



RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for broadband commercial and industrial applications with frequencies from 1930 to 1990 MHz. The high gain and broadband performance of these devices make them ideal for large-signal, common-source amplifier applications in 28 Volt base station equipment.

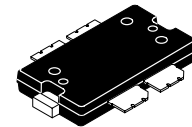
- Typical 2-carrier N-CDMA Performance: $V_{DD} = 28$ Volts, $I_{DQ} = 750$ mA, $P_{out} = 12$ Watts Avg., 1990 MHz, IS-95 (Pilot, Sync, Paging, Traffic Codes 8 Through 13) Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.
 Power Gain — 14 dB
 Drain Efficiency — 23%
 IM3 @ 2.5 MHz Offset — -37 dBc in 1.2288 MHz Channel Bandwidth
 ACPR @ 885 kHz Offset — -51 dBc in 30 kHz Channel Bandwidth
- Capable of Handling 5:1 VSWR, @ 28 Vdc, 1960 MHz, 12 Watts CW Output Power

Features

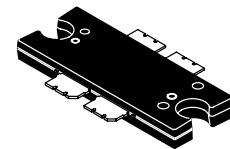
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- 200°C Capable Plastic Package
- N Suffix Indicates Lead-Free Terminations. RoHS Compliant.
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel.

MRF5S19060NR1
MRF5S19060NBR1

1930-1990 MHz, 12 W AVG., 28 V
2 x N-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 1486-03, STYLE 1
TO-270 WB-4
PLASTIC
MRF5S19060NR1



CASE 1484-04, STYLE 1
TO-272 WB-4
PLASTIC
MRF5S19060NBR1

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 |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C | P_D | 218.8 1.25 | W W/°C |
| Storage Temperature Range | T_{stg} | - 65 to +175 | °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 75°C, 12 W CW | $R_{\theta JC}$ | 0.80 | °C/W |

1. MTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTF 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 Methodology | Class |
|---------------------------------------|--------------|
| Human Body Model (per JESD22-A114) | 1C (Minimum) |
| Machine Model (per EIA/JESD22-A115) | C (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 ($V_{DS} = 65\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | I_{DSS} | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | 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 ($V_{DS} = 10\text{ Vdc}$, $I_D = 225\ \mu\text{Adc}$) | $V_{GS(th)}$ | 2.5 | — | 3.5 | Vdc |
| Gate Quiescent Voltage ($V_{DS} = 28\text{ Vdc}$, $I_D = 750\text{ mAdc}$) | $V_{GS(Q)}$ | — | 3.8 | — | Vdc |
| Drain-Source On-Voltage ($V_{GS} = 5\text{ Vdc}$, $I_D = 2.25\text{ Adc}$) | $V_{DS(on)}$ | — | 0.26 | — | Vdc |
| Forward Transconductance ($V_{DS} = 10\text{ Vdc}$, $I_D = 2.25\text{ Adc}$) | g_{fs} | — | 5 | — | S |

Dynamic Characteristics (1)

| | | | | | |
|---|-----------|---|-----|---|----|
| Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{rss} | — | 1.5 | — | pF |
|---|-----------|---|-----|---|----|

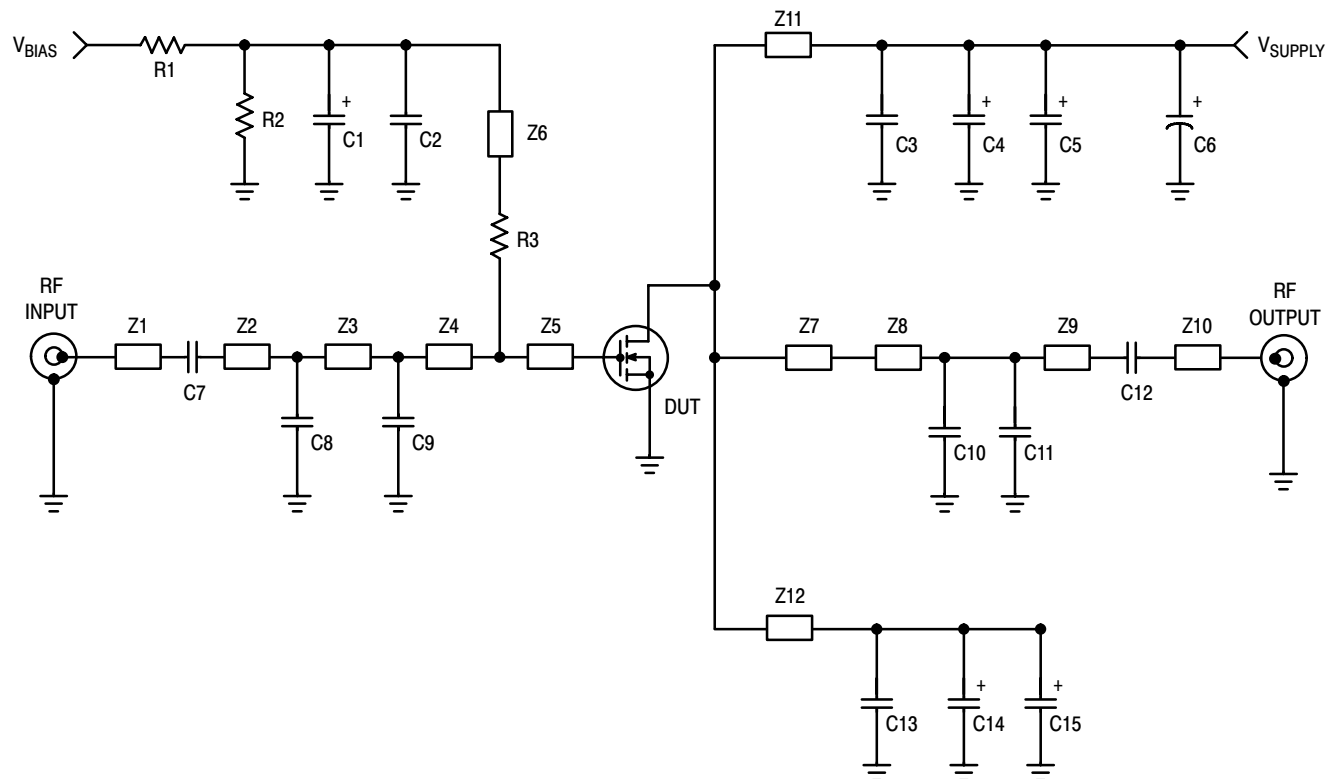
Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 750\text{ mA}$, $P_{out} = 12\text{ W Avg.}$, $f_1 = 1987.5\text{ MHz}$, $f_2 = 1990\text{ MHz}$, 2-carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carriers. ACPR measured in 30 kHz Channel Bandwidth @ $\pm 885\text{ kHz}$ Offset. IM3 measured in 1.2288 MHz Channel Bandwidth @ $\pm 2.5\text{ MHz}$ Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF.

| | | | | | |
|------------------------------|----------|------|-----|-----|-----|
| Power Gain | G_{ps} | 12.5 | 14 | 16 | dB |
| Drain Efficiency | η_D | 21 | 23 | — | % |
| Intermodulation Distortion | IM3 | — | -37 | -35 | dBc |
| Adjacent Channel Power Ratio | ACPR | — | -51 | -48 | dBc |
| Input Return Loss | IRL | — | -12 | -9 | dB |

Typical RF Performance (50 ohm system)

| | | | | | |
|--|-----------|---|-----|---|-----|
| Pulse Peak Power ($V_{DD} = 28\text{ Vdc}$, 1-Tone CW Pulsed, $I_{DQ} = 750\text{ mA}$, $t_{ON} = 8\ \mu\text{s}$, 1% Duty Cycle) | P_{sat} | — | 110 | — | W |
| Video Bandwidth ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 60\text{ W PEP}$, $I_{DQ} = 750\text{ mA}$, Tone Spacing = 1 MHz to VBW, $\Delta\text{IM3} < 2\text{ dB}$) | VBW | — | 35 | — | MHz |

1. Part is internally matched both on input and output.



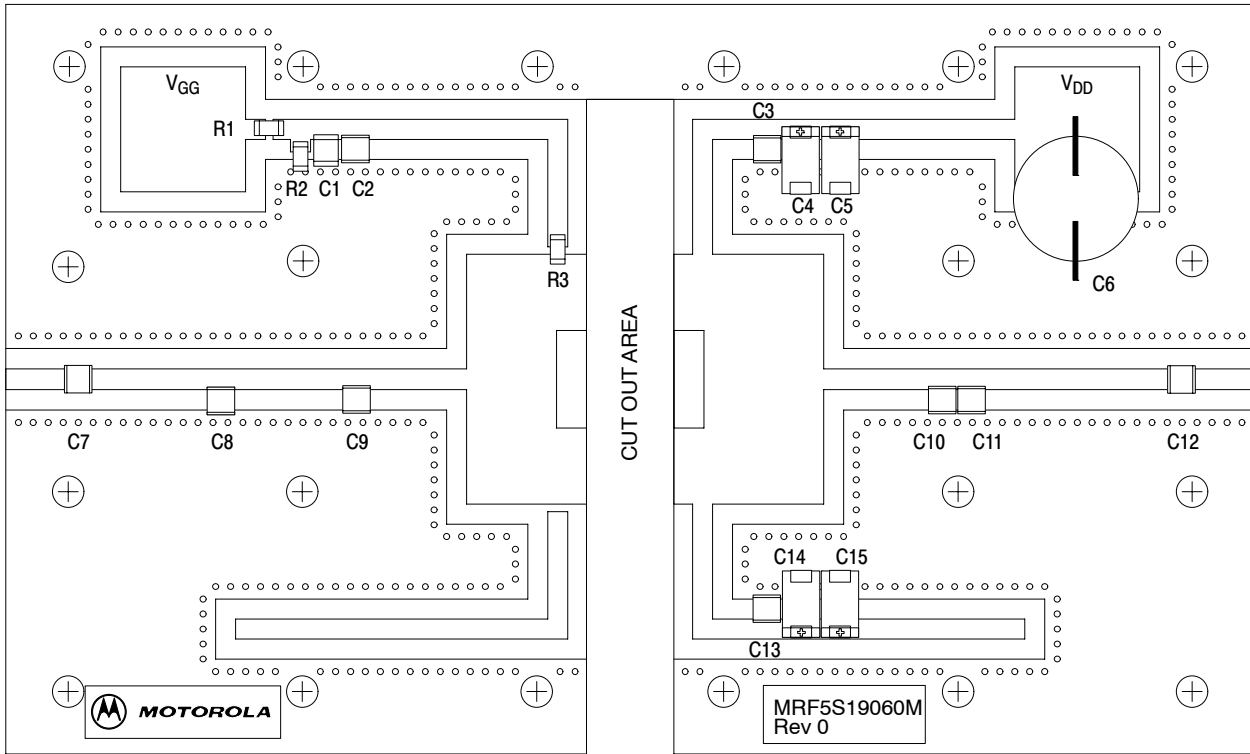
Z1 0.250" x 0.083" Microstrip
 Z2* 0.500" x 0.083" Microstrip
 Z3* 0.500" x 0.083" Microstrip
 Z4* 0.515" x 0.083" Microstrip
 Z5 0.480" x 1.000" Microstrip
 Z6 1.140" x 0.080" Microstrip
 Z7 0.600" x 1.000" Microstrip

Z8* 0.420" x 0.083" Microstrip
 Z9* 0.975" x 0.083" Microstrip
 Z10 0.250" x 0.083" Microstrip
 Z11 0.700" x 0.080" Microstrip
 Z12 0.700" x 0.080" Microstrip
 PCB Taconic TLX8-0300, 0.030", $\epsilon_r = 2.55$
 * Variable for tuning

Figure 1. MRF5S19060NR1/NBR1 Test Circuit Schematic

Table 6. MRF5S19060NR1/NBR1 Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|------------------|--|--------------------|--------------|
| C1 | 1 μ F, 35 V Tantalum Capacitor | TAJB105K35S | AVX |
| C2 | 10 pF 100B Chip Capacitor | ATC100B10R0CT500XT | ATC |
| C3, C7, C12, C13 | 6.8 pF 100B Chip Capacitors | ATC100B6R8CT500XT | ATC |
| C4, C5, C14, C15 | 10 μ F, 35 V Tantalum Capacitors | TAJD106K035S | AVX |
| C6 | 220 μ F, 63 V Electrolytic Capacitor, Radial | 2222-136-68221 | Vishay |
| C8 | 0.8 pF 100B Chip Capacitor | ATC100B0R8BT500XT | ATC |
| C9 | 1.5 pF 100B Chip Capacitor | ATC100B1R5BT500XT | ATC |
| C10 | 1.0 pF 100B Chip Capacitor | ATC100B1R0BT500XT | ATC |
| C11 | 0.2 pF 100B Chip Capacitor | ATC100B0R2BT500XT | ATC |
| R1, R2 | 10 k Ω , 1/4 W Chip Resistors | CRCW12061002FKEA | Vishay |
| R3 | 10 Ω , 1/4 W Chip Resistors | CRCW120610R0FKEA | Vishay |



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

Figure 2. MRF5S19060NR1/NBR1 Test Circuit Component Layout

TYPICAL CHARACTERISTICS

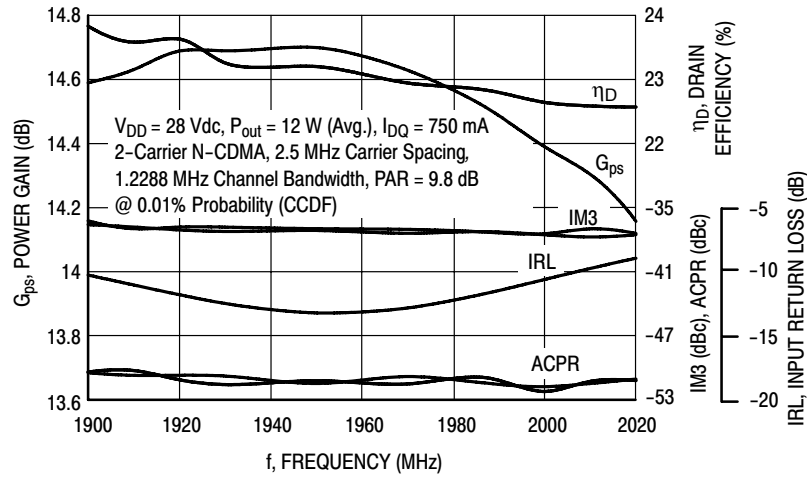


Figure 3. 2-Carrier N-CDMA Broadband Performance @ $P_{out} = 12$ Watts Avg.

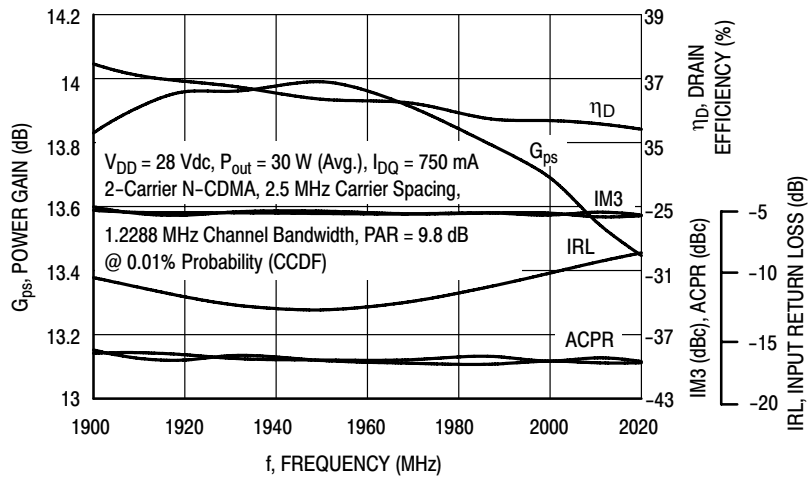


Figure 4. 2-Carrier N-CDMA Broadband Performance @ $P_{out} = 30$ Watts Avg.

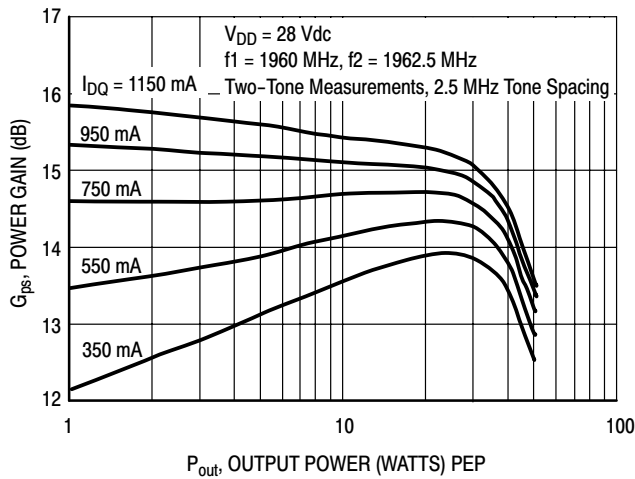


Figure 5. Two-Tone Power Gain versus Output Power

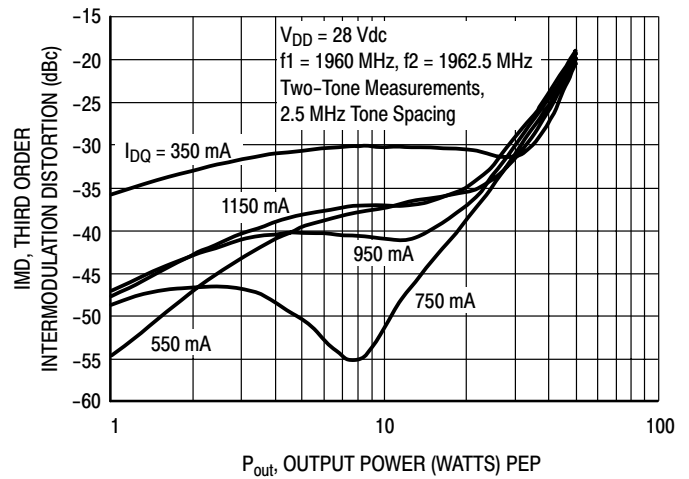


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

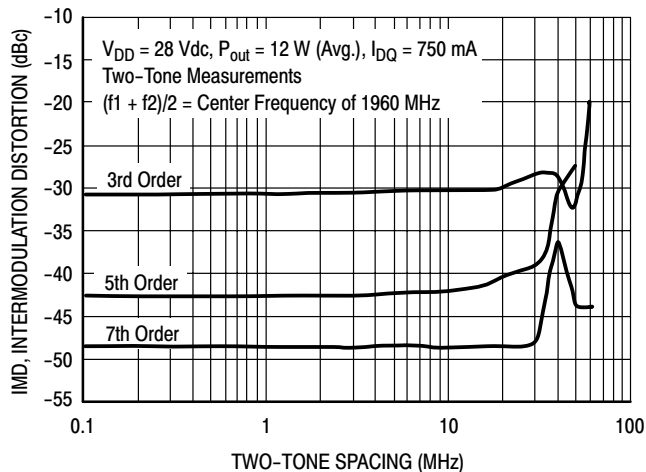


Figure 7. Intermodulation Distortion Products versus Tone Spacing

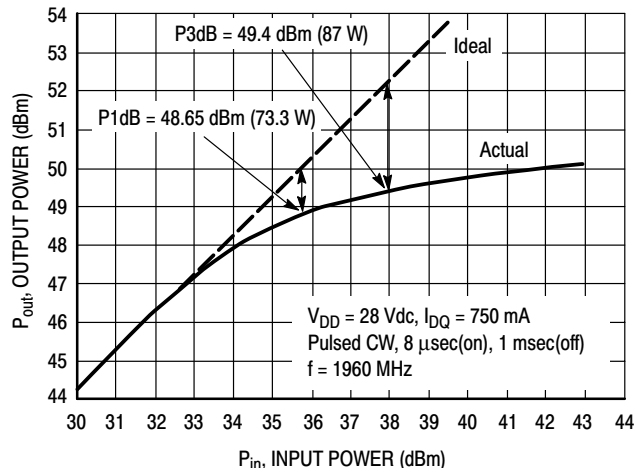


Figure 8. Pulse CW Output Power versus Input Power

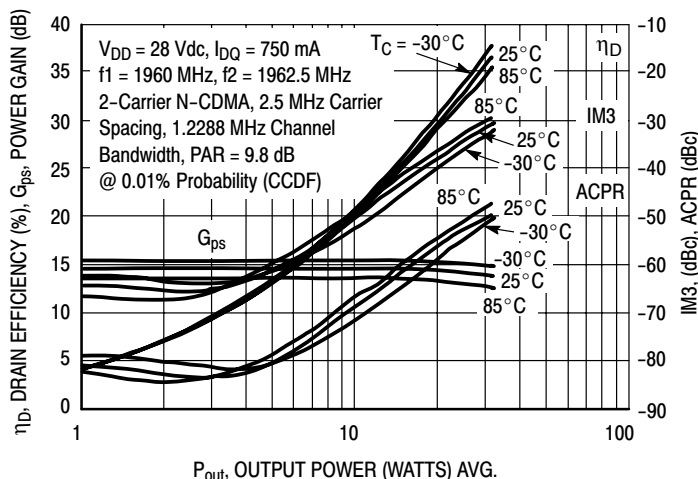


Figure 9. 2-Carrier N-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

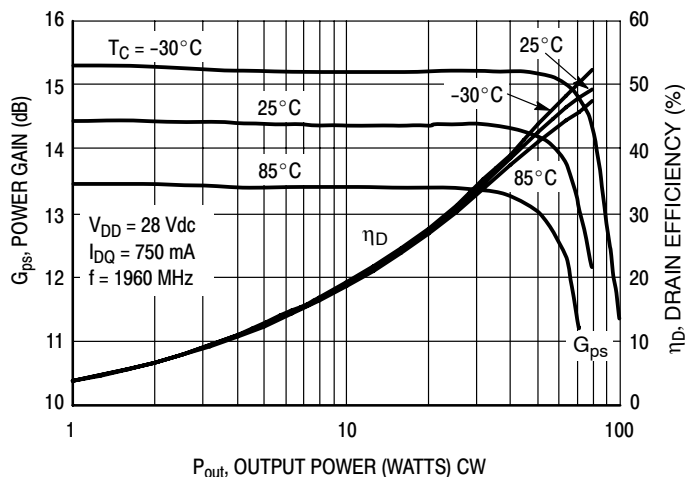


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

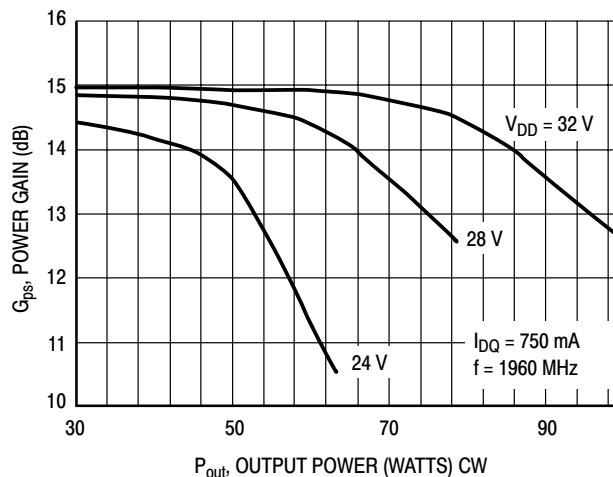
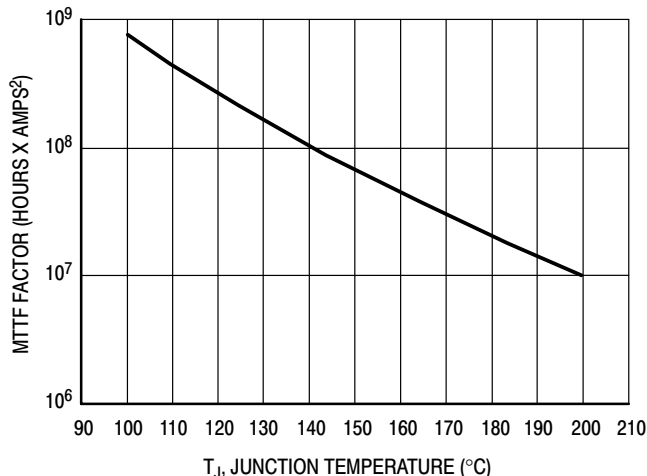


Figure 11. Power Gain versus Output Power

MRF5S19060NR1 MRF5S19060NBR1

TYPICAL CHARACTERISTICS



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_D² for MTTF in a particular application.

Figure 12. MTTF Factor versus Junction Temperature

N-CDMA TEST SIGNAL

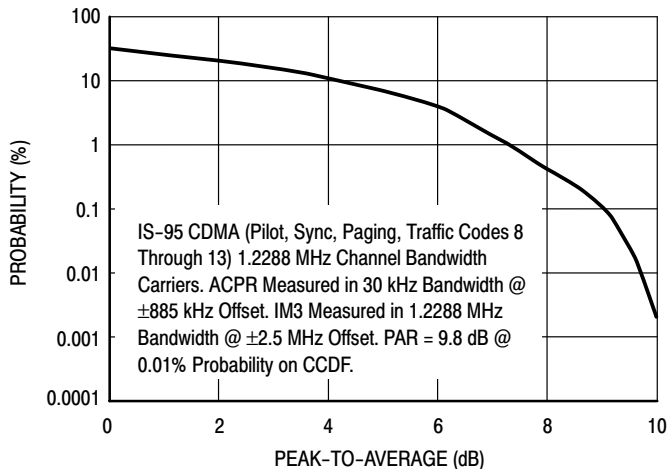


Figure 13. 2-Carrier CCDF N-CDMA

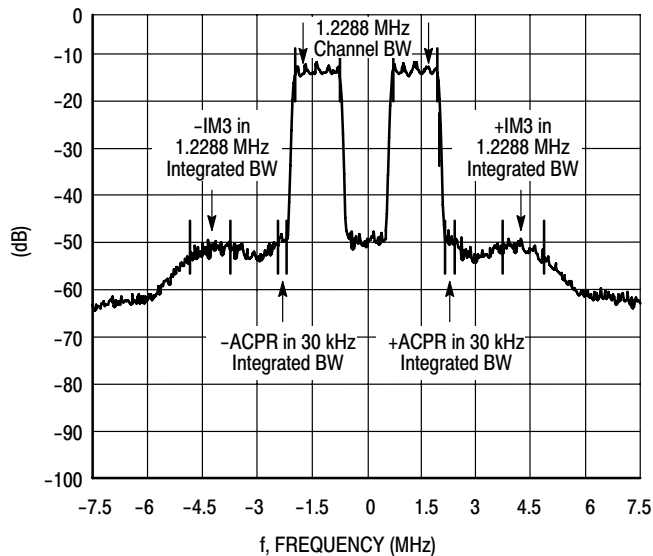
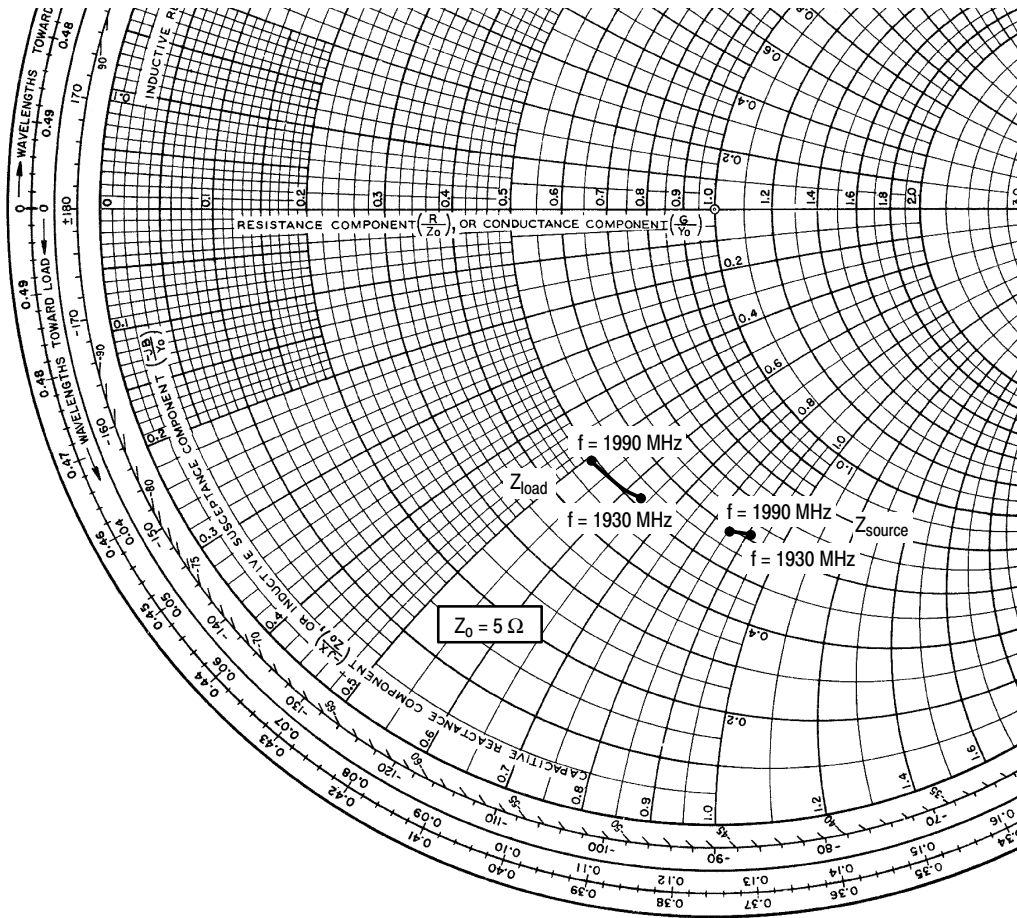


Figure 14. 2-Carrier N-CDMA Spectrum



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 750 \text{ mA}$, $P_{out} = 12 \text{ W Avg.}$

| f MHz | Z_{source} Ω | Z_{load} Ω |
|----------|--------------------------|------------------------|
| 1930 | $3.11 - j4.55$ | $2.60 - j3.18$ |
| 1960 | $3.06 - j4.38$ | $2.50 - j2.85$ |
| 1990 | $2.93 - j4.28$ | $2.44 - j2.53$ |

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

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

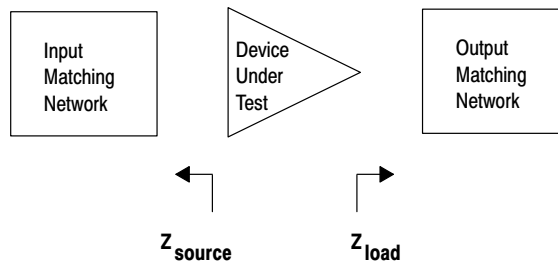
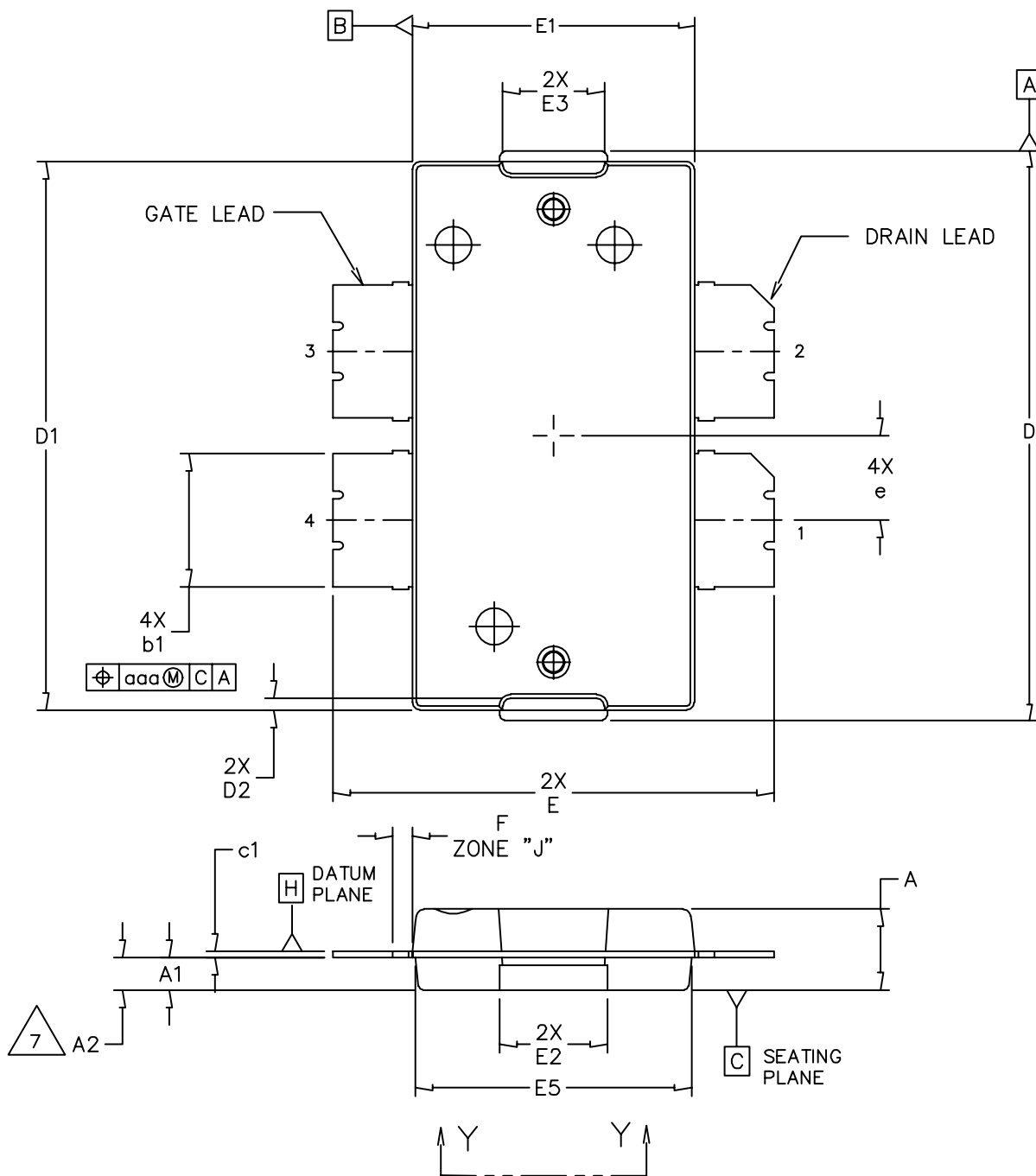
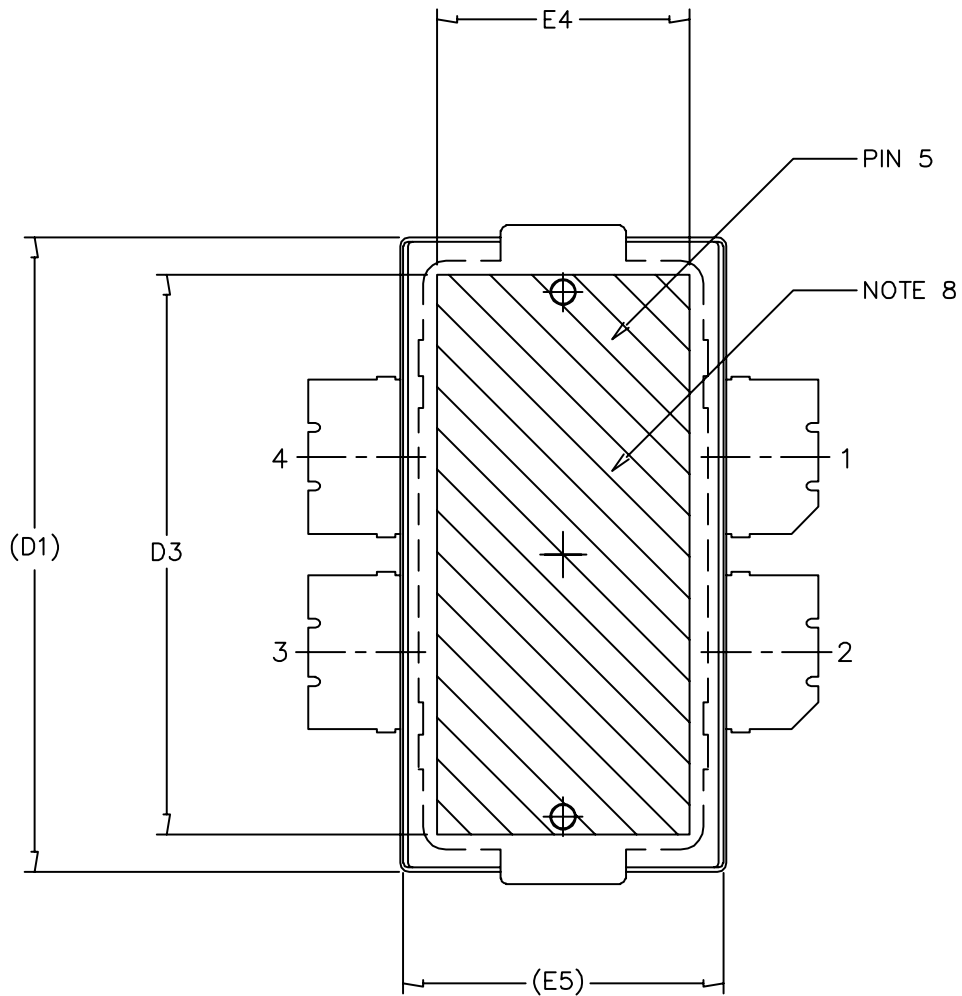


Figure 15. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS



| | | | |
|---|--------------------------|----------------------------|--|
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| TITLE: TO-270 4 LEAD, WIDE BODY | DOCUMENT NO: 98ASA10577D | REV: D | |
| | CASE NUMBER: 1486-03 | 13 AUG 2007 | |
| | STANDARD: NON-JEDEC | | |



| | | | |
|---|--------------------|----------------------------|-------------|
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| | | CASE NUMBER: 1486-03 | 13 AUG 2007 |
| | | STANDARD: NON-JEDEC | |

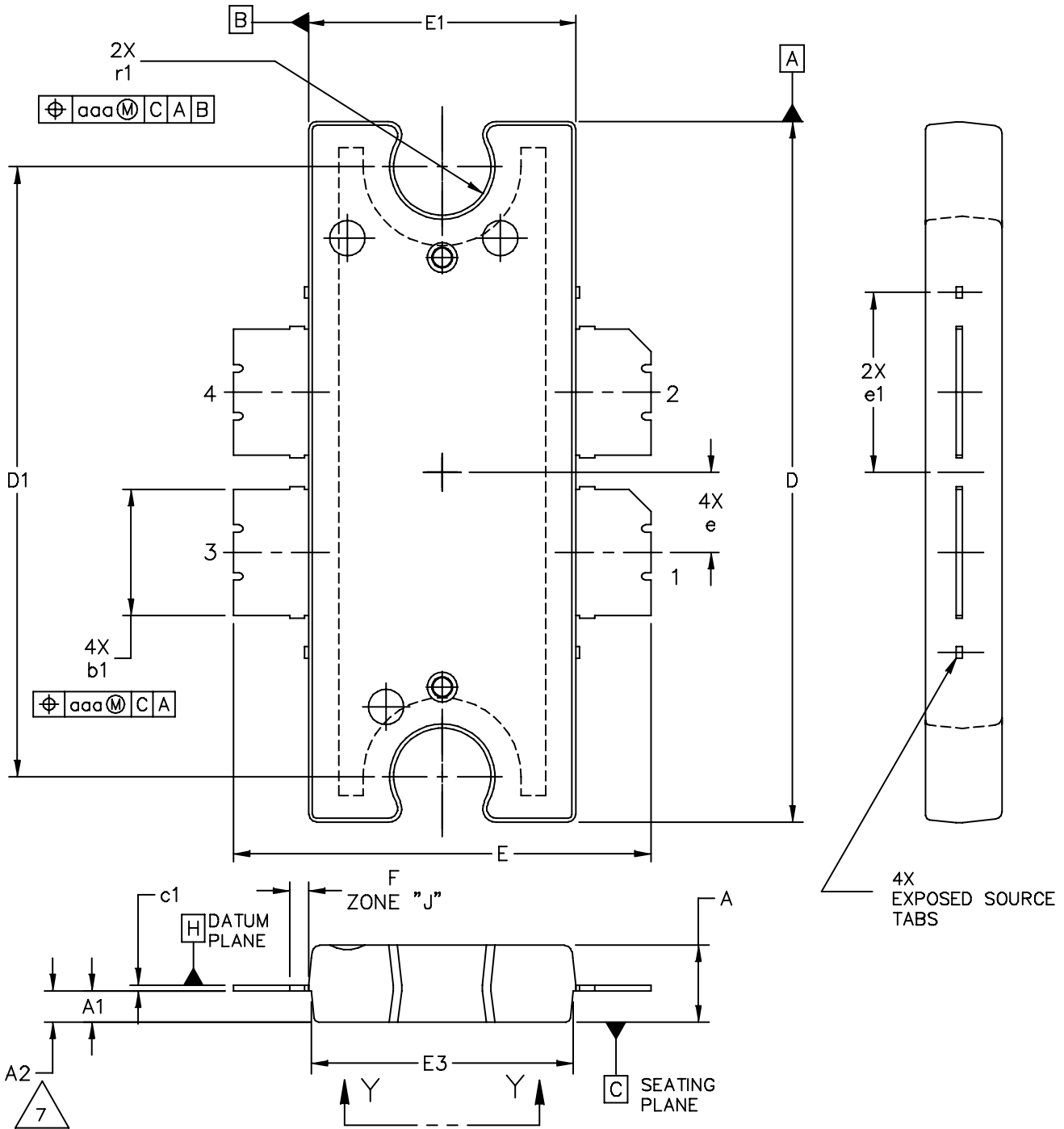
NOTES:

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 PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSIONS "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.

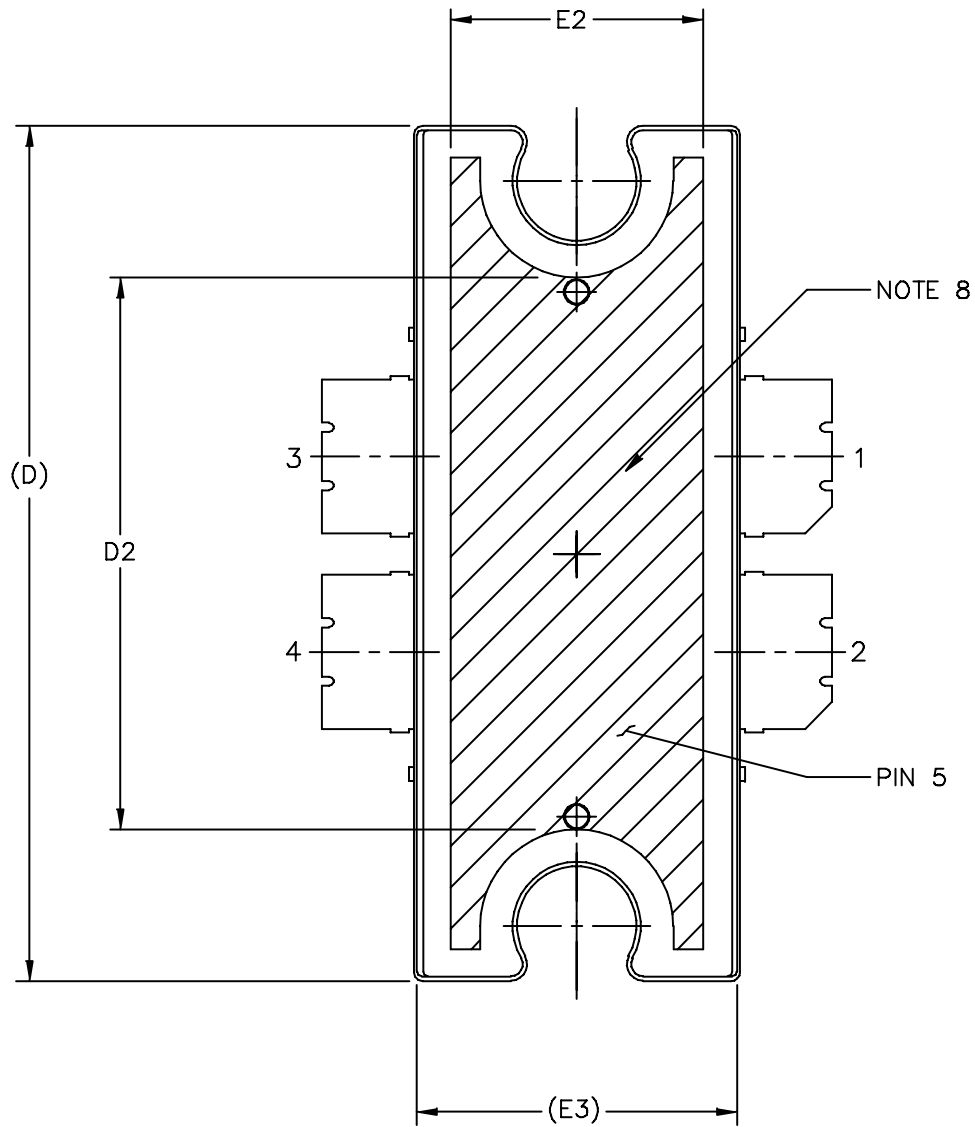
STYLE 1:

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 | F | .025 BSC | | 0.64 BSC | |
| A1 | .039 | .043 | 0.99 | 1.09 | b1 | .164 | .170 | 4.17 | 4.32 |
| A2 | .040 | .042 | 1.02 | 1.07 | c1 | .007 | .011 | .18 | .28 |
| D | .712 | .720 | 18.08 | 18.29 | e | .106 BSC | | 2.69 BSC | |
| D1 | .688 | .692 | 17.48 | 17.58 | aaa | .004 | | .10 | |
| 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 | | | | | |
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| | | CASE NUMBER: 1484-04 | 31 AUG 2007 |
| | | STANDARD: NON-JEDEC | |



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| TITLE: TO-272 4 LEAD, WIDE BODY | | DOCUMENT NO: 98ASA10575D | REV: E |
| | | CASE NUMBER: 1484-04 | 31 AUG 2007 |
| | | STANDARD: NON-JEDEC | |

MRF5S19060NR1 MRF5S19060NBR1

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. DIMENSIONS "b1" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE "b1" DIMENSION AT MAXIMUM MATERIAL CONDITION.
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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| | CASE NUMBER: 1484-04 | | 31 AUG 2007 |
| | STANDARD: NON-JEDEC | | |

PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date | Description |
|----------|-----------|---|
| 7 | Oct. 2008 | <ul style="list-style-type: none">• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN12779, p. 1, 2• Updated Part Numbers in Table 6, Component Designations and Values, to RoHS compliant part numbers, p. 3• Replaced Case Outline 1486-03, Issue C, with 1486-03, Issue D, p. 9-11. Added pin numbers 1 through 4 on Sheet 1.• Replaced Case Outline 1484-04, Issue D, with 1484-04, Issue E, p. 12-14. Added pin numbers 1 through 4 on Sheet 1, replacing Gate and Drain notations with Pin 1 and Pin 2 designations.• Added Product Documentation and Revision History, p. 15 |

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