

RF LDMOS Wideband Integrated Power Amplifiers

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

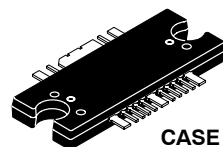
- Typical Two-Tone Performance: $V_{DD} = 26$ Volts, $I_{DQ1} = 80$ mA, $I_{DQ2} = 200$ mA, $I_{DQ3} = 300$ mA, $P_{out} = 20$ Watts PEP, Full Frequency Band
Power Gain — 29 dB
IMD — -32 dBc
Drain Efficiency — 26% (at 1805 MHz) and 20% (at 1990 MHz)

Driver Applications

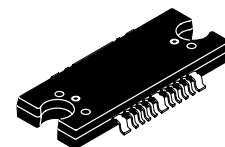
- Typical GSM EDGE Performance: $V_{DD} = 26$ Volts, $I_{DQ1} = 80$ mA, $I_{DQ2} = 230$ mA, $I_{DQ3} = 230$ mA, $P_{out} = 5$ Watts Avg., Full Frequency Band
Power Gain — 29 dB
Spectral Regrowth @ 400 kHz Offset = -66 dBc
Spectral Regrowth @ 600 kHz Offset = -77 dBc
EVM — 1% rms
- Typical CDMA Performance: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

MW4IC2020NBR1
MW4IC2020GNBR1

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

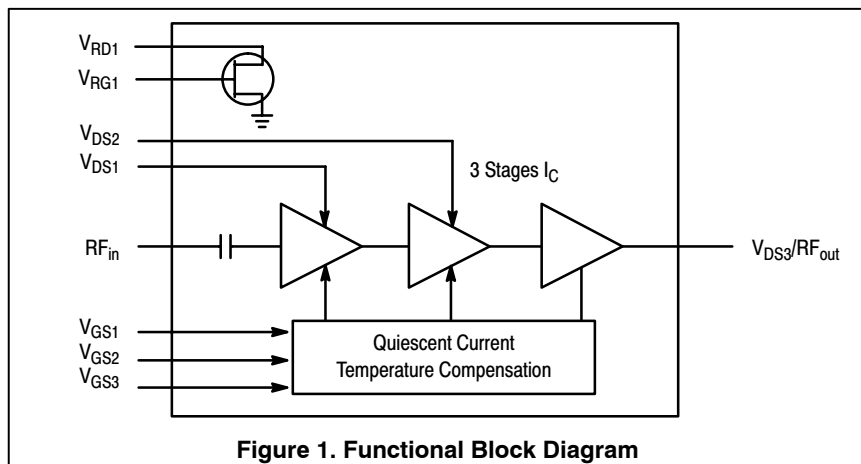
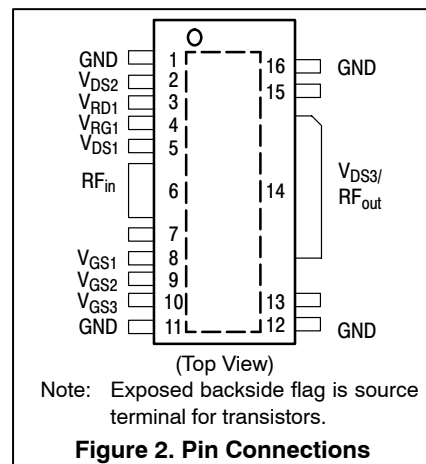


Figure 1. Functional Block Diagram



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.

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 | $R_{\theta JC}$ | | °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

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

Table 5. Electrical Characteristics ($T_C = 25^\circ\text{C}$ 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, $f_1 = 1990$ MHz, $f_2 = 1990.1$ MHz and $f_1 = 1805$ MHz, $f_2 = 1805.1$ MHz, Two-Tone CW

| | | | | | |
|----------------------------|--------------------------------------|----|-----|-----|-----|
| Power Gain | G_{ps} | 27 | 29 | — | dB |
| Drain Efficiency | η_D | 24 | 26 | — | % |
| | $f_1 = 1805$ MHz, $f_2 = 1805.1$ MHz | 18 | 20 | | |
| | $f_1 = 1990$ MHz, $f_2 = 1990.1$ MHz | | | | |
| 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 ($f = 1$ 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 @ $P_{out} = 1$ 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 | — | ° |
| 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.

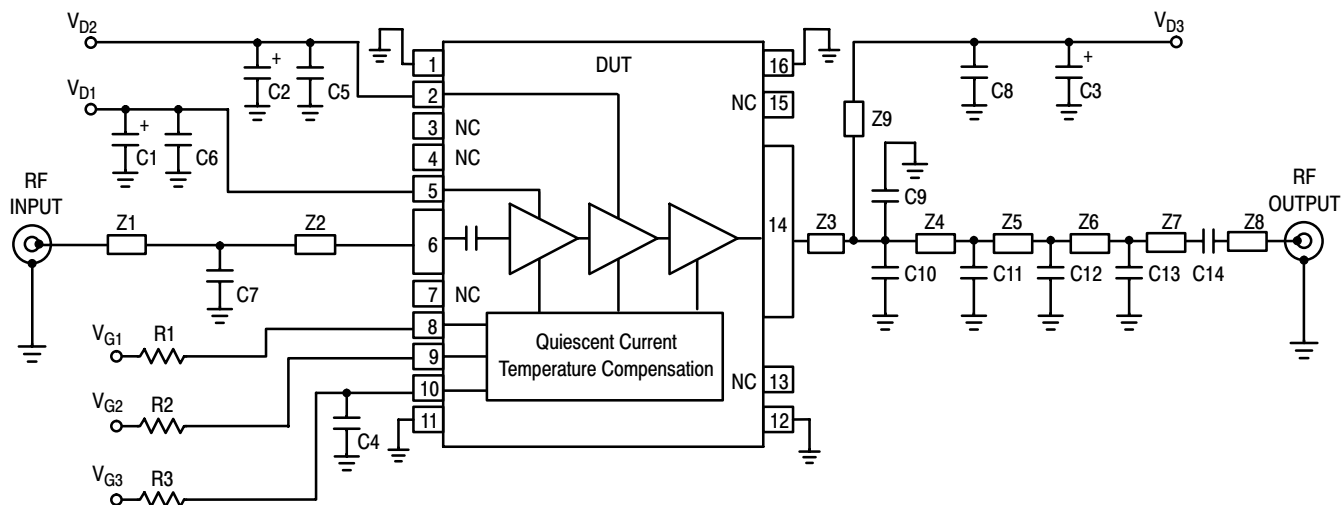
(continued)

Table 5. Electrical Characteristics ($T_C = 25^\circ\text{C}$ unless otherwise noted) (continued)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|--|----------|-----|-----|-----|------|
| Typical CDMA Performances (In Modified CDMA Test Fixture, 50 ohm system) $V_{DD} = 26\text{ Vdc}$, $I_{DQ1} = 80\text{ mA}$, $I_{DQ2} = 240\text{ mA}$, $I_{DQ3} = 250\text{ mA}$, $P_{out} = 1\text{ W Avg.}$, 11930 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 | η_D | — | 5 | — | % |
| Adjacent Channel Power Ratio ($\pm 885\text{ kHz}$ in 30 kHz Bandwidth) | ACPR | — | -61 | — | dBc |
| Alternate 1 Channel Power Ratio ($\pm 1.25\text{ MHz}$ in 12.5 kHz Bandwidth) | ALT1 | — | -69 | — | dBc |
| Alternate 2 Channel Power Ratio ($\pm 2.25\text{ MHz}$ in 1 MHz Bandwidth) | ALT2 | — | -59 | — | dBc |

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

| | | | | | |
|-------------------------------------|----------|---|-----|---|-------|
| 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 |

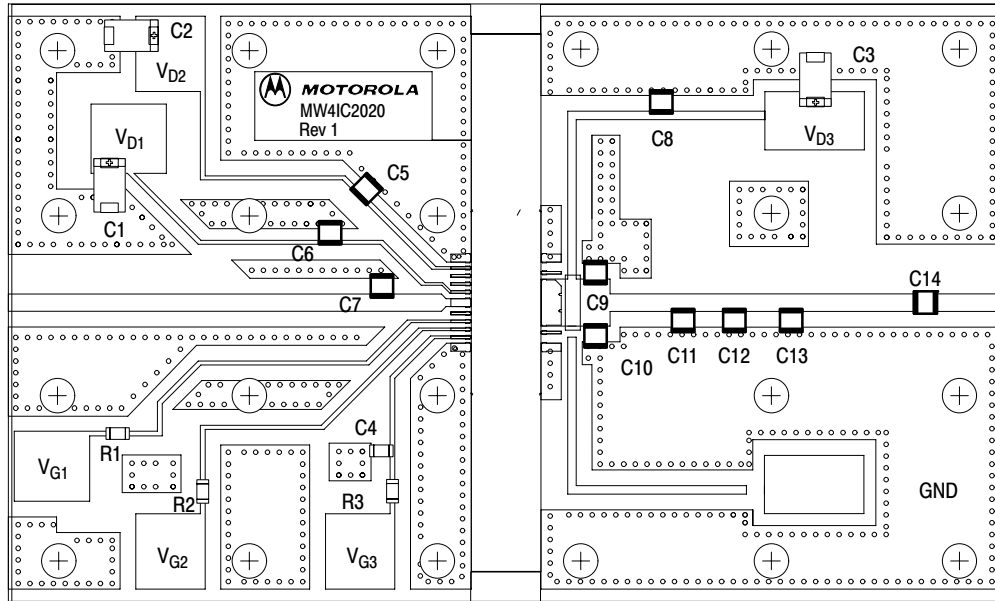


| | | | |
|----|----------------------------|-----|--|
| Z1 | 1.820" x 0.087" Microstrip | Z6 | 0.303" x 0.087" Microstrip |
| Z2 | 0.245" x 0.087" Microstrip | Z7 | 0.640" x 0.087" Microstrip |
| Z3 | 0.345" x 0.236" Microstrip | Z8 | 0.334" x 0.087" Microstrip |
| Z4 | 0.327" x 0.087" Microstrip |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

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 μ F, 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 k Ω 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

TYPICAL CHARACTERISTICS

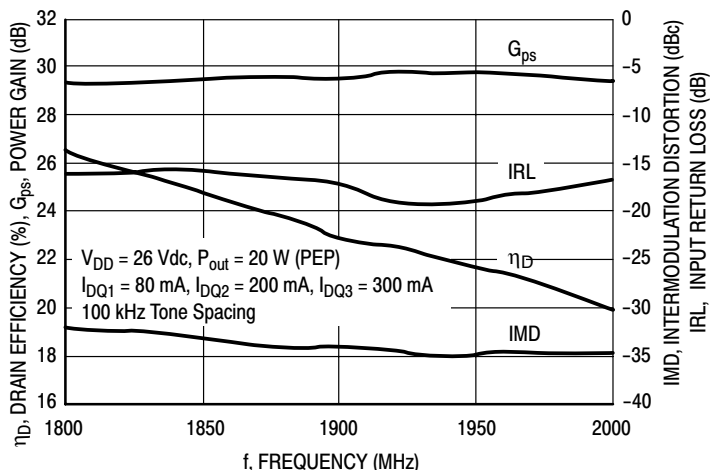


Figure 5. Two-Tone Wideband Performance

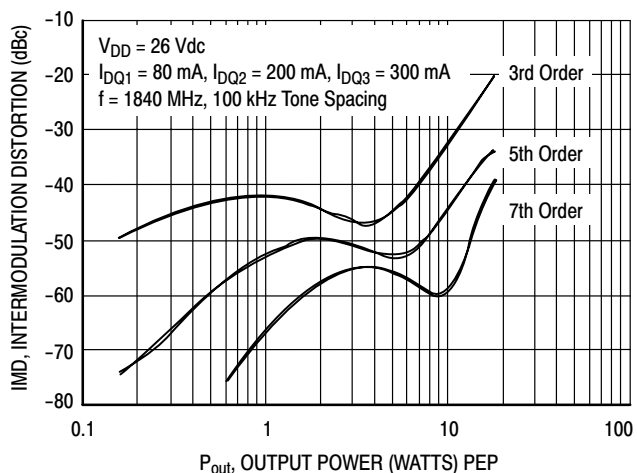


Figure 6. Intermodulation Distortion Products versus Output Power @ 1840 MHz

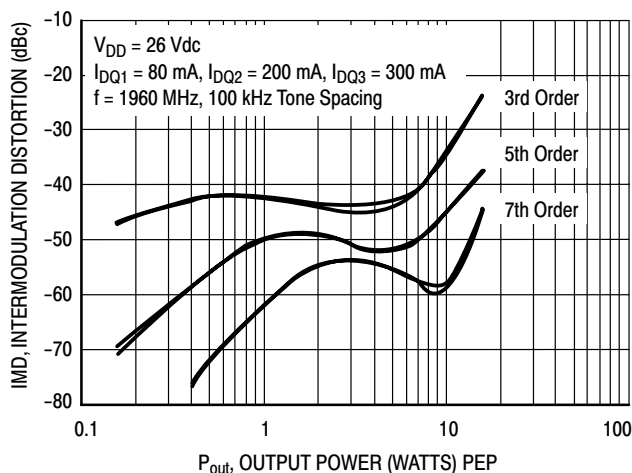


Figure 7. Intermodulation Distortion Products versus Output Power @ 1960 MHz

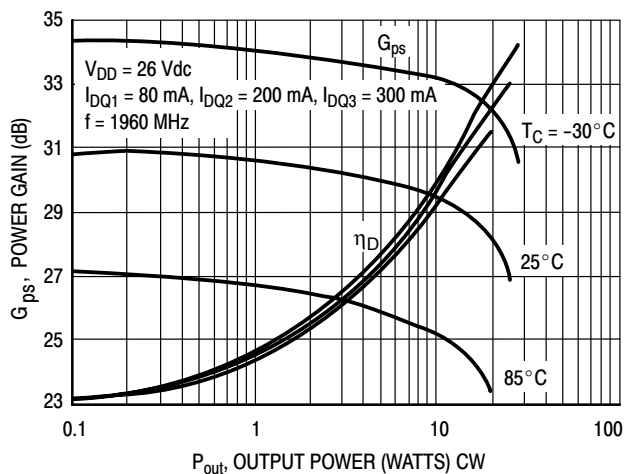


Figure 8. Power Gain and Drain Efficiency versus Output Power

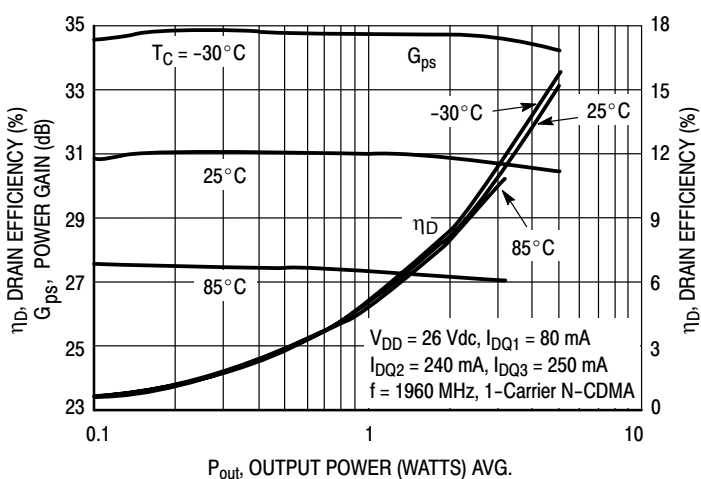


Figure 9. Power Gain and Drain Efficiency versus Output Power

TYPICAL CHARACTERISTICS

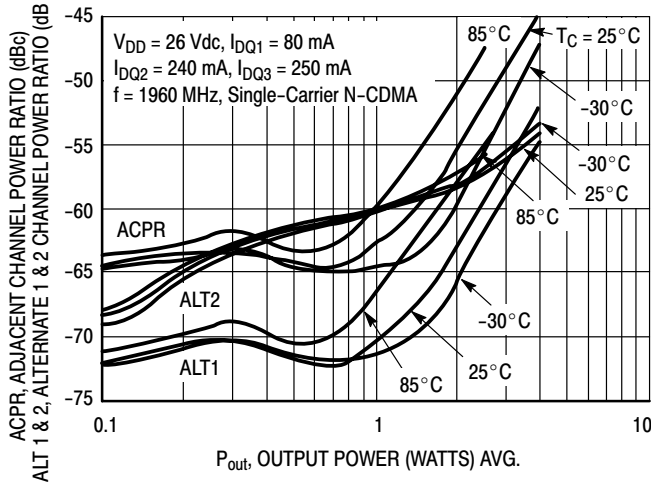


Figure 10. Alternate Channel Power Ratio, Alternate 1 and 2 Channel Power Ratio versus Output Power

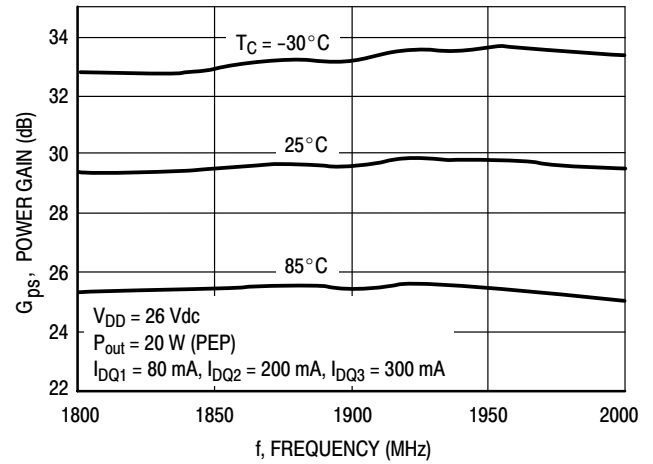


Figure 11. Power Gain versus Frequency

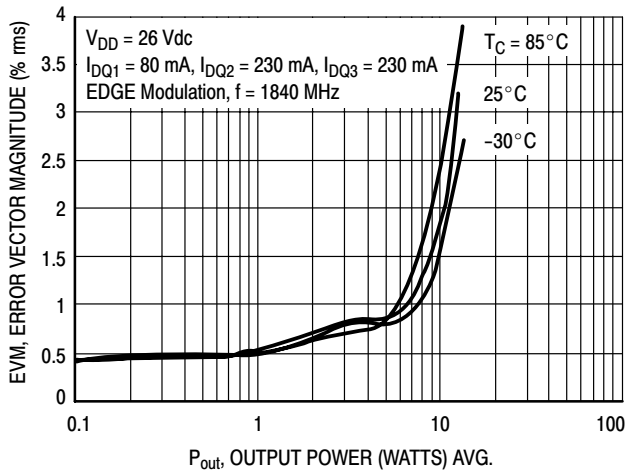


Figure 12. EVM versus Output Power @ 1840 MHz

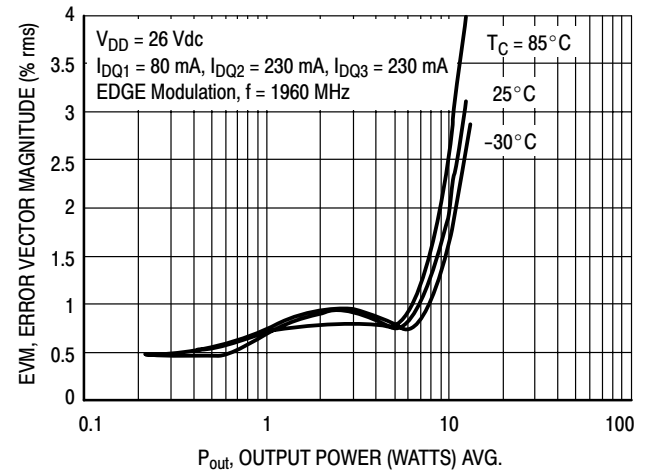


Figure 13. EVM versus Output Power @ 1960 MHz

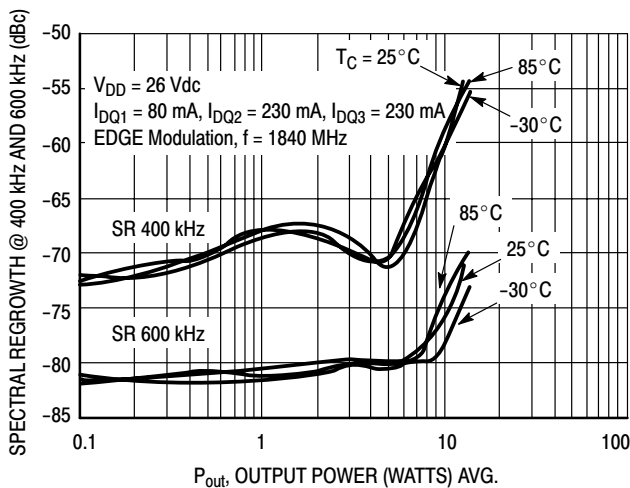


Figure 14. Spectral Regrowth at 400 and 600 kHz versus Output Power @ 1840 MHz

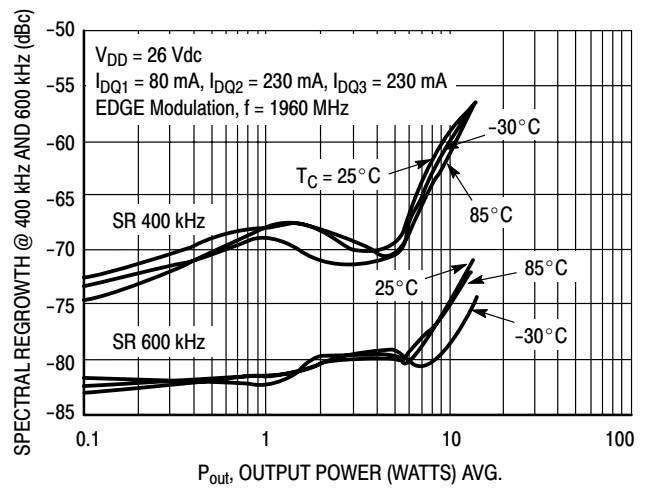
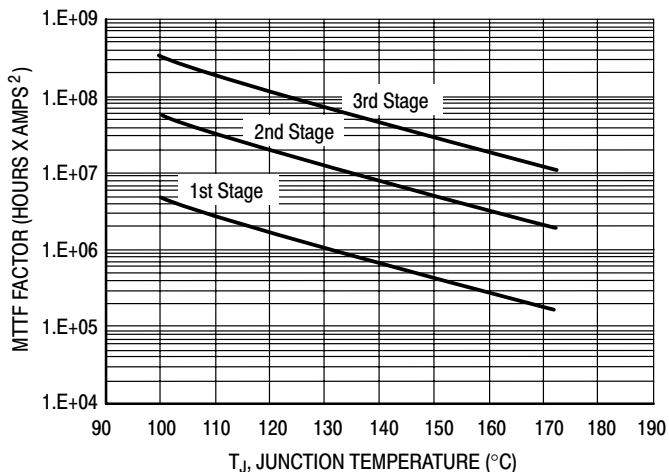


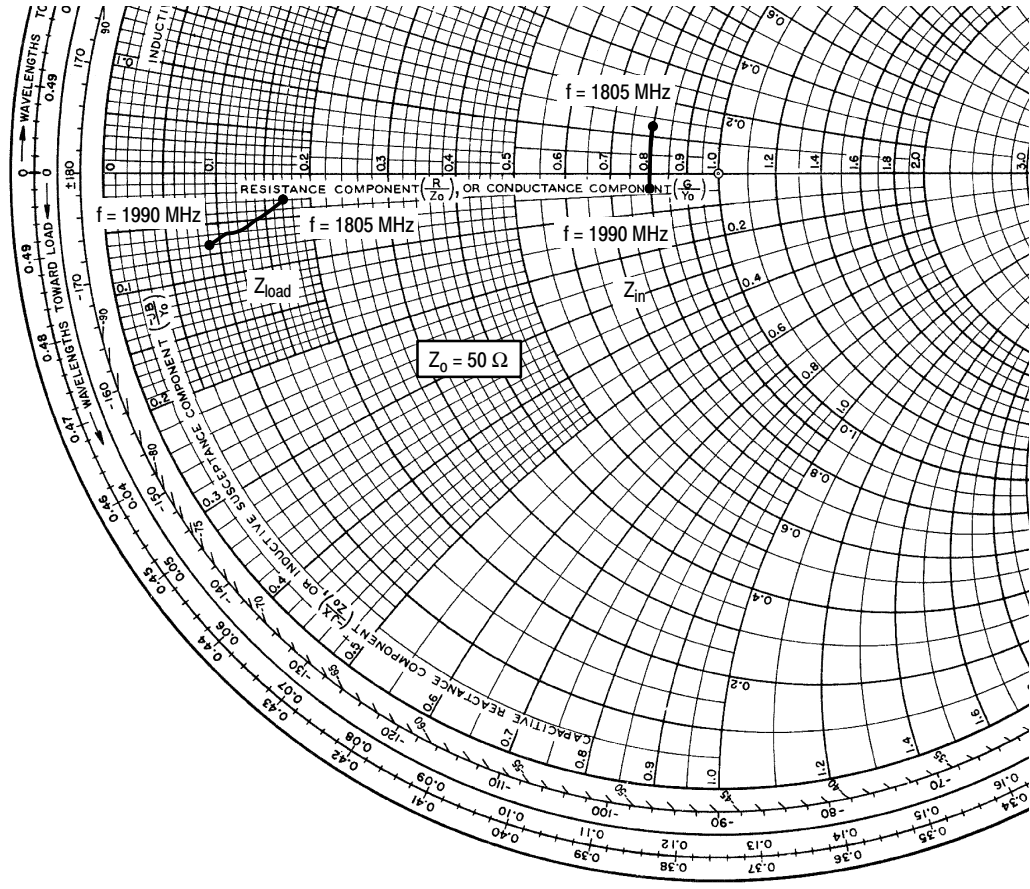
Figure 15. Spectral Regrowth at 400 and 600 kHz versus Output Power @ 1960 MHz

TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours x amperes² 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



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

| 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.

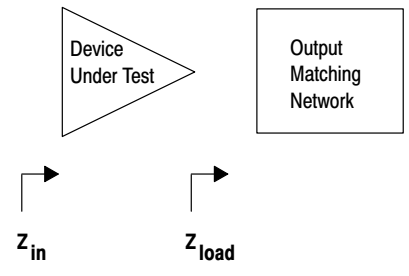
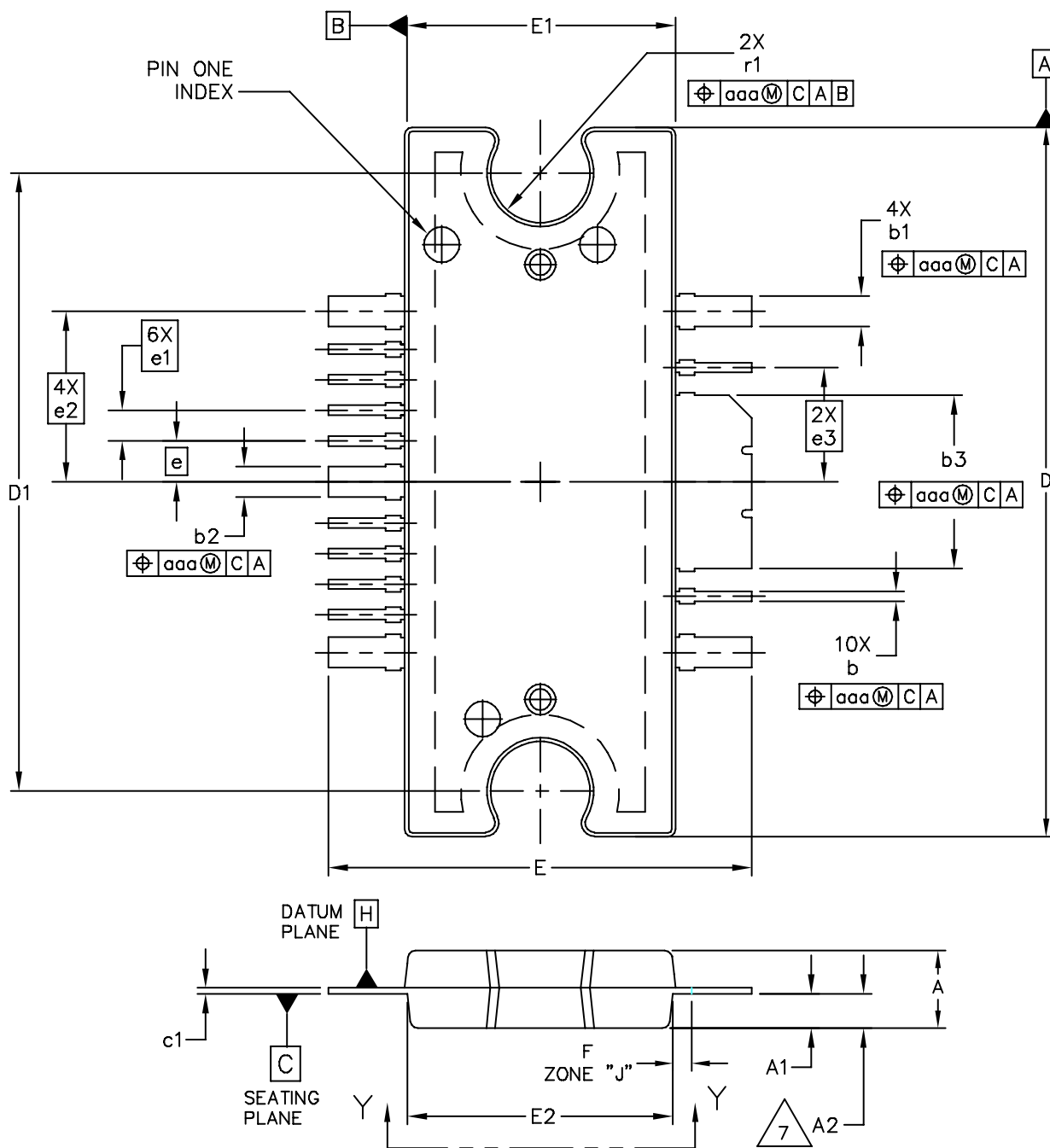
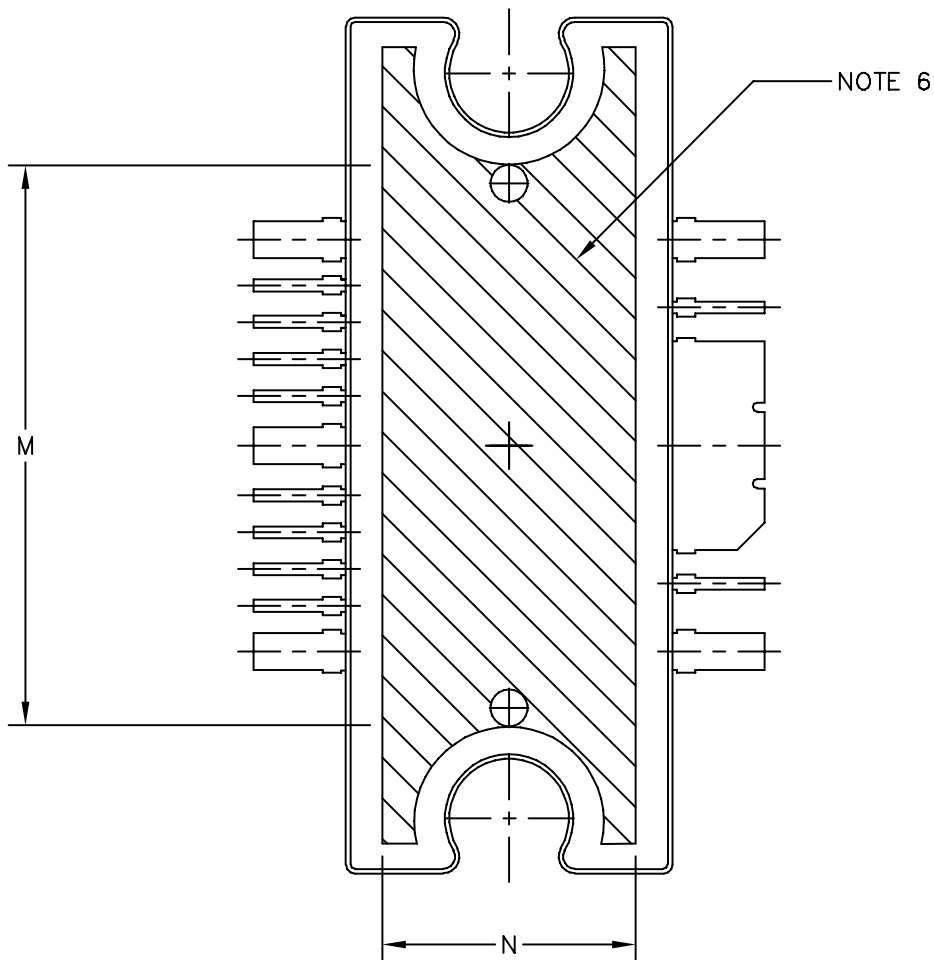


Figure 17. Series Equivalent Input and Load Impedance

PACKAGE DIMENSIONS



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



VIEW Y-Y

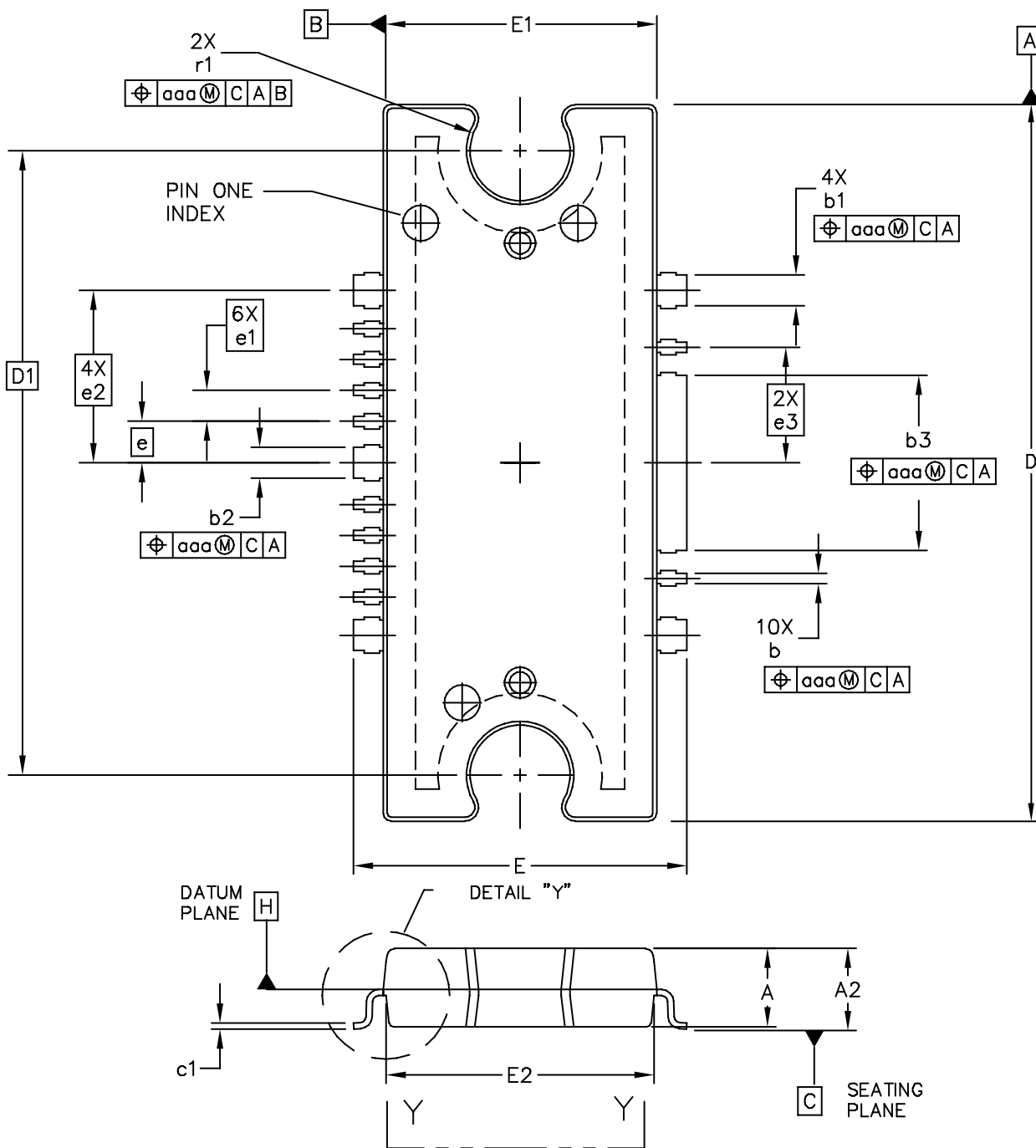
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| | CASE NUMBER: 1329-09 | 13 MAR 2006 | |
| | STANDARD: NON-JEDEC | | |

NOTES:

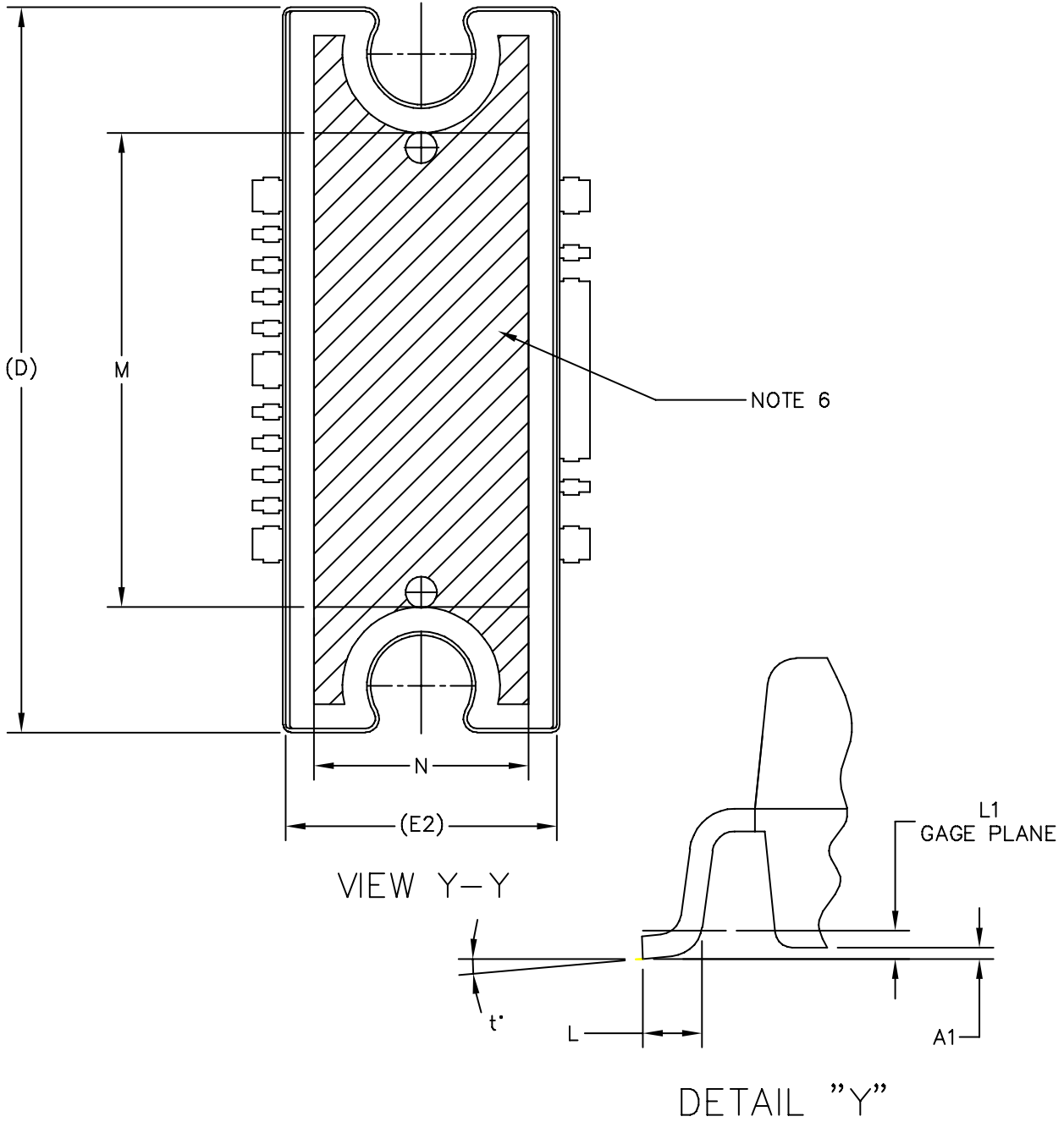
1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT THE TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. 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 OF THE HEAT SLUG. HATCHED AREA SHOWN IS ON THE SAME PLANE.
7. DIM A2 APPLIES WITHIN ZONE "J" ONLY.

| DIM | INCH | | MILLIMETER | | DIM | INCH | | MILLIMETER | |
|-----|----------|------|------------|-------|-----|----------|------|------------|------|
| | MIN | MAX | MIN | MAX | | 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 | |

| | | | | | |
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| | | CASE NUMBER: 1329-09 | | 13 MAR 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 | | |



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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.

| DIM | INCH | | MILLIMETER | | DIM | INCH | | MILLIMETER | |
|-----|----------|------|------------|-------|-----|----------|------|------------|------|
| | MIN | MAX | MIN | MAX | | 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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|---|--|---------------------------|--------------------------|----------------------------|------------|
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