



RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for broadband commercial and industrial applications with frequencies up to 1000 MHz. The high gain and broadband performance of these devices make them ideal for large-signal, common-source amplifier applications in 26 volt base station equipment.

- Typical Single-Carrier N-CDMA Performance @ 880 MHz, $V_{DD} = 26$ Volts, $I_{DQ} = 950$ mA, $P_{out} = 20$ Watts Avg., 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 — 19.5 dB
 Drain Efficiency — 28%
 ACPR @ 750 kHz Offset — -46.8 dBc in 30 kHz Bandwidth
- Capable of Handling 10:1 VSWR, @ 26 Vdc, 880 MHz, 100 Watts CW Output Power

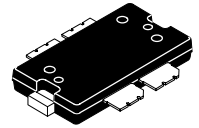
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Features

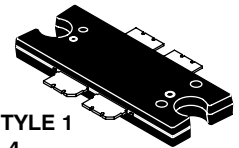
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- 200°C Capable Plastic Package
- N Suffix Indicates Lead-Free Terminations. RoHS Compliant.
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel.

MRF5S9100NR1
MRF5S9100NBR1

880 MHz, 20 W AVG., 26 V
SINGLE N-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 1486-03, STYLE 1
TO-270 WB-4
PLASTIC
MRF5S9100NR1



CASE 1484-04, STYLE 1
TO-272 WB-4
PLASTIC
MRF5S9100NBR1

Table 1. Maximum Ratings

| Rating | Symbol | Value | Unit |
|--|-----------|--------------|-----------|
| Drain-Source Voltage | V_{DSS} | - 0.5, +68 | Vdc |
| Gate-Source Voltage | V_{GS} | - 0.5, + 15 | Vdc |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C | P_D | 336 1.92 | W W/°C |
| Storage Temperature Range | T_{stg} | - 65 to +150 | °C |
| Operating Junction Temperature | T_J | 200 | °C |

Table 2. Thermal Characteristics

| Characteristic | Symbol | Value (1,2) | Unit |
|--|-----------------|-------------|------|
| Thermal Resistance, Junction to Case Case Temperature 80°C, 20 W CW | $R_{\theta JC}$ | 0.52 | °C/W |

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.

Table 3. ESD Protection Characteristics

| Test Conditions | Class |
|---------------------------------------|--------------|
| Human Body Model (per JESD22-A114) | 1C (Minimum) |
| Machine Model (per EIA/JESD22-A115) | A (Minimum) |
| Charge Device Model (per JESD22-C101) | IV (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 |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

Off Characteristics

| | | | | | |
|---|-----------|---|---|----|-----------------|
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 68\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | I_{DSS} | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 26\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | I_{DSS} | — | — | 1 | μAdc |
| Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$) | I_{GSS} | — | — | 1 | μAdc |

On Characteristics

| | | | | | |
|---|--------------|---|------|-----|-----|
| Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 400\ \mu\text{A}$) | $V_{GS(th)}$ | 2 | 2.8 | 3.5 | Vdc |
| Gate Quiescent Voltage ($V_{DS} = 26\text{ Vdc}$, $I_D = 950\text{ mAdc}$) | $V_{GS(Q)}$ | — | 3.7 | — | Vdc |
| Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 2.0\text{ Adc}$) | $V_{DS(on)}$ | — | 0.21 | 0.3 | Vdc |
| Forward Transconductance ($V_{DS} = 10\text{ Vdc}$, $I_D = 6\text{ Adc}$) | g_{fs} | — | 7 | — | S |

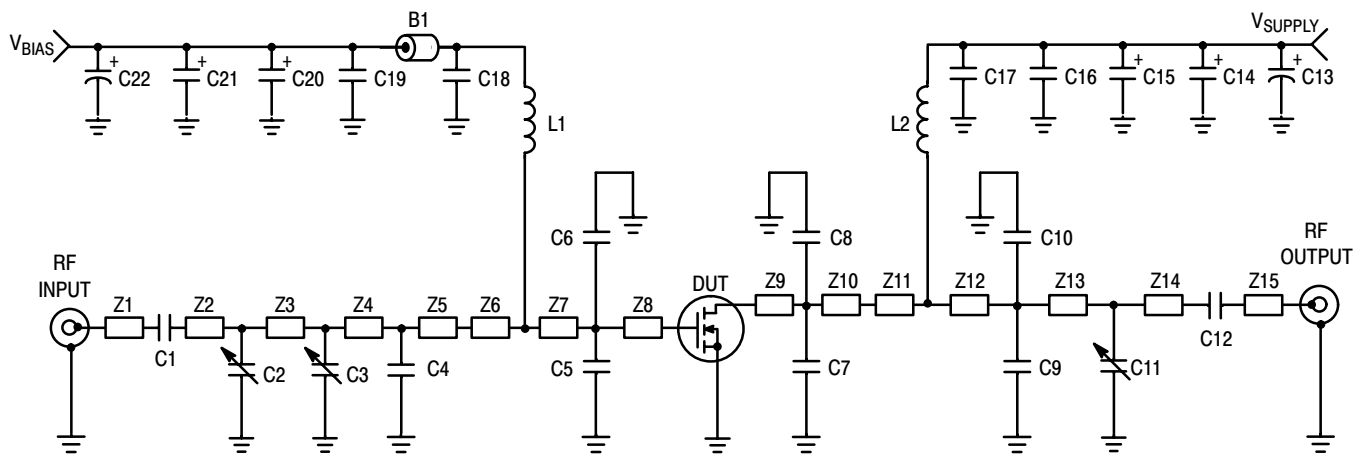
Dynamic Characteristics ⁽¹⁾

| | | | | | |
|---|-----------|---|-----|---|----|
| Output Capacitance ($V_{DS} = 26\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{OSS} | — | 70 | — | pF |
| Reverse Transfer Capacitance ($V_{DS} = 26\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{rSS} | — | 2.2 | — | pF |

Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 26\text{ Vdc}$, $I_{DQ} = 950\text{ mA}$, $P_{out} = 20\text{ W Avg}$. N-CDMA, $f = 880\text{ MHz}$, Single-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carrier. ACPR measured in 30 kHz Bandwidth @ $\pm 750\text{ kHz}$ Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF

| | | | | | |
|------------------------------|----------|----|-------|-----|-----|
| Power Gain | G_{ps} | 18 | 19.5 | — | dB |
| Drain Efficiency | η_D | 26 | 28 | — | % |
| Adjacent Channel Power Ratio | ACPR | — | -46.8 | -45 | dBc |
| Input Return Loss | IRL | — | -19 | -9 | dB |

1. Part internally input matched.



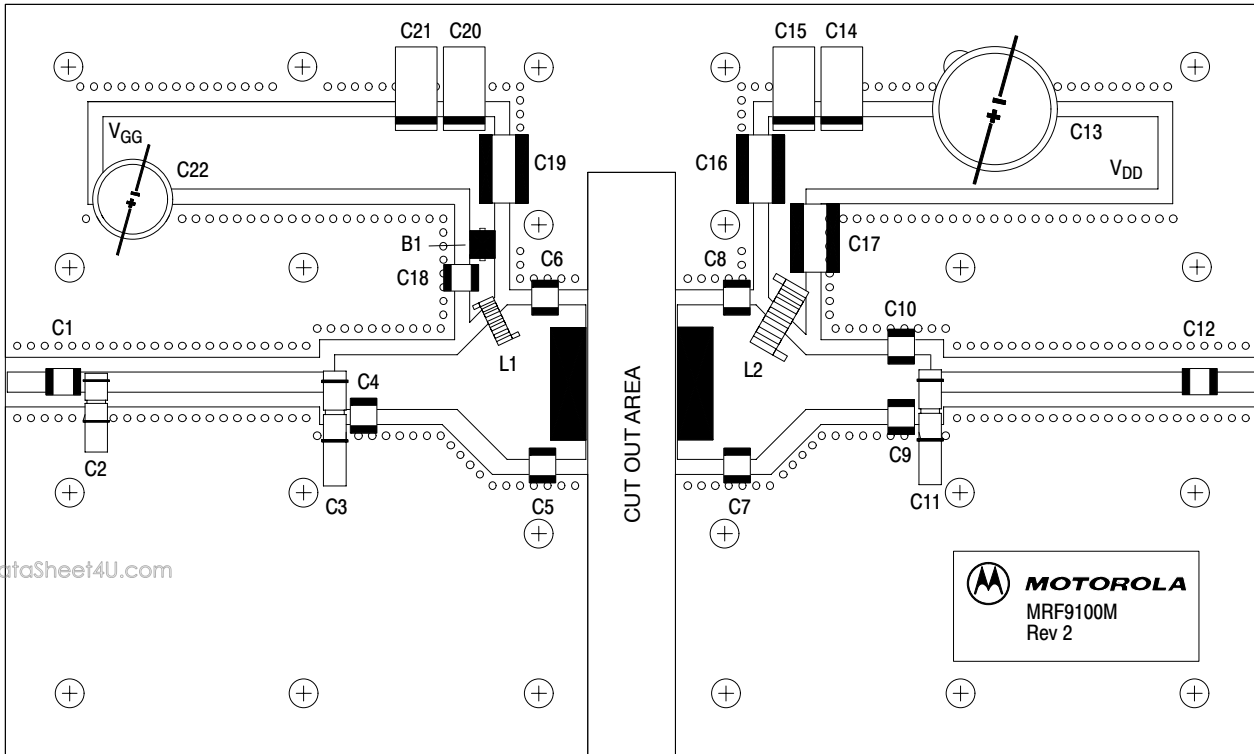
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| | | | |
|---------|--------------------------------|-----|---|
| Z1, Z15 | 0.200" x 0.080" Microstrip | Z8 | 0.163" x 0.620" Microstrip |
| Z2 | 0.105" x 0.080" Microstrip | Z9 | 0.238" x 0.620" Microstrip |
| Z3 | 0.954" x 0.080" Microstrip | Z10 | 0.077" x 0.620" Microstrip |
| Z4 | 0.115" x 0.220" Microstrip | Z12 | 0.381" x 0.220" Microstrip |
| Z5 | 0.375" x 0.220" Microstrip | Z13 | 0.114" x 0.220" Microstrip |
| Z6, Z11 | 0.200" x 0.220" x 0.620" Taper | Z14 | 1.052" x 0.080" Microstrip |
| Z7 | 0.152" x 0.620" Microstrip | PCB | Arlon GX0300, 0.030", $\epsilon_r = 2.55$ |

Figure 1. MRF5S9100NR1(NBR1) Test Circuit Schematic

Table 6. MRF5S9100NR1(NBR1) Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|---------------|--|-----------------|----------------------|
| B1 | Ferrite Bead, Surface Mount | 2743019447 | Fair-Rite |
| C1, C12, C18 | 18 pF Chip Capacitors | 100B180JP 500X | ATC |
| C2 | 0.6-4.5 pF Variable Capacitor, Gigatrim | 27271SL | Johanson Dielectrics |
| C3, C11 | 0.8-8.0 pF Variable Capacitors, Gigatrim | 27291SL | Johanson Dielectrics |
| C4 | 6.2 pF Chip Capacitor | 100B6R2JP 500X | ATC |
| C5, C6 | 12 pF Chip Capacitors | 100B120JP 500X | ATC |
| C7, C8 | 11 pF Chip Capacitors | 100B110JP 500X | ATC |
| C9, C10 | 5.1 pF Chip Capacitors | 100B5R1JP 500X | ATC |
| C13 | 470 μ F, 63 V Electrolytic Capacitor | NACZF471M63V | Nippon |
| C14, C15 | 22 μ F, 50 V Tantalum Capacitors | T491X226K035AS | Kemet |
| C16, C17, C19 | 0.56 μ F, 50 V Chip Capacitors | C1825C564J5GAC | Kemet |
| C20, C21 | 47 μ F, 16 V Tantalum Capacitors | T491D4T6K016AS | Kemet |
| C22 | 100 μ F, 50 V Electrolytic Capacitor | 515D107M050BB6A | Multicomp |
| L1 | 7.15 nH Inductor | 1606-7 | CoilCraft |
| L2 | 22 nH Inductor | B07T-5 | CoilCraft |



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 2. MRF5S9100NR1(NBR1) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

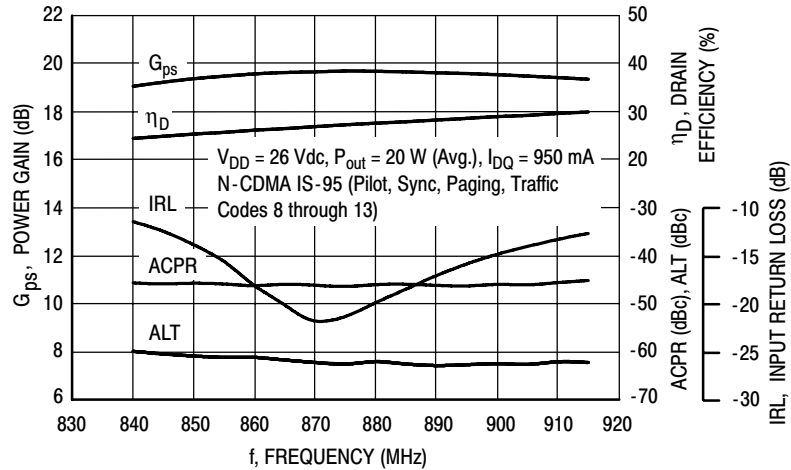


Figure 3. IS-95 Broadband Performance @ $P_{out} = 20$ Watts Avg.

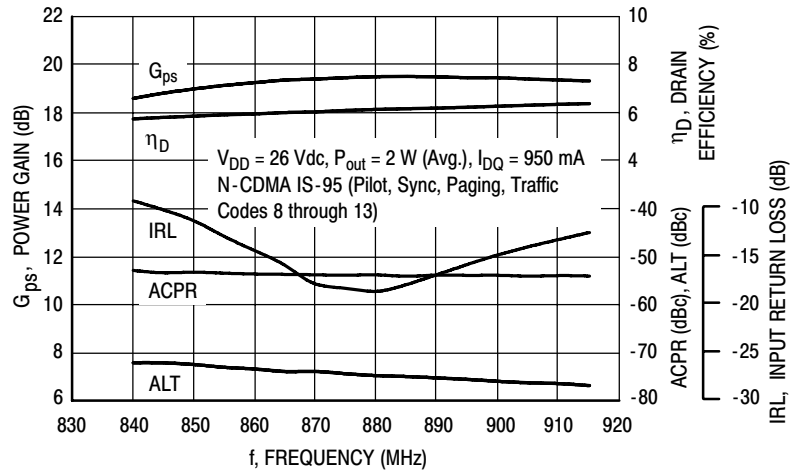


Figure 4. IS-95 Broadband Performance @ $P_{out} = 2$ Watts Avg.

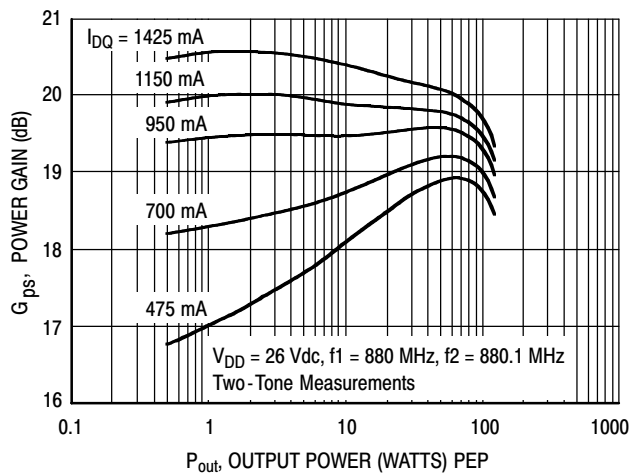


Figure 5. Two-Tone Power Gain versus Output Power

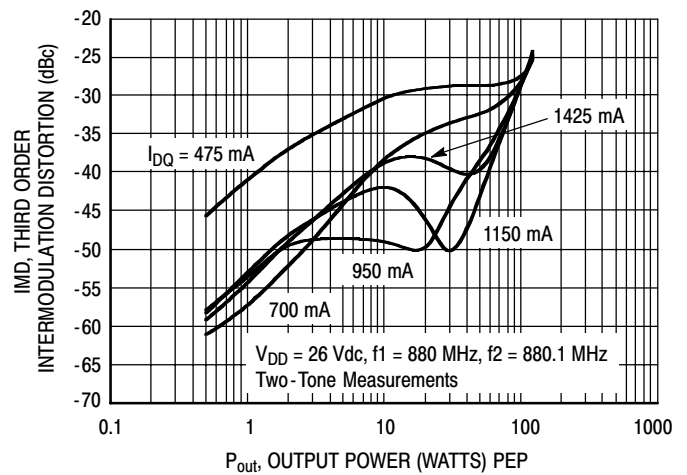


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

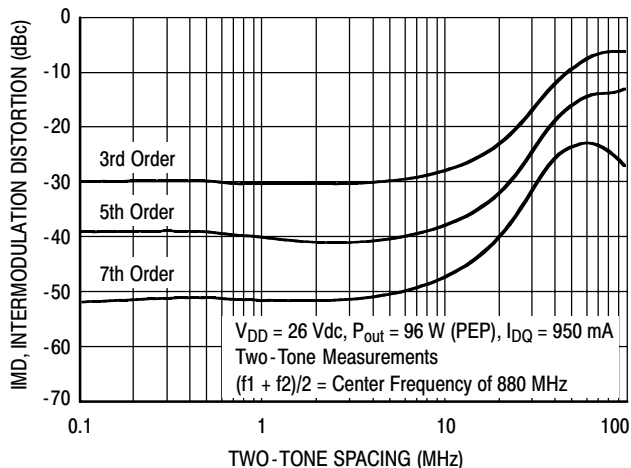


Figure 7. Intermodulation Distortion Products versus Tone Spacing

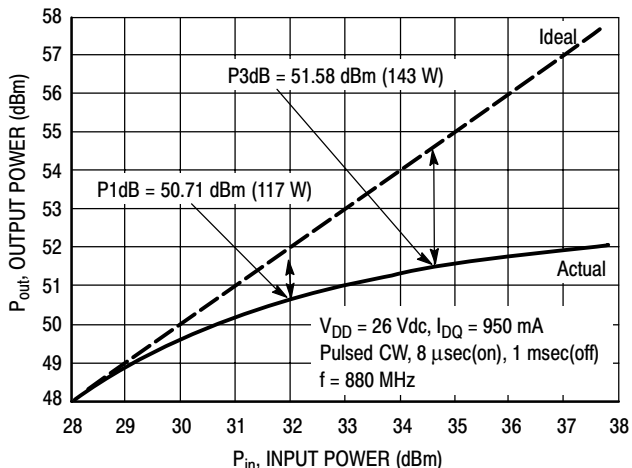


Figure 8. Pulse CW Output Power versus Input Power

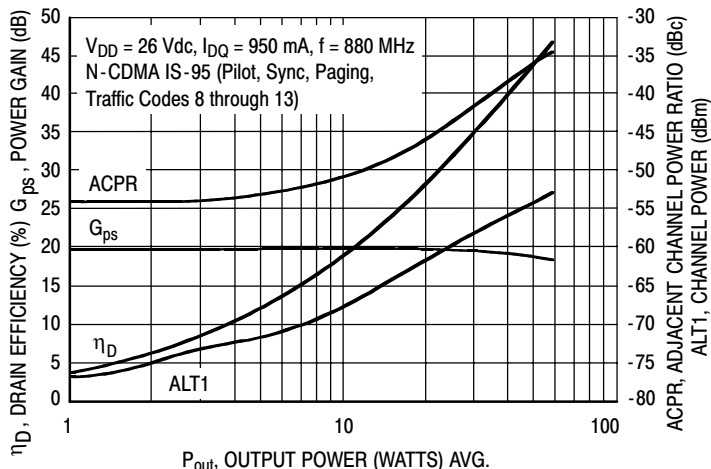


Figure 9. Single-Carrier N-CDMA ACPR, Power Gain, Efficiency and ALT1 versus Output Power

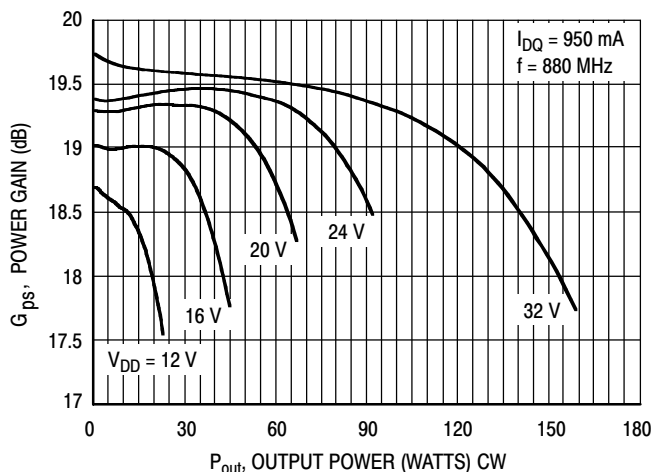
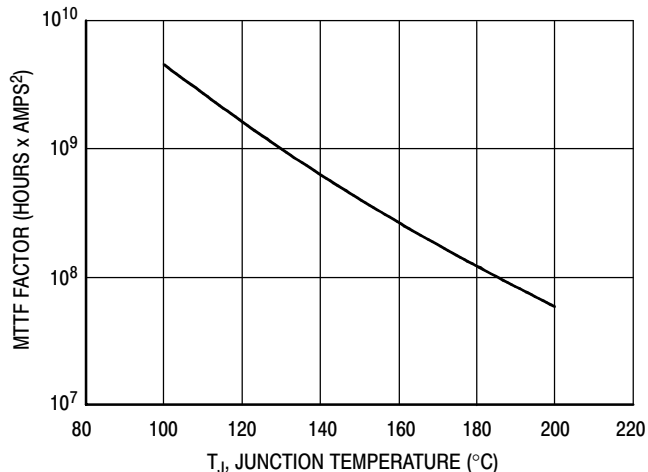


Figure 10. Power Gain versus Output Power



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 11. MTTF Factor versus Junction Temperature

N-CDMA TEST SIGNAL

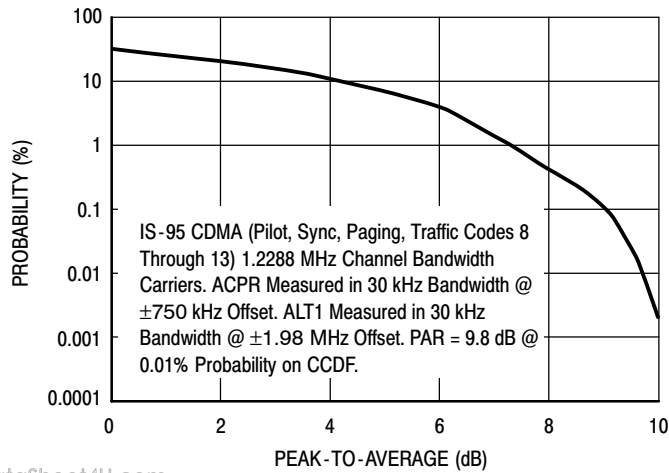


Figure 12. Single-Carrier CCDF N-CDMA

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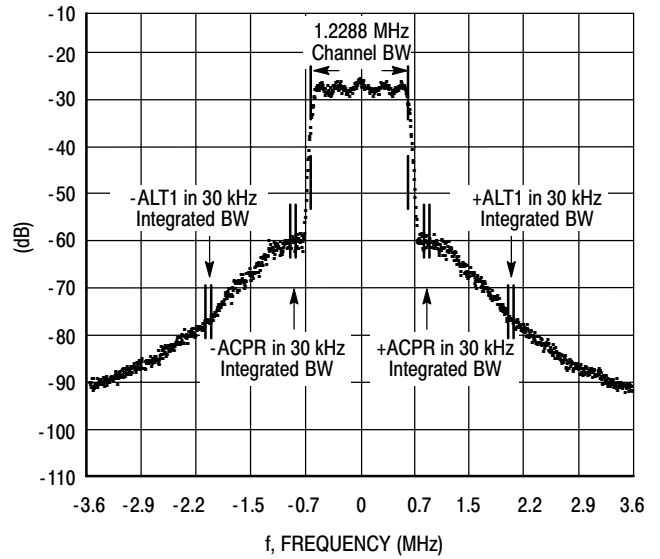
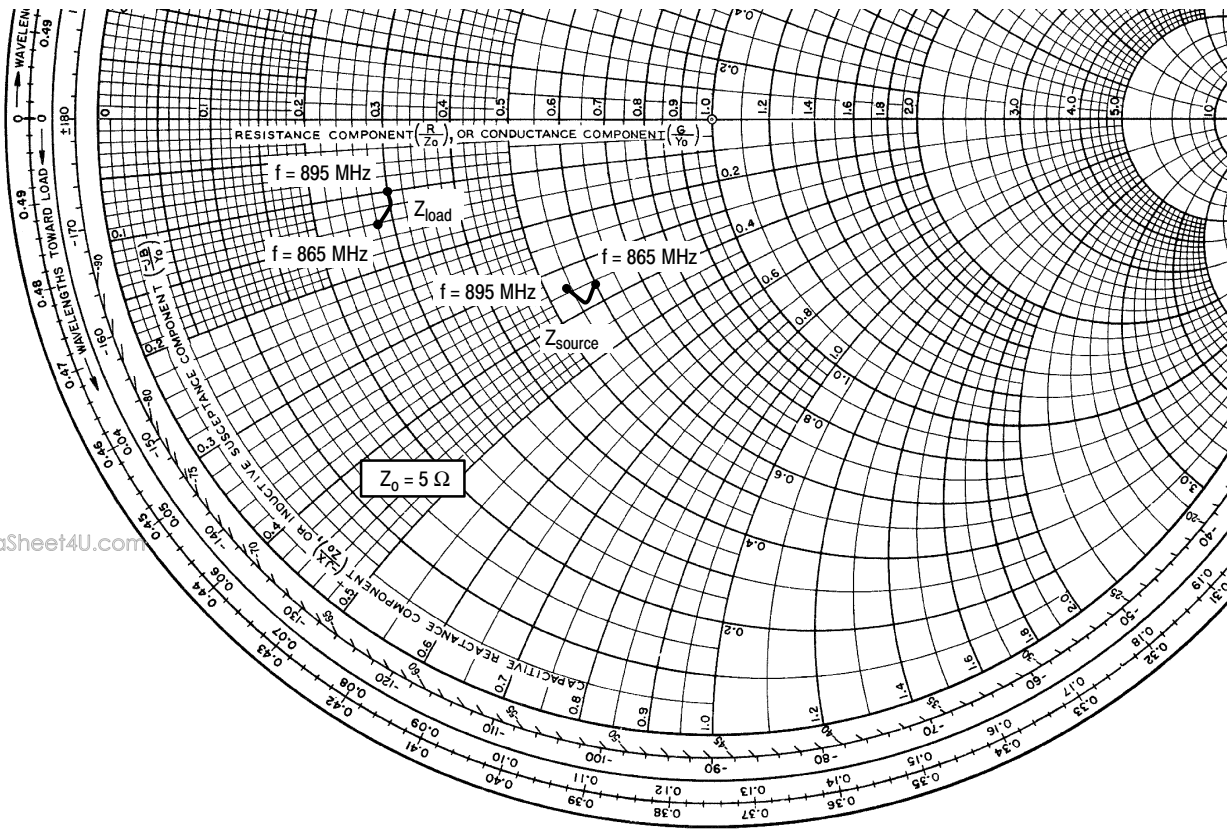


Figure 13. Single-Carrier N-CDMA Spectrum



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$V_{DD} = 26 \text{ Vdc}$, $I_{DQ} = 950 \text{ mA}$, $P_{out} = 20 \text{ W Avg.}$

| f MHz | Z_{source} Ω | Z_{load} Ω |
|----------|--------------------------|------------------------|
| 865 | $3.0 - j1.8$ | $1.4 - j0.7$ |
| 880 | $2.8 - j1.9$ | $1.5 - j0.6$ |
| 895 | $2.7 - j1.7$ | $1.5 - j0.5$ |

Z_{source} = Test circuit impedance as measured from gate to ground.

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

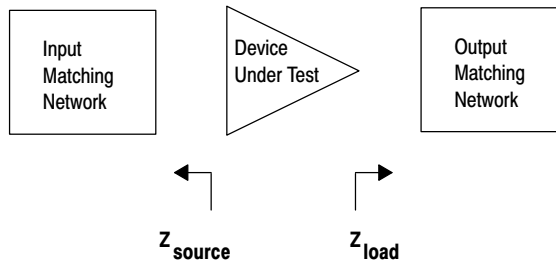


Figure 14. Series Equivalent Source and Load Impedance

NOTES

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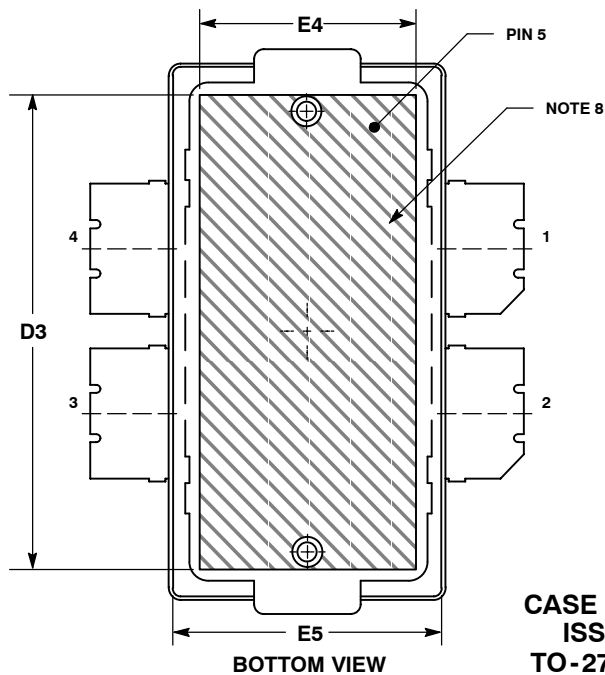
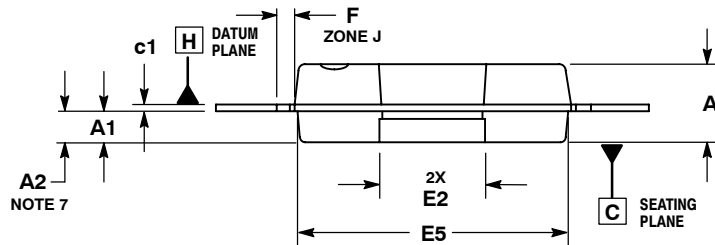
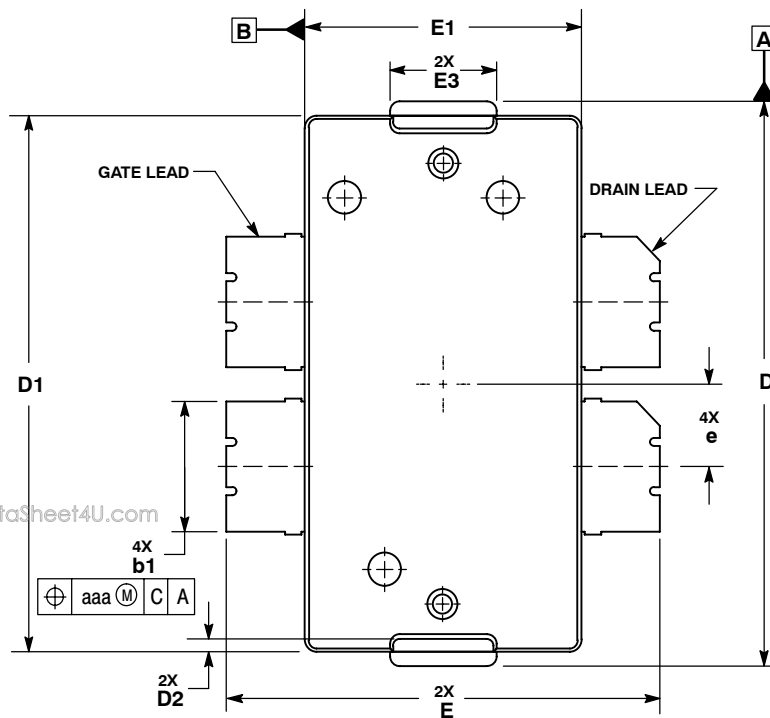
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PACKAGE DIMENSIONS



NOTES:

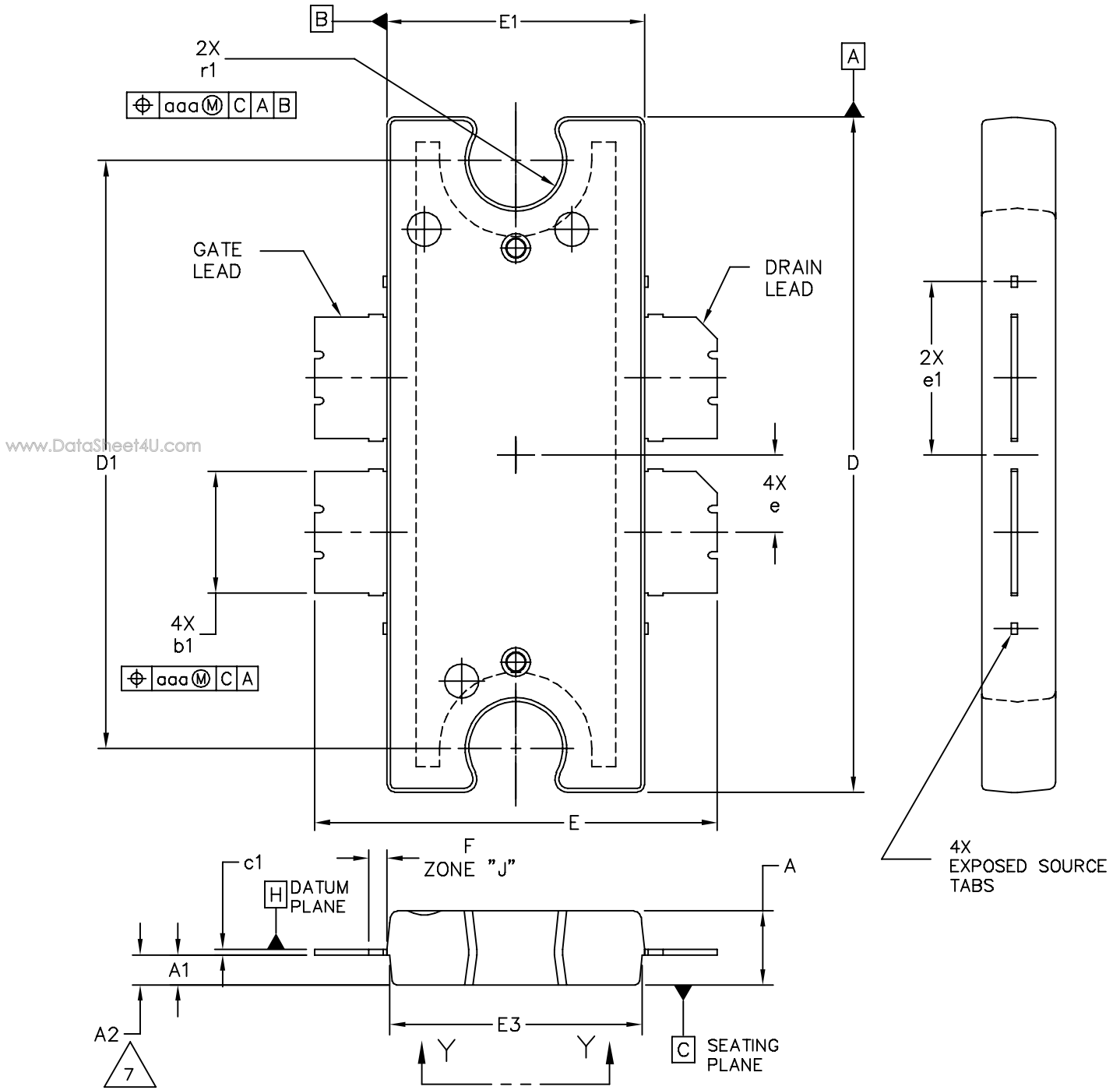
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT THE TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION.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

| DIM | INCHES | | MILLIMETERS | |
|-----|----------|------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | .100 | .104 | 2.54 | 2.64 |
| A1 | .039 | .043 | 0.99 | 1.09 |
| A2 | .040 | .042 | 1.02 | 1.07 |
| D | .712 | .720 | 18.08 | 18.29 |
| D1 | .688 | .692 | 17.48 | 17.58 |
| D2 | .011 | .019 | 0.28 | 0.48 |
| D3 | .600 | --- | 15.24 | --- |
| E | .551 | .559 | 14 | 14.2 |
| E1 | .353 | .357 | 8.97 | 9.07 |
| E2 | .132 | .140 | 3.35 | 3.56 |
| E3 | .124 | .132 | 3.15 | 3.35 |
| E4 | .270 | --- | 6.86 | --- |
| E5 | .346 | .350 | 8.79 | 8.89 |
| F | .025 BSC | | 0.64 BSC | |
| b1 | .164 | .170 | 4.17 | 4.32 |
| c1 | .007 | .011 | 0.18 | 0.28 |
| e | .106 BSC | | 2.69 BSC | |
| aaa | .004 | | 0.10 | |

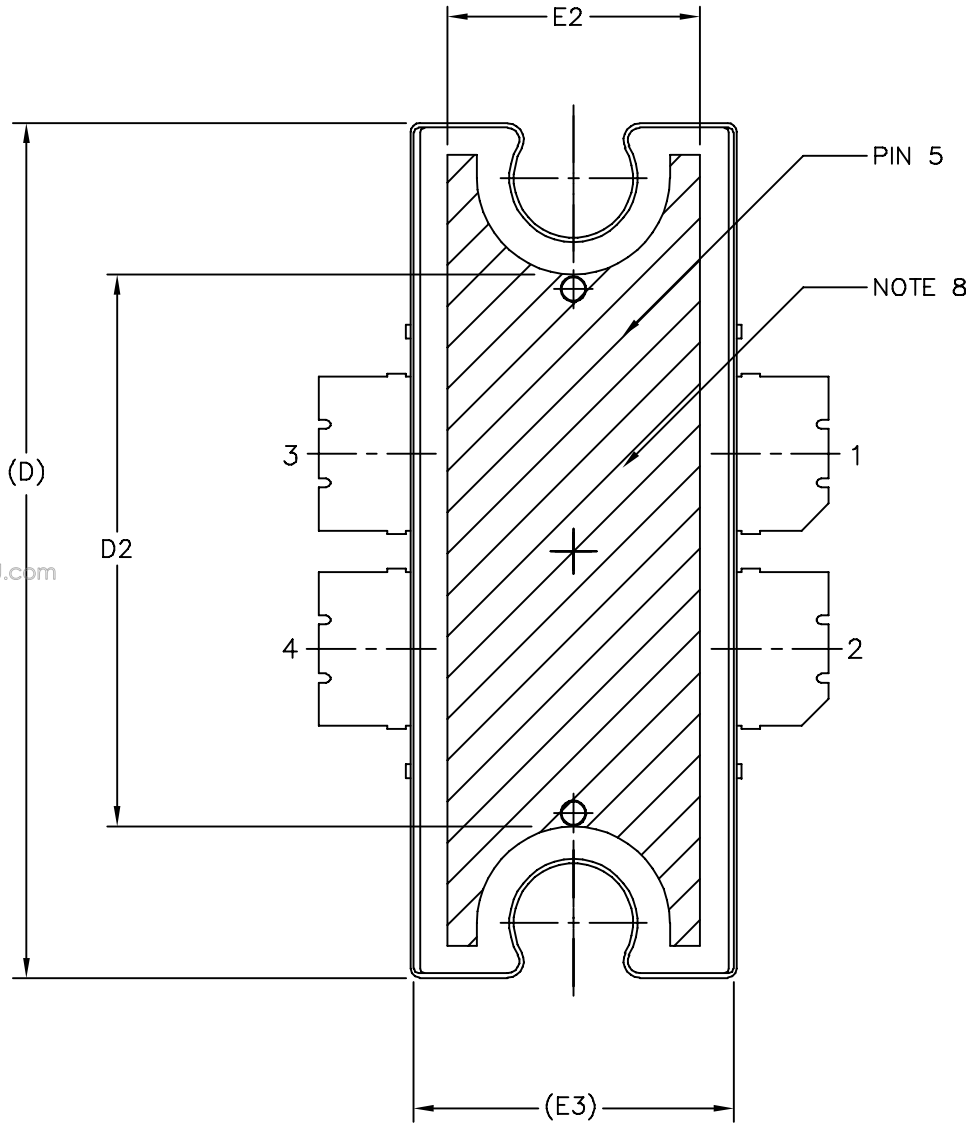
STYLE 1:

1. DRAIN
2. DRAIN
3. GATE
4. GATE
5. SOURCE

**CASE 1486-03
ISSUE C
TO-270 WB-4
PLASTIC
MRF5S9100NR1**



| | | | | | |
|---|--|---------------------------|--------------------------|----------------------------|-------------|
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| | | | CASE NUMBER: 1484-04 | | 05 APR 2006 |
| | | | STANDARD: NON-JEDEC | | |



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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 PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.
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6. DATUM A AND B TO BE DETERMINED AT DATUM PLANE H.
7. DIMENSION A2 APPLIES WITHIN ZONE "J" ONLY.
8. HATCHING REPRESENTS EXPOSED AREA OF THE HEAT SLUG. HATCHED AREA SHOWN IS ON THE SAME PLANE.

STYLE 1:

PIN 1 - DRAIN PIN 2 - DRAIN
 PIN 3 - GATE PIN 4 - GATE
 PIN 5 - SOURCE

| DIM | INCH | | MILLIMETER | | DIM | INCH | | MILLIMETER | |
|-----|----------|------|------------|-------|-----|----------------|------|----------------|------|
| | MIN | MAX | MIN | MAX | | MIN | MAX | MIN | MAX |
| A | .100 | .104 | 2.54 | 2.64 | b1 | .164 | .170 | 4.17 | 4.32 |
| A1 | .039 | .043 | 0.99 | 1.09 | c1 | .007 | .011 | .18 | .28 |
| A2 | .040 | .042 | 1.02 | 1.07 | r1 | .063 | .068 | 1.60 | 1.73 |
| D | .928 | .932 | 23.57 | 23.67 | e | .106 BSC | | 2.69 BSC | |
| D1 | .810 BSC | | 20.57 BSC | | e1 | .239 INFO ONLY | | 6.07 INFO ONLY | |
| D2 | .600 | --- | 15.24 | --- | aaa | .004 | | .10 | |
| E | .551 | .559 | 14 | 14.2 | | | | | |
| E1 | .353 | .357 | 8.97 | 9.07 | | | | | |
| E2 | .270 | --- | 6.86 | --- | | | | | |
| E3 | .346 | .350 | 8.79 | 8.89 | | | | | |
| F | .025 BSC | | 0.64 BSC | | | | | | |

| | | | | | |
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| | | STANDARD: NON-JEDEC | | | |

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