Document Number: MRF8S26120H
Rev. 0, 6/2010

RoHS

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

**MRF8S26120HR3**
**MRF8S26120HSR3**

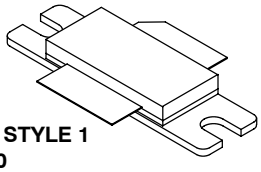
**2620-2690 MHz, 28 W AVG., 28 V**
**W-CDMA, LTE**
**LATERAL N-CHANNEL**
**RF POWER MOSFETs**

Designed for W-CDMA and LTE base station applications with frequencies from 2620 to 2690 MHz. Can be used in Class AB and Class C for all typical cellular base station modulation formats.

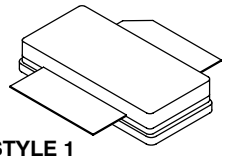
- Typical Single-Carrier W-CDMA Performance: $V_{DD}$ = 28 Volts, $I_{DQ}$ = 900 mA, $P_{out}$ = 28 Watts Avg., IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.

| Frequency | $G_{ps}$ (dB) | $\eta_D$ (%) | Output PAR (dB) | ACPR (dBc) |
|---|---|---|---|---|
| 2620 MHz | 15.5 | 31.5 | 6.3 | -38.0 |
| 2655 MHz | 15.5 | 31.1 | 6.3 | -37.3 |
| 2690 MHz | 15.6 | 31.1 | 6.2 | -36.7 |

- Capable of Handling 10:1 VSWR, @ 32 Vdc, 2655 MHz, 135 Watts CW Output Power (3 dB Input Overdrive from Rated $P_{out}$)
- Typical $P_{out}$ @ 1 dB Compression Point ≃ 110 Watts CW



**CASE 465-06, STYLE 1**
**NI-780**
**MRF8S26120HR3**



**CASE 465A-06, STYLE 1**
**NI-780S**
**MRF8S26120HSR3**

**Features**

- 100% PAR Tested for Guaranteed Output Power Capability
- Characterized with Series Equivalent Large-Signal Impedance Parameters and Common Source S-Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Designed for Digital Predistortion Error Correction Systems
- Optimized for Doherty Applications
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**Table 1. Maximum Ratings**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | -0.5, +65 | Vdc |
| Gate-Source Voltage | $V_{GS}$ | -6.0, +10 | Vdc |
| Operating Voltage | $V_{DD}$ | 32, +0 | 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 |
| CW Operation @ $T_C$ = 25°C<br>Derate above 25°C | CW | 141<br>0.78 | W<br>W/°C |

**Table 2. Thermal Characteristics**

| Characteristic | Symbol | Value (2,3) | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case<br>Case Temperature 72°C, 28 W CW, 28 Vdc, $I_{DQ}$ = 900 mA, 2690 MHz<br>Case Temperature 85°C, 110 W CW(4), 28 Vdc, $I_{DQ}$ = 900 mA, 2690 MHz | $R_{\theta JC}$ | <br>0.53<br>0.47 | °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.
4. Exceeds recommended operating conditions. See CW operation data in Maximum Ratings table.



freescale semiconductor

**Table 3. ESD Protection Characteristics**

| Test Methodology | Class |
|---|---|
| Human Body Model (per JESD22-A114) | 2 (Minimum) |
| Machine Model (per EIA/JESD22-A115) | A (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** | | | | | |
| Zero Gate Voltage Drain Leakage Current ($V_{DS}$ = 65 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS}$ = 28 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** | | | | | |
| Gate Threshold Voltage ($V_{DS}$ = 10 Vdc, $I_D$ = 172 μAdc) | $V_{GS(th)}$ | 1.2 | 2.0 | 2.7 | Vdc |
| Gate Quiescent Voltage ($V_{DD}$ = 28 Vdc, $I_D$ = 900 mAdc, Measured in Functional Test) | $V_{GS(Q)}$ | 1.5 | 2.6 | 3.0 | Vdc |
| Drain-Source On-Voltage ($V_{GS}$ = 10 Vdc, $I_D$ = 1.7 Adc) | $V_{DS(on)}$ | 0.1 | 0.24 | 0.3 | Vdc |

**Functional Tests** (1) (In Freescale Test Fixture, 50 ohm system) $V_{DD}$ = 28 Vdc, $I_{DQ}$ = 900 mA, $P_{out}$ = 28 W Avg., f = 2690 MHz, Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset.

| | | | | | |
|---|---|---|---|---|---|
| Power Gain | $G_{ps}$ | 14.5 | 15.6 | 17.5 | dB |
| Drain Efficiency | $\eta_D$ | 28.0 | 31.1 | — | % |
| Output Peak-to-Average Ratio @ 0.01% Probability on CCDF | PAR | 5.7 | 6.2 | — | dB |
| Adjacent Channel Power Ratio | ACPR | — | -36.7 | -34.5 | dBc |
| Input Return Loss | IRL | — | -14 | -9 | dB |

**Typical Broadband Performance** (In Freescale Test Fixture, 50 ohm system) $V_{DD}$ = 28 Vdc, $I_{DQ}$ = 900 mA, $P_{out}$ = 28 W Avg., Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset.

| Frequency | $G_{ps}$ (dB) | $\eta_D$ (%) | Output PAR (dB) | ACPR (dBc) | IRL (dB) |
|---|---|---|---|---|---|
| 2620 MHz | 15.5 | 31.5 | 6.3 | -38.0 | -13 |
| 2655 MHz | 15.5 | 31.1 | 6.3 | -37.3 | -14 |
| 2690 MHz | 15.6 | 31.1 | 6.2 | -36.7 | -14 |

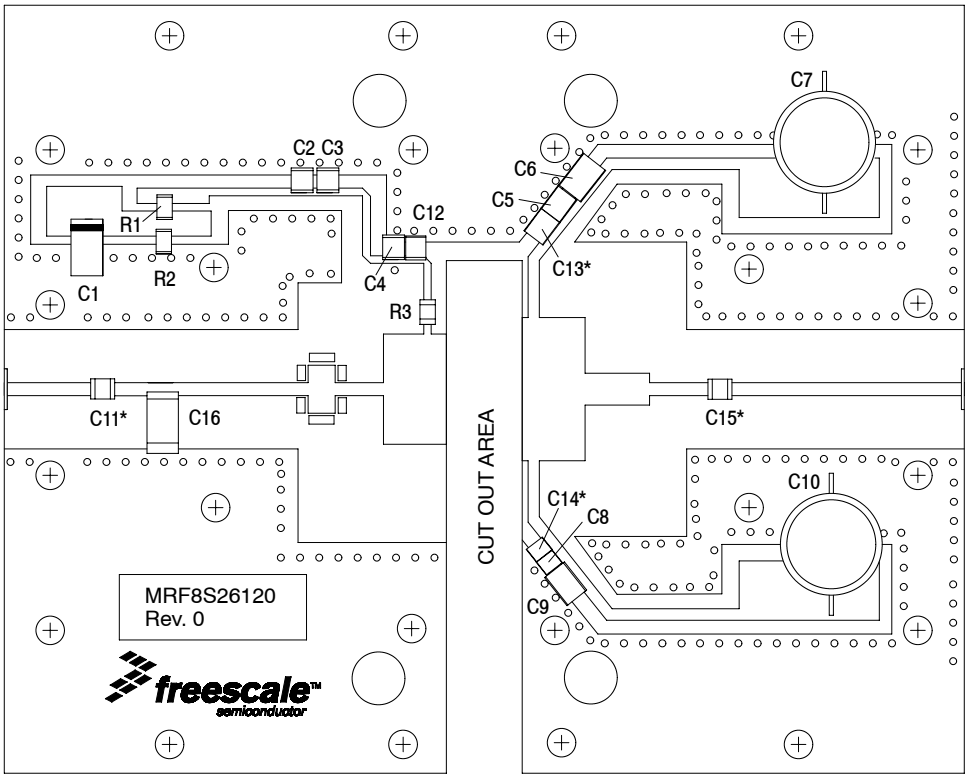
1. Part internally matched both on input and output.

(continued)

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Typical Performances** (In Freescale Test Fixture, 50 ohm system) $V_{DD}$ = 28 Vdc, $I_{DQ}$ = 900 mA, 2620–2690 MHz Bandwidth | | | | | |
| $P_{out}$ @ 1 dB Compression Point, CW | P1dB | — | 110 | — | W |
| IMD Symmetry @ 80 W PEP, $P_{out}$ where IMD Third Order Intermodulation ≅ 30 dBc (Delta IMD Third Order Intermodulation between Upper and Lower Sidebands > 2 dB) | $IMD_{sym}$ | — | 18 | — | MHz |
| VBW Resonance Point (IMD Third Order Intermodulation Inflection Point) | $VBW_{res}$ | — | 65 | — | MHz |
| Gain Flatness in 70 MHz Bandwidth @ $P_{out}$ = 28 W Avg. | $G_F$ | — | 0.1 | — | dB |
| Gain Variation over Temperature (–30°C to +85°C) | ΔG | — | 0.015 | — | dB/°C |
| Output Power Variation over Temperature (–30°C to +85°C) (1) | ΔP1dB | — | 0.007 | — | dB/°C |

1. Exceeds recommended operating conditions. See CW operation data in Maximum Ratings table.




*C11, C13, C14, and C15 are mounted vertically.

**Figure 1. MRF8S26120HR3(HSR3) Test Circuit Component Layout**

**Table 5. MRF8S26120HR3(HSR3) Test Circuit Component Designations and Values**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| C1 | 22 μF, 35 V Tantalum Capacitor | T494X226K035AT | Kemet |
| C2 | 330 nF, 100 V Chip Capacitor | C3225X7R2A334KT | TDK |
| C3 | 15 nF, 100 V Chip Capacitor | C3225C0G2A153JT | TDK |
| C4, C5, C8 | 2.2 μF, 100 V Chip Capacitors | C3225X7R2A225KT | TDK |
| C6, C9 | 22 μF, 50 V Chip Capacitors | C5750JF1H226ZT | TDK |
| C7, C10 | 470 μF, 63 V Electrolytic Capacitors | MCGPR63V477M13X26-RH | Multicomp |
| C11, C12, C13, C14, C15 | 27 pF Chip Capacitors | ATC800B270JT500XT | ATC |
| C16 | 0.8 pF Chip Capacitor | ATC100B0R8BT500XT | ATC |
| R1 | 1 kΩ, 1/4 W Chip Resistor | CRCW12061K00FKEA | Vishay |
| R2 | 10 kΩ, 1/4 W Chip Resistor | CRCW120610K0FKEA | Vishay |
| R3 | 7.5 Ω, 1/4 W Chip Resistor | CRCW12067R50FNEA | Vishay |
| PCB | 0.030″, $\varepsilon_r$ = 3.5 | RF-35 | Taconic |

## TYPICAL CHARACTERISTICS

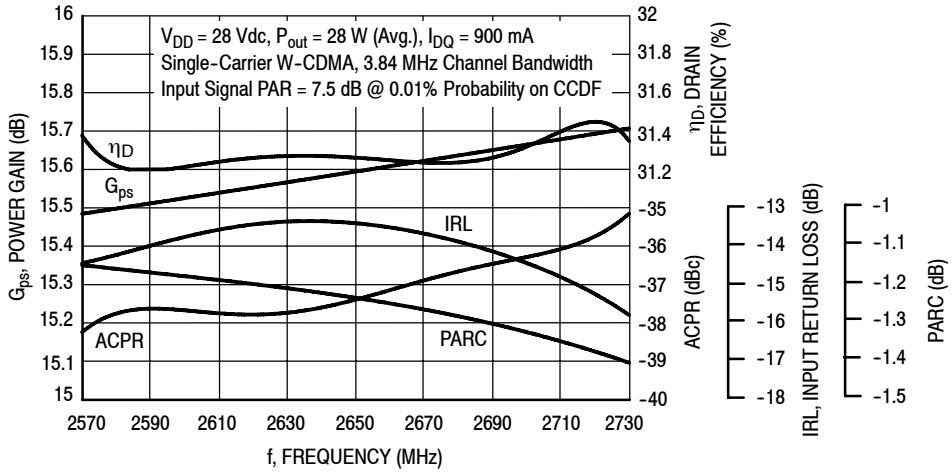



**Figure 2. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ $P_{out}$ = 28 Watts Avg.**

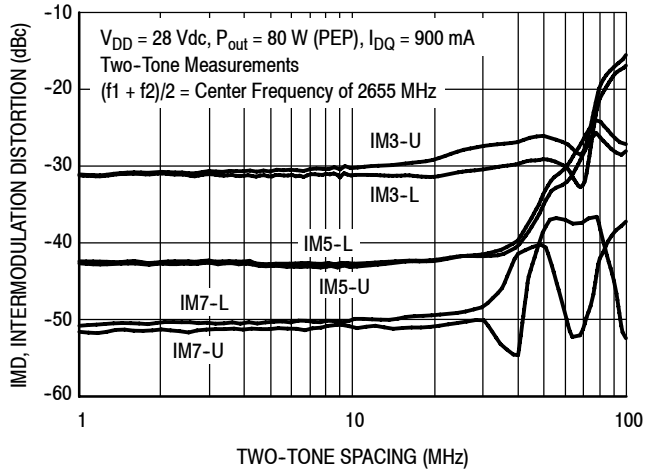



**Figure 3. Intermodulation Distortion Products versus Two-Tone Spacing**

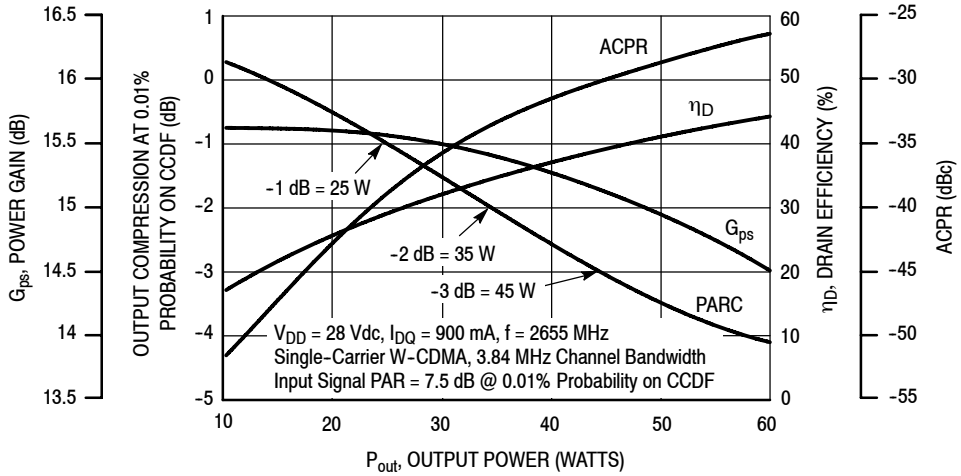



**Figure 4. Output Peak-to-Average Ratio Compression (PARC) versus Output Power**

## TYPICAL CHARACTERISTICS

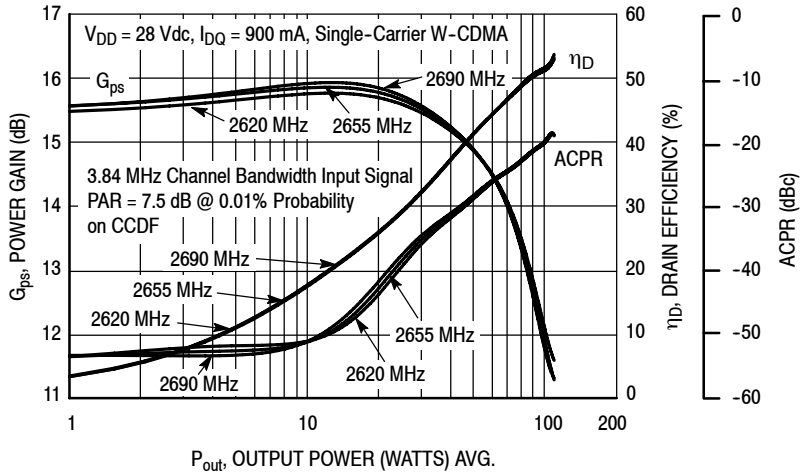



**Figure 5. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power**

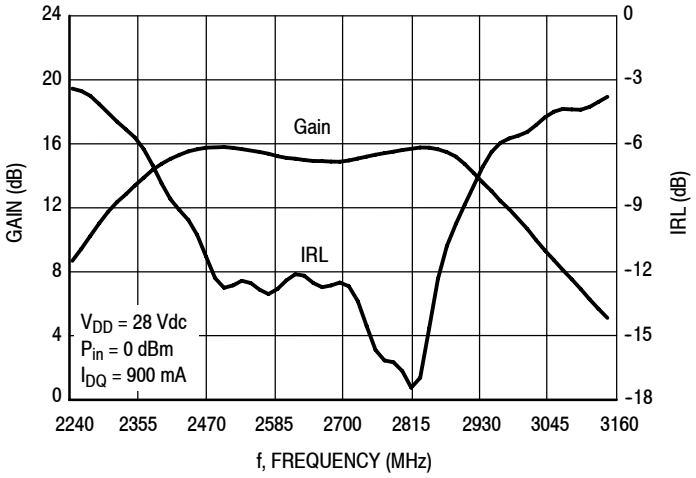



**Figure 6. Broadband Frequency Response**

## W-CDMA TEST SIGNAL

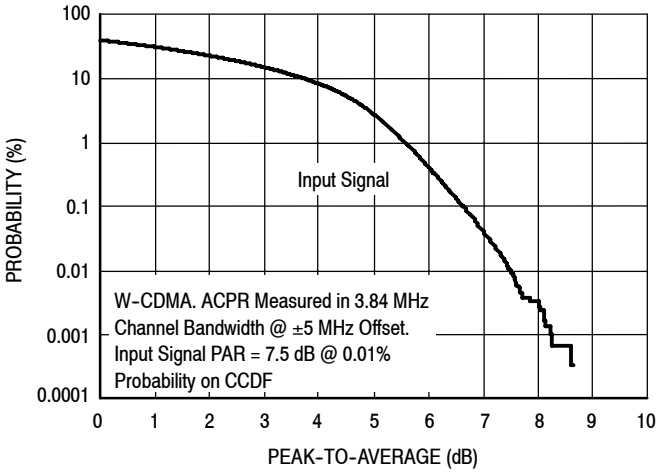



**Figure 7. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal**

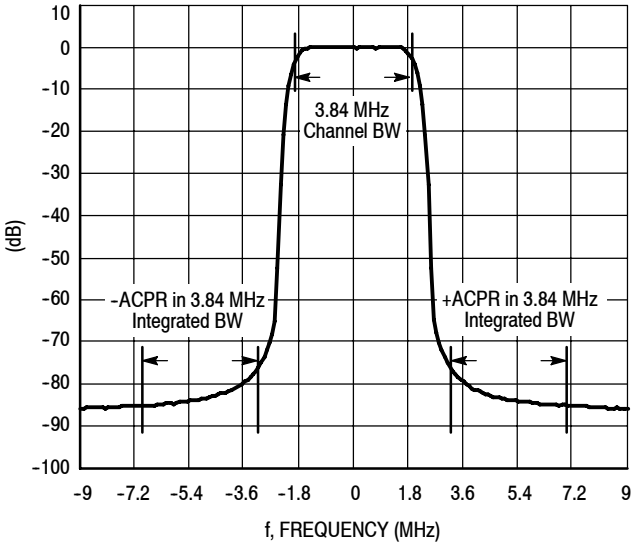



**Figure 8. Single-Carrier W-CDMA Spectrum**

$V_{DD}$ = 28 Vdc, $I_{DQ}$ = 900 mA, $P_{out}$ = 28 W Avg.

| f MHz | $Z_{source}$ Ω | $Z_{load}$ Ω |
|---|---|---|
| 2570 | 5.21 – j5.62 | 3.17 – j4.27 |
| 2590 | 5.26 – j5.33 | 3.15 – j4.20 |
| 2610 | 5.31 – j5.02 | 3.12 – j4.12 |
| 2630 | 5.35 – j4.71 | 3.10 – j4.04 |
| 2650 | 5.39 – j4.39 | 3.07 – j3.96 |
| 2670 | 5.46 – j4.05 | 3.06 – j3.88 |
| 2690 | 5.53 – j3.77 | 3.06 – j3.82 |
| 2710 | 5.57 – j3.47 | 3.05 – j3.77 |
| 2730 | 5.59 – j3.15 | 3.05 – j3.73 |

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

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

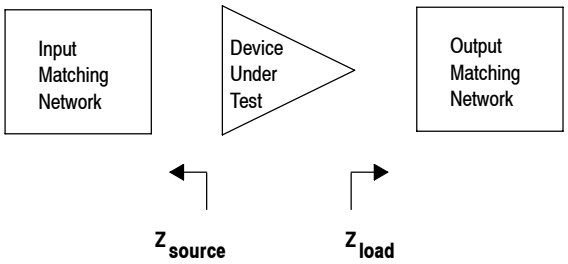
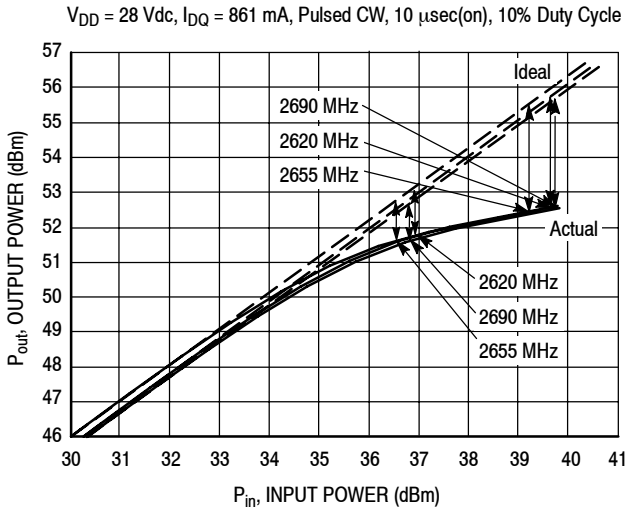



**Figure 9. Series Equivalent Source and Load Impedance**

## ALTERNATIVE PEAK TUNE LOAD PULL CHARACTERISTICS




NOTE: Load Pull Test Fixture Tuned for Peak P1dB Output Power @ 28 V

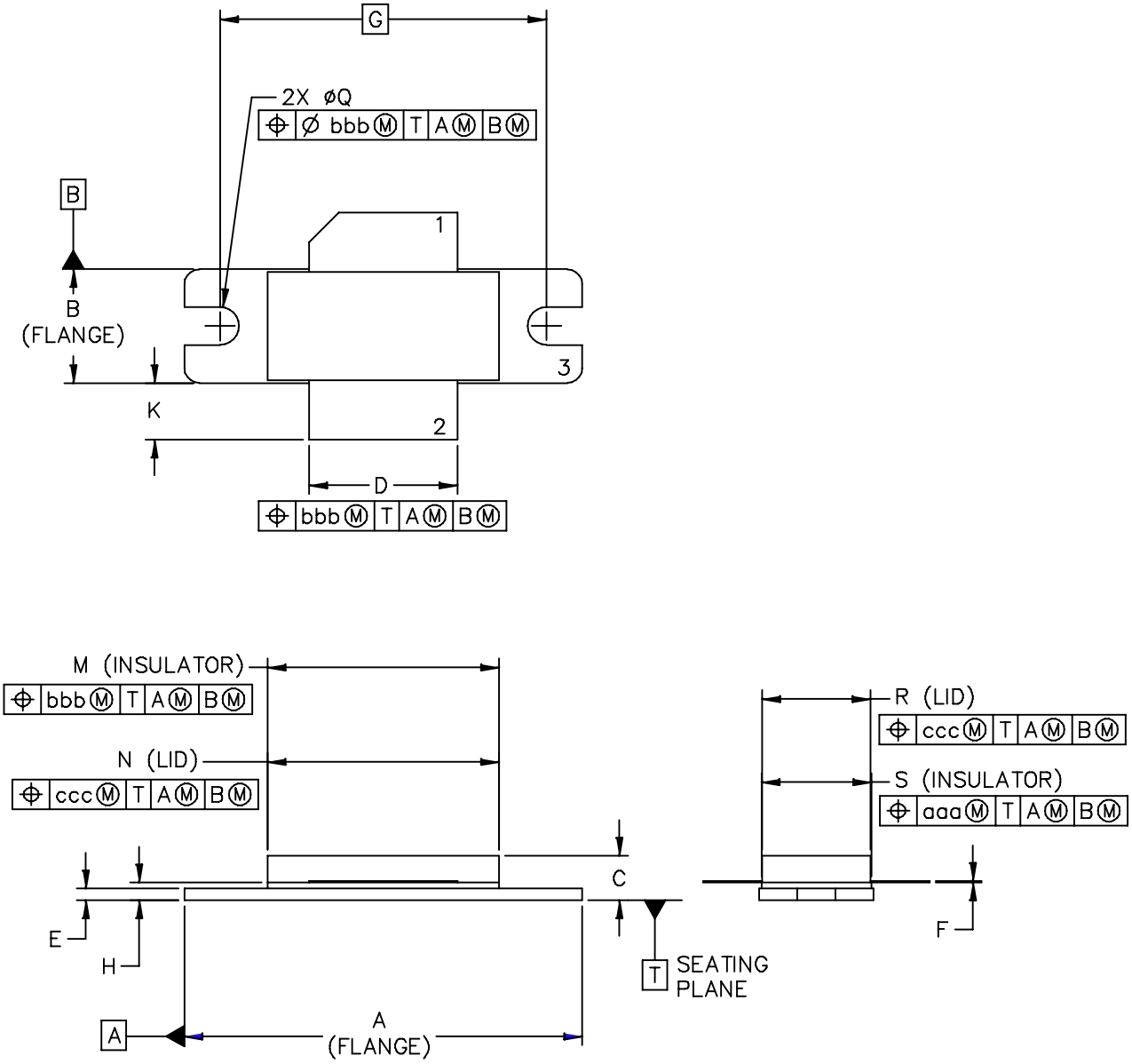
| f (MHz) | P1dB | | P3dB | |
|---|---|---|---|---|
| | Watts | dBm | Watts | dBm |
| 2620 | 149 | 51.7 | 182 | 52.6 |
| 2655 | 144 | 51.6 | 177 | 52.5 |
| 2690 | 146 | 51.6 | 179 | 52.5 |

Test Impedances per Compression Level

| f (MHz) | | $Z_{source}$ Ω | $Z_{load}$ Ω |
|---|---|---|---|
| 2620 | P1dB | 5.83 - j7.00 | 1.44 - j2.87 |
| 2655 | P1dB | 7.87 - j6.87 | 1.72 - j3.15 |
| 2690 | P1dB | 9.46 - j5.13 | 1.52 - j3.20 |

**Figure 10. Pulsed CW Output Power versus Input Power @ 28 V**

## PACKAGE DIMENSIONS




| © FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED. | MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE |
|---|---|---|
| TITLE: NI-780 | DOCUMENT NO: 98ASB15607C | REV: G |
| | CASE NUMBER: 465-06 | 31 MAR 2005 |
| | STANDARD: NON-JEDEC | |

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED .030 (.762) AWAY FROM PACKAGE BODY.

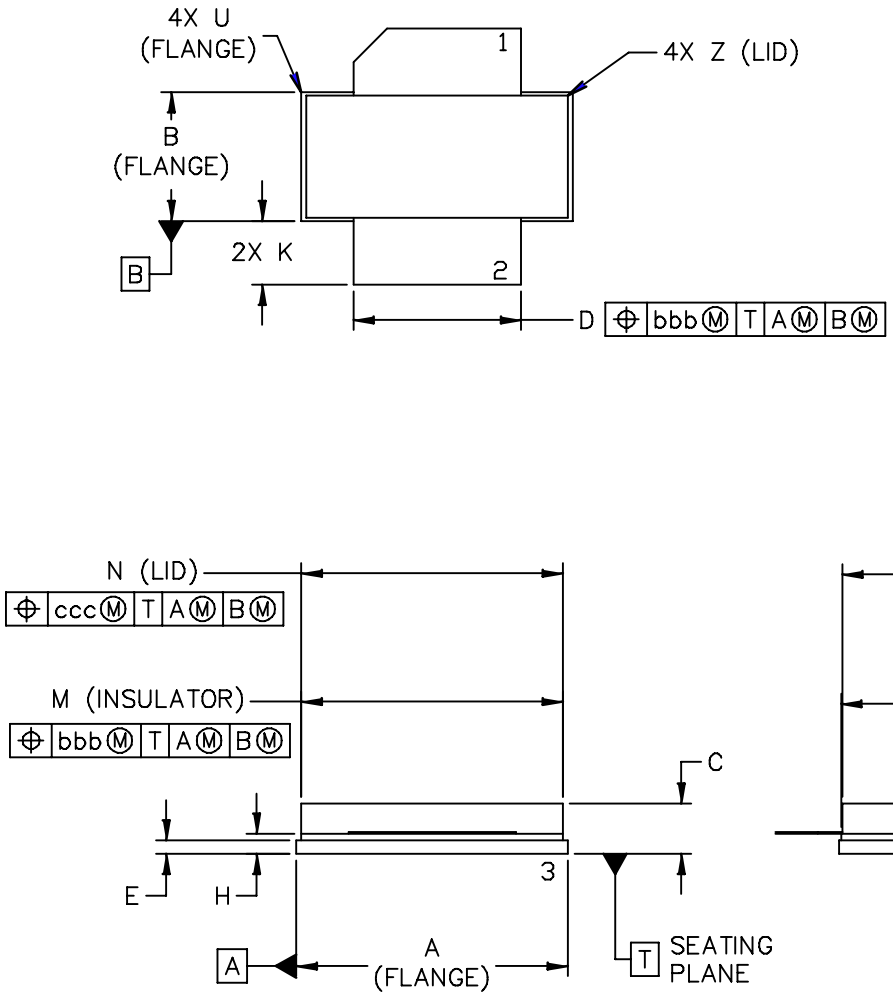
STYLE 1:
PIN 1. DRAIN
2. GATE
3. SOURCE

| DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX | DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX |
|---|---|---|---|---|---|---|---|---|---|
| A | 1.335 | 1.345 | 33.91 | 34.16 | R | .365 | .375 | 9.27 | 9.53 |
| B | .380 | .390 | 9.65 | 9.91 | S | .365 | .375 | 9.27 | 9.52 |
| C | .125 | .170 | 3.18 | 4.32 | aaa | – | .005 | – | 0.127 |
| D | .495 | .505 | 12.57 | 12.83 | bbb | – | .010 | – | 0.254 |
| E | .035 | .045 | 0.89 | 1.14 | ccc | – | .015 | – | 0.381 |
| F | .003 | .006 | 0.08 | 0.15 | – | – | – | – | – |
| G | 1.100 BSC | | 27.94 BSC | | – | – | – | – | – |
| H | .057 | .067 | 1.45 | 1.7 | – | – | – | – | – |
| K | .170 | .210 | 4.32 | 5.33 | – | – | – | – | – |
| M | .774 | .786 | 19.66 | 19.96 | – | – | – | – | – |
| N | .772 | .788 | 19.6 | 20 | – | – | – | – | – |
| Q | ø.118 | ø.138 | ø3 | ø3.51 | – | – | – | – | – |



**MECHANICAL OUTLINE** | PRINT VERSION NOT TO SCALE

| TITLE: | DOCUMENT NO: 98ASB15607C | REV: G |
|---|---|---|
| NI–780 | CASE NUMBER: 465–06 | 31 MAR 2005 |
| | STANDARD: NON–JEDEC | |




| © FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED. | MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE |
|---|---|---|
| TITLE: NI-780S | DOCUMENT NO: 98ASB16718C | REV: H |
| | CASE NUMBER: 465A-06 | 31 MAR 2005 |
| | STANDARD: NON-JEDEC | |

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M–1994.

2. CONTROLLING DIMENSION: INCH.

3. DELETED

4. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY.

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

| DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX | DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX |
|---|---|---|---|---|---|---|---|---|---|
| A | .805 | .815 | 20.45 | 20.7 | U | – | .040 | – | 1.02 |
| B | .380 | .390 | 9.65 | 9.91 | Z | – | .030 | – | 0.76 |
| C | .125 | .170 | 3.18 | 4.32 | aaa | – | .005 | – | 0.127 |
| D | .495 | .505 | 12.57 | 12.83 | bbb | – | .010 | – | 0.254 |
| E | .035 | .045 | 0.89 | 1.14 | ccc | – | .015 | – | 0.381 |
| F | .003 | .006 | 0.08 | 0.15 | – | – | – | – | – |
| H | .057 | .067 | 1.45 | 1.7 | – | – | – | – | – |
| K | .170 | .210 | 4.32 | 5.33 | – | – | – | – | – |
| M | .774 | .786 | 19.61 | 20.02 | – | – | – | – | – |
| N | .772 | .788 | 19.61 | 20.02 | – | – | – | – | – |
| R | .365 | .375 | 9.27 | 9.53 | – | – | – | – | – |
| S | .365 | .375 | 9.27 | 9.52 | – | – | – | – | – |



**MECHANICAL OUTLINE** | PRINT VERSION NOT TO SCALE

| TITLE: | DOCUMENT NO: 98ASB16718C | REV: H |
|---|---|---|
| NI–780S | CASE NUMBER: 465A–06 | 31 MAR 2005 |
| | STANDARD: NON–JEDEC | |

## PRODUCT DOCUMENTATION AND SOFTWARE

Refer to the following documents, tools and software 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

**Software**

- Electromigration MTTF Calculator
- RF High Power Model
- .s2p File

For Software, do a Part Number search at http://www.freescale.com, and select the “Part Number” link. Go to the Software & Tools tab on the part’s Product Summary page to download the respective tool.

## REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date | Description |
|---|---|---|
| 0 | June 2010 | • Initial Release of Data Sheet |

## *How to Reach Us:*

**Home Page:**
www.freescale.com

**Web Support:**
http://www.freescale.com/support

**USA/Europe or Locations Not Listed:**
Freescale Semiconductor, Inc.
Technical Information Center, EL516
2100 East Elliot Road
Tempe, Arizona 85284
1-800-521-6274 or +1-480-768-2130
www.freescale.com/support

**Europe, Middle East, and Africa:**
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
www.freescale.com/support

**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
support.asia@freescale.com

***For Literature Requests Only:***
Freescale Semiconductor Literature Distribution Center
1-800-441-2447 or +1-303-675-2140
Fax: +1-303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com



Document Number: MRF8S26120H
Rev. 0, 6/2010