Document Number: MRFE6P3300H
Rev. 2, 12/2009

RoHS

# RF Power Field Effect Transistor

## N-Channel Enhancement-Mode Lateral MOSFET

Designed for broadband commercial and industrial applications with frequencies from 470 to 860 MHz. The high gain and broadband performance of this device make it ideal for large- signal, common- source amplifier applications in 32 volt analog or digital television transmitter equipment.

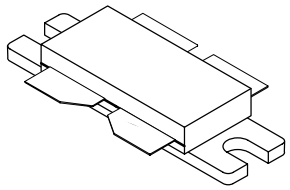
- Typical Narrowband Two-Tone Performance @ 860 MHz: $V_{DD}$ = 32 Volts, $I_{DQ}$ = 1600 mA, $P_{out}$ = 270 Watts PEP
  Power Gain — 20.4 dB
  Drain Efficiency — 44.8%
  IMD — -28.8 dBc
- Capable of Handling 10:1 VSWR, @ 32 Vdc, 860 MHz, 3 dB Overdrive, Designed for Enhanced Ruggedness

**Features**

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Designed for Push-Pull Operation Only
- Qualified Up to a Maximum of 32 $V_{DD}$ Operation
- Integrated ESD Protection
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.
  R5 Suffix = 50 Units per 56 mm, 13 inch Reel.

**MRFE6P3300HR3**

**860 MHz, 300 W, 32 V
LATERAL N-CHANNEL
RF POWER MOSFET**



**CASE 375G-04, STYLE 1
NI-860C3**

**Table 1. Maximum Ratings**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | -0.5, +66 | Vdc |
| Gate-Source Voltage | $V_{GS}$ | -0.5, +12 | Vdc |
| Storage Temperature Range | $T_{stg}$ | -65 to +150 | °C |
| Case Operating Temperature | $T_C$ | 150 | °C |
| Operating Junction Temperature (1,2) | $T_J$ | 225 | °C |

**Table 2. Thermal Characteristics**

| Characteristic | Symbol | Value (2,3) | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | | °C/W |
| Case Temperature 80°C, 300 W CW | | 0.23 | |
| Case Temperature 82°C, 220 W CW | | 0.24 | |
| Case Temperature 79°C, 100 W CW | | 0.27 | |
| Case Temperature 81°C, 60 W CW | | 0.27 | |

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.freescale.com/rf. Select Software & Tools/Development Tools/Calculators to access 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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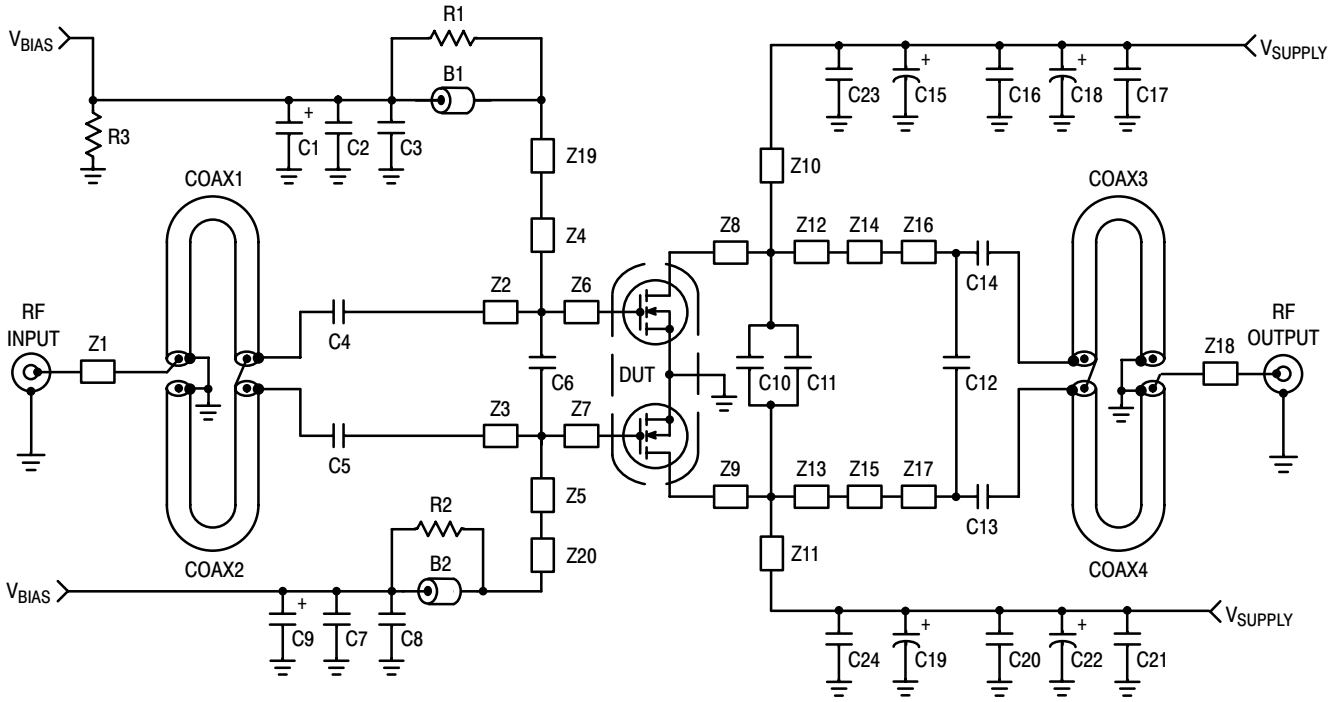
**Table 3. ESD Protection Characteristics**

| Test Methodology | Class |
|---|---|
| Human Body Model (per JESD22-A114) | 3B (Minimum) |
| Machine Model (per EIA/JESD22-A115) | C (Minimum) |
| Charge Device Model (per JESD22-C101) | IV (Minimum) |

**Table 4. Electrical Characteristics** ($T_A$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Off Characteristics** (1) | | | | | |
| Zero Gate Voltage Drain Leakage Current (4) ($V_{DS}$ = 66 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current (4) ($V_{DS}$ = 32 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 1 | μAdc |
| Gate-Source Leakage Current ($V_{GS}$ = 5 Vdc, $V_{DS}$ = 0 Vdc) | $I_{GSS}$ | — | — | 1 | μAdc |
| **On Characteristics** (1) | | | | | |
| Gate Threshold Voltage ($V_{DS}$ = 10 Vdc, $I_D$ = 350 μAdc) | $V_{GS(th)}$ | 1 | 2.2 | 3 | Vdc |
| Gate Quiescent Voltage (3) ($V_{DD}$ = 32 Vdc, $I_D$ = 1600 mAdc, Measured in Functional Test) | $V_{GS(Q)}$ | 2 | 2.8 | 4 | Vdc |
| Drain-Source On-Voltage ($V_{GS}$ = 10 Vdc, $I_D$ = 2.4 Adc) | $V_{DS(on)}$ | — | 0.22 | 0.3 | Vdc |
| **Dynamic Characteristics** (1,2) | | | | | |
| Reverse Transfer Capacitance (4) ($V_{DS}$ = 32 Vdc ± 30 mV(rms)ac @ 1 MHz, $V_{GS}$ = 0 Vdc) | $C_{rss}$ | — | 1.22 | — | pF |
| Output Capacitance (4) ($V_{DS}$ = 32 Vdc ± 30 mV(rms)ac @ 1 MHz, $V_{GS}$ = 0 Vdc) | $C_{oss}$ | — | 217 | — | pF |
| Input Capacitance (1) ($V_{DS}$ = 32 Vdc, $V_{GS}$ = 0 Vdc ± 30 mV(rms)ac @ 1 MHz) | $C_{iss}$ | — | 1060 | — | pF |
| **Functional Tests** (3) (In Freescale Narrowband Test Fixture, 50 ohm system) $V_{DD}$ = 32 Vdc, $I_{DQ}$ = 1600 mA, $P_{out}$ = 270 W PEP, f1 = 857 MHz, f2 = 863 MHz | | | | | |
| Power Gain | $G_{ps}$ | 19 | 20.4 | 23 | dB |
| Drain Efficiency | $\eta_D$ | 41 | 44.8 | — | % |
| Intermodulation Distortion | IMD | — | -28.8 | -27 | dBc |
| Input Return Loss | IRL | — | -18.4 | -9 | dB |

1. Each side of the device measured separately.
2. Part internally matched both on input and output.
3. Measurement made with device in push-pull configuration.
4. Drains are tied together internally as this is a total device value.




| | | | |
|---|---|---|---|
| Z1 | 0.401″ x 0.081″ Microstrip | Z12, Z13 | 0.225″ x 0.507″ Microstrip |
| Z2, Z3 | 0.563″ x 0.101″ Microstrip | Z14, Z15 | 0.440″ x 0.435″ Microstrip |
| Z4, Z5 | 1.186″ x 0.058″ Microstrip | Z16, Z17 | 0.123″ x 0.215″ Microstrip |
| Z6, Z7 | 0.416″ x 0.727″ Microstrip | Z18 | 0.401″ x 0.081″ Microstrip |
| Z8, Z9 | 0.191″ x 0.507″ Microstrip | Z19, Z20 | 0.339″ x 0.165″ Microstrip |
| Z10, Z11 | 1.306″ x 0.150″ Microstrip | PCB | Arlon CuClad 250GX-0300-55-22, 0.030″, $\varepsilon_r$ = 2.5 |

**Figure 1. 820-900 MHz Narrowband Test Circuit Schematic**

**Table 5. 820-900 MHz Narrowband Test Circuit Component Designations and Values**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| B1, B2 | Ferrite Beads, Short | 2743019447 | Fair-Rite |
| C1, C9 | 1.0 μF, 50 V Tantulum Chip Capacitors | T491C105K050AT | Kemet |
| C2, C7, C17, C21 | 0.1 μF, 50 V Chip Capacitors | CDR33BX104AKYS | Kemet |
| C3, C8, C16, C20 | 1000 pF Chip Capacitors | ATC100B102JT50XT | ATC |
| C4, C5, C13, C14 | 100 pF Chip Capacitors | ATC100B101JT500XT | ATC |
| C6, C12 | 8.2 pF Chip Capacitors | ATC100B8R2JT500XT | ATC |
| C10 | 9.1 pF Chip Capacitor | ATC100B9R1BT500XT | ATC |
| C11 | 1.8 pF Chip Capacitor | ATC100B1R8BT500XT | ATC |
| C15, C19 | 47 μF, 50 V Electrolytic Capacitors | EMVY500ADA470MF80G | Nippon |
| C18, C22 | 470 μF, 63 V Electrolytic Capacitors | ESME630ELL471MK25S | United Chemi-Con |
| C23, C24 | 22 pF Chip Capacitors | ATC100B220FT500XT | ATC |
| Coax1, 2, 3, 4 | 50 Ω, Semi Rigid Coax, 2.06″ Long | UT-141A-TP | Micro-Coax |
| R1, R2 | 10 Ω, 1/4 W Chip Resistors | CRCW120610R0FKEA | Vishay |
| R3 | 1 kΩ, 1/4 W Chip Resistor | CRCW12061001FKEA | Vishay |

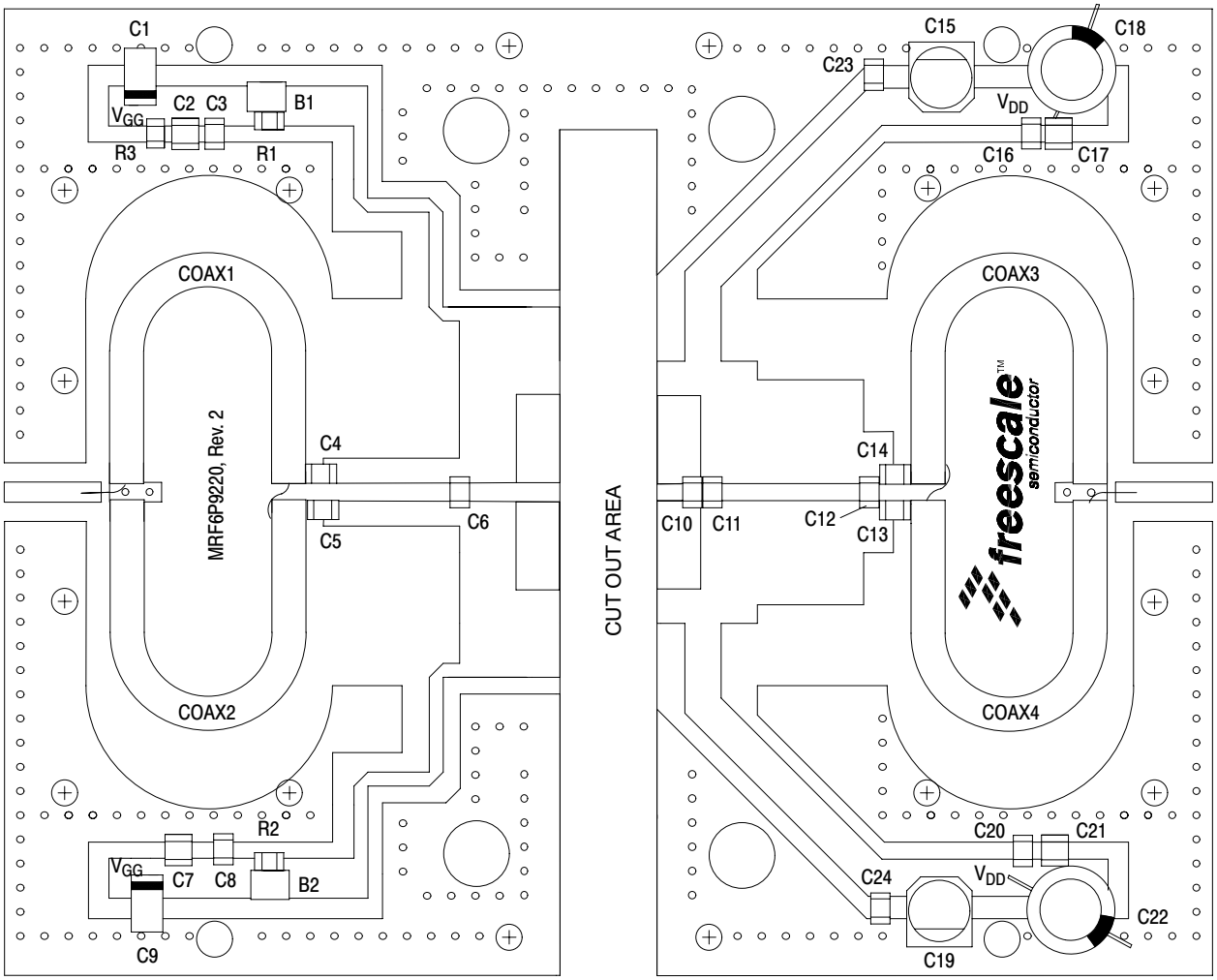



**Figure 2. 820-900 MHz Narrowband Test Circuit Component Layout**

## TYPICAL NARROWBAND CHARACTERISTICS

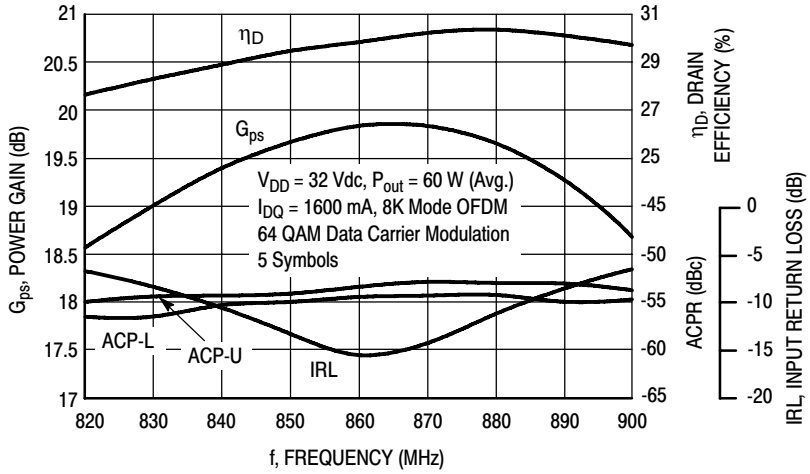



**Figure 3. Single-Carrier OFDM Broadband Performance @ 60 Watts Avg.**

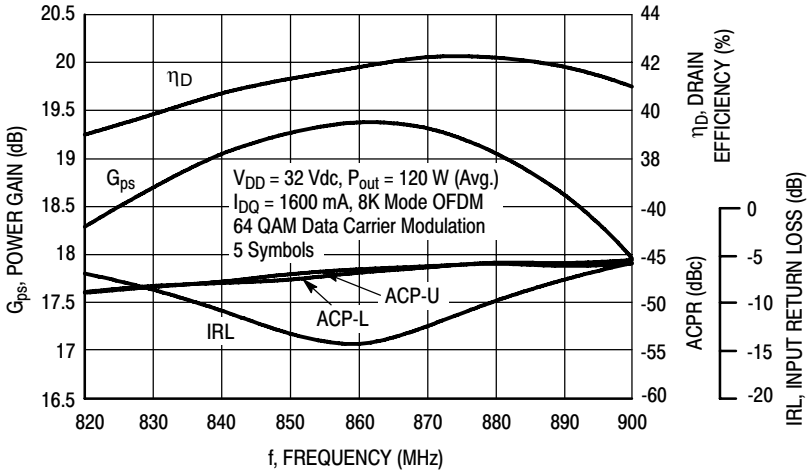



**Figure 4. Single-Carrier OFDM Broadband Performance @ 120 Watts Avg.**

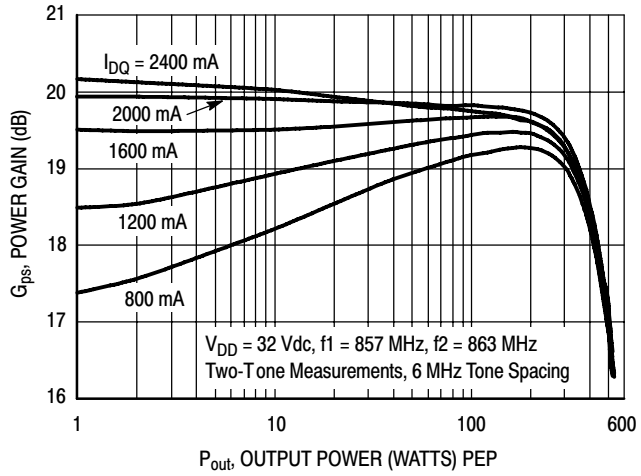



**Figure 5. Two-Tone Power Gain versus Output Power**

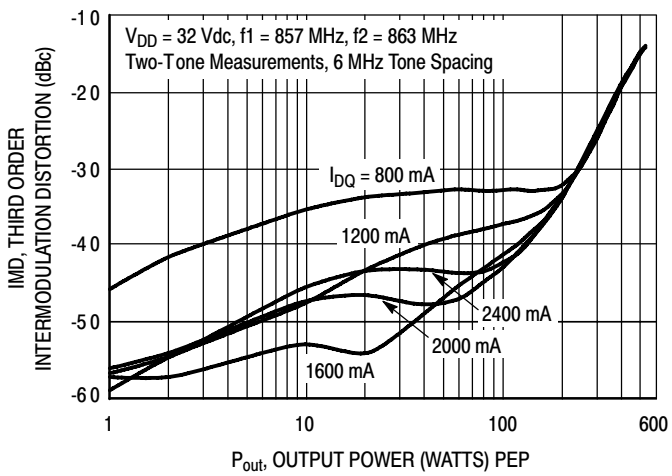



**Figure 6. Third Order Intermodulation Distortion versus Output Power**

## TYPICAL NARROWBAND CHARACTERISTICS

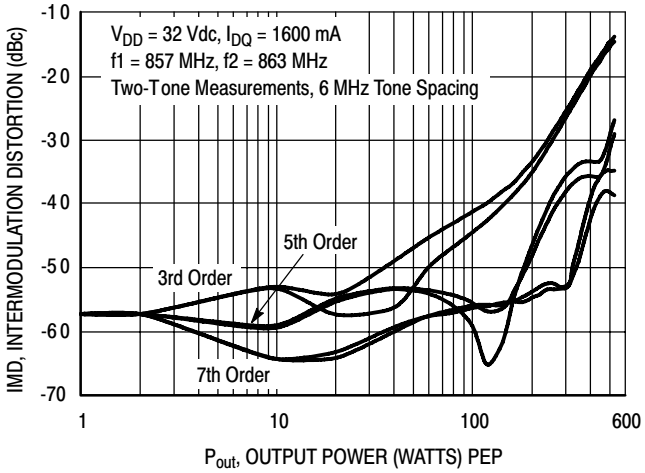



**Figure 7. Intermodulation Distortion Products versus Output Power**

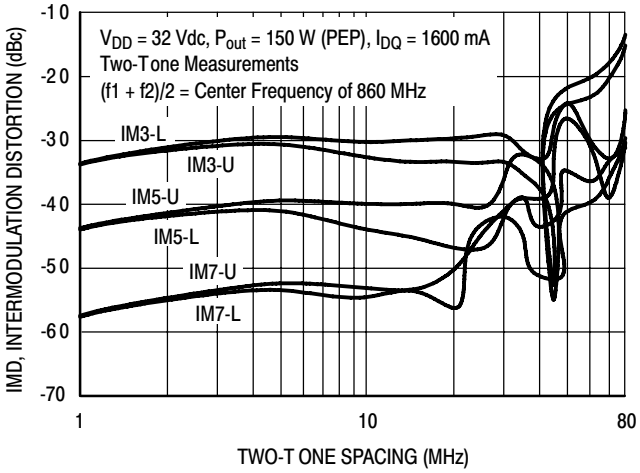



**Figure 8. Intermodulation Distortion Products versus Tone Spacing**

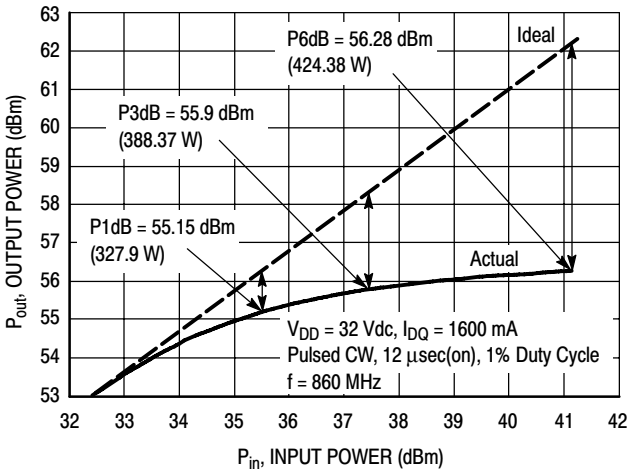



**Figure 9. Pulsed CW Output Power versus Input Power**

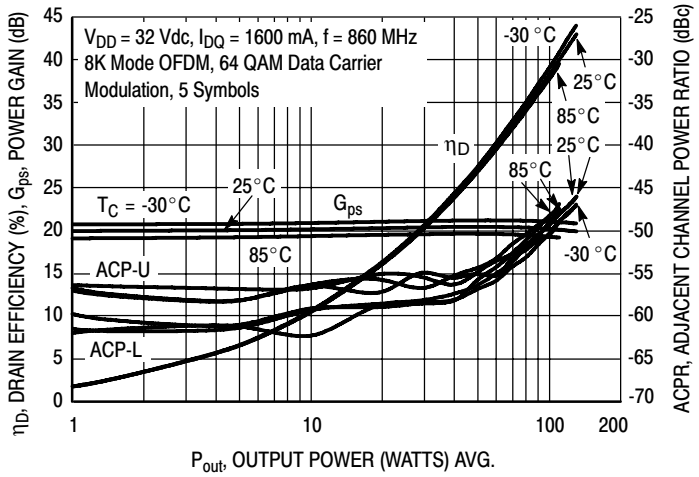



**Figure 10. Single-Carrier DVBT OFDM ACPR, Power Gain and Drain Efficiency versus Output Power**

## TYPICAL NARROWBAND CHARACTERISTICS

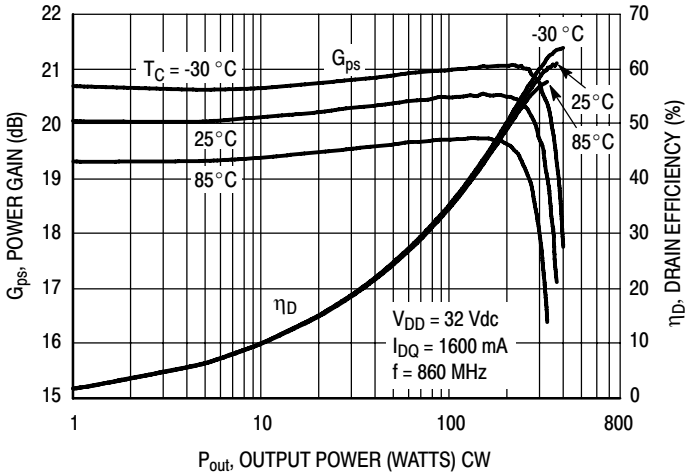



**Figure 11. Power Gain and Drain Efficiency versus CW Output Power**

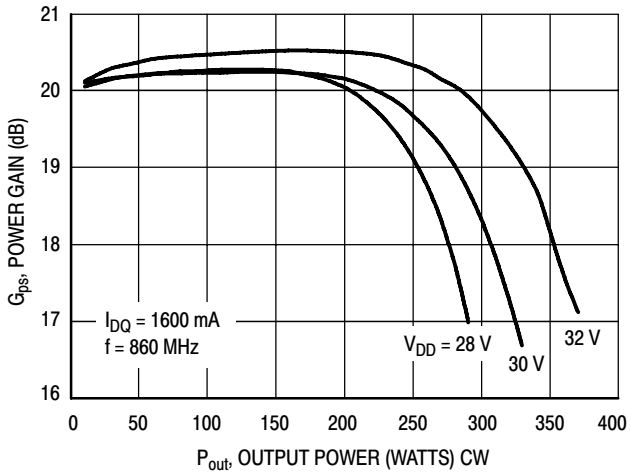
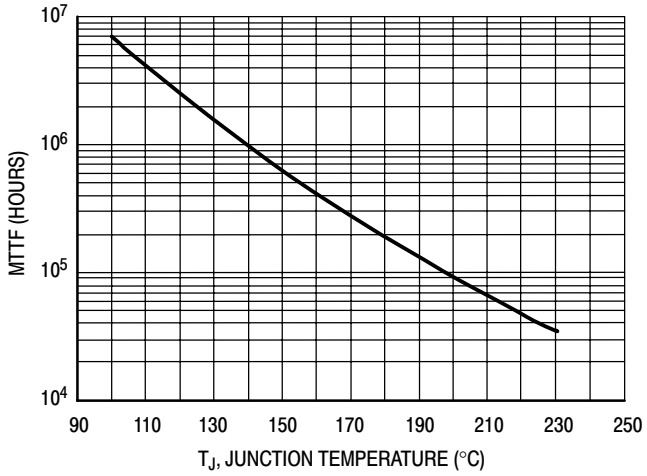



**Figure 12. Power Gain versus Output Power**




This above graph displays calculated MTTF in hours when the device is operated at $V_{DD}$ = 32 Vdc, $P_{out}$ = 270 W PEP, and $\eta_D$ = 44.8%.

MTTF calculator available at http://www.freescale.com/rf. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

**Figure 13. MTTF versus Junction Temperature**

## DIGITAL TEST SIGNALS

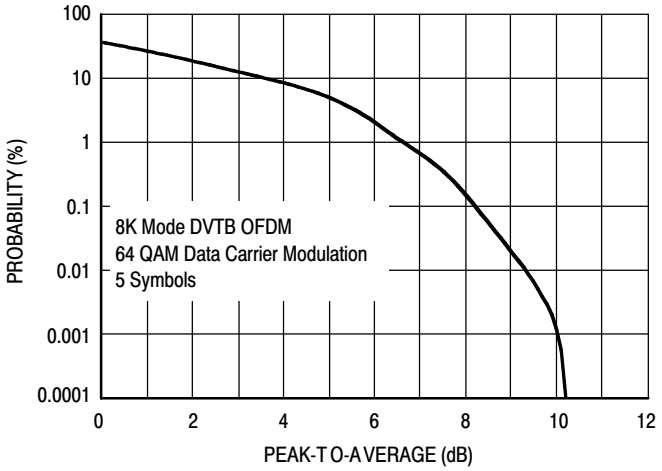



**Figure 14. Single-Carrier DVTB OFDM**

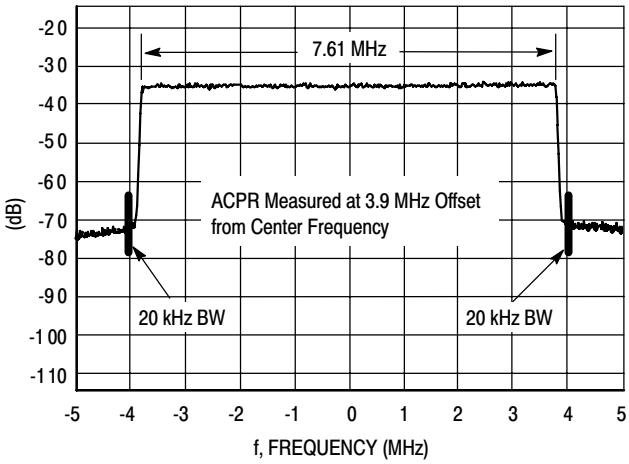
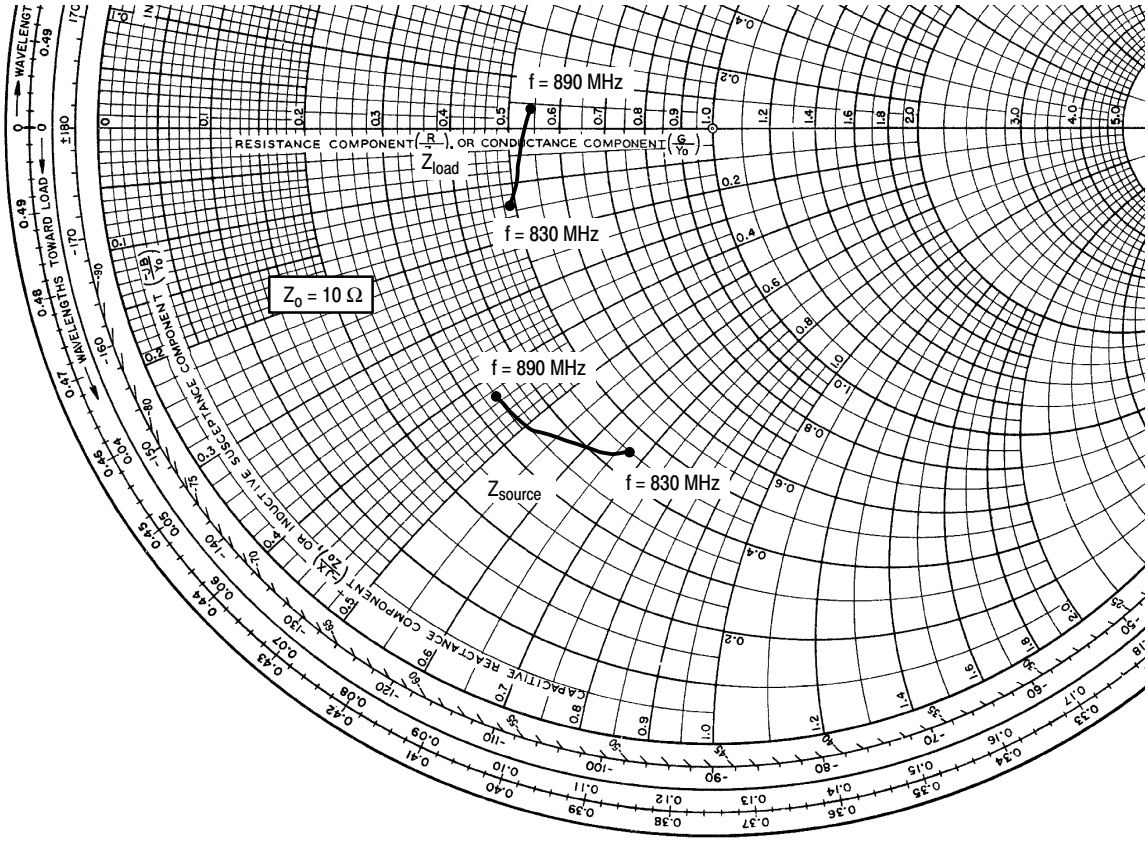



**Figure 15. 8K Mode DVBT OFDM Spectrum**




$V_{DD}$ = 32 Vdc, $I_{DQ}$ = 1600 mA, $P_{out}$ = 270 W PEP

| f MHz | $Z_{source}$ Ω | $Z_{load}$ Ω |
|---|---|---|
| 830 | 4.52 - j6.73 | 4.89 - j1.35 |
| 845 | 4.22 - j6.38 | 5.06 - j1.01 |
| 860 | 3.89 - j5.81 | 5.18 - j0.58 |
| 875 | 3.54 - j5.10 | 5.27 - j0.11 |
| 890 | 3.39 - j4.32 | 5.36 + j0.43 |

$Z_{source}$ = Test circuit impedance as measured from gate to gate, balanced configuration.

$Z_{load}$ = Test circuit impedance as measured from drain to drain, balanced configuration.

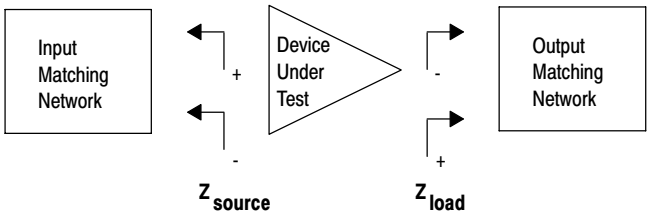
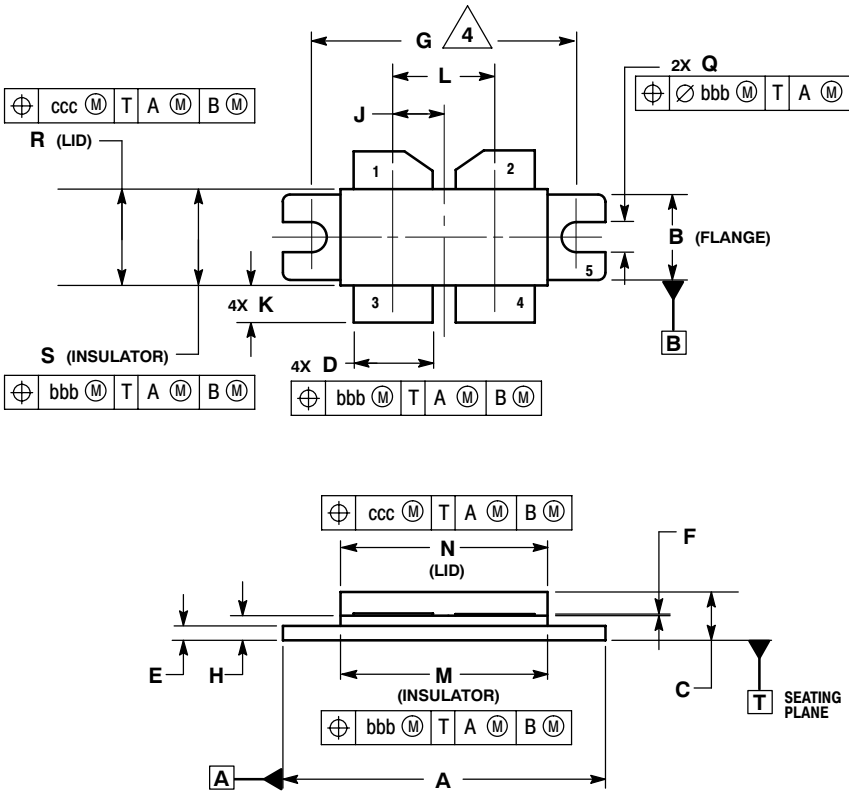



**Figure 16. 820-900 MHz Narrowband Series Equivalent Source and Load Impedance**

## PACKAGE DIMENSIONS




NOTES:
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DIMENSION H TO BE MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
4. RECOMMENDED BOLT CENTER DIMENSION OF 1.140 (28.96) BASED ON 3M SCREW.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 1.335 | 1.345 | 33.91 | 34.16 |
| B | 0.380 | 0.390 | 9.65 | 9.91 |
| C | 0.180 | 0.224 | 4.57 | 5.69 |
| D | 0.325 | 0.335 | 8.26 | 8.51 |
| E | 0.060 | 0.070 | 1.52 | 1.78 |
| F | 0.004 | 0.006 | 0.10 | 0.15 |
| G | 1.100 BSC | | 27.94 BSC | |
| H | 0.097 | 0.107 | 2.46 | 2.72 |
| J | 0.2125 BSC | | 5.397 BSC | |
| K | 0.135 | 0.165 | 3.43 | 4.19 |
| L | 0.425 BSC | | 10.8 BSC | |
| M | 0.852 | 0.868 | 21.64 | 22.05 |
| N | 0.851 | 0.869 | 21.62 | 22.07 |
| Q | 0.118 | 0.138 | 3.00 | 3.30 |
| R | 0.395 | 0.405 | 10.03 | 10.29 |
| S | 0.394 | 0.406 | 10.01 | 10.31 |
| bbb | 0.010 REF | | 0.25 REF | |
| ccc | 0.015 REF | | 0.38 REF | |

STYLE 1:
PIN 1. DRAIN
2. DRAIN
3. GATE
4. GATE
5. SOURCE

**CASE 375G-04**
**ISSUE G**
**NI-860C3**

## 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 |
|---|---|---|
| 0 | May 2007 | • Initial Release of Data Sheet |
| 1 | Dec. 2008 | • Table 4, Dynamic Characteristics, corrected $C_{iss}$ test condition to indicate AC stimulus on the $V_{GS}$ connection versus the $V_{DS}$ connection, corrected Typ value from 106 to 1060 pF, p. 2<br>• Fig. 1, Test Circuit Schematic, Z-list, changed Z4, Z5 from 1.013″ x 0.058″ Microstrip to 1.186″ x 0.058″ Microstrip; Z10, Z11 from 1.054″ x 0.150″ Microstrip to 1.306″ x 0.150″ Microstrip; and Z19, Z20 from 0.165″ x 0.339″ Microstrip to 0.339″ x 0.165″ Microstrip; also separated Z1 and Z18 into two lines in Z-list, p. 3<br>• Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3<br>• Updated Part Numbers in Table 5, Component Designations and Values, to latest RoHS compliant part numbers, p. 3 |
| 2 | Dec. 2009 | • Data sheet revised to reflect part status change, removing MRFE6P3300HR5. Refer to PCN13420. (See Rev. 1 data sheet for MRFE6P3300HR5.) |

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