## The RF Line

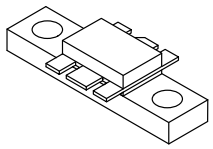
# NPN Silicon RF Power Transistor

**MRF6409**

The MRF6409 is designed for GSM base stations applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- To be used in Class AB
- Specified 26 Volts, 960 MHz Characteristics
  Output Power — 20 Watts CW
  Gain — 11 dB Typ
  Efficiency — 60% Typ

**20 W, 960 MHz**
**RF POWER TRANSISTOR**
**NPN SILICON**



**CASE 319–07, STYLE 2**

**MAXIMUM RATINGS**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector–Emitter Voltage | $V_{CEO}$ | 24 | Vdc |
| Collector–Emitter Voltage | $V_{CES}$ | 55 | Vdc |
| Emitter–Base Voltage | $V_{EBO}$ | 4.0 | Vdc |
| Collector–Current — Continuous | $I_C$ | 5.0 | Adc |
| Total Device Dissipation @ $T_C$ = 25°C<br>Derate above 25°C | $P_D$ | 45<br>0.26 | Watts<br>W/°C |
| Storage Temperature Range | $T_{stg}$ | –65 to +150 | °C |
| Operating Junction Temperature | $T_J$ | 200 | °C |

**THERMAL CHARACTERISTICS**

| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case (1) | $R_{\theta JC}$ | 3.8 | °C/W |

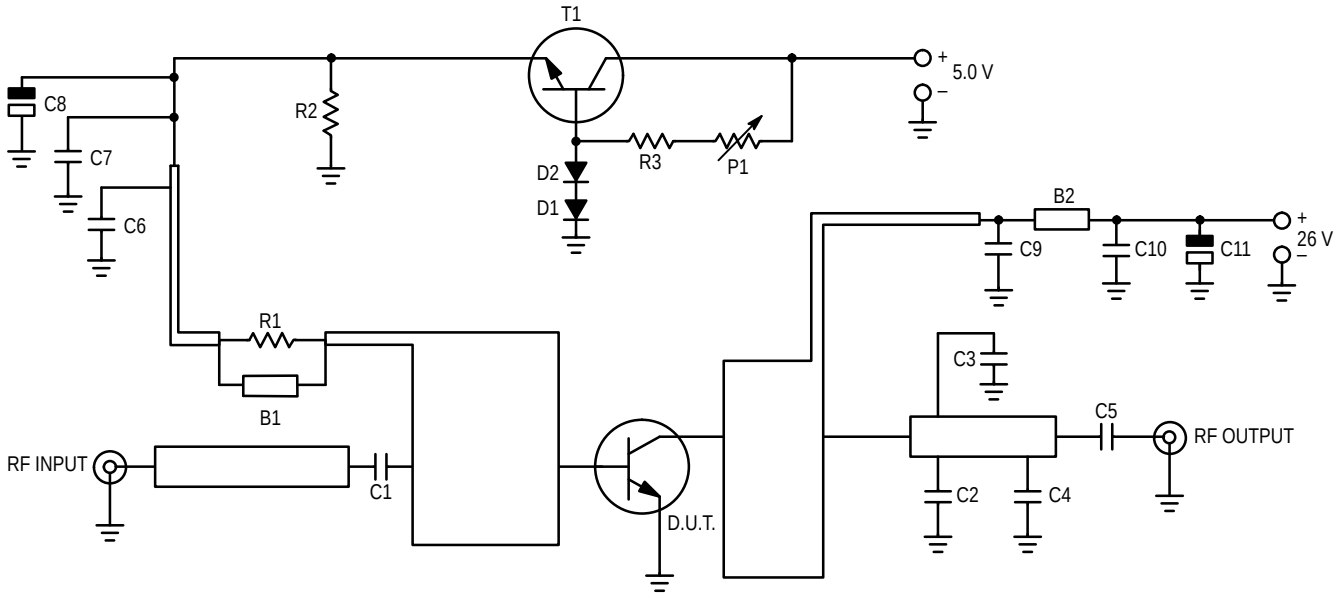
**ELECTRICAL CHARACTERISTICS** ($T_C$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector–Emitter Breakdown Voltage<br>($I_C$ = 20 mAdc, $I_B$ = 0) | $V_{(BR)CEO}$ | 24 | 30 | — | Vdc |
| Emitter–Base Breakdown Voltage<br>($I_B$ = 5.0 mAdc, $I_C$ =0) | $V_{(BR)EBO}$ | 4.0 | 5.0 | — | Vdc |
| Collector–Emitter Breakdown Voltage<br>($I_C$ = 20 mAdc, $V_{BE}$ = 0) | $V_{(BR)CES}$ | 55 | 60 | — | Vdc |
| Collector–Cutoff Current<br>($V_{CE}$ = 30 Vdc, $V_{BE}$ = 0) | $I_{CES}$ | — | — | 6.0 | mA |

(1) Thermal resistance is determined under specified RF operating condition.

**ELECTRICAL CHARACTERISTICS — continued** ($T_C$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **ON CHARACTERISTICS** | | | | | |
| DC Current Gain ($I_{CE}$ = 1.0 Adc, $V_{CE}$ = 5.0 Vdc) | $h_{FE}$ | 20 | 35 | 80 | — |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Output Capacitance ($V_{CB}$ = 26 Vdc, $I_E$ = 0, f = 1.0 MHz) | $C_{ob}$ | — | 18 | — | pF |
| **FUNCTIONAL TESTS** | | | | | |
| Common–Emitter Amplifier Power Gain ($V_{CC}$ = 26 Vdc, $P_{out}$ = 20 W (CW), $I_{CQ}$ = 50 mA, f = 960 MHz) | $G_{pe}$ | 10 | 11 | — | dB |
| Collector Efficiency ($V_{CC}$ = 26 Vdc, $P_{out}$ = 20 W (CW), $I_{CQ}$ = 50 mA, f = 960 MHz) | $\eta$ | 50 | 60 | — | % |
| Load Mismatch ($V_{CC}$ = 26 Vdc, $P_{out}$ = 15 W (CW), $I_{CQ}$ = 50 mA, f = 960 MHz, Load VSWR = 3:1, All Phase Angles at Frequency of Test) | $\Psi$ | No Degradation in Output Power | | | |




| | | | |
|---|---|---|---|
| B1, B2 | Ferrite Bead | C11 | 4.7 μF, 50 V, Tantalum Capacitor |
| C1 | 3.3 pF, Chip Capacitor, High Q | D1, D2 | Diode BAS16 Type or Equivalent |
| C2, C3 | 4.7 pF, Chip Capacitor, High Q | P1 | 1.0 kΩ, Trimmer |
| C4 | 2.2 pF, Chip Capacitor, High Q | R1 | 3.3 Ω, Chip Resistor |
| C5 | 82 pF, Chip Capacitor, High Q | R2 | 68 Ω, Chip Resistor |
| C6, C9 | 330 pF, Chip Capacitor, High Q | R3 | 2.2 kΩ, Resistor |
| C7, C10 | 0.1 μF, Chip Capacitor | T1 | NPN Transistor |
| C8 | 22 μF, 16 V, Tantalum Capacitor | Board | Glass Teflon®, $\varepsilon_r$ = 2.55, H = 1/50 inch |

**Figure 1. Test Circuit Electrical Schematic**

## TYPICAL CHARACTERISTICS

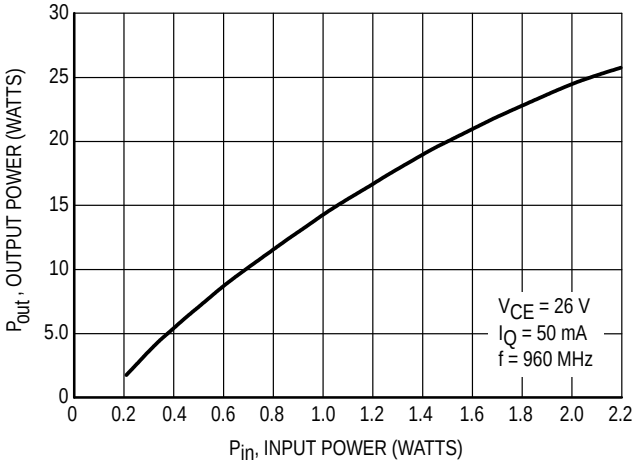



**Figure 2. Output Power versus Input Power (CW)**

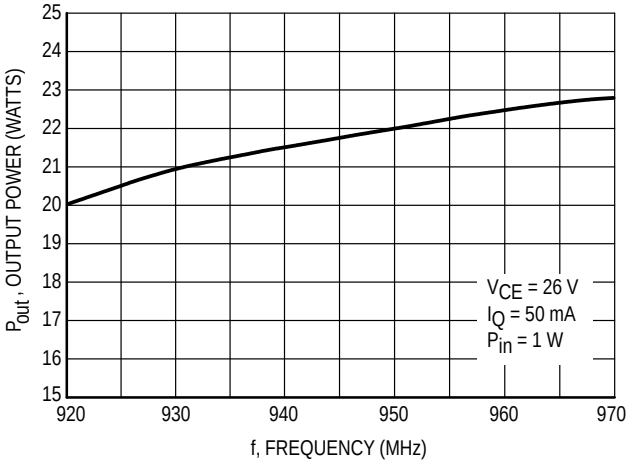



**Figure 3. Output Power versus Frequency (CW)**

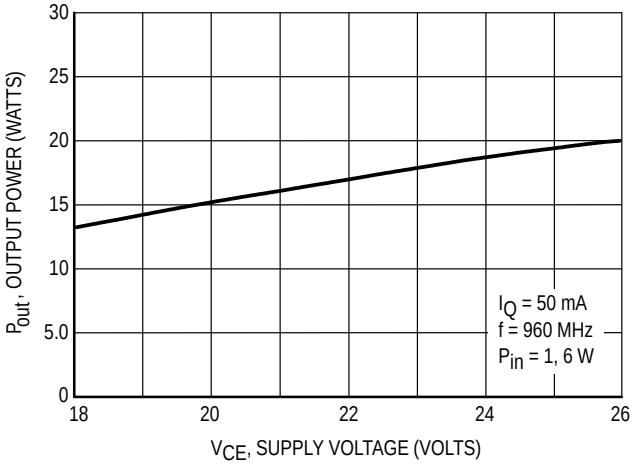



**Figure 4. Output Power versus Supply Voltage (CW)**

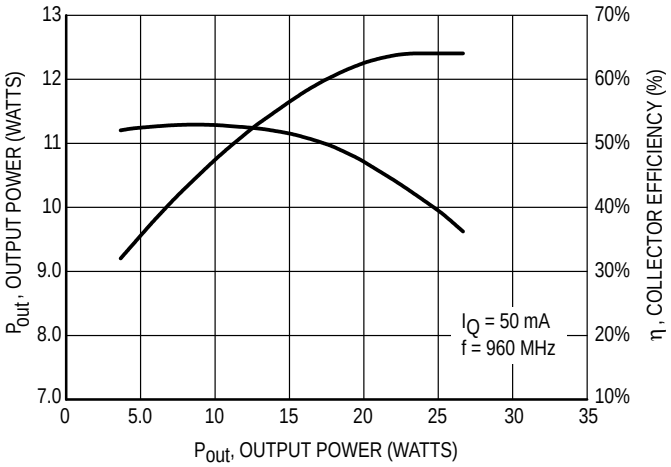



**Figure 5. Power Gain and Efficiency versus Output Power**

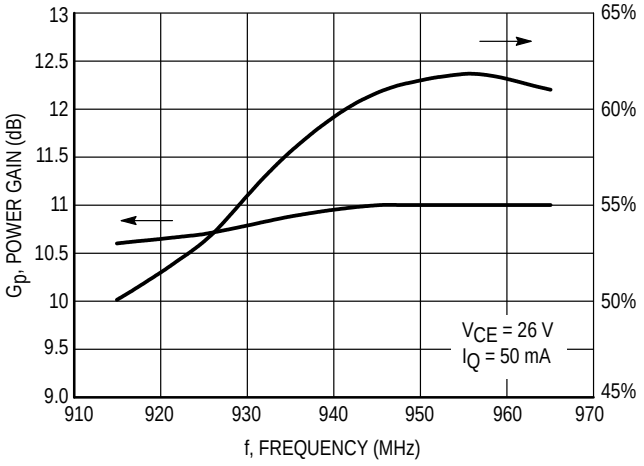



**Figure 6. Typical Broadband Performances**

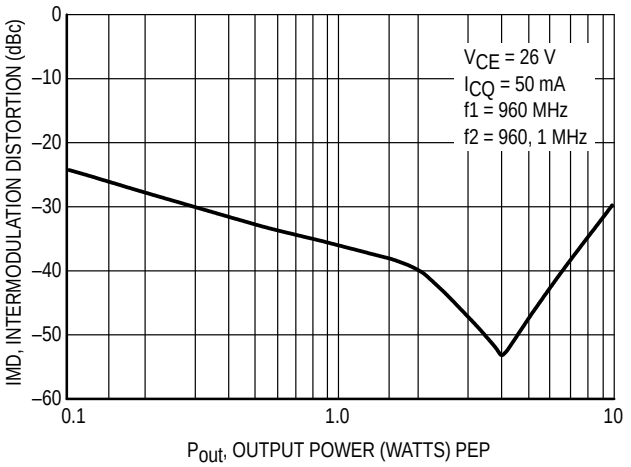
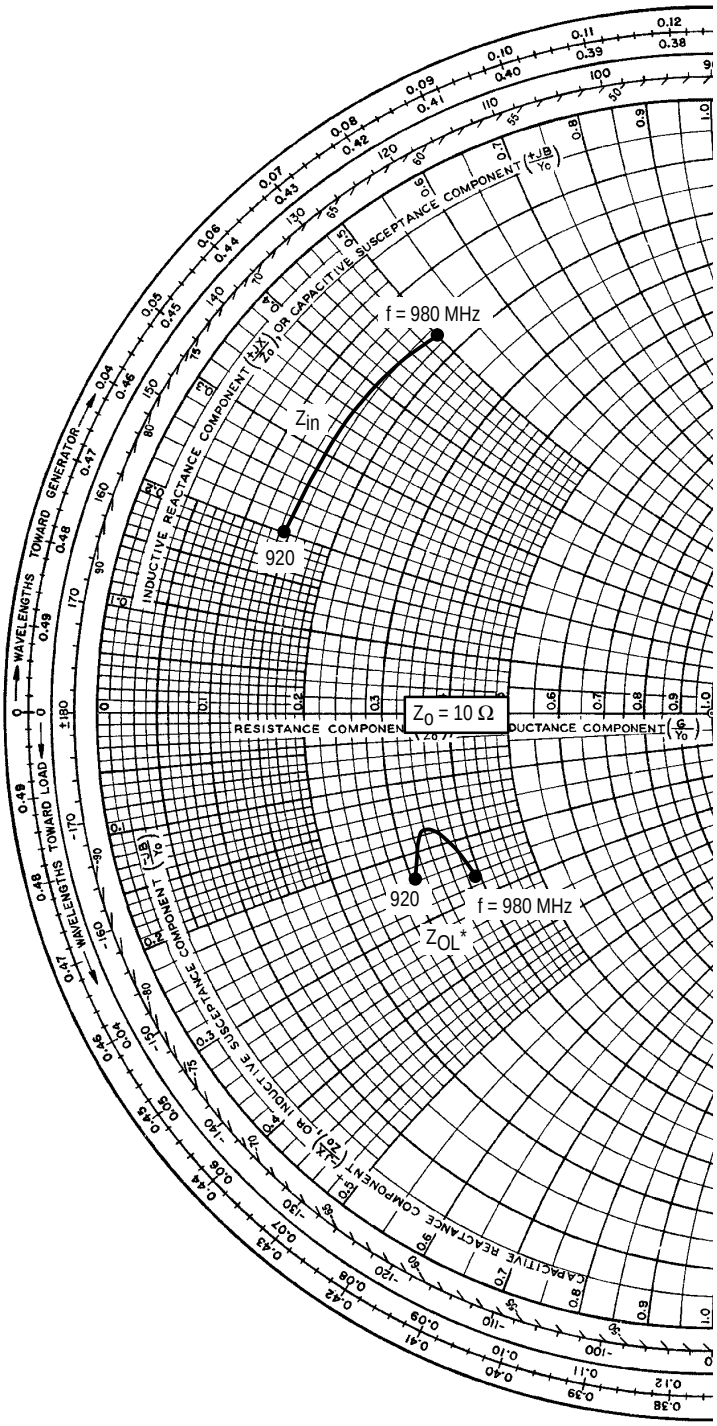



**Figure 7. Intermodulation Distortion versus Output Power**




| f (MHz) | $Z_{in}$ (Ω) | $Z_{OL}^*$ (Ω) |
|---|---|---|
| 920 | 1.4 + j3.0 | 3.2 – j2.5 |
| 940 | 1.5 + j3.9 | 3.5 – j1.88 |
| 960 | 1.5 + j4.2 | 3.9 – j2.5 |
| 980 | 1.6 + j4.4 | 4.0 – j2.8 |

$Z_{OL}^*$: Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

**Figure 8. Input and Output Impedances with Circuit Tuned for Maximum Gain @ $V_{CC}$ = 26 V, $I_{CQ}$ = 50 mA, $P_{out}$ = 20 W (CW)**

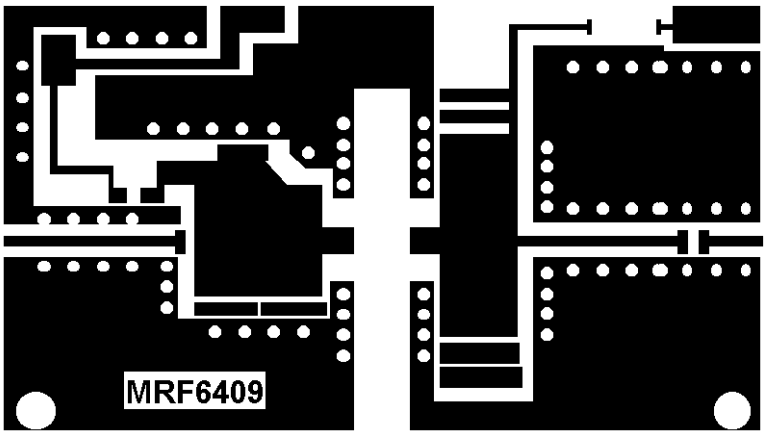



**Figure 9. 960 MHz Test Circuit RF, Photomaster Scale 1:1**
**(Reduced 25% in printed data book, DL110/D)**

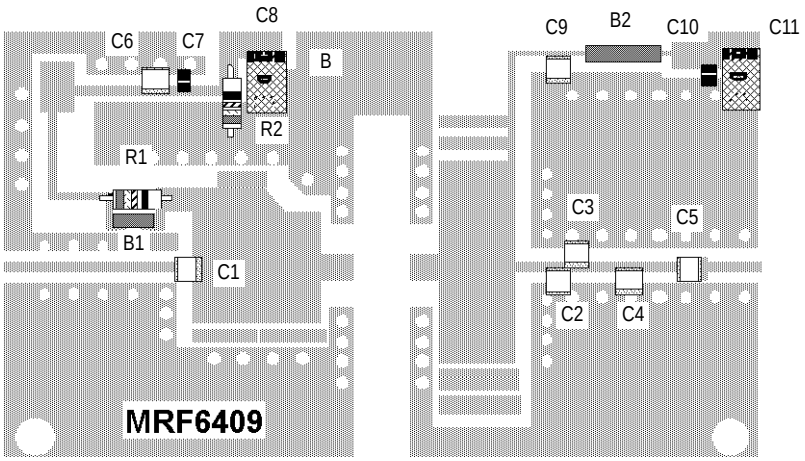
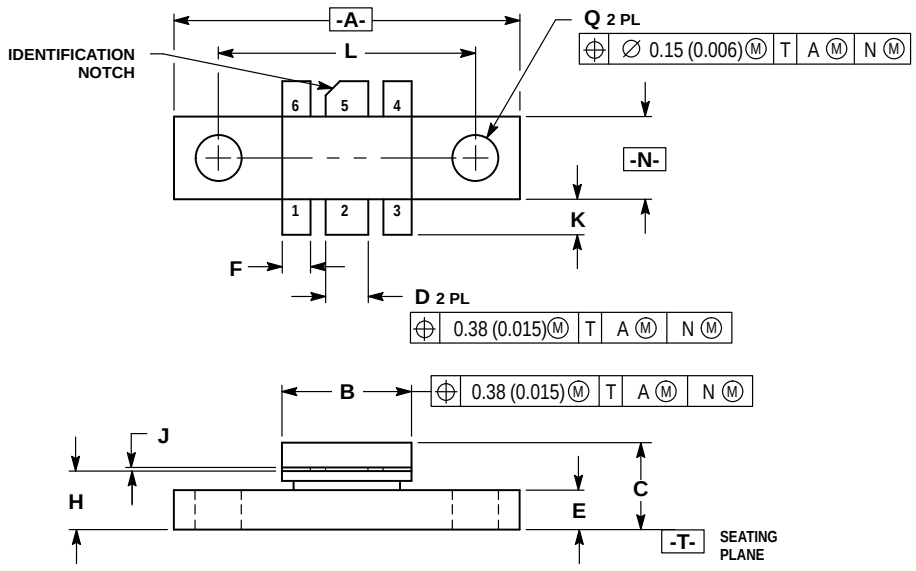



**Figure 10. 960 MHz Test Circuit RF, Photomaster Scale 1:1**
**and Components Location**
**(Reduced 25% in printed data book, DL110/D)**

## PACKAGE DIMENSIONS




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

| | INCHES | | MILLIMETER | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.965 | 0.985 | 24.52 | 25.01 |
| B | 0.355 | 0.375 | 9.02 | 9.52 |
| C | 0.230 | 0.260 | 5.85 | 6.60 |
| D | 0.115 | 0.125 | 2.93 | 3.17 |
| E | 0.102 | 0.114 | 2.59 | 2.90 |
| F | 0.075 | 0.085 | 1.91 | 2.15 |
| H | 0.160 | 0.170 | 4.07 | 4.31 |
| J | 0.004 | 0.006 | 0.11 | 0.15 |
| K | 0.090 | 0.110 | 2.29 | 2.79 |
| L | 0.725 BSC | | 18.42 BSC | |
| N | 0.225 | 0.241 | 5.72 | 6.12 |
| Q | 0.125 | 0.135 | 3.18 | 3.42 |

STYLE 2:
PIN 1. EMITTER (COMMON)
2. BASE (INPUT)
3. EMITTER (COMMON)
4. EMITTER (COMMON)
5. COLLECTOR (OUTPUT)
6. EMITTER (COMMON)

**CASE 319–07**
**ISSUE M**



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