The RF MOSFET Line
125W, 200MHz

Designed primarily for wideband large–signal output and driver stages up to 200 MHz frequency range.

N–Channel enhancement mode MOSFET

- Guaranteed performance at 150 MHz, 28 Vdc
  Output power = 125 W
  Minimum gain = 9.0 dB
- Efficiency = 50% (min.)
- Excellent thermal stability, ideally suited for Class A operation
- Facilitates manual gain control, ALC and modulation techniques
- 100% tested for load mismatch at all phase angles with 30:1 VSWR
- Low noise figure — 3.0 dB typ. at 2.0 A, 150 MHz

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>13</td>
<td>Adc</td>
</tr>
<tr>
<td>Total Device Dissipation @ TC = 25°C</td>
<td>PD</td>
<td>270</td>
<td>Watts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.54</td>
<td>W/°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>Tstg</td>
<td>-65 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>Operating Junction Temperature</td>
<td>TJ</td>
<td>200</td>
<td>°C</td>
</tr>
</tbody>
</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>RθJC</td>
<td>0.65</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.
**ELECTRICAL CHARACTERISTICS** \( (T_C = 25^\circ\text{C unless otherwise noted.}) \)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain–Source Breakdown Voltage ((V_{GS} = 0, , I_D = 50 , \text{mA}))</td>
<td>(V_{BRDSS})</td>
<td>65</td>
<td></td>
<td></td>
<td>(\text{Vdc})</td>
</tr>
<tr>
<td>Zero Gate Voltage Drain Current ((V_{DS} = 28 , \text{V}, , V_{GS} = 0))</td>
<td>(I_{DSS})</td>
<td></td>
<td>10</td>
<td></td>
<td>(\mu\text{A})</td>
</tr>
<tr>
<td>Gate–Source Leakage Current ((V_{GS} = 20 , \text{V}, , V_{DS} = 0))</td>
<td>(I_{GSS})</td>
<td></td>
<td>1.0</td>
<td></td>
<td>(\mu\text{A})</td>
</tr>
</tbody>
</table>

**ON CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate Threshold Voltage ((V_{DS} = 10 , \text{V}, , I_D = 100 , \text{mA}))</td>
<td>(V_{GS(th)})</td>
<td>1.0</td>
<td>3.0</td>
<td>6.0</td>
<td>(\text{Vdc})</td>
</tr>
<tr>
<td>Forward Transconducance ((V_{DS} = 10 , \text{V}, , I_D = 3.0 , \text{A}))</td>
<td>(g_f)</td>
<td>1.75</td>
<td>2.5</td>
<td></td>
<td>(\text{mhos})</td>
</tr>
</tbody>
</table>

**DYNAMIC CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Capacitance ((V_{DS} = 28 , \text{V}, , V_{GS} = 0, , f = 1.0 , \text{MHz}))</td>
<td>(C_{iss})</td>
<td>—</td>
<td>175</td>
<td></td>
<td>(\text{pF})</td>
</tr>
<tr>
<td>Output Capacitance ((V_{DS} = 28 , \text{V}, , V_{GS} = 0, , f = 1.0 , \text{MHz}))</td>
<td>(C_{oss})</td>
<td>—</td>
<td>190</td>
<td></td>
<td>(\text{pF})</td>
</tr>
<tr>
<td>Reverse Transfer Capacitance ((V_{DS} = 28 , \text{V}, , V_{GS} = 0, , f = 1.0 , \text{MHz}))</td>
<td>(C_{rss})</td>
<td>—</td>
<td>40</td>
<td></td>
<td>(\text{pF})</td>
</tr>
</tbody>
</table>

**FUNCTIONAL CHARACTERISTICS** (Figure 1)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise Figure ((V_{DD} = 28 , \text{Vdc}, , I_D = 2.0 , \text{A}, , f = 150 , \text{MHz}))</td>
<td>(NF)</td>
<td>—</td>
<td>3.0</td>
<td></td>
<td>(\text{dB})</td>
</tr>
<tr>
<td>Common Source Power Gain ((V_{DD} = 28 , \text{Vdc}, , P_{out} = 125 , \text{W}, , f = 150 , \text{MHz}, , I_{DQ} = 100 , \text{mA}))</td>
<td>(G_{ps})</td>
<td>9.0</td>
<td>11.8</td>
<td></td>
<td>(\text{dB})</td>
</tr>
<tr>
<td>Drain Efficiency ((V_{DD} = 28 , \text{Vdc}, , P_{out} = 125 , \text{W}, , f = 150 , \text{MHz}, , I_{DQ} = 100 , \text{mA}))</td>
<td>(\eta)</td>
<td>50</td>
<td>60</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>Electrical Ruggedness ((V_{DD} = 28 , \text{Vdc}, , P_{out} = 125 , \text{W}, , f = 150 , \text{MHz}, , I_{DQ} = 100 , \text{mA}, , VSWR 30:1 , \text{at all Phase Angles}))</td>
<td>(\psi)</td>
<td></td>
<td></td>
<td>No Degradation in Output Power</td>
<td></td>
</tr>
</tbody>
</table>
The RF MOSFET Line
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Figure 1. 150 MHz Test Circuit

C1 — 15 pF Unelco
C2 — Arco 462, 5.0—80 pF
C3 — 100 pF Unelco
C4 — 25 pF Unelco
C6 — 40 pF Unelco
C7 — Arco 461, 2.7—30 pF
C5, C8 — Arco 463, 9.0—180 pF
C9, C11, C14 — 0.1 μF Eric Redcap
C10 — 50 μF, 50 V
C12, C13 — 680 pF Feedthru
D1 — 1N5926A Motorola Zener

L1 — #16 AWG, 1—1/4 Turns, 0.213” ID
L2 — #16 AWG, Hairpin 0.25”
L3 — #14 AWG, Hairpin 0.062” 0.47”
L4 — 10 Turns #16 AWG Enamelled Wire on R1
RFC1 — 18 Turns #16 AWG Enamelled Wire, 0.3” ID
R1 — 10 Ω, 2.0 W
R2 — 1.6 kΩ, 1/2 W
R3 — 10 kΩ, 10 Turn Bourns
R4 — 10 kΩ, 1/4 W
The RF MOSFET Line
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**Figure 2. Output Power versus Input Power**

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

**Figure 4. Output Power versus Supply Voltage**

**Figure 5. Output Power versus Supply Voltage**
MRF174

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Figure 6. Output Power versus Supply Voltage

Figure 7. Power Gain versus Frequency
MRF174

The RF MOSFET Line
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Figure 8. Output Power versus Gate Voltage

Figure 9. Drain Current versus Gate Voltage
(Transfer Characteristics)

Figure 10. Gate-Source Voltage versus

Figure 11. Capacitance versus Drain Voltage
Figure 12. DC Safe Operating Area
The RF MOSFET Line
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Figure 13. $S_{11}$, Input Reflection Coefficient versus Frequency
$V_{DS} = 28 \, \text{V}, I_{D} = 3.0 \, \text{A}$

Figure 14. $S_{12}$, Reverse Transmission Coefficient versus Frequency
$V_{DS} = 28 \, \text{V}, I_{D} = 3.0 \, \text{A}$

Figure 15. $S_{21}$, Forward Transmission Coefficient versus Frequency
$V_{DS} = 28 \, \text{V}, I_{D} = 3.0 \, \text{A}$

Figure 16. $S_{22}$, Output Reflection Coefficient versus Frequency
$V_{DS} = 28 \, \text{V}, I_{D} = 3.0 \, \text{A}$
The RF MOSFET Line
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MRF174

Figure 17. Series Equivalent Input/Output Impedance, $Z_{in}$, $Z_{OL}^{*}$

<table>
<thead>
<tr>
<th>f MHz</th>
<th>$Z_{in}$ Ohms</th>
<th>$Z_{OL}^{*}$ Ohms</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>2.90 – j3.95</td>
<td>2.95 – j3.90</td>
</tr>
<tr>
<td>100</td>
<td>1.25 – j2.90</td>
<td>1.85 – j1.05</td>
</tr>
<tr>
<td>150</td>
<td>1.18 – j1.40</td>
<td>1.72 – j0.05</td>
</tr>
<tr>
<td>200</td>
<td>1.30 – j0.90</td>
<td>1.70 – j0.25</td>
</tr>
</tbody>
</table>
DESIGN CONSIDERATIONS

The MRF174 is a RF MOSFET power N–channel enhancement mode field–effect transistor (FET) designed for UHF 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 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, ALC and modulation.

DC BIAS

The MRF174 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 9 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 (IDQ) is not critical for many applications. The MRF174 was characterized at IDQ = 100 mA, which is the suggested minimum value of IDQ. For special applications such as linear amplification, IDQ 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 MRF174 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 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar VHF transistors are suitable for MRF174. See M/A-COM Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOSFETs 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.
MRF174

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Rev. V1

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