

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed primarily for CW large-signal output and driver applications with frequencies up to 450 MHz. Devices are unmatched and are suitable for use in industrial, medical and scientific applications.

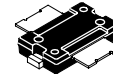
- Typical CW Performance at 220 MHz:  $V_{DD} = 50$  Volts,  $I_{DQ} = 30$  mA,  $P_{out} = 10$  Watts  
Power Gain — 23.9 dB  
Drain Efficiency — 62%
- Capable of Handling 10:1 VSWR, @ 50 Vdc, 220 MHz, 10 Watts CW Output Power

### Features

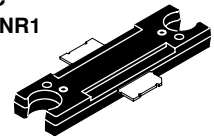
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Qualified Up to a Maximum of 50  $V_{DD}$  Operation
- Integrated ESD Protection
- 225°C Capable Plastic Package
- RoHS Compliant
- TO-270-2 in Tape and Reel. R1 Suffix = 500 Units per 24 mm, 13 inch Reel.
- TO-272-2 in Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel.

**MRF6V2010NR1**  
**MRF6V2010NBR1**

**10-450 MHz, 10 W, 50 V**  
**LATERAL N-CHANNEL**  
**BROADBAND**  
**RF POWER MOSFETs**



**CASE 1265-09, STYLE 1**  
**TO-270-2**  
**PLASTIC**  
**MRF6V2010NR1**



**CASE 1337-04, STYLE 1**  
**TO-272-2**  
**PLASTIC**  
**MRF6V2010NBR1**

**Table 1. Maximum Ratings**

| Rating                               | Symbol    | Value        | Unit |
|--------------------------------------|-----------|--------------|------|
| Drain-Source Voltage                 | $V_{DSS}$ | -0.5, +110   | Vdc  |
| Gate-Source Voltage                  | $V_{GS}$  | -0.5, +10    | 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<br>Case Temperature 81°C, 10 W CW | $R_{\theta JC}$ | 3.0         | °C/W |

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescal Semiconductor.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.freescal Semiconductor.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. Moisture Sensitivity Level**

| Test Methodology                      | Rating | Package Peak Temperature | Unit |
|---------------------------------------|--------|--------------------------|------|
| Per JESD 22-A113, IPC/JEDEC J-STD-020 | 3      | 260                      | °C   |

**Table 5. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**Off Characteristics**

|                                                                                                    |               |     |   |     |                 |
|----------------------------------------------------------------------------------------------------|---------------|-----|---|-----|-----------------|
| Gate-Source Leakage Current<br>( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )               | $I_{GSS}$     | —   | — | 10  | $\mu\text{Adc}$ |
| Drain-Source Breakdown Voltage<br>( $I_D = 5\text{ mA}$ , $V_{GS} = 0\text{ Vdc}$ )                | $V_{(BR)DSS}$ | 110 | — | —   | Vdc             |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 50\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )  | $I_{DSS}$     | —   | — | 50  | $\mu\text{Adc}$ |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 100\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ ) | $I_{DSS}$     | —   | — | 2.5 | mA              |

**On Characteristics**

|                                                                                                              |              |     |      |     |     |
|--------------------------------------------------------------------------------------------------------------|--------------|-----|------|-----|-----|
| Gate Threshold Voltage<br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 28\text{ }\mu\text{Adc}$ )                     | $V_{GS(th)}$ | 1   | 1.68 | 3   | Vdc |
| Gate Quiescent Voltage<br>( $V_{DD} = 50\text{ Vdc}$ , $I_D = 30\text{ mAdc}$ , Measured in Functional Test) | $V_{GS(Q)}$  | 1.5 | 2.68 | 3.5 | Vdc |
| Drain-Source On-Voltage<br>( $V_{GS} = 10\text{ Vdc}$ , $I_D = 70\text{ mAdc}$ )                             | $V_{DS(on)}$ | —   | 0.26 | —   | Vdc |

**Dynamic Characteristics**

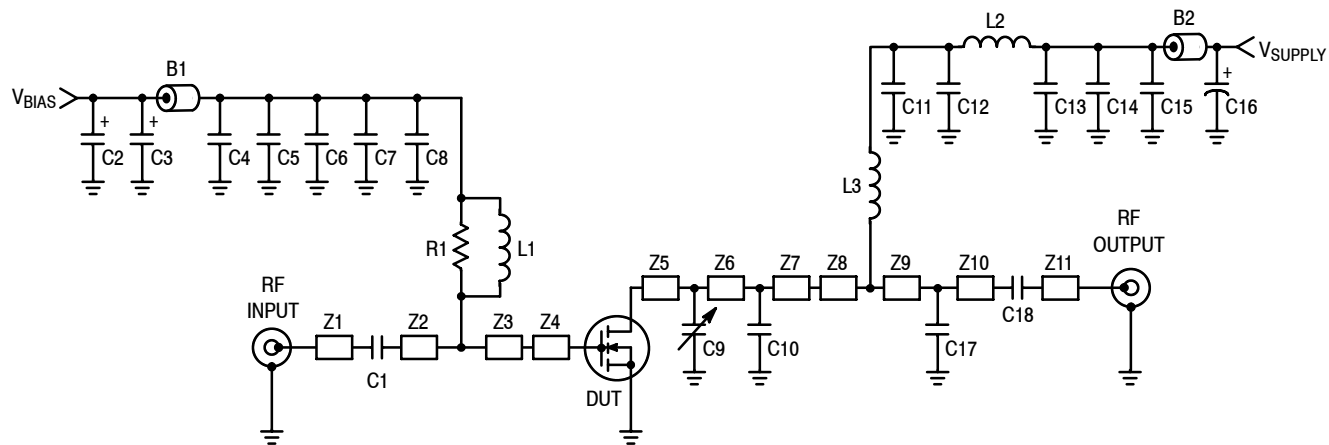
|                                                                                                                       |           |   |      |   |    |
|-----------------------------------------------------------------------------------------------------------------------|-----------|---|------|---|----|
| Reverse Transfer Capacitance<br>( $V_{DS} = 50\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ ) | $C_{rss}$ | — | 0.13 | — | pF |
| Output Capacitance<br>( $V_{DS} = 50\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )           | $C_{oss}$ | — | 7.3  | — | pF |
| Input Capacitance<br>( $V_{DS} = 50\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz)            | $C_{iss}$ | — | 16.3 | — | pF |

**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 50\text{ Vdc}$ ,  $I_{DQ} = 30\text{ mA}$ ,  $P_{out} = 10\text{ W}$ ,  $f = 220\text{ MHz}$ , CW

|                   |          |      |      |      |    |
|-------------------|----------|------|------|------|----|
| Power Gain        | $G_{ps}$ | 22.5 | 23.9 | 25.5 | dB |
| Drain Efficiency  | $\eta_D$ | 58   | 62   | —    | %  |
| Input Return Loss | IRL      | —    | -14  | -9   | dB |



ATTENTION: The MRF6V2010N and MRF6V2010NB are high power devices and special considerations must be followed in board design and mounting. Incorrect mounting can lead to internal temperatures which exceed the maximum allowable operating junction temperature. Refer to Freescale Application Note AN3263 (for bolt down mounting) or AN1907 (for solder reflow mounting) **PRIOR TO STARTING SYSTEM DESIGN** to ensure proper mounting of these devices.



|    |                            |     |                                                            |
|----|----------------------------|-----|------------------------------------------------------------|
| Z1 | 0.235" x 0.082" Microstrip | Z7  | 0.062" x 0.270" Microstrip                                 |
| Z2 | 1.190" x 0.082" Microstrip | Z8  | 0.198" x 0.082" Microstrip                                 |
| Z3 | 0.619" x 0.082" Microstrip | Z9  | 5.600" x 0.082" Microstrip                                 |
| Z4 | 0.190" x 0.270" Microstrip | Z10 | 0.442" x 0.082" Microstrip                                 |
| Z5 | 0.293" x 0.270" Microstrip | Z11 | 0.341" x 0.082" Microstrip                                 |
| Z6 | 0.120" x 0.270" Microstrip | PCB | Arlon CuClad 250GX-0300-55-22, 0.030", $\epsilon_r = 2.55$ |

**Figure 1. MRF6V2010NR1(NBR1) Test Circuit Schematic**

**Table 6. MRF6V2010NR1(NBR1) Test Circuit Component Designations and Values**

| Part             | Description                              | Part Number        | Manufacturer     |
|------------------|------------------------------------------|--------------------|------------------|
| B1, B2           | 95 $\Omega$ , 100 MHz Long Ferrite Beads | 2743021447         | Fair-Rite        |
| C1, C8, C11, C18 | 1000 pF Chip Capacitors                  | ATC100B102JT50XT   | ATC              |
| C2               | 10 $\mu$ F, 35 V Tantalum Capacitor      | T491D106K035AT     | Kemet            |
| C3               | 22 $\mu$ F, 35 V Tantalum Capacitor      | T491X226K035AT     | Kemet            |
| C4, C13          | 39 K pF Chip Capacitors                  | ATC200B393KT50XT   | ATC              |
| C5, C14          | 22 K pF Chip Capacitors                  | ATC200B223KT50XT   | ATC              |
| C6, C15          | 0.1 $\mu$ F Chip Capacitors              | CDR33BX104AKYS     | Kemet            |
| C7, C12          | 2.2 $\mu$ F, 50 V Chip Capacitors        | C1825C225J5RAC     | Kemet            |
| C9               | 0.6-4.5 pF Variable Capacitor, Gigatrim  | 27271SL            | Johanson         |
| C10              | 12 pF Chip Capacitor                     | ATC100B120JT500XT  | ATC              |
| C16              | 470 $\mu$ F, 63 V Electrolytic Capacitor | ESMG630ELL471MK205 | United Chemi-Con |
| C17              | 27 pF Chip Capacitor                     | ATC100B270JT500XT  | ATC              |
| L1               | 17.5 nH Inductor                         | B06T               | CoilCraft        |
| L2, L3           | 82 nH Inductors                          | 1812SMS-82NJ       | CoilCraft        |
| R1               | 120 $\Omega$ , 1/4 W Chip Resistor       | CRCW1206120RFKEA   | Vishay           |

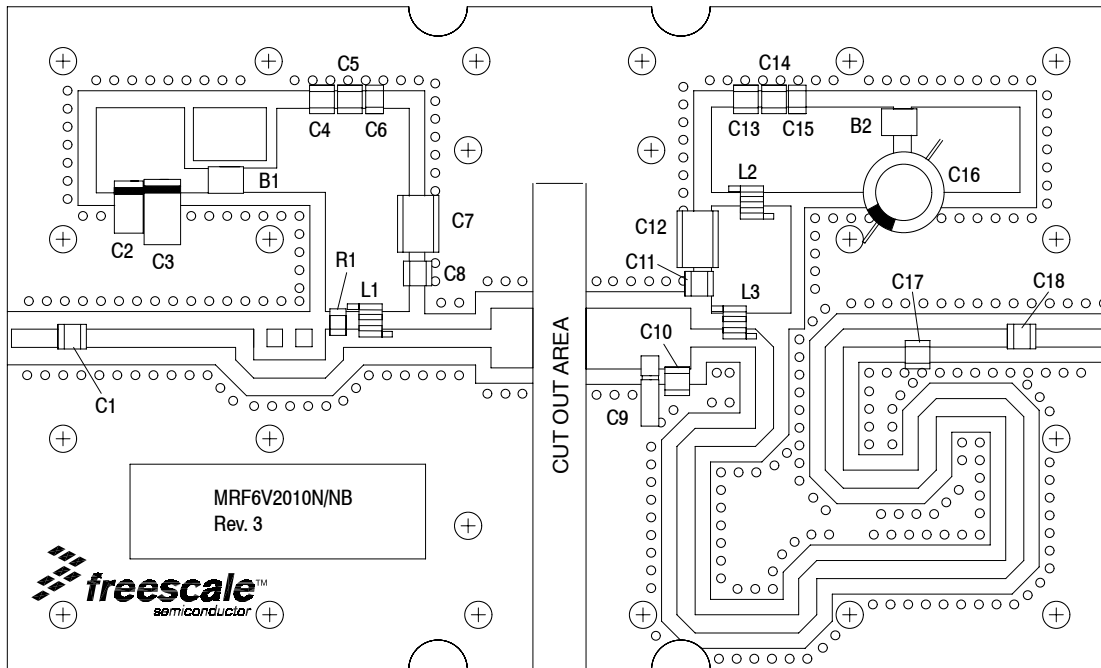


Figure 2. MRF6V2010NR1(NBR1) Test Circuit Component Layout

## TYPICAL CHARACTERISTICS

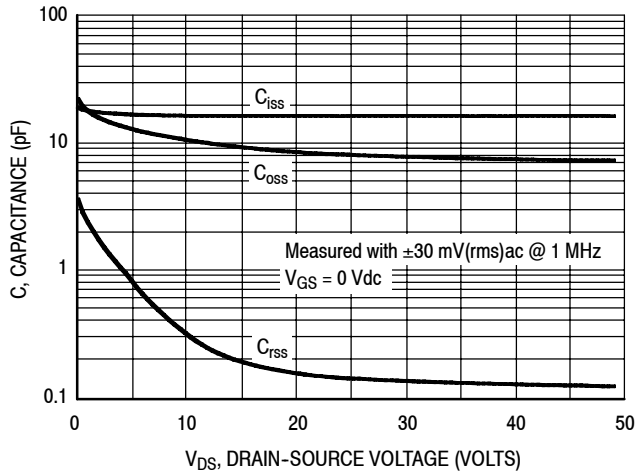


Figure 3. Capacitance versus Drain-Source Voltage

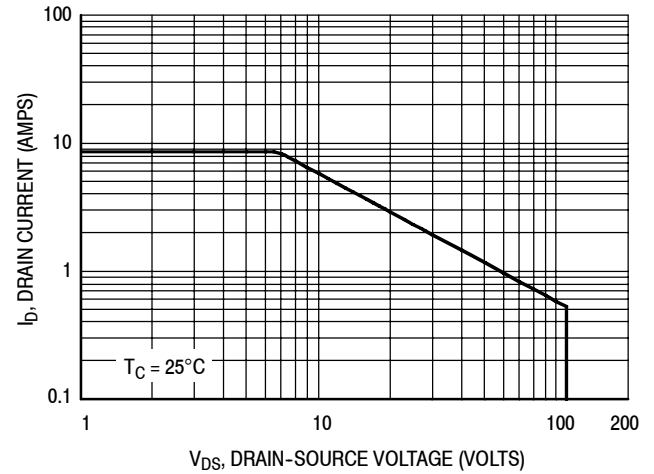


Figure 4. DC Safe Operating Area

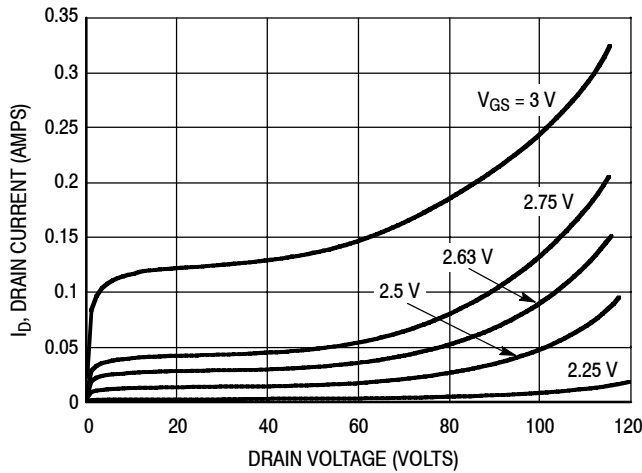


Figure 5. DC Drain Current versus Drain Voltage

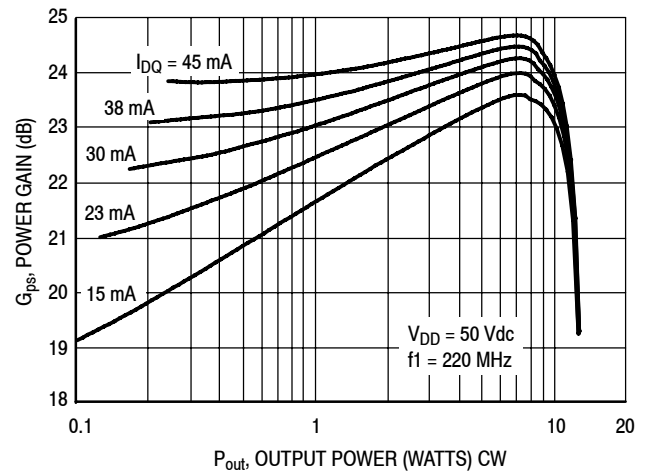


Figure 6. CW Power Gain versus Output Power

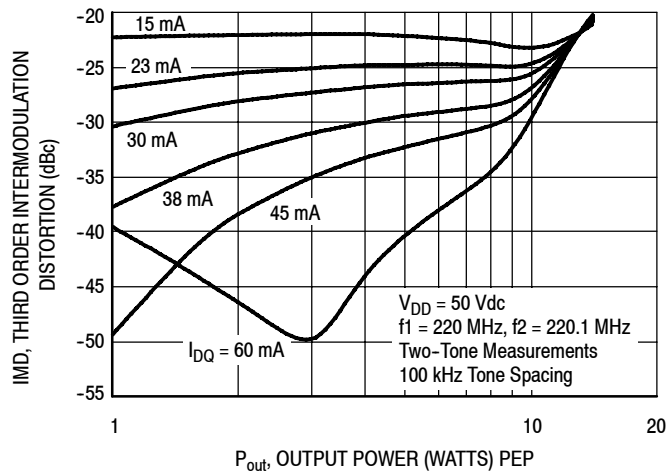


Figure 7. Third Order Intermodulation Distortion versus Output Power

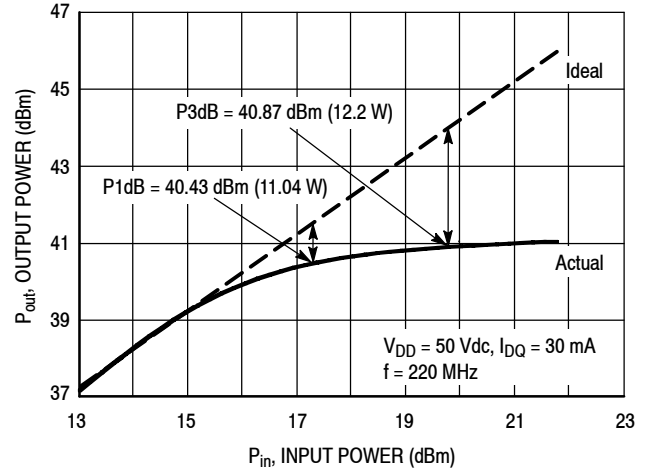


Figure 8. CW Output Power versus Input Power

## TYPICAL CHARACTERISTICS

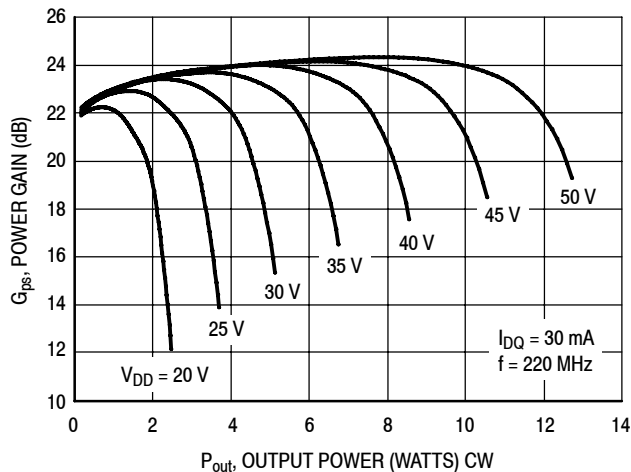


Figure 9. Power Gain versus Output Power

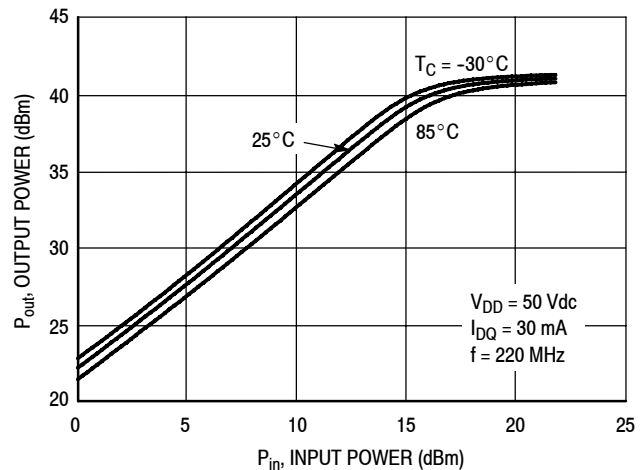


Figure 10. Power Output versus Power Input

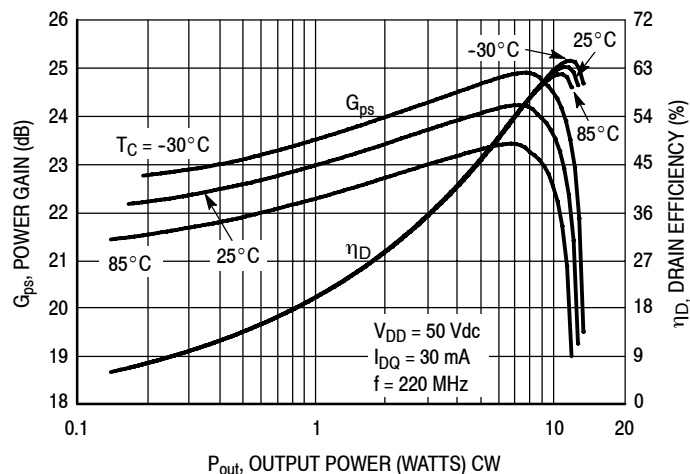


Figure 11. Power Gain and Drain Efficiency versus CW Output Power

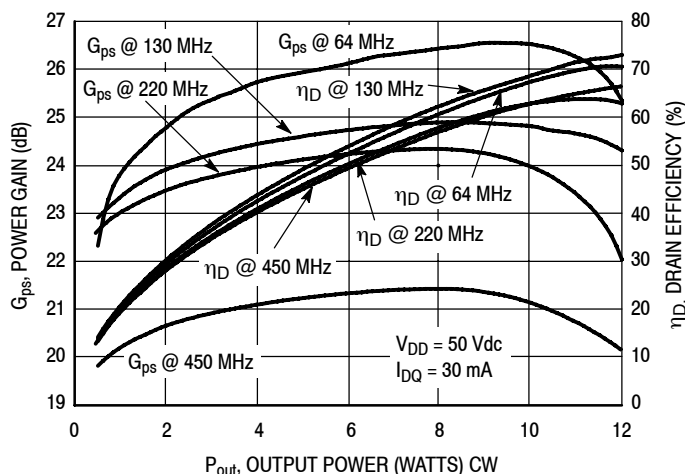
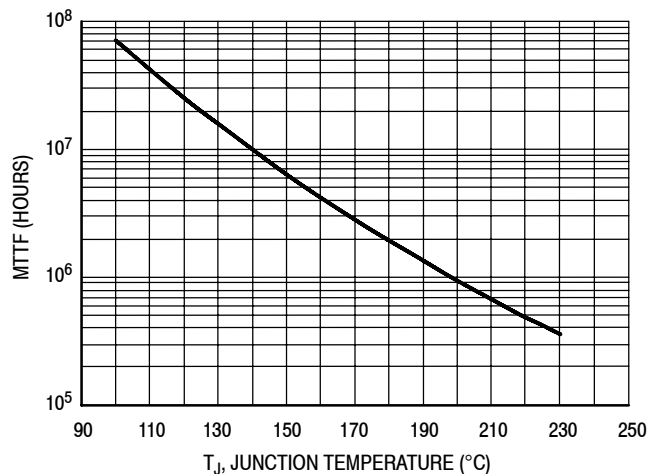


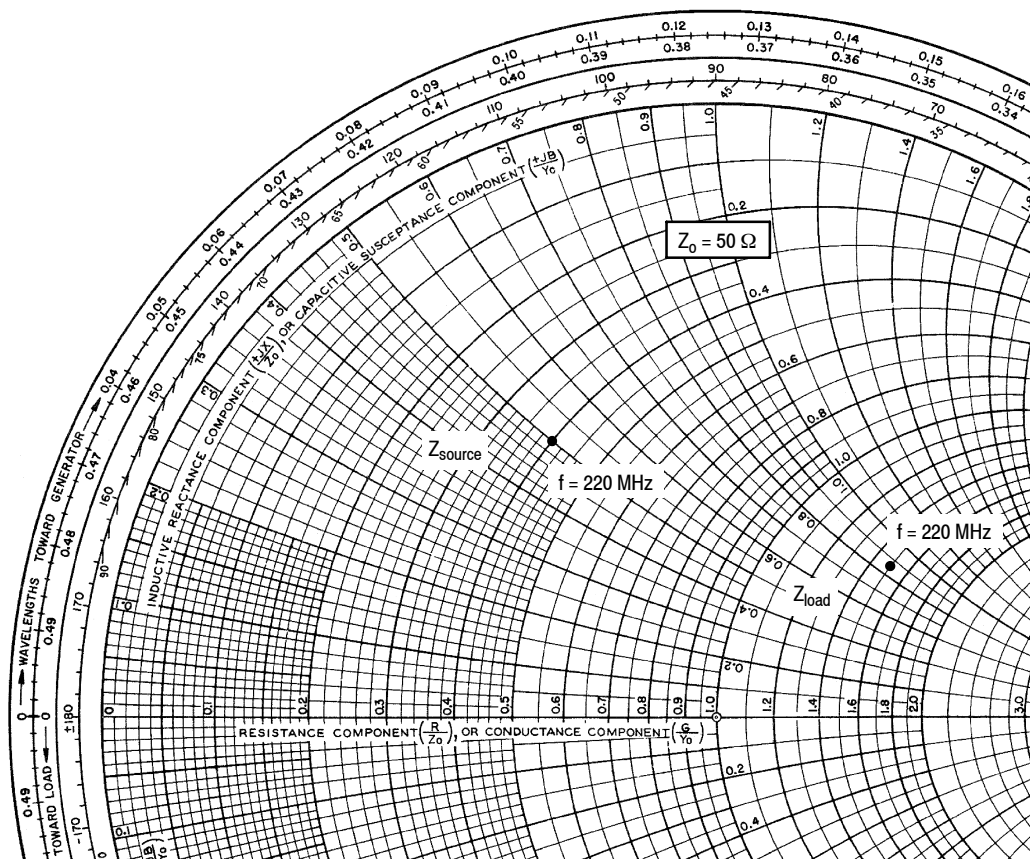
Figure 12. Power Gain and Drain Efficiency versus CW Output Power



This above graph displays calculated MTTF in hours when the device is operated at  $V_{DD} = 50$  Vdc,  $P_{out} = 10$  W CW, and  $\eta_D = 62\%$ .

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



$V_{DD} = 50 \text{ Vdc}$ ,  $I_{DQ} = 30 \text{ mA}$ ,  $P_{out} = 10 \text{ W CW}$

| f<br>MHz | $Z_{source}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|----------|--------------------------|------------------------|
| 220      | $20 + j25$               | $75 + j44$             |

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

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

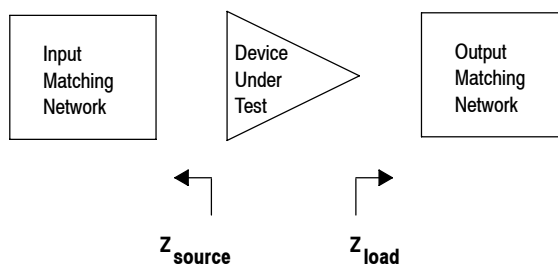


Figure 14. Series Equivalent Source and Load Impedance

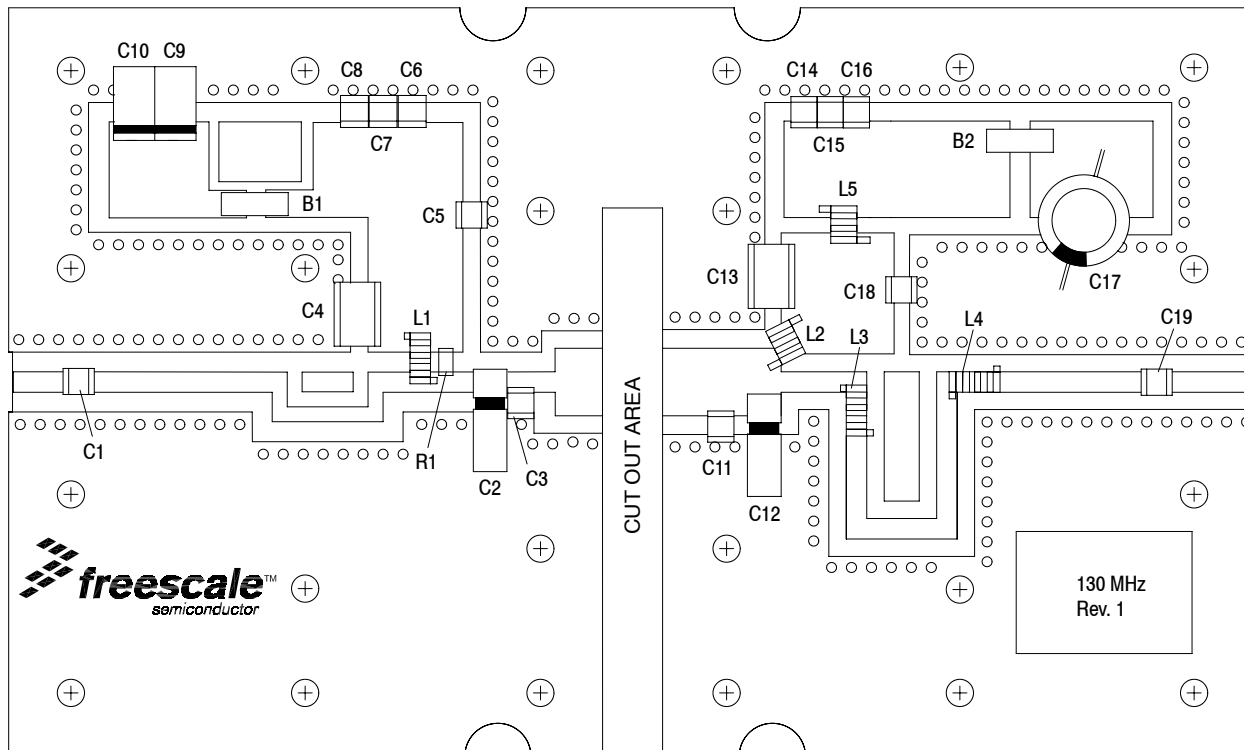


Figure 15. MRF6V2010NR1(NBR1) Test Circuit Component Layout — 130 MHz

Table 7. MRF6V2010NR1(NBR1) Test Circuit Component Designations and Values — 130 MHz

| Part             | Description                                             | Part Number                                             | Manufacturer |
|------------------|---------------------------------------------------------|---------------------------------------------------------|--------------|
| B1, B2           | 95 $\Omega$ , 100 MHz Long Ferrite Beads, Surface Mount | 2743021447                                              | Fair-Rite    |
| C1, C5, C18, C19 | 1000 pF Chip Capacitors                                 | ATC100B102JT50XT                                        | ATC          |
| C2, C12          | 0.6–4.5 pF Variable Capacitors, Gigatrim                | 27271 SL                                                | Johanson     |
| C3               | 27 pF Chip Capacitor                                    | ATC100B270JT500XT                                       | ATC          |
| C4, C13          | 2.2 $\mu$ F, 50 V Chip Capacitors                       | C1825C225J5RAC                                          | Kemet        |
| C6, C14          | 0.1 $\mu$ F, 50 V Chip Capacitors                       | CDR33BX104AKYM                                          | Kemet        |
| C7, C15          | 22K pF Chip Capacitors                                  | ATC200B223KT50XT                                        | ATC          |
| C8, C16          | 39K pF Chip Capacitors                                  | ATC200B393KT50XT                                        | ATC          |
| C9               | 22 $\mu$ F, 35 V Tantalum Capacitor                     | T491X226K035AT                                          | Kemet        |
| C10              | 10 $\mu$ F, 35 V Tantalum Capacitor                     | T491D106K035AT                                          | Kemet        |
| C11              | 16 pF Chip Capacitor                                    | ATC100B160JT500XT                                       | ATC          |
| C17              | 330 $\mu$ F, 63 V Electrolytic Capacitor                | MCRH63V337M13X21-RH                                     | Multicomp    |
| L1               | 17.5 nH Inductor                                        | B06T                                                    | CoilCraft    |
| L2, L5           | 82 nH Inductors                                         | 1812SMS-82NJ                                            | CoilCraft    |
| L3               | 35.5 nH Inductor                                        | B09T                                                    | CoilCraft    |
| L4               | 43 nH Inductor                                          | B10T                                                    | CoilCraft    |
| R1               | 100 $\Omega$ , 1/4 W Chip Resistor                      | CRCW1206100RFKEA                                        | Vishay       |
| PCB              | PCB Material 0.030"                                     | CuClad 250GX-0300-55-22,<br>0.030", $\epsilon_r = 2.55$ | Arlon        |



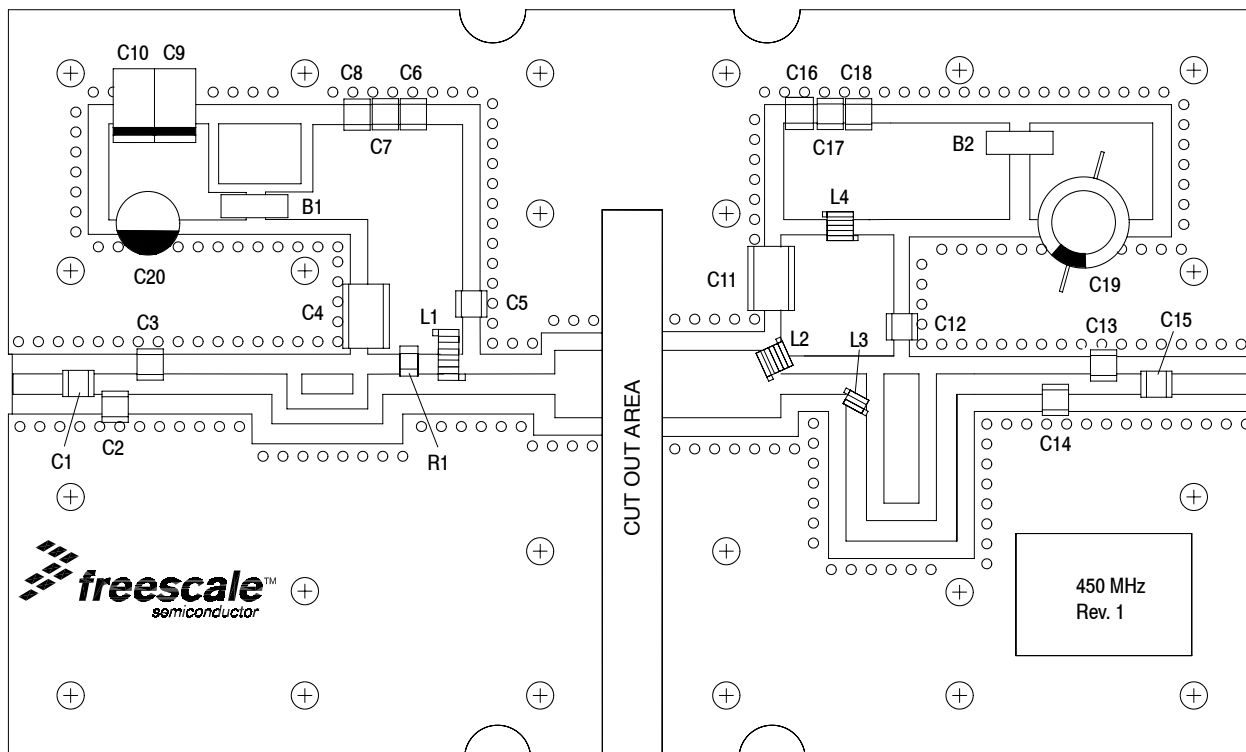


Figure 16. MRF6V2010NR1(NBR1) Test Circuit Component Layout — 450 MHz

Table 8. MRF6V2010NR1(NBR1) Test Circuit Component Designations and Values — 450 MHz

| Part             | Description                                             | Part Number                                             | Manufacturer |
|------------------|---------------------------------------------------------|---------------------------------------------------------|--------------|
| B1, B2           | 95 $\Omega$ , 100 MHz Long Ferrite Beads, Surface Mount | 2743021447                                              | Fair-Rite    |
| C1, C5, C12, C15 | 240 pF Chip Capacitors                                  | ATC100B241JT200XT                                       | ATC          |
| C2, C3           | 10 pF Chip Capacitors                                   | ATC100B100JT500XT                                       | ATC          |
| C4, C11          | 2.2 $\mu$ F, 50 V Chip Capacitors                       | C1825C225J5RAC                                          | Kemet        |
| C6, C16          | 0.1 $\mu$ F 50V Chip Capacitors                         | CDR33BX104AKYM                                          | Kemet        |
| C7, C17          | 22K pF Chip Capacitors                                  | ATC200B223KT50XT                                        | ATC          |
| C8, C18          | 39K pF Chip Capacitors                                  | ATC200B393KT50XT                                        | ATC          |
| C9               | 22 $\mu$ F, 35 V Tantalum Capacitor                     | T491X226K035AT                                          | Kemet        |
| C10              | 10 $\mu$ F, 35 V Tantalum Capacitor                     | T491D106K035AT                                          | Kemet        |
| C13, C14         | 6.2 pF Chip Capacitors                                  | ATC100B6R2BT500XT                                       | ATC          |
| C19              | 470 $\mu$ F, 63 V Electrolytic Capacitor                | MCGPR63V477M13X26-RH                                    | Multicomp    |
| C20              | 47 $\mu$ F, 50 V Electrolytic Capacitor                 | 476KXM050M                                              | Illinois Cap |
| L1               | 17.5 nH Inductor                                        | B06T                                                    | CoilCraft    |
| L2, L4           | 82 nH Inductors                                         | 1812SMS-82NJ                                            | CoilCraft    |
| L3               | 5.0 nH Inductor                                         | A02T                                                    | CoilCraft    |
| R1               | 120 $\Omega$ , 1/4 W Chip Resistor                      | CRCW1206120RFKEA                                        | Vishay       |
| PCB              | PCB Material 0.030"                                     | CuClad 250GX-0300-55-22,<br>0.030", $\epsilon_r = 2.55$ | Arlon        |

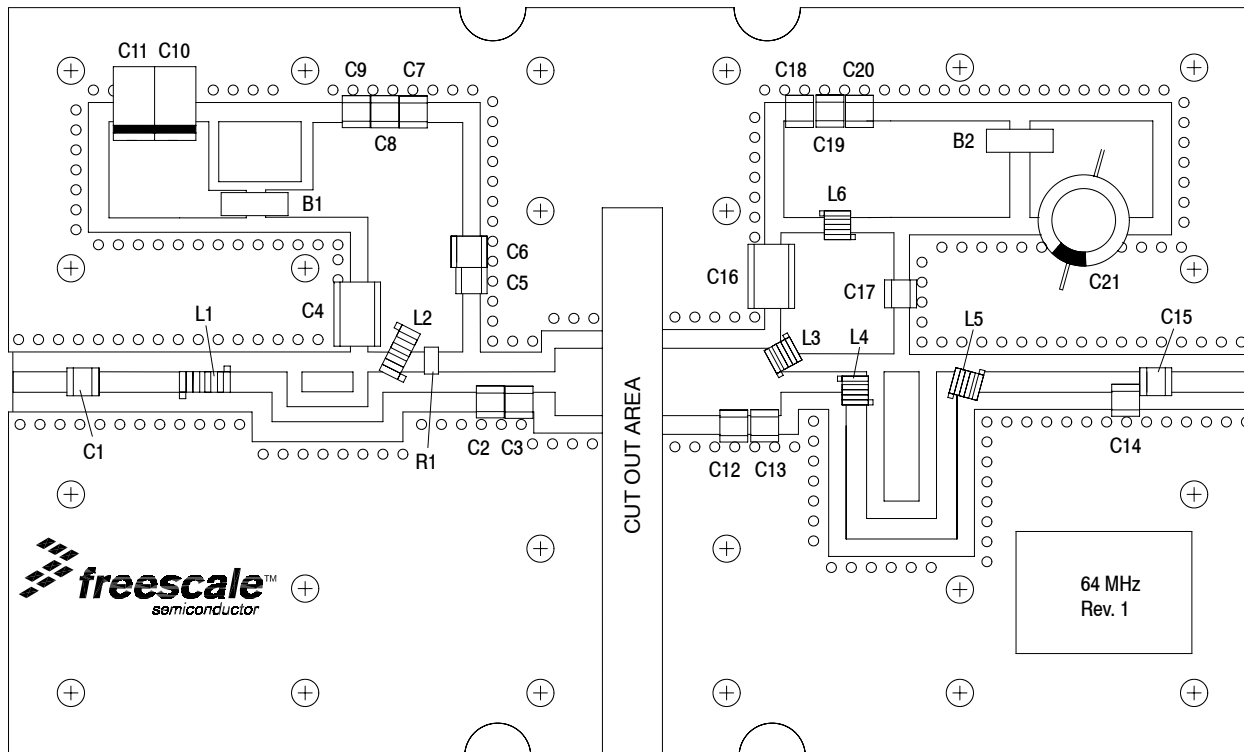
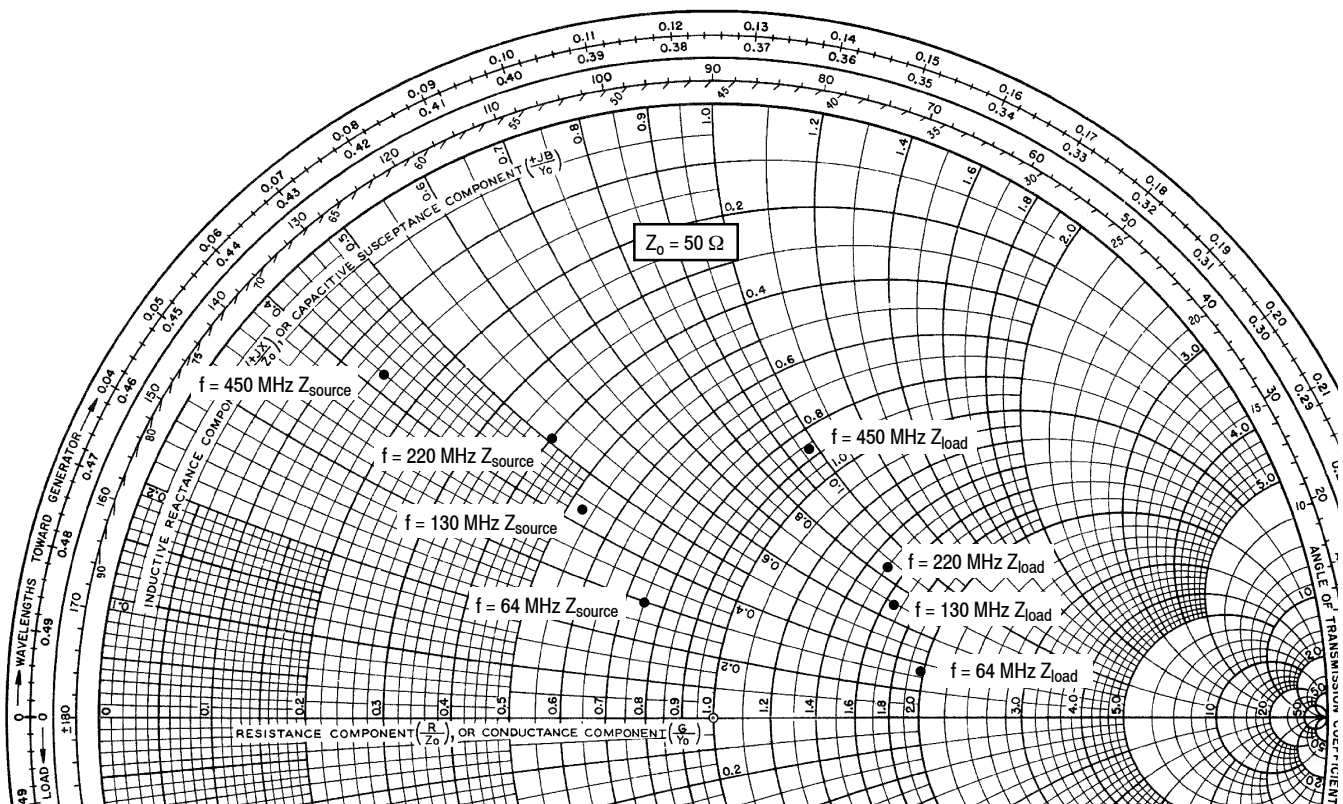


Figure 17. MRF6V2010NR1(NBR1) Test Circuit Component Layout — 64 MHz

Table 9. MRF6V2010NR1(NBR1) Test Circuit Component Designations and Values — 64 MHz

| Part             | Description                                             | Part Number                                             | Manufacturer |
|------------------|---------------------------------------------------------|---------------------------------------------------------|--------------|
| B1, B2           | 95 $\Omega$ , 100 MHz Long Ferrite Beads, Surface Mount | 2743021447                                              | Fair-Rite    |
| C1, C5, C15, C17 | 1000 pF Chip Capacitors                                 | ATC100B102JT50XT                                        | ATC          |
| C2               | 91 pF Chip Capacitor                                    | ATC100B910JT500XT                                       | ATC          |
| C3, C14          | 22 pF Chip Capacitors                                   | ATC100B220JT500XT                                       | ATC          |
| C4, C16          | 2.2 $\mu$ F, 50 V Chip Capacitors                       | C1825C225J5RAC                                          | Kemet        |
| C6               | 220 nF, 50 V Chip Capacitor                             | C1812C224J5RAC                                          | Kemet        |
| C7, C18          | 0.1 $\mu$ F, 50 V Chip Capacitors                       | CDR33BX104AKYM                                          | Kemet        |
| C8, C19          | 100K pF Chip Capacitors                                 | ATC200B104KT50XT                                        | ATC          |
| C9, C20          | 22K pF Chip Capacitors                                  | ATC200B223KT50XT                                        | ATC          |
| C10              | 22 $\mu$ F, 35 V Tantalum Capacitor                     | T491X226K035AT                                          | Kemet        |
| C11              | 10 $\mu$ F, 35 V Tantalum Capacitor                     | T491D106K035AT                                          | Kemet        |
| C12              | 68 pF Chip Capacitor                                    | ATC100B680JT500XT                                       | ATC          |
| C13              | 27 pF Chip Capacitor                                    | ATC100B270JT500XT                                       | ATC          |
| C21              | 330 $\mu$ F, 63 V Electrolytic Capacitor                | MCRH63V337M13X21-RH                                     | Multicomp    |
| L1               | 17.5 nH Inductor                                        | B06T                                                    | CoilCraft    |
| L2               | 43 nH Inductor                                          | B10T                                                    | CoilCraft    |
| L3, L4, L5, L6   | 82 nH Inductors                                         | 1812SMS-82NJ                                            | CoilCraft    |
| R1               | 180 $\Omega$ , 1/4 W Chip Resistor                      | CRCW1206180RFKEA                                        | Vishay       |
| PCB              | PCB Material 0.030"                                     | CuClad 250GX-0300-55-22,<br>0.030", $\epsilon_r = 2.55$ | Arlon        |



$V_{DD} = 50 \text{ Vdc}$ ,  $I_{DQ} = 30 \text{ mA}$ ,  $P_{out} = 10 \text{ W CW}$

| f<br>MHz | $Z_{source}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|----------|--------------------------|------------------------|
| 64       | $37.5 + j15.1$           | $94.5 + j16.7$         |
| 130      | $26.7 + j21.3$           | $83.8 + j35.0$         |
| 220      | $20.0 + j25.4$           | $75.0 + j44.0$         |
| 450      | $7.70 + j21.0$           | $43.0 + j49.0$         |

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

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

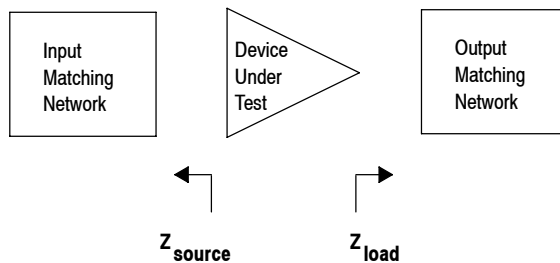


Figure 18. Series Equivalent Source and Load Impedance

## 50 OHM TYPICAL CHARACTERISTICS

**Table 10. Common Source S-Parameters** ( $V_{DD} = 50\text{ V}$ ,  $I_{DQ} = 30\text{ mA}$ ,  $T_A = 25^\circ\text{C}$ , 50 Ohm System)

| f<br>MHz | S <sub>11</sub> |        | S <sub>21</sub> |       | S <sub>12</sub> |       | S <sub>22</sub> |        |
|----------|-----------------|--------|-----------------|-------|-----------------|-------|-----------------|--------|
|          | S <sub>11</sub> | ∠ φ    | S <sub>21</sub> | ∠ φ   | S <sub>12</sub> | ∠ φ   | S <sub>22</sub> | ∠ φ    |
| 10       | 0.997           | -5.0   | 11.520          | 175.6 | 0.000790        | 84.6  | 0.960           | -0.8   |
| 20       | 0.994           | -9.5   | 11.419          | 171.6 | 0.00157         | 84.3  | 0.962           | -3.5   |
| 30       | 0.992           | -14.5  | 11.356          | 167.9 | 0.00232         | 78.1  | 0.963           | -5.5   |
| 40       | 0.987           | -19.3  | 11.278          | 164.1 | 0.00307         | 74.6  | 0.964           | -7.7   |
| 50       | 0.981           | -24.0  | 11.187          | 160.1 | 0.00380         | 71.0  | 0.964           | -9.9   |
| 60       | 0.974           | -28.6  | 11.042          | 156.1 | 0.00449         | 67.4  | 0.963           | -12.1  |
| 70       | 0.965           | -33.0  | 10.848          | 152.1 | 0.00513         | 63.8  | 0.961           | -14.2  |
| 80       | 0.955           | -37.4  | 10.636          | 148.2 | 0.00574         | 60.4  | 0.958           | -16.3  |
| 90       | 0.944           | -41.6  | 10.405          | 144.5 | 0.00631         | 57.0  | 0.955           | -18.4  |
| 100      | 0.933           | -45.7  | 10.147          | 140.8 | 0.00683         | 53.8  | 0.951           | -20.4  |
| 120      | 0.912           | -53.3  | 9.603           | 134.2 | 0.00776         | 47.9  | 0.944           | -24.2  |
| 140      | 0.892           | -60.4  | 9.061           | 127.9 | 0.00851         | 42.4  | 0.936           | -27.9  |
| 160      | 0.873           | -66.7  | 8.516           | 122.2 | 0.00914         | 37.6  | 0.929           | -31.3  |
| 180      | 0.856           | -72.7  | 7.993           | 116.9 | 0.00967         | 32.9  | 0.923           | -34.6  |
| 200      | 0.841           | -78.1  | 7.497           | 112.1 | 0.0101          | 28.7  | 0.918           | -37.9  |
| 220      | 0.828           | -83.0  | 7.040           | 107.5 | 0.0104          | 24.9  | 0.914           | -41.1  |
| 240      | 0.819           | -87.5  | 6.612           | 103.3 | 0.0107          | 21.3  | 0.912           | -44.2  |
| 260      | 0.810           | -91.7  | 6.214           | 99.3  | 0.0109          | 18.0  | 0.909           | -47.2  |
| 280      | 0.804           | -95.5  | 5.845           | 95.7  | 0.0110          | 15.0  | 0.908           | -50.2  |
| 300      | 0.799           | -99.0  | 5.507           | 92.2  | 0.0112          | 11.9  | 0.907           | -53.0  |
| 320      | 0.796           | -102.2 | 5.192           | 88.8  | 0.0112          | 9.1   | 0.906           | -55.9  |
| 340      | 0.794           | -105.1 | 4.901           | 85.7  | 0.0113          | 6.5   | 0.906           | -58.6  |
| 360      | 0.793           | -107.8 | 4.630           | 82.8  | 0.0112          | 4.1   | 0.906           | -61.4  |
| 380      | 0.793           | -110.4 | 4.382           | 79.9  | 0.0112          | 2.0   | 0.906           | -64.1  |
| 400      | 0.794           | -112.7 | 4.152           | 77.2  | 0.0112          | -0.3  | 0.906           | -66.7  |
| 420      | 0.796           | -114.9 | 3.937           | 74.6  | 0.0112          | -2.5  | 0.907           | -69.3  |
| 440      | 0.798           | -116.9 | 3.733           | 72.2  | 0.0111          | -4.4  | 0.907           | -71.8  |
| 460      | 0.800           | -118.8 | 3.547           | 69.8  | 0.0110          | -6.5  | 0.908           | -74.2  |
| 480      | 0.803           | -120.5 | 3.372           | 67.6  | 0.0109          | -8.5  | 0.908           | -76.7  |
| 500      | 0.807           | -122.2 | 3.213           | 65.4  | 0.0108          | -10.0 | 0.909           | -79.0  |
| 520      | 0.810           | -123.8 | 3.061           | 63.3  | 0.0107          | -11.9 | 0.910           | -81.3  |
| 540      | 0.814           | -125.4 | 2.919           | 61.2  | 0.0105          | -13.5 | 0.911           | -83.6  |
| 560      | 0.817           | -126.8 | 2.784           | 59.3  | 0.0104          | -14.9 | 0.912           | -85.8  |
| 580      | 0.821           | -128.1 | 2.661           | 57.5  | 0.0103          | -16.6 | 0.914           | -87.9  |
| 600      | 0.825           | -129.3 | 2.545           | 55.7  | 0.0101          | -18.1 | 0.915           | -90.0  |
| 620      | 0.829           | -130.5 | 2.436           | 53.9  | 0.00996         | -19.6 | 0.917           | -92.1  |
| 640      | 0.833           | -131.6 | 2.334           | 52.2  | 0.00981         | -21.0 | 0.918           | -94.1  |
| 660      | 0.837           | -132.7 | 2.237           | 50.5  | 0.00963         | -22.4 | 0.920           | -96.0  |
| 680      | 0.840           | -133.8 | 2.144           | 48.9  | 0.00946         | -23.7 | 0.921           | -97.9  |
| 700      | 0.843           | -134.8 | 2.058           | 47.3  | 0.00928         | -25.0 | 0.923           | -99.7  |
| 720      | 0.847           | -135.8 | 1.977           | 45.8  | 0.00910         | -26.1 | 0.924           | -101.4 |
| 740      | 0.850           | -136.8 | 1.900           | 44.4  | 0.00894         | -27.3 | 0.926           | -103.0 |
| 760      | 0.854           | -137.8 | 1.828           | 43.0  | 0.00876         | -28.6 | 0.928           | -104.7 |
| 780      | 0.857           | -138.7 | 1.760           | 41.6  | 0.00859         | -29.7 | 0.930           | -106.2 |

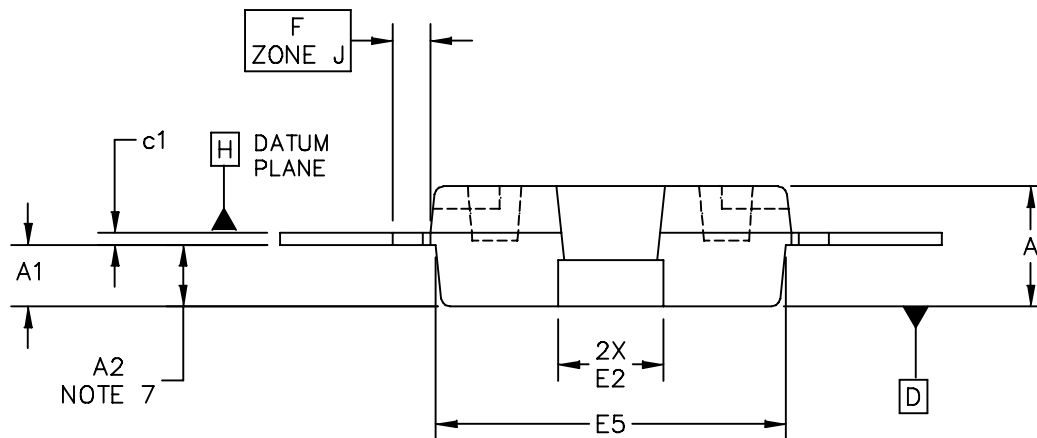
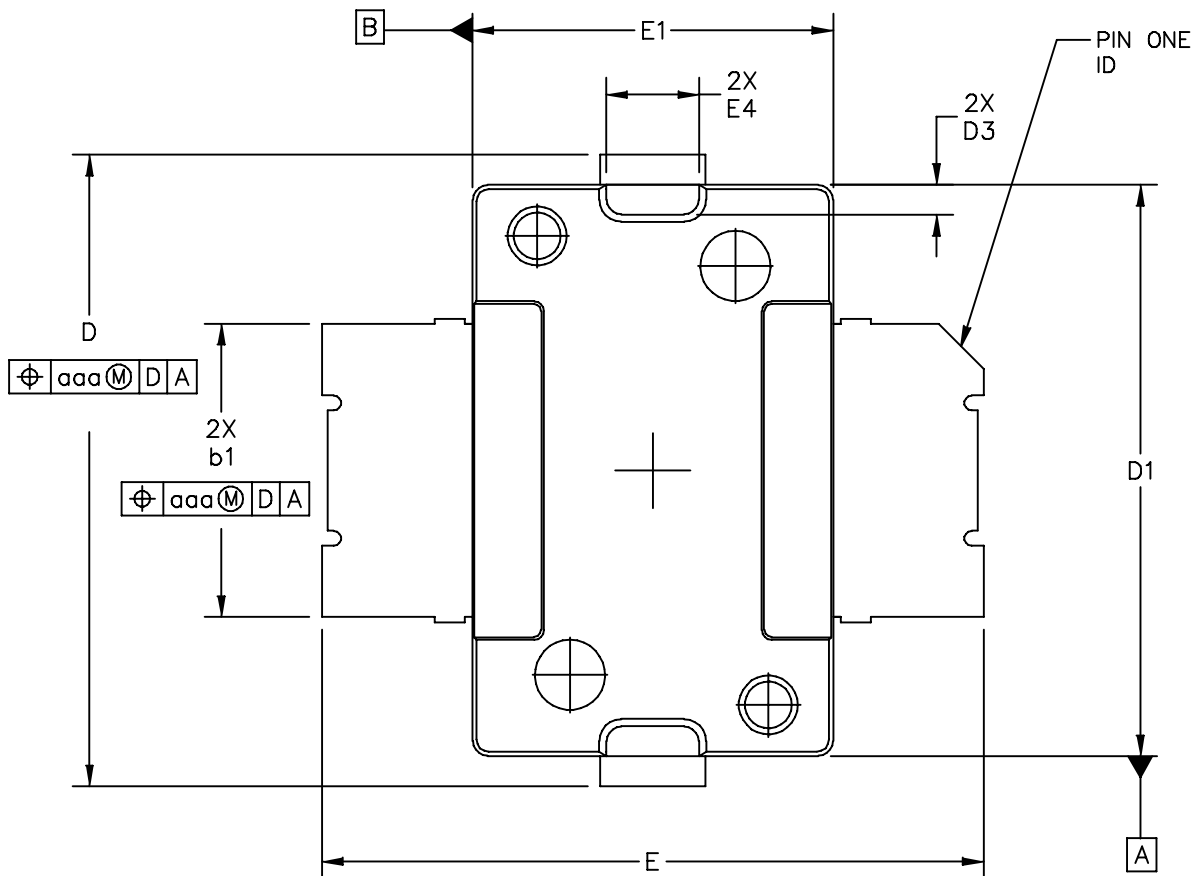
(continued)

## 50 OHM TYPICAL CHARACTERISTICS

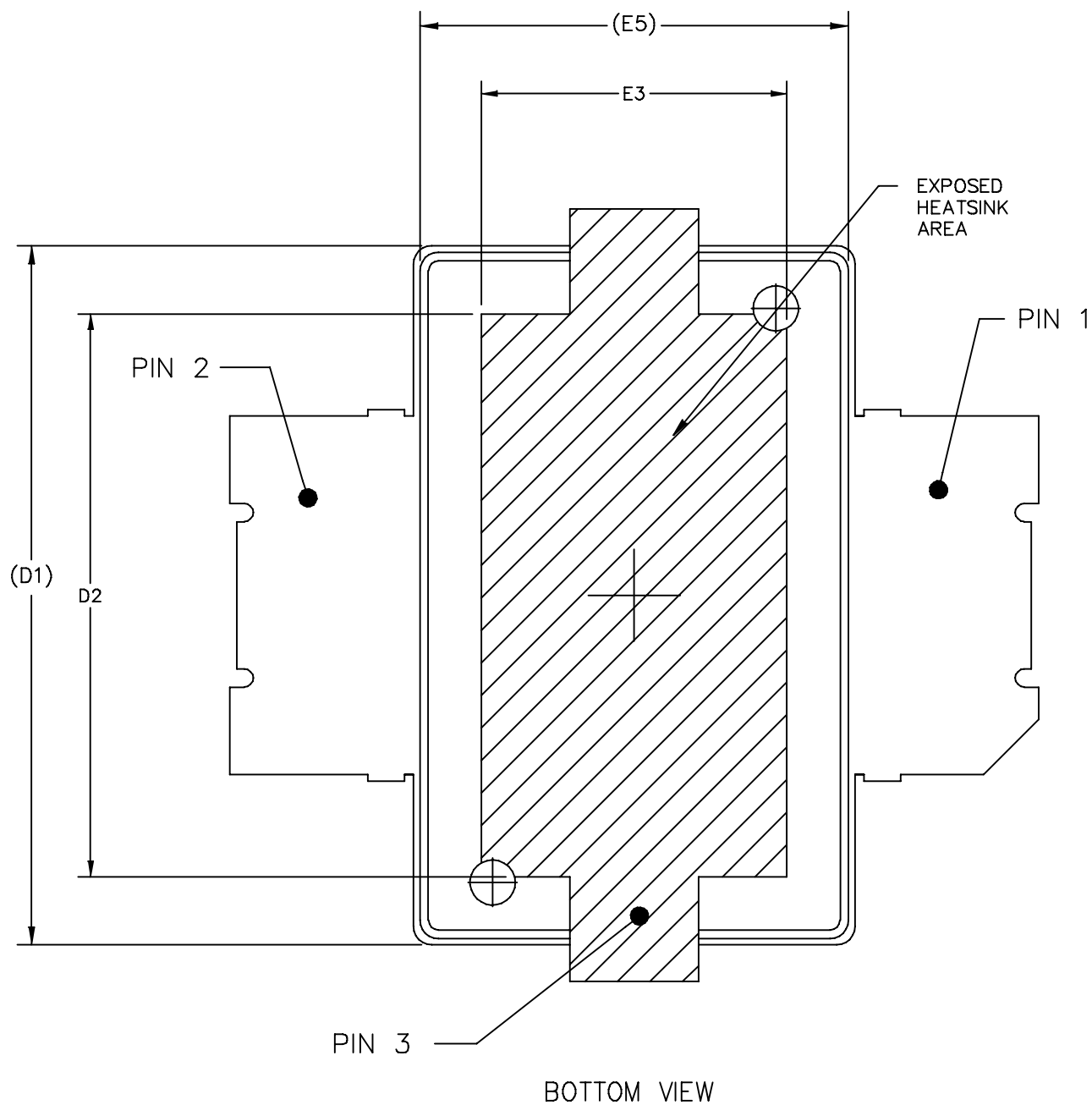
**Table 10. Common Source S-Parameters** ( $V_{DD} = 50\text{ V}$ ,  $I_{DQ} = 30\text{ mA}$ ,  $T_A = 25^\circ\text{C}$ , 50 Ohm System) (continued)

| f<br>MHz | S <sub>11</sub> |        | S <sub>21</sub> |      | S <sub>12</sub> |       | S <sub>22</sub> |        |
|----------|-----------------|--------|-----------------|------|-----------------|-------|-----------------|--------|
|          | S <sub>11</sub> | ∠ φ    | S <sub>21</sub> | ∠ φ  | S <sub>12</sub> | ∠ φ   | S <sub>22</sub> | ∠ φ    |
| 800      | 0.858           | -139.7 | 1.697           | 40.2 | 0.00839         | -31.1 | 0.932           | -107.6 |
| 820      | 0.861           | -140.7 | 1.636           | 38.9 | 0.00818         | -32.1 | 0.934           | -109.0 |
| 840      | 0.864           | -141.6 | 1.578           | 37.6 | 0.00798         | -33.1 | 0.935           | -110.4 |
| 860      | 0.867           | -142.6 | 1.523           | 36.4 | 0.00781         | -33.8 | 0.936           | -111.7 |
| 880      | 0.870           | -143.5 | 1.471           | 35.1 | 0.00763         | -34.8 | 0.938           | -112.9 |
| 900      | 0.873           | -144.5 | 1.421           | 33.9 | 0.00745         | -35.9 | 0.939           | -114.1 |

# PACKAGE DIMENSIONS



|                                                         |                    |                            |             |
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|                                                         |                    | CASE NUMBER: 1265-09       | 29 JUN 2007 |
|                                                         |                    | STANDARD: JEDEC TO-270 AA  |             |



|                                                         |  |                    |                           |                            |             |
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|                                                         |  |                    | CASE NUMBER: 1265-09      |                            | 29 JUN 2007 |
|                                                         |  |                    | STANDARD: JEDEC TO-270 AA |                            |             |

NOTES:

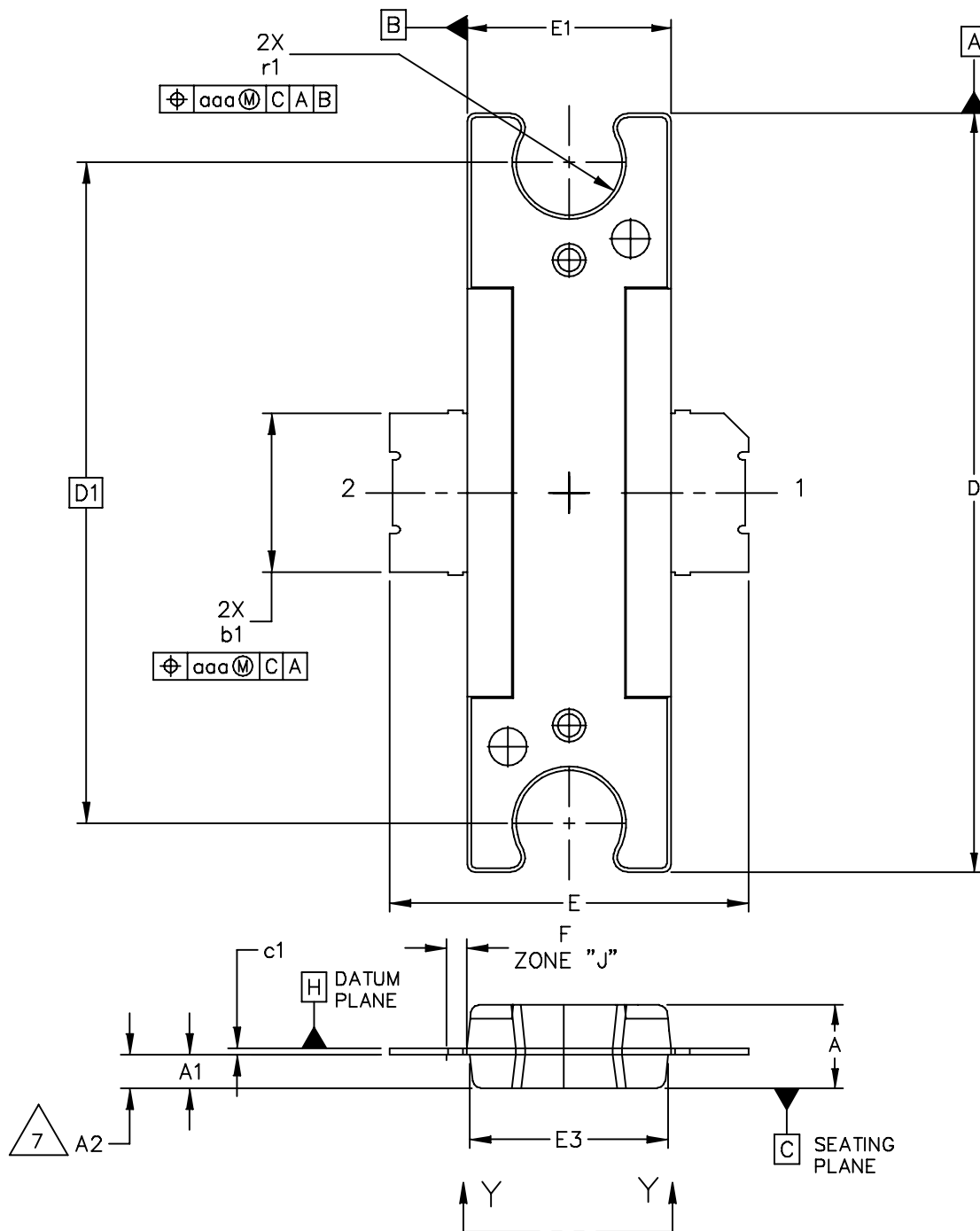
1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D1" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D1 AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSION "b1" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE "b1" DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-.
7. DIMENSION "A2" APPLIES WITHIN ZONE "J" ONLY.
8. DIMENSIONS "D" AND "E2" DO NOT INCLUDE MOLD PROTRUSION. OVERALL LENGTH INCLUDING MOLD PROTRUSION SHOULD NOT EXCEED 0.430 INCH FOR DIMENSION "D" AND 0.080 INCH FOR DIMENSION "E2". DIMENSIONS "D" AND "E2" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -D-.

STYLE 1:

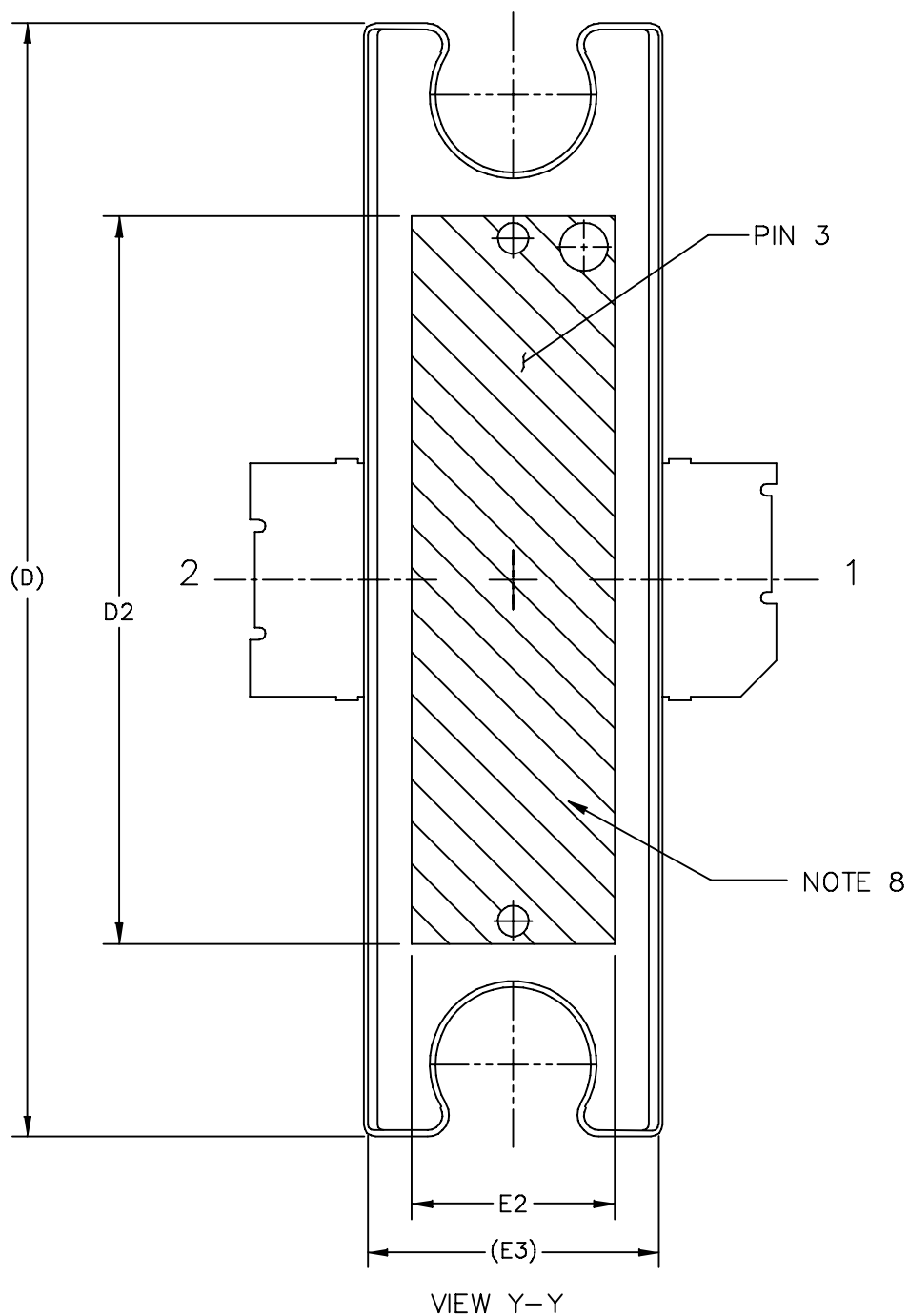
PIN 1 - DRAIN  
PIN 2 - GATE  
PIN 3 - SOURCE

| INCH                                                    |      |      | MILLIMETER         |       | INCH                      |                            |      | MILLIMETER  |      |
|---------------------------------------------------------|------|------|--------------------|-------|---------------------------|----------------------------|------|-------------|------|
| DIM                                                     | MIN  | MAX  | MIN                | MAX   | DIM                       | MIN                        | MAX  | MIN         | MAX  |
| A                                                       | .078 | .082 | 1.98               | 2.08  | F                         | .025 BSC                   |      | 0.64 BSC    |      |
| A1                                                      | .039 | .043 | 0.99               | 1.09  | b1                        | .193                       | .199 | 4.90        | 5.06 |
| A2                                                      | .040 | .042 | 1.02               | 1.07  | c1                        | .007                       | .011 | 0.18        | 0.28 |
| D                                                       | .416 | .424 | 10.57              | 10.77 | aaa                       | .004                       |      | 0.10        |      |
| D1                                                      | .378 | .382 | 9.60               | 9.70  |                           |                            |      |             |      |
| D2                                                      | .290 | ---- | 7.37               | ----  |                           |                            |      |             |      |
| D3                                                      | .016 | .024 | 0.41               | 0.61  |                           |                            |      |             |      |
| E                                                       | .436 | .444 | 11.07              | 11.28 |                           |                            |      |             |      |
| E1                                                      | .238 | .242 | 6.04               | 6.15  |                           |                            |      |             |      |
| E2                                                      | .066 | .074 | 1.68               | 1.88  |                           |                            |      |             |      |
| E3                                                      | .150 | ---- | 3.81               | ----  |                           |                            |      |             |      |
| E4                                                      | .058 | .066 | 1.47               | 1.68  |                           |                            |      |             |      |
| E5                                                      | .231 | .235 | 5.87               | 5.97  |                           |                            |      |             |      |
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|                                                         |      |      |                    |       | CASE NUMBER: 1265-09      |                            |      | 29 JUN 2007 |      |
|                                                         |      |      |                    |       | STANDARD: JEDEC TO-270 AA |                            |      |             |      |





|                                                         |  |                           |                            |
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|                                                         |  | CASE NUMBER: 1337-04      | 10 SEP 2007                |
|                                                         |  | STANDARD: JEDEC TO-272 BC |                            |



|                                                         |                           |                    |                            |
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| TITLE:<br><br>TO-272<br>2 LEAD                          | DOCUMENT NO: 98ASA99191D  |                    | REV: E                     |
|                                                         | CASE NUMBER: 1337-04      |                    | 10 SEP 2007                |
|                                                         | STANDARD: JEDEC TO-272 BC |                    |                            |

NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT THE TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSIONS "b1" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE "b1" DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-.
7. DIMENSION A2 APPLIES WITHIN ZONE "J" ONLY.
8. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG.

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

| INCH                                                    |          |      | MILLIMETER         |       | INCH                      |                            |      | MILLIMETER  |      |
|---------------------------------------------------------|----------|------|--------------------|-------|---------------------------|----------------------------|------|-------------|------|
| DIM                                                     | MIN      | MAX  | MIN                | MAX   | DIM                       | MIN                        | MAX  | MIN         | MAX  |
| A                                                       | .100     | .104 | 2.54               | 2.64  | b1                        | .193                       | .199 | 4.90        | 5.05 |
| A1                                                      | .039     | .043 | 0.99               | 1.09  | c1                        | .007                       | .011 | 0.18        | 0.28 |
| A2                                                      | .040     | .042 | 1.02               | 1.07  | r1                        | .063                       | .068 | 1.60        | 1.73 |
| D                                                       | .928     | .932 | 23.57              | 23.67 | aaa                       | .004                       |      | 0.1         |      |
| D1                                                      | .810 BSC |      | 20.57 BSC          |       |                           |                            |      |             |      |
| D2                                                      | .604     | ---- | 15.34              | ----  |                           |                            |      |             |      |
| E                                                       | .438     | .442 | 11.12              | 11.23 |                           |                            |      |             |      |
| E1                                                      | .248     | .252 | 6.30               | 6.40  |                           |                            |      |             |      |
| E2                                                      | .162     | ---- | 4.11               | ----  |                           |                            |      |             |      |
| E3                                                      | .241     | .245 | 6.12               | 6.22  |                           |                            |      |             |      |
| F                                                       | .025 BSC |      | 0.64 BSC           |       |                           |                            |      |             |      |
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|                                                         |          |      |                    |       | CASE NUMBER: 1337-04      |                            |      | 10 SEP 2007 |      |
|                                                         |          |      |                    |       | STANDARD: JEDEC TO-272 BS |                            |      |             |      |

## PRODUCT DOCUMENTATION AND SOFTWARE

Refer to the following documents to aid your design process.

### Application Notes

- AN1907: Solder Reflow Attach Method for High Power RF Devices in Plastic Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers
- AN3263: Bolt Down Mounting Method for High Power RF Transistors and RFICs in Over-Molded Plastic Packages

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

### Software

- Electromigration MTTF Calculator
- RF High Power Model

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        | Feb. 2007 | <ul style="list-style-type: none"><li>• Initial Release of Data Sheet</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 1        | May 2007  | <ul style="list-style-type: none"><li>• Corrected Test Circuit Component part numbers in Table 6, Component Designations and Values for C1, C8, C11, C18, C4, C13, C5, and C14, p. 3</li><li>• Corrected Series Impedance <math>Z_{\text{source}}</math> and <math>Z_{\text{load}}</math> values, Fig. 13, Series Equivalent Source and Load Impedance, p. 7</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 2        | Aug. 2007 | <ul style="list-style-type: none"><li>• Replaced Case Outline 1265-08 with 1265-09, Issue K, p. 1, 12-14. Corrected cross hatch pattern in bottom view and changed its dimensions (D2 and E3) to minimum value on source contact (D2 changed from Min-Max .290-.320 to .290 Min; E3 changed from Min-Max .150-.180 to .150 Min). Added JEDEC Standard Package Number.</li><li>• Replaced Case Outline 1337-03 with 1337-04, p. 1, 15-17. Issue D: Removed Drain-ID label from View Y-Y on Sheet 2. Renamed E2 to E3. Added cross-hatch region dimensions D2 and E2.</li><li>• Corrected Test Circuit Component part number in Table 6, Component Designations and Values for R1, p. 3</li><li>• Added Figure 12, Power Gain and Drain Efficiency versus CW Output Power, p. 6</li><li>• Corrected plot points to show 50 Ohms in Figure 14, Series Equivalent Source and Load Impedance, p. 7</li><li>• Added Figures 15-17, Test Circuit Component Layout and Tables 7-9, Test Circuit Component Designations and Values to show 130, 450 and 64 MHz, respectively, p. 8-10</li><li>• Added Figure 18, Series Equivalent Source and Load Impedance to show 64, 130, 220 and 450 MHz plot points, p. 11</li></ul> |
| 3        | Feb. 2008 | <ul style="list-style-type: none"><li>• Added Case Operating Temperature limit to the Maximum Ratings table and set limit to 150°C, p. 1</li><li>• Corrected <math>C_{\text{iss}}</math> test condition to indicate AC stimulus on the <math>V_{\text{GS}}</math> connection versus the <math>V_{\text{DS}}</math> connection, Dynamic Characteristics table, p. 2</li><li>• Replaced Case Outline 1337-04, Issue D, with 1337-04, Issue E, p. 15-17. Corrected document number 98ASA99191D on Sheet 3.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 4        | Mar. 2008 | <ul style="list-style-type: none"><li>• Corrected <math>Z_{\text{source}}</math> (37.5 + j15.1) and <math>Z_{\text{load}}</math> (94.5 + j16.7) 64 MHz values and replotted both, p. 11</li><li>• Added S-Parameter table, p. 12, 13</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 5        | Apr. 2010 | <ul style="list-style-type: none"><li>• Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table, related “Continuous use at maximum temperature will affect MTTF” footnote added and changed 200°C to 225°C in Capable Plastic Package bullet, p. 1</li><li>• Added Electromigration MTTF Calculator and RF High Power Model availability to Product Software, p. 20</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

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