

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for N-CDMA, GSM and GSM EDGE base station applications with frequencies from 865 to 960 MHz. Suitable for multicarrier amplifier applications.

- Typical Single-Carrier N-CDMA. Performance @ 880 MHz: $V_{DD} = 28$ Volts, $I_{DQ} = 1200$ mA, $P_{out} = 35$ 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 — 21 dB
 Drain Efficiency — 31%
 ACPR @ 750 kHz Offset — -46.8 dBc in 30 kHz Bandwidth
- Capable of Handling 10:1 VSWR, @ 32 Vdc, 880 MHz, 3 dB Overdrive, Designed for Enhanced Ruggedness.

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
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRFE6S9160HR3
MRFE6S9160HSR3

880 MHz, 35 W AVG., 28 V
SINGLE N-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs

CASE 465-06, STYLE 1
NI-780
MRFE6S9160HR3

CASE 465A-06, STYLE 1
NI-780S
MRFE6S9160HSR3

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 Case Temperature 81°C, 160 W CW Case Temperature 73°C, 35 W CW | $R_{\theta JC}$ | 0.31 0.33 | °C/W |

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.

Table 3. ESD Protection Characteristics

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

Table 4. 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 ($V_{DS} = 66\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | 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 ($V_{DS} = 10\text{ Vdc}$, $I_D = 525\ \mu\text{Adc}$) | $V_{GS(th)}$ | 1 | 2 | 3 | Vdc |
| Gate Quiescent Voltage ($V_{DS} = 28\text{ Vdc}$, $I_D = 1200\ \text{mAdc}$) | $V_{GS(Q)}$ | — | 3 | — | Vdc |
| Fixture Gate Quiescent Voltage ⁽¹⁾ ($V_{DD} = 28\text{ Vdc}$, $I_D = 1200\ \text{mAdc}$, Measured in Functional Test) | $V_{GG(Q)}$ | 2.1 | 3.17 | 4.22 | Vdc |
| Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 3.6\ \text{Adc}$) | $V_{DS(on)}$ | 0.1 | 0.175 | 0.3 | Vdc |

Dynamic Characteristics ⁽²⁾

| | | | | | |
|--|-----------|---|------|---|----|
| Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\ \text{mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{rss} | — | 2.2 | — | pF |
| Output Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\ \text{mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{oss} | — | 80.2 | — | pF |

Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1200\ \text{mA}$, $P_{out} = 35\ \text{W Avg. N-CDMA}$, $f = 880\ \text{MHz}$, 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.

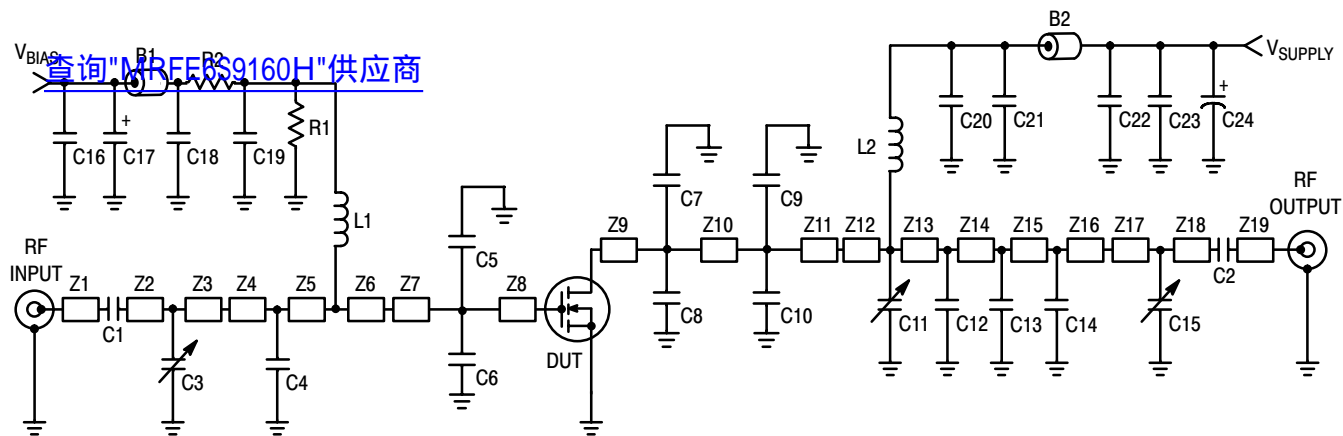
| | | | | | |
|------------------------------|----------|----|-------|-----|-----|
| Power Gain | G_{ps} | 20 | 21 | 23 | dB |
| Drain Efficiency | η_D | 29 | 31 | — | % |
| Adjacent Channel Power Ratio | ACPR | — | -46.8 | -45 | dBc |
| Input Return Loss | IRL | — | -17 | -9 | dB |

- $V_{GG} = 19/18 \times V_{GS(Q)}$. Parameter measured on Freescale Test Fixture, due to resistive divider network on the board. Refer to Test Circuit schematic.
- Part is internally matched on input.

(continued)

Table 4. Electrical Characteristics ($T_C = 25^\circ\text{C}$ unless otherwise noted) (continued)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|------------------|-----|-------|-----|-----------------------|
| Typical Performances (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1200\text{ mA}$, 865-900 MHz Bandwidth | | | | | |
| Video Bandwidth @ 160 W PEP P_{out} where $IM3 = -30\text{ dBc}$ (Tone Spacing from 100 kHz to VBW) $\Delta IMD3 = IMD3 @ \text{VBW frequency} - IMD3 @ 100\text{ kHz} < 1\text{ dBc}$ (both sidebands) | VBW | — | 10 | — | MHz |
| Gain Flatness in 35 MHz Bandwidth @ $P_{out} = 35\text{ W Avg.}$ | G_F | — | 0.5 | — | dB |
| Gain Variation over Temperature (-30°C to $+85^\circ\text{C}$) | ΔG | — | 0.016 | — | dB/ $^\circ\text{C}$ |
| Output Power Variation over Temperature (-30°C to $+85^\circ\text{C}$) | ΔP_{1dB} | — | 0.008 | — | dBm/ $^\circ\text{C}$ |



| | | | |
|-----|--------------------------------|-----|--|
| Z1 | 0.426" x 0.080" Microstrip | Z11 | 0.066" x 0.630" Microstrip |
| Z2 | 0.813" x 0.080" Microstrip | Z12 | 0.630" x 0.425" x 0.220" Taper |
| Z3 | 0.471" x 0.080" Microstrip | Z13 | 0.120" x 0.220" Microstrip |
| Z4 | 0.319" x 0.220" Microstrip | Z14 | 0.292" x 0.220" Microstrip |
| Z5 | 0.171" x 0.220" Microstrip | Z15 | 0.023" x 0.220" Microstrip |
| Z6 | 0.200" x 0.425" x 0.630" Taper | Z16 | 0.030" x 0.220" Microstrip |
| Z7 | 0.742" x 0.630" Microstrip | Z17 | 0.846" x 0.080" Microstrip |
| Z8 | 0.233" x 0.630" Microstrip | Z18 | 0.440" x 0.080" Microstrip |
| Z9 | 0.128" x 0.630" Microstrip | Z19 | 0.434" x 0.080" Microstrip |
| Z10 | 0.134" x 0.630" Microstrip | PCB | Arlon CuClad 250GX-0300-55-22, 0.030", $\epsilon_r = 2.55$ |

Figure 1. MRFE6S9160HR3(SR3) Test Circuit Schematic

Table 5. MRFE6S9160HR3(SR3) Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|---------------|--|--------------------|------------------|
| B1, B2 | Ferrite Beads, Small | 2743019447 | Fair Rite |
| C1, C2, C19 | 47 pF Chip Capacitors | ATC100B470JT500XT | ATC |
| C3, C11 | 0.8-8.0 pF Variable Capacitors, Gigatrim | 27291SL | Johanson |
| C4 | 2.7 pF Chip Capacitor | ATC100B2R7JT500XT | ATC |
| C5, C6 | 15 pF Chip Capacitors | ATC100B150JT500XT | ATC |
| C7, C8 | 12 pF Chip Capacitors | ATC100B120JT500XT | ATC |
| C9, C10 | 4.3 pF Chip Capacitors | ATC100B4R3JT500XT | ATC |
| C12 | 8.2 pF Chip Capacitor | ATC100B8R2JT500XT | ATC |
| C13, C14 | 3.9 pF Chip Capacitors | ATC100B3R9JT500XT | ATC |
| C15 | 0.6-4.5 pF Variable Capacitor, Gigatrim | 27271SL | Johanson |
| C16 | 22 pF Chip Capacitor | ATC100B220JT500XT | ATC |
| C17 | 1 μ F, 50 V Tantalum Capacitor | T491C105K0J0AT | Kemet |
| C18 | 20K pF Chip Capacitor | CDR35BP203AKYS | Kemet |
| C20 | 180 pF Chip Capacitor | ATC100B181JT500XT | ATC |
| C21, C22, C23 | 10 μ F, 50 V Chip Capacitors | GRM55DR61H106KA88B | Murata |
| C24 | 470 μ F, 63 V Electrolytic Capacitor | ESME630ELL471MK25S | United Chemi-Con |
| L1, L2 | 10 nH Inductors | 0603HC | Coilcraft |
| R1 | 180 Ω , 1/4 W Chip Resistor | CRCW12061800FKEA | Vishay |
| R2 | 10 Ω , 1/4 W Chip Resistor | CRCW120610R0FKEA | Vishay |

查询"MRFE6S9160HR3"供应商

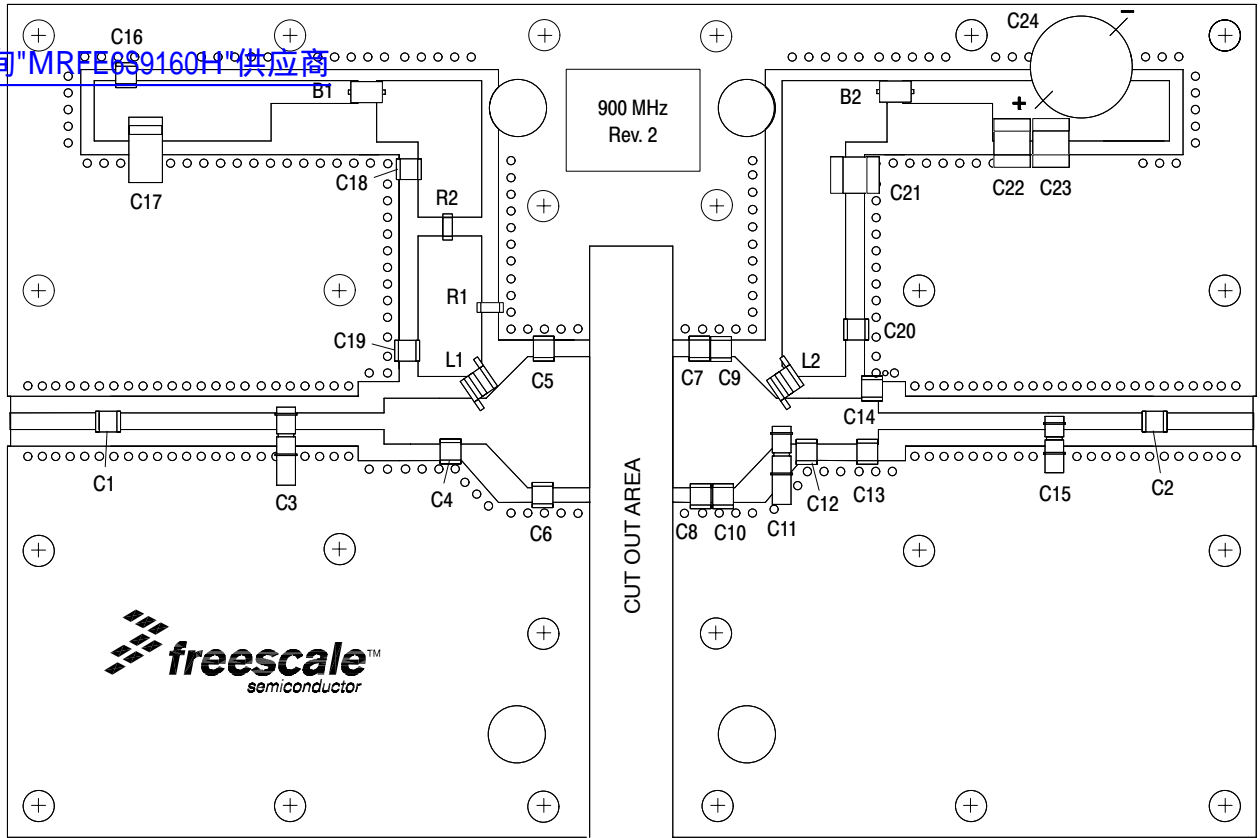


Figure 2. MRFE6S9160HR3(SR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

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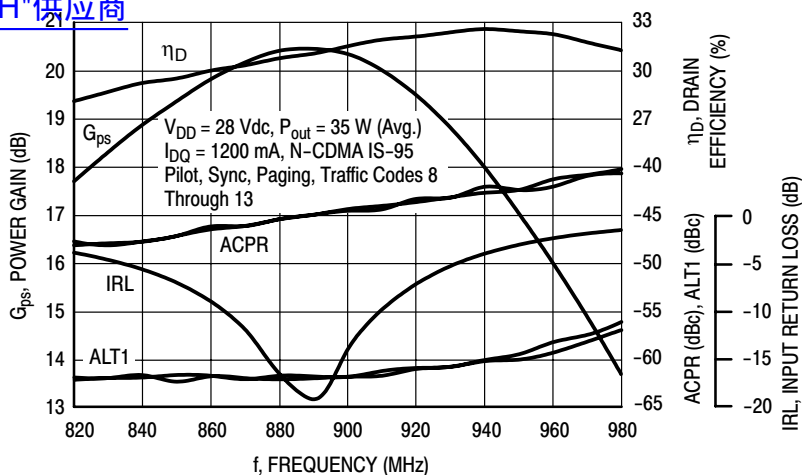


Figure 3. Single-Carrier N-CDMA Broadband Performance @ $P_{out} = 35$ Watts Avg.

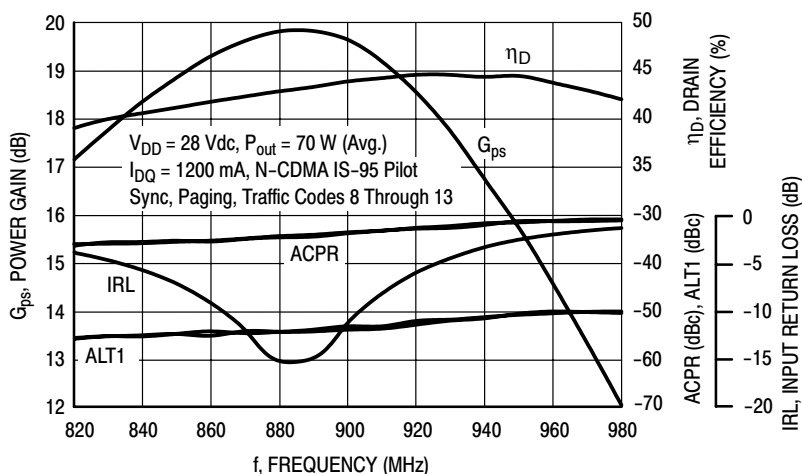


Figure 4. Single-Carrier N-CDMA Broadband Performance @ $P_{out} = 70$ Watts Avg.

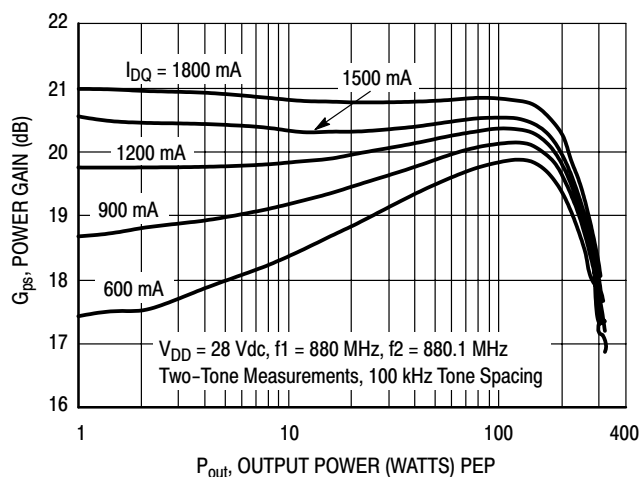


Figure 5. Two-Tone Power Gain versus Output Power

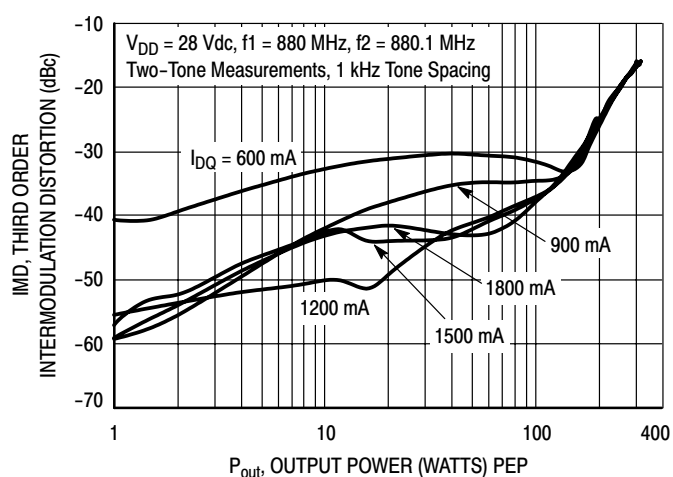


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

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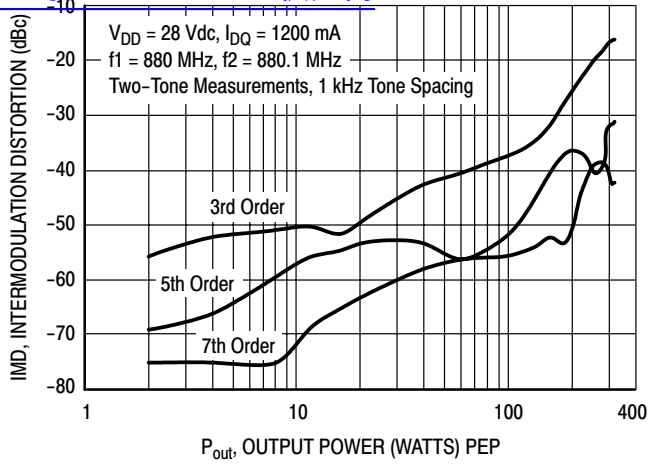


Figure 7. Intermodulation Distortion Products versus Output Power

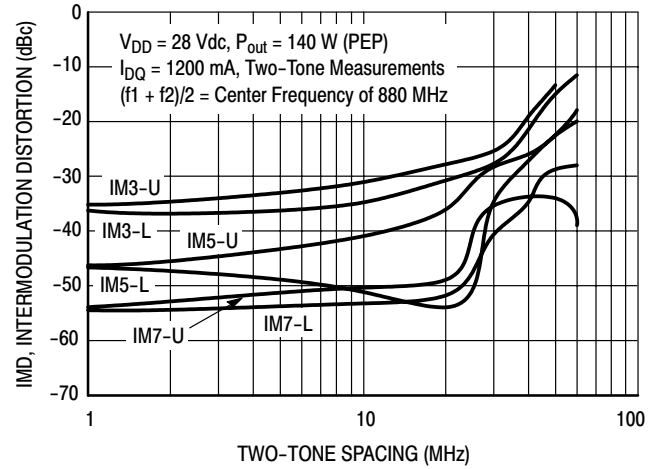


Figure 8. Intermodulation Distortion Products versus Tone Spacing

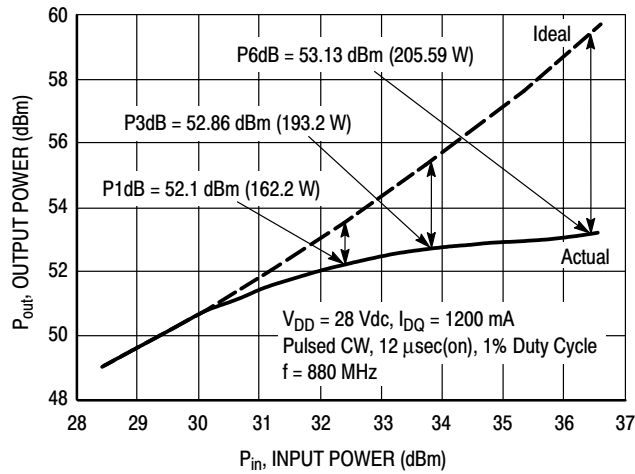


Figure 9. Pulsed CW Output Power versus Input Power

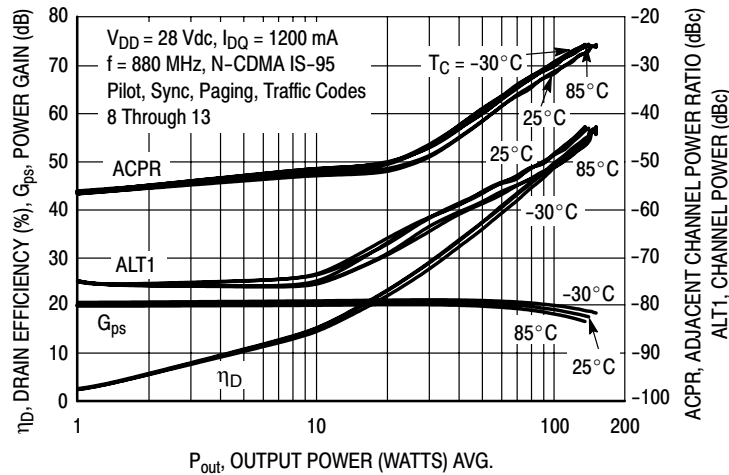


Figure 10. Single-Carrier N-CDMA ACPR, ALT1, Power Gain and Drain Efficiency versus Output Power

TYPICAL CHARACTERISTICS

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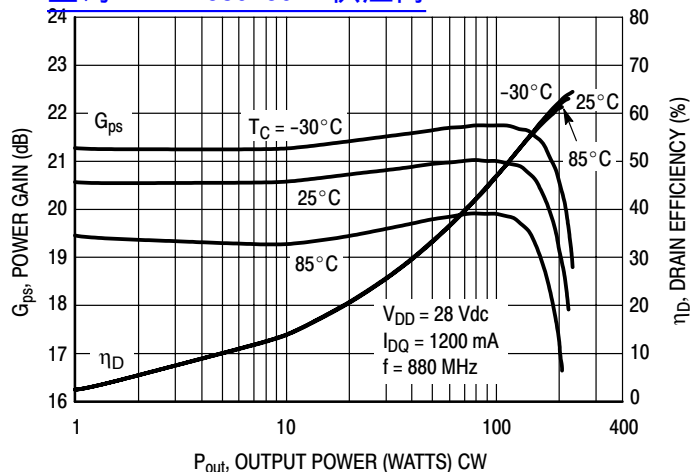


Figure 11. Power Gain and Drain Efficiency versus CW Output Power

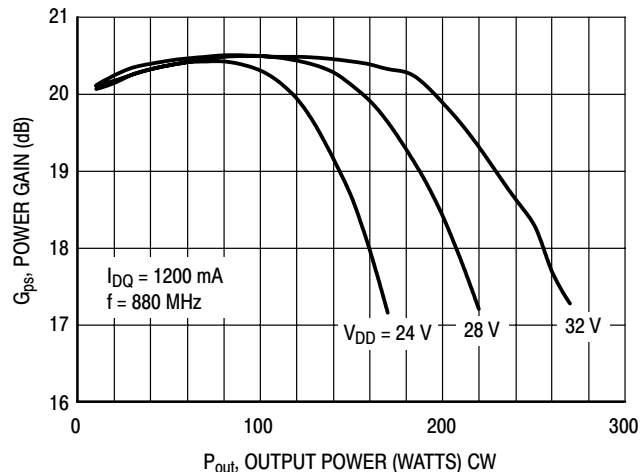
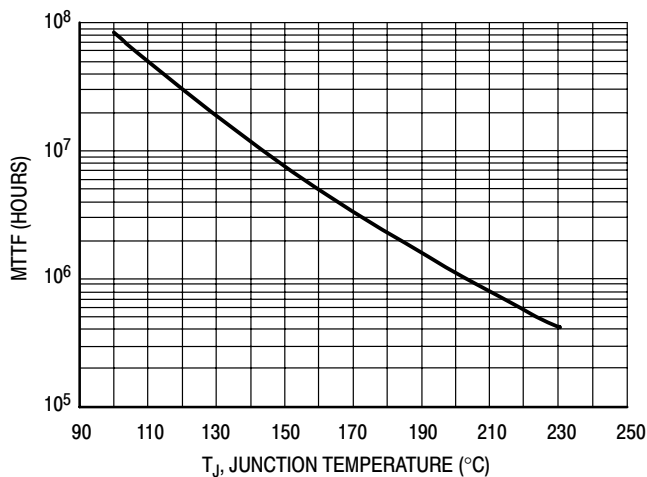


Figure 12. Power Gain versus Output Power



This above graph displays calculated MTTF in hours when the device is operated at $V_{DD} = 28 \text{ Vdc}$, $P_{out} = 35 \text{ W Avg.}$, and $\eta_D = 31\%$.

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

N-CDMA TEST SIGNAL

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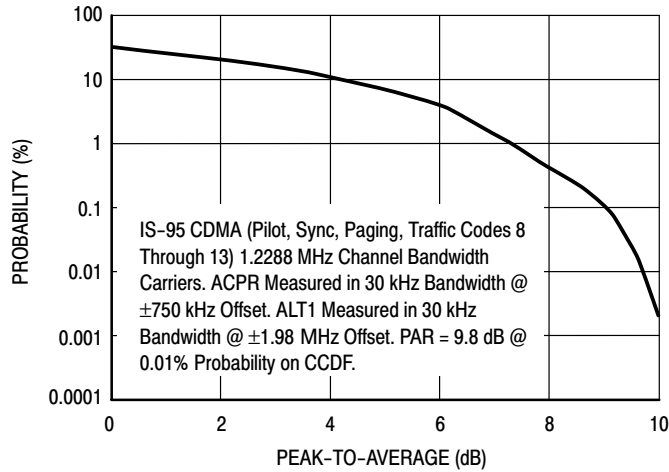


Figure 14. Single-Carrier CCDF N-CDMA

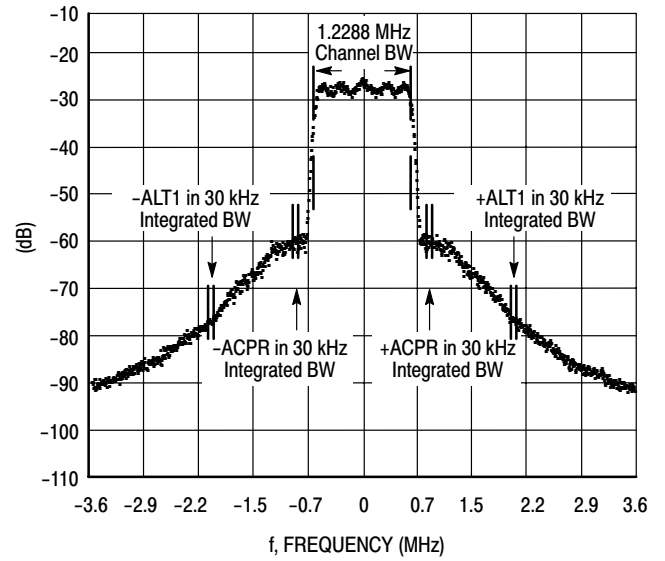
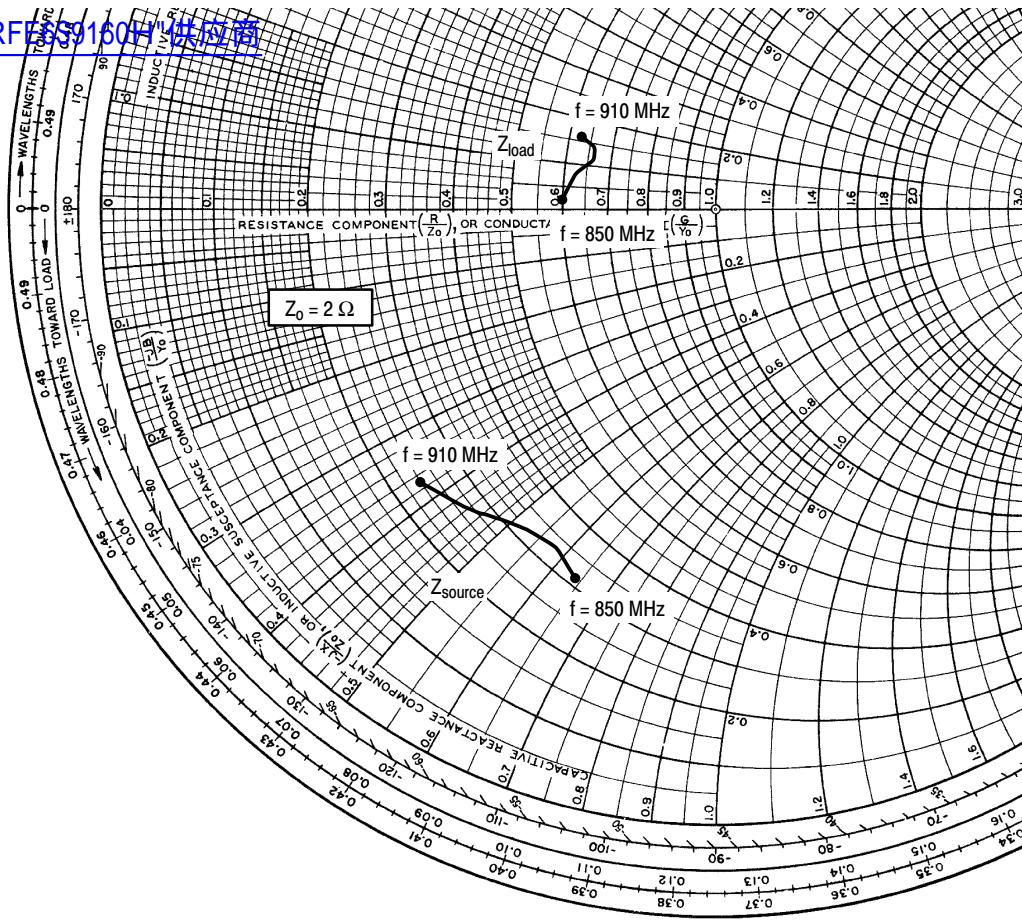


Figure 15. Single-Carrier N-CDMA Spectrum



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1200 \text{ mA}$, $P_{out} = 35 \text{ W Avg.}$

| f MHz | Z_{source} Ω | Z_{load} Ω |
|-------|-----------------------|---------------------|
| 850 | $0.61 - j1.27$ | $1.20 + j0.03$ |
| 865 | $0.66 - j1.15$ | $1.26 + j0.15$ |
| 880 | $0.64 - j1.05$ | $1.31 + j0.22$ |
| 895 | $0.55 - j0.90$ | $1.32 + j0.28$ |
| 910 | $0.48 - j0.74$ | $1.26 + j0.32$ |

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

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

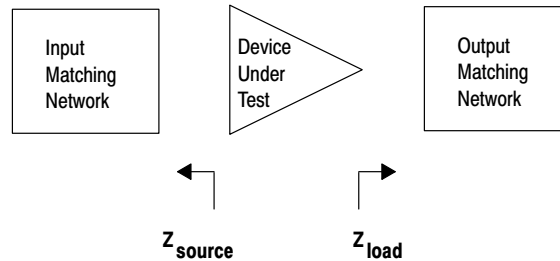
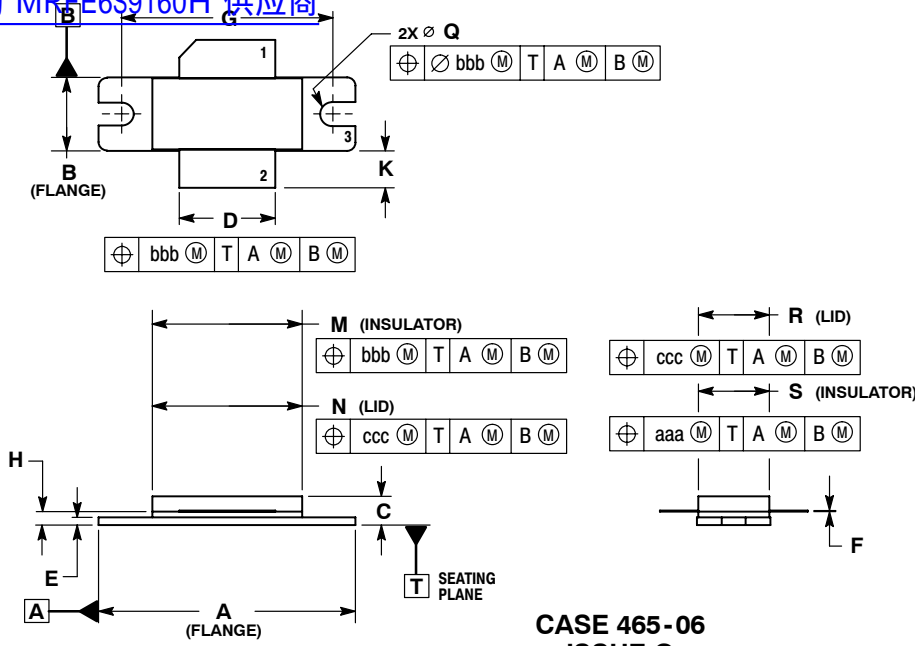


Figure 16. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS

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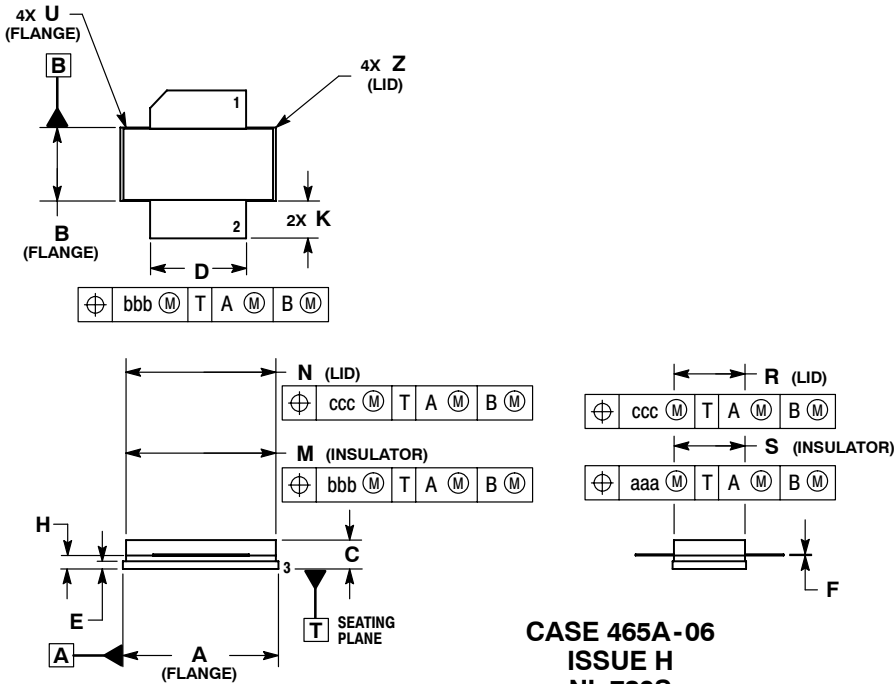


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
 2. CONTROLLING DIMENSION: INCH.
 3. DELETED
 4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 1.335 | 1.345 | 33.91 | 34.16 |
| B | 0.380 | 0.390 | 9.65 | 9.91 |
| C | 0.125 | 0.170 | 3.18 | 4.32 |
| D | 0.495 | 0.505 | 12.57 | 12.83 |
| E | 0.035 | 0.045 | 0.89 | 1.14 |
| F | 0.003 | 0.006 | 0.08 | 0.15 |
| G | 1.100 BSC | | 27.94 BSC | |
| H | 0.057 | 0.067 | 1.45 | 1.70 |
| K | 0.170 | 0.210 | 4.32 | 5.33 |
| M | 0.774 | 0.786 | 19.66 | 19.96 |
| N | 0.772 | 0.788 | 19.60 | 20.00 |
| Q | ∅.118 | ∅.138 | ∅3.00 | ∅3.51 |
| R | 0.365 | 0.375 | 9.27 | 9.53 |
| S | 0.365 | 0.375 | 9.27 | 9.52 |
| aaa | 0.005 REF | | 0.127 REF | |
| bbb | 0.010 REF | | 0.254 REF | |
| ccc | 0.015 REF | | 0.381 REF | |

- STYLE 1:
1. DRAIN
 2. GATE
 3. SOURCE

**CASE 465-06
ISSUE G
NI-780
MRFE6S9160HR3**



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
 2. CONTROLLING DIMENSION: INCH.
 3. DELETED
 4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.805 | 0.815 | 20.45 | 20.70 |
| B | 0.380 | 0.390 | 9.65 | 9.91 |
| C | 0.125 | 0.170 | 3.18 | 4.32 |
| D | 0.495 | 0.505 | 12.57 | 12.83 |
| E | 0.035 | 0.045 | 0.89 | 1.14 |
| F | 0.003 | 0.006 | 0.08 | 0.15 |
| H | 0.057 | 0.067 | 1.45 | 1.70 |
| K | 0.170 | 0.210 | 4.32 | 5.33 |
| M | 0.774 | 0.786 | 19.61 | 20.02 |
| N | 0.772 | 0.788 | 19.61 | 20.02 |
| R | 0.365 | 0.375 | 9.27 | 9.53 |
| S | 0.365 | 0.375 | 9.27 | 9.52 |
| U | --- | 0.040 | --- | 1.02 |
| Z | --- | 0.030 | --- | 0.76 |
| aaa | 0.005 REF | | 0.127 REF | |
| bbb | 0.010 REF | | 0.254 REF | |
| ccc | 0.015 REF | | 0.381 REF | |

- STYLE 1:
1. DRAIN
 2. GATE
 3. SOURCE

**CASE 465A-06
ISSUE H
NI-780S
MRFE6S9160HSR3**

MRFE6S9160HR3 MRFE6S9160HSR3

PRODUCT DOCUMENTATION

[查询"MRFE6S9160H"供应商](#)

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 | Mar. 2007 | <ul style="list-style-type: none">• Initial Release of Data Sheet |
| 1 | Dec. 2008 | <ul style="list-style-type: none">• Table 4, On Characteristics, tightened $V_{DS(on)}$ Min value from 0.05 to 0.1 to match production test values, p. 2• Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 4• Updated Part Numbers in Table 5, Component Designations and Values, to latest RoHS compliant part numbers, p. 4• Adjust scale for Fig. 8, Intermodulation Distortion Products versus Tone Spacing, to show wider dynamic range, p. 7 |

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Europe, Middle East, and Africa:

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+44 1296 380 456 (English)
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Japan:

Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:

Freescale Semiconductor China Ltd.
Exchange Building 23F
No. 118 Jianguo Road
Chaoyang District
Beijing 100022
China
+86 10 5879 8000
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