RF Power Field-Effect Transistor
150 W, 50 V, 175 MHz N-Channel Broadband MOSFET

Features
Guaranteed Performance at 30 MHz, 50 V:
- Output Power — 150 W
- Gain — 18 dB (22 dB Typ)
- Efficiency — 40%

Typical Performance at 175 MHz, 50 V:
- Output Power — 150 W
- Gain — 13 dB
- Low Thermal Resistance
- Ruggedness Tested at Rated Output Power
- Nitride Passivated Die for Enhanced Reliability

Description and Applications
Designed for broadband commercial and military applications at frequencies to 175 MHz. The high power, high gain and broadband performance of this device makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

Package Outline

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>125</td>
<td>Vdc</td>
</tr>
<tr>
<td>Drain–Gate Voltage</td>
<td>VDGO</td>
<td>125</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>16</td>
<td>Adc</td>
</tr>
<tr>
<td>Total Device Dissipation @ Tc = 25°C</td>
<td>Pd</td>
<td>300</td>
<td>Watts</td>
</tr>
<tr>
<td>Derate above 25°C</td>
<td></td>
<td>1.71</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>RWJC</td>
<td>0.6</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.
# MRF151

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### ELECTRICAL CHARACTERISTICS (Tc = 25°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><strong>OFF CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain-Source Breakdown Voltage (Vgs = 0, Ig = 100 mA)</td>
<td>VGS(Off)</td>
<td>125</td>
<td></td>
<td></td>
<td>Vdc</td>
</tr>
<tr>
<td>Zero Gate Voltage Drain Current (Vgs = 50 V, Vds = 0)</td>
<td>IDSS</td>
<td></td>
<td>5.0</td>
<td></td>
<td>mAdc</td>
</tr>
<tr>
<td>Gate-Body Leakage Current (Vgs = 30 V, Vds = 0)</td>
<td>ISBS</td>
<td></td>
<td>1.0</td>
<td></td>
<td>μAdc</td>
</tr>
<tr>
<td><strong>ON CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate-Source On-Voltage (Vgs = 10 V, Ig = 10 A)</td>
<td>VD(Gon)</td>
<td>1.0</td>
<td>3.0</td>
<td>5.0</td>
<td>Vdc</td>
</tr>
<tr>
<td>Drain-Source On-Voltage (Vgs = 10 V, Vds = 0)</td>
<td>VD(Son)</td>
<td>1.0</td>
<td>3.0</td>
<td>5.0</td>
<td>Vdc</td>
</tr>
<tr>
<td>Forward Transconductance (Vgs = 10 V, Ig = 5.0 A)</td>
<td>gfs</td>
<td>5.0</td>
<td>7.0</td>
<td></td>
<td>mhos</td>
</tr>
<tr>
<td><strong>DYNAMIC CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Capacitance (Vgs = 50 V, Vds = 0, f = 1.0 MHz)</td>
<td>Ciss</td>
<td></td>
<td>350</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>Output Capacitance (Vds = 50 V, Vgs = 0, f = 1.0 MHz)</td>
<td>Coss</td>
<td></td>
<td>220</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>Reverse Transfer Capacitance (Vgs = 50 V, Vds = 0, f = 1.0 MHz)</td>
<td>CRss</td>
<td></td>
<td>15</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td><strong>FUNCTIONAL TESTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Source Amplifier Power Gain, f = 30, 30.001 MHz (Vdd = 50 V, Pout = 150 W (PEP), Vgs = 250 mA)</td>
<td>GSPD</td>
<td>15</td>
<td>22</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Drain Efficiency, f = 30, 30.001 MHz (Vdd = 50 V, Pout = 150 W (PEP), Ig (Max) = 5.75 A)</td>
<td>η</td>
<td>40</td>
<td>45</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>Intermodulation Distortion (1) f = 30 MHz, (f2 = 30.001 MHz, I GS = 50 mA)</td>
<td>IMD(30)</td>
<td></td>
<td></td>
<td>32</td>
<td>dB</td>
</tr>
<tr>
<td>Load Match, f = 30, 30.001 MHz, VGS=250 mA, VSWR: 30:1 at all Phase Angles</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td>No Degradation in Output Power</td>
</tr>
<tr>
<td><strong>CLASS A PERFORMANCE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermodulation Distortion (1) and Power Gain, f = 30 MHz, I GS = 50 mA,</td>
<td>GSPD</td>
<td></td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>IMD(30)</td>
<td>IMD(0,13)</td>
<td></td>
<td></td>
<td></td>
<td>dB</td>
</tr>
</tbody>
</table>

**NOTE:**


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### Diagram

![30 MHz Test Circuit](https://www.macom.com/sup...)

- C1 — 470 pF Capacitor
- C2, C6, C7, C8, C9 = 0.1 μF Ceramic Chip or Monolithic with Short Leads
- C3 — 200 μF Monolithic with Short Leads
- C4 — 15 μF Monolithic with Short Leads
- C10 — 10 μF 100 V Electrolytic
- L1 — YAGE045 Ferrite Choke or Equivalent, 3.0 μH
- L2 — Ferrite Bead (A), 2.0 μH
- R1, R2 — 51 Ω, 1.0 W Carbons
- R3 — 330 μF 1.0 W Carbon (or 2 x 6.8 μF/12 W in Parallel)
- T1 — 0.1 Bandwidth Transformer
- T2 — 3.3 Bandwidth Transformer
- Board Material — 0.062" Fiberglass (G10), 1 oz. Copper Clad, 2 Sides, εr = 5

Figure 1. 30 MHz Test Circuit
RF Power Field-Effect Transistor
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Figure 2. 175 MHz Test Circuit

TYPICAL CHARACTERISTICS

Figure 3. Capacitance versus Drain-Source Voltage

Figure 4. Gate-Source Voltage versus Case Temperature
RF Power Field-Effect Transistor
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TYPICAL CHARACTERISTICS

Figure 5. DC Safe Operating Area

Figure 6. Common Source Unity Gain Frequency versus Drain Current

Figure 7. Power Gain versus Frequency

Figure 8. Output Power versus Input Power

Figure 9. IMD versus P_out

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https://www.macom.com/support
Table 1. Common Source S-Parameters (VDS = 50 V, ID = 2 A)

| f MHz | S11 | | S21 | | S12 | | S22 |
|-------|-----|-----|-----|-----|-----|-----|
| 30    | 0.977 | -174 | 15.10 | 77 | 0.005 | 19 | 0.707 | -169 |
| 40    | 0.966 | -175 | 7.47 | 69 | 0.009 | 24 | 0.715 | -172 |
| 50    | 0.965 | -175 | 5.76 | 83 | 0.008 | 33 | 0.756 | -174 |
| 60    | 0.962 | -176 | 4.73 | 50 | 0.008 | 38 | 0.764 | -171 |
| 70    | 0.912 | -176 | 3.86 | 52 | 0.009 | 46 | 0.784 | -172 |
| 80    | 0.910 | -177 | 3.15 | 48 | 0.010 | 54 | 0.787 | -173 |
| 90    | 0.925 | -177 | 2.69 | 45 | 0.011 | 62 | 0.808 | -172 |
| 100   | 0.932 | -177 | 2.34 | 40 | 0.013 | 67 | 0.850 | -173 |
| 110   | 0.936 | -178 | 2.06 | 37 | 0.014 | 72 | 0.865 | -173 |
| 120   | 0.942 | -179 | 1.77 | 35 | 0.016 | 76 | 0.874 | -172 |
| 130   | 0.946 | -179 | 1.55 | 32 | 0.017 | 77 | 0.874 | -172 |
| 140   | 0.950 | -179 | 1.32 | 30 | 0.019 | 77 | 0.884 | -174 |
| 150   | 0.954 | -180 | 1.23 | 27 | 0.021 | 78 | 0.909 | -175 |
| 160   | 0.957 | -180 | 1.13 | 24 | 0.023 | 79 | 0.911 | -175 |
| 170   | 0.960 | -180 | 1.01 | 22 | 0.024 | 82 | 0.924 | -177 |
| 180   | 0.962 | -179 | 0.90 | 20 | 0.026 | 82 | 0.931 | -175 |
| 190   | 0.964 | -179 | 0.84 | 19 | 0.026 | 82 | 0.939 | -175 |
| 200   | 0.967 | -178 | 0.75 | 18 | 0.030 | 79 | 0.922 | -179 |
| 210   | 0.967 | -178 | 0.71 | 18 | 0.032 | 80 | 0.937 | -180 |
| 220   | 0.969 | -178 | 0.67 | 14 | 0.036 | 82 | 0.949 | -180 |
| 230   | 0.971 | -178 | 0.60 | 12 | 0.036 | 81 | 0.950 | -175 |
| 240   | 0.970 | -177 | 0.57 | 12 | 0.037 | 80 | 0.950 | -175 |
| f MHz | | $|S_{11}|$ | $|S_{21}|$ | $|S_{12}|$ | $|S_{22}|$ |
|-------|----------|----------|----------|----------|----------|
| 250   | 0.972    | 0.51     | 0.039    | 0.935    | 179      |
| 260   | 0.973    | 0.47     | 0.041    | 0.954    | 178      |
| 270   | 0.972    | 0.45     | 0.044    | 0.953    | 176      |
| 280   | 0.974    | 0.41     | 0.046    | 0.965    | 175      |
| 290   | 0.974    | 0.40     | 0.046    | 0.944    | 175      |
| 300   | 0.975    | 0.39     | 0.048    | 0.929    | 176      |
| 310   | 0.976    | 0.36     | 0.049    | 0.943    | 176      |
| 320   | 0.974    | 0.33     | 0.053    | 0.954    | 176      |
| 330   | 0.975    | 0.31     | 0.056    | 0.935    | 172      |
| 340   | 0.976    | 0.30     | 0.056    | 0.948    | 172      |
| 350   | 0.975    | 0.29     | 0.058    | 0.950    | 174      |
| 360   | 0.977    | 0.28     | 0.059    | 0.978    | 172      |
| 370   | 0.976    | 0.26     | 0.061    | 0.981    | 170      |
| 380   | 0.976    | 0.26     | 0.065    | 0.944    | 171      |
| 390   | 0.977    | 0.24     | 0.066    | 0.960    | 171      |
| 400   | 0.976    | 0.23     | 0.068    | 0.955    | 173      |
| 410   | 0.976    | 0.22     | 0.071    | 0.999    | 170      |
| 420   | 0.977    | 0.21     | 0.071    | 0.962    | 168      |
| 430   | 0.976    | 0.19     | 0.073    | 0.950    | 168      |
| 440   | 0.976    | 0.20     | 0.075    | 0.953    | 168      |
| 450   | 0.978    | 0.19     | 0.080    | 0.982    | 168      |
| 460   | 0.978    | 0.18     | 0.082    | 0.990    | 165      |
| 470   | 0.978    | 0.18     | 0.081    | 0.953    | 168      |
| 480   | 0.974    | 0.18     | 0.085    | 0.944    | 167      |
| 490   | 0.973    | 0.17     | 0.086    | 0.966    | 165      |
| 500   | 0.972    | 0.17     | 0.089    | 0.980    | 165      |
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES
The physical structure of a MOSFET results in capacitors between the terminals. The metal anode 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 MOSFET results in a junction capacitance from drain-to-source ($C_{ds}$). These capacitances are characterized as input ($C_{gs}$), output ($C_{gd}$), and reverse transfer ($C_{gd}$) capacitances on data sheets. The relationships between the inter- and terminal capacitances and those given on data sheets are shown below. The $C_{gd}$ 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 6 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity gain frequency at a given drain current level. This is equivalent to $f_T$ for bipolar transistors.

DRAIN CHARACTERISTICS
One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $R_{ON(mw)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for $50$-ohm voltage and drain current. For MOSFETs, $R_{ON(mw)}$ 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 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 $10^6$ 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 gate of this device is essentially capacitive. Circuits that leave the gate open–circuit or floating should be avoided. These conditions can result in turn-on of the device due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — This device does not have an internal monolithic zener diode from gate–to–source. If gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate–to–source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate–drain capacitance. If the gate–to–source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate–threshold voltage and turn the device on.

HANDLING CONSIDERATIONS
When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear ground straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with a grounded iron.

DESIGN CONSIDERATIONS
The MRF151 is an RF Power, MOS, N-channel enhancement mode field–effect transistor (FET) designed for RF and VHF power amplifier applications.

DC BIAS
The MRF151 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. RF power FETs require forward bias for optimum performance. The value of quiescent drain current ($I_{DSS}$) is not critical for many applications. The MRF151 was characterized at $I_{DSS} = 250$ mA, each side, which is the suggested minimum value of $I_{DSS}$. For special applications such as linear amplification, $I_{DSS}$ 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 be just a simple resistor divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL
Power output of the MRF151 may be controlled from its rated voltage 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.
MRF151

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Rev. V1

Unless otherwise noted, tolerances are inches ±0.005" [millimeters ±0.13mm].

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MRF151

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