Document Number: MW5IC2030N
Rev. 8, 5/2006

RoHS

RF LDMOS Wideband Integrated Power Amplifiers

MW5IC2030NBR1
MW5IC2030GNBR1

The MW5IC2030N wideband integrated circuit is designed with on-chip matching that makes it usable from 1930 to 1990 MHz. This multi-stage structure is rated for 26 to 28 Volt operation and covers all typical cellular base station modulation formats.

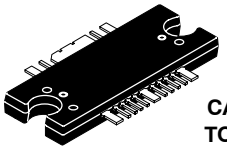
1930-1990 MHz, 30 W, 26 V
GSM/GSM EDGE, W-CDMA, PHS
RF LDMOS WIDEBAND
INTEGRATED POWER AMPLIFIERS

Final Application

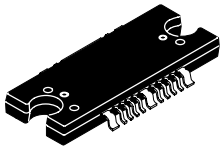
- Typical CDMA Performance: V_{DD} = 27 Volts, I_{DQ1} = 160 mA, I_{DQ2} = 230 mA, P_{out} = 5 Watts Avg., Full Frequency Band, IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13), Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.
  Power Gain — 23 dB
  Drain Efficiency — 20%
  ACPR @ 885 kHz Offset — -49 dBc in 30 kHz Channel Bandwidth

Driver Application

- Typical CDMA Performance: V_{DD} = 27 Volts, I_{DQ1} = 220 mA, I_{DQ2} = 240 mA, P_{out} = 1 Watt Avg., Full Frequency Band, IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13), Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.
  Power Gain — 24 dB
  ACPR @ 885 kHz Offset — -63 dBc in 30 kHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 27 Vdc, 1990 MHz, 30 Watts CW Output Power
- Stable into a 3:1 VSWR. All Spurs Below -60 dBc @ 0 to 43 dBm CW P_{out}.
- On-Chip Matching (50 Ohm Input, >4 Ohm Output)
- Integrated Temperature Compensation Capability with Enable/Disable Function
- On-Chip Current Mirror g_m Reference FET for Self Biasing Application (1)
- 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



CASE 1329-09
TO-272 WB-16
PLASTIC
MW5IC2030NBR1



CASE 1329A-03
TO-272 WB-16 GULL
PLASTIC
MW5IC2030GNBR1

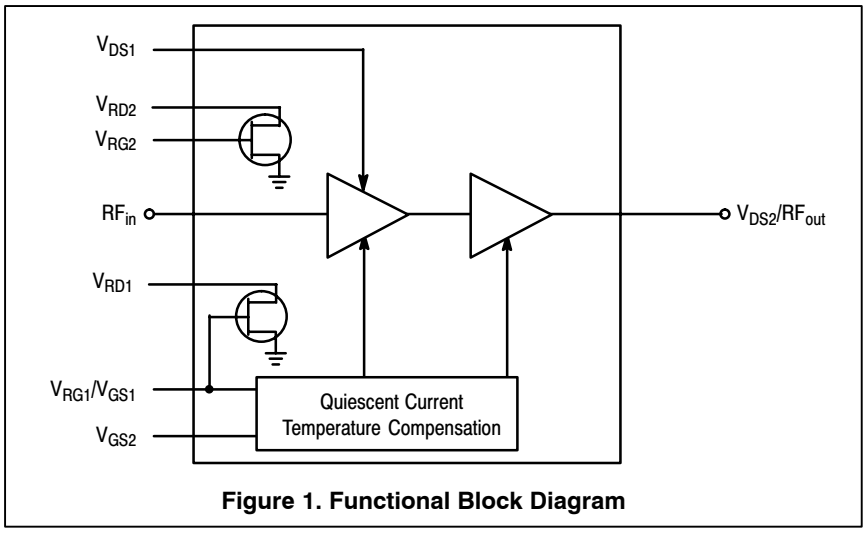
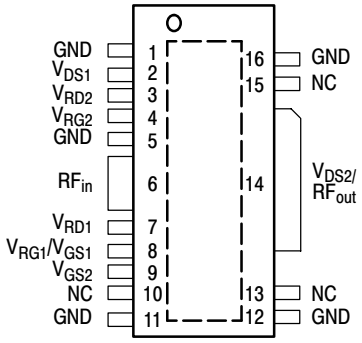


Figure 1. Functional Block Diagram



(Top View)

Note: Exposed backside flag is source terminal for transistors.

Figure 2. Pin Connections

1. Refer to AN1987, *Quiescent Current Control for the RF Integrated Circuit Device Family.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1987.

freescale semiconductor

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +65	Vdc
Gate-Source Voltage	V_{GS}	-0.5, +15	Vdc
Storage Temperature Range	T_{stg}	-65 to +175	°C
Operating Junction Temperature	T_J	200	°C
Input Power	P_{in}	20	dBm

Table 2. Thermal Characteristics

Characteristic		Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case		$R_{\theta JC}$		°C/W
CDMA Application (P_{out} = 5 W CW)	Stage 1, 27 Vdc, I_{DQ} = 160 mA		4.89	
	Stage 2, 27 Vdc, I_{DQ} = 230 mA		1.75	
PHS Application (P_{out} = 12.6 W CW)	Stage 1, 26 Vdc, I_{DQ} = 300 mA		4.85	
	Stage 2, 26 Vdc, I_{DQ} = 1300 mA		1.61	

Table 3. ESD Protection Characteristics

Test Conditions	Class
Human Body Model	1B (Minimum)
Machine Model	A (Minimum)
Charge Device Model	3 (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)

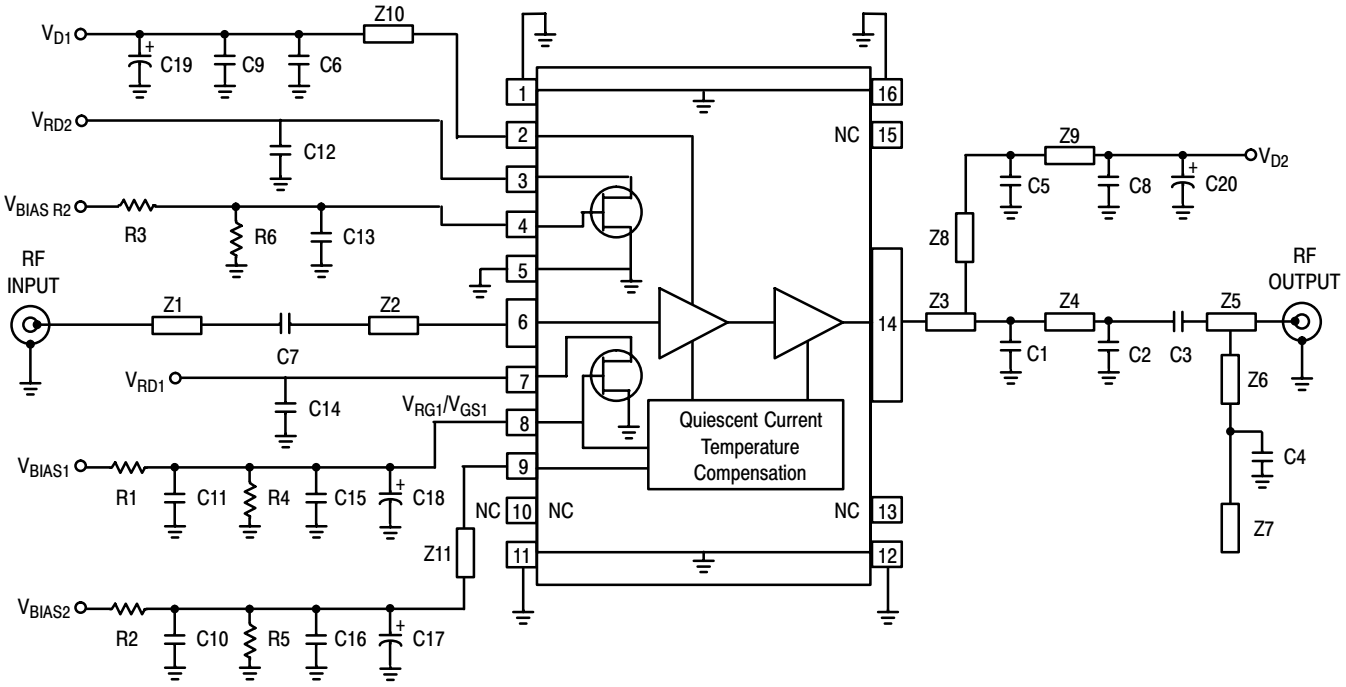
Characteristic	Symbol	Min	Typ	Max	Unit
CDMA Functional Tests (In Freescale 1900 MHz Test Fixture, 50 ohm system) V_{DD} = 27 Vdc, I_{DQ1} = 160 mA, I_{DQ2} = 230 mA, P_{out} = 5 W Avg., 1960 MHz, Single-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carrier. ACPR measured in 30 kHz Channel Bandwidth @ ± 885 kHz Offset. PAR = 9.8 dB @ 0.01 Probability on CCDF.					
Power Gain	G_{ps}	21.5	23	—	dB
Drain Efficiency	η_D	18	20	—	%
Input Return Loss	IRL	—	-18	-10	dB
Adjacent Channel Power Ratio	ACPR	—	-49	-47	dBc
Gain Flatness in 30 MHz BW, 1930-1990 MHz	G_F	—	0.2	0.3	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) V_{DD} = 26 Vdc, I_{DQ1} = 160 mA, I_{DQ2} = 230 mA, P_{out} = 5 W, f = 1960 MHz					
P_{out} @ 1 dB Compression Point, CW	P1dB	—	30	—	W
Deviation from Linear Phase in 30 MHz BW (Characterized from 1930-1990 MHz)	Φ	—	±1	—	°
Delay	Delay	—	2.25	—	ns
Part-to-Part Phase Variation	ΔΦ	—	±10	—	°
Part-to-Part Gain Variation (Per Lot or Reel)	ΔG	—	±1.5	—	dB
Reference FET to RF FET Scaling Ratio Delta (Stages 1 and 2)		—	10	—	%
Typical PHS Performances (In Freescale Test Fixture, 50 ohm system) V_{DD} = 26 Vdc, I_{DQ1} = 260 mA, I_{DQ2} = 1100 mA, P_{out} = 12.6 W, 1900 MHz, PHS Signal Mask					
Power Gain	G_{ps}	—	24	—	dB
Drain Efficiency	η_D	—	25	—	%
Input Return Loss	IRL	—	-15	—	dB
Adjacent Channel Power Ratio (600 kHz Offset in 192 kHz BW)	ACPR	—	-72	—	dBc

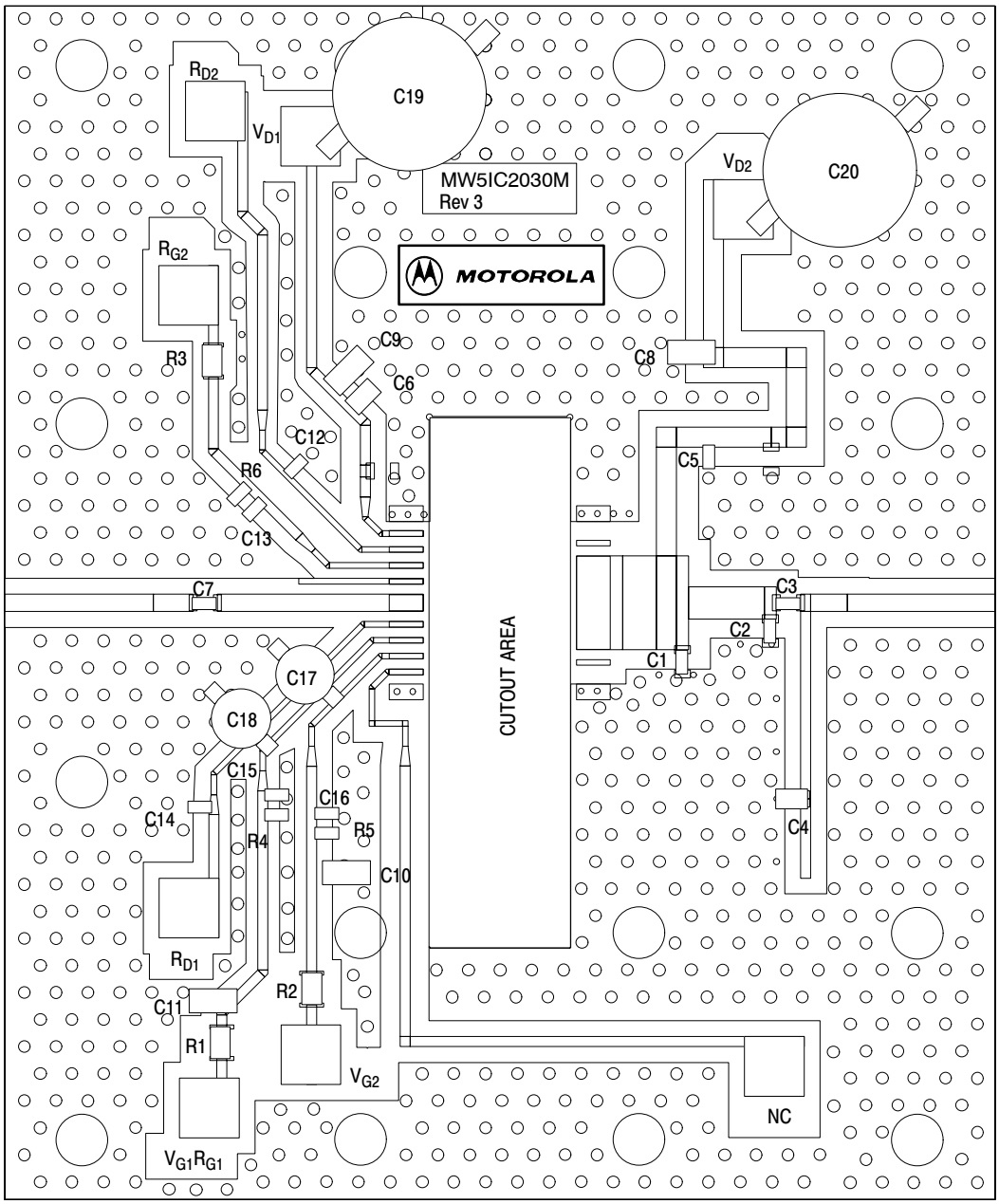


Z1	0.465″ x 0.041″ Microstrip	Z7	0.200″ x 0.025″ Microstrip
Z2	0.518″ x 0.041″ Microstrip	Z8	0.274″ x 0.050″ Microstrip
Z3	0.282″ x 0.235″ Microstrip	Z9	0.615″ x 0.050″ Microstrip
Z4	0.221″ x 0.081″ Microstrip	Z10	0.450″ x 0.025″ Microstrip
Z5	0.489″ x 0.041″ Microstrip	Z11	0.340″ x 0.014″ Microstrip
Z6	0.471″ x 0.025″ Microstrip	PCB	Rogers 4350, 0.020″, ε_r = 3.5

Figure 3. MW5IC2030NBR1(GNBR1) Test Circuit Schematic

Table 6. MW5IC2030NBR1(GNBR1) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	1.8 pF High Q Chip Capacitor (0603)	600S1R8AT-250-T	ATC
C2	1.5 pF High Q Chip Capacitor (0603)	600S1R5AT-250-T	ATC
C3	3.9 pF High Q Chip Capacitor (0603)	600S3R9AT-250-T	ATC
C4	6.8 pF High Q Chip Capacitor (0805)	600S6R8AT-250-T	ATC
C5, C6	100 pF Class 1 NPO Chip Capacitors (0805)	GRM215CB1H101CZ01D	Murata
C7	4.7 pF Class 1 NPO Chip Capacitor (0805)	GRM215CB1H4R7CZ01D	Murata
C8, C9, C10, C11	0.1 μF X7R Chip Capacitors (1206)	C1206C104K5RACT	Kemet
C12, C13, C14, C15, C16	0.01 μF Class 2 X7R Chip Capacitors (0805)	C0805C103K5RACT	Kemet
C17, C18	22 μF, 35 V Electrolytic Capacitors	ECE-1AVKS220	Panasonic
C19, C20	330 μF, 50 V Electrolytic Capacitors	ECA-1HM331	Panasonic
R1, R3	1 kΩ, 5% Chip Resistors (0805)		
R2	499 Ω, 1% Chip Resistor (0805)		
R4, R5, R6	100 kΩ, 5% Chip Resistors (0805)		



Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

Figure 4. MW5IC2030NBR1(GNBR1) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

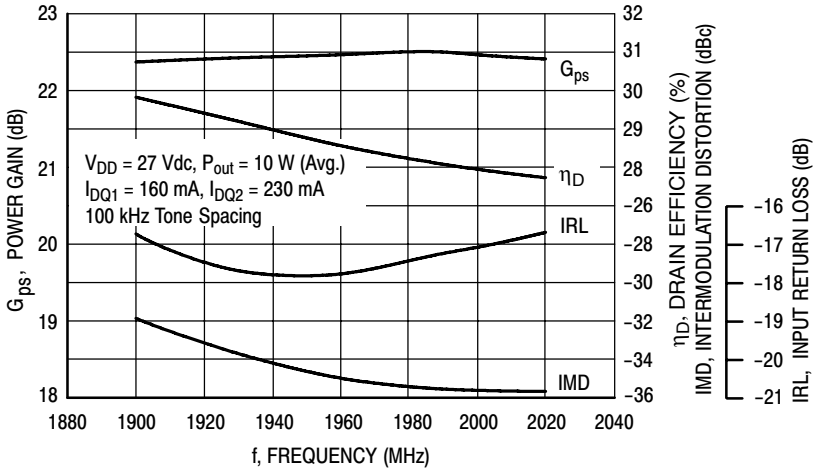


Figure 5. Two-Tone Broadband Performance @ P_{out} = 10 Watts Avg.

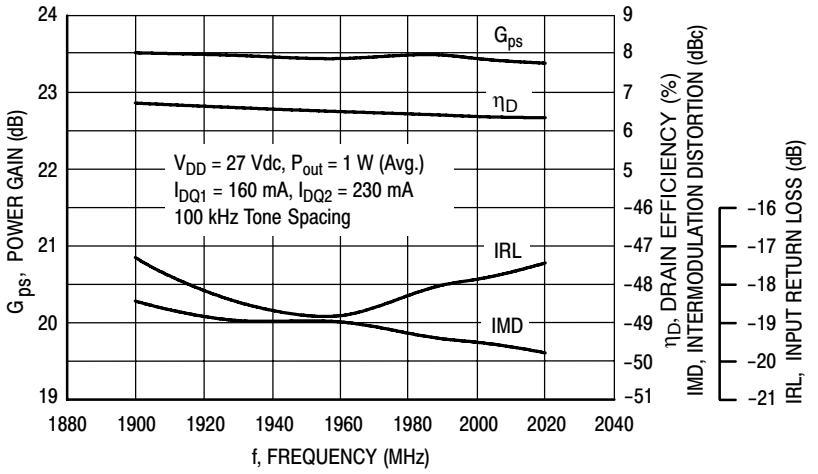


Figure 6. Two-Tone Broadband Performance @ P_{out} = 1 Watt Avg.

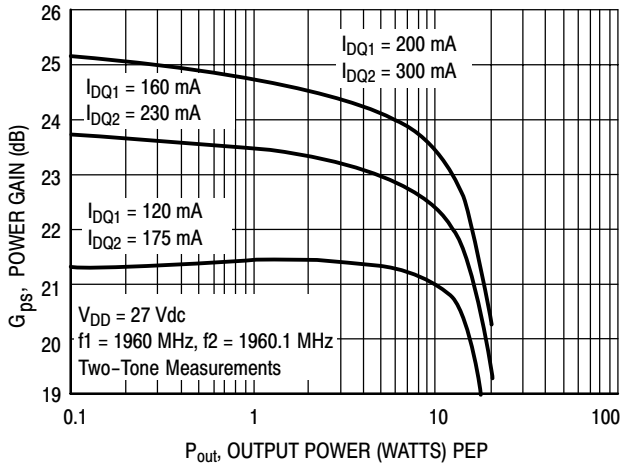


Figure 7. Two-Tone Power Gain versus Output Power

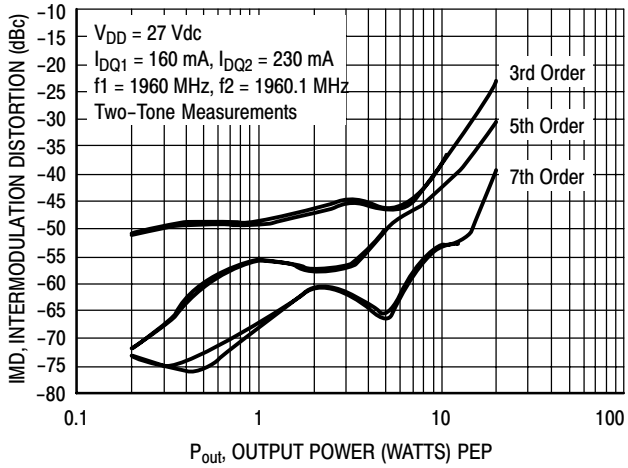


Figure 8. Intermodulation Distortion Products versus Output Power

TYPICAL CHARACTERISTICS

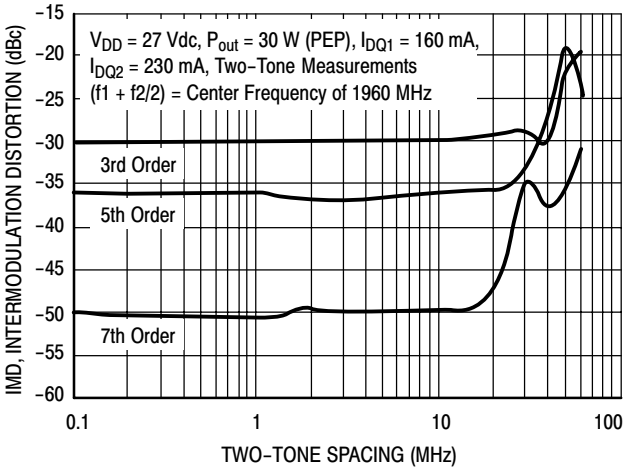


Figure 9. Intermodulation Distortion Products versus Tone Spacing

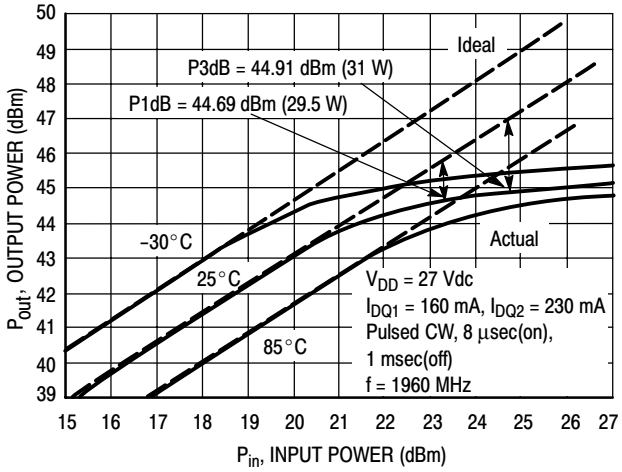


Figure 10. Pulse CW Output Power versus Input Power

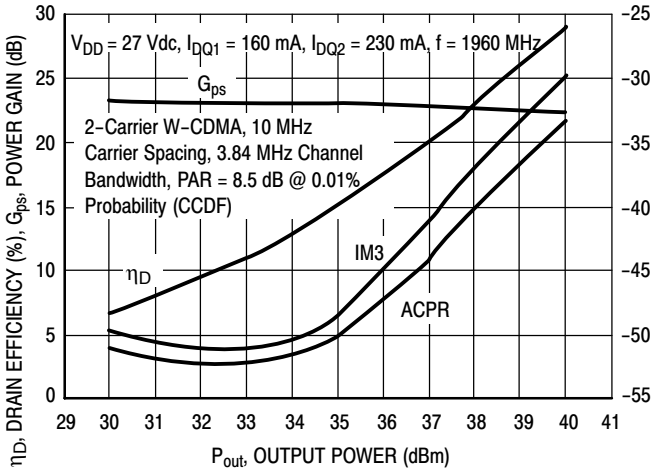


Figure 11. 2-Carrier W-CDMA ACPR, IM3, Power Gain, and Drain Efficiency versus Output Power

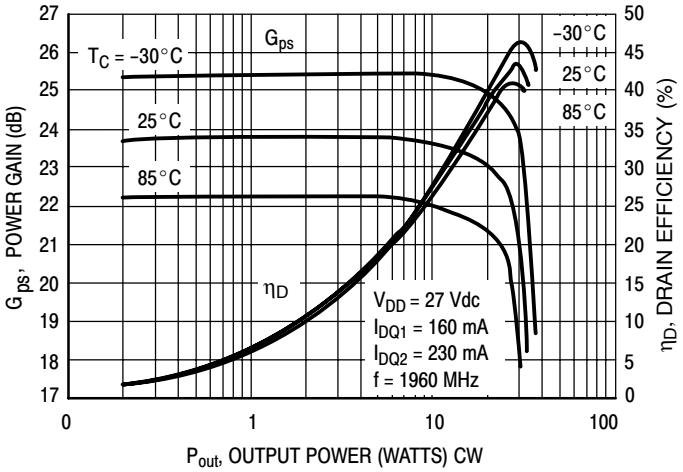


Figure 12. Power Gain and Drain Efficiency versus Output Power

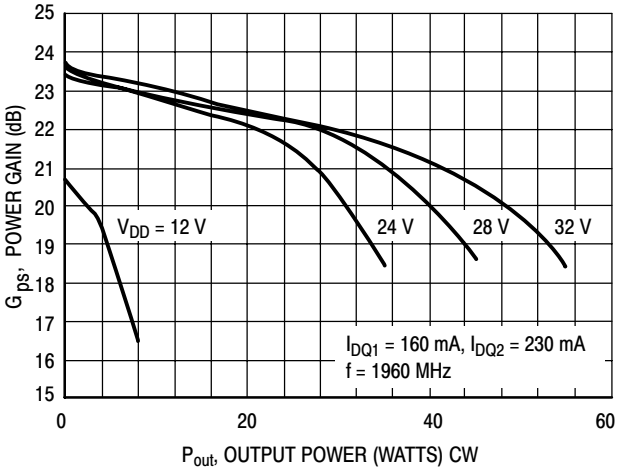


Figure 13. Power Gain versus Output Power

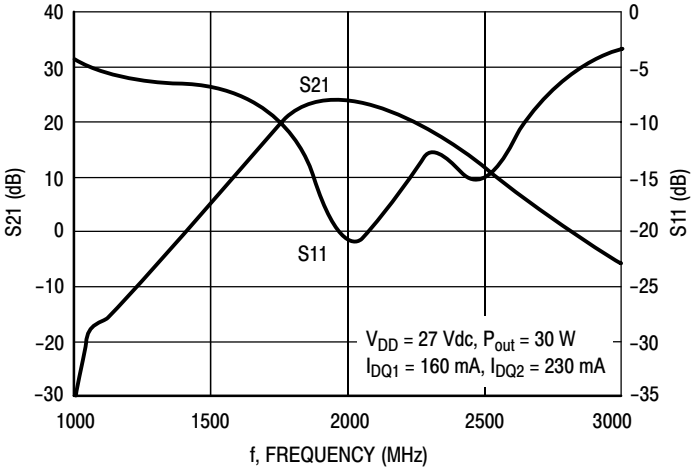


Figure 14. Broadband Frequency Response

TYPICAL CHARACTERISTICS

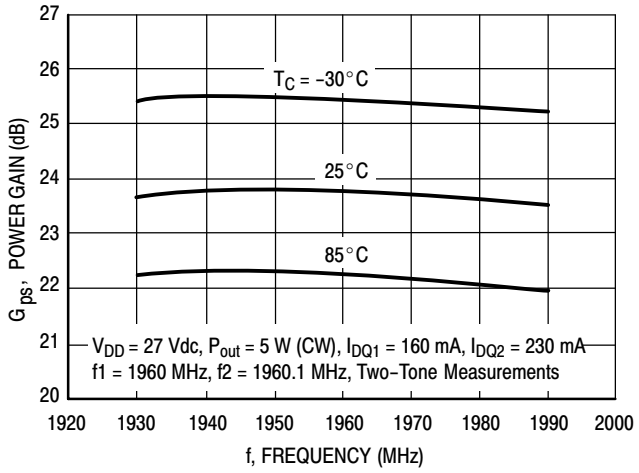


Figure 15. Power Gain versus Frequency

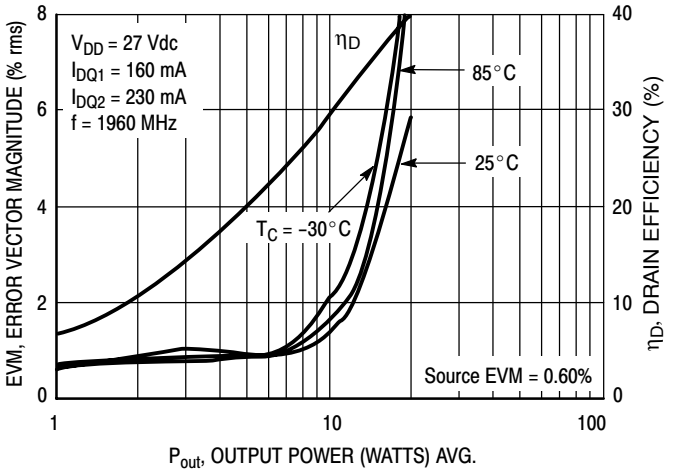


Figure 16. EVM and Drain Efficiency versus Output Power

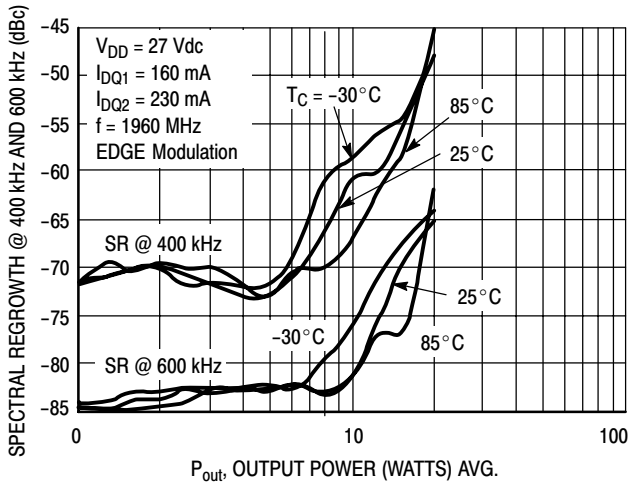


Figure 17. Spectral Regrowth at 400 kHz and 600 kHz versus Output Power

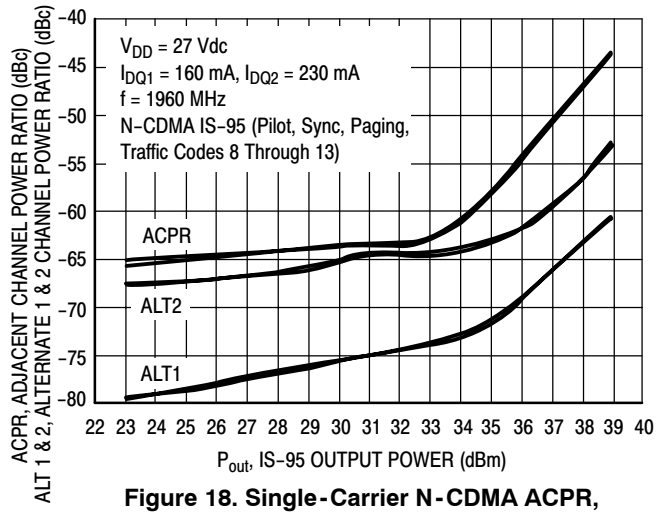


Figure 18. Single-Carrier N-CDMA ACPR, ALT1 and ALT2 versus Output Power

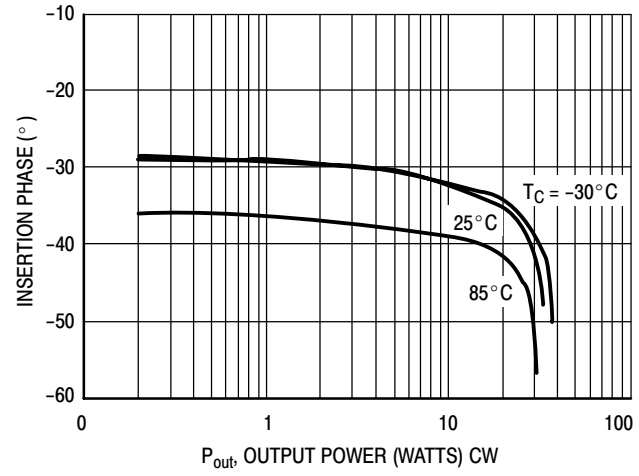
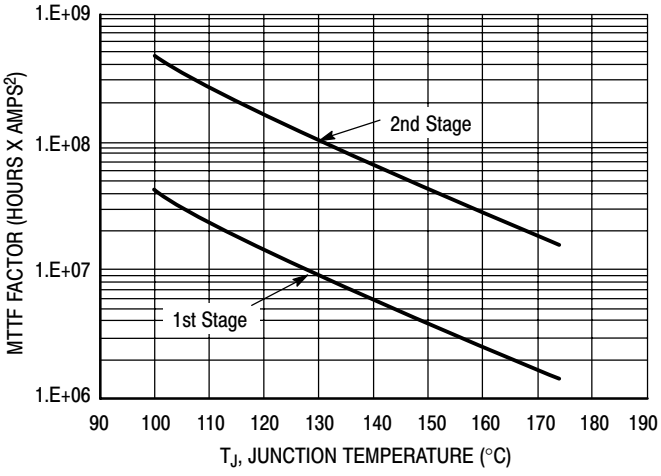
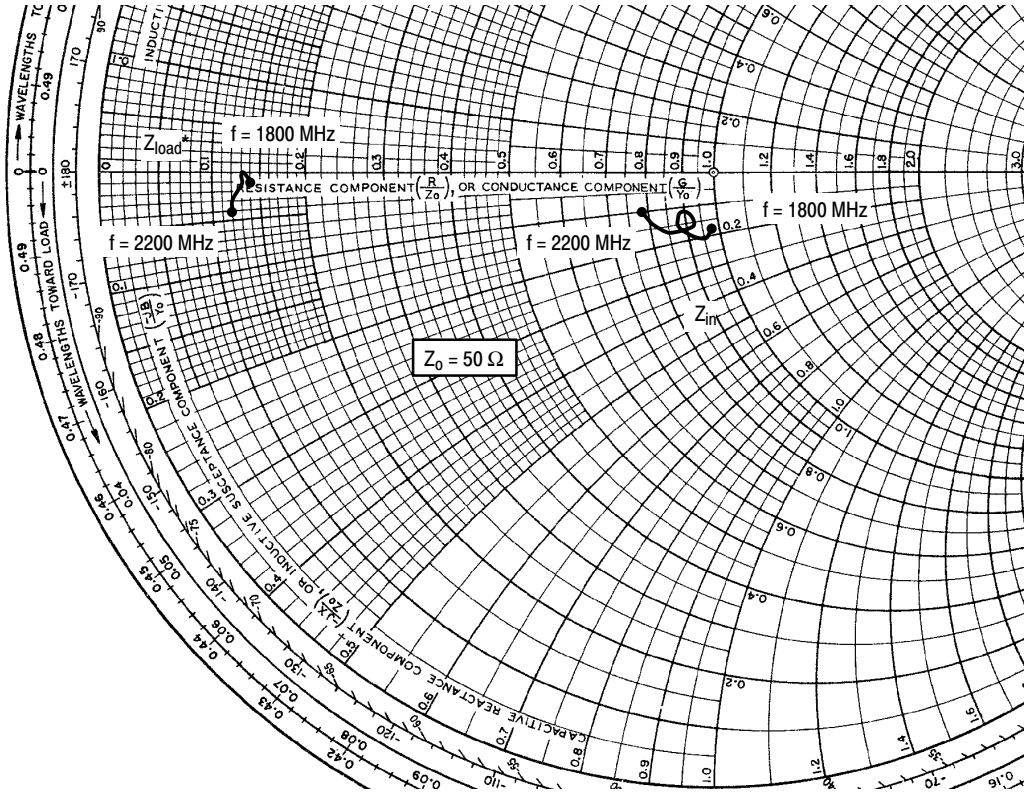


Figure 19. Insertion Phase versus Output Power



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 20. MTTF Factor versus Junction Temperature



V_{DD} = 27 V, I_{DQ1} = 160 mA, I_{DQ2} = 230 mA

f MHz	Z_{in} Ω	Z_{load} Ω
1800	49.7 - j9.3	6.9 - j0.3
1850	47.7 - j9.8	6.9 - j0.3
1930	44.8 - j8.5	6.7 - j0.1
1960	44.0 - j7.3	6.6 - j0.0
1990	44.6 - j5.6	6.6 + j0.1
2050	45.7 - j8.6	6.4 + j0.4
2100	42.5 - j8.3	6.2 + j0.8
2150	40.6 - j6.8	6.1 + j1.1
2200	39.3 - j5.0	6.0 + j1.6

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

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

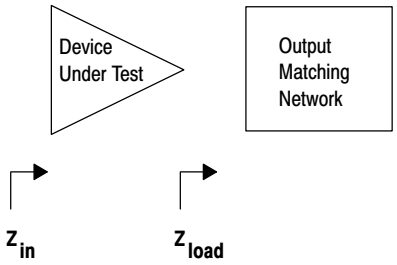
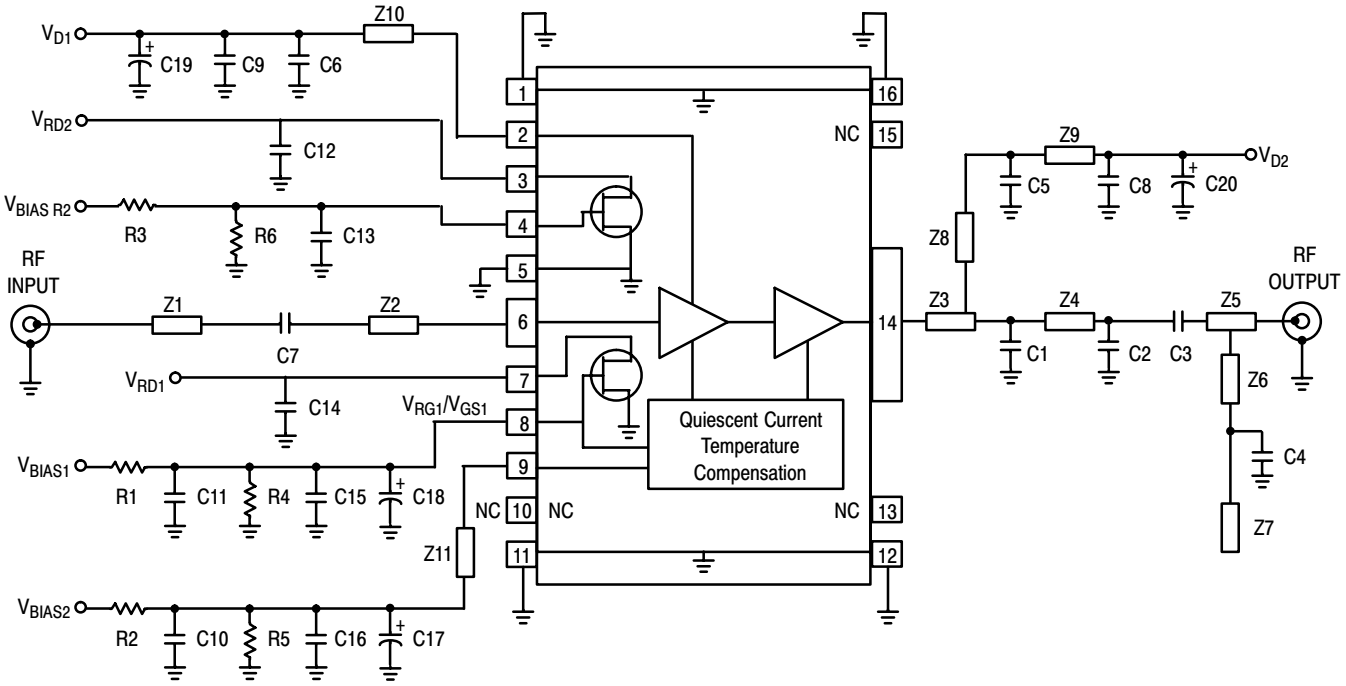


Figure 21. Series Equivalent Input and Load Impedance

DRIVER APPLICATION PERFORMANCE

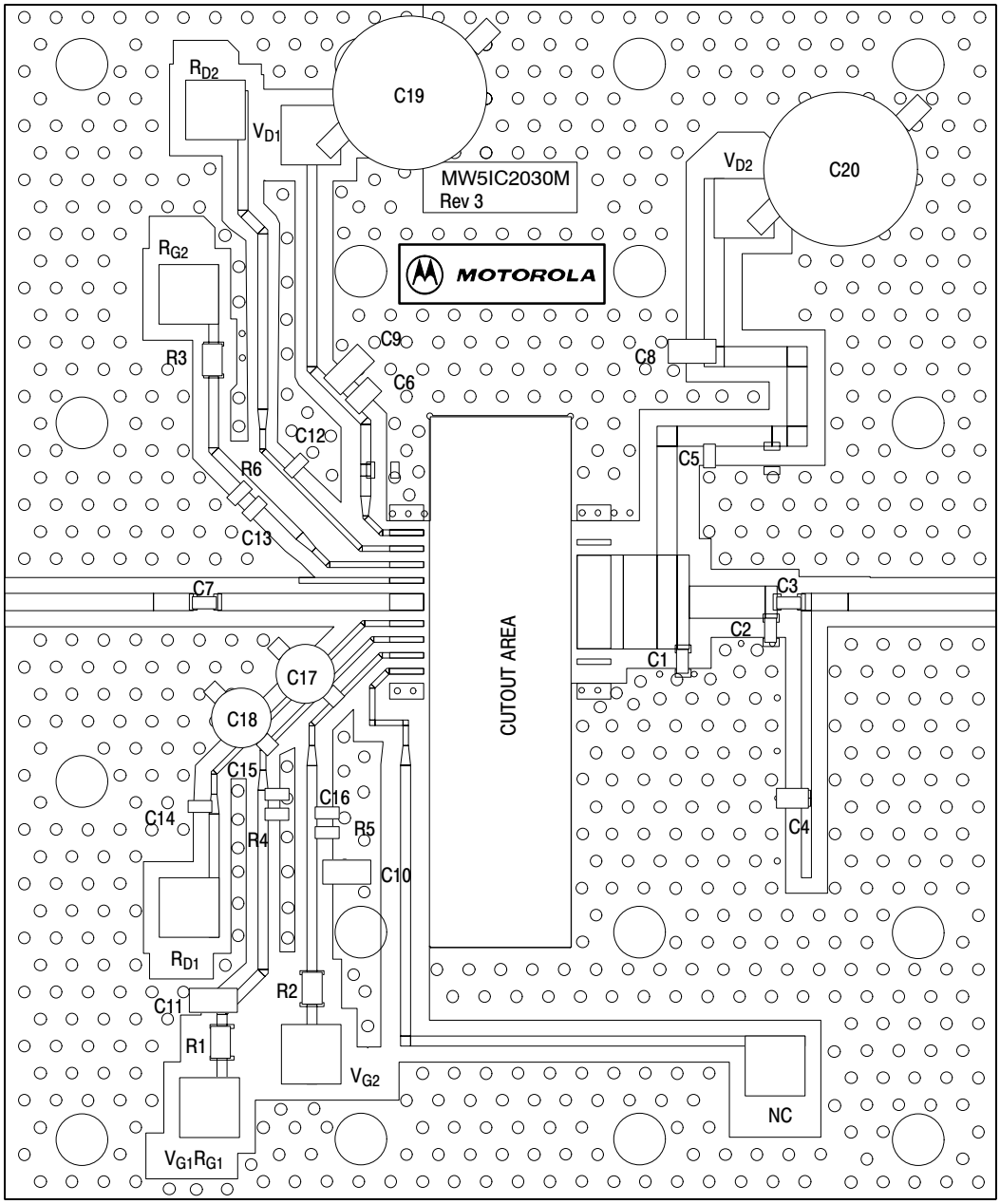


Z1	0.465″ x 0.041″ Microstrip	Z7	0.200″ x 0.025″ Microstrip
Z2	0.518″ x 0.041″ Microstrip	Z8	0.274″ x 0.050″ Microstrip
Z3	0.282″ x 0.235″ Microstrip	Z9	0.615″ x 0.050″ Microstrip
Z4	0.221″ x 0.081″ Microstrip	Z10	0.450″ x 0.025″ Microstrip
Z5	0.489″ x 0.041″ Microstrip	Z11	0.340″ x 0.014″ Microstrip
Z6	0.471″ x 0.025″ Microstrip	PCB	Rogers 4350, 0.020″, ε_r = 3.5

Figure 22. MW5IC2030NBR1(GNBR1) Test Circuit Schematic for Driver Application Tests

Table 7. MW5IC2030NBR1(GNBR1) Test Circuit Component Designations and Values for Driver Application Tests

Part	Description	Part Number	Manufacturer
C1	2.2 pF High Q Chip Capacitor (0603)	600S2R2AT-250-T	ATC
C2	1.8 pF High Q Chip Capacitor (0603)	600S1R8AT-250-T	ATC
C3	3.9 pF High Q Chip Capacitor (0603)	600S3R9AT-250-T	ATC
C4	6.8 pF High Q Chip Capacitor (0805)	600S6R8AT-250-T	ATC
C5, C6	100 pF Class 1 NPO Chip Capacitors (0805)	GRM215CB1H101CZ01D	Murata
C7	4.7 pF Class 1 NPO Chip Capacitor (0805)	GRM215CB1H4R7CZ01D	Murata
C8, C9, C10, C11	0.1 μF X7R Chip Capacitors (1206)	C1206C104K5RACT	Kemet
C12, C13, C14, C15, C16	0.01 μF Class 2 X7R Chip Capacitors (0805)	C0805C103K5RACT	Kemet
C17, C18	22 μF, 35 V Electrolytic Capacitors	ECE-1AVKS220	Panasonic
C19, C20	330 μF, 50 V Electrolytic Capacitors	ECA-1HM331	Panasonic
R1, R3	1 kΩ, 5% Chip Resistors (0805)		
R2	499 Ω, 1% Chip Resistor (0805)		
R4, R5, R6	100 kΩ, 5% Chip Resistors (0805)		



Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

Figure 23. MW5IC2030NBR1(GNBR1) Test Circuit Component Layout for Driver Application Tests

TYPICAL DRIVER APPLICATION CHARACTERISTICS

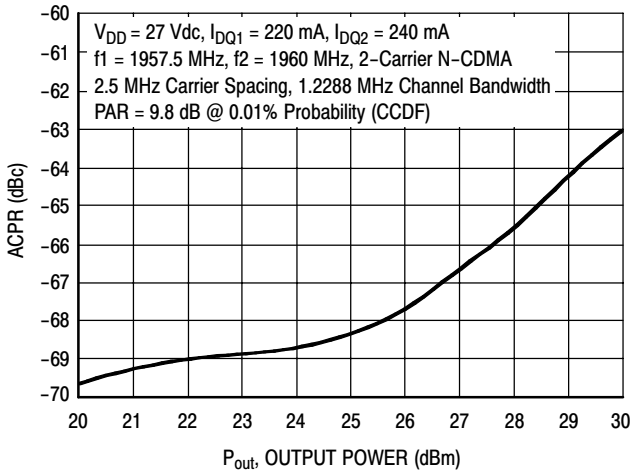
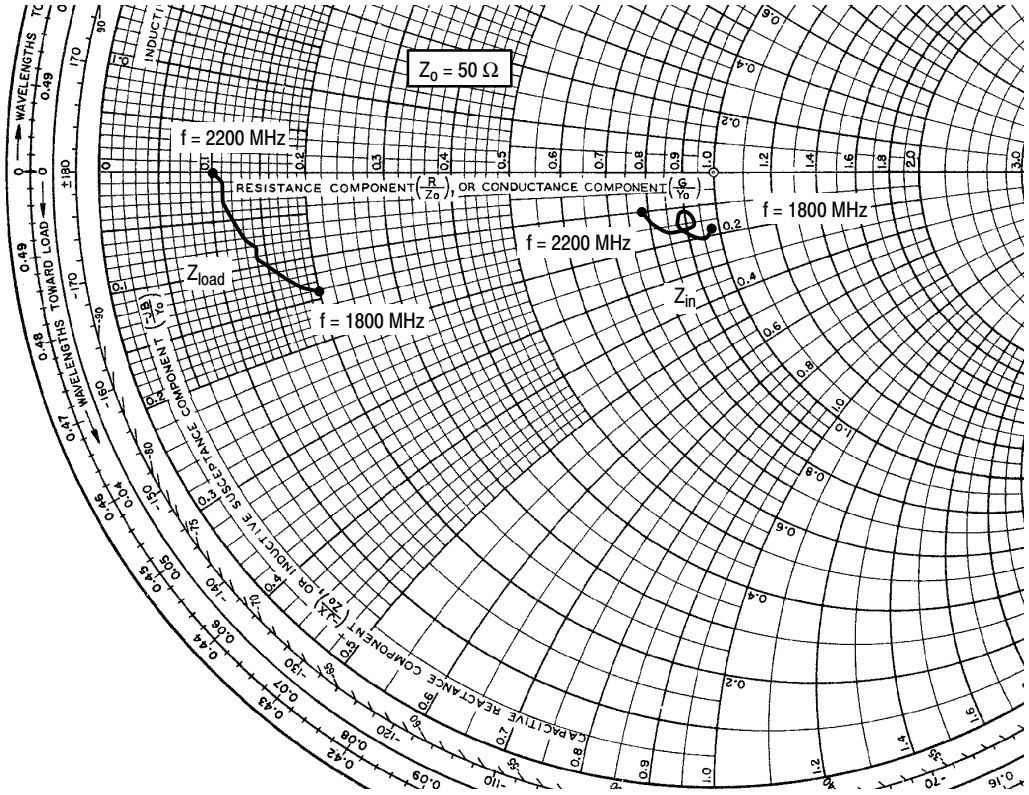


Figure 24. 2-Carrier N-CDMA ACPR versus Output Power



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1850	47.7 - j9.8	8.9 - j6.3
1930	44.8 - j8.5	7.2 - j4.6
1960	44.0 - j7.3	6.8 - j3.9
1990	44.6 - j5.6	6.5 - j3.4
2050	45.7 - j8.6	5.9 - j2.3
2100	42.5 - j8.3	5.6 - j1.5
2150	40.6 - j6.8	5.4 - j0.7
2200	39.3 - j5.0	5.2 + j0.1

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

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

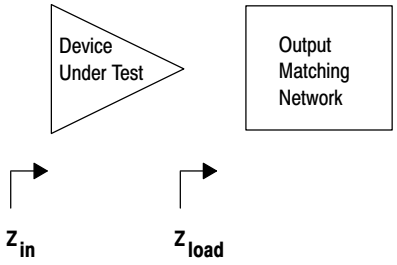
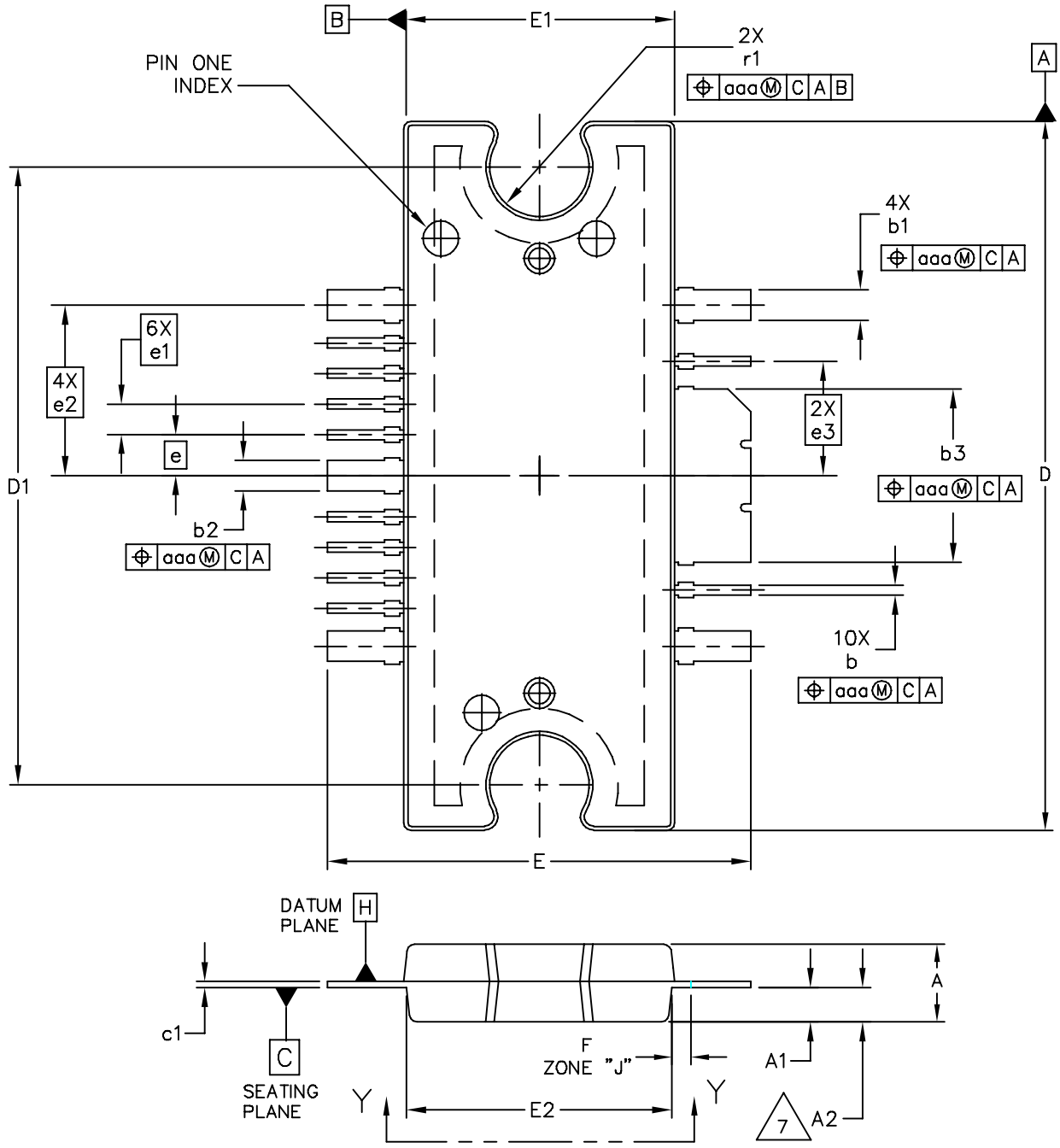


Figure 25. Series Equivalent Input and Load Impedance for Driver Application

PACKAGE DIMENSIONS



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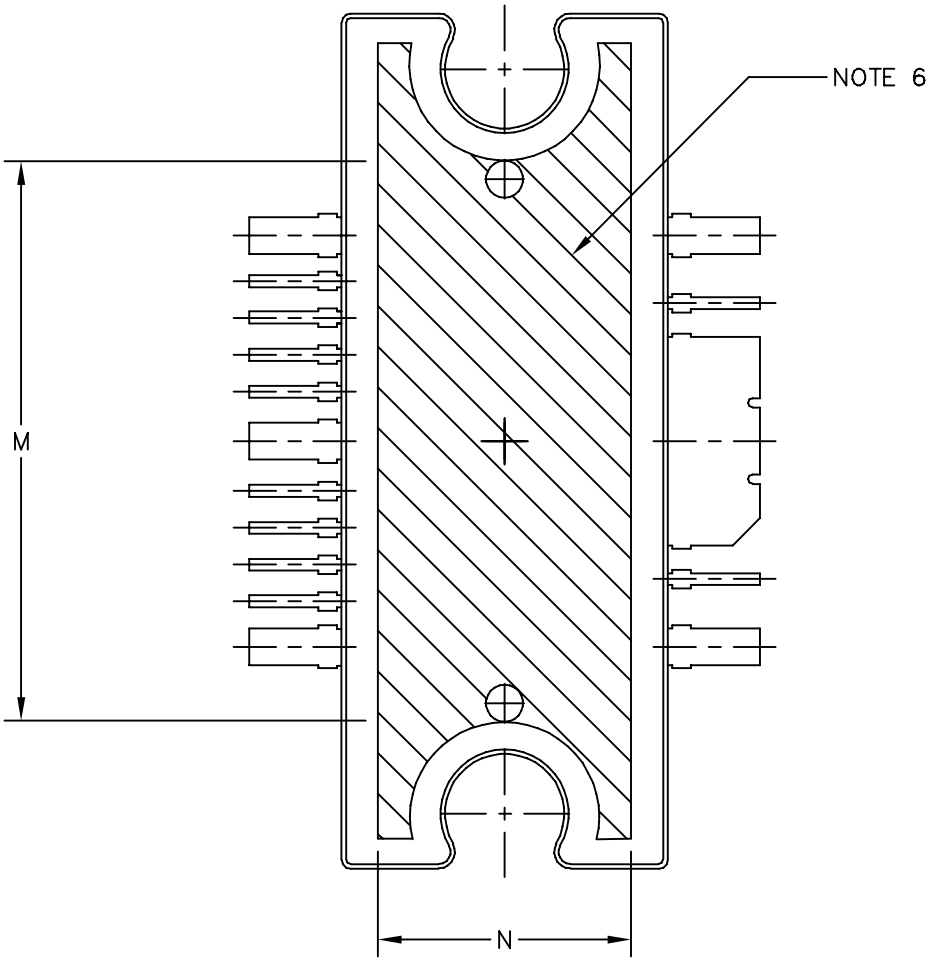
	CASE NUMBER: 1329-09	13 MAR 2006
	STANDARD: NON-JEDEC	



VIEW Y–Y

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	CASE NUMBER: 1329–09	13 MAR 2006
	STANDARD: NON–JEDEC	

NOTES:

1. CONTROLLING DIMENSION: INCH

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M−1994.

3. DATUM PLANE −H− IS LOCATED AT THE 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 OFTHE HEAT SLUG. HATCHED AREA SHOWN IS ON THE SAME PLANE.

7. DIM A2 APPLIES WITHIN ZONE "J" ONLY.

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

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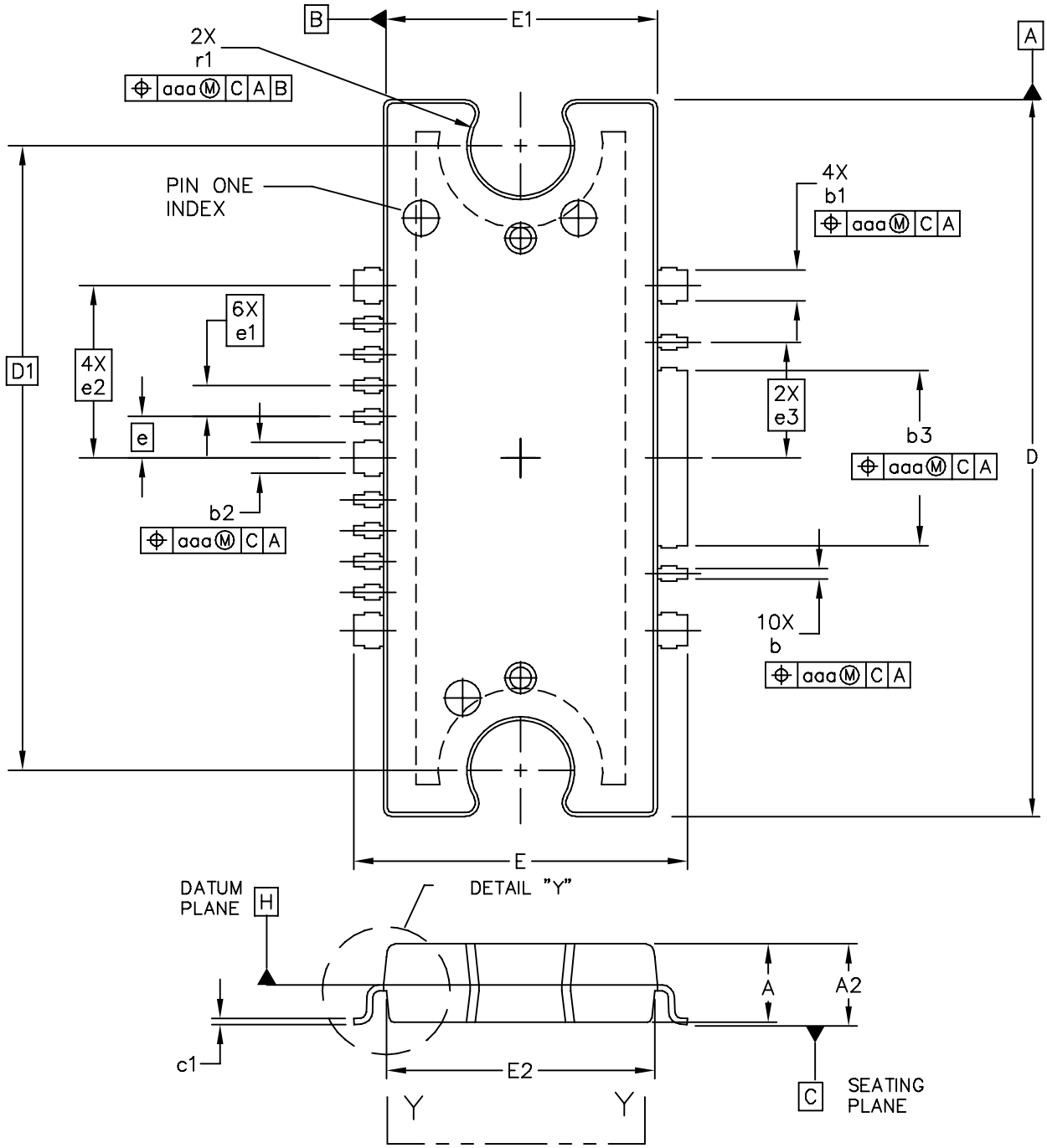

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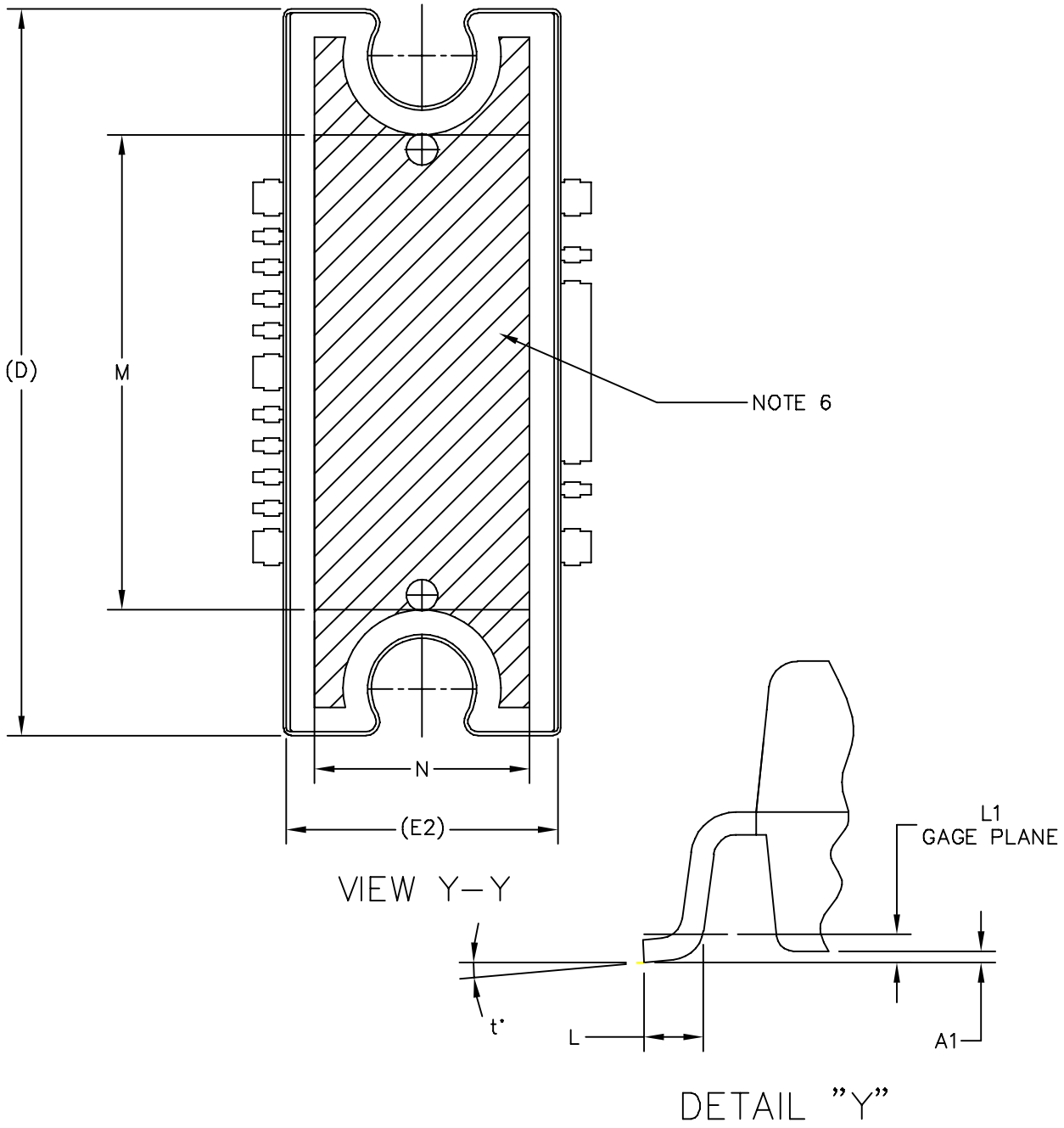
	CASE NUMBER: 1329A-03	3 APR 2006
	STANDARD: NON-JEDEC	



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TITLE: TO–272WB, 16 LEAD GULL WING PLASTIC	DOCUMENT NO: 98ASA10532D	REV: E
	CASE NUMBER: 1329A–03	3 APR 2006
	STANDARD: NON–JEDEC	

NOTES:

1. CONTROLLING DIMENSION: INCH

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.

3. DATUM PLANE –H– IS LOCATED AT THE 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 EXPOSED AREA OF THE HEAT SLUG. HATCHED AREA SHOWN IS ON THE SAME PLANE.

	INCH		MILLIMETER			INCH		MILLIMETER	
DIM	MIN	MAX	MIN	MAX	DIM	MIN	MAX	MIN	MAX
A	.100	.104	2.54	2.64	b	.011	.017	0.28	0.43
A1	.001	.004	0.02	0.10	b1	.037	.043	0.94	1.09
A2	.099	.110	2.51	2.79	b2	.037	.043	0.94	1.09
D	.928	.932	23.57	23.67	b3	.225	.231	5.72	5.87
D1	.810 BSC		20.57 BSC		c1	.007	.011	.18	.28
E	.429	.437	10.9	11.1	e	.054 BSC		1.37 BSC	
E1	.353	.357	8.97	9.07	e1	.040 BSC		1.02 BSC	
E2	.346	.350	8.79	8.89	e2	.224 BSC		5.69 BSC	
L	.018	.024	4.90	5.06	e3	.150 BSC		3.81 BSC	
L1	.01 BSC		.025 BSC		r1	.063	.068	1.6	1.73
M	.600	----	15.24	----	t	2°	8°	2°	8°
N	.270	----	6.86						
				----	aaa	.004		.10	

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