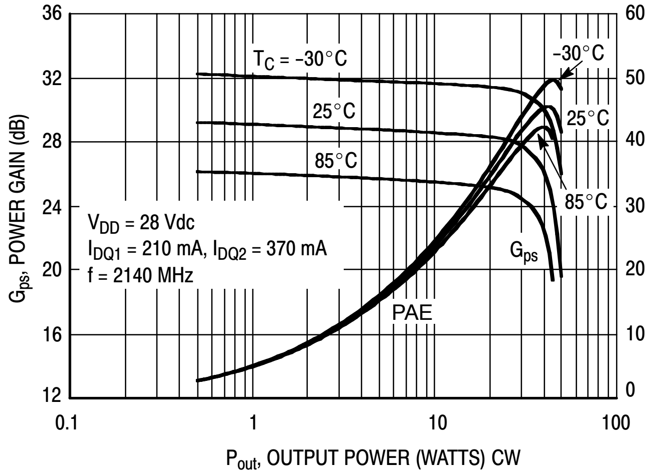


Figure 13. Power Gain and Power Added Efficiency versus Output Power

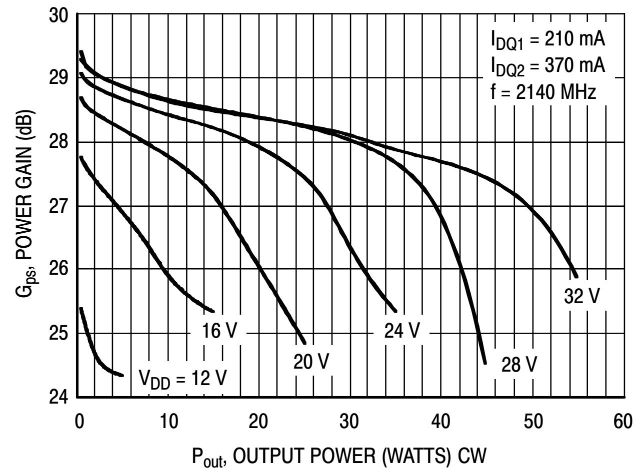
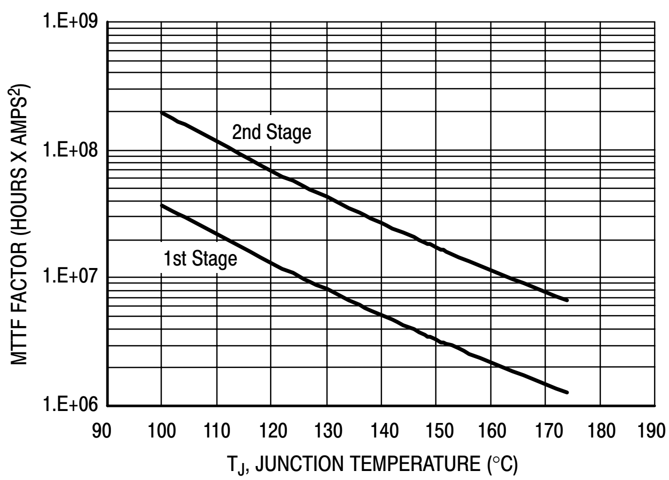
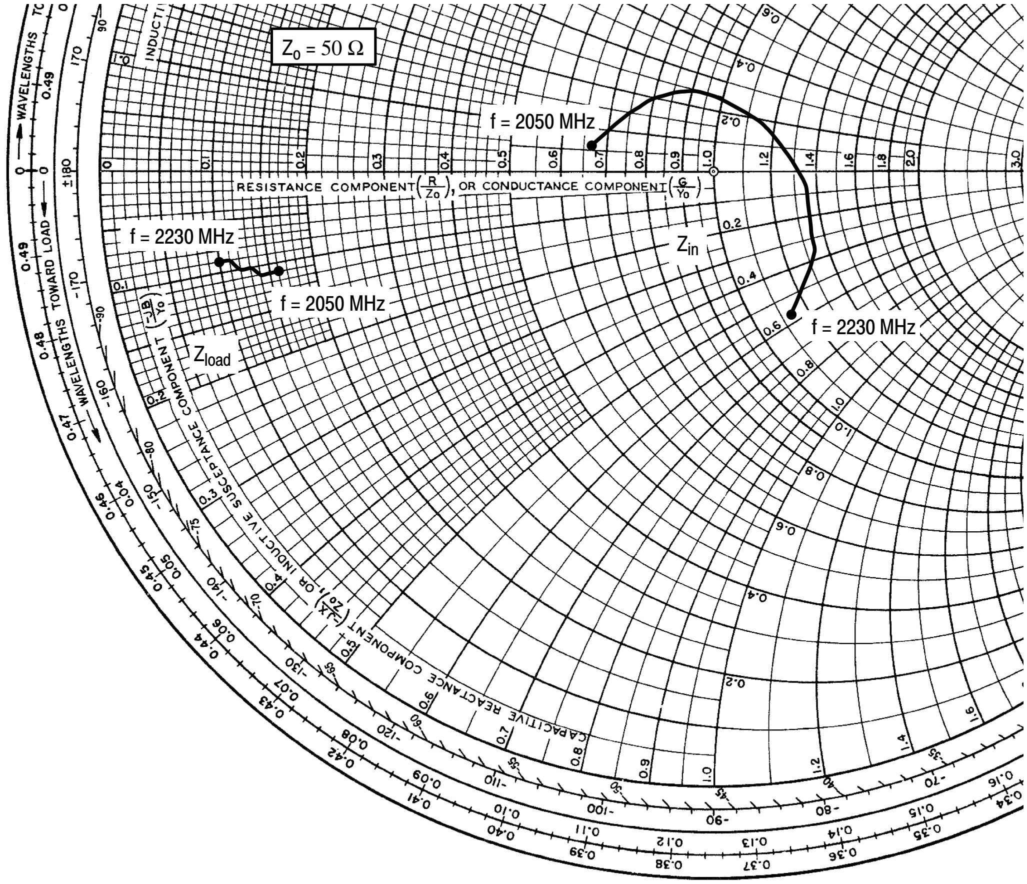


Figure 14. Power Gain versus Output Power



This above graph displays calculated MTTF in hours x ampere^2 drain current. Life tests at elevated temperatures have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTTF factor by I_D^2 for MTTF in a particular application.

Figure 15. MTTF Factor versus Junction Temperature



V_{DD} = 28 Vdc, I_{DQ1} = 210 mA, I_{DQ2} = 370 mA, P_{out} = 4.5 W Avg.

f MHz	Z_{in} Ω	Z_{load} Ω
2050	33.723 + j3.048	7.971 - j5.705
2080	38.052 + j8.201	7.559 - j5.532
2110	45.972 + j12.306	7.117 - j5.345
2140	59.075 + 9.272	6.642 - j5.119
2170	68.368 - j3.227	6.132 - j4.891
2200	67.177 - j19.071	5.626 - j4.619
2230	58.213 - j28.879	5.118 - j4.305

Z_{in} = Device input impedance as measured from gate to ground.

Z_{load} = Test circuit impedance as measured from drain to ground.

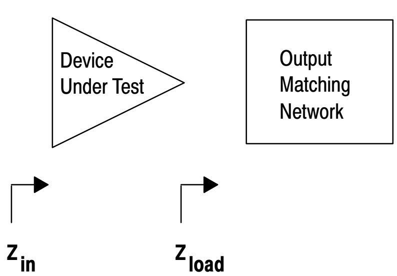


Figure 16. Series Equivalent Input and Load Impedance

Table 8. Common Source Scattering Parameters (V_{DD} = 28 V, 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
	I_{DQ1} = 210 mA, I_{DQ2} = 370 mA							
1000	0.788	131.360	0.0013	63.602	0.0020	25.353	0.9940	172.664
1200	0.713	113.326	0.0012	42.219	0.0094	10.742	0.9910	169.954
1400	0.584	86.885	0.0007	55.210	0.1180	-39.325	0.9850	166.452
1600	0.389	41.593	0.0006	117.726	0.6690	-92.822	0.9780	161.752
1800	0.239	-54.753	0.0022	122.409	4.9300	-164.584	0.9310	152.388
2000	0.221	-162.180	0.0036	118.178	21.396	49.432	0.6120	151.441
2200	0.216	-38.746	0.0057	68.626	19.739	-105.946	0.7530	-177.800
2400	0.467	-113.440	0.0043	64.758	7.8281	166.887	0.9010	171.868
2600	0.539	-153.020	0.0044	48.498	3.8868	113.310	0.9350	167.252
2800	0.635	-171.630	0.0044	52.829	2.4331	69.460	0.9480	164.137
3000	0.716	169.263	0.0049	56.398	1.6119	29.135	0.9570	161.593

NOTES

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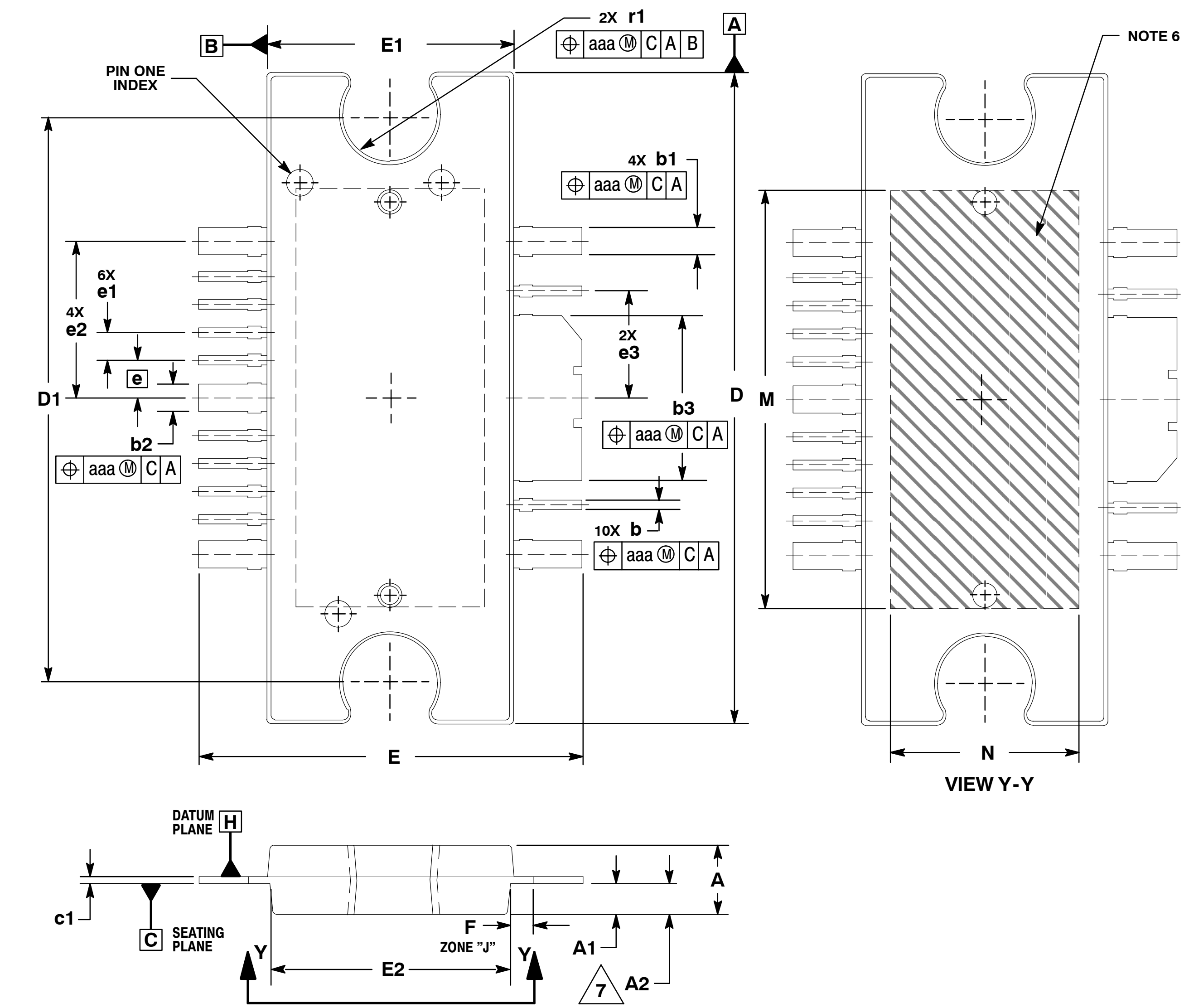
NOTES

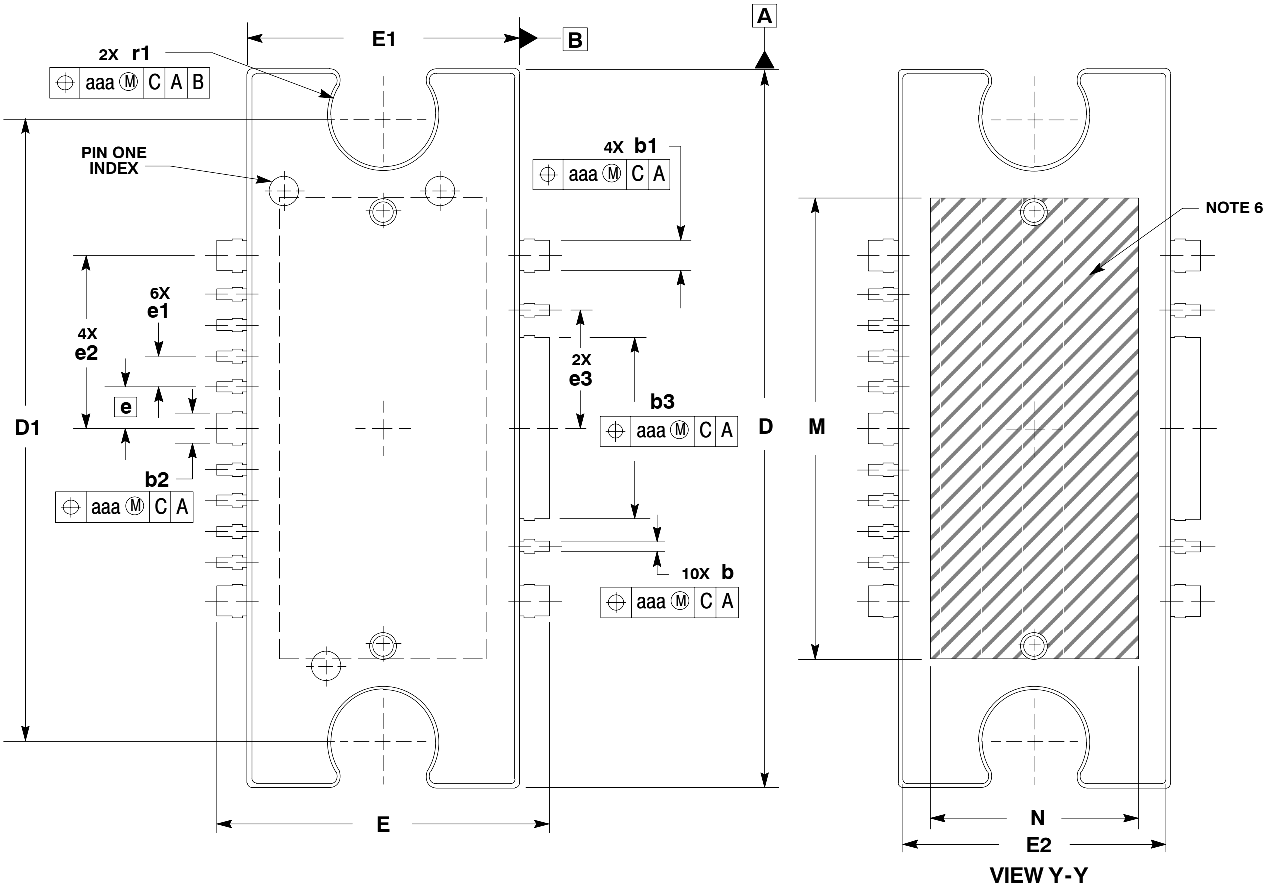
PACKAGE DIMENSIONS

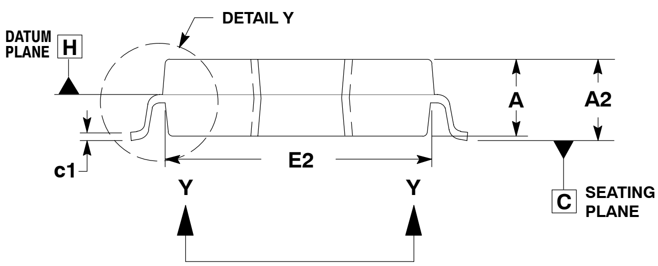


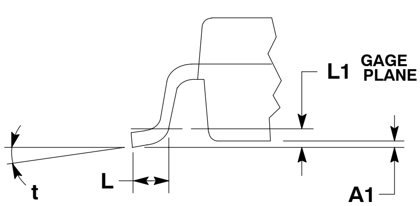
NOTES:
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M−1994.
3. DATUM PLANE -H- IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 (0.15) PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSIONS "b", "b1", "b2" AND "b3" DO NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 (0.13) TOTAL IN EXCESS OF THE "b", "b1", "b2" AND "b3" DIMENSIONS AT MAXIMUM MATERIAL CONDITION.
6. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG.
7. DIM A2 APPLIES WITHIN ZONE "J" ONLY.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	.100	.104	2.54	2.64
A1	.038	.044	0.96	1.12
A2	.040	.042	1.02	1.07
D	.928	.932	23.57	23.67
D1	.810 BSC		20.57 BSC	
E	.551	.559	14.00	14.20
E1	.353	.357	8.97	9.07
E2	.346	.350	8.79	8.89
F	.025 BSC		0.64 BSC	
M	.600	---	15.24	---
N	.270	---	6.86	---
b	.011	.017	0.28	0.43
b1	.037	.043	0.94	1.09
b2	.037	.043	0.94	1.09
b3	.225	.231	5.72	5.87
c1	.007	.011	.18	.28
e	.054 BSC		1.37 BSC	
e1	.040 BSC		1.02 BSC	
e2	.224 BSC		5.69 BSC	
e3	.150 BSC		3.81 BSC	
r1	.063	.068	1.6	1.73
aaa	.004		.10	

CASE 1329-09
ISSUE K
TO-272 WB-16
PLASTIC
MW6IC2240NBR1







DETAIL Y

NOTES:
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6. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SINK.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	.100	.104	2.54	2.64
A1	.001	.004	0.02	0.10
A2	.099	.110	2.51	2.79
D	.928	.932	23.57	23.67
D1	.810 BSC		20.57 BSC	
E	.429	.437	10.90	11.10
E1	.353	.357	8.97	9.07
E2	.346	.350	8.79	8.89
L	.018	.024	4.90	5.06
L1	.01 BSC		0.25 BSC	
M	.600	---	15.24	---
N	.270	---	6.86	---
b	.011	.017	0.28	0.43
b1	.037	.043	0.94	1.09
b2	.037	.043	0.94	1.09
b3	.225	.231	5.72	5.87
c1	.007	.011	.18	.28
e	.054 BSC		1.37 BSC	
e1	.040 BSC		1.02 BSC	
e2	.224 BSC		5.69 BSC	
e3	.150 BSC		3.81 BSC	
r1	.063	.068	1.6	1.73
t	2°	8°	2°	8°
aaa	.004		.10	

CASE 1329A-03
ISSUE D
TO-272 WB-16 GULL
PLASTIC
MW6IC2240GNBR1

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