



**THE DATASHEET OF
MRF5S4125NR1**



RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for broadband commercial and industrial applications with frequencies up to 500 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.

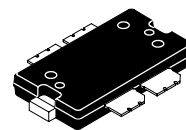
- Typical Single-Carrier N-CDMA Performance @ 465 MHz: $V_{DD} = 28$ Volts, $I_{DQ} = 1100$ mA, $P_{out} = 25$ Watts Avg., IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13). Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.
Power Gain — 23 dB
Drain Efficiency — 30.2%
ACPR @ 750 kHz Offset — -47.6 dBc in 30 kHz Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 465 MHz, 125 Watts CW Output Power

Features

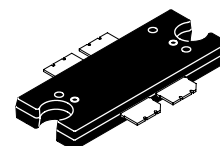
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- 200°C Capable Plastic Package
- RoHS Compliant
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel.

MRF5S4125NR1
MRF5S4125NBR1

450-480 MHz, 25 W AVG., 28 V
SINGLE N-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 1486-03, STYLE 1
TO-270 WB-4
MRF5S4125NR1



CASE 1484-04, STYLE 1
TO-272 WB-4
MRF5S4125NBR1

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 +150 | °C |
| Operating Junction Temperature (1,2) | T_J | 200 | °C |

Table 2. Thermal Characteristics

| Characteristic | Symbol | Value (2,3) | Unit |
|--------------------------------------|-----------------|-------------|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | | °C/W |
| Case Temperature 90°C, 125 W CW | | 0.33 | |
| Case Temperature 90°C, 25 W CW | | 0.43 | |

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescale.com/rf>. Select Tools/Software/Application Software/Calculators to access the MTTF calculators by product.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.

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Table 3. ESD Protection Characteristics

| Test Methodology | Class |
|---------------------------------------|--------------|
| Human Body Model (per JESD22-A114) | 1B (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 ($V_{DS} = 65\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | 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} | — | — | 10 | μAdc |

On Characteristics

| | | | | | |
|--|--------------|------|-------|-----|-----|
| Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 400\ \mu\text{Adc}$) | $V_{GS(th)}$ | 2 | 3 | 4 | Vdc |
| Gate Quiescent Voltage ($V_{DS} = 28\text{ Vdc}$, $I_D = 1100\text{ mAdc}$, Measured in Functional Test) | $V_{GS(Q)}$ | 3.5 | 4.25 | 5 | Vdc |
| Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 1.5\text{ Adc}$) | $V_{DS(on)}$ | 0.05 | 0.175 | 0.3 | Vdc |

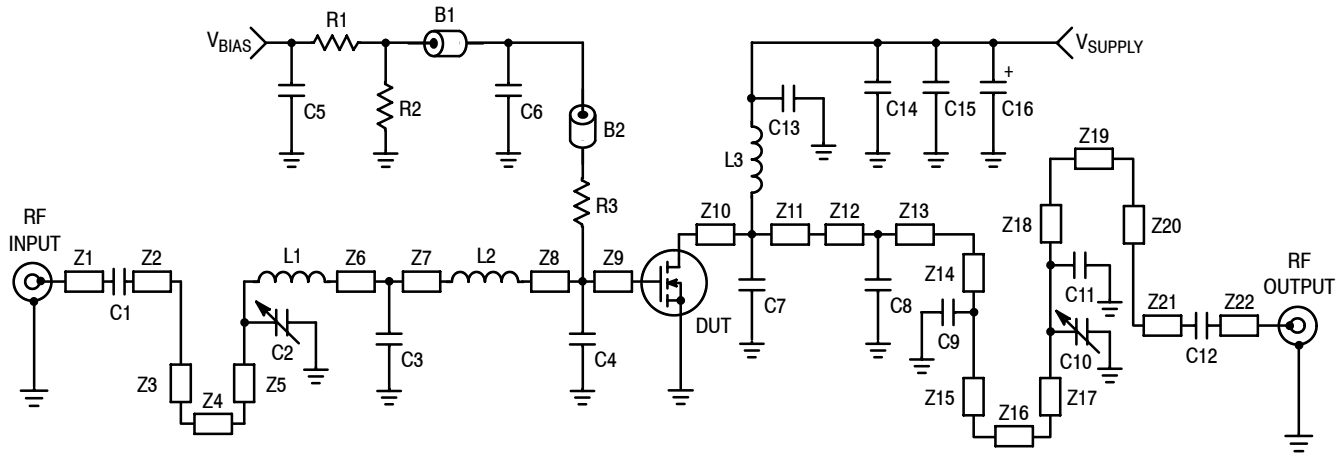
Dynamic Characteristics (1)

| | | | | | |
|---|-----------|---|-------|---|----|
| Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{rss} | — | 2.41 | — | pF |
| Output Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{oss} | — | 74.61 | — | pF |

Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1100\text{ mA}$, $P_{out} = 25\text{ W Avg}$. N-CDMA, $f = 465\text{ MHz}$, Single-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carrier. ACPR measured in 30 kHz Channel Bandwidth @ $\pm 750\text{ kHz}$ Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF.

| | | | | | |
|------------------------------|----------|----|-------|-----|-----|
| Power Gain | G_{ps} | 22 | 23 | 25 | dB |
| Drain Efficiency | η_D | 28 | 30.2 | — | % |
| Adjacent Channel Power Ratio | ACPR | — | -47.6 | -45 | dBc |
| Input Return Loss | IRL | — | -15 | -9 | dB |

1. Part internally input matched.



| | | | |
|--------|----------------------------|-----|---|
| Z1 | 0.186" x 0.084" Microstrip | Z13 | 0.063" x 0.084" Microstrip |
| Z2 | 0.206" x 0.084" Microstrip | Z14 | 0.315" x 0.084" Microstrip |
| Z3 | 1.171" x 0.084" Microstrip | Z15 | 0.473" x 0.084" Microstrip |
| Z4 | 0.275" x 0.084" Microstrip | Z16 | 0.522" x 0.084" Microstrip |
| Z5 | 0.985" x 0.084" Microstrip | Z17 | 0.448" x 0.084" Microstrip |
| Z6, Z7 | 0.130" x 0.084" Microstrip | Z18 | 0.628" x 0.084" Microstrip |
| Z8 | 0.131" x 0.084" Microstrip | Z19 | 0.291" x 0.084" Microstrip |
| Z9 | 0.675" x 0.504" Microstrip | Z20 | 0.318" x 0.084" Microstrip |
| Z10 | 0.397" x 0.656" Microstrip | Z21 | 0.202" x 0.084" Microstrip |
| Z11 | 0.071" x 0.084" Microstrip | Z22 | 0.190" x 0.084" Microstrip |
| Z12 | 0.008" x 0.084" Microstrip | PCB | Arlon AD250, 0.030", $\epsilon_r = 2.5$ |

Figure 1. MRF5S4125NR1(NBR1) Test Circuit Schematic

Table 6. MRF5S4125NR1(NBR1) Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|------------------|---|--------------------|--------------|
| B1, B2 | Ferrite Beads, Short | 2743019447 | Fair-Rite |
| C1, C6, C12, C13 | 120 pF Chip Capacitors | ATC600B121BT250XT | ATC |
| C2, C10 | 0.8–8.0 pF, Variable Capacitors, Gigatrim | 27291SL | Johanson |
| C3, C9 | 20 pF Chip Capacitors | ATC600B200BT250XT | ATC |
| C4 | 8.2 pF Chip Capacitor | ATC600B8R2BT250XT | ATC |
| C5, C14, C15 | 10 μ F, 50 V Chip Capacitors | GRM55DR61H106KA88L | Murata |
| C7 | 27 pF Chip Capacitor | ATC600B270BT250XT | ATC |
| C8 | 47 pF Chip Capacitor | ATC600B470BT250XT | ATC |
| C11 | 3.3 pF Chip Capacitor | ATC600B3R3BT250XT | ATC |
| C16 | 22 μ F, 35 V Tantalum Capacitor | T491X226K035A5 | Kemet |
| L1, L2 | 1.6 nH Inductors | 0906-2 | Coilcraft |
| L3 | 27 nH Inductor | 1812SMS-27N_L | Coilcraft |
| R1 | 1000 Ω , 1/4 W Chip Resistor | CRCW12061001FKTA | Vishay |
| R2 | 10 k Ω , 1/4 W Chip Resistor | CRCW12061002FKTA | Vishay |
| R3 | 100 Ω , 1/4 W Chip Resistor | CRCW1206100RFKTA | Vishay |

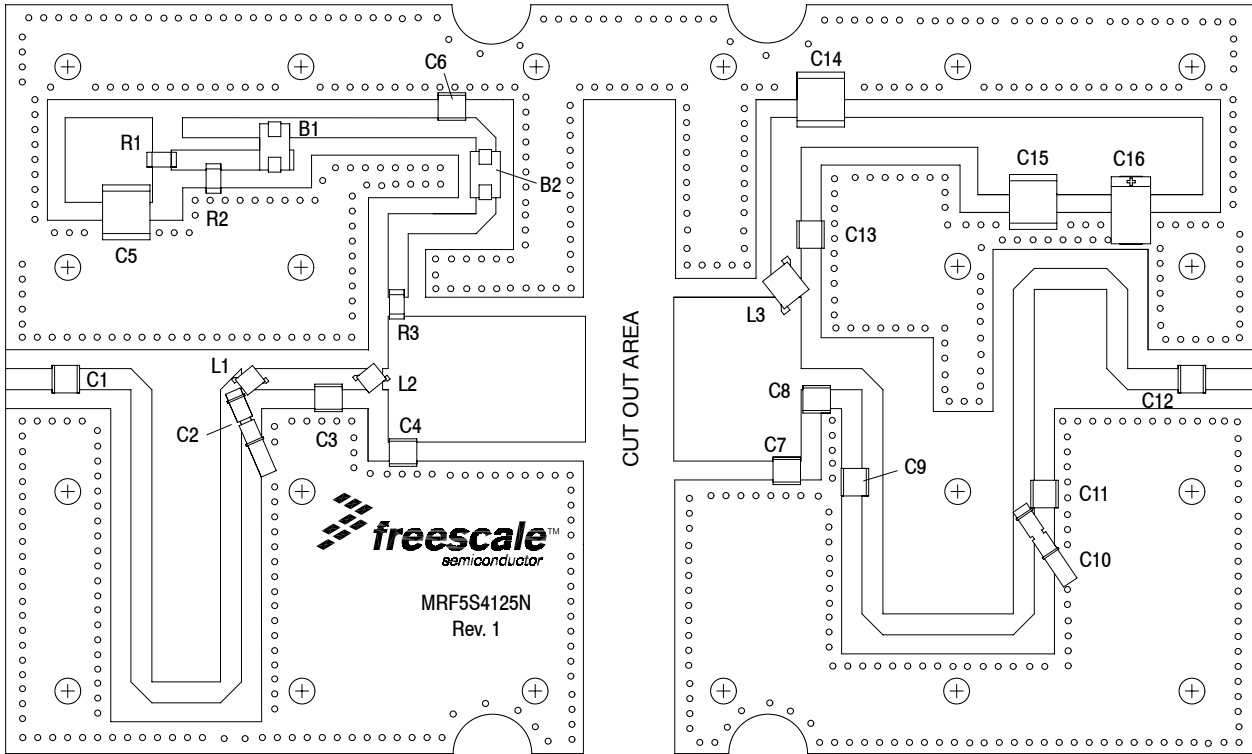


Figure 2. MRF5S4125NR1(NBR1) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

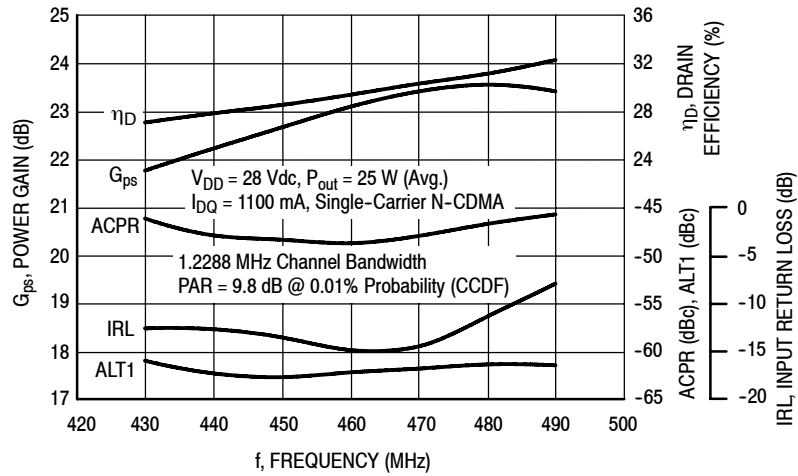


Figure 3. Single-Carrier N-CDMA Broadband Performance @ $P_{out} = 25$ Watts Avg.

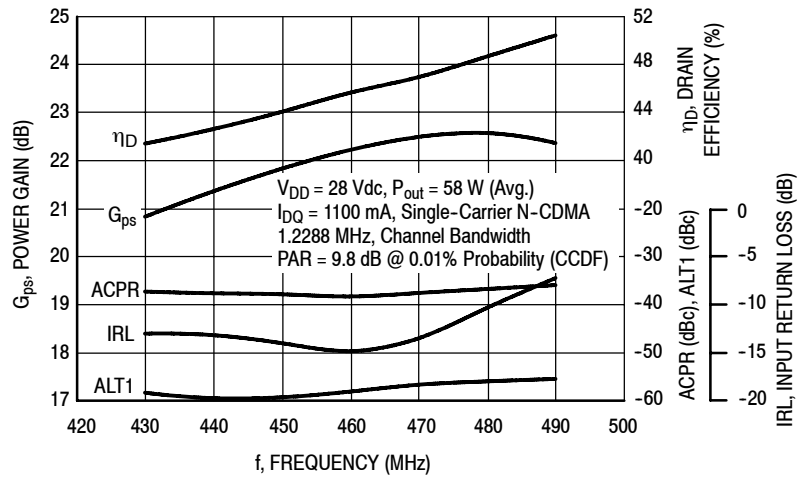


Figure 4. Single-Carrier N-CDMA Broadband Performance @ $P_{out} = 58$ Watts Avg.

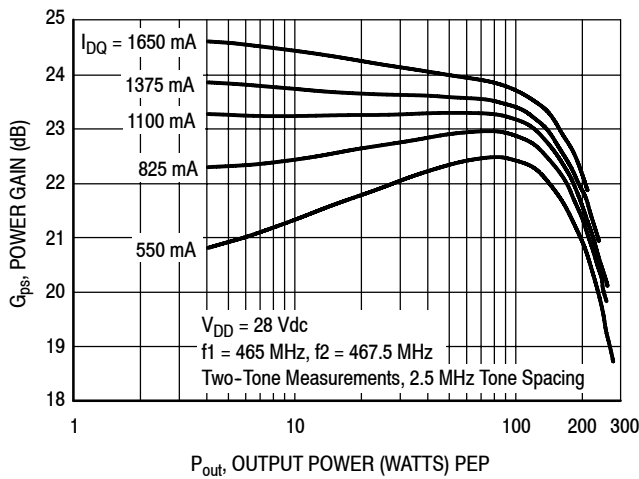


Figure 5. Two-Tone Power Gain versus Output Power

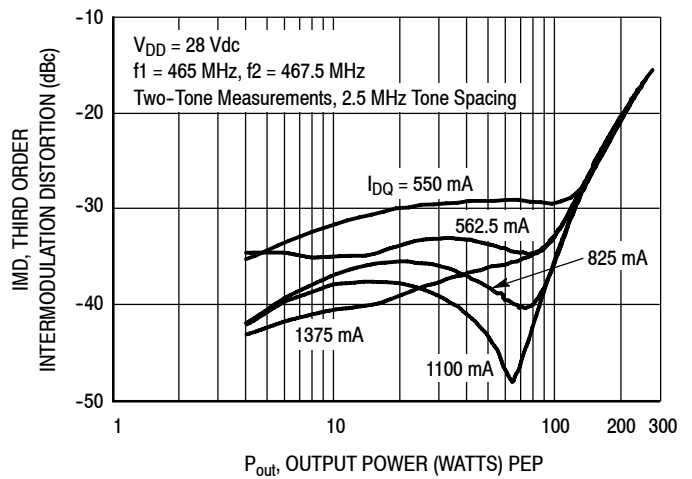


Figure 6. Third Order Intermodulation Distortion versus Output Power

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TYPICAL CHARACTERISTICS

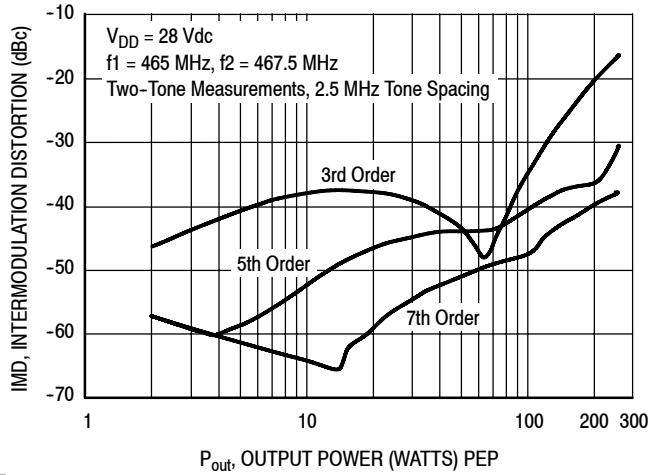


Figure 7. Intermodulation Distortion Products versus Output Power

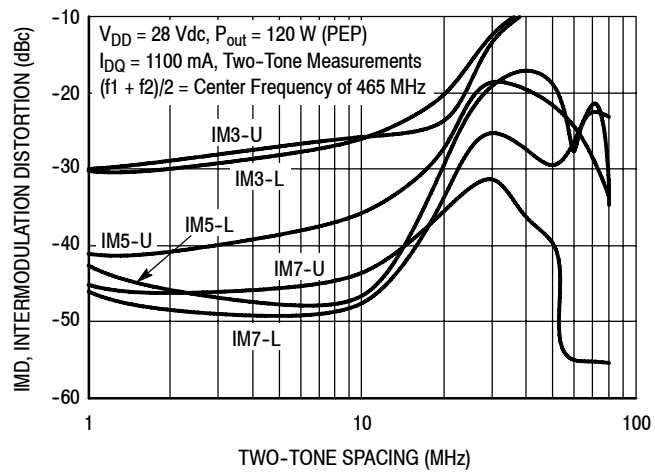


Figure 8. Intermodulation Distortion Products versus Tone Spacing

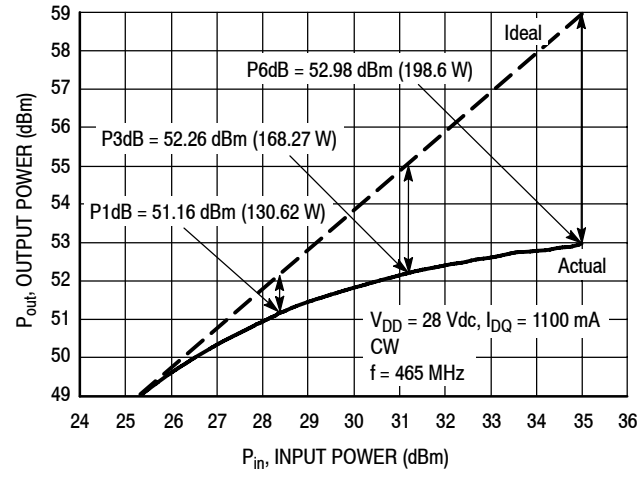


Figure 9. Pulsed CW Output Power versus Input Power

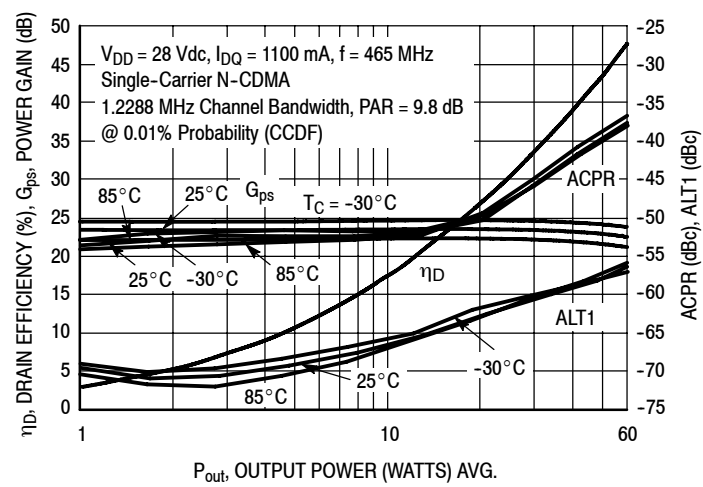


Figure 10. Single-Carrier N-CDMA ACPR, ALT1, Power Gain and Drain Efficiency versus Output Power

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TYPICAL CHARACTERISTICS

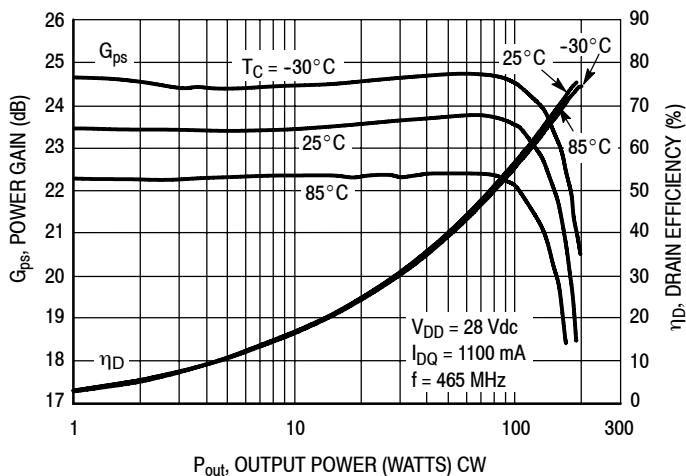


Figure 11. Power Gain and Drain Efficiency versus CW Output Power

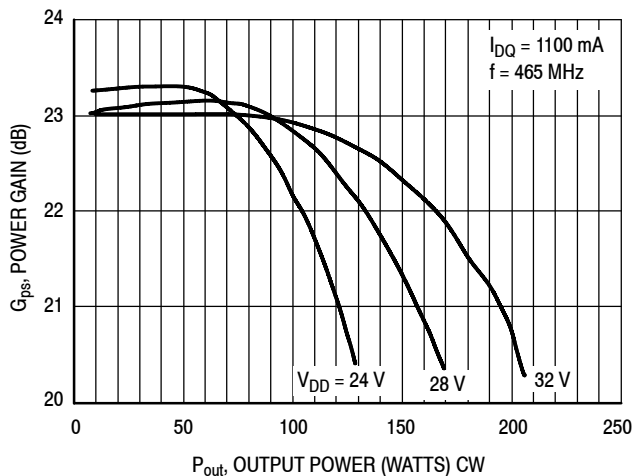
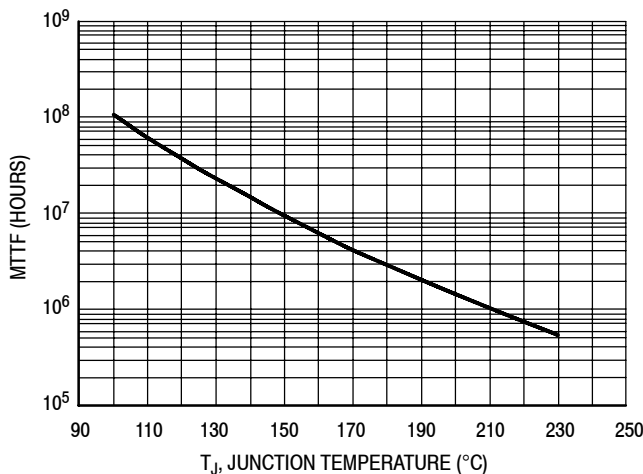


Figure 12. Power Gain versus Output Power



This above graph displays calculated MTTF in hours when the device is operated at $V_{DD} = 28$ Vdc, $P_{out} = 25$ W Avg., and $\eta_D = 30.2\%$.

MTTF calculator available at <http://www.freescale.com/rf>. Select Tools/Software/Application Software/Calculators to access the MTTF calculators by product.

Figure 13. MTTF versus Junction Temperature

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N-CDMA TEST SIGNAL

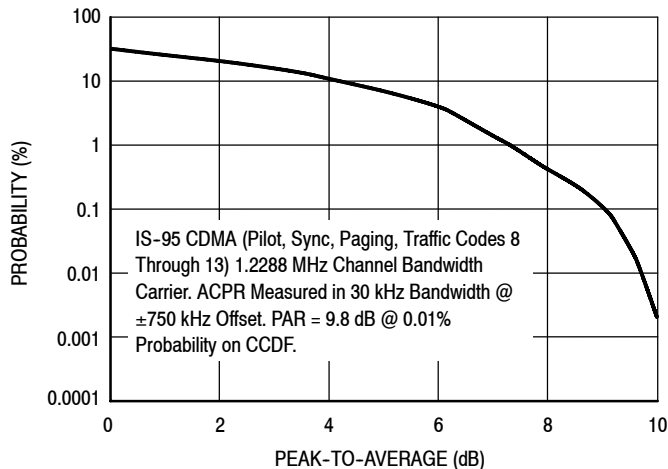


Figure 14. Single-Carrier CCDF N-CDMA

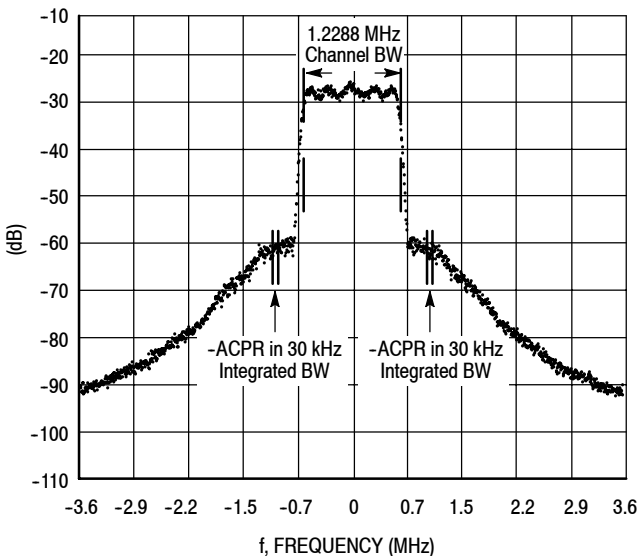
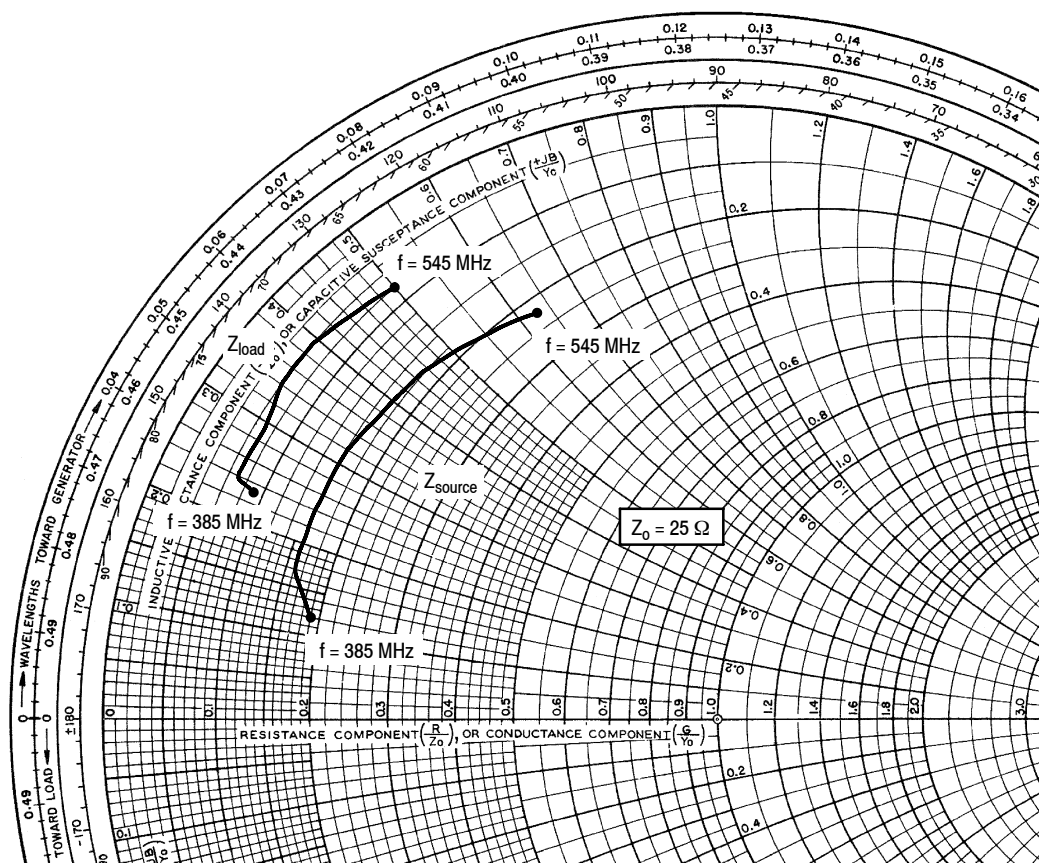


Figure 15. Single-Carrier N-CDMA Spectrum

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$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1100 \text{ mA}$, $P_{out} = 25 \text{ W Avg.}$

| f MHz | Z_{source} Ω | Z_{load} Ω |
|-------|-----------------------|---------------------|
| 385 | $4.735 + j2.917$ | $2.229 + j5.627$ |
| 405 | $4.073 + j4.202$ | $1.809 + j6.123$ |
| 425 | $3.987 + j5.466$ | $1.842 + j6.684$ |
| 445 | $3.909 + j6.743$ | $1.767 + j7.187$ |
| 465 | $4.094 + j7.661$ | $1.822 + j7.338$ |
| 485 | $4.128 + j9.483$ | $1.566 + j8.397$ |
| 505 | $4.446 + j11.620$ | $1.525 + j9.787$ |
| 525 | $4.921 + j13.710$ | $1.769 + j11.120$ |
| 545 | $5.437 + j15.838$ | $2.023 + j12.467$ |

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

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

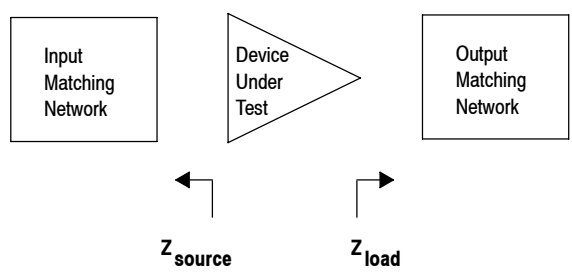
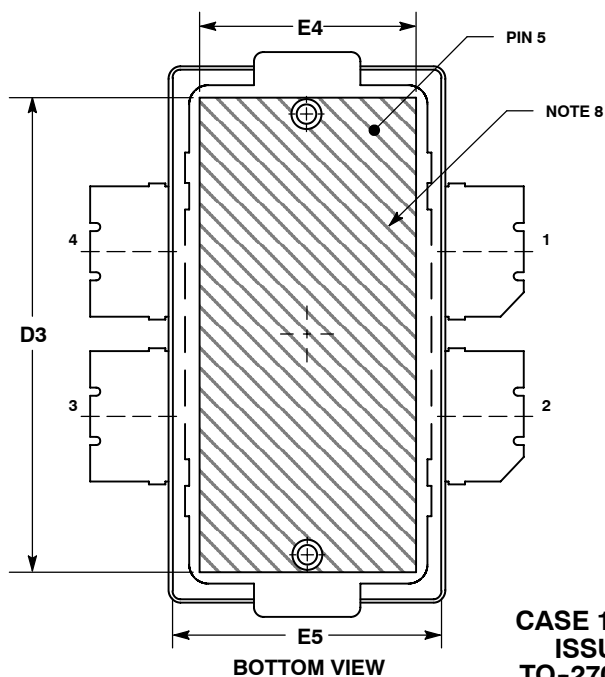
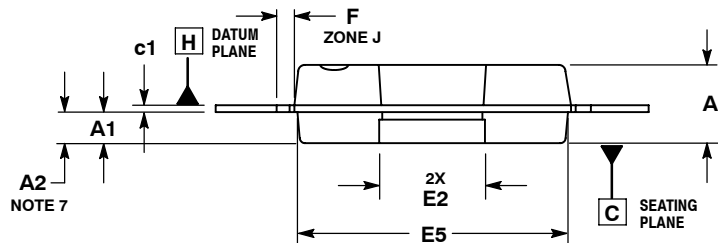
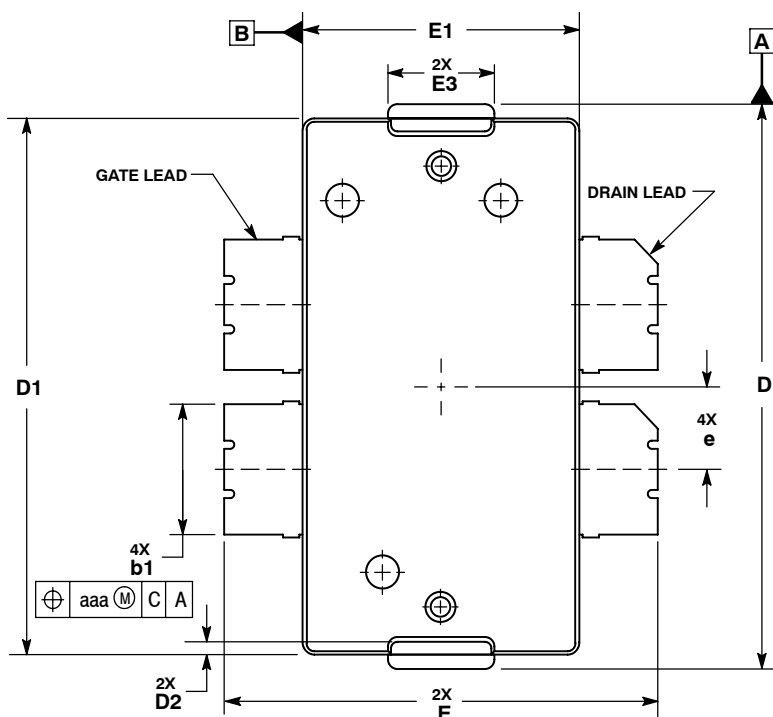


Figure 16. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS



**CASE 1486-03
ISSUE C
TO-270 WB-4
PLASTIC
MRF5S4125NR1**

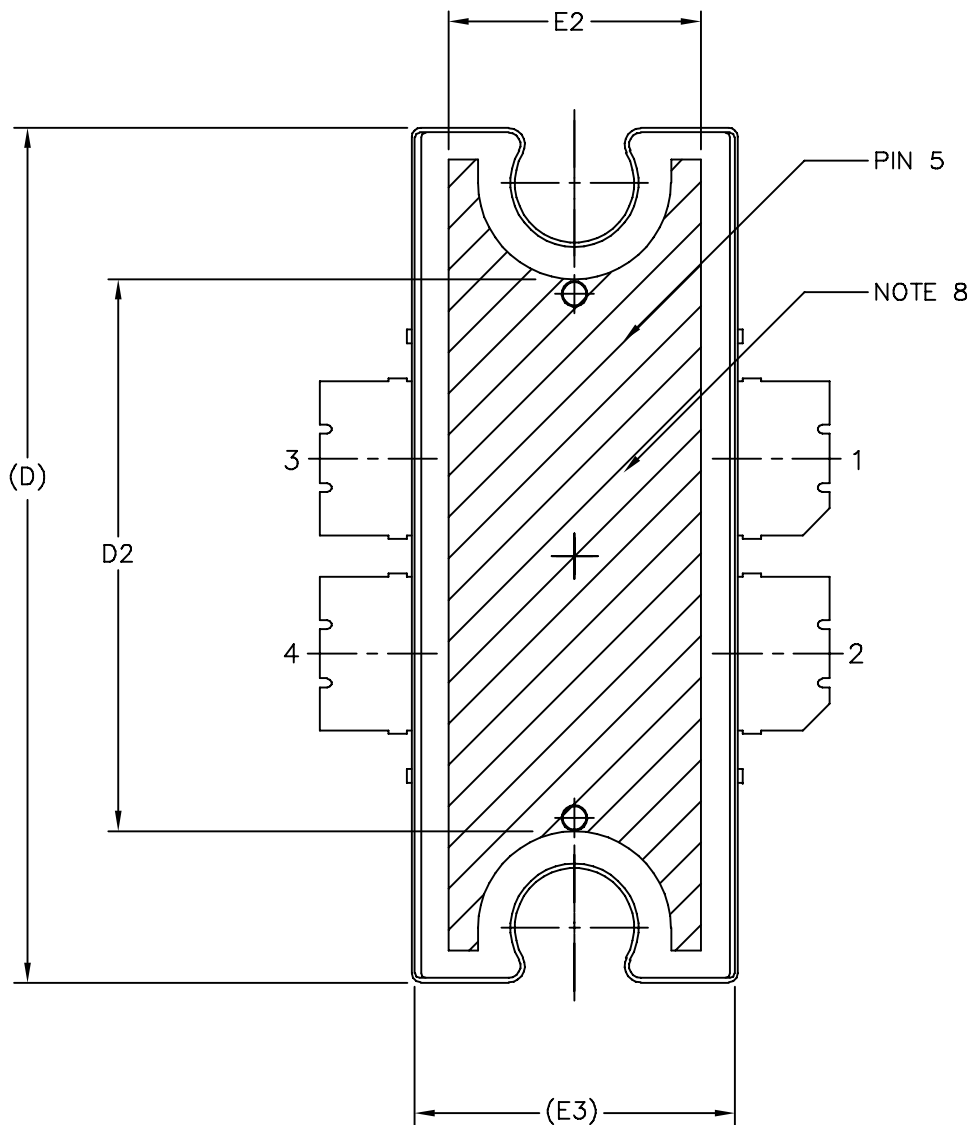
NOTES:

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:

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



| | | | |
|---|---------------------------|----------------------------|--|
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| TITLE: TO-272 4 LEAD, WIDE BODY | DOCUMENT NO: 98ASA10575D | REV: D | |
| | CASE NUMBER: 1484-04 | 05 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 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 | | 05 APR 2006 |
| | | | STANDARD: NON-JEDEC | | |

PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

Application Notes

- AN1907: Solder Reflow Attach Method for High Power RF Devices in Plastic Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers
- AN3263: Bolt Down Mounting Method for High Power RF Transistors and RFICs in Over-Molded Plastic Packages

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date | Description |
|----------|-----------|---------------------------------|
| 0 | Jan. 2007 | • Initial Release of Data Sheet |

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