**Freescale Semiconductor**
Technical Data

Document Number: MW4IC2020N
Rev. 9, 5/2006

RoHS

# RF LDMOS Wideband Integrated Power Amplifiers

**MW4IC2020NBR1**
**MW4IC2020GNBR1**

The MW4IC2020N 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.

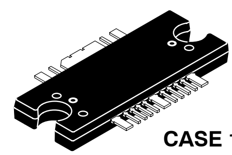
### Final Application

- 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)

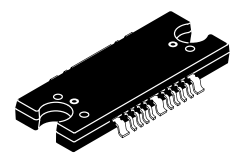
### Driver Applications

- 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 $P_{out}$.
- 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
- N Suffix Indicates Lead-Free Terminations. RoHS Compliant.
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel

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



**CASE 1329-09**
**TO-272 WB-16**
**PLASTIC**
**MW4IC2020NBR1**



**CASE 1329A-03**
**TO-272 WB-16 GULL**
**PLASTIC**
**MW4IC2020GNBR1**

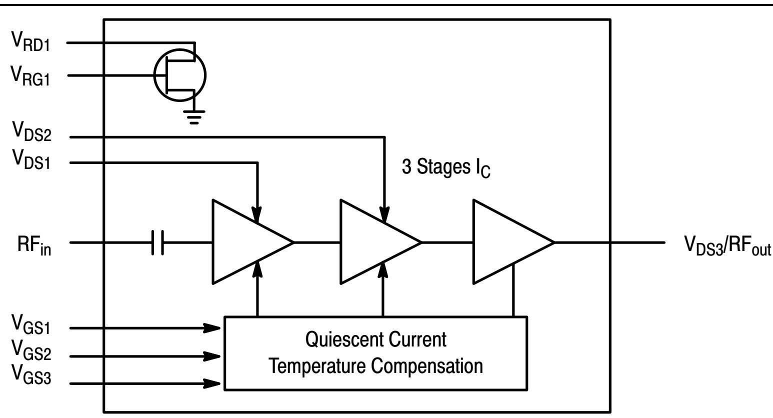
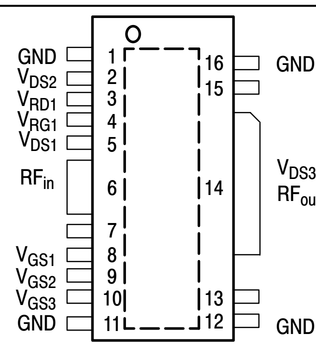



**Figure 1. Functional Block Diagram**




(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.



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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 | $T_J$ | 200 | °C |
| Input Power | $P_{in}$ | 20 | dBm |

### Table 2. Thermal Characteristics

| Characteristic | Symbol | Value (1) | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case<br>Stage 1<br>Stage 2<br>Stage 3 | $R_{\theta JC}$ | <br>10.5<br>5.1<br>2.3 | °C/W |

### 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

| 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)

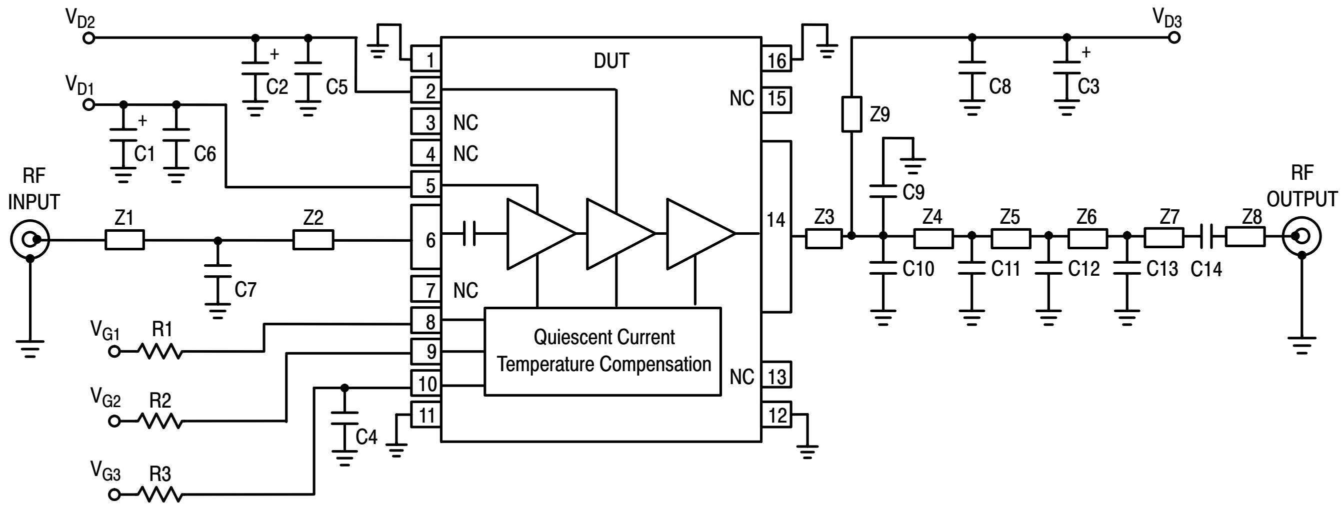
| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Functional Tests** (In Freescale Wideband 1805-1990 MHz Test Fixture, 50 ohm system) $V_{DD}$ = 26 Vdc, $I_{DQ1}$ = 80 mA, $I_{DQ2}$ = 200 mA, $I_{DQ3}$ = 300 mA, $P_{out}$ = 20 W PEP, f1 = 1990 MHz, f2 = 1990.1 MHz and f1 = 1805 MHz, f2 = 1805.1 MHz, Two-Tone CW | | | | | |
| Power Gain | $G_{ps}$ | 27 | 29 | — | dB |
| Drain Efficiency<br>f1 = 1805 MHz, f2 = 1805.1 MHz<br>f1 = 1990 MHz, f2 = 1990.1 MHz | $\eta_D$ | <br>24<br>18 | <br>26<br>20 | — | % |
| Input Return Loss | IRL | — | — | -10 | dB |
| Intermodulation Distortion | IMD | — | -32 | -27 | dBc |
| **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 | | | | | |
| Saturated Pulsed Output Power<br>(f = 1 kHz, Duty Cycle 10%) | $P_{sat}$ | — | 33 | — | W |
| Quiescent Current Accuracy over Temperature (-10 to 85°C) (2) | $\Delta I_{QT}$ | — | ±5 | — | % |
| Gain Flatness in 30 MHz Bandwidth @ $P_{out}$ = 1 W CW | $G_F$ | — | 0.15 | — | dB |
| Deviation from Linear Phase in 30 MHz Bandwidth @ $P_{out}$ = 1 W CW<br>1805-1880 MHz<br>1930-1990 MHz | $\Phi$ | — | <br>±0.5<br>±0.2 | — | ° |
| Delay @ $P_{out}$ = 1 W CW Including Output Matching | Delay | — | 1.8 | — | ns |
| Part-to-Part Phase Variation @ $P_{out}$ = 1 W CW | $\Phi\Delta$ | — | ±10 | — | ° |

1. 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)

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Typical CDMA Performances** (In Modified CDMA Test Fixture, 50 ohm system) $V_{DD}$ = 26 Vdc, $_{DQ1}$ = 80 mA, $I_{DQ2}$ = 240 mA, $I_{DQ3}$ = 250 mA, $P_{out}$ = 1 W Avg., I1930 MHz<Frequency<1990 MHz, 1-Tone, 9 Channel Forward Model (Pilot, Paging, Sync, Traffic Codes 8 through 13). Peak/Avg. Ratio 9.8 dB @ 0.01% Probability on CCDF. | | | | | |
| Power Gain | $G_{ps}$ | — | 30 | — | dB |
| Drain Efficiency | $\eta_D$ | — | 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 |
| **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 | | | | | |
| Power Gain | $G_{ps}$ | — | 29 | — | dB |
| Drain Efficiency | $\eta_D$ | — | 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 |

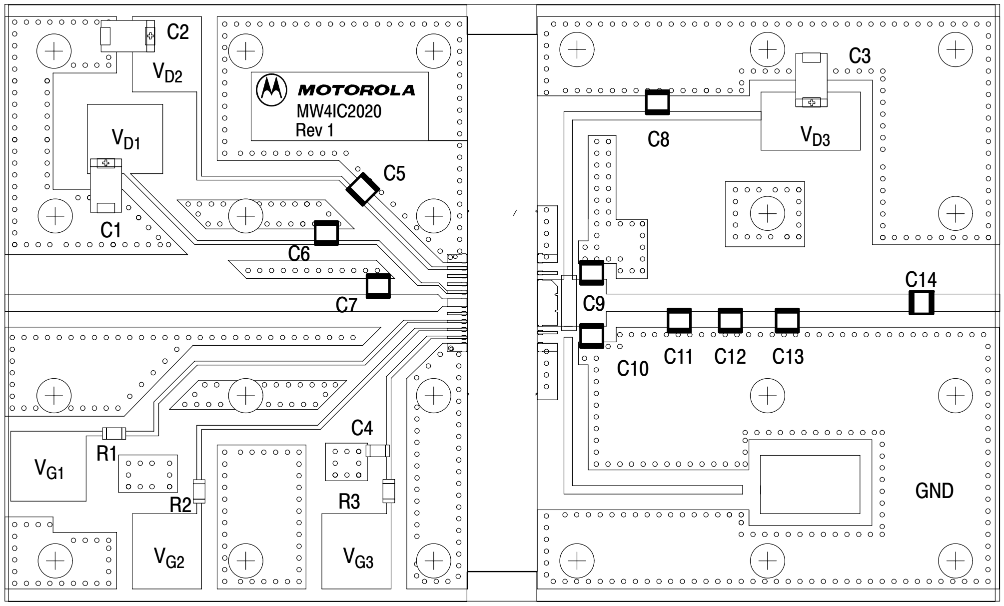



| | | | |
|---|---|---|---|
| Z1 | 1.820″ x 0.087″ Microstrip | Z6 | 0.303″ x 0.087″ Microstrip |
| Z2 | 0.245″ x 0.087″ Microstrip | Z7 | 0.640″ x 0.087″ Microstrip |
| Z3 | 0.345″ x 0.236″ Microstrip | Z8 | 0.334″ x 0.087″ Microstrip |
| Z4 | 0.327″ x 0.087″ Microstrip | Z9 | 1.231″ x 0.043″ Microstrip |
| Z5 | 0.271″ x 0.087″ Microstrip | PCB | Taconic TLX8-0300, 0.030″, $\varepsilon_r = 2.55$ |

**Figure 3. MW4IC2020NBR1(GNBR1) Test Circuit Schematic**

**Table 6. MW4IC2020NBR1(GNBR1) 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. MW4IC2020NBR1(GNBR1) Test Circuit Component Layout**

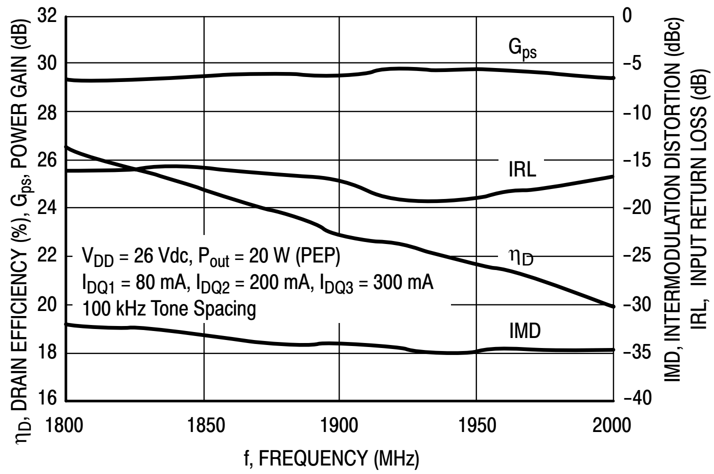



**Figure 5. Two-Tone Wideband Performance**

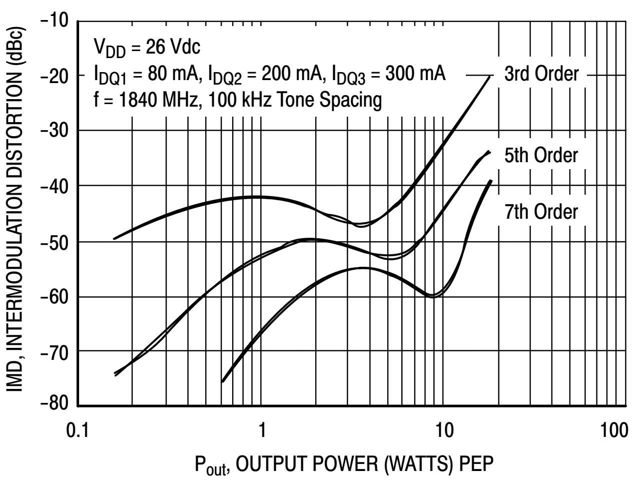



**Figure 6. Intermodulation Distortion Products versus Output Power @ 1840 MHz**

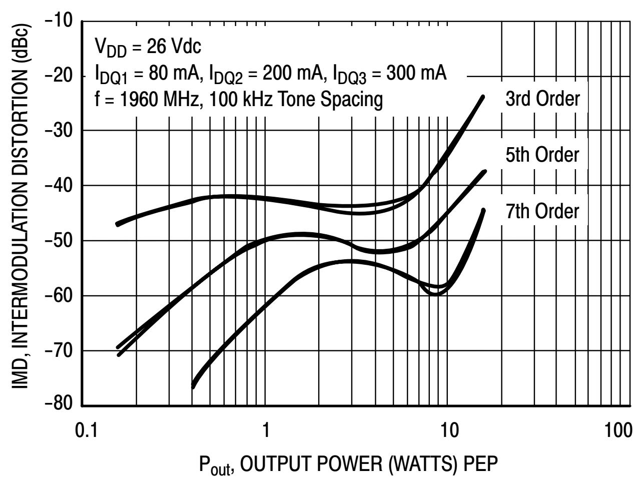



**Figure 7. Intermodulation Distortion Products versus Output Power @ 1960 MHz**

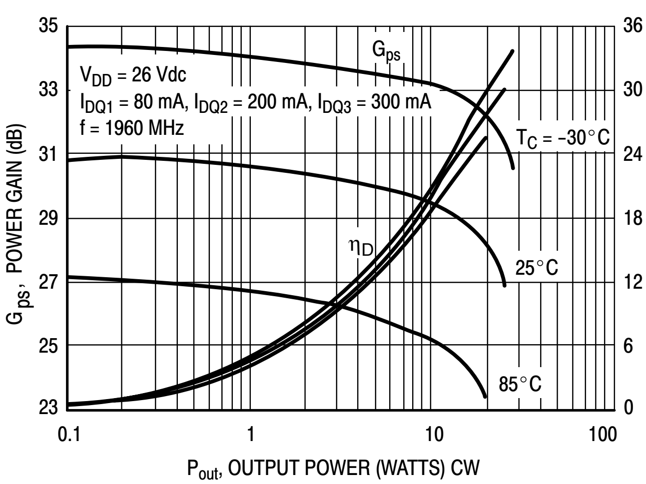



**Figure 8. Power Gain and Drain Efficiency versus Output Power**

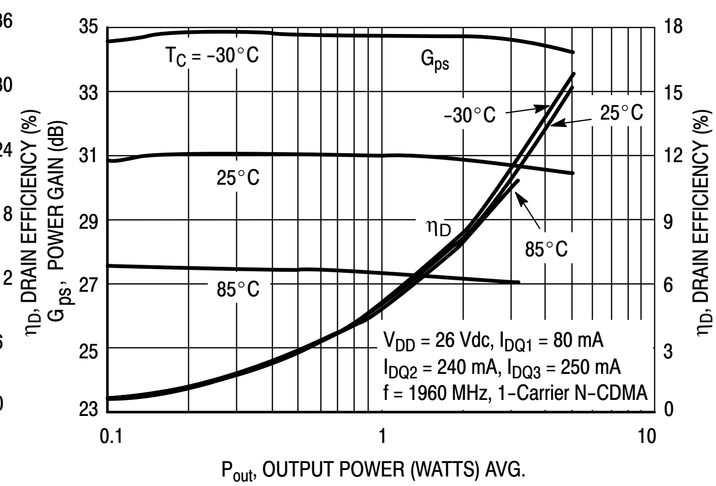



**Figure 9. Power Gain and Drain Efficiency versus Output Power**

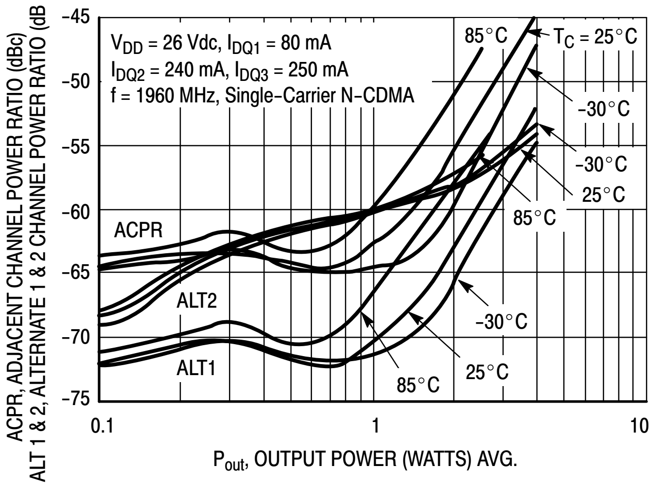



**Figure 10. Alternate Channel Power Ratio, Alternate 1 and 2 Channel Power Ratio versus Output Power**

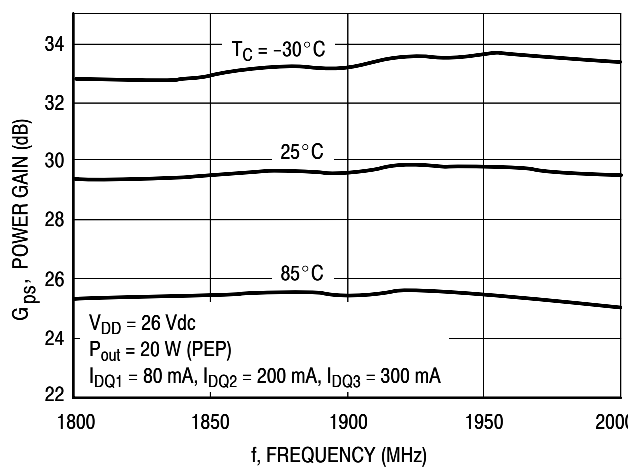



**Figure 11. Power Gain versus Frequency**

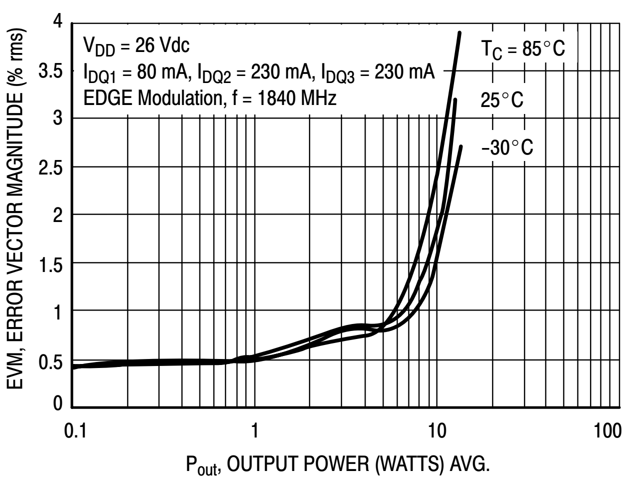



**Figure 12. EVM versus Output Power @ 1840 MHz**

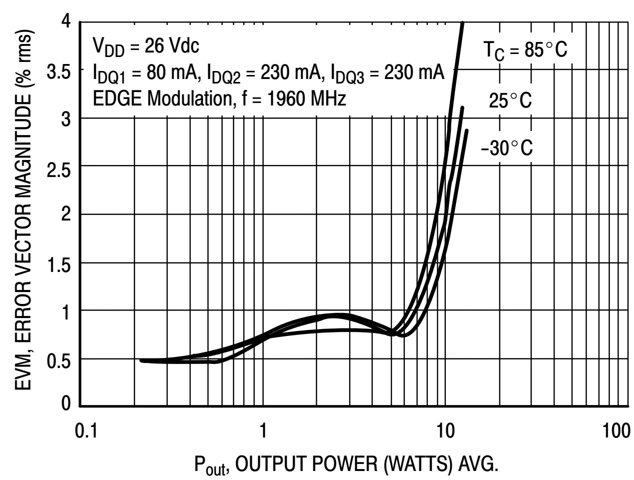



**Figure 13. EVM versus Output Power @ 1960 MHz**

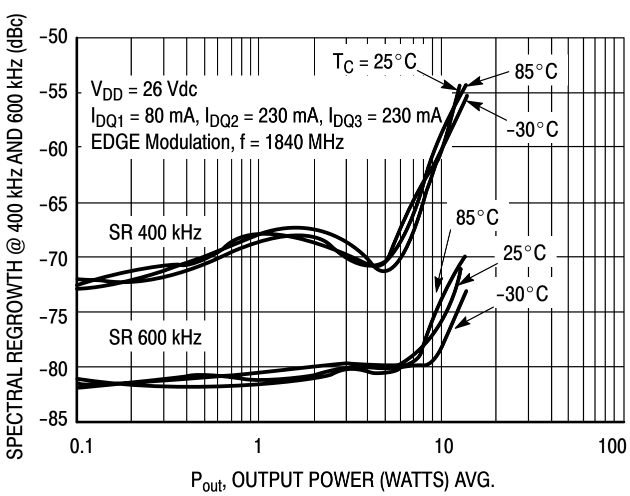



**Figure 14. Spectral Regrowth at 400 and 600 kHz versus Output Power @ 1840 MHz**

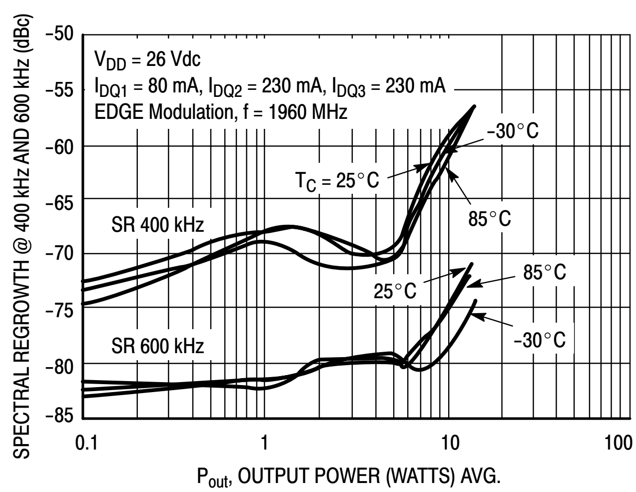
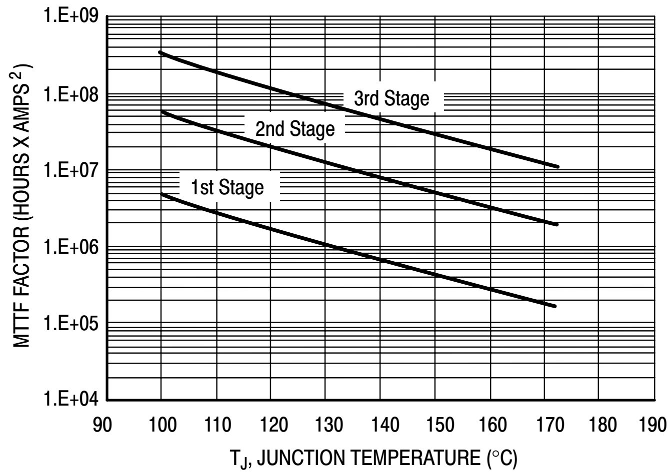
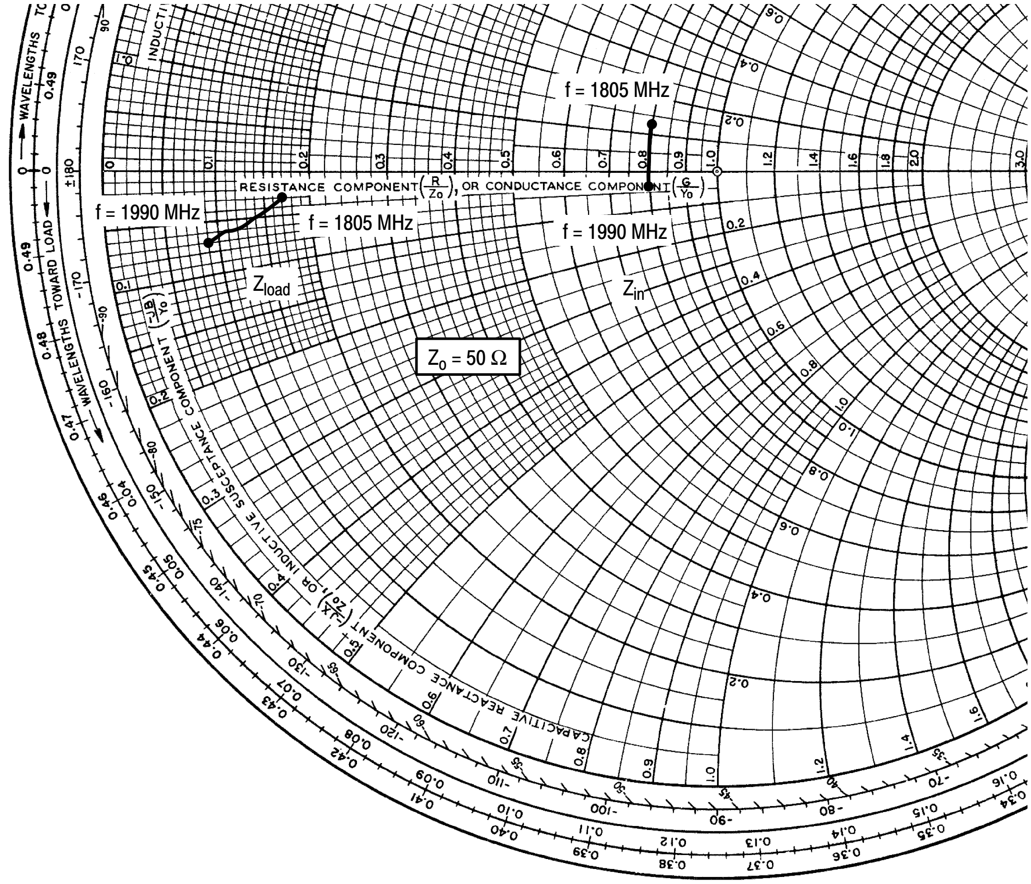



**Figure 15. Spectral Regrowth at 400 and 600 kHz versus Output Power @ 1960 MHz**




This above graph displays calculated MTTF in hours x ampere² 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 16. MTTF Factor versus Junction Temperature**




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

| f MHz | $Z_{in}$ Ω | $Z_{load}$ Ω |
|---|---|---|
| 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.

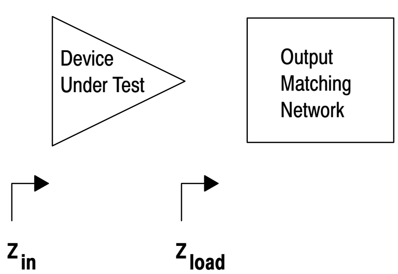
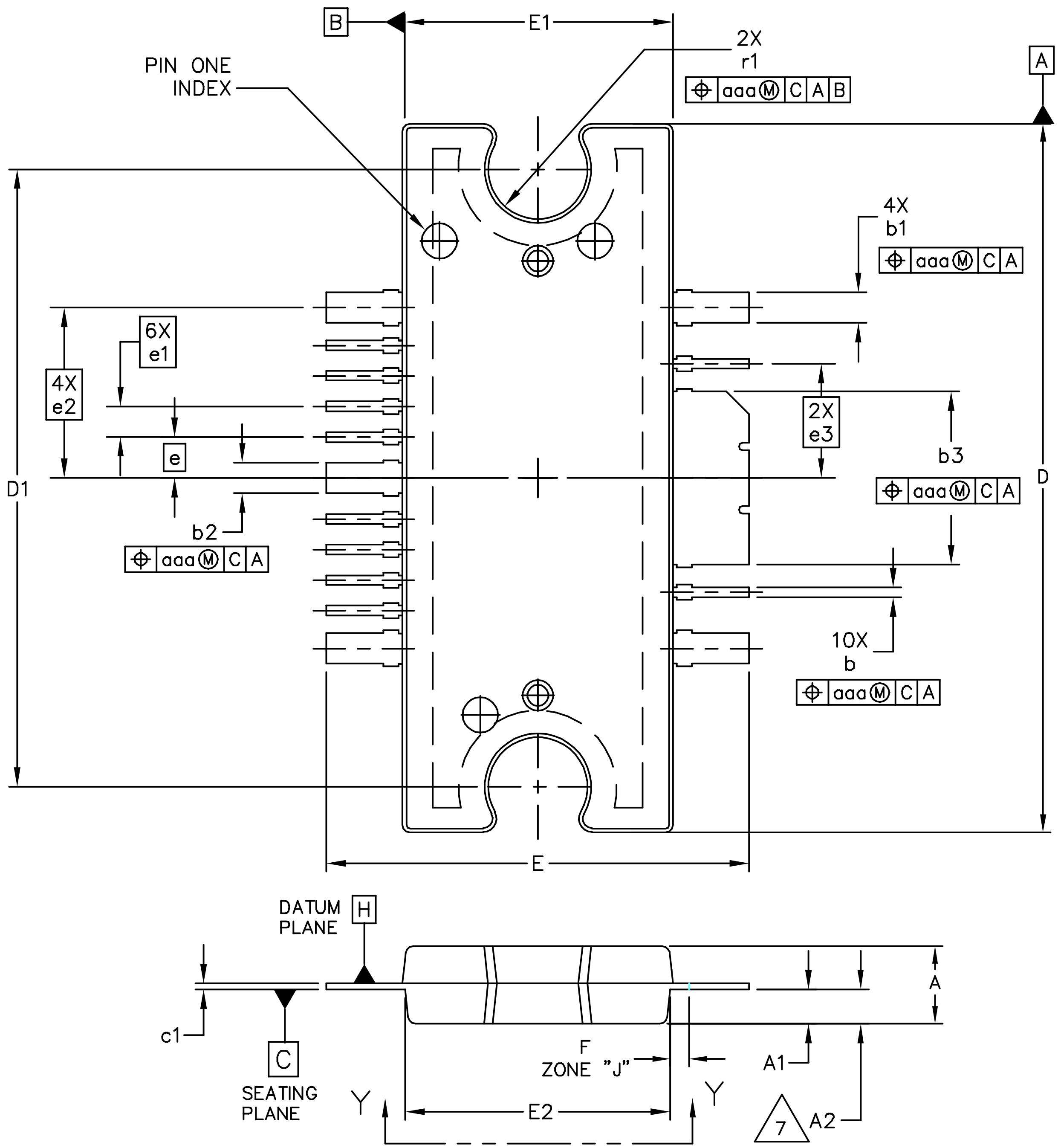
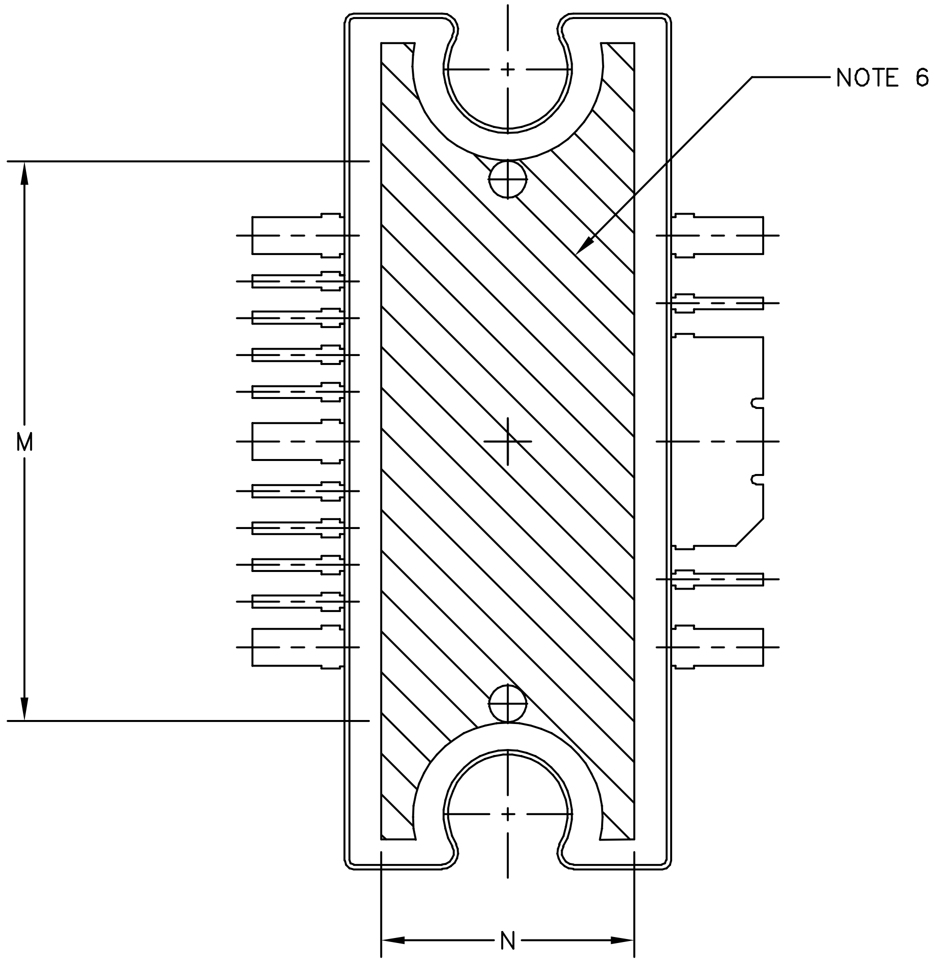



**Figure 17. Series Equivalent Input and Load Impedance**

## PACKAGE DIMENSIONS




|  | MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE |
|---|---|---|
| TITLE: TO–272 WIDE BODY MULTI–LEAD | DOCUMENT NO: 98ARH99164A | REV: L |
| | CASE NUMBER: 1329–09 | 13 MAR 2006 |
| | STANDARD: NON–JEDEC | |




VIEW Y–Y

|  | **MECHANICAL OUTLINE** | PRINT VERSION NOT TO SCALE |
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| TITLE: TO–272 WIDE BODY MULTI–LEAD | DOCUMENT NO: 98ARH99164A | REV: L |
| | 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.

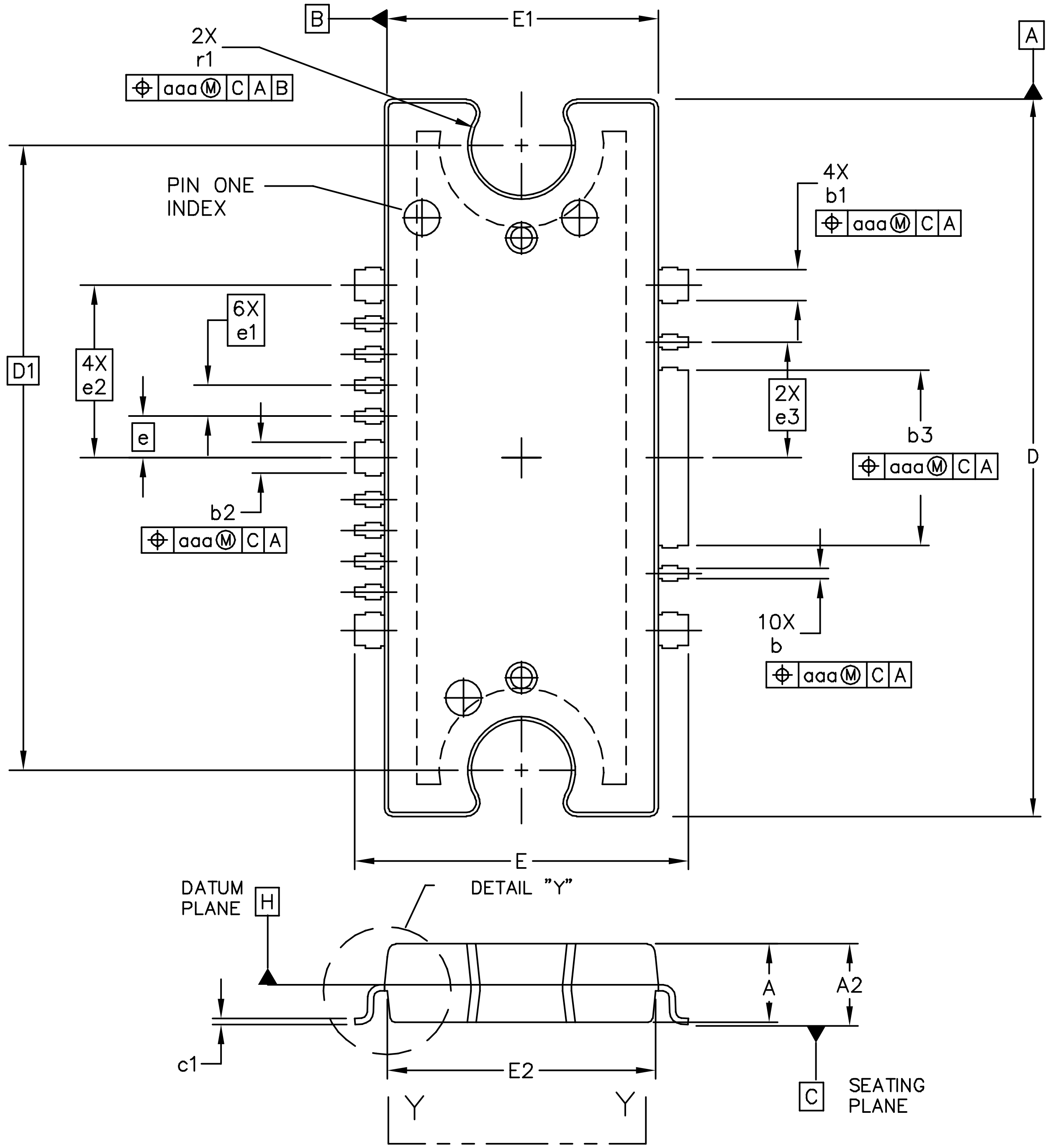
6. HATCHING REPRESENTS THE EXPOSED AREA OFTHE HEAT SLUG. HATCHED AREA SHOWN IS ON THE SAME PLANE.

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

| | 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 | .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 | |



| MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE | |
|---|---|---|
| TITLE: TO-272 WIDE BODY MULTI-LEAD | DOCUMENT NO: 98ARH99164A | REV: L |
| | CASE NUMBER: 1329-09 | 13 MAR 2006 |
| | STANDARD: NON-JEDEC | |

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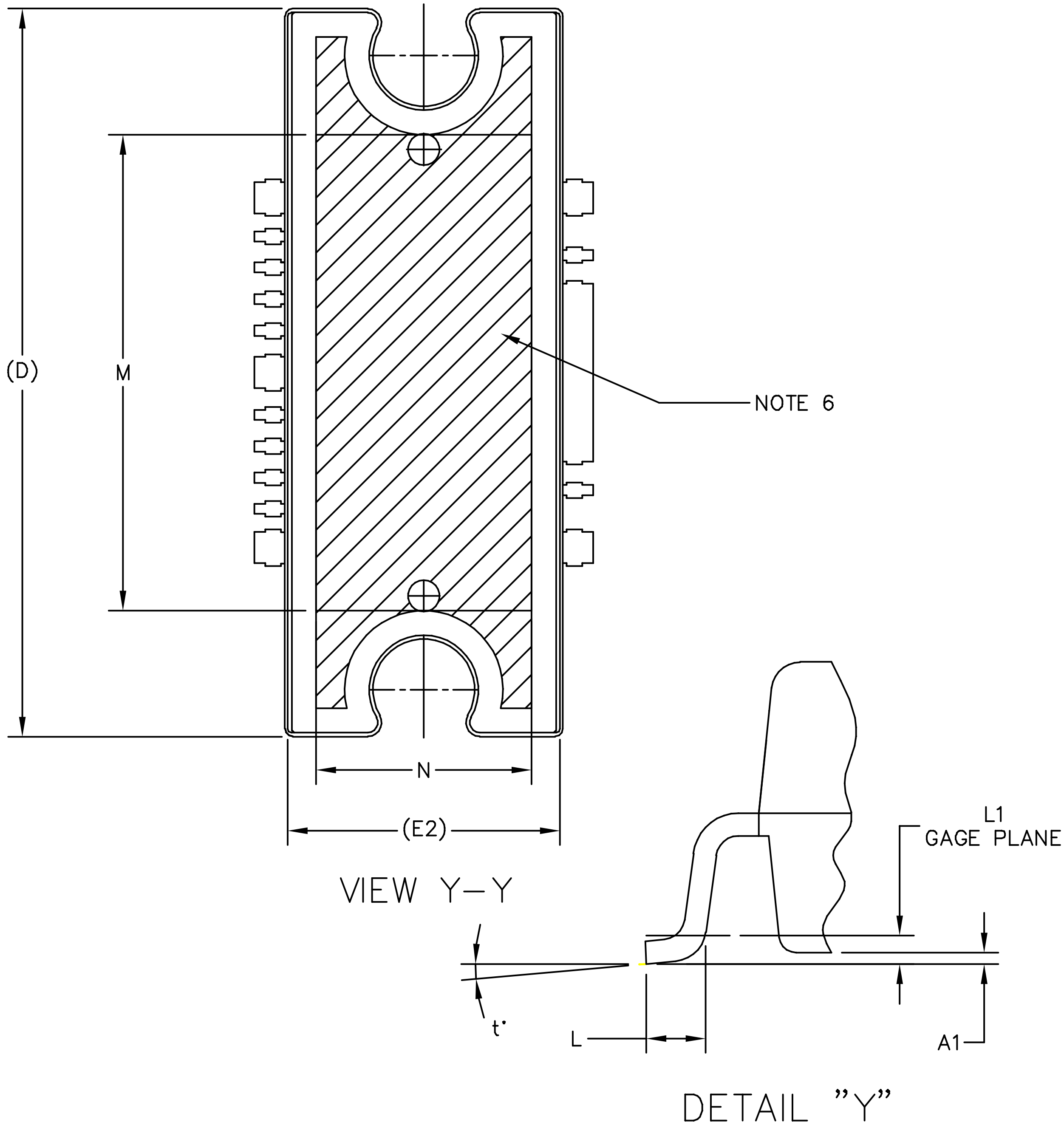
| | CASE NUMBER: 1329A–03 | 3 APR 2006 |
| | STANDARD: NON–JEDEC | |

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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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| | CASE NUMBER: 1329A—03 | 3 APR 2006 |
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Document Number: MW4IC2020N
Rev. 9, 5/2006