

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for CDMA base station applications with frequencies from 2300 to 2400 MHz. Suitable for WiMAX, WiBro and multicarrier amplifier applications. To be used in Class AB and Class C for WLL applications.

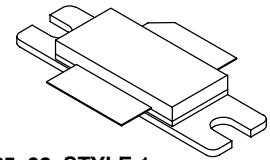
- Typical 2-Carrier W-CDMA Performance: $V_{DD} = 28$ Volts, $I_{DQ} = 1000$ mA, $P_{out} = 20$ Watts Avg., Full Frequency Band, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
Power Gain — 15.4 dB
Drain Efficiency — 23.5%
IM3 @ 10 MHz Offset — -37 dBc @ 3.84 MHz Channel Bandwidth
ACPR @ 5 MHz Offset — -40.5 dBc @ 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2390 MHz, 100 Watts CW Output Power

Features

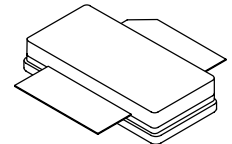
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- Lower Thermal Resistance Package
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications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

MRF6S23100HR3
MRF6S23100HSR3

2300-2400 MHz, 20 W AVG., 28 V
2 x W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465-06, STYLE 1
NI-780
MRF6S23100HR3



CASE 465A-06, STYLE 1
NI-780S
MRF6S23100HSR3

Table 1. Maximum Ratings

| Rating | Symbol | Value | Unit |
|---|-----------|--------------|--------------------------|
| Drain-Source Voltage | V_{DSS} | -0.5, +68 | Vdc |
| Gate-Source Voltage | V_{GS} | -0.5, +12 | Vdc |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25 $^\circ\text{C}$ | P_D | 330 1.9 | 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 75 $^\circ\text{C}$, 20 W CW | $R_{\theta JC}$ | 0.53 0.59 | $^\circ\text{C}/\text{W}$ |

1. MTTF calculator available at <http://www.freescale.com/rf>. Select Tools/Software/Application Software/Calculators to access the MTTF 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 Methodology | Class |
|---------------------------------------|--------------|
| Human Body Model (per JESD22-A114) | 3A (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 ($V_{DS} = 68\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | 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} | — | — | 1 | μAdc |

On Characteristics

| | | | | | |
|---|--------------|-----|------|-----|-----|
| Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 250\ \mu\text{Adc}$) | $V_{GS(th)}$ | 1 | 2 | 3 | Vdc |
| Gate Quiescent Voltage ($V_{DS} = 28\text{ Vdc}$, $I_D = 1000\ \text{mAdc}$) | $V_{GS(Q)}$ | 2 | 2.8 | 4 | Vdc |
| Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 2.2\ \text{Adc}$) | $V_{DS(on)}$ | 0.1 | 0.21 | 0.3 | Vdc |
| Forward Transconductance ($V_{DS} = 10\text{ Vdc}$, $I_D = 2\ \text{Adc}$) | g_{fs} | — | 5.3 | — | S |

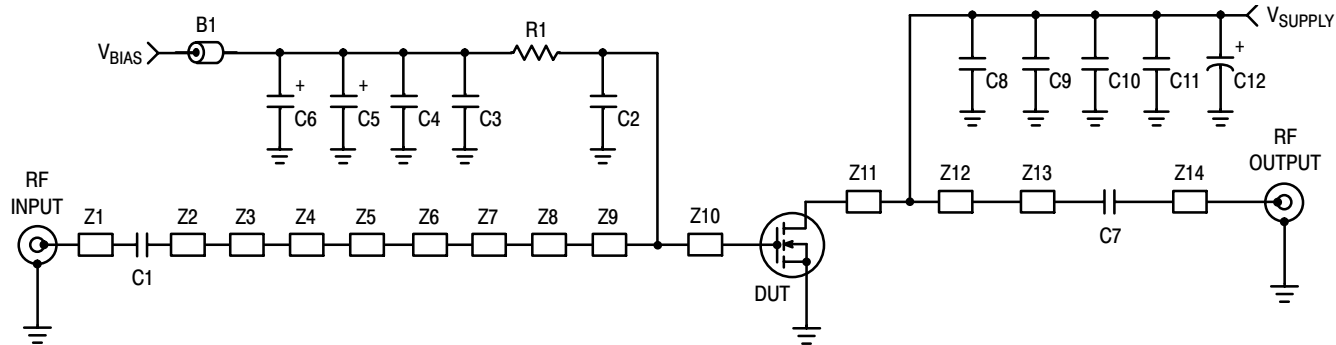
Dynamic Characteristics ⁽¹⁾

| | | | | | |
|--|-----------|---|-----|---|----|
| Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\ \text{mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{rss} | — | 1.5 | — | pF |
|--|-----------|---|-----|---|----|

Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1000\ \text{mA}$, $P_{out} = 20\ \text{W Avg.}$, $f_1 = 2300\ \text{MHz}$, $f_2 = 2310\ \text{MHz}$ and $f_1 = 2390\ \text{MHz}$, $f_2 = 2400\ \text{MHz}$, 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} | 14 | 15.4 | 17 | dB |
| Drain Efficiency | η_D | 22.5 | 23.5 | — | % |
| Intermodulation Distortion | IM3 | -35 | -37 | — | dBc |
| Adjacent Channel Power Ratio | ACPR | -38 | -40.5 | — | dBc |
| Input Return Loss | IRL | — | -10 | — | dB |

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



| | | | |
|----|----------------------------|-----|--|
| Z1 | 0.725" x 0.080" Microstrip | Z9 | 0.329" x 0.756" Microstrip |
| Z2 | 0.240" x 0.080" Microstrip | Z10 | 0.083" x 0.756" Microstrip |
| Z3 | 0.110" x 0.240" Microstrip | Z11 | 0.092" x 0.800" Microstrip |
| Z4 | 0.140" x 0.080" Microstrip | Z12 | 0.436" x 0.800" Microstrip |
| Z5 | 0.167" x 0.500" Microstrip | Z13 | 0.974" x 0.080" Microstrip |
| Z6 | 0.130" x 0.080" Microstrip | Z14 | 0.727" x 0.080" Microstrip |
| Z7 | 0.250" x 0.611" Microstrip | PCB | Arlon GX-0300-5022, 0.030", $\epsilon_r = 2.5$ |
| Z8 | 0.060" x 0.080" Microstrip | | |

Figure 1. MRF6S23100HR3(HSR3) Test Circuit Schematic

Table 5. MRF6S23100HR3(HSR3) Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|----------------|--|--------------------|---------------------|
| B1 | Ferrite Bead | 2743019447 | Fair-Rite |
| C1, C2, C7, C8 | 5.6 pF Chip Capacitors, B Case | 100B5R6CP500X | ATC |
| C3 | 0.01 μ F Chip Capacitor (1825) | C1825C103J1RAC | Kemet |
| C4, C9 | 2.2 μ F, 50 V Chip Capacitors (1825) | C1825C225J5RAC | Kemet |
| C5 | 22 μ F, 25 V Tantalum Capacitor | ECS-T1ED226R | Panasonic TE series |
| C6 | 47 μ F, 16 V Tantalum Capacitor | T491D476K016AS | Kemet |
| C10, C11 | 10 μ F, 50 V Chip Capacitors (2220) | GRM55DR61H106KA88B | Murata |
| C12 | 330 μ F, 63 V Electrolytic Capacitor | NACZF331M63V | Nippon |
| R1 | 10 Ω , 1/8 W Chip Resistor (1206) | CRC120610R0F100 | Dale/Vishay |

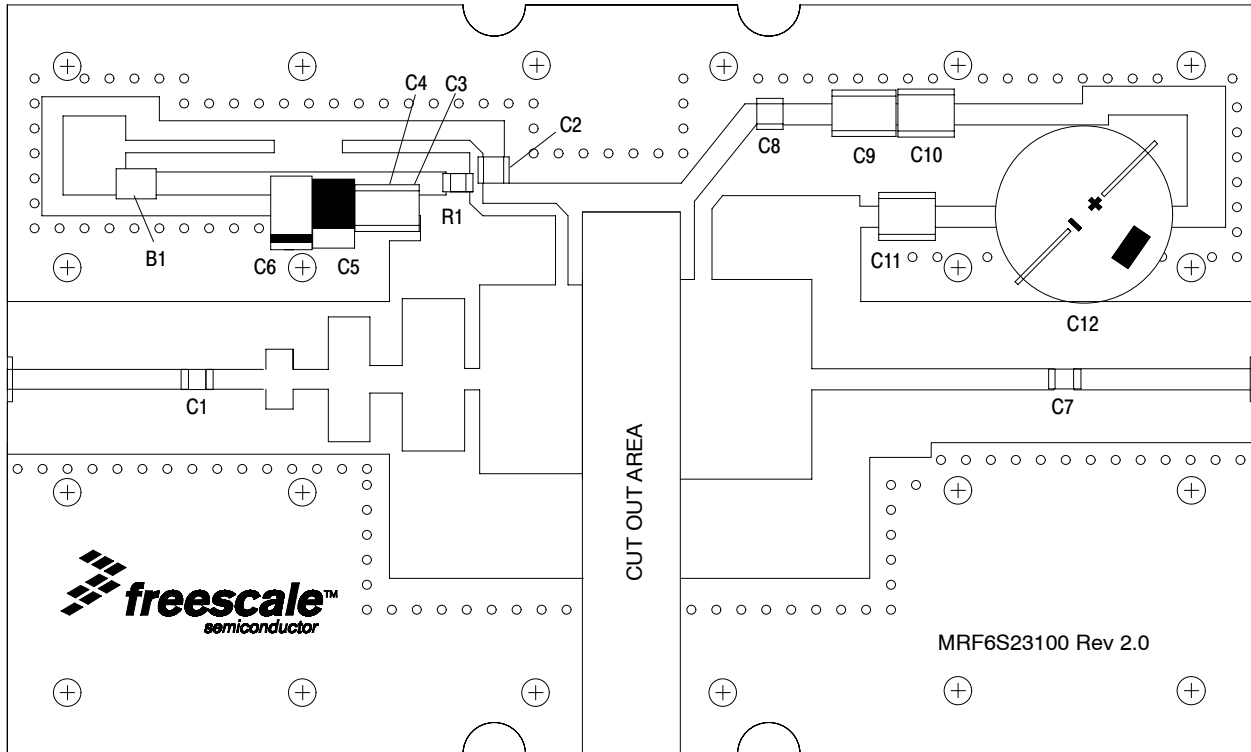


Figure 2. MRF6S23100HR3(HSR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

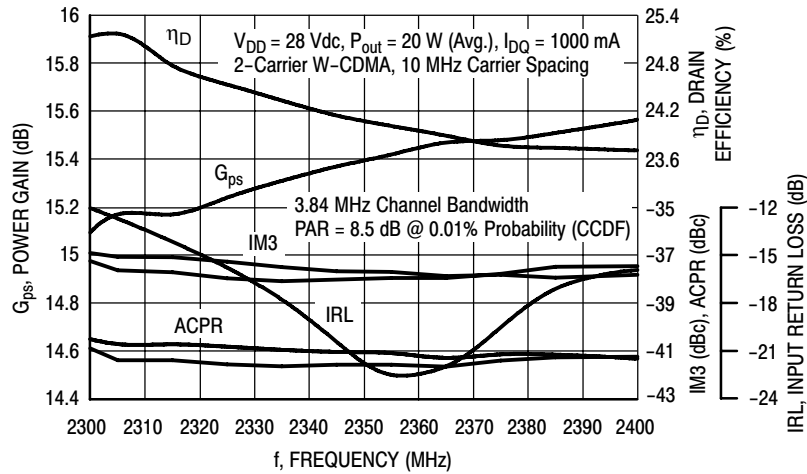


Figure 3. 2-Carrier W-CDMA Broadband Performance @ $P_{out} = 20$ Watts Avg.

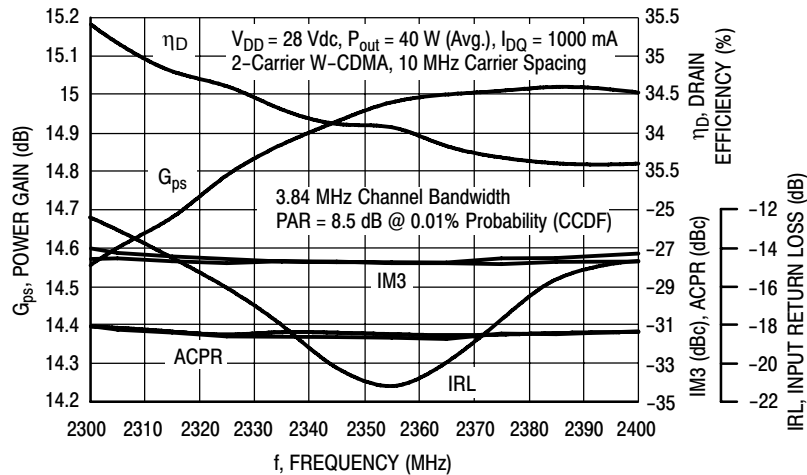


Figure 4. 2-Carrier W-CDMA Broadband Performance @ $P_{out} = 40$ Watts Avg.

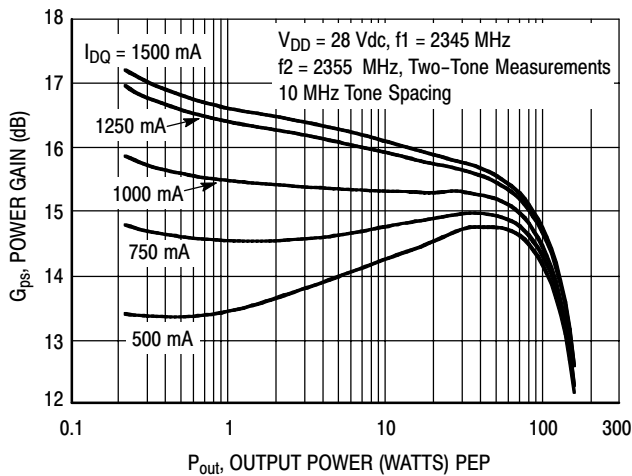


Figure 5. Two-Tone Power Gain versus Output Power

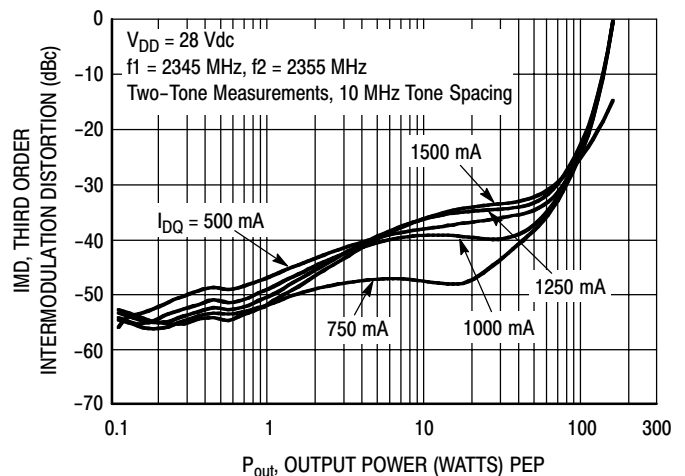


Figure 6. Third Order Intermodulation Distortion versus Output Power

MRF6S23100HR3 MRF6S23100HSR3

TYPICAL CHARACTERISTICS

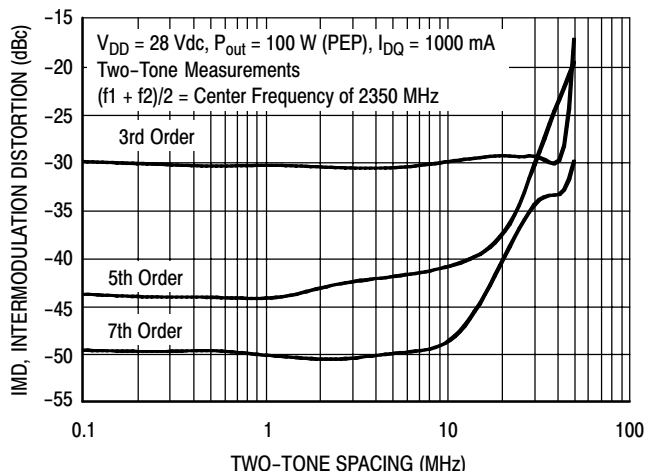


Figure 7. Intermodulation Distortion Products versus Tone Spacing

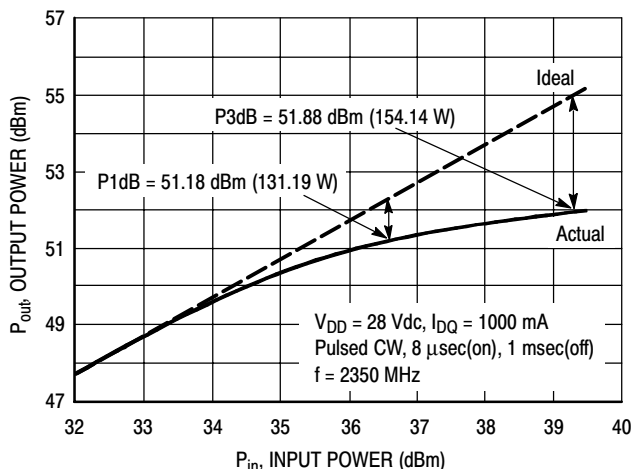


Figure 8. Pulse CW Output Power versus Input Power

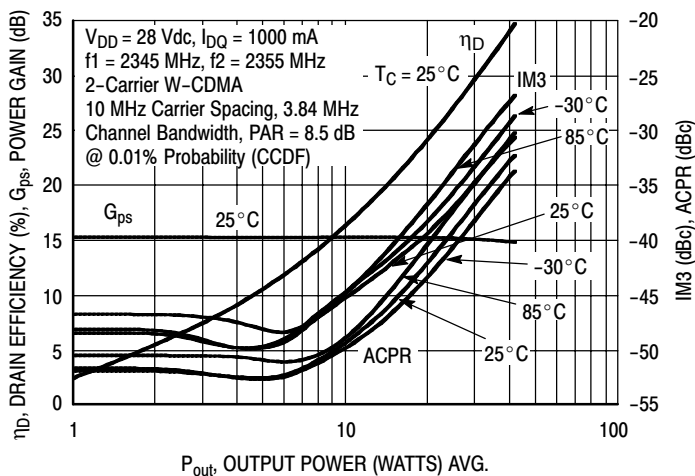


Figure 9. 2-Carrier W-CDMA ACPR, IM_3 , Power Gain and Drain Efficiency versus Output Power

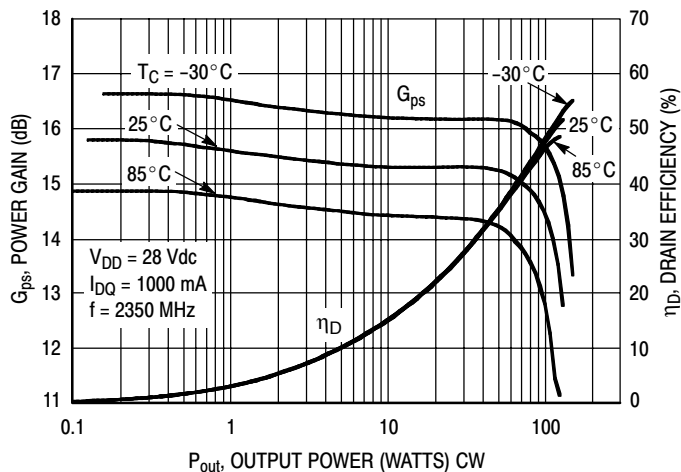


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

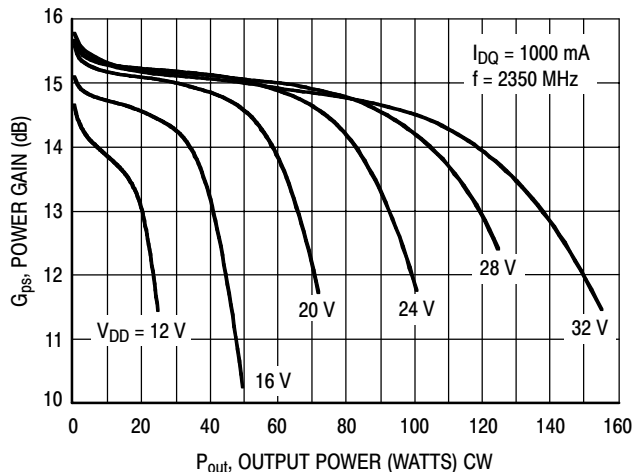
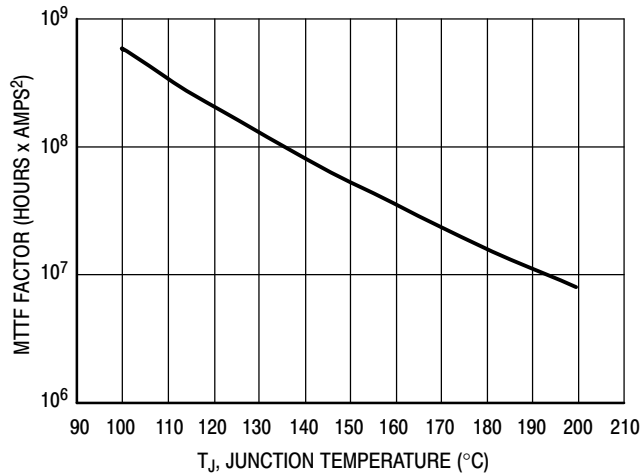


Figure 11. Power Gain versus Output Power

TYPICAL CHARACTERISTICS



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 12. MTTF Factor versus Junction Temperature

W-CDMA TEST SIGNAL

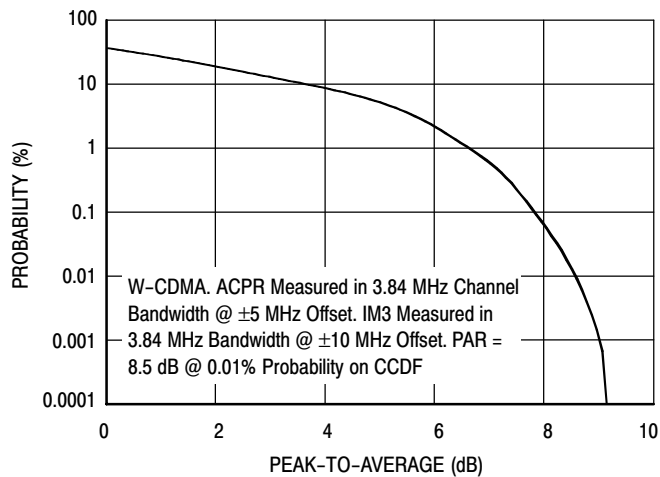


Figure 13. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single-Carrier Test Signal

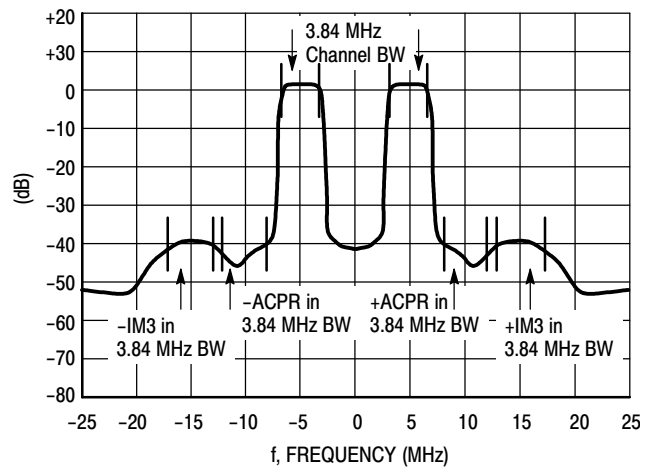
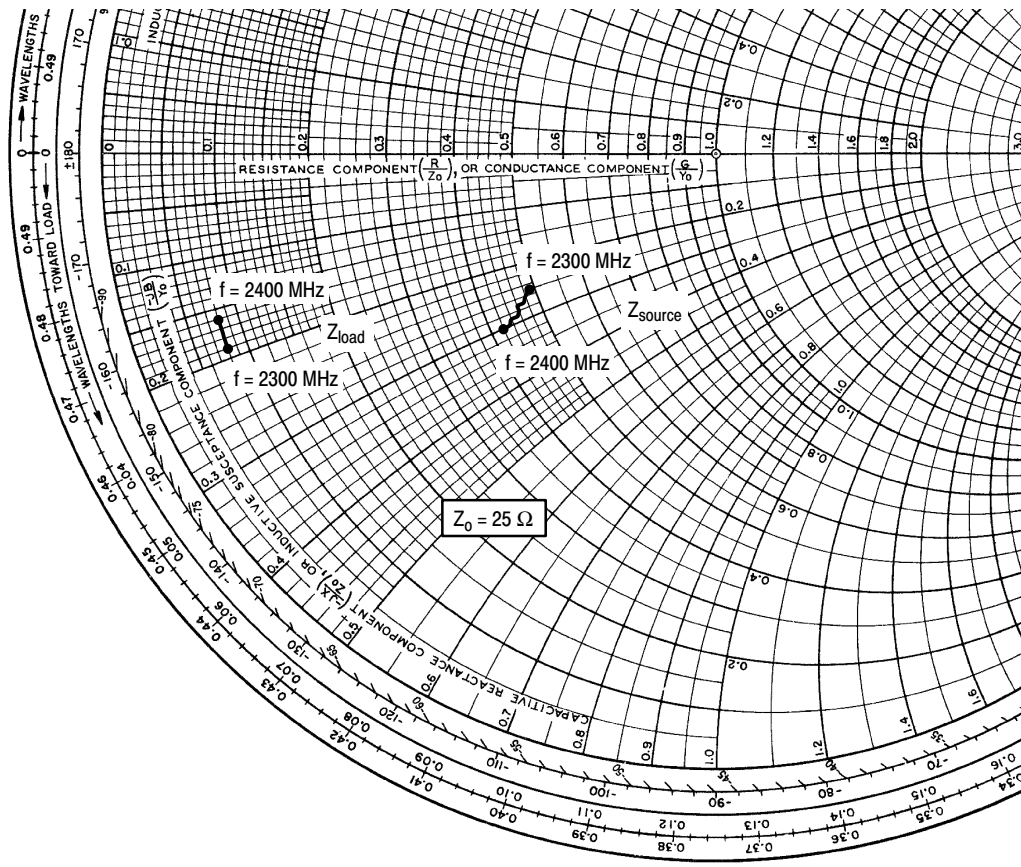


Figure 14. 2-Carrier W-CDMA Spectrum



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1000 \text{ mA}$, $P_{out} = 20 \text{ W Avg.}$

| f MHz | Z _{source} Ω | Z _{load} Ω |
|----------|--------------------------|------------------------|
| 2300 | 12.20 - j6.20 | 2.06 - j4.69 |
| 2310 | 12.06 - j6.40 | 2.04 - j4.62 |
| 2320 | 11.91 - j6.56 | 2.02 - j4.55 |
| 2330 | 11.76 - j6.71 | 2.01 - j4.48 |
| 2340 | 11.60 - j6.86 | 1.99 - j4.42 |
| 2350 | 11.44 - j7.00 | 1.97 - j4.35 |
| 2360 | 11.27 - j7.13 | 1.96 - j4.28 |
| 2370 | 11.10 - j7.22 | 1.94 - j4.22 |
| 2380 | 10.92 - j7.34 | 1.93 - j4.15 |
| 2390 | 10.73 - j7.46 | 1.91 - j4.09 |
| 2400 | 10.55 - j7.53 | 1.90 - j4.02 |

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

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

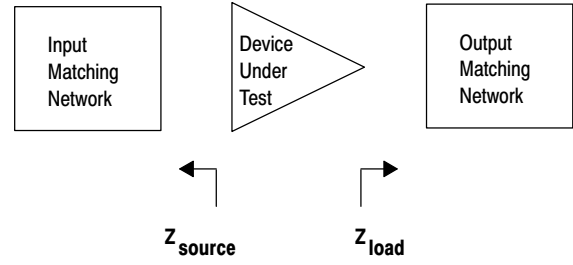


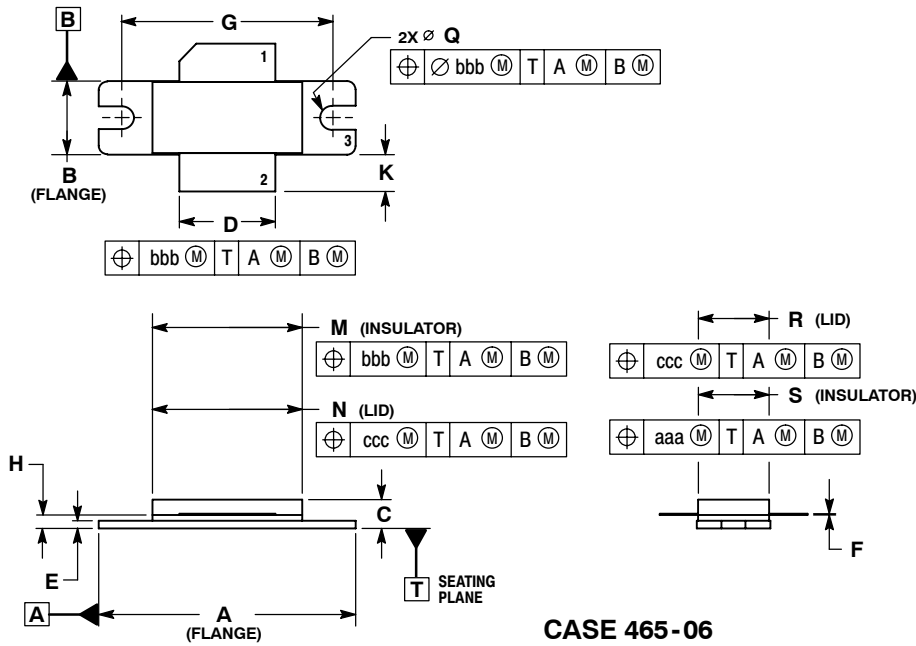
Figure 15. Series Equivalent Source and Load Impedance

MRF6S23100HR3 MRF6S23100HSR3

NOTES

NOTES

PACKAGE DIMENSIONS

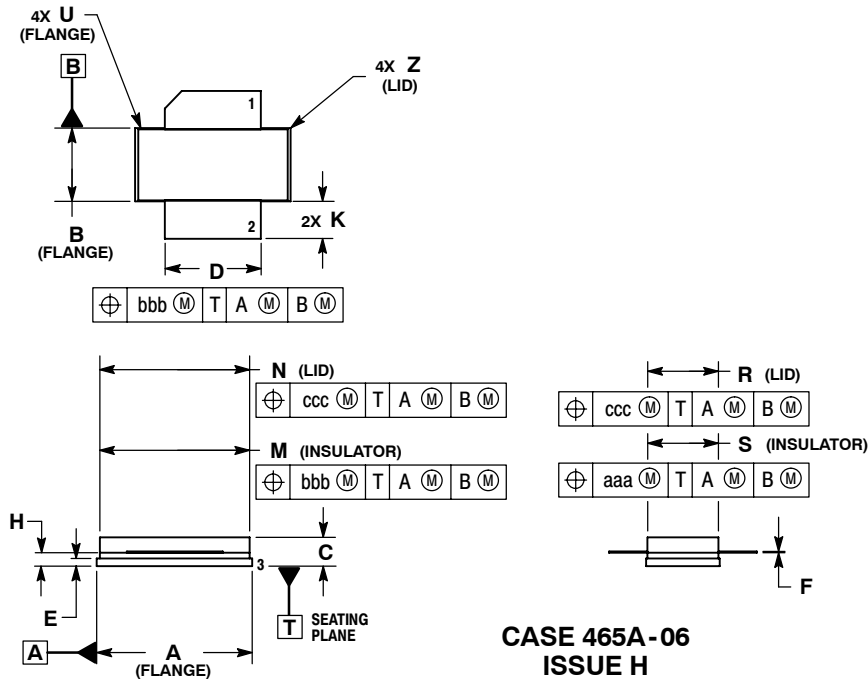


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
 2. CONTROLLING DIMENSION: INCH.
 3. DELETED
 4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

| 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 | Ø 1.118 | Ø 1.138 | Ø 3.00 | Ø 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
 MRF6S23100HR3**



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
 2. CONTROLLING DIMENSION: INCH.
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| 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
 MRF6S23100HSR3**

MRF6S23100HR3 MRF6S23100HSR3

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