Linear RF Power MOSFET
600W, to 80MHz

Designed primarily for linear large signal output stages to 80 MHz.
- Specified 50 volts, 30 MHz characteristics
  - Output power = 600 watts
  - Power gain = 21 dB (typ.)
  - Efficiency = 45% (typ.)

Product Image

CASE 368-03, STYLE 2

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>V_{DSS}</td>
<td>125</td>
<td>Vdc</td>
</tr>
<tr>
<td>Drain–Gate Voltage</td>
<td>V_{DGG}</td>
<td>125</td>
<td>Vdc</td>
</tr>
<tr>
<td>Gate–Source Voltage</td>
<td>V_{GS}</td>
<td>±40</td>
<td>Vdc</td>
</tr>
<tr>
<td>Drain Current — Continuous</td>
<td>I_D</td>
<td>60</td>
<td>Adc</td>
</tr>
<tr>
<td>Total Device Dissipation @ T_C = 25°C</td>
<td>P_D</td>
<td>1350</td>
<td>Watts</td>
</tr>
<tr>
<td>Derate above 25°C</td>
<td></td>
<td>7.7</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>
</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>R_{eJC}</td>
<td>0.13</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

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

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## ELECTRICAL CHARACTERISTICS  \((T_C = 25\, ^\circ C\) 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>OFF CHARACTERISTICS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain–Source Breakdown Voltage ((V_{DS} = 0, I_D = 100, mA))</td>
<td>(V_{BR(PS)})</td>
<td>125</td>
<td>—</td>
<td>—</td>
<td>Vdc</td>
</tr>
<tr>
<td>Zero Gate Voltage Drain Current ((V_{DS} = 50, V, V_{GS} = 0))</td>
<td>(I_{DSS})</td>
<td>—</td>
<td>—</td>
<td>20</td>
<td>mA(\mu)</td>
</tr>
<tr>
<td>Gate–Body Leakage Current ((V_{GS} = 20, V, V_{DS} = 0))</td>
<td>(I_{GSS})</td>
<td>—</td>
<td>—</td>
<td>5.0</td>
<td>(\mu)A</td>
</tr>
<tr>
<td>ON CHARACTERISTICS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate Threshold Voltage ((V_{DS} = 10, V, I_D = 100, mA))</td>
<td>(V_{G(on)})</td>
<td>1.0</td>
<td>3.0</td>
<td>5.0</td>
<td>Vdc</td>
</tr>
<tr>
<td>Drain–Source On–Voltage ((V_{GS} = 10, V, I_D = 40, A))</td>
<td>(V_{D(on)})</td>
<td>1.0</td>
<td>3.0</td>
<td>5.0</td>
<td>Vdc</td>
</tr>
<tr>
<td>Forward Transconductance ((V_{DS} = 10, V, I_D = 20, A))</td>
<td>(g_{fs})</td>
<td>16</td>
<td>24</td>
<td>—</td>
<td>mhos</td>
</tr>
<tr>
<td>DYNAMIC CHARACTERISTICS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Capacitance ((V_{DS} = 50, V, V_{GS} = 0, V, f = 1.0, MHz))</td>
<td>(C_{iss})</td>
<td>—</td>
<td>1800</td>
<td>—</td>
<td>pF</td>
</tr>
<tr>
<td>Output Capacitance ((V_{DS} = 50, V, V_{GS} = 0, f = 1.0, MHz))</td>
<td>(C_{oss})</td>
<td>—</td>
<td>750</td>
<td>—</td>
<td>pF</td>
</tr>
<tr>
<td>Reverse Transfer Capacitance ((V_{DS} = 50, V, V_{GS} = 0, f = 1.0, MHz))</td>
<td>(C_{rss})</td>
<td>—</td>
<td>75</td>
<td>—</td>
<td>pF</td>
</tr>
<tr>
<td>FUNCTIONAL TESTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Source Amplifier Power Gain ((V_{DD} = 50, V, P_{out} = 600, W, I_{DQ} = 800, mA, f = 30, MHz))</td>
<td>(G_{ps})</td>
<td>15</td>
<td>21</td>
<td>—</td>
<td>dB</td>
</tr>
<tr>
<td>Drain Efficiency ((V_{DD} = 50, V, P_{out} = 600, W, f = 30, MHz, I_{DQ} = 800, mA))</td>
<td>(h)</td>
<td>40</td>
<td>45</td>
<td>—</td>
<td>%</td>
</tr>
<tr>
<td>Intermodulation Distortion ((V_{DD} = 50, V, P_{out} = 600, W(PEP), f_1 = 30, MHz, f_2 = 30.001, MHz, I_{DQ} = 800, mA))</td>
<td>(IMD_{(d)})</td>
<td>—</td>
<td>—25</td>
<td>—</td>
<td>dB</td>
</tr>
</tbody>
</table>
MRF157

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Figure 1. 30 MHz Test Circuit

Figure 2. Power Gain versus Frequency

Figure 3. Output Power versus Input Power

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Figure 8. Output Power versus Input Power
Under Pulse Conditions (2 x MRF157)
Note: Pulse data for this graph was taken in a push-pull circuit similar
to the one shown. However, the output matching network was
modified for the higher level of peak power.

Figure 9. Thermal Response versus
Pulse Width

Figure 10. Series Equivalent Impedance
Note: To determine $Z_{OL}^*$, use formula
$$\frac{(V_{CC} - V_{sat})^2}{2 \cdot P_0} = Z_{OL}^*$$
Figure 11. 2.0 to 50 MHz, 1.0 kW Wideband Amplifier

Unless otherwise noted, all resistors are 1/2 watt metal film type. All chip capacitors except C13 are .1nF type 100/200V or Dielectric Laboratories type C17.
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 (Cgd), and gate–to–source (Cgs). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain–to–source (Cds).
These capacitances are characterized as input (Ciss), output (Coss) and reverse transfer (Crss) capacitances on data sheets. The relationships between the inter–terminal capacitances and those given on data sheets are shown below. The

Ciss 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.

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, VGS(th).

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated VGS 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.

IMPEDEANCE CHARACTERISTICS
Device input and output impedances are normally obtained by measuring their conjugates in an optimized narrow band test circuit. These test circuits are designed and constructed for a number of frequency points depending on the frequency coverage of characterization. For low frequencies the circuits consist of standard LC matching networks including variable capacitors for peak tuning. At increasing power levels the output impedance decreases, resulting in higher RF currents in the matching network. This makes the practicality of output impedance measurements in the manner described questionable at power levels higher than 200–300 W for devices operated at 50 V and 150–200 W for devices operated at 28 V. The physical sizes and values required for the components to withstand the RF currents increase to a point where physical construction of the output matching network gets difficult if not impossible. For this reason the output impedances are not given for high power devices such as the MRF154 and MRF157.

However, formulas like 
\[ \frac{(V_{DS} - V_{sat})^2}{2P_{out}} \]
for a single ended
design
\[ \frac{2(V_{DS} - V_{sat})^2}{P_{out}} \]
or for a push–pull design can be used to obtain reasonably close approximations to actual values.
MOUNTING OF HIGH POWER RF POWER TRANSISTORS
The package of this device is designed for conduction cooling. It is extremely important to minimize the thermal resistance between the device flange and the heat dissipator.
Since the device mounting flange is made of soft copper, it may be deformed during various stages of handling or during transportation. It is recommended that the user makes a final inspection on this before the device installation. ±0.0005, is considered sufficient for the flange bottom.
The same applies to the heat dissipator in the device mounting area. If copper heat sink is not used, a copper head spreader is strongly recommended between the device mounting surfaces and the main heat sink. It should be at least 1/4, thick and extend at least one inch from the flange edges. A thin layer of thermal compound in all interfaces is, of course, essential. The recommended torque on the 4–40 mounting screws should be in the area of 4–5 lbs. –inch, and spring type lock washers along with flat washers are recommended.
For die temperature calculations, the Δ temperature from a corner mounting screw area to the bottom center of the flange is approximately 5°C and 10°C under normal operating conditions (dissipation 150 W and 300 W respectively). The main heat dissipater must be sufficiently large and have low Rθ for moderate air velocity, unless liquid cooling is employed.

CIRCUIT CONSIDERATIONS
At high power levels (500 W and up), the circuit layout becomes critical due to the low impedance levels and high RF currents associated with the output matching. Some of the components, such as capacitors and inductors must also withstand these currents. The component losses are directly proportional to the operating frequency. The manufacturers specifications on capacitor ratings should be consulted on these aspects prior to design.
Push–pull circuits are less critical in general, since the ground referenced RF loops are practically eliminated, and the impedance levels are higher for a given power output. High power broadband transformers are also easier to design than comparable LC matching networks.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector ................................................. Drain
Emitter ................................................. Source
Base .......................................................... Gate


\[ R_{CE(sat)} = \frac{V_CE(sat)}{I_C} = \frac{V_DS(on)}{I_D} \]
MRF157

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