

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for W-CDMA base station applications with frequencies from 2110 to 2170 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications. To be used in Class AB for PCN-PCS/cellular radio and WLL applications.

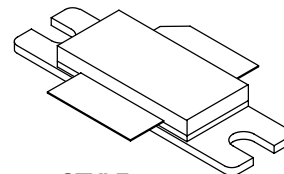
- Typical 2-carrier W-CDMA Performance: $V_{DD} = 28$ Volts, $I_{DQ} = 1050$ mA, $P_{out} = 23$ Watts Avg., $f = 2167.5$ MHz, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
 Power Gain — 13.5 dB
 Drain Efficiency — 26%
 IM3 @ 10 MHz Offset — -37 dBc in 3.84 MHz Channel Bandwidth
 ACPR @ 5 MHz Offset — -40 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 MHz, 100 Watts CW Output Power

Features

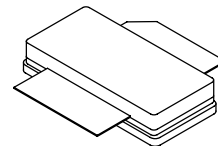
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- Lower Thermal Resistance Package
- Low Gold Plating Thickness on Leads, 40 μ " Nominal.
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF5S21100HR3
MRF5S21100HSR3

2110-2170 MHz, 23 W AVG., 28 V
2 x W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465-06, STYLE 1
NI-780
MRF5S21100HR3



CASE 465A-06, STYLE 1
NI-780S
MRF5S21100HSR3

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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 $^\circ\text{C}$ | P_D | 273 1.56 | W W/ $^\circ\text{C}$ |
| Storage Temperature Range | T_{stg} | - 65 to +150 | $^\circ\text{C}$ |
| Case Operating Temperature | T_C | 150 | $^\circ\text{C}$ |
| Operating Junction Temperature | T_J | 200 | $^\circ\text{C}$ |

Table 2. Thermal Characteristics

| Characteristic | Symbol | Value (1,2) | Unit |
|---|-----------------|--------------|---------------------------|
| Thermal Resistance, Junction to Case Case Temperature 80 $^\circ\text{C}$, 100 W CW Case Temperature 78 $^\circ\text{C}$, 23 W CW | $R_{\theta JC}$ | 0.57 0.64 | $^\circ\text{C}/\text{W}$ |

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 Conditions | Class |
|---------------------|--------------|
| Human Body Model | 2 (Minimum) |
| Machine Model | M3 (Minimum) |
| Charge Device Model | C7 (Minimum) |

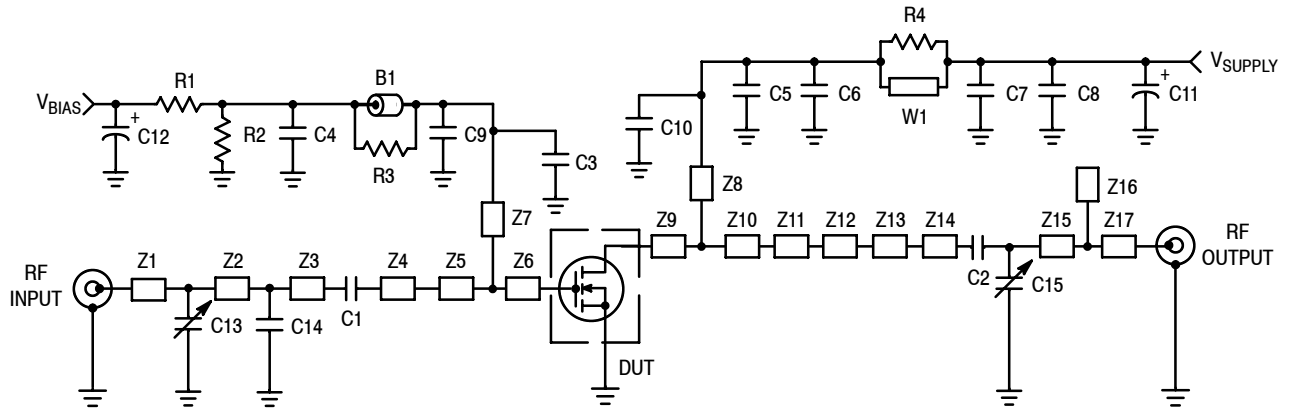
Table 4. Electrical Characteristics ($T_A = 25^\circ\text{C}$ unless otherwise noted)

| 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} | — | — | 0.5 | μAdc |
| On Characteristics (DC) | | | | | |
| Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 250\ \mu\text{Adc}$) | $V_{GS(th)}$ | 2.5 | 2.8 | 3.5 | Vdc |
| Gate Quiescent Voltage ($V_{DS} = 28\text{ Vdc}$, $I_D = 1050\text{ mAdc}$) | $V_{GS(Q)}$ | — | 3.8 | — | Vdc |
| Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 2.5\text{ Adc}$) | $V_{DS(on)}$ | — | 0.24 | 0.3 | Vdc |
| Forward Transconductance ($V_{DS} = 10\text{ Vdc}$, $I_D = 2.5\text{ Adc}$) | g_{fs} | — | 6 | — | 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} | — | 2.14 | — | pF |

Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1050\text{ mA}$, $P_{out} = 23\text{ W Avg.}$, $f_1 = 2157.5\text{ MHz}$, $f_2 = 2167.5\text{ MHz}$, 2-carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers. ACPR measured in 3.84 MHz Channel Bandwidth @ $\pm 5\text{ MHz}$ Offset. IM3 measured in 3.84 MHz Bandwidth @ $\pm 10\text{ MHz}$ Offset. PAR = 8.5 dB @ 0.01% Probability on CCDF.

| | | | | | |
|------------------------------|----------|------|------|-----|-----|
| Power Gain | G_{ps} | 12.5 | 13.5 | — | dB |
| Drain Efficiency | η_D | 24 | 26 | — | % |
| Intermodulation Distortion | IM3 | — | -37 | -35 | dBc |
| Adjacent Channel Power Ratio | ACPR | — | -40 | -38 | dBc |
| Input Return Loss | IRL | — | -16 | -9 | dB |

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

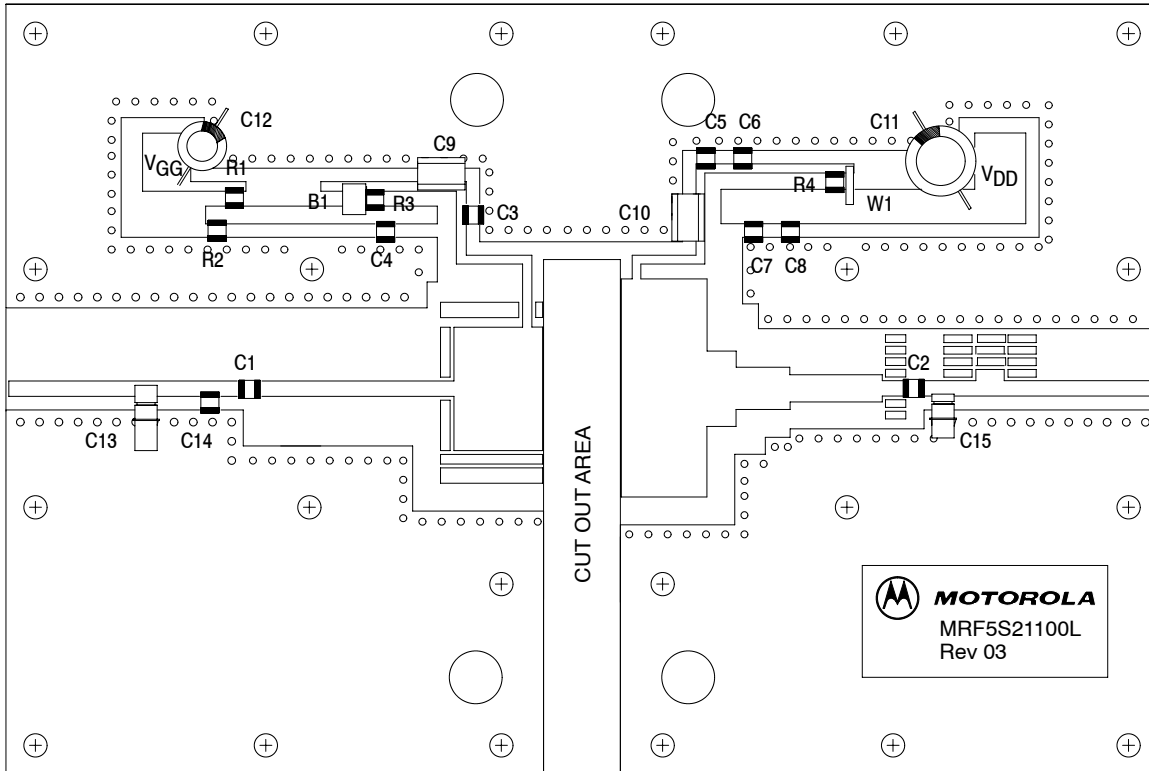


| | | | |
|----|----------------------------|-----|--|
| Z1 | 0.674" x 0.080" Microstrip | Z10 | 0.368" x 1.136" Microstrip |
| Z2 | 0.421" x 0.080" Microstrip | Z11 | 0.151" x 0.393" Microstrip |
| Z3 | 0.140" x 0.080" Microstrip | Z12 | 0.280" x 0.220" Microstrip |
| Z4 | 1.031" x 0.080" Microstrip | Z13 | 0.481" x 0.142" Microstrip |
| Z5 | 0.380" x 0.643" Microstrip | Z14 | 0.138" x 0.080" Microstrip |
| Z6 | 0.080" x 0.643" Microstrip | Z15 | 0.344" x 0.080" Microstrip |
| Z7 | 0.927" x 0.048" Microstrip | Z16 | 0.147" x 0.099" Microstrip |
| Z8 | 0.620" x 0.048" Microstrip | Z17 | 0.859" x 0.080" Microstrip |
| Z9 | 0.079" x 1.136" Microstrip | PCB | Arlon GX-0300-SS-22, 0.030", $\epsilon_r = 2.55$ |

Figure 1. MRF5S21100HR3(SR3) Test Circuit Schematic

Table 5. MRF5S21100HR3(SR3) Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|---------|--|---------------------|--------------|
| B1 | Short RF Bead | 2743019447 | Fair-Rite |
| C1, C2 | 8.2 pF Chip Capacitors | ATC100B8R2CT500XT | ATC |
| C3 | 5.6 pF Chip Capacitor | ATC100B5R6CT500XT | ATC |
| C4 | 0.1 μ F Chip Capacitor | C1210C104J5RAC | Kemet |
| C5, C7 | 7.5 pF Chip Capacitors | ATC100B7R5JT500XT | ATC |
| C6 | 1.2 pF Chip Capacitor | ATC100B1R2BT500XT | ATC |
| C8 | 1K pF Chip Capacitor | ATC100B102JT500XT | ATC |
| C9, C10 | 0.56 μ F Chip Capacitors | C1825C564J5RAC | Kemet |
| C11 | 470 μ F, 63 V Electrolytic Capacitor | EKME630ELL471MK25S | Multicomp |
| C12 | 100 μ F, 50 V Electrolytic Capacitor | MCHT101M1HB-1017-RH | Multicomp |
| C13 | 0.6-4.5 pF Gigatrim Variable Capacitor | 27271SL | Johanson |
| C14 | 2.7 pF Chip Capacitor | ATC100B2R7CT500XT | ATC |
| C15 | 0.4-2.5 pF Gigatrim Variable Capacitor | 27271SL | Johanson |
| R1 | 1 k Ω , 1/4 W Chip Resistor | CRCW12061001FKEA | Vishay |
| R2 | 560 k Ω , 1/4 W Chip Resistor | CRCW12065600FKEA | Vishay |
| R3, R4 | 12 Ω , 1/4 W Chip Resistors | CRCW120612R0FKEA | Vishay |



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

Figure 2. MRF5S21100HR3(SR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

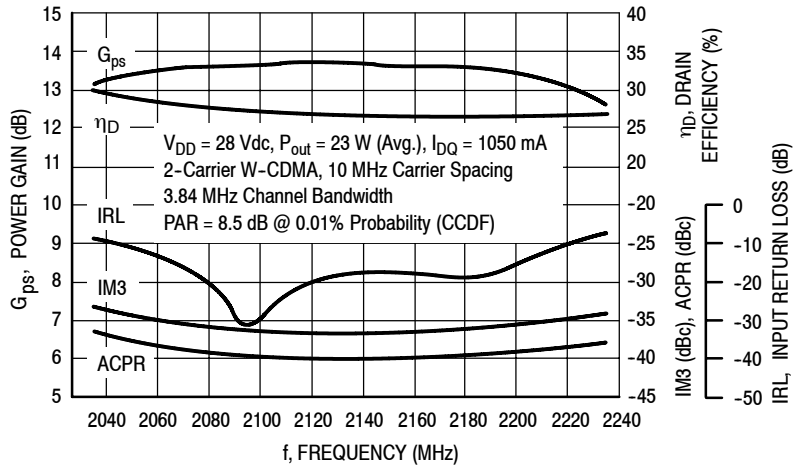


Figure 3. 2-Carrier W-CDMA Broadband Performance

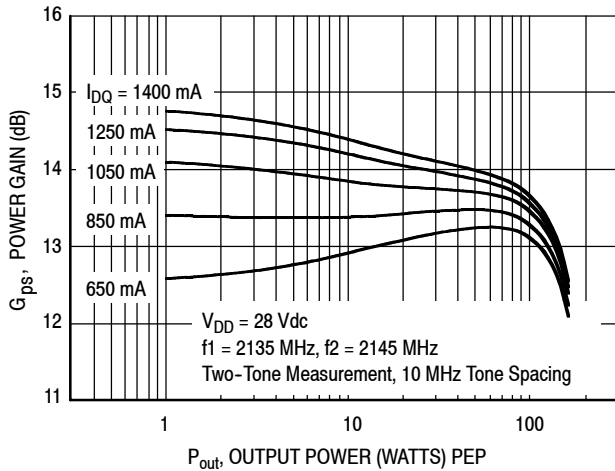


Figure 4. Two-Tone Power Gain versus Output Power

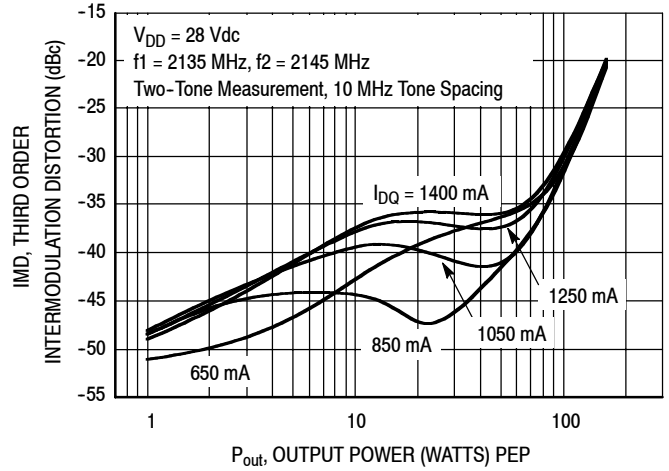


Figure 5. Third Order Intermodulation Distortion versus Output Power

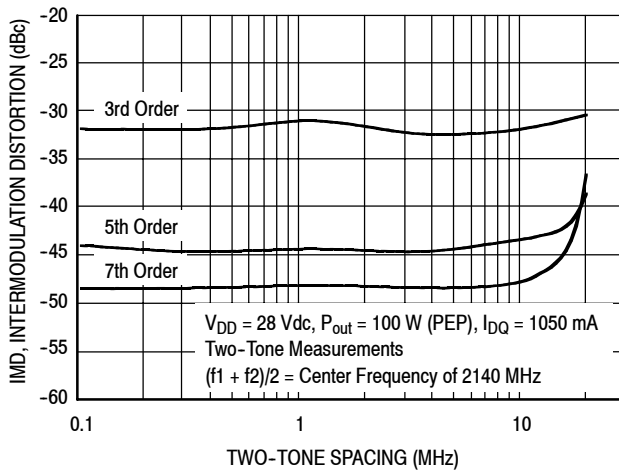


Figure 6. Intermodulation Distortion Products versus Tone Spacing

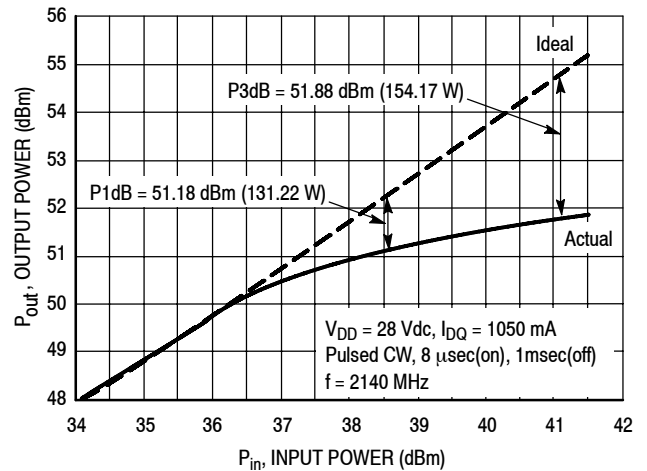


Figure 7. Pulse CW Output Power versus Input Power

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TYPICAL CHARACTERISTICS

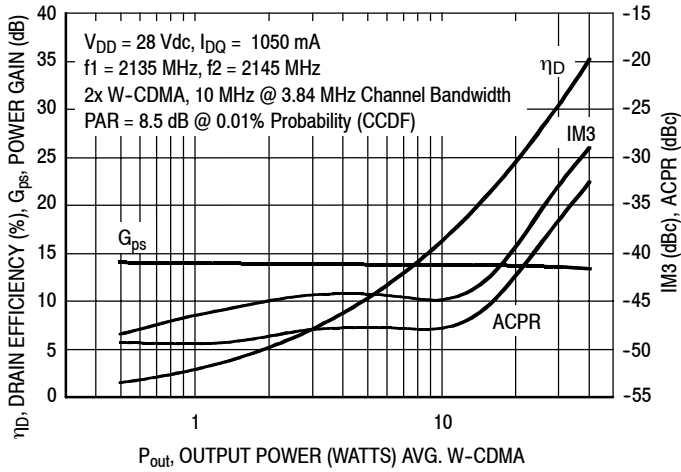
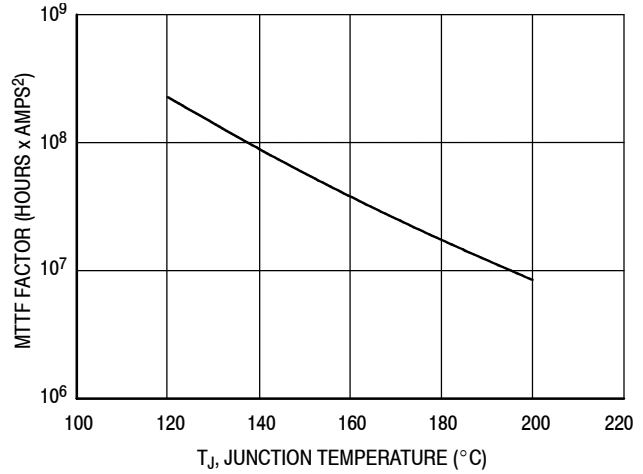


Figure 8. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power



This above graph displays calculated MTTF in hours x ampere² drain current. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ of the theoretical prediction for metal failure. Divide MTTF factor by I_D^2 for MTTF in a particular application.

Figure 9. MTTF Factor versus Junction Temperature

W-CDMA TEST SIGNAL

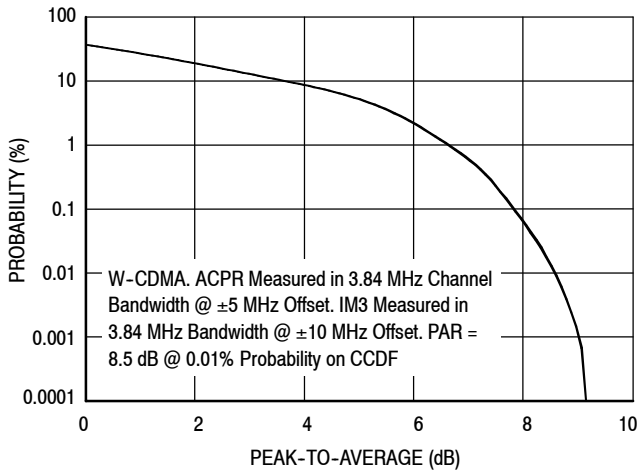


Figure 10. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single Carrier Test Signal

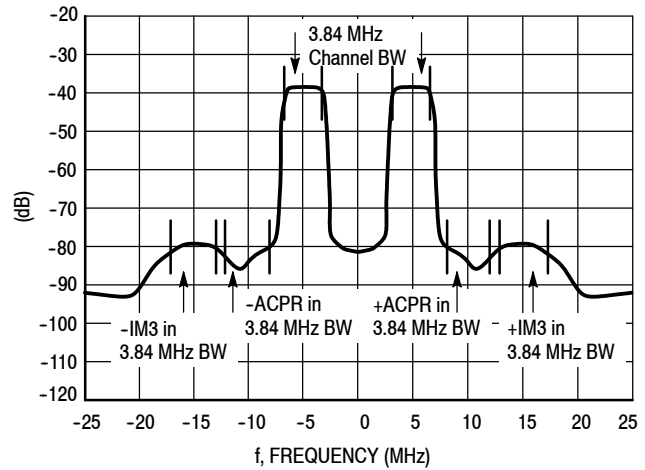
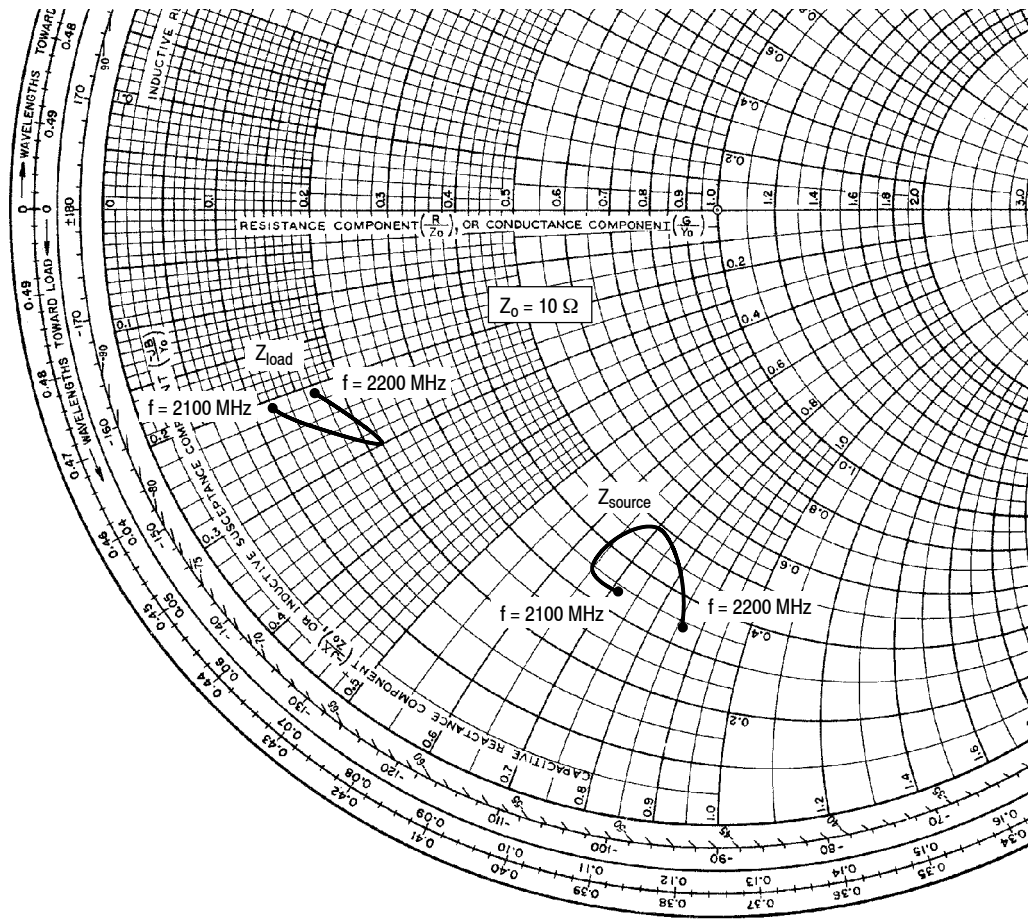


Figure 11. 2-Carrier W-CDMA Spectrum

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$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1050 \text{ mA}$, $P_{out} = 23 \text{ W Avg.}$

| f MHz | Z _{source} Ω | Z _{load} Ω |
|----------|--------------------------|------------------------|
| 2100 | 3.4 - j7.2 | 1.2 - j2.1 |
| 2120 | 3.4 - j6.5 | 1.4 - j2.3 |
| 2160 | 4.9 - j7.0 | 2.2 - j3.0 |
| 2200 | 3.4 - j8.6 | 1.7 - j2.1 |

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

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

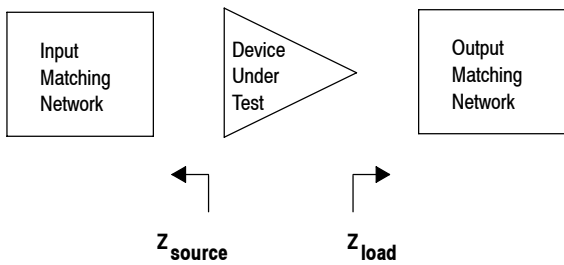
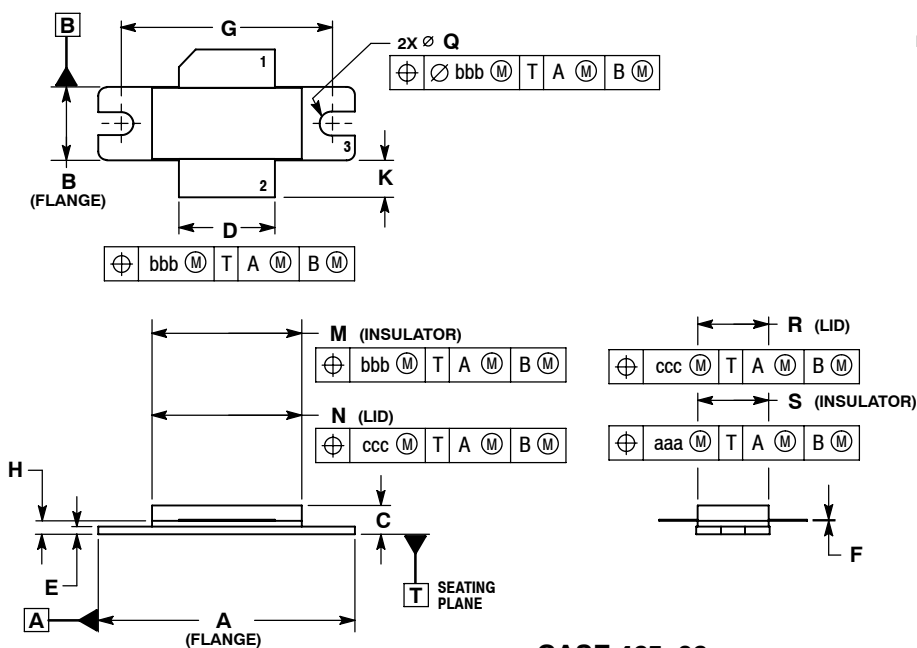


Figure 12. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS

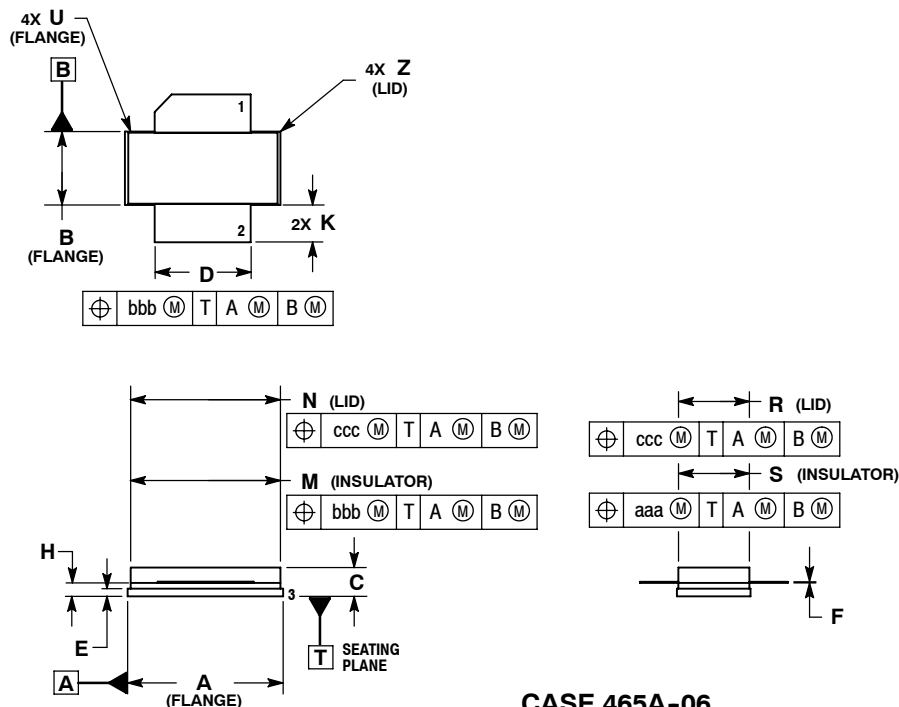


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
 2. CONTROLLING DIMENSION: INCH.
 3. DELETED
 4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

| 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 | ∅ 1.18 | ∅ 1.38 | ∅ 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:
 PIN 1. DRAIN
 2. GATE
 3. SOURCE

**CASE 465-06
 ISSUE G
 NI-780
 MRF5S21100HR3**



- 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:
 PIN 1. DRAIN
 2. GATE
 5. SOURCE

**CASE 465A-06
 ISSUE H
 NI-780S
 MRF5S21100HSR3**

REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date | Description |
|----------|-----------|---|
| 4 | Dec. 2010 | <ul style="list-style-type: none"> • Data sheet revised to reflect part status change, p. 1, including use of applicable overlay. • 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 5, Component Designations and Values, to RoHS compliant part numbers, p. 3 • Added Revision History, p. 9 • Data sheet archived. Parts no longer manufactured. |

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