



RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed primarily for large-signal output applications at 2450 MHz. Devices are suitable for use in industrial, medical and scientific applications.

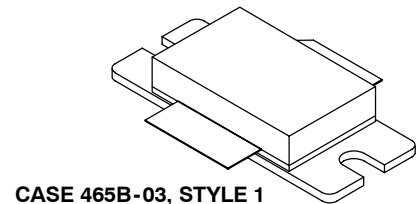
- Typical CW Performance at 2450 MHz, $V_{DD} = 28$ Volts, $I_{DQ} = 1200$ mA, $P_{out} = 140$ Watts
 Power Gain — 13.2 dB
 Drain Efficiency — 45%
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2390 MHz, 140 Watts CW Output Power

Features

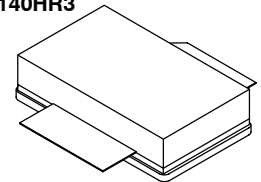
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF6S24140HR3
MRF6S24140HSR3

**2450 MHz, 140 W, 28 V
 CW
 LATERAL N-CHANNEL
 RF POWER MOSFETs**



**CASE 465B-03, STYLE 1
 NI-880
 MRF6S24140HR3**



**CASE 465C-02, STYLE 1
 NI-880S
 MRF6S24140HSR3**

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 |
| 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 82°C, 140 W CW Case Temperature 75°C, 28 W CW | $R_{\theta JC}$ | 0.29 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

| 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 ($T_C = 25^\circ\text{C}$ 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} | — | — | 500 | nAdc |

On Characteristics

| | | | | | |
|--|--------------|-----|------|-----|-----|
| Gate Threshold Voltage ($V_{DS} = 10 \text{ Vdc}$, $I_D = 300 \mu\text{Adc}$) | $V_{GS(th)}$ | 1 | 2 | 3 | Vdc |
| Gate Quiescent Voltage ($V_{DD} = 28 \text{ Vdc}$, $I_D = 1300 \text{ mAdc}$, Measured in Functional Test) | $V_{GS(Q)}$ | 2 | 2.8 | 4 | Vdc |
| Drain-Source On-Voltage ($V_{GS} = 10 \text{ Vdc}$, $I_D = 3 \text{ Adc}$) | $V_{DS(on)}$ | 0.1 | 0.21 | 0.3 | Vdc |

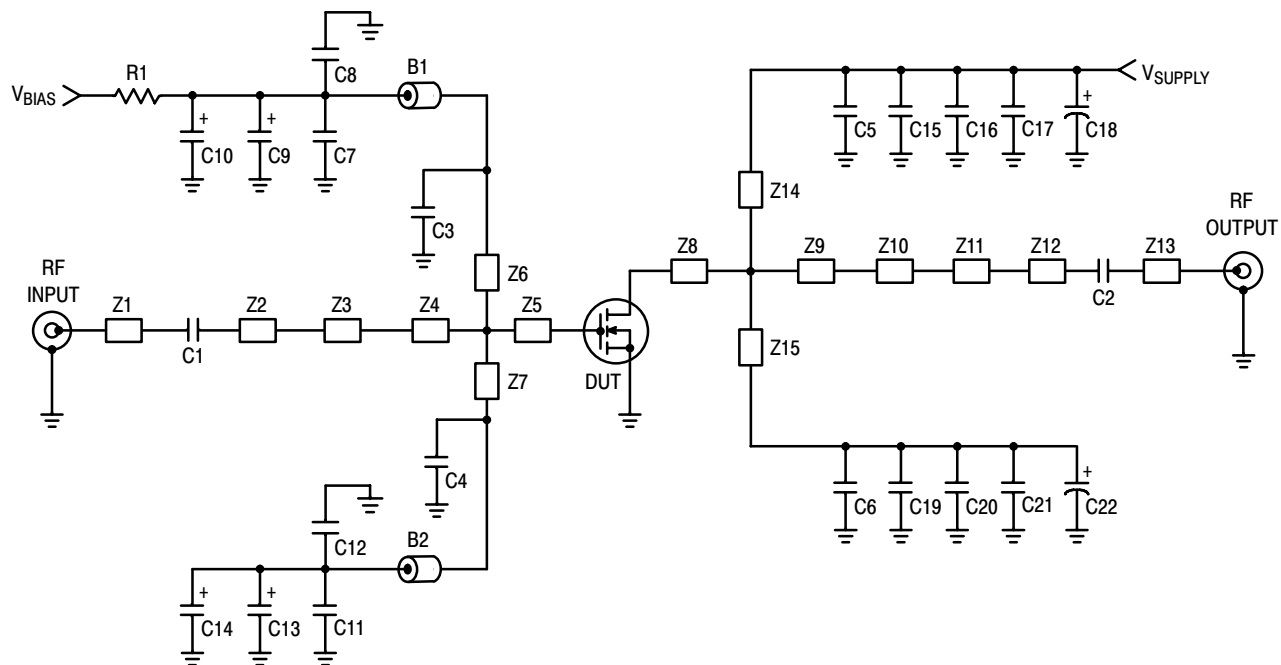
Dynamic Characteristics ⁽¹⁾

| | | | | | |
|--|-----------|---|---|---|----|
| Reverse Transfer Capacitance ($V_{DS} = 28 \text{ Vdc} \pm 30 \text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0 \text{ Vdc}$) | C_{rss} | — | 2 | — | pF |
|--|-----------|---|---|---|----|

Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1300 \text{ mA}$, $P_{out} = 28 \text{ W Avg.}$, $f_1 = 2300 \text{ MHz}$, $f_2 = 2310 \text{ MHz}$ 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. Input Signal PAR = 8.5 dB @ 0.01% Probability on CCDF.

| | | | | | |
|------------------------------|----------|----|------|-----|-----|
| Power Gain | G_{ps} | 13 | 15.2 | 17 | dB |
| Drain Efficiency | η_D | 23 | 25 | — | % |
| Intermodulation Distortion | IM3 | — | -37 | -35 | dBc |
| Adjacent Channel Power Ratio | ACPR | — | -40 | -38 | dBc |
| Input Return Loss | IRL | — | -15 | — | dB |

1. Part internally matched both on input and output.

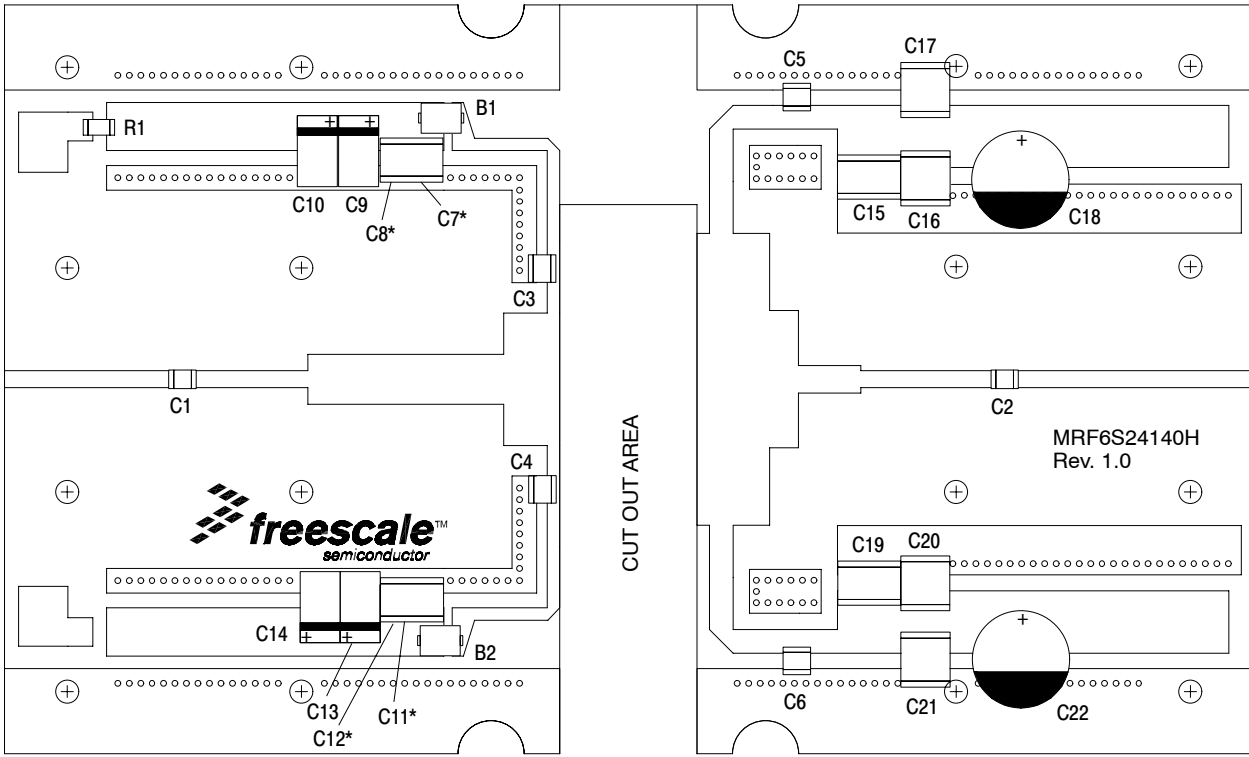


| | | | |
|--------|----------------------------|----------|--|
| Z1 | 0.678" x 0.068" Microstrip | Z9 | 0.193" x 1.170" Microstrip |
| Z2 | 0.466" x 0.068" Microstrip | Z10 | 0.115" x 0.550" Microstrip |
| Z3 | 0.785" x 0.200" Microstrip | Z11 | 0.250" x 0.110" Microstrip |
| Z4 | 0.200" x 0.530" Microstrip | Z12 | 0.538" x 0.068" Microstrip |
| Z5 | 0.025" x 0.530" Microstrip | Z13 | 0.957" x 0.068" Microstrip |
| Z6, Z7 | 0.178" x 0.050" Microstrip | Z14, Z15 | 0.673" x 0.095" Microstrip |
| Z8 | 0.097" x 1.170" Microstrip | PCB | Arlon CuClad 250GX-0300-55-22, 0.030", $\epsilon_r = 2.55$ |

Figure 1. MRF6S24140HR3(SR3) Test Circuit Schematic — 2450 MHz

Table 5. MRF6S24140HR3(SR3) Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|------------------------|--|--------------------|--------------|
| B1, B2 | 47 Ω , 100 MHz Short Ferrite Beads, Surface Mount | 2743019447 | Fair-Rite |
| C1, C2, C3, C4, C5, C6 | 5.6 pF Chip Capacitors | ATC600B5R6BT500XT | ATC |
| C7, C11 | 0.01 μ F, 100 V Chip Capacitors | C1825C103J1RAC | Kemet |
| C8, C12, C15, C19 | 2.2 μ F, 50 V Chip Capacitors | C1825C225J5RAC | Kemet |
| C9, C13 | 22 μ F, 25 V Tantalum Capacitors | T491D226M025AT | Kemet |
| C10, C14 | 47 μ F, 16 V Tantalum Capacitors | T491D476K016AT | Kemet |
| C16, C17, C20, C21 | 10 μ F, 50 V Chip Capacitors | GRM55DR61H106KA88B | Murata |
| C18, C22 | 220 μ F, 50 V Electrolytic Capacitors | 2222-150-95102 | Vishay |
| R1 | 240 Ω , 1/4 W Chip Resistor | CRC12062400FKEA | Vishay |



* Stacked

Figure 2. MRF6S24140HR3(SR3) Test Circuit Component Layout — 2450 MHz

TYPICAL CHARACTERISTICS — 2450 MHz

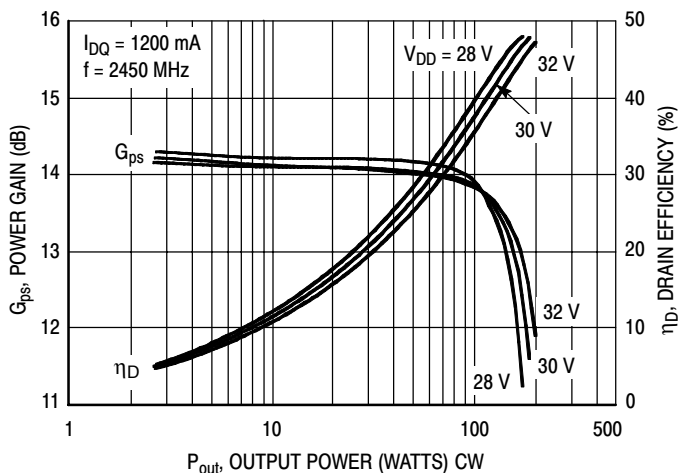


Figure 3. Power Gain and Drain Efficiency versus CW Output Power as a Function of V_{DD}

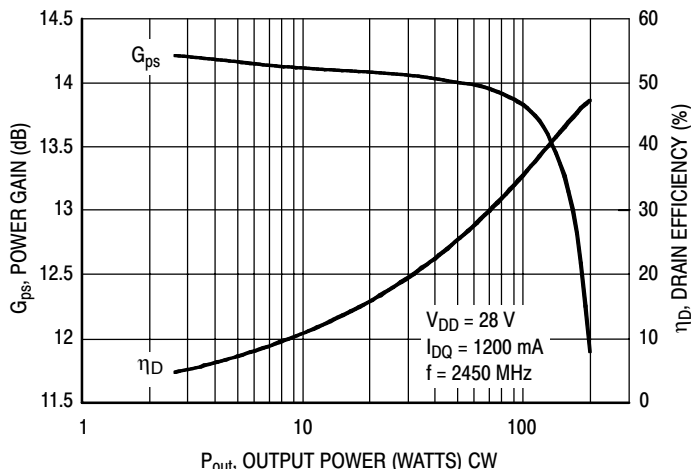


Figure 4. Power Gain and Drain Efficiency versus CW Output Power

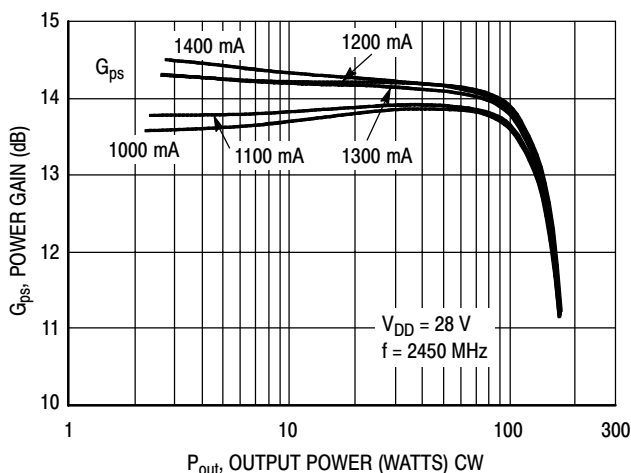
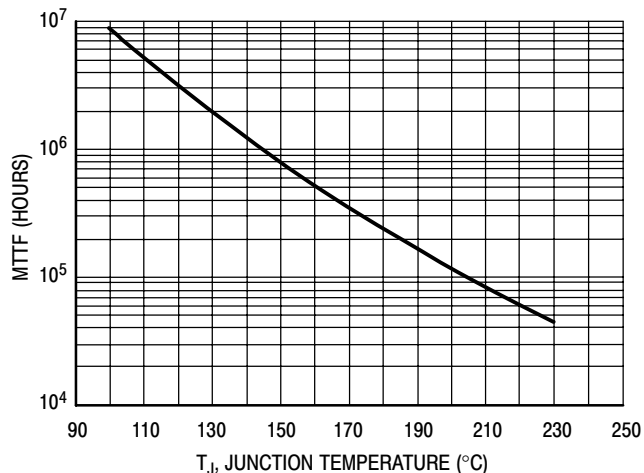


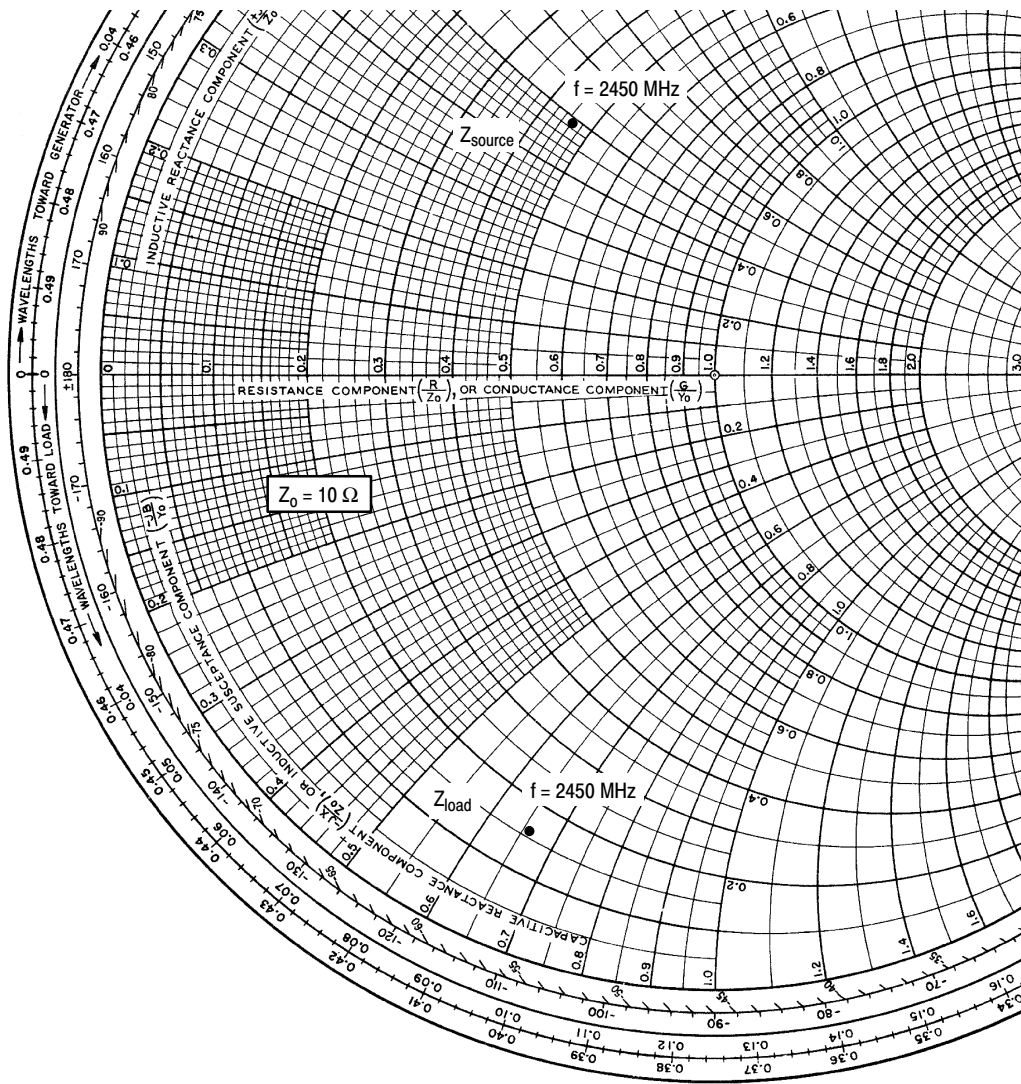
Figure 5. Power Gain and Drain Efficiency versus CW Output Power as a Function of Total I_{DQ}



This above graph displays calculated MTTF in hours when the device is operated at $V_{DD} = 28$ Vdc, $P_{out} = 140$ W CW, and $\eta_D = 45\%$.

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

Figure 6. MTTF versus Junction Temperature



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1200 \text{ mA}$, $P_{out} = 140 \text{ W CW}$

| f MHz | Z_{source} Ω | Z_{load} Ω |
|----------|--------------------------|------------------------|
| 2450 | $4.55 + j4.9$ | $1.64 - j6.57$ |

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

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

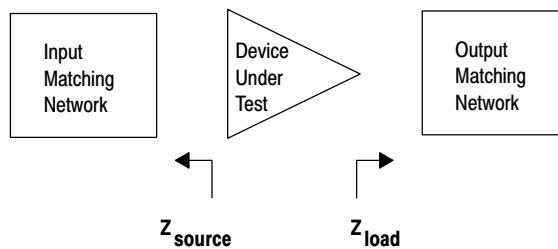
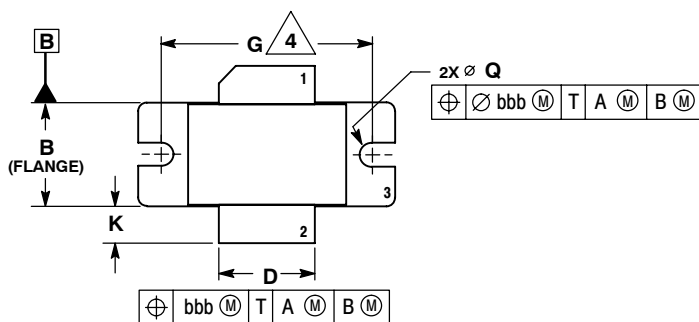


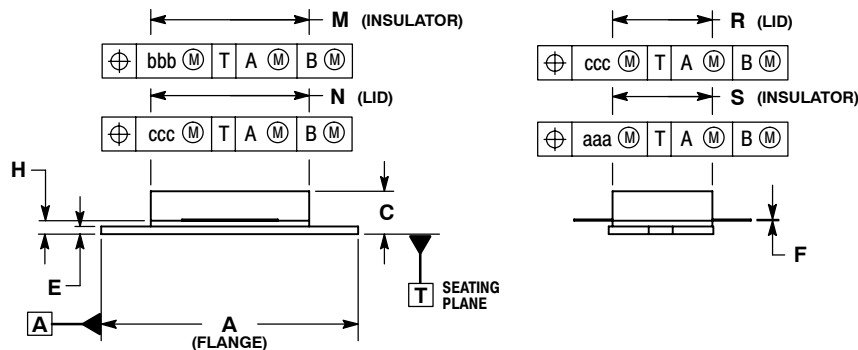
Figure 7. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS



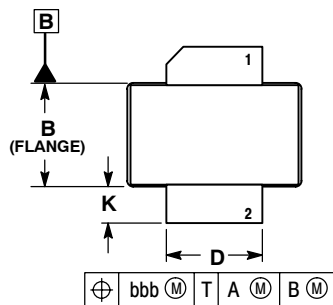
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
 4. RECOMMENDED BOLT CENTER DIMENSION OF 1.16 (29.57) BASED ON M3 SCREW.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 1.335 | 1.345 | 33.91 | 34.16 |
| B | 0.535 | 0.545 | 13.6 | 13.8 |
| C | 0.147 | 0.200 | 3.73 | 5.08 |
| 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 | 0.175 | 0.205 | 4.44 | 5.21 |
| M | 0.872 | 0.888 | 22.15 | 22.55 |
| N | 0.871 | 0.889 | 19.30 | 22.60 |
| Q | Ø.118 | Ø.138 | Ø3.00 | Ø3.51 |
| R | 0.515 | 0.525 | 13.10 | 13.30 |
| S | 0.515 | 0.525 | 13.10 | 13.30 |
| aaa | 0.007 REF | | 0.178 REF | |
| bbb | 0.010 REF | | 0.254 REF | |
| ccc | 0.015 REF | | 0.381 REF | |



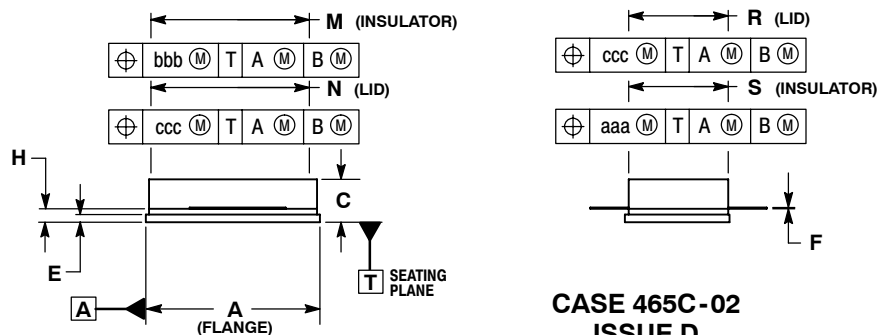
**CASE 465B-03
ISSUE D
NI-880
MRF6S24140HR3**

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



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

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.905 | 0.915 | 22.99 | 23.24 |
| B | 0.535 | 0.545 | 13.60 | 13.80 |
| C | 0.147 | 0.200 | 3.73 | 5.08 |
| 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 | 0.872 | 0.888 | 22.15 | 22.55 |
| N | 0.871 | 0.889 | 19.30 | 22.60 |
| R | 0.515 | 0.525 | 13.10 | 13.30 |
| S | 0.515 | 0.525 | 13.10 | 13.30 |
| aaa | 0.007 REF | | 0.178 REF | |
| bbb | 0.010 REF | | 0.254 REF | |
| ccc | 0.015 REF | | 0.381 REF | |



**CASE 465C-02
ISSUE D
NI-880S
MRF6S24140HSR3**

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

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 | Mar. 2007 | <ul style="list-style-type: none">• Initial Release of Data Sheet |
| 1 | Apr. 2008 | <ul style="list-style-type: none">• Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table and related "Continuous use at maximum temperature will affect MTTF" footnote added, p. 1• Corrected V_{DS} to V_{DD} in the RF test condition voltage callout for $V_{GS(Q)}$, and added "Measured in Functional Test", On Characteristics table, p. 2• Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3 |

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