Rev. 8, 5/2006

Technical Data

Replaced by MW4IC2020NBR1 (GNBR1). There are no form, fit or function changes with this part replacement. N suffix added to part number to indicate transition to lead-free terminations.

RF LDMOS Wideband Integrated Power Amplifiers

The MW4IC2020 wideband integrated circuit is designed with on-chip matching that makes it usable from 1600 to 2400 MHz. This multi-stage structure is rated for 26 to 28 Volt operation and covers all typical cellular base station modulation formats.

Final Application

Typical Two-Tone Performance: V_{DD} = 26 Volts, I_{DQ1} = 80 mA, I_{DQ2} = 200 mA, I_{DQ3} = 300 mA, P_{out} = 20 Watts PEP, Full Frequency Band Power Gain — 29 dB
 IMD — -32 dBc

Drain Efficiency - 26% (at 1805 MHz) and 20% (at 1990 MHz)

Driver Applications

Typical GSM EDGE Performance: V_{DD} = 26 Volts, I_{DQ1} = 80 mA, I_{DQ2} = 230 mA, I_{DQ3} = 230 mA, P_{out} = 5 Watts Avg., Full Frequency Band Power Gain — 29 dB
 Spectral Regrowth @ 400 kHz Offset = -66 dBc
 Spectral Regrowth @ 600 kHz Offset = -77 dBc
 EVM — 1% rms

Typical CDMA Performance: V_{DD} = 26 Volts, I_{DQ1} = 80 mA, I_{DQ2} = 240 mA, I_{DQ3} = 250 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 — 30 dB ACPR @ 885 kHz Offset = -61 dBc in 30 kHz Bandwidth ALT1 @ 1.25 MHz Offset = -69 dBc in 12.5 kHz Bandwidth ALT2 @ 2.25 MHz Offset = -59 dBc in 1 MHz Bandwidth

- Capable of Handling 3:1 VSWR, @ 26 Vdc, 1990 MHz, 8 Watts CW Output Power
- Stable into a 3:1 VSWR. All Spurs Below -60 dBc @ 100 mW to 8 W CW Pout.
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- On-Chip Matching (50 Ohm Input, DC Blocked, >5 Ohm Output)
- Integrated Temperature Compensation 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
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel

V_{RG1} V_{DS2} V_{DS1} RF_{in} V_{GS1} V_{GS2} V_{GS3} Quiescent Current Temperature Compensation Figure 1. Functional Block Diagram

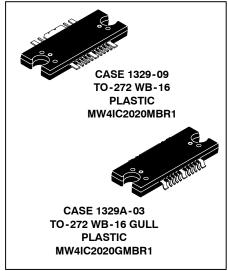
GND [16 **GND** V_{DS2} □ 2 15 V_{RD1} | 3 V_{RG1} V_{DS1} 5 $V_{DS3/}$ $\mathsf{RF}_{\mathsf{in}}$ 6 RF_out 8 V_{GS1} V_{GS2} V_{GS3} 113 101 **_** 12 GND 11 L **GND** (Top View) Note: Exposed backside flag is source terminal for transistors. Figure 2. Pin Connections

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.

MW4IC2020GMBR1

MW4IC2020MBR1

1805-1990 MHz, 20 W, 26 V GSM/GSM EDGE, CDMA RF LDMOS WIDEBAND INTEGRATED POWER AMPLIFIERS





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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	TJ	200	°C
Input Power	P _{in}	20	dBm

Table 2. Thermal Characteristics

Characteristic	Symbol	Value ⁽¹⁾	Unit
Thermal Resistance, Junction to Case	$R_{ heta JC}$		°C/W
Stage 1		10.5	
Stage 2		5.1	
Stage 3		2.3	

Table 3. ESD Protection Characteristics

Test Conditions	Class
Human Body Model	2 (Minimum)
Machine Model	M3 (Minimum)
Charge Device Model	C5 (Minimum)

Table 4. Moisture Sensitivity Level

Intermodulation Distortion

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

Symbol

IMD

Min

Тур

-32

Max

-27

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

Functional Tests (In Freescale Wideband 1805-1990 MHz Test Fixture, 50 ohm system) V _{DD} = 26 Vdc, I _{DQ1} = 80 mA, I _{DQ2} = 200 mA,						
I_{DQ3} = 300 mA, P_{out} = 20 W PEP, f1 = 1990 MHz, f2 = 1990.1 MHz and f1 = 1805 MHz, f2 = 1805.1 MHz, Two-Tone CW						
Power Gain		G _{ps}	27	29	_	dB
Drain Efficiency		η_{D}			=	%
	f1 = 1805 MHz, f2 = 1805.1 MHz		24	26		
	f1 = 1990 MHz, f2 = 1990.1 MHz		18	20		
Input Return Loss		IRL	_		-10	dB

Typical Performances (In Freescale Test Fixture, 50 ohm system) V_{DD} = 26 Vdc, I_{DQ1} = 80 mA, I_{DQ2} = 200 mA, I_{DQ3} = 300 mA, 1805 MHz<Frequency<1990 MHz, 1-Tone

1000 Wil 12<1 Tequency 1000 Wil 12, 1 - Tolic					
Saturated Pulsed Output Power (f = 1 kHz, Duty Cycle 10%)	P _{sat}	_	33	_	W
Quiescent Current Accuracy over Temperature (-10 to 85°C) (2)	ΔI_{QT}	_	±5	_	%
Gain Flatness in 30 MHz Bandwidth @ Pout = 1 W CW	G _F	_	0.15	_	dB
Deviation from Linear Phase in 30 MHz Bandwidth @ P _{out} = 1 W CW 1805-1880 MHz 1930-1990 MHz	Φ	_	±0.5 ±0.2	_	0
Delay @ P _{out} = 1 W CW Including Output Matching	Delay	_	1.8	_	ns
Part-to-Part Phase Variation @ Pout = 1 W CW	ΦΔ	_	±10	_	٥

- Refer to AN1955, Thermal Measurement Methodology of RF Power Amplifiers. Go to http://www.freescale.com/rf.
 Select Documentation/Application Notes AN1955.
- 2. Refer to AN1977, Quiescent Current Thermal Tracking Circuit in the RF Integrated Circuit Family. Go to http://www.freescale.com/rf. Select Documentation/Application Notes AN1977.

(continued)

Unit

dBc

MW4IC2020MBR1 MW4IC2020GMBR1

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

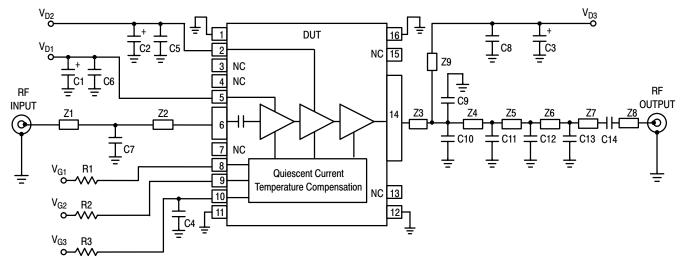
Characteristic	Symbol	Min	Тур	Max	Unit

Typical CDMA Performances (In Modified CDMA Test Fixture, 50 ohm system) $V_{DD} = 26 \text{ Vdc}$, $D_{Q1} = 80 \text{ mA}$, $I_{DQ2} = 240 \text{ mA}$, $I_{DQ3} = 250 \text{ mA}$, $P_{out} = 1 \text{ W Avg.}$, P_{Out

Power Gain	G _{ps}	_	30	_	dB
Drain Efficiency	η_{D}	_	5	_	%
Adjacent Channel Power Ratio (±885 kHz in 30 kHz Bandwidth)	ACPR	_	-61	_	dBc
Alternate 1 Channel Power Ratio (±1.25 MHz in 12.5 kHz Bandwidth)	ALT1	_	-69	_	dBc
Alternate 2 Channel Power Ratio (±2.25 MHz in 1 MHz Bandwidth)	ALT2	_	-59	_	dBc

 $\begin{tabular}{l} \textbf{Typical GSM EDGE Performances} & (In Modified GSM EDGE Test Fixture, 50 ohm system) V_{DD} = 26 Vdc, I_{DQ1} = 80 mA, I_{DQ2} = 230 mA, I_{DQ3} = 230 mA, P_{out} = 5 W Avg., 1805 MHz < Frequency < 1990 MHz \\ \end{tabular}$

Power Gain	G _{ps}	_	29	_	dB
Drain Efficiency	η_{D}	_	15	_	%
Error Vector Magnitude	EVM	_	1	_	% rms
Spectral Regrowth at 400 kHz Offset	SR1	_	-66	_	dBc
Spectral Regrowth at 600 kHz Offset	SR2	=	-77	_	dBc

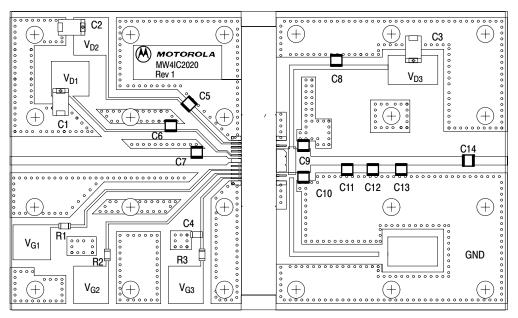


Z1	1.820" x 0.087" Microstrip	Z6	0.303" x 0.087" Microstrip
Z2	0.245" x 0.087" Microstrip	Z 7	0.640" x 0.087" Microstrip
Z3	0.345" x 0.236" Microstrip	Z8	0.334" x 0.087" Microstrip
Z4	0.327" x 0.087" Microstrip	Z9	1.231" x 0.043" Microstrip
Z 5	0.271" x 0.087" Microstrip	PCB	Taconic TLX8-0300, 0.030", $\varepsilon_r = 2.55$

Figure 3. MW4IC2020MBR1(GMBR1) Test Circuit Schematic

Table 6. MW4IC2020MBR1(GMBR1) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2, C3	10 μF, 35 V Tantalum Capacitors	TAJE226M035	AVX
C4	220 nF Chip Capacitor (1206)	12065C224K28	AVX
C5, C6, C8	6.8 pF 100B Chip Capacitors	100B6R8CW	ATC
C7	0.5 pF 100B Chip Capacitor	100B0R5BW	ATC
C9, C11	1.8 pF 100B Chip Capacitors	100B1R8BW	ATC
C10	2.2 pF 100B Chip Capacitor	100B2R2BW	ATC
C12	1 pF 100B Chip Capacitor	100B1R0BW	ATC
C13	0.3 pF 100B Chip Capacitor	100B0R3BW	ATC
C14	10 pF 100B Chip Capacitor	100B100GW	ATC
R1, R2, R3	1.8 kΩ Chip Resistors (1206)		



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. MW4IC2020MBR1(GMBR1) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

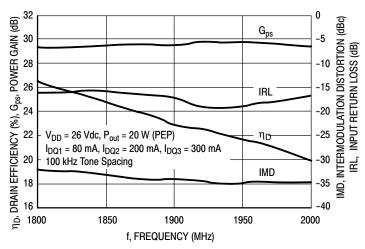


Figure 5. Two-Tone Wideband Performance

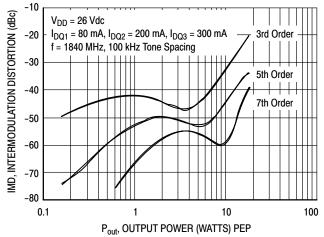


Figure 6. Intermodulation Distortion Products versus Output Power @ 1840 MHz

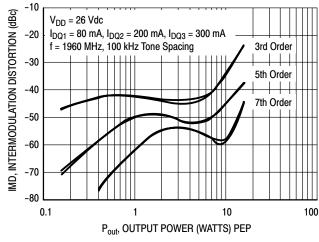


Figure 7. Intermodulation Distortion Products versus Output Power @ 1960 MHz

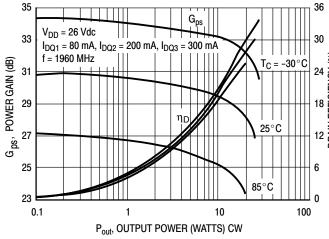


Figure 8. Power Gain and Drain Efficiency versus Output Power

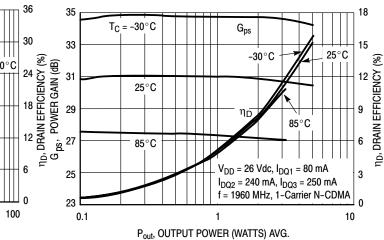


Figure 9. Power Gain and Drain Efficiency versus Output Power

MW4IC2020MBR1 MW4IC2020GMBR1

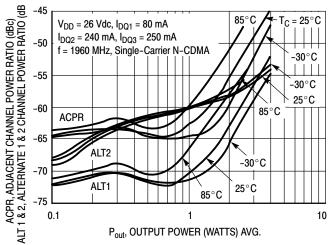


Figure 10. Alternate Channel Power Ratio, Alternate 1 and 2 Channel Power Ratio versus Output Power

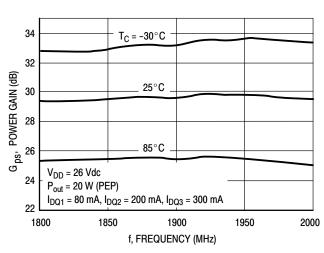


Figure 11. Power Gain versus Frequency

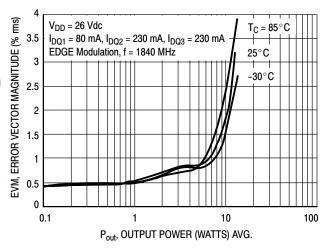


Figure 12. EVM versus Output Power @ 1840 MHz

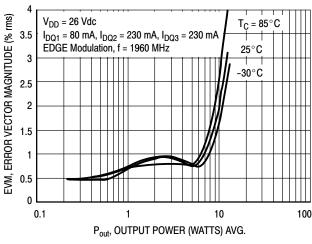


Figure 13. EVM versus Output Power @ 1960 MHz

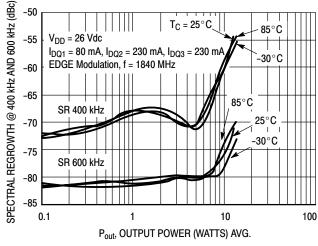


Figure 14. Spectral Regrowth at 400 and 600 kHz versus Output Power @ 1840 MHz

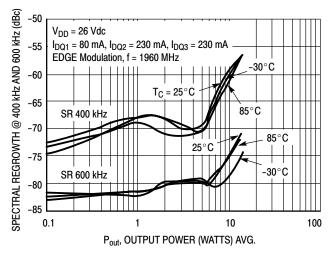
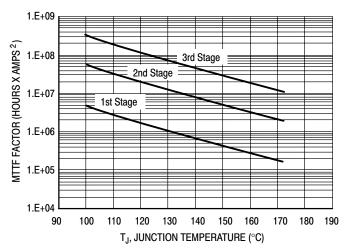


Figure 15. Spectral Regrowth at 400 and 600 kHz versus Output Power @ 1960 MHz

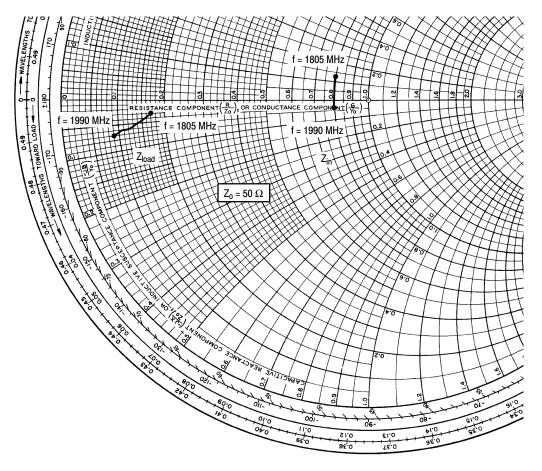
MW4IC2020MBR1 MW4IC2020GMBR1

TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours x ampere² drain current. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ of the theoretical prediction for metal failure. Divide MTTF factor by $I_D{}^2$ for MTTF in a particular application.

Figure 16. MTTF Factor versus Junction Temperature



 $\rm V_{DD}$ = 26 V, $\rm I_{DQ1}$ = 80 mA, $\rm I_{DQ2}$ = 200 mA, $\rm I_{DQ3}$ = 300 mA, $\rm P_{out}$ = 20 W PEP

f MHz	$egin{array}{c} \mathbf{Z_{in}} \\ \Omega \end{array}$	$\mathbf{Z_{load}}_{\Omega}$
1805	40.00 + j6.50	8.75 - j1.42
1842	40.00 + j2.00	7.00 - j2.70
1880	40.00 - j1.50	5.90 - j2.97
1930	40.00 - j1.80	5.46 - j3.20
1960	40.00 - j2.10	4.30 - j3.35
1990	40.00 - j2.60	4.45 - j3.30

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

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

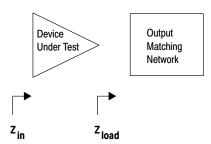
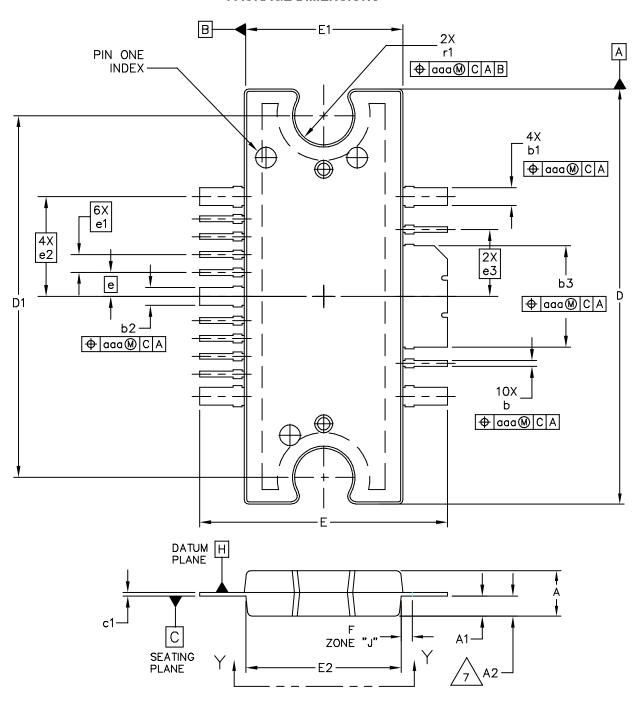


Figure 17. Series Equivalent Input and Load Impedance

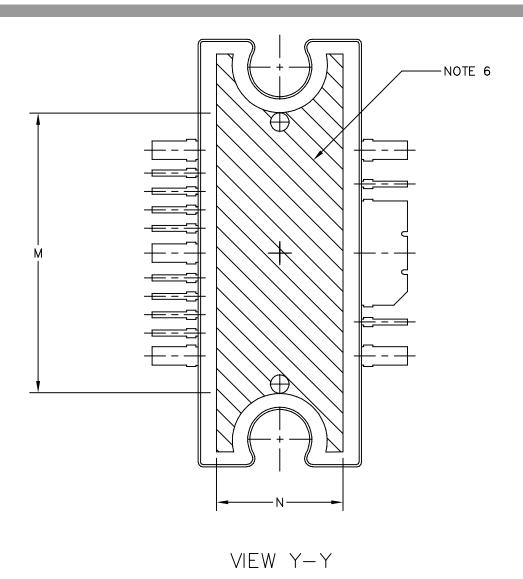
MW4IC2020MBR1 MW4IC2020GMBR1

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PACKAGE DIMENSIONS



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WOLT LEAD	STANDARD: NO	N-JEDEC	



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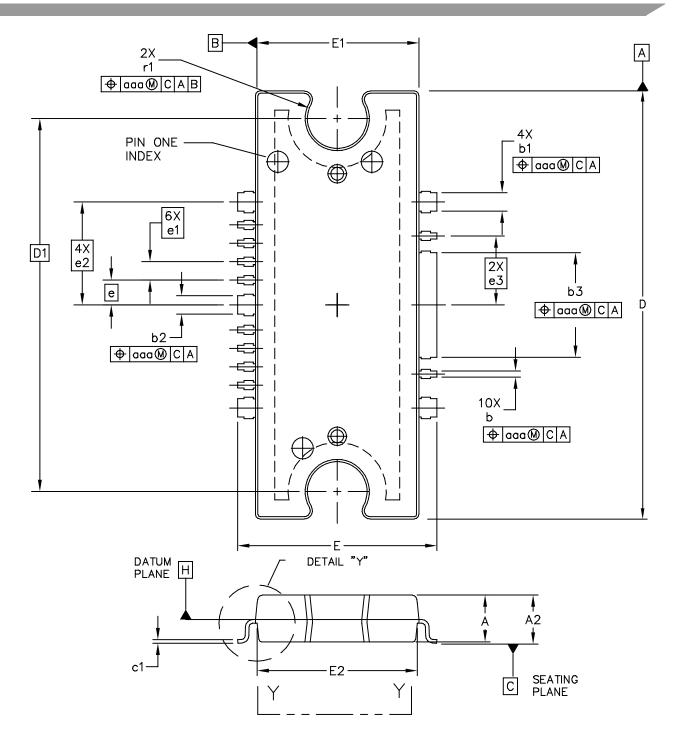
NOTES:

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- 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.

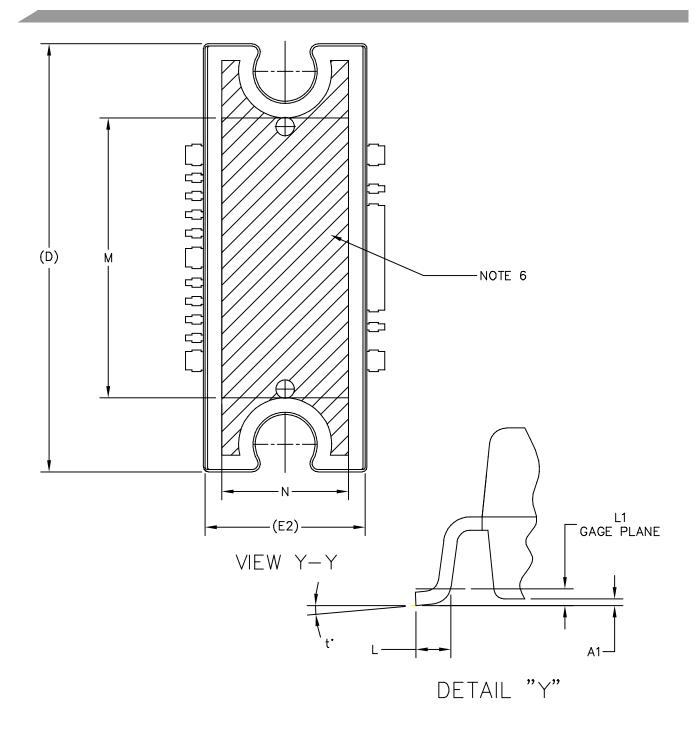
	IN	СН	MIL	LIMETER		INCH		М	ILLIMETER
DIM	MIN	MAX	MIN	MAX	DIM	MIN	MAX	MIN	MAX
Α	.100	.104	2.54	2.64	Ф	.011	.017	0.28	0.43
A1	.038	.044	0.96	1.12	b1	.037	.043	0.94	1.09
A2	.040	.042	1.02	1.07	b2	.037	.043	0.94	1.09
D	.928	.932	23.57	23.67	b3	.225	.231	5.72	2 5.87
D1	.810	BSC	20.	.57 BSC	c1	.007	.011	.18	.28
E	.551	.559	14.00	14.20	е	.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	еЗ	.150 BSC		,	3.81 BSC
М	.600		15.24		r1	.063	.068	1.6	1.73
N	.270		6.86						
					aaa		.004	.10	
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TO-272 WIDE BODY			CASE	NUMBER	R: 1329–09		13 MAR 2006		

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STANDARD: NON-JEDEC



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GULL WING	CASE NUMBER: 1329A-03 3 APR 200			
PLASTIC	STANDARD: NO	N-JEDEC		



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			CASE NUMBER: 1329A-03 3 APR 2006		
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- 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
Α	.100	.104	2.54	2.64	Ь	.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
Е	.429	.437	10.9	11.1	е	.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	.0:	25 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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GULL WING				CASE	CASE NUMBER: 1329A-03 3 APR 20			3 APR 2006	
PLASTIC				STANDARD: NON-JEDEC					

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