

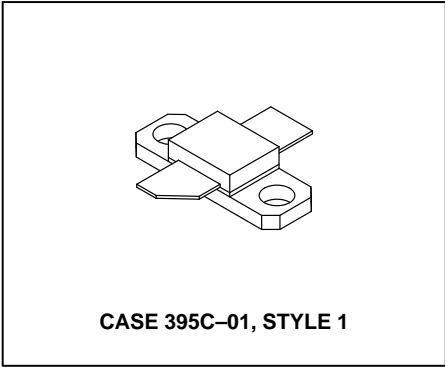
The RF Line  
**NPN Silicon**  
**RF Power Transistor**

**MRF6404**

**30 W, 1.88 GHz**  
**RF POWER TRANSISTOR**  
**NPN SILICON**

The MRF6404 is designed for 26 volts microwave large signal, common emitter, class AB linear amplifier applications operating in the range 1.8 to 2.0 GHz.

- Specified 26 Volts, 1.88 GHz Characteristics  
Output Power — 30 Watts  
Gain — 7.5 dB Min @ 30 Watts  
Efficiency — 38% Min @ 30 Watts
- Characterized with Series Equivalent Large-Signal Parameters from 1.8 to 2.0 GHz
- To be used in Class AB for DCS1800 and PCS1900/Cellular Radio
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration



**MAXIMUM RATINGS**

| Rating   | Symbol    | Value       | Unit                         |
|--|-----------|-------------|------------------------------|
| Collector-Emitter Voltage  | $V_{CEO}$ | 24          | Vdc                          |
| Collector-Emitter Voltage  | $V_{CES}$ | 60          | Vdc                          |
| Emitter-Base Voltage   | $V_{EBO}$ | 4           | Vdc                          |
| Collector-Current — Continuous   | $I_C$     | 10          | Adc                          |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$     | 125<br>0.71 | Watts<br>W/ $^\circ\text{C}$ |
| Storage Temperature Range  | $T_{stg}$ | -65 to +150 | $^\circ\text{C}$             |
| Operating Junction Temperature   | $T_J$     | 200         | $^\circ\text{C}$             |

**THERMAL CHARACTERISTICS**

| Characteristic                           | Symbol          | Max | Unit                      |
|--|-----------------|-----|---------------------------|
| Thermal Resistance, Junction to Case (1) | $R_{\theta JC}$ | 1.4 | $^\circ\text{C}/\text{W}$ |

**ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|   |               |    |    |    |     |
|---|---------------|----|----|----|-----|
| Collector-Emitter Breakdown Voltage ( $I_C = 50\text{ mA}$ , $I_B = 0$ )            | $V_{(BR)CEO}$ | 24 | 29 | —  | Vdc |
| Emitter-Base Breakdown Voltage ( $I_E = 10\text{ mAdc}$ )                           | $V_{(BR)EBO}$ | 4  | 5  | —  | Vdc |
| Collector-Base Breakdown Voltage ( $I_C = 50\text{ mAdc}$ )                         | $V_{(BR)CES}$ | 60 | 68 | —  | Vdc |
| Collector-Base Breakdown Voltage ( $I_C = 50\text{ mAdc}$ , $R_{BE} = 75\ \Omega$ ) | $V_{(BR)CER}$ | 40 | 56 | —  | Vdc |
| Collector Cutoff Current ( $V_{CE} = 30\text{ V}$ , $V_{BE} = 0$ )                  | $I_{CES}$     | —  | —  | 10 | mA  |

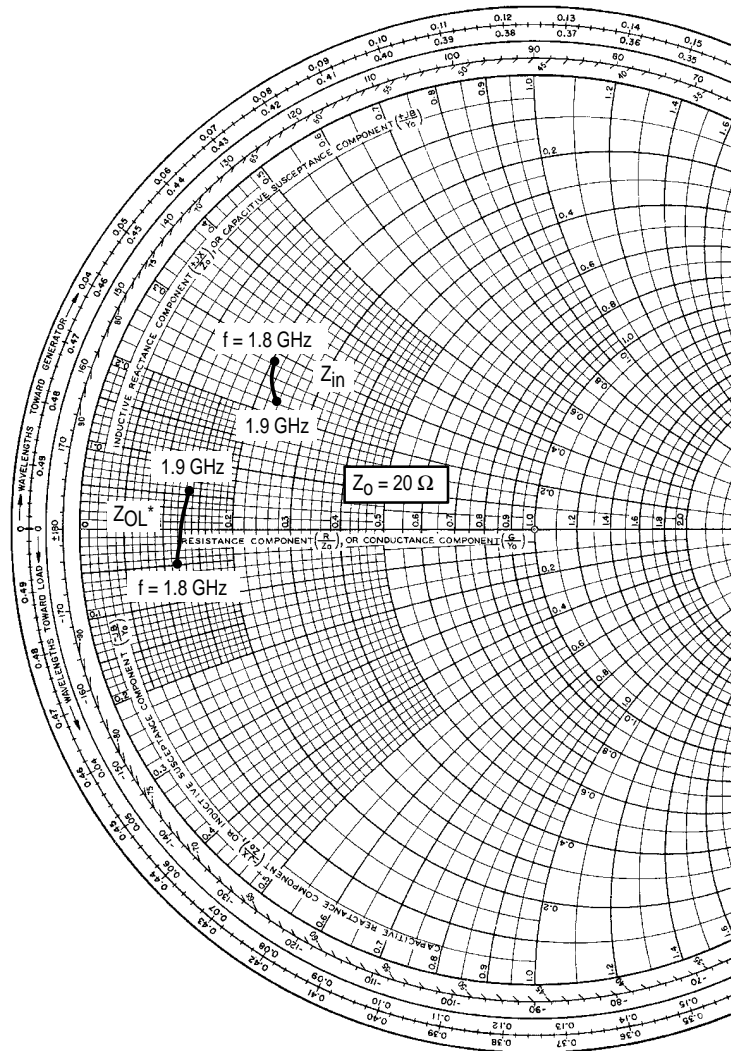
**ON CHARACTERISTICS**

|  |          |    |    |     |   |
|--|----------|----|----|-----|---|
| DC Current Gain ( $I_C = 1\text{ Adc}$ , $V_{CE} = 5\text{ Vdc}$ ) | $h_{FE}$ | 20 | 50 | 120 | — |
|--|----------|----|----|-----|---|

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

**ELECTRICAL CHARACTERISTICS — continued** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic   | Symbol     | Min                            | Typ      | Max    | Unit  |
|--|------------|--------------------------------|----------|--------|-------|
| <b>DYNAMIC CHARACTERISTICS</b>   |            |                                |          |        |       |
| Output Capacitance<br>( $V_{CB} = 26\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ )<br>For information only. This part is collector matched.   | $C_{ob}$   | 30                             | 38       | —      | pF    |
| <b>FUNCTIONAL TESTS</b>  |            |                                |          |        |       |
| Common-Emitter Amplifier Power Gain<br>( $V_{CC} = 26\text{ V}$ , $P_{out} = 30\text{ W}$ , $I_{CQ} = 150\text{ mA}$ , $f = 1.88\text{ GHz}$ )                                       | $G_{pe}$   | 7.5                            | 8.5      | —      | dB    |
| Common-Emitter Amplifier Power Gain<br>( $V_{CC} = 26\text{ V}$ , $P_{out} = 28\text{ W}$ , $I_{CQ} = 150\text{ mA}$ )<br>( $f = 1.99\text{ GHz}$ )                                  | $G_{pe}$   | 7                              | 8        | —      | dB    |
| Collector Efficiency<br>( $V_{CC} = 26\text{ V}$ , $P_{out} = 30\text{ W}$ , $f = 1.88\text{ GHz}$ )<br>( $V_{CC} = 26\text{ V}$ , $P_{out} = 28\text{ W}$ , $f = 1.99\text{ GHz}$ ) | $\eta$     | 38<br>35                       | 43<br>40 | —<br>— | %     |
| Output Power at 1 dBc<br>( $V_{CC} = 26\text{ V}$ , $f = 1.88\text{ GHz}$ )<br>( $V_{CC} = 26\text{ V}$ , $f = 1.99\text{ GHz}$ )  | $P_{1dBc}$ | 30<br>28                       | 35<br>33 | —<br>— | Watts |
| Output Mismatch Stress: VSWR = 3:1 (all phase angles)<br>( $V_{CC} = 26\text{ Vdc}$ , $P_{out} = 25\text{ W}$ , $I_{CQ} = 150\text{ mA}$ , $f = 1.88\text{ GHz}$ )                   | $\Psi$     | No Degradation in Output Power |          |        |       |



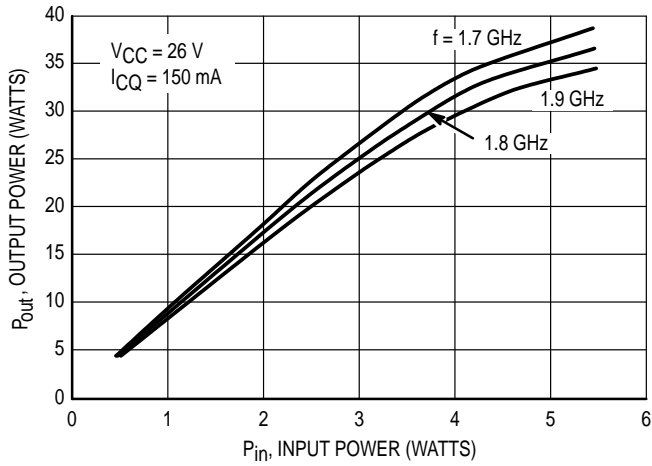
**DCS EVALUATION**

| f (GHz) | $Z_{in}$ ( $\Omega$ ) | $Z_{OL}^*$ ( $\Omega$ ) |
|---------|-----------------------|-------------------------|
| 1.8     | $4.3 + j6.1$          | $2.7 - j1.0$            |
| 1.85    | $4.6 + j5.3$          | $2.9 + j0.3$            |
| 1.9     | $4.8 + j5.0$          | $3.0 + j1.2$            |

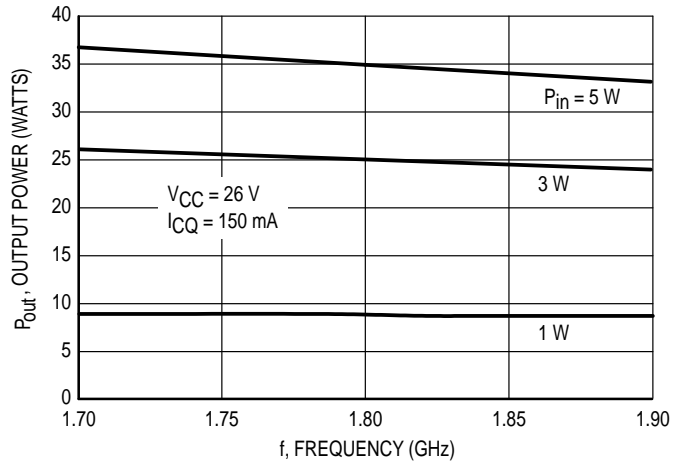
$Z_{OL}^*$ : Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

**Figure 1. Input and Output Impedances with Circuit Tuned for Maximum Gain  
@  $V_{CC} = 26\text{ V}$ ,  $I_{CQ} = 150\text{ mA}$ ,  $P_{out} = 30\text{ W}$**

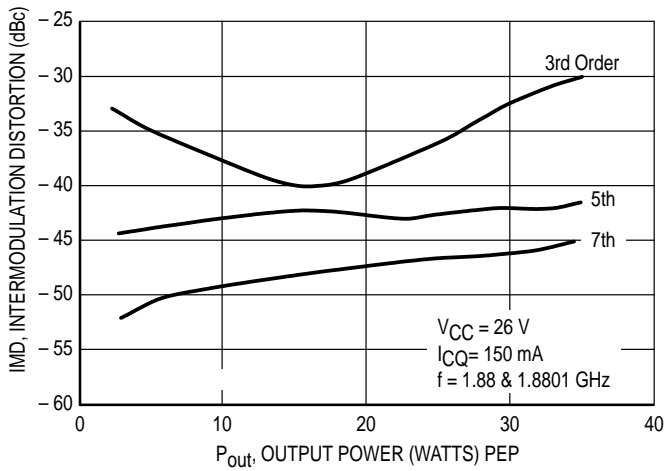
## TYPICAL CHARACTERISTICS



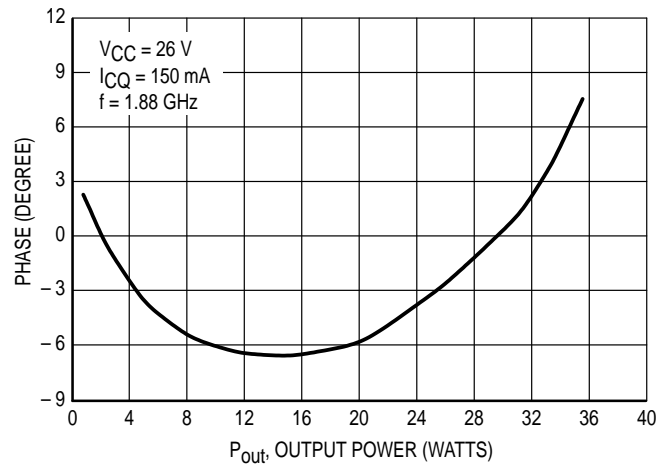
**Figure 2. Output Power versus Input Power**



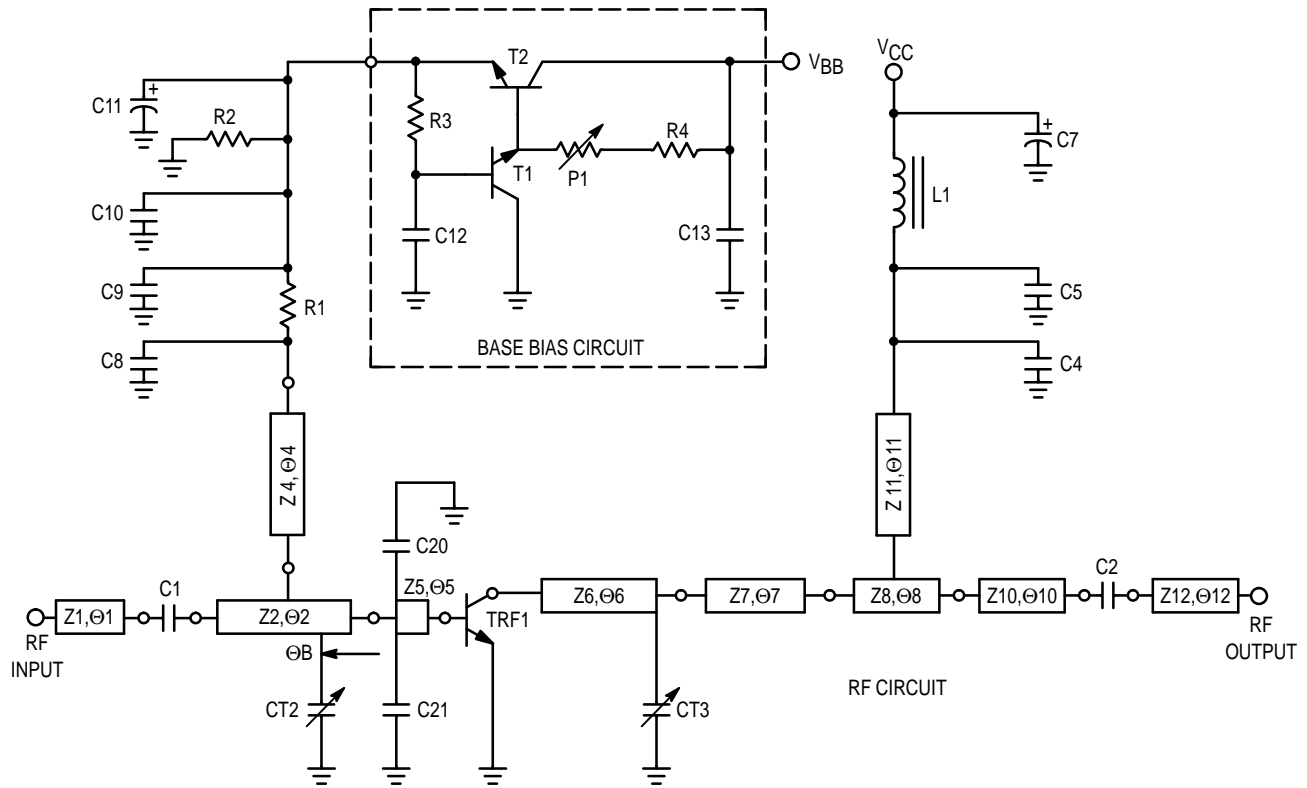
**Figure 3. Output Power versus Frequency**



**Figure 4. Intermodulation versus Output Power**



**Figure 5. AM/PM Conversion**



**Base Bias Circuit**

- C12, C13 15 nF, Chip Capacitor, Vitramon (0805 A153 JXB)
- P1 1 K $\Omega$ , Trimmer
- R3 47  $\Omega$ , Chip Resistor, 0805
- R4 330  $\Omega$ , Chip Resistor, 0805
- T1, T2 Motorola MJD 31C

**Decoupling Base Bias Circuit**

- C4 68 pF, Chip Capacitor, ATC 100A
- C5, C9 330 pF, Chip Capacitor, Vitramon (0805 A331 JXB)
- C7, C11 4.7  $\mu$ F, 63 V, Electrolytic Capacitor
- C8 68 pF, Chip Capacitor, ATC 100A
- C10 15 nF, Chip Capacitor, Vitramon (0805 A153 JXB)
- R1 1.5  $\Omega$ , Chip Resistor, 0805
- R2 56  $\Omega$ , Chip Resistor, 1206

**RF Circuit**

- C1, C2 68 pF, Chip Capacitor, ATC 100A
- C20, C21 1.3 pF, Chip Capacitor, ATC 100A
- CT2 Trimmer Capacitor, Gigatrim, Ref 37281
- CT3 Trimmer Capacitor, Gigatrim, Ref 37291
- TRF1 MRF6404

PC Board Material:  
 $\epsilon_r = 2.55$ , H = 0.508 mm, T = 0.035 mm

All Electrical Lengths Are Referenced from  $\lambda_g$  @ f = 1.9 GHz

- Z1 : 50  $\Omega$   $\Theta 1$  : 10 $^\circ$
- Z2 : 50  $\Omega$   $\Theta 2$  : 74.5 $^\circ$   $\Theta B$  : 16.5 $^\circ$
- Z4 : 74  $\Omega$   $\Theta 4$  : 68 $^\circ$
- Z5 : 12.8  $\Omega$   $\Theta 5$  : 21 $^\circ$
- Z6 : 10.4  $\Omega$   $\Theta 6$  : 49.5 $^\circ$
- Z7 : 18  $\Omega$   $\Theta 7$  : 36.5 $^\circ$
- Z8 : 45  $\Omega$   $\Theta 8$  : 20 $^\circ$
- Z10 : 50  $\Omega$   $\Theta 10$  : 10 $^\circ$
- Z11 : 74  $\Omega$   $\Theta 11$  : 74.5 $^\circ$
- Z12 : 50  $\Omega$   $\Theta 12$  : 10 $^\circ$

**Figure 6. 1.80–1.88 GHz Test Circuit Electrical Schematic and Components List**



(Not to Scale)

Teflon® Glass 0.5 mm – Double Side 35 μm Cu.

Figure 7. 1.80–1.88 GHz PCN Test Circuit Photomaster

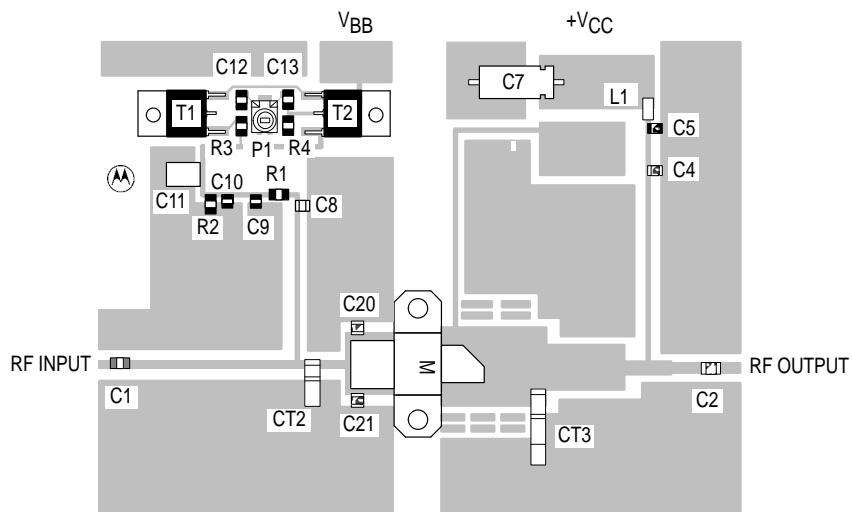
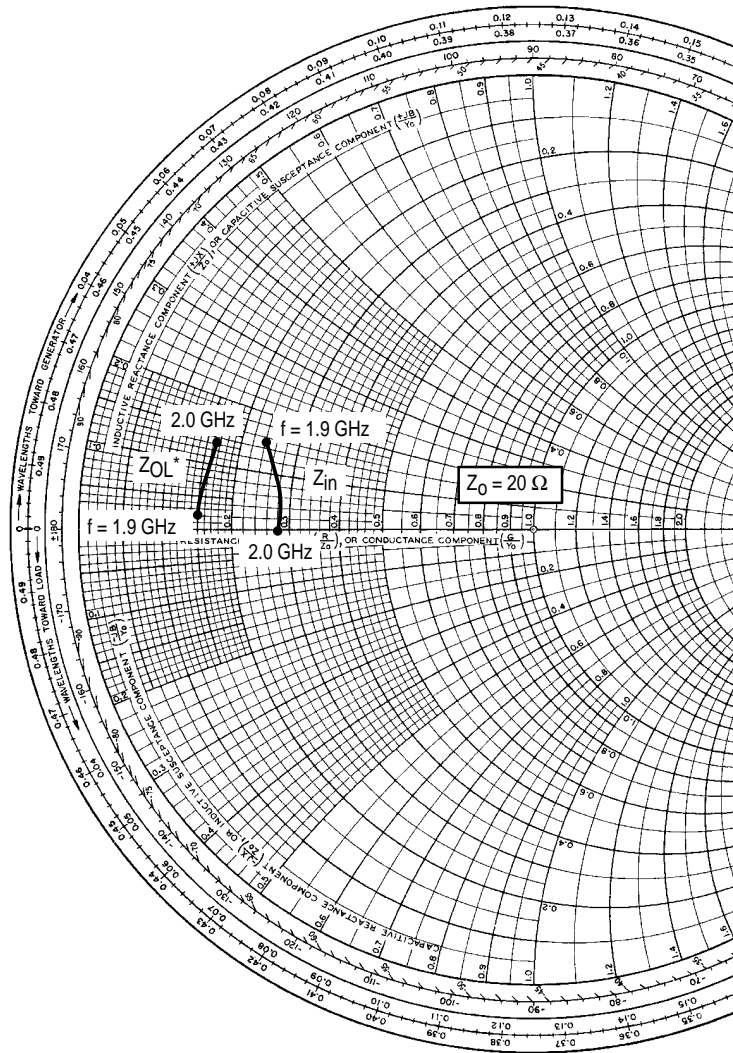


Figure 8. 1.80–1.88 GHz PCN Test Circuit Components Layout



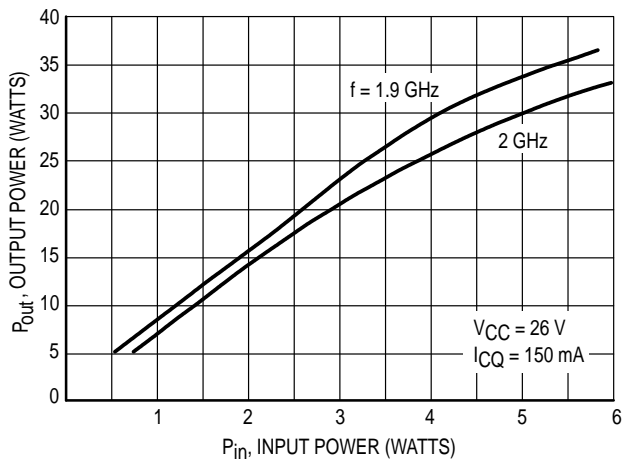
**PCS EVALUATION**

| f (GHz) | Z <sub>in</sub> (Ω) | Z <sub>OL</sub> * (Ω) |
|---------|---------------------|-----------------------|
| 1.90    | 4.9 + j3.0          | 3.2 + j0.5            |
| 1.93    | 5.4 + j2.5          | 3.3 + j1.2            |
| 1.97    | 5.6 + j1.4          | 3.4 + j1.5            |
| 2.00    | 5.4 - j0.2          | 3.6 + j2.5            |

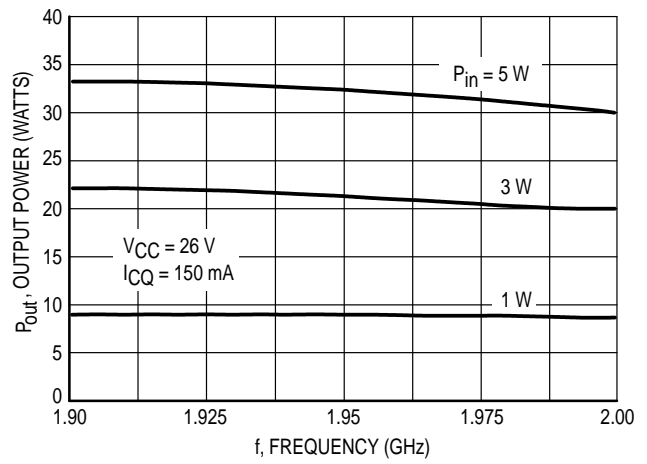
Z<sub>OL</sub>\*: Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

**Figure 9. Input and Output Impedances with Circuit Tuned for Maximum Gain @ V<sub>CC</sub> = 26 V, I<sub>CQ</sub> = 150 mA, P<sub>Out</sub> = 28 W**

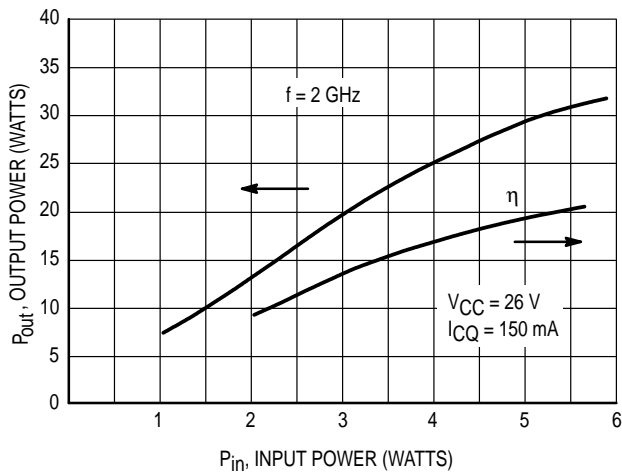
## TYPICAL CHARACTERISTICS



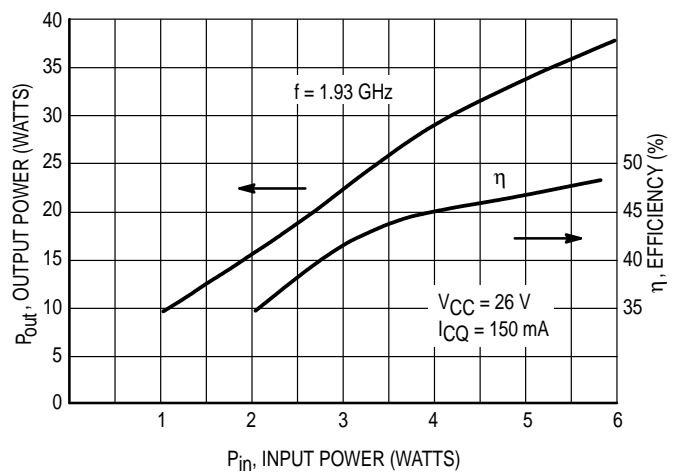
**Figure 10. Output Power versus Input Power**



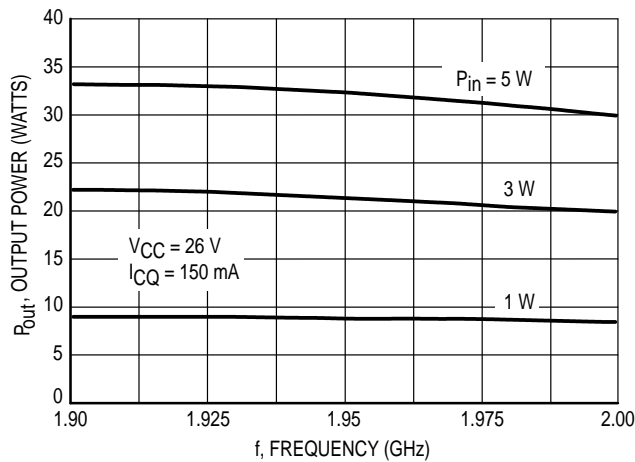
**Figure 11. Output Power versus Frequency**



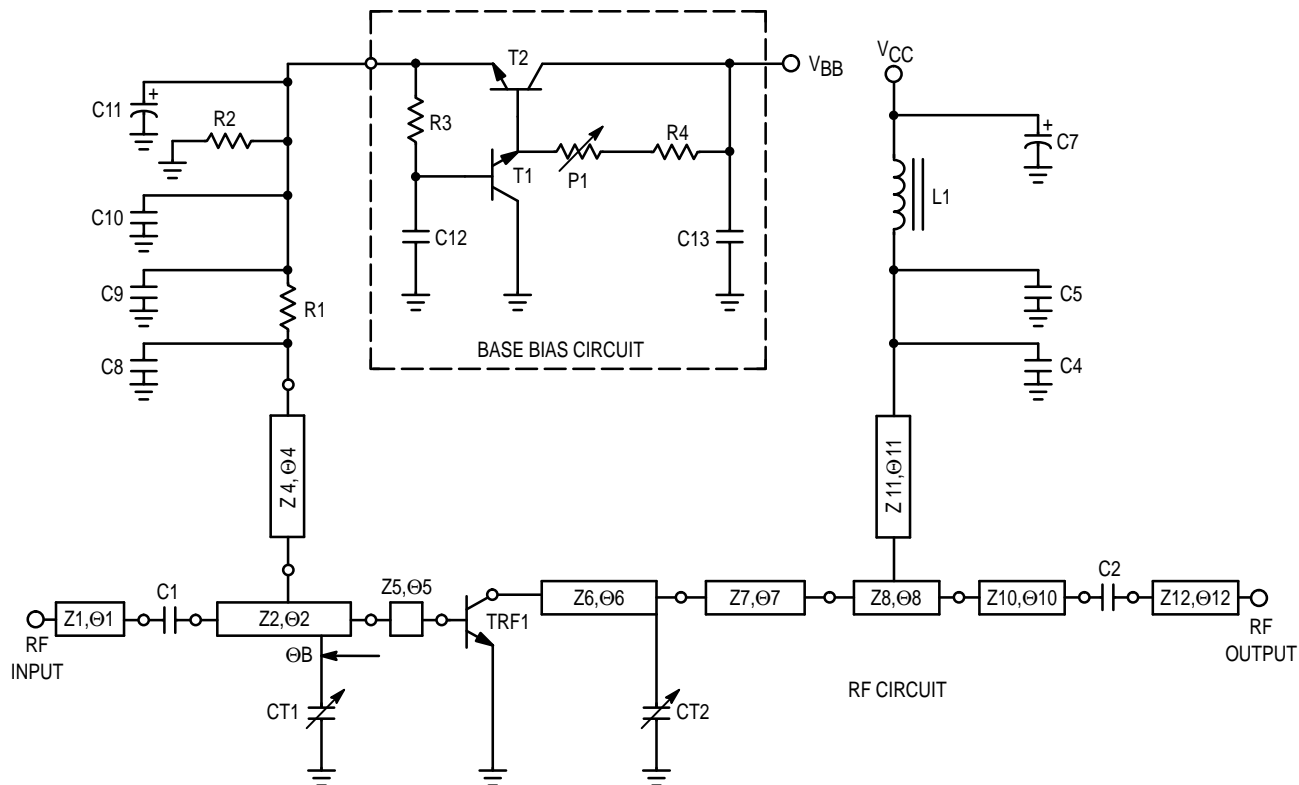
**Figure 12. Output Power and Efficiency versus Input Power**



**Figure 13. Output Power and Efficiency versus Input Power**



**Figure 14. Output Power versus Frequency**



#### Base Bias Circuit

|          |   |
|----------|---|
| C12, C13 | 15 nF, Chip Capacitor, Vitramon (0805 A153 JXB) |
| P1       | 1 K $\Omega$ , Trimmer                          |
| R3       | 47 $\Omega$ , Chip Resistor, 0805               |
| R4       | 330 $\Omega$ , Chip Resistor, 0805              |
| T1, T2   | Motorola MJD 31C                                |

#### Decoupling Base Bias Circuit

|         |  |
|---------|--|
| C4      | 68 pF, Chip Capacitor, ATC 100A                  |
| C5, C9  | 330 pF, Chip Capacitor, Vitramon (0805 A331 JXB) |
| C7, C11 | 4.7 $\mu$ F, 63 V, Electrolytic Capacitor        |
| C8      | 68 pF, Chip Capacitor, ATC 100A                  |
| C10     | 15 nF, Chip Capacitor, Vitramon (0805 A153 JXB)  |
| R1      | 1.2 $\Omega$ , Chip Resistor, 0805               |
| R2      | 56 $\Omega$ , Chip Resistor, 1206                |

#### RF Circuit

|          |  |
|----------|--|
| C1, C2   | 68 pF, Chip Capacitor, ATC 100A        |
| C20, C21 | 1.3 pF, Chip Capacitor, ATC 100A       |
| CT1, CT2 | Trimmer Capacitor, Gigatrim, Ref 37271 |
| TRF1     | MRF6404                                |

PC Board Material:

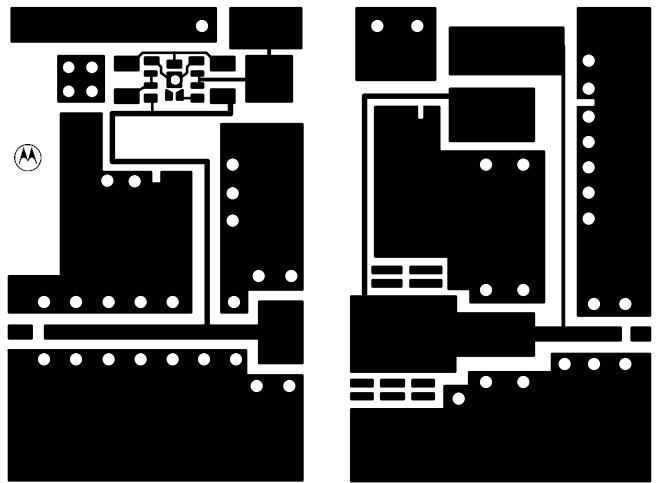
$\epsilon_r = 2.55$ ,  $H = 0.508$  mm,  $T = 0.035$  mm

All Electrical Lengths Are Referenced from  $\lambda_g$  @  $f = 1.9$  GHz

|                    |                                       |
|--------------------|---------------------------------------|
| Z1 : 50 $\Omega$   | $\theta_1$ : 10°                      |
| Z2 : 50 $\Omega$   | $\theta_2$ : 74.5° $\theta_B$ : 16.5° |
| Z4 : 74 $\Omega$   | $\theta_4$ : 68°                      |
| Z5 : 12.8 $\Omega$ | $\theta_5$ : 21°                      |
| Z6 : 10.4 $\Omega$ | $\theta_6$ : 49.5°                    |
| Z7 : 18 $\Omega$   | $\theta_7$ : 36.5°                    |
| Z8 : 45 $\Omega$   | $\theta_8$ : 20°                      |
| Z10 : 50 $\Omega$  | $\theta_{10}$ : 10°                   |
| Z11 : 74 $\Omega$  | $\theta_{11}$ : 60°                   |
| Z12 : 50 $\Omega$  | $\theta_{12}$ : 10°                   |

Figure 15. 1.9–2.0 GHz Test Circuit Electrical Schematic and Components List

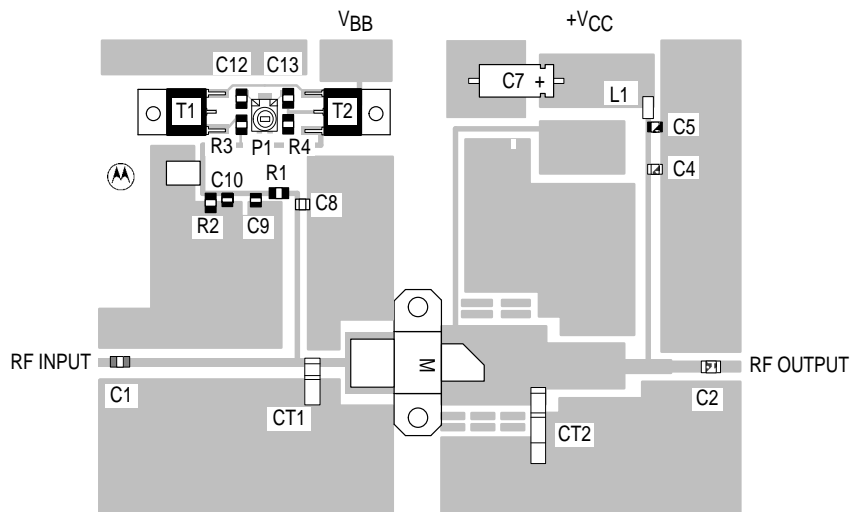




(Not to Scale)

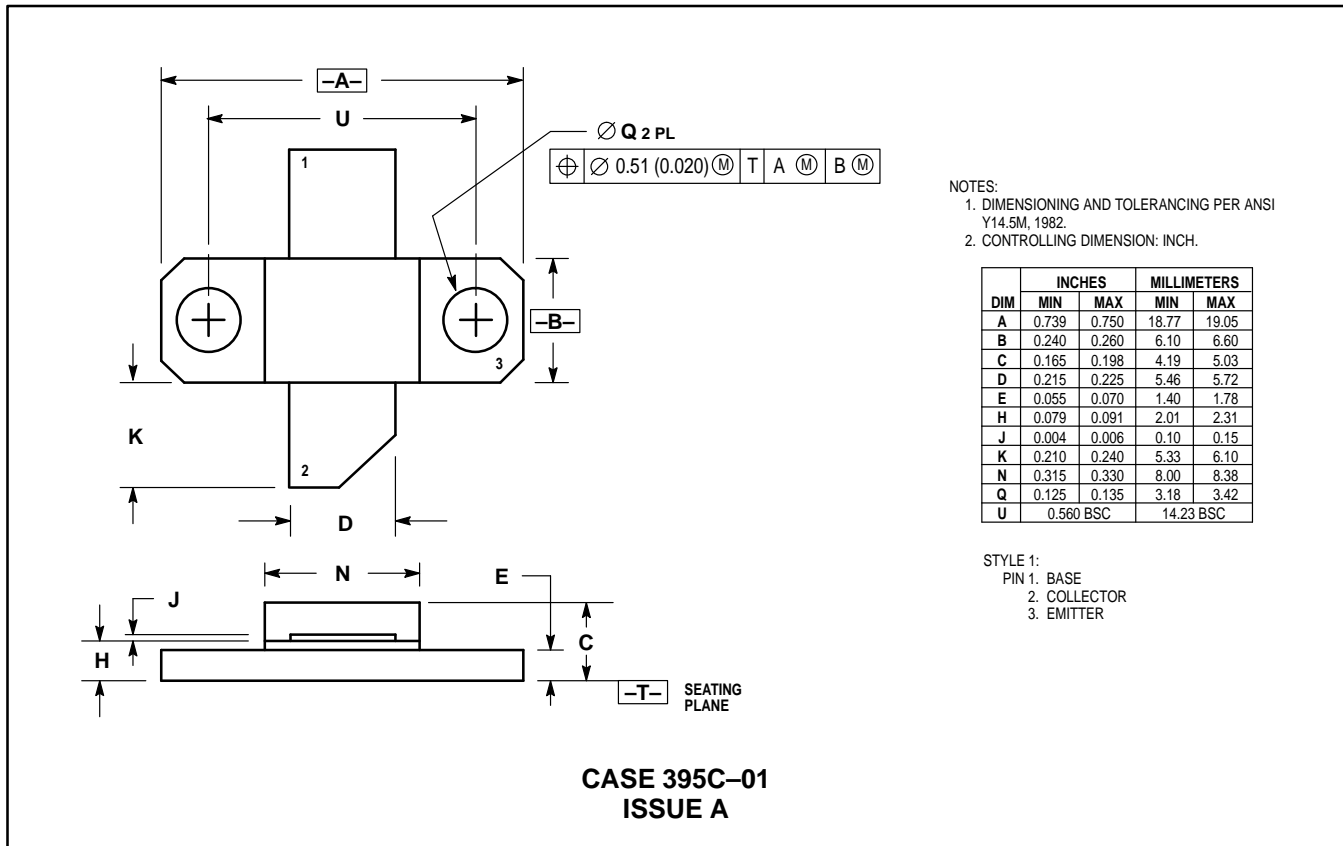
Teflon® Glass 0.5 mm – Double Side 35 μm Cu.

**Figure 16. 1.9–2.0 GHz Test Circuit Photomaster**



**Figure 17. 1.9–2.0 GHz Test Circuit Components Layout**

# PACKAGE DIMENSIONS



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