

## The RF MOSFET Line 150W, to 150MHz, 28V

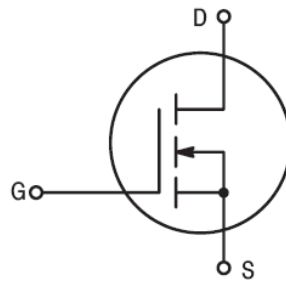
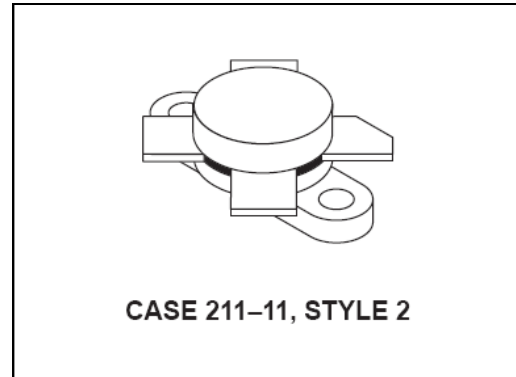
Rev. V1

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

N-Channel enhancement mode

- Specified 28 volts, 30 MHz characteristics  
Output power = 150 watts  
Power gain = 15 dB (Typ.)  
Efficiency = 40% (Typ.)
- Superior high order IMD
- IMD<sub>(d3)</sub> (150 W PEP): -30 dB (Typ.)
- IMD<sub>(d11)</sub> (150 W PEP): -60 dB (Typ.)
- 100% tested for load mismatch at all phase angles with 30:1 VSWR

### Product Image



### MAXIMUM RATINGS

| Rating   | Symbol    | Value       | Unit                         |
|--|-----------|-------------|------------------------------|
| Drain-Source Voltage   | $V_{DSS}$ | 65          | Vdc                          |
| Drain-Gate Voltage   | $V_{DGO}$ | 65          | Vdc                          |
| Gate-Source Voltage  | $V_{GS}$  | $\pm 40$    | 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>1.7  | Watts<br>W/ $^\circ\text{C}$ |
| Storage Temperature Range  | $T_{stg}$ | -65 to +150 | $^\circ\text{C}$             |
| Operating Junction Temperature   | $T_J$     | 200         | $^\circ\text{C}$             |

### THERMAL CHARACTERISTICS

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

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

## The RF MOSFET Line 150W, to 150MHz, 28V

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> | 65 | — | —   | Vdc  |
| Zero Gate Voltage Drain Current (V <sub>DS</sub> = 28 Vdc, V <sub>GS</sub> = 0) | I <sub>DSS</sub>     | —  | — | 5.0 | mAdc |
| Gate–Body Leakage Current (V <sub>GS</sub> = 20 Vdc, 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 Adc) | V <sub>DS(on)</sub> | 0.1 | 0.9 | 1.5 | 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

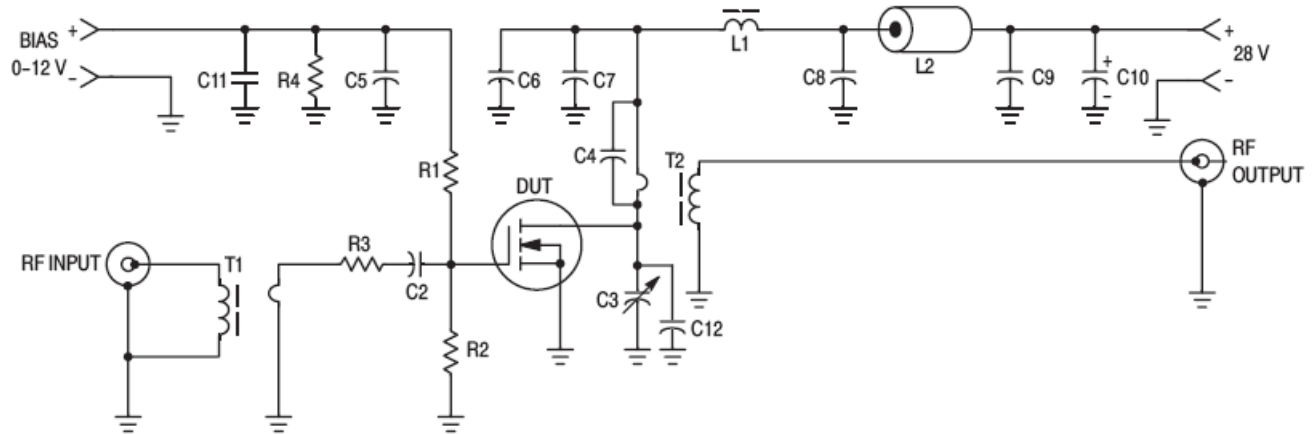
|   |                  |   |     |   |    |
|---|------------------|---|-----|---|----|
| Input Capacitance (V <sub>DS</sub> = 28 V, V <sub>GS</sub> = 0, f = 1.0 MHz)            | C <sub>iss</sub> | — | 450 | — | pF |
| Output Capacitance (V <sub>DS</sub> = 28 V, V <sub>GS</sub> = 0, f = 1.0 MHz)           | C <sub>oss</sub> | — | 400 | — | pF |
| Reverse Transfer Capacitance (V <sub>DS</sub> = 28 V, V <sub>GS</sub> = 0, f = 1.0 MHz) | C <sub>rss</sub> | — | 75  | — | pF |

#### FUNCTIONAL TESTS (SSB)

|   |   |                                |            |        |    |
|---|---|--------------------------------|------------|--------|----|
| Common Source Amplifier Power Gain<br>(V <sub>DD</sub> = 28 V, P <sub>out</sub> = 150 W (PEP), I <sub>DQ</sub> = 250 mA)                                  | G <sub>ps</sub>                             | —<br>—                         | 15<br>6.0  | —<br>— | dB |
| Drain Efficiency<br>(V <sub>DD</sub> = 28 V, P <sub>out</sub> = 150 W (PEP), f = 30; 30.001 MHz,<br>I <sub>D</sub> (Max) = 6.5 A)                         | η   | —                              | 40         | —      | %  |
| Intermodulation Distortion (1)<br>(V <sub>DD</sub> = 28 V, P <sub>out</sub> = 150 W (PEP), f1 = 30 MHz,<br>f2 = 30.001 MHz, I <sub>DQ</sub> = 250 mA)     | IMD <sub>(d3)</sub><br>IMD <sub>(d11)</sub> | —<br>—                         | –30<br>–60 | —<br>— | dB |
| Load Mismatch<br>(V <sub>DD</sub> = 28 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 |            |        |    |

#### NOTE:

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



C2, C5, C6, C7, C8, C9 — 0.1  $\mu$ F Ceramic Chip or Monolithic with Short Leads  
 C3 — Arco 469  
 C4 — 820 pF Unencapsulated Mica or Dipped Mica with Short Leads  
 C10 — 10  $\mu$ F/100 V Electrolytic  
 C11 — 1  $\mu$ F, 50 V, Tantalum  
 C12 — 330 pF, Dipped Mica (Short leads)

L1 — VK200/4B Ferrite Choke or Equivalent, 3.0  $\mu$ H  
 L2 — Ferrite Bead(s), 2.0  $\mu$ H  
 R1, R2 — 51  $\Omega$ /1.0 W Carbon  
 R3 — 1.0  $\Omega$ /1.0 W Carbon or Parallel Two 2  $\Omega$ , 1/2 W Resistors  
 R4 — 1 k $\Omega$ /1/2 W Carbon  
 T1 — 16:1 Broadband Transformer  
 T2 — 1:25 Broadband Transformer

Figure 1. 30 MHz Test Circuit (Class AB)

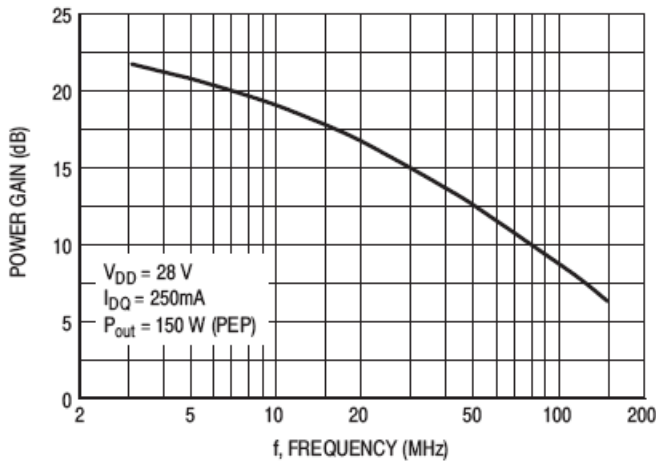


Figure 2. Power Gain versus Frequency

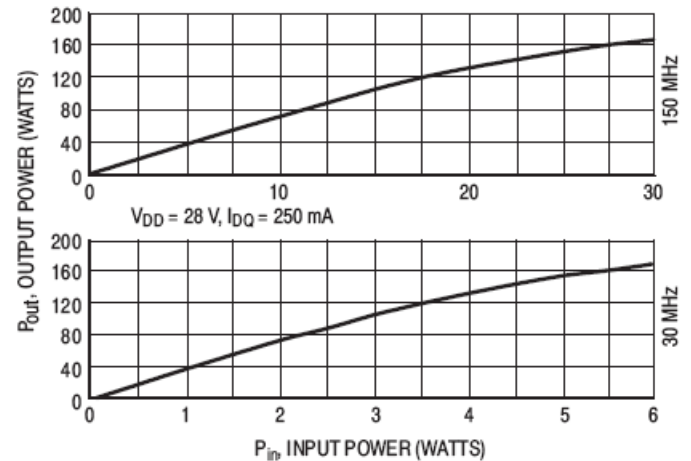


Figure 3. Output Power versus Input Power

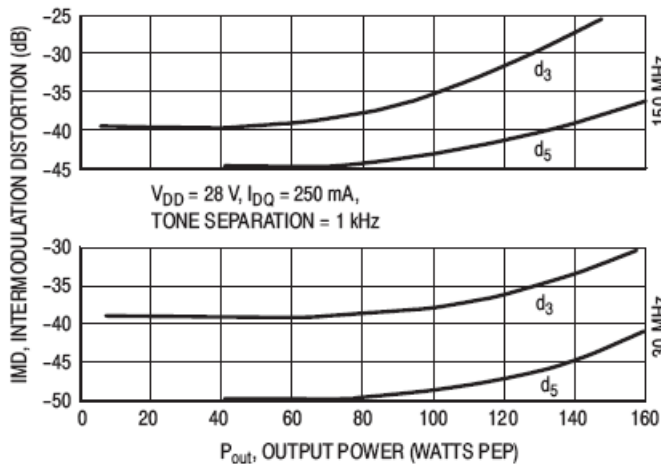


Figure 4. IMD versus  $P_{out}$

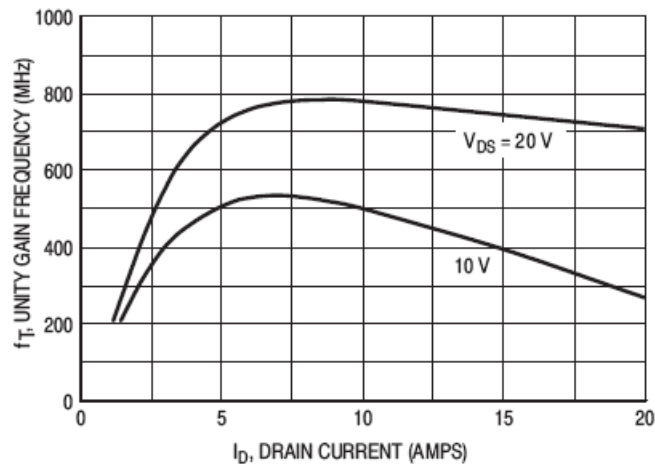


Figure 5. Common Source Unity Gain Frequency versus Drain Current

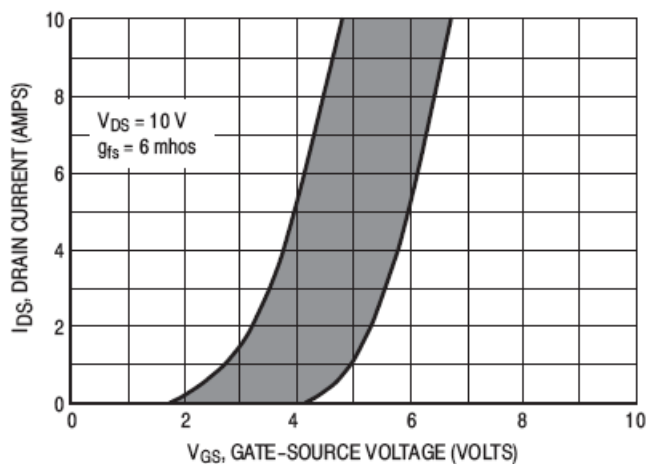
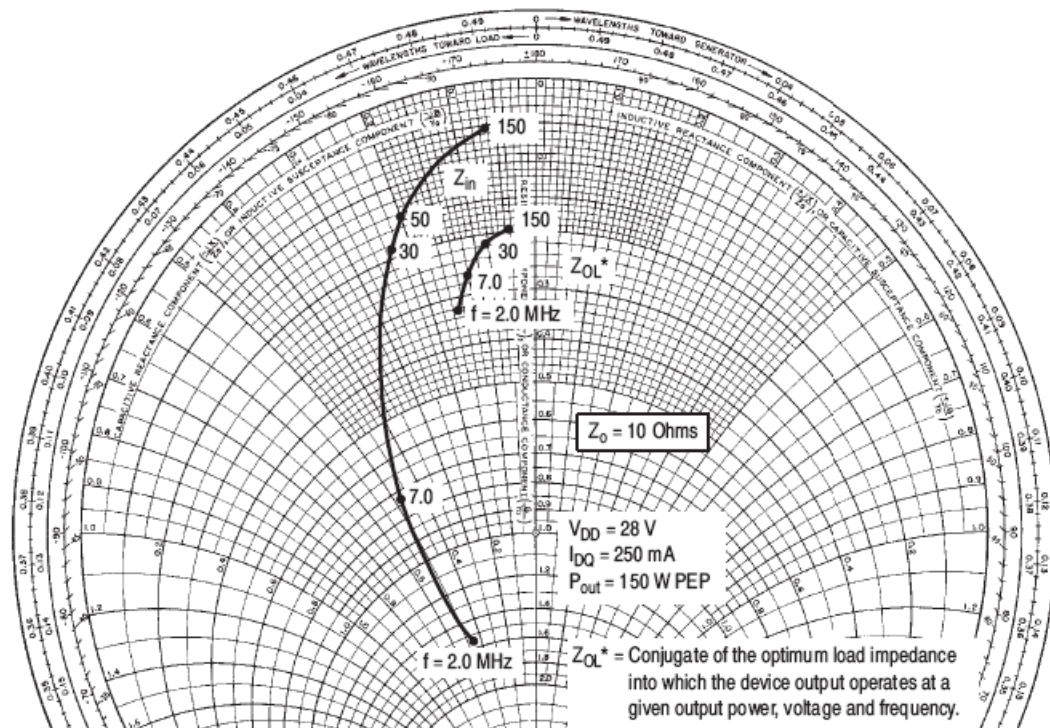
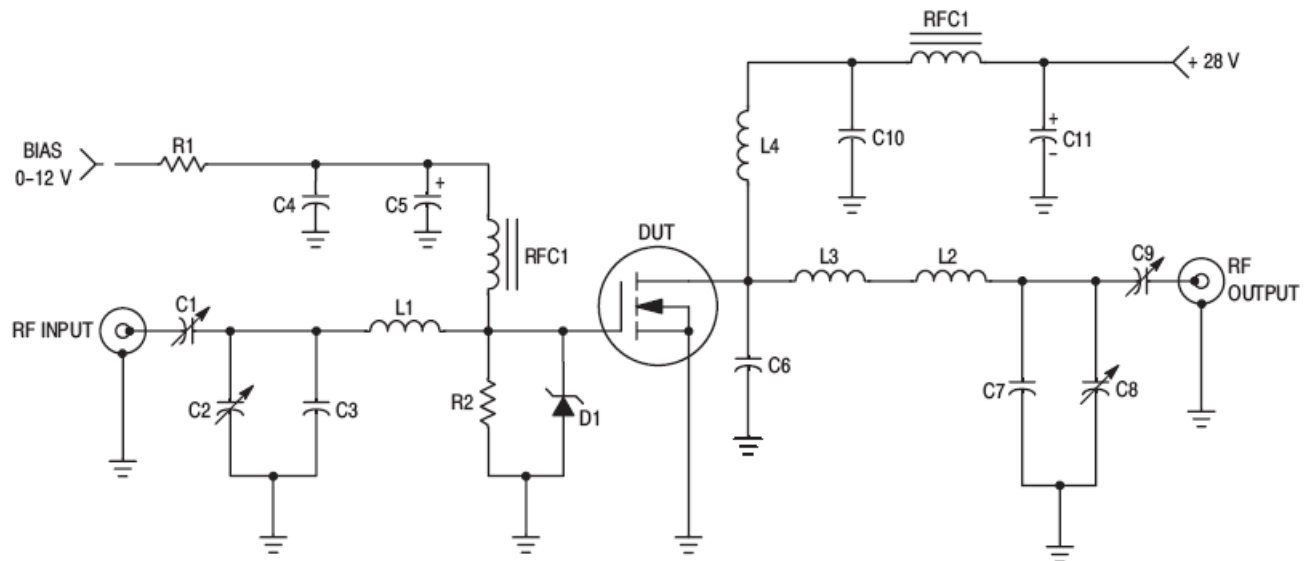


Figure 6. Gate Voltage versus Drain Current



NOTE: Gate Shunted by 25 Ohms.

Figure 7. Series Equivalent Impedance



C1, C2, C8 — Arco 463 or equivalent  
 C3 — 25 pF, Unelco  
 C4 — 0.1  $\mu$ F, Ceramic  
 C5 — 1.0  $\mu$ F, 15 WV Tantalum  
 C6 — 15 pF, Unelco J101  
 C7 — 25 pF, Unelco J101  
 C9 — Arco 262 or equivalent  
 C10 — 0.05  $\mu$ F, Ceramic  
 C11 — 15  $\mu$ F, 35 WV Electrolytic

L1 — 3/4", #18 AWG into Hairpin  
 L2 — Printed Line, 0.200" x 0.500"  
 L3 — 7/8", #16 AWG into Hairpin  
 L4 — 2 Turns, #16 AWG, 5/16 ID  
 RFC1 — 5.6  $\mu$ H, Molded Choke  
 RFC2 — VK200-4B  
 R1, R2 — 150  $\Omega$ , 1.0 W Carbon

Figure 8. 150 MHz Test Circuit (Class AB)

Table 1. Common Source S-Parameters ( $V_{DS} = 28\text{ V}$ ,  $I_D = 5\text{ A}$ )

| 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       | 0.957           | 180 | 1.88            | 86 | 0.008           | 22 | 0.938           | -178 |
| 40       | 0.956           | 180 | 1.46            | 81 | 0.010           | 23 | 0.940           | 179  |
| 50       | 0.956           | 180 | 1.17            | 78 | 0.012           | 33 | 0.936           | 179  |
| 60       | 0.956           | 179 | 1.00            | 76 | 0.013           | 44 | 0.936           | 177  |
| 70       | 0.957           | 179 | 0.86            | 73 | 0.012           | 54 | 0.960           | 177  |
| 80       | 0.957           | 179 | 0.73            | 72 | 0.010           | 53 | 0.970           | 179  |
| 90       | 0.957           | 179 | 0.64            | 71 | 0.011           | 45 | 0.952           | 180  |
| 100      | 0.957           | 178 | 0.58            | 67 | 0.015           | 44 | 0.934           | 178  |
| 110      | 0.956           | 178 | 0.55            | 64 | 0.018           | 53 | 0.947           | 176  |
| 120      | 0.957           | 178 | 0.48            | 64 | 0.019           | 67 | 0.961           | 177  |
| 130      | 0.957           | 178 | 0.43            | 61 | 0.017           | 75 | 0.973           | 178  |
| 140      | 0.958           | 177 | 0.41            | 60 | 0.016           | 73 | 0.964           | 178  |
| 150      | 0.958           | 177 | 0.37            | 59 | 0.017           | 60 | 0.978           | 179  |
| 160      | 0.957           | 177 | 0.36            | 56 | 0.023           | 58 | 0.934           | 178  |
| 170      | 0.959           | 177 | 0.34            | 54 | 0.026           | 67 | 0.923           | 176  |
| 180      | 0.958           | 177 | 0.31            | 51 | 0.028           | 75 | 0.974           | 175  |
| 190      | 0.958           | 176 | 0.30            | 53 | 0.026           | 82 | 0.986           | 175  |
| 200      | 0.959           | 176 | 0.27            | 52 | 0.024           | 77 | 0.986           | 176  |
| 210      | 0.958           | 176 | 0.27            | 54 | 0.026           | 67 | 0.988           | 177  |
| 220      | 0.960           | 176 | 0.28            | 52 | 0.032           | 67 | 0.951           | 175  |
| 230      | 0.962           | 176 | 0.24            | 45 | 0.039           | 70 | 1.020           | 172  |
| 240      | 0.960           | 176 | 0.24            | 44 | 0.038           | 76 | 0.988           | 171  |
| 250      | 0.962           | 175 | 0.21            | 47 | 0.038           | 81 | 0.980           | 175  |
| 260      | 0.962           | 175 | 0.21            | 44 | 0.036           | 77 | 0.994           | 175  |
| 270      | 0.960           | 175 | 0.20            | 44 | 0.038           | 72 | 0.980           | 173  |
| 280      | 0.963           | 175 | 0.20            | 43 | 0.043           | 71 | 0.962           | 172  |
| 290      | 0.964           | 175 | 0.19            | 40 | 0.046           | 74 | 0.952           | 170  |
| 300      | 0.965           | 175 | 0.20            | 42 | 0.049           | 78 | 0.945           | 170  |
| 310      | 0.966           | 174 | 0.18            | 42 | 0.046           | 79 | 1.010           | 172  |
| 320      | 0.963           | 174 | 0.18            | 45 | 0.049           | 74 | 0.971           | 170  |
| 330      | 0.964           | 174 | 0.16            | 42 | 0.053           | 74 | 0.930           | 170  |
| 340      | 0.966           | 174 | 0.18            | 46 | 0.055           | 71 | 0.947           | 169  |

Table 1. Common Source S-Parameters ( $V_{DS} = 28\text{ V}$ ,  $I_D = 5\text{ A}$ ) 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  |
| 350      | 0.965           | 174 | 0.17            | 43 | 0.059           | 74  | 0.964           | 169 |
| 360      | 0.967           | 173 | 0.16            | 43 | 0.061           | 74  | 1.010           | 167 |
| 370      | 0.968           | 173 | 0.15            | 43 | 0.063           | 70  | 1.010           | 167 |
| 380      | 0.967           | 173 | 0.16            | 41 | 0.065           | 70  | 0.952           | 168 |
| 390      | 0.968           | 173 | 0.16            | 45 | 0.068           | 72  | 0.970           | 168 |
| 400      | 0.968           | 172 | 0.15            | 42 | 0.069           | 77  | 0.957           | 170 |
| 410      | 0.967           | 172 | 0.15            | 44 | 0.070           | 72  | 1.000           | 165 |
| 420      | 0.969           | 172 | 0.14            | 43 | 0.070           | 68  | 0.986           | 164 |
| 430      | 0.968           | 172 | 0.13            | 45 | 0.078           | 65  | 0.980           | 166 |
| 440      | 0.968           | 171 | 0.14            | 47 | 0.086           | 68  | 0.953           | 166 |
| 450      | 0.969           | 171 | 0.15            | 45 | 0.087           | 74  | 0.981           | 166 |
| 460      | 0.968           | 171 | 0.14            | 48 | 0.076           | 73  | 0.971           | 163 |
| 470      | 0.965           | 171 | 0.13            | 41 | 0.046           | 75  | 0.980           | 163 |
| 480      | 0.958           | 170 | 0.13            | 40 | 0.017           | 115 | 1.050           | 162 |
| 490      | 0.954           | 170 | 0.13            | 37 | 0.041           | 113 | 1.050           | 163 |
| 500      | 0.956           | 170 | 0.13            | 35 | 0.070           | 74  | 1.040           | 162 |



## RF POWER MOSFET CONSIDERATIONS

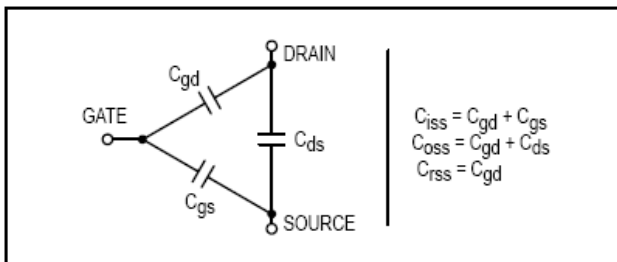
### MOSFET CAPACITANCES

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 applica-



tions.

### 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.

### 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 109 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,  $V_{GS(th)}$ .

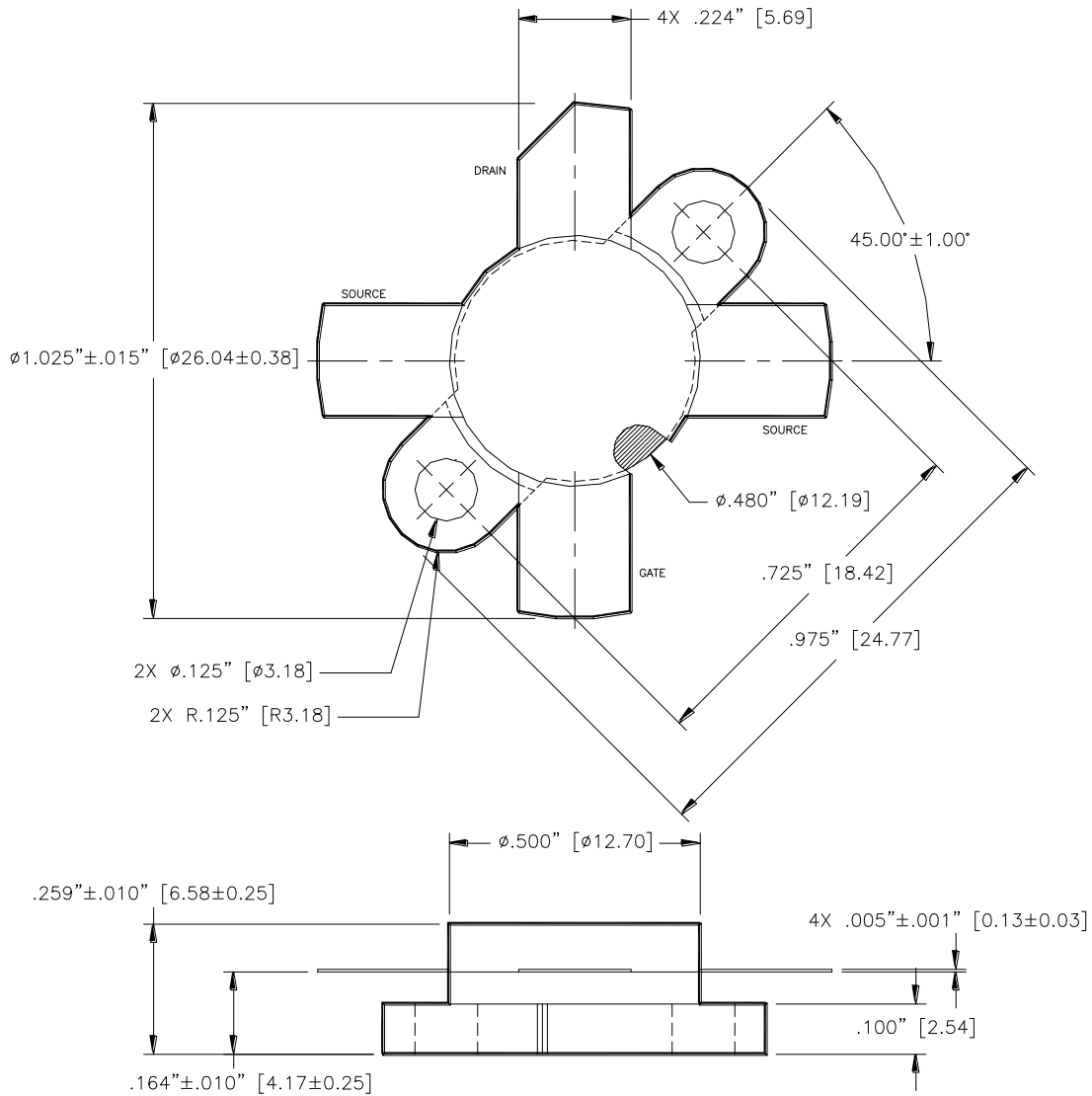
**Gate Voltage Rating** — Never exceed the gate voltage rating. Exceeding the rated  $V_{GS}$  can result in permanent damage to the oxide layer in the gate region.

**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                                  |
| $V_{(BR)CES}$ .....                           | $V_{(BR)DSS}$                         |
| $V_{CBO}$ .....                               | $V_{DGO}$                             |
| $I_C$ .....                                   | $I_D$                                 |
| $I_{CES}$ .....                               | $I_{DSS}$                             |
| $I_{EBO}$ .....                               | $I_{GSS}$                             |
| $V_{BE(on)}$ .....                            | $V_{GS(th)}$                          |
| $V_{CE(sat)}$ .....                           | $V_{DS(on)}$                          |
| $C_{ib}$ .....                                | $C_{iss}$                             |
| $C_{ob}$ .....                                | $C_{oss}$                             |
| $h_{fe}$ .....                                | $g_{fs}$                              |
| $R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$ ..... | $r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$ |



Unless otherwise noted, tolerances are inches  $\pm .005$  [millimeters  $\pm 0.13$ mm]