Designed for wideband large signal output and drive stages up to 400 MHz range.

N–Channel enhancement mode

- Guaranteed 28 V, 150 MHz performance
  - Output power = 30 W
  - Minimum gain = 13 dB
  - Efficiency — 60% (Typical)
- Small- and large–signal characterization
- Typical performance at 400 MHz, 28 Vdc, 30 W output = 7.7 dB gain
- 100% tested for load mismatch at all phase angles with 30:1 VSWR
- Low noise figure — 1.5 dB (typ.) at 1.0 A, 150 MHz
- Excellent thermal stability, ideally suited for Class A operation
- Facilitates manual gain control, ALC and modulation techniques

Maximum Ratings

<table>
<thead>
<tr>
<th>Rating</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain–Source Voltage</td>
<td>VDSS</td>
<td>65</td>
<td>Vdc</td>
</tr>
<tr>
<td>Drain–Gate Voltage (RGS = 1.0 MΩ)</td>
<td>VDGR</td>
<td>65</td>
<td>Vdc</td>
</tr>
<tr>
<td>Gate–Source Voltage</td>
<td>VGS</td>
<td>±40</td>
<td>Vdc</td>
</tr>
<tr>
<td>Drain Current — Continuous</td>
<td>ID</td>
<td>5.0</td>
<td>Adc</td>
</tr>
<tr>
<td>Total Device Dissipation @ T_C = 25°C</td>
<td>P_D</td>
<td>100</td>
<td>Watts</td>
</tr>
<tr>
<td>Derate above 25°C</td>
<td></td>
<td>0.571</td>
<td>W/°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>T_stg</td>
<td>-65 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>Operating Junction Temperature</td>
<td>T_J</td>
<td>200</td>
<td>°C</td>
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</table>

THERMAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Resistance, Junction to Case</td>
<td>R_AJC</td>
<td>1.75</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.
# MRF137

**The RF MOSFET Line**

30W, to 400MHz, 28V  

---

## ELECTRICAL CHARACTERISTICS

(T\(_\text{D} = 25^\circ\text{C}\) unless otherwise noted.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
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<tbody>
<tr>
<td><strong>OFF CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain–Source Breakdown Voltage ((V_{\text{GS}} = 0, I_D = 10 \text{ mA}))</td>
<td>(V_{\text{BRSS}})</td>
<td>65</td>
<td>—</td>
<td>—</td>
<td>Vdc</td>
</tr>
<tr>
<td>Zero Gate Voltage Drain Current ((V_{\text{DS}} = 28 \text{ V}, V_{\text{GS}} = 0))</td>
<td>(I_{\text{DSS}})</td>
<td>—</td>
<td>—</td>
<td>4.0</td>
<td>mA</td>
</tr>
<tr>
<td>Gate–Source Leakage Current ((V_{\text{GS}} = 26 \text{ V}, V_{\text{DS}} = 0))</td>
<td>(I_{\text{GSS}})</td>
<td>—</td>
<td>—</td>
<td>1.0</td>
<td>(\mu\text{A})</td>
</tr>
<tr>
<td><strong>ON CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate Threshold Voltage ((V_{\text{DD}} = 10 \text{ V}, I_D = 25 \text{ mA}))</td>
<td>(V_{\text{Gth}})</td>
<td>1.0</td>
<td>3.0</td>
<td>6.0</td>
<td>Vdc</td>
</tr>
<tr>
<td>Forward Transconductance ((V_{\text{DD}} = 10 \text{ V}, I_D = 500 \text{ mA}))</td>
<td>(g_{\text{m}})</td>
<td>500</td>
<td>750</td>
<td>—</td>
<td>(\text{mmhos})</td>
</tr>
<tr>
<td><strong>DYNAMIC CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Capacitance ((V_{\text{DD}} = 28 \text{ V}, V_{\text{GS}} = 0, f = 1.0 \text{ MHz}))</td>
<td>(C_{\text{iss}})</td>
<td>—</td>
<td>43</td>
<td>—</td>
<td>(\text{pF})</td>
</tr>
<tr>
<td>Output Capacitance ((V_{\text{GS}} = 28 \text{ V}, V_{\text{GS}} = 0, f = 1.0 \text{ MHz}))</td>
<td>(C_{\text{oss}})</td>
<td>—</td>
<td>54</td>
<td>—</td>
<td>(\text{pF})</td>
</tr>
<tr>
<td>Reverse Transfer Capacitance ((V_{\text{GS}} = 28 \text{ V}, V_{\text{GS}} = 0, f = 1.0 \text{ MHz}))</td>
<td>(C_{\text{rec}})</td>
<td>—</td>
<td>11</td>
<td>—</td>
<td>(\text{pF})</td>
</tr>
<tr>
<td><strong>FUNCTIONAL CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise Figure ((V_{\text{DD}} = 28 \text{ Vdc}, I_D = 1.0 \text{ A}, f = 150 \text{ MHz}))</td>
<td>NF</td>
<td>—</td>
<td>1.5</td>
<td>—</td>
<td>dB</td>
</tr>
<tr>
<td>Common Source Power Gain ((V_{\text{DD}} = 28 \text{ Vdc}, P_{\text{out}} = 30 \text{ W}, I_D = 25 \text{ mA}), (f = 150 \text{ MHz}) (Figure 1), (f = 400 \text{ MHz}) (Figure 14))</td>
<td>(G_{\text{ps}})</td>
<td>13</td>
<td>16</td>
<td>—</td>
<td>dB</td>
</tr>
<tr>
<td>Drain Efficiency (Figure 1) ((V_{\text{DD}} = 28 \text{ Vdc}, P_{\text{out}} = 30 \text{ W}, f = 150 \text{ MHz}, I_D = 25 \text{ mA}))</td>
<td>(\eta)</td>
<td>50</td>
<td>—</td>
<td>50</td>
<td>%</td>
</tr>
<tr>
<td>Electrical Ruggedness (Figure 1) ((V_{\text{DD}} = 28 \text{ Vdc}, P_{\text{out}} = 30 \text{ W}, f = 150 \text{ MHz}, I_D = 25 \text{ mA}, \text{VSWR} 30:1 \text{ at All Phase Angles}))</td>
<td>(\nu)</td>
<td>—</td>
<td>—</td>
<td>No Degradation in Output Power</td>
<td></td>
</tr>
</tbody>
</table>
The RF MOSFET Line
30W, to 400MHz, 28V

Rev. V2

MRF137

C1 — Arco 403, 3.0–36 pF, or equivalent
C2 — Arco 406, 15–115 pF, or equivalent
C3 — 56 pF Mini–Unelco, or equivalent
C4 — Arco 404, 8.0–60 pF, or equivalent
C5 — 660 pF, 100 Mils Cnp
C6 — 0.01 μF, 100 V, Disc Ceramic
C7 — 100 μF, 40 V
C8 — 0.1 μF, 50 V, Disc Ceramic
C9, C10 — 680 pF, Feedthru
D1 — 1N5925A Motorola Zener

L1 — 2 Turns, 0.20” ID, #18 AWG Enamel, Closedwound
L2 — 1-1/4 Turns, 0.2” ID, #18 AWG Enamel, Closedwound
L3 — 2 Turns, 0.2” ID, #18 AWG Enamel, Closedwound
RFC1 — 20 Turns, 0.30” ID, #20 AWG Enamel, Closedwound
RFC2 — Ferroxcube VK-200 — 19/4B
R1 — 10 kΩ, 1/2 W Thin Film
R2 — 10 kΩ, 1/4 W
R3 — 10 Turns, 10 kΩ
R4 — 1.8 kΩ, 1/2 W
Board — G10, 62 Mils

Figure 1. 150 MHz Test Circuit

Figure 2. Output Power versus Input Power

Figure 3. Output Power versus Input Power
The RF MOSFET Line
30W, to 400MHz, 28V

Figure 4. Output Power versus Input Power

Figure 5. Output Power versus Supply Voltage

Figure 6. Output Power versus Supply Voltage

Figure 7. Output Power versus Supply Voltage
The RF MOSFET Line
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Figure 8. Output Power versus Supply Voltage

Figure 9. Output Power versus Gate Voltage

Figure 10. Drain Current versus Gate Voltage (Transfer Characteristics)

Figure 11. Gate Source Voltage versus Case Temperature

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The RF MOSFET Line
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Figure 12. Capacitance versus Drain-Source Voltage

Figure 13. DC Safe Operating Area

Figure 14. 400 MHz Test Circuit

C1, C2, C3, C4 — 0.2-20 pF Johnson, or equivalent
C5, C8 — 270 pF, 100 MΩ Chip
C6, C7 — 24 pF Mini-Unisoc, or equivalent
C9 — 0.01 μF, 100 V, Disc Ceramic
C10 — 100 μF, 40 V
C11 — 0.1 μF, 50 V, Disc Ceramic
C12, C13 — 660 pF Feedthru
D1 — 1N5825A Motorola Zener
R1, R2 — 10 kΩ, 1/4 W
R3 — 10 Tungs, 10 kΩ

R4 — 1.8 kΩ, 1/2 W
Z1 — 2.9” × 0.165” Microstrip
Z2, Z4 — 0.35” × 0.165” Microstrip
Z3 — 0.40” × 0.165” Microstrip
Z5 — 1.05” × 0.165” Microstrip
Z6 — 1.9” × 0.165” Microstrip
RFC1 — 6 Tums, 0.300” ID, #20 AWG Enamal, Closedwound
RFC2 — Ferroxcube YK–200 — 18/43
Board — Glass Teflon, 52 Mils

Visit www.macom.com for additional data sheets and product information.
Figure 15. Large-Signal Series Equivalent Input and Output Impedance, $Z_{in}, Z_{out}$
### Table 1. Common Source Scattering Parameters

<table>
<thead>
<tr>
<th>f (MHz)</th>
<th>$S_{11}$</th>
<th>$\angle \phi$</th>
<th>$S_{21}$</th>
<th>$\angle \phi$</th>
<th>$S_{12}$</th>
<th>$\angle \phi$</th>
<th>$S_{22}$</th>
<th>$\angle \phi$</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0.977</td>
<td>$-32$</td>
<td>59.48</td>
<td>$163$</td>
<td>0.011</td>
<td>$67$</td>
<td>0.681</td>
<td>$-36$</td>
</tr>
<tr>
<td>50</td>
<td>0.919</td>
<td>$-102$</td>
<td>48.57</td>
<td>$142$</td>
<td>0.024</td>
<td>$44$</td>
<td>0.692</td>
<td>$-76$</td>
</tr>
<tr>
<td>100</td>
<td>0.815</td>
<td>$-168$</td>
<td>4.703</td>
<td>$86$</td>
<td>0.032</td>
<td>$11$</td>
<td>0.787</td>
<td>$-169$</td>
</tr>
<tr>
<td>150</td>
<td>0.812</td>
<td>$-171$</td>
<td>4.550</td>
<td>$63$</td>
<td>0.032</td>
<td>$11$</td>
<td>0.787</td>
<td>$-170$</td>
</tr>
<tr>
<td>200</td>
<td>0.803</td>
<td>$-170$</td>
<td>2.626</td>
<td>$77$</td>
<td>0.039</td>
<td>$14$</td>
<td>0.787</td>
<td>$-171$</td>
</tr>
<tr>
<td>250</td>
<td>0.814</td>
<td>$-171$</td>
<td>2.176</td>
<td>$72$</td>
<td>0.039</td>
<td>$14$</td>
<td>0.790</td>
<td>$-174$</td>
</tr>
<tr>
<td>300</td>
<td>0.832</td>
<td>$-170$</td>
<td>2.176</td>
<td>$72$</td>
<td>0.039</td>
<td>$14$</td>
<td>0.793</td>
<td>$-174$</td>
</tr>
<tr>
<td>350</td>
<td>0.865</td>
<td>$-175$</td>
<td>1.098</td>
<td>$56$</td>
<td>0.040</td>
<td>$17$</td>
<td>0.826</td>
<td>$-174$</td>
</tr>
<tr>
<td>400</td>
<td>0.880</td>
<td>$-176$</td>
<td>1.098</td>
<td>$56$</td>
<td>0.040</td>
<td>$17$</td>
<td>0.842</td>
<td>$-174$</td>
</tr>
<tr>
<td>450</td>
<td>0.891</td>
<td>$-176$</td>
<td>1.098</td>
<td>$56$</td>
<td>0.040</td>
<td>$17$</td>
<td>0.859</td>
<td>$-174$</td>
</tr>
<tr>
<td>500</td>
<td>0.907</td>
<td>$-175$</td>
<td>1.098</td>
<td>$56$</td>
<td>0.040</td>
<td>$17$</td>
<td>0.875</td>
<td>$-174$</td>
</tr>
<tr>
<td>550</td>
<td>0.923</td>
<td>$-175$</td>
<td>1.098</td>
<td>$56$</td>
<td>0.040</td>
<td>$17$</td>
<td>0.888</td>
<td>$-174$</td>
</tr>
<tr>
<td>600</td>
<td>0.935</td>
<td>$-176$</td>
<td>1.098</td>
<td>$56$</td>
<td>0.040</td>
<td>$17$</td>
<td>0.893</td>
<td>$-174$</td>
</tr>
<tr>
<td>650</td>
<td>0.945</td>
<td>$-176$</td>
<td>1.098</td>
<td>$56$</td>
<td>0.040</td>
<td>$17$</td>
<td>0.893</td>
<td>$-174$</td>
</tr>
</tbody>
</table>

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Figure 16. $S_{11}$, Input Reflection Coefficient versus Frequency
$V_{DS} = 28\, V$  $I_D = 0.75\, A$

Figure 17. $S_{12}$, Reverse Transmission Coefficient versus Frequency
$V_{DS} = 28\, V$  $I_D = 0.75\, A$

Figure 18. $S_{21}$, Forward Transmission Coefficient versus Frequency
$V_{DS} = 28\, V$  $I_D = 0.75\, A$

Figure 19. $S_{22}$, Output Reflection Coefficient versus Frequency
$V_{DS} = 28\, V$  $I_D = 0.75\, A$

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RF POWER MOSFET CONSIDERATIONS

DESIGN CONSIDERATIONS
The MRF137 is an enhancement mode field-effect transistor (FET) designed especially for VHF power amplifier applications. M/A-COM RF MOSFETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

M/A-COM Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, AGC/ALC and modulation.

DC BIAS
The MRF137 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 10 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance.

The value of quiescent drain current (I_DQ) is not critical for many applications. The MRF137 was characterized at I_DQ = 25 mA, which is the suggested minimum value of I_DQ. For special applications such as linear amplification, I_DQ may have to be selected to optimize the critical parameters. The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL
Power output of the MRF137 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 9.)

AMPLIFIER DESIGN
Impedance matching networks similar to those used with bipolar VHF transistors are suitable for MRF137. See M/A-COM Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF137, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF137 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See M/A-COM Application Note AN215A for a discussion of two port network theory and stability.
The RF MOSFET Line
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MRF137

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