



# THE DATASHEET OF MRF150

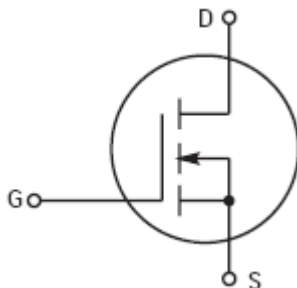


## RF Power FET 150W, to 150MHz, 50V

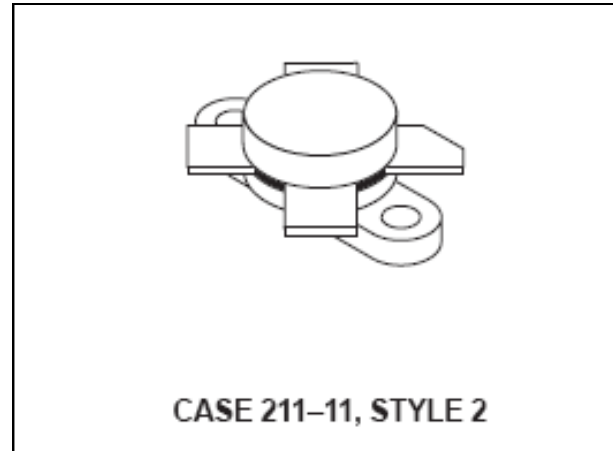
Rev. V1

Designed primarily for linear large-signal output stages up to 150 MHz

- Superior high order IMD  
IMD(d3) (150W PEP): -32dB (Typ.)  
IMD(d11) (150W PEP): -60dB (Typ.)
- Specified 50V, 30MHz characteristics  
Output power = 150 Watts  
Power gain = 17 dB (Typ.)  
Efficiency = 45% (Typ.)
- 100% tested for load mismatch at all phase angles



### Product Image



### MAXIMUM RATINGS

| Rating   | Symbol    | Value       | Unit          |
|--|-----------|-------------|---------------|
| Drain-Source Voltage   | $V_{DSS}$ | 125         | Vdc           |
| Drain-Gate Voltage   | $V_{DGO}$ | 125         | Vdc           |
| Gate-Source Voltage  | $V_{GS}$  | ±40         | Vdc           |
| Drain Current — Continuous   | $I_D$     | 16          | Adc           |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$     | 300<br>1.71 | Watts<br>W/°C |
| Storage Temperature Range  | $T_{stg}$ | -65 to +150 | °C            |
| Operating Junction Temperature   | $T_J$     | 200         | °C            |

### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 0.6 | °C/W |

**NOTE — CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

## RF Power FET 150W, to 150MHz, 50V

Rev. V1

### ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted.)

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

#### OFF CHARACTERISTICS

|   |                      |     |   |     |      |
|---|----------------------|-----|---|-----|------|
| Drain–Source Breakdown Voltage (V <sub>GS</sub> = 0, I <sub>D</sub> = 100 mA) | V <sub>(BR)DSS</sub> | 125 | — | —   | Vdc  |
| Zero Gate Voltage Drain Current (V <sub>DS</sub> = 50 V, V <sub>GS</sub> = 0) | I <sub>DSS</sub>     | —   | — | 5.0 | mAdc |
| Gate–Body Leakage Current (V <sub>GS</sub> = 20 V, V <sub>DS</sub> = 0)       | I <sub>GSS</sub>     | —   | — | 1.0 | μAdc |

#### ON CHARACTERISTICS

|   |                     |     |     |     |      |
|---|---------------------|-----|-----|-----|------|
| Gate Threshold Voltage (V <sub>DS</sub> = 10 V, I <sub>D</sub> = 100 mA)  | V <sub>GS(th)</sub> | 1.0 | 3.0 | 5.0 | Vdc  |
| Drain–Source On–Voltage (V <sub>GS</sub> = 10 V, I <sub>D</sub> = 10 A)   | V <sub>DS(on)</sub> | 1.0 | 3.0 | 5.0 | Vdc  |
| Forward Transconductance (V <sub>DS</sub> = 10 V, I <sub>D</sub> = 5.0 A) | g <sub>fs</sub>     | 4.0 | 7.0 | —   | mhos |

#### DYNAMIC CHARACTERISTICS

|   |                  |   |     |   |    |
|---|------------------|---|-----|---|----|
| Input Capacitance (V <sub>DS</sub> = 50 V, V <sub>GS</sub> = 0, f = 1.0 MHz)            | C <sub>ISS</sub> | — | 400 | — | pF |
| Output Capacitance (V <sub>DS</sub> = 50 V, V <sub>GS</sub> = 0, f = 1.0 MHz)           | C <sub>OSS</sub> | — | 240 | — | pF |
| Reverse Transfer Capacitance (V <sub>DS</sub> = 50 V, V <sub>GS</sub> = 0, f = 1.0 MHz) | C <sub>rss</sub> | — | 40  | — | pF |

#### FUNCTIONAL TESTS (SSB)

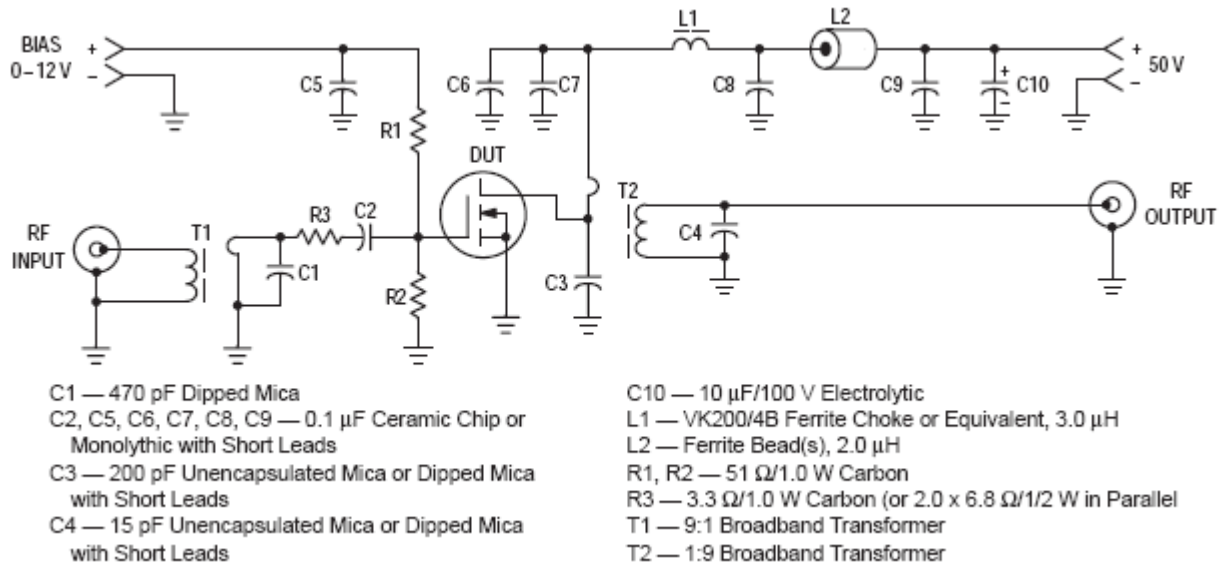
|   |                           |   |                                |            |        |    |
|---|---------------------------|---|--------------------------------|------------|--------|----|
| Common Source Amplifier Power Gain<br>(V <sub>DD</sub> = 50 V, P <sub>out</sub> = 150 W (PEP), I <sub>DQ</sub> = 250 mA)                                  | f = 30 MHz<br>f = 150 MHz | G <sub>ps</sub>                             | —<br>—                         | 17<br>8.0  | —<br>— | dB |
| Drain Efficiency<br>(V <sub>DD</sub> = 50 V, P <sub>out</sub> = 150 W (PEP), f = 30; 30.001 MHz,<br>I <sub>D</sub> (Max) = 3.75 A)                        |                           | η   | —                              | 45         | —      | %  |
| Intermodulation Distortion (1)<br>(V <sub>DD</sub> = 50 V, P <sub>out</sub> = 150 W (PEP),<br>f1 = 30 MHz, f2 = 30.001 MHz, I <sub>DQ</sub> = 250 mA)     |                           | IMD <sub>(d3)</sub><br>IMD <sub>(d11)</sub> | —<br>—                         | –32<br>–60 | —<br>— | dB |
| Load Mismatch<br>(V <sub>DD</sub> = 50 V, P <sub>out</sub> = 150 W (PEP), f = 30; 30.001 MHz,<br>I <sub>DQ</sub> = 250 mA, VSWR 30:1 at all Phase Angles) |                           | ψ   | No Degradation in Output Power |            |        |    |

#### CLASS A PERFORMANCE

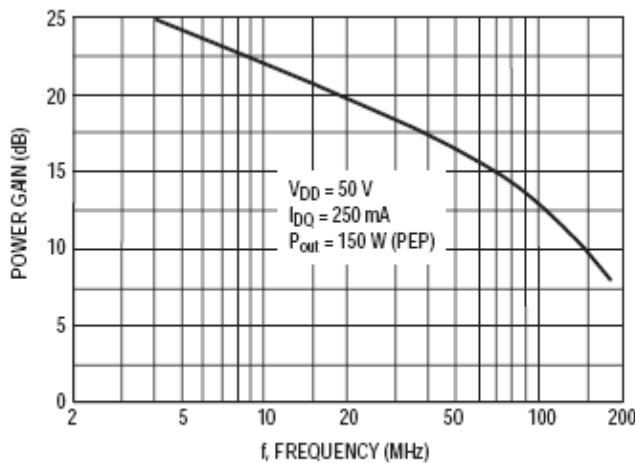
|  |  |             |                  |             |    |
|--|--|-------------|------------------|-------------|----|
| Intermodulation Distortion (1) and Power Gain<br>(V <sub>DD</sub> = 50 V, P <sub>out</sub> = 50 W (PEP), f1 = 30 MHz,<br>f2 = 30.001 MHz, I <sub>DQ</sub> = 3.0 A) | G <sub>PS</sub><br>IMD <sub>(d3)</sub><br>IMD <sub>(d9–13)</sub> | —<br>—<br>— | 20<br>–50<br>–75 | —<br>—<br>— | dB |
|--|--|-------------|------------------|-------------|----|

#### NOTE:

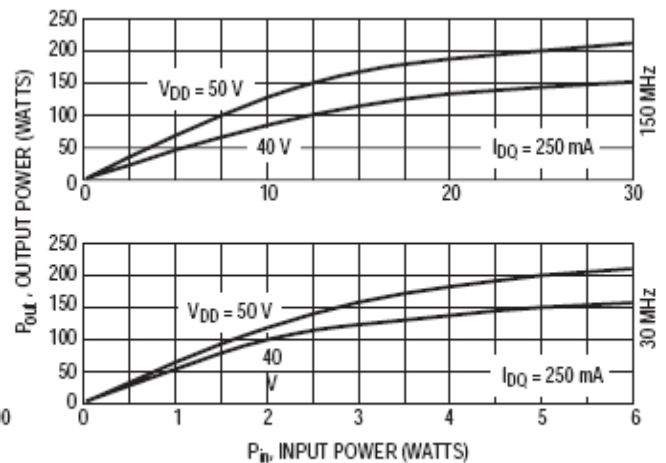
- To MIL–STD–1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.



**Figure 1. 30MHz test circuit, 30MHz**



**Figure 2. Power Gain versus Frequency**



**Figure 3. Output Power versus Input Power**

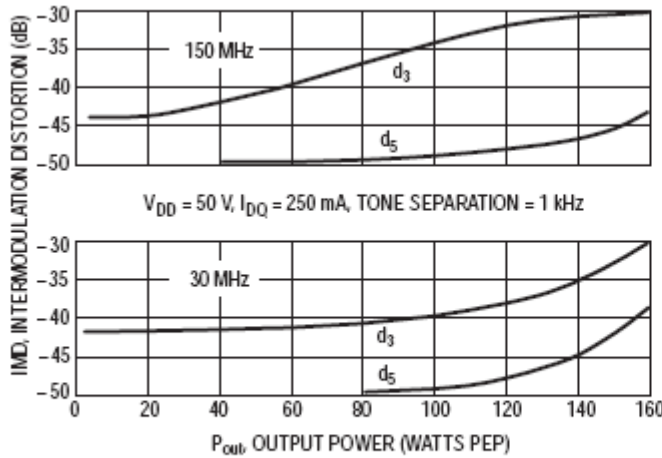


Figure 4. IMD versus  $P_{out}$

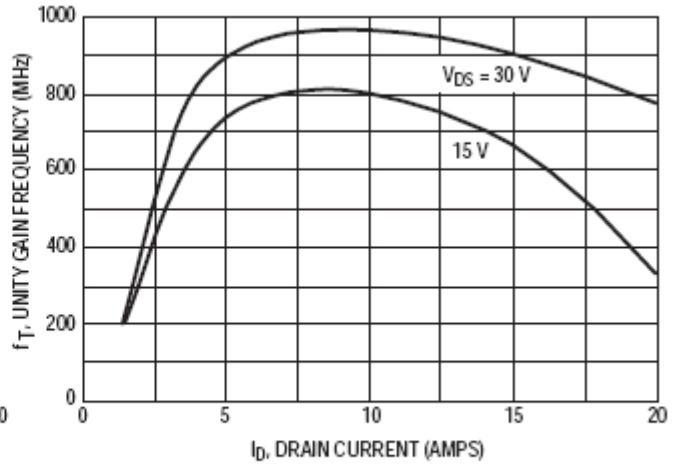


Figure 5. Common Source Unity Gain Frequency versus Drain Current

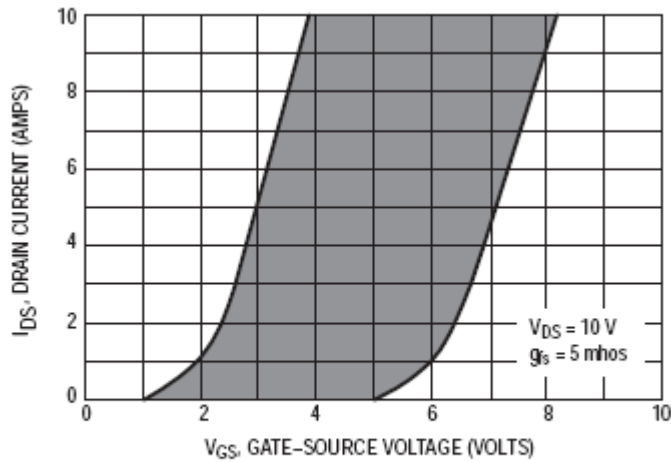


Figure 6. Gate Voltage versus Drain Current

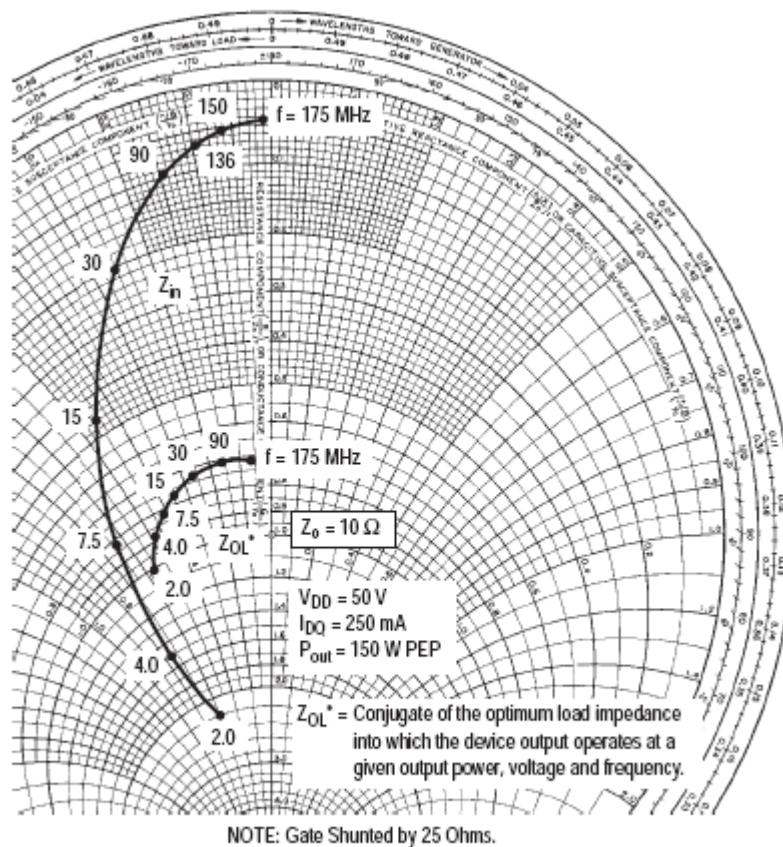


Figure 7. Series Equivalent Impedance

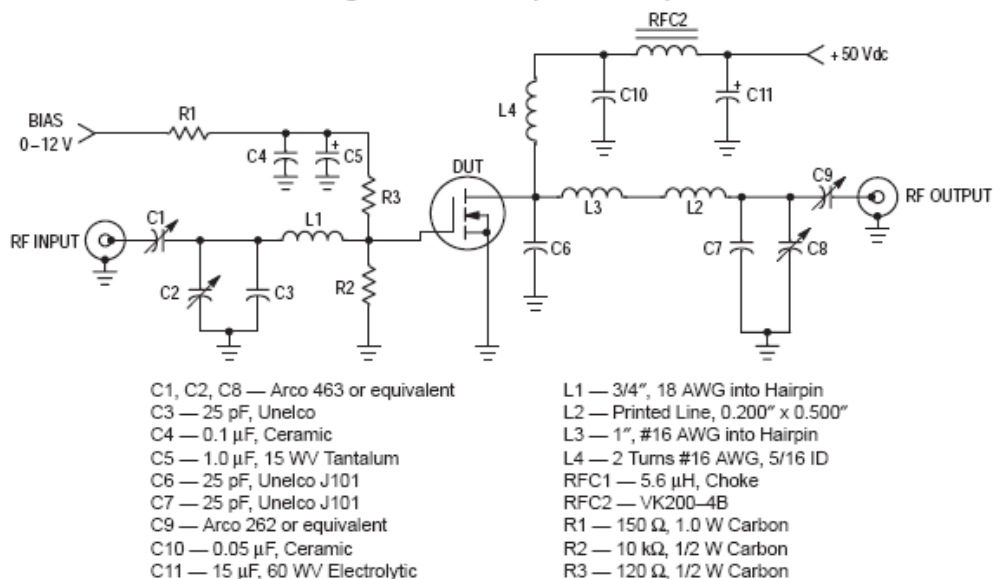


Figure 8. 150 MHz Test Circuit (Class AB)

Table 1. Common Source S-Parameters ( $V_{DS} = 50\text{ V}$ ,  $I_D = 2\text{ A}$ )

| 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    |
| 30       | 0.936           | -179 | 4.13            | 84 | 0.011           | 22 | 0.844           | -176 |
| 40       | 0.936           | -179 | 3.16            | 79 | 0.012           | 23 | 0.842           | -180 |
| 50       | 0.936           | -180 | 2.52            | 75 | 0.013           | 29 | 0.855           | -179 |
| 60       | 0.937           | 180  | 2.13            | 72 | 0.014           | 36 | 0.854           | 179  |
| 70       | 0.939           | 179  | 1.81            | 68 | 0.013           | 42 | 0.870           | 179  |
| 80       | 0.940           | 179  | 1.53            | 67 | 0.013           | 45 | 0.868           | -179 |
| 90       | 0.941           | 179  | 1.34            | 65 | 0.014           | 46 | 0.855           | -178 |
| 100      | 0.942           | 179  | 1.21            | 60 | 0.016           | 46 | 0.874           | 180  |
| 110      | 0.942           | 179  | 1.11            | 58 | 0.018           | 52 | 0.875           | 178  |
| 120      | 0.945           | 178  | 0.99            | 56 | 0.019           | 61 | 0.893           | 180  |
| 130      | 0.946           | 178  | 0.88            | 53 | 0.019           | 67 | 0.902           | -179 |
| 140      | 0.947           | 178  | 0.83            | 52 | 0.019           | 68 | 0.919           | -179 |
| 150      | 0.949           | 177  | 0.74            | 49 | 0.020           | 63 | 0.910           | -179 |
| 160      | 0.949           | 177  | 0.71            | 46 | 0.024           | 62 | 0.889           | -180 |
| 170      | 0.952           | 177  | 0.65            | 44 | 0.026           | 68 | 0.878           | 179  |
| 180      | 0.953           | 177  | 0.59            | 42 | 0.029           | 72 | 0.921           | 179  |
| 190      | 0.954           | 176  | 0.57            | 41 | 0.029           | 75 | 0.949           | 178  |
| 200      | 0.956           | 176  | 0.52            | 39 | 0.028           | 74 | 0.929           | 178  |
| 210      | 0.955           | 176  | 0.51            | 38 | 0.030           | 71 | 0.934           | 179  |
| 220      | 0.957           | 175  | 0.49            | 35 | 0.034           | 70 | 0.918           | 177  |
| 230      | 0.960           | 175  | 0.43            | 32 | 0.039           | 71 | 0.977           | 175  |
| 240      | 0.959           | 175  | 0.42            | 32 | 0.040           | 74 | 0.941           | 175  |
| 250      | 0.961           | 175  | 0.39            | 32 | 0.040           | 77 | 0.944           | 176  |
| 260      | 0.961           | 175  | 0.36            | 31 | 0.040           | 76 | 0.948           | 177  |
| 270      | 0.960           | 174  | 0.35            | 29 | 0.043           | 74 | 0.947           | 175  |
| 280      | 0.963           | 174  | 0.34            | 29 | 0.046           | 73 | 0.929           | 174  |
| 290      | 0.963           | 174  | 0.32            | 25 | 0.048           | 74 | 0.918           | 172  |
| 300      | 0.965           | 173  | 0.32            | 28 | 0.051           | 78 | 0.925           | 174  |
| 310      | 0.966           | 173  | 0.29            | 27 | 0.052           | 79 | 0.953           | 174  |
| 320      | 0.963           | 173  | 0.28            | 26 | 0.054           | 76 | 0.954           | 172  |
| 330      | 0.965           | 172  | 0.26            | 22 | 0.057           | 74 | 0.914           | 171  |
| 340      | 0.966           | 172  | 0.26            | 27 | 0.058           | 72 | 0.925           | 171  |
| 350      | 0.965           | 172  | 0.26            | 25 | 0.062           | 75 | 0.934           | 171  |
| 360      | 0.968           | 171  | 0.25            | 25 | 0.065           | 74 | 0.979           | 171  |
| 370      | 0.967           | 171  | 0.23            | 24 | 0.064           | 73 | 0.993           | 168  |
| 380      | 0.967           | 171  | 0.24            | 22 | 0.068           | 74 | 0.952           | 172  |
| 390      | 0.969           | 170  | 0.22            | 26 | 0.069           | 74 | 0.942           | 170  |
| 400      | 0.968           | 170  | 0.21            | 23 | 0.072           | 76 | 0.936           | 172  |
| 410      | 0.968           | 170  | 0.21            | 24 | 0.076           | 73 | 0.984           | 168  |
| 420      | 0.970           | 169  | 0.20            | 25 | 0.078           | 71 | 0.977           | 167  |
| 430      | 0.969           | 169  | 0.18            | 25 | 0.082           | 72 | 0.959           | 168  |
| 440      | 0.970           | 169  | 0.19            | 25 | 0.082           | 73 | 0.953           | 169  |

Table 1. Common Source S-Parameters ( $V_{DS} = 50\text{ V}$ ,  $I_D = 2\text{ A}$ ) 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   |
| 450      | 0.971           | 168 | 0.19            | 24 | 0.085           | 75 | 0.960           | 168 |
| 460      | 0.972           | 168 | 0.17            | 26 | 0.086           | 70 | 0.960           | 164 |
| 470      | 0.972           | 168 | 0.17            | 23 | 0.087           | 70 | 0.952           | 165 |
| 480      | 0.969           | 167 | 0.18            | 26 | 0.093           | 70 | 0.977           | 166 |
| 490      | 0.969           | 167 | 0.18            | 25 | 0.099           | 71 | 0.966           | 166 |
| 500      | 0.969           | 166 | 0.17            | 26 | 0.101           | 71 | 0.972           | 164 |

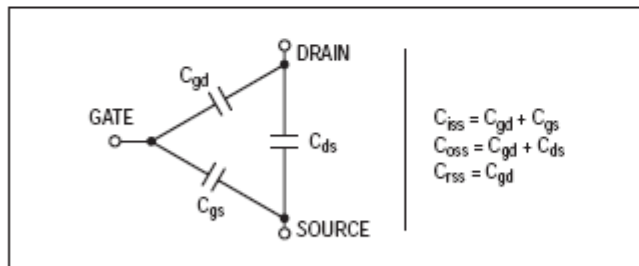
## RF POWER MOSFET CONSIDERATIONS

### MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain ( $C_{gd}$ ), and gate-to-source ( $C_{gs}$ ). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source ( $C_{ds}$ ).

These capacitances are characterized as input ( $C_{iss}$ ), output ( $C_{oss}$ ) and reverse transfer ( $C_{rss}$ ) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The  $C_{iss}$  can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



### LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to  $f_T$  for bipolar transistors.

Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

### DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance,  $V_{DS(on)}$ , occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs,  $V_{DS(on)}$  has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

### GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of  $10^9$  ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage,  $V_{GS(th)}$ .

**Gate Voltage Rating** — Never exceed the gate voltage rating. Exceeding the rated  $V_{GS}$  can result in permanent damage to the oxide layer in the gate region.

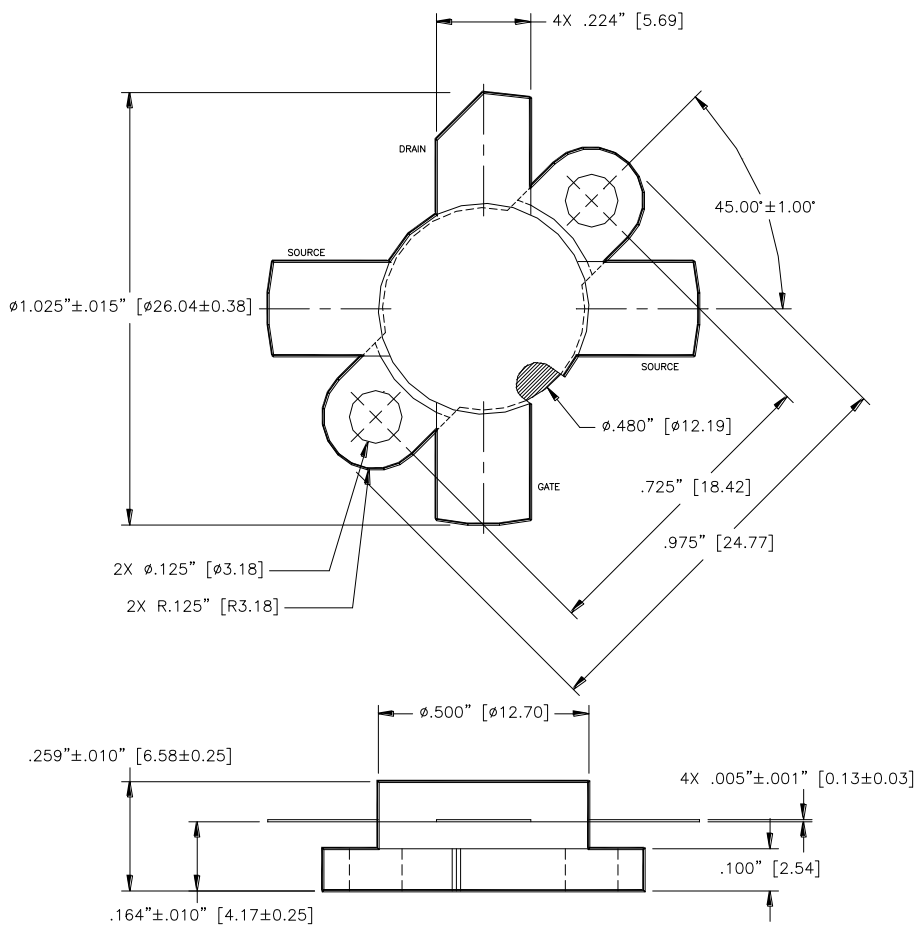
**Gate Termination** — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

**Gate Protection** — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

## EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

|                     |               |
|---------------------|---------------|
| Collector .....     | Drain         |
| Emitter .....       | Source        |
| Base .....          | Gate          |
| $V_{(BR)CES}$ ..... | $V_{(BR)DSS}$ |
| $V_{CBO}$ .....     | $V_{DGO}$     |
| $I_C$ .....         | $I_D$         |
| $I_{CES}$ .....     | $I_{DSS}$     |
| $I_{EBO}$ .....     | $I_{GSS}$     |
| $V_{BE(on)}$ .....  | $V_{GS(th)}$  |
| $V_{CE(sat)}$ ..... | $V_{DS(on)}$  |
| $C_{ib}$ .....      | $C_{iss}$     |
| $C_{cb}$ .....      | $C_{oss}$     |
| $h_{fe}$ .....      | $g_{fs}$      |

$$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C} \quad \dots \quad r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$$



Unless otherwise noted, tolerances are inches  $\pm 0.005$  [millimeters  $\pm 0.13$ mm]

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