

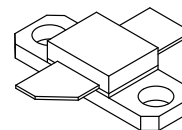
The RF Line  
**NPN Silicon**  
**RF Power Transistor**

**MRF6404**  
**MRF6404K**

**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



CASE 395C-01, STYLE 1

**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 @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	125 0.71	Watts 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
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**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

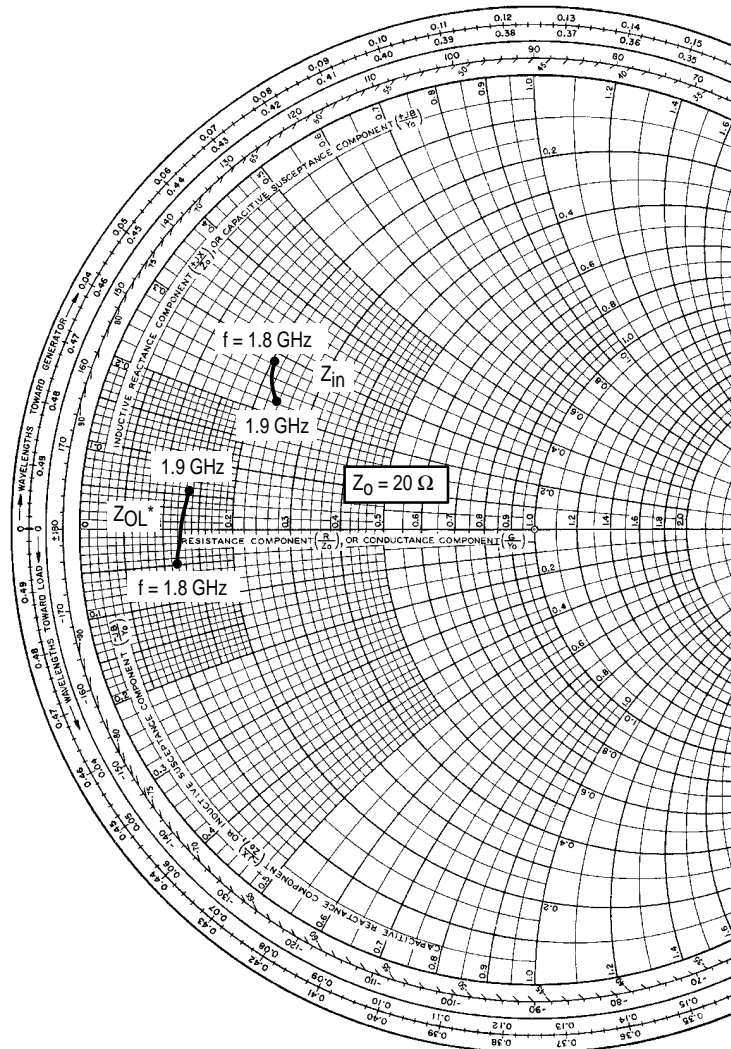
**ON CHARACTERISTICS**

DC Current Gain ( $I_C = 1\text{ Adc}$ , $V_{CE} = 5\text{ Vdc}$ )	$h_{FE}$	20	50	120	—
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(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 ( $V_{CB} = 26\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ ) For information only. This part is collector matched.	$C_{ob}$	30	38	—	pF
<b>FUNCTIONAL TESTS</b>					
Common-Emitter Amplifier Power Gain ( $V_{CC} = 26\text{ V}$ , $P_{out} = 30\text{ W}$ , $I_{CQ} = 150\text{ mA}$ , $f = 1.88\text{ GHz}$ )	$G_{pe}$	7.5	8.5	—	dB
Common-Emitter Amplifier Power Gain ( $V_{CC} = 26\text{ V}$ , $P_{out} = 28\text{ W}$ , $I_{CQ} = 150\text{ mA}$ ) ( $f = 1.99\text{ GHz}$ )	$G_{pe}$	7	8	—	dB
Collector Efficiency ( $V_{CC} = 26\text{ V}$ , $P_{out} = 30\text{ W}$ , $f = 1.88\text{ GHz}$ ) ( $V_{CC} = 26\text{ V}$ , $P_{out} = 28\text{ W}$ , $f = 1.99\text{ GHz}$ )	$\eta$	38 35	43 40	— —	%
Output Power at 1 dBc ( $V_{CC} = 26\text{ V}$ , $f = 1.88\text{ GHz}$ ) ( $V_{CC} = 26\text{ V}$ , $f = 1.99\text{ GHz}$ )	$P_{1dBc}$	30 28	35 33	— —	Watts
Output Mismatch Stress: VSWR = 3:1 (all phase angles) ( $V_{CC} = 26\text{ Vdc}$ , $P_{out} = 25\text{ W}$ , $I_{CQ} = 150\text{ mA}$ , $f = 1.88\text{ GHz}$ )	$\Psi$	No Degradation in Output Power			



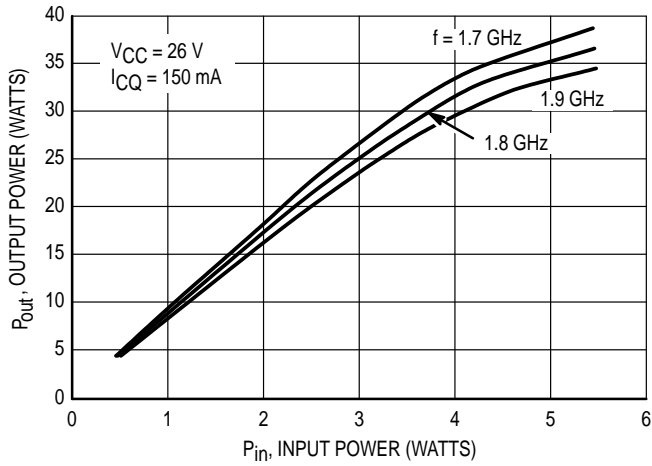
**DCS EVALUATION**

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	$4.8 + j5.0$	$3.0 + j1.2$

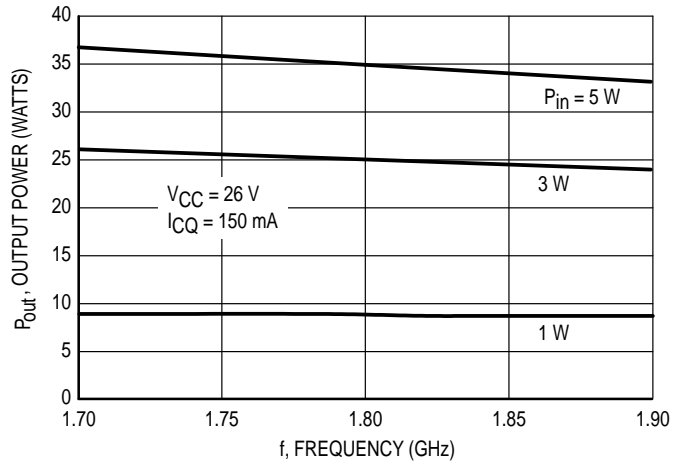
$Z_{OL}^*$ : Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

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

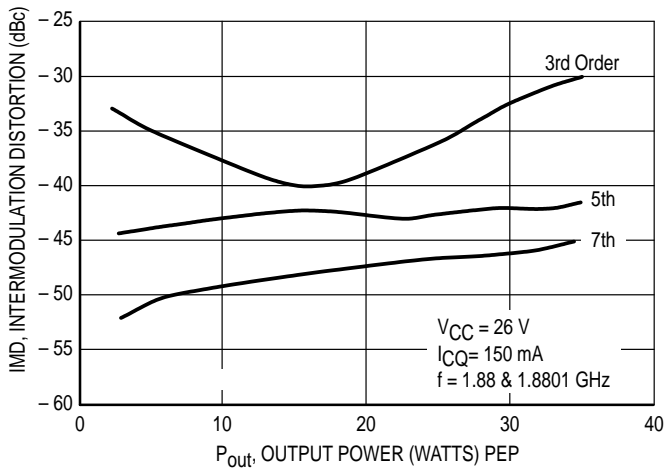
## TYPICAL CHARACTERISTICS



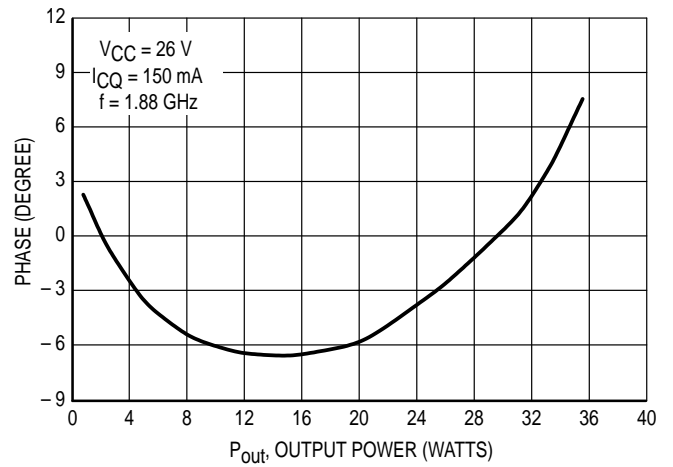
**Figure 2. Output Power versus Input Power**



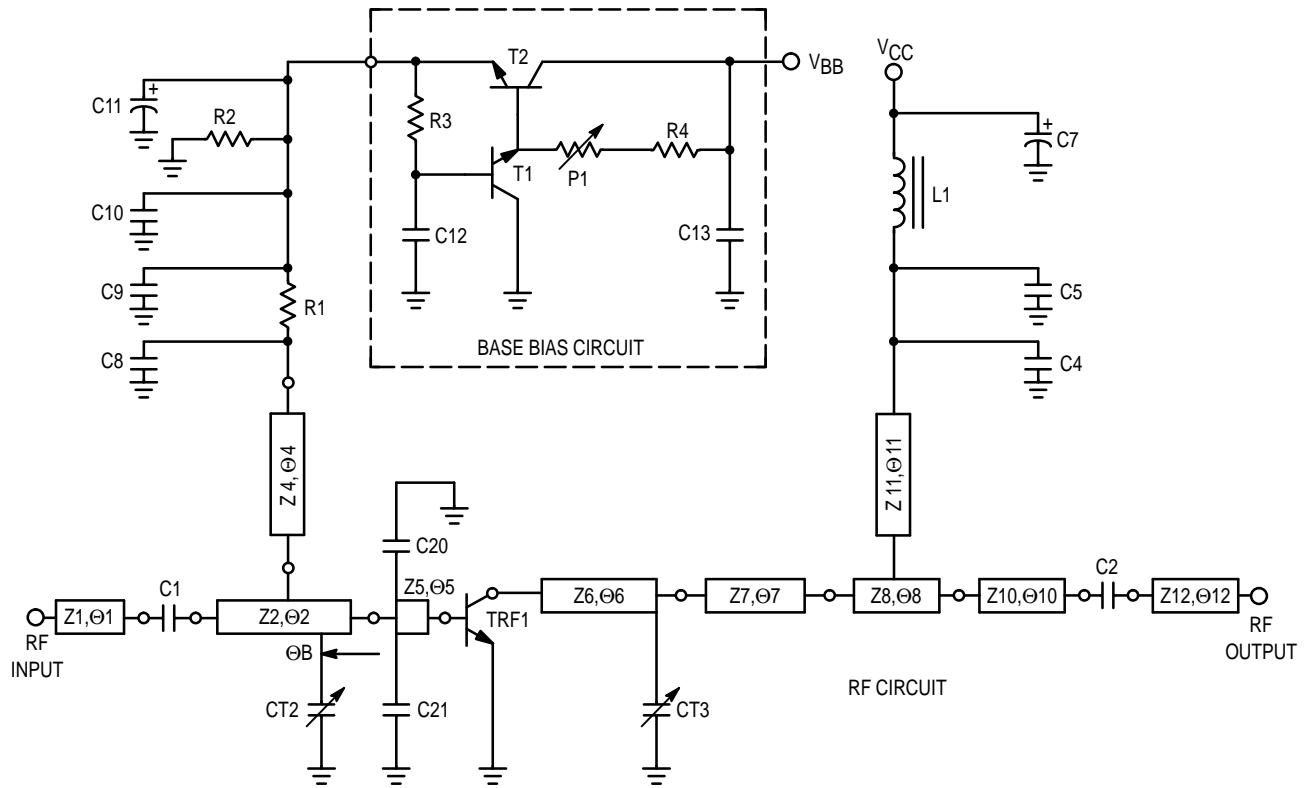
**Figure 3. Output Power versus Frequency**



**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

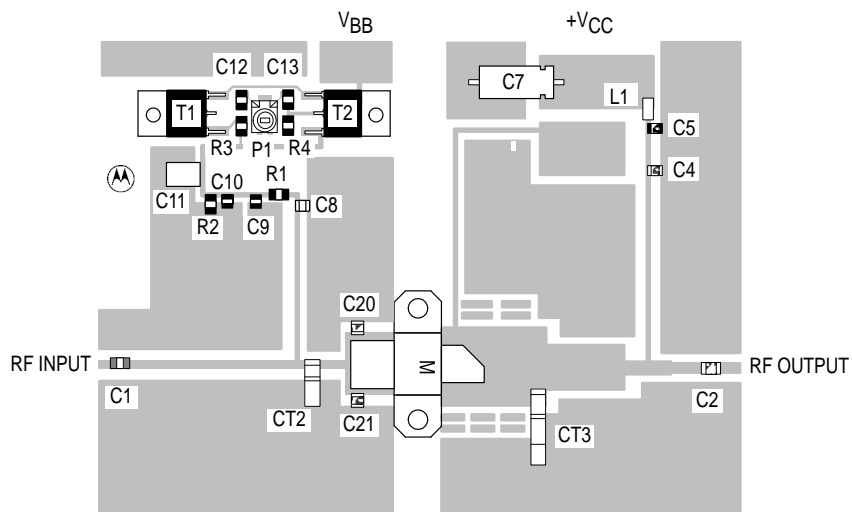
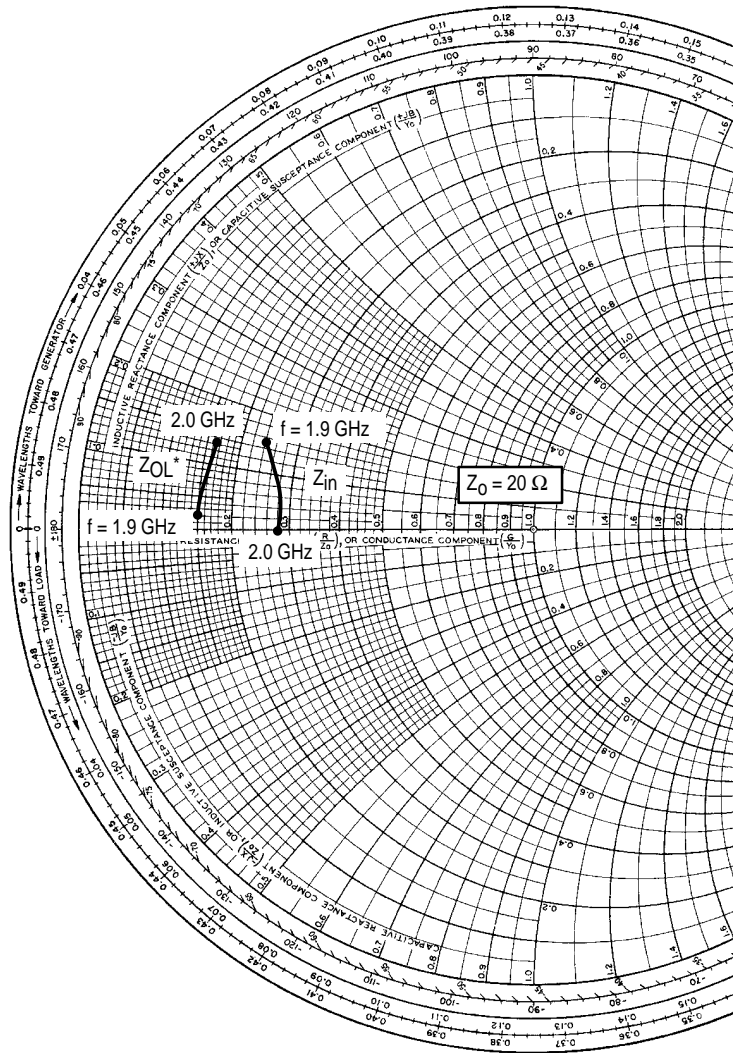


Figure 8. 1.80–1.88 GHz PCN Test Circuit Components Layout



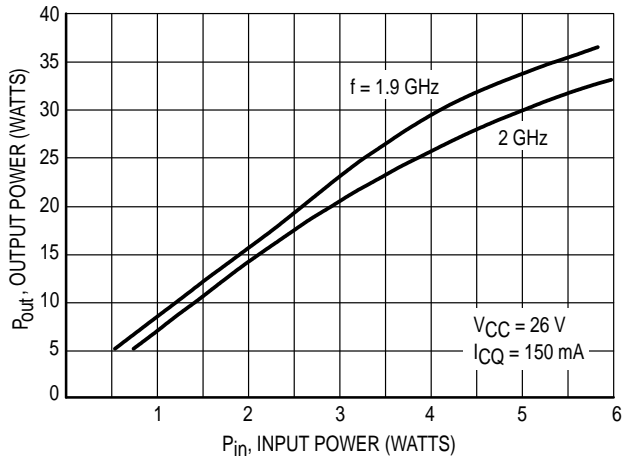
**PCS EVALUATION**

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

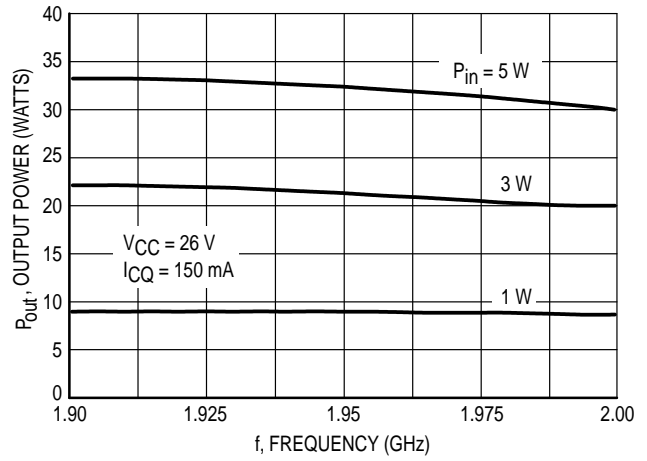
Z<sub>OL</sub>\*: Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

**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**

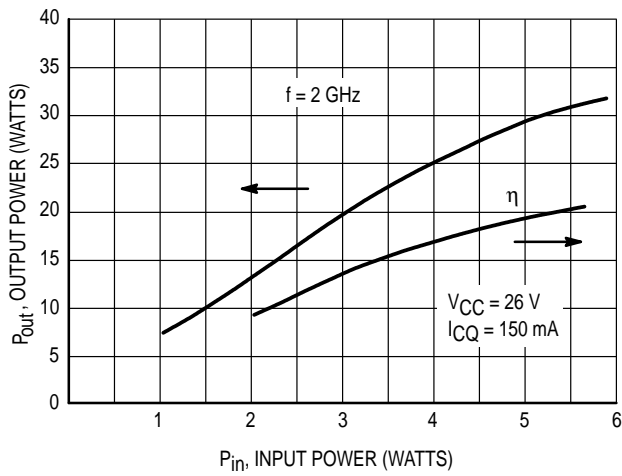
## TYPICAL CHARACTERISTICS



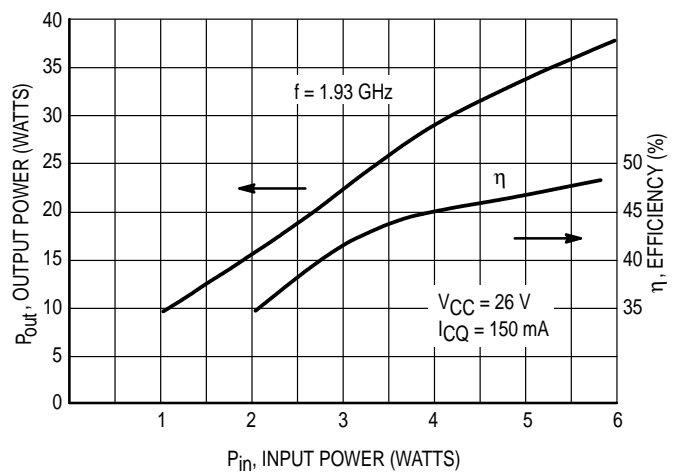
**Figure 10. Output Power versus Input Power**



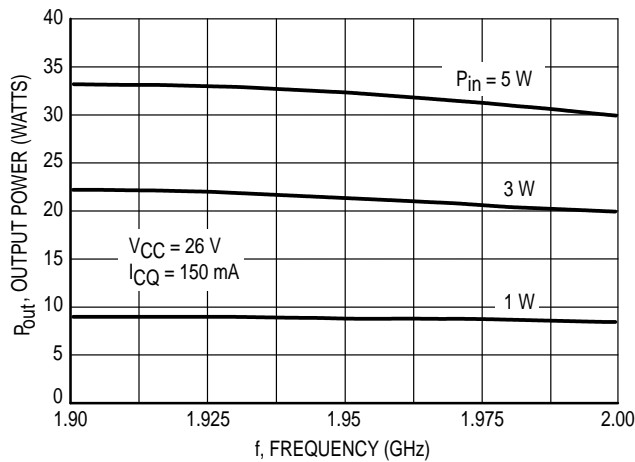
**Figure 11. Output Power versus Frequency**



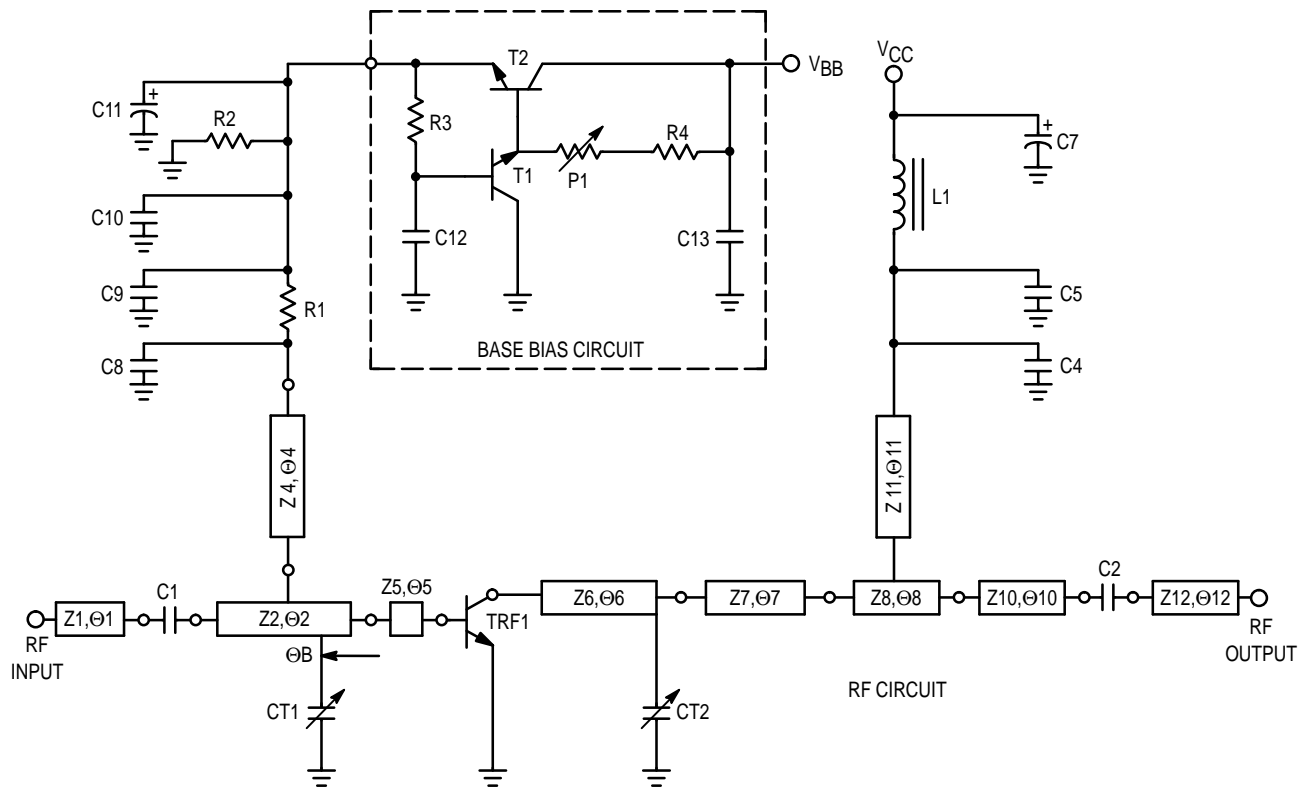
**Figure 12. Output Power and Efficiency versus Input Power**



**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:

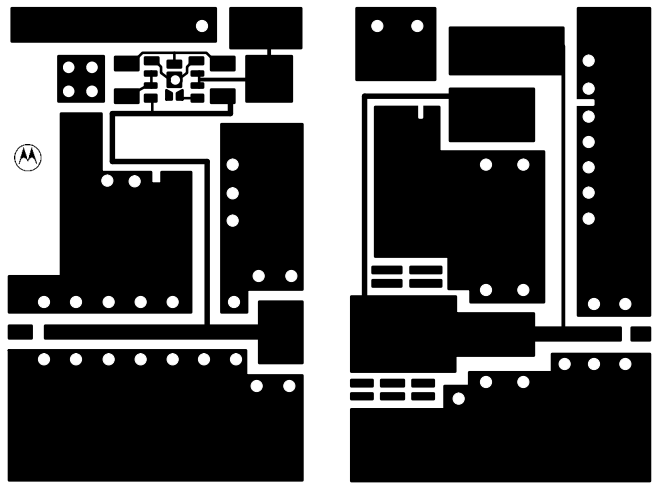
$\epsilon_r = 2.55$ ,  $H = 0.508$  mm,  $T = 0.035$  mm

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

Z1 : 50 $\Omega$	$\Theta 1$ : 10 $^\circ$
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Z10 : 50 $\Omega$	$\Theta 10$ : 10 $^\circ$
Z11 : 74 $\Omega$	$\Theta 11$ : 60 $^\circ$
Z12 : 50 $\Omega$	$\Theta 12$ : 10 $^\circ$

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

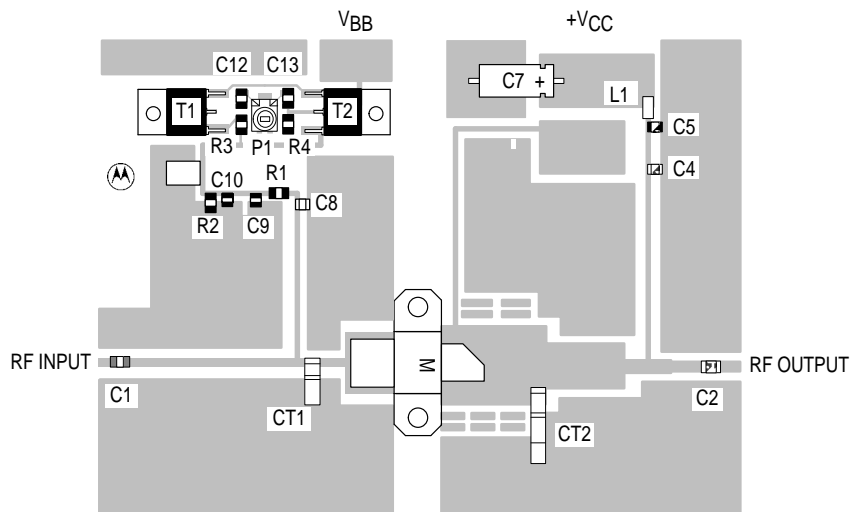
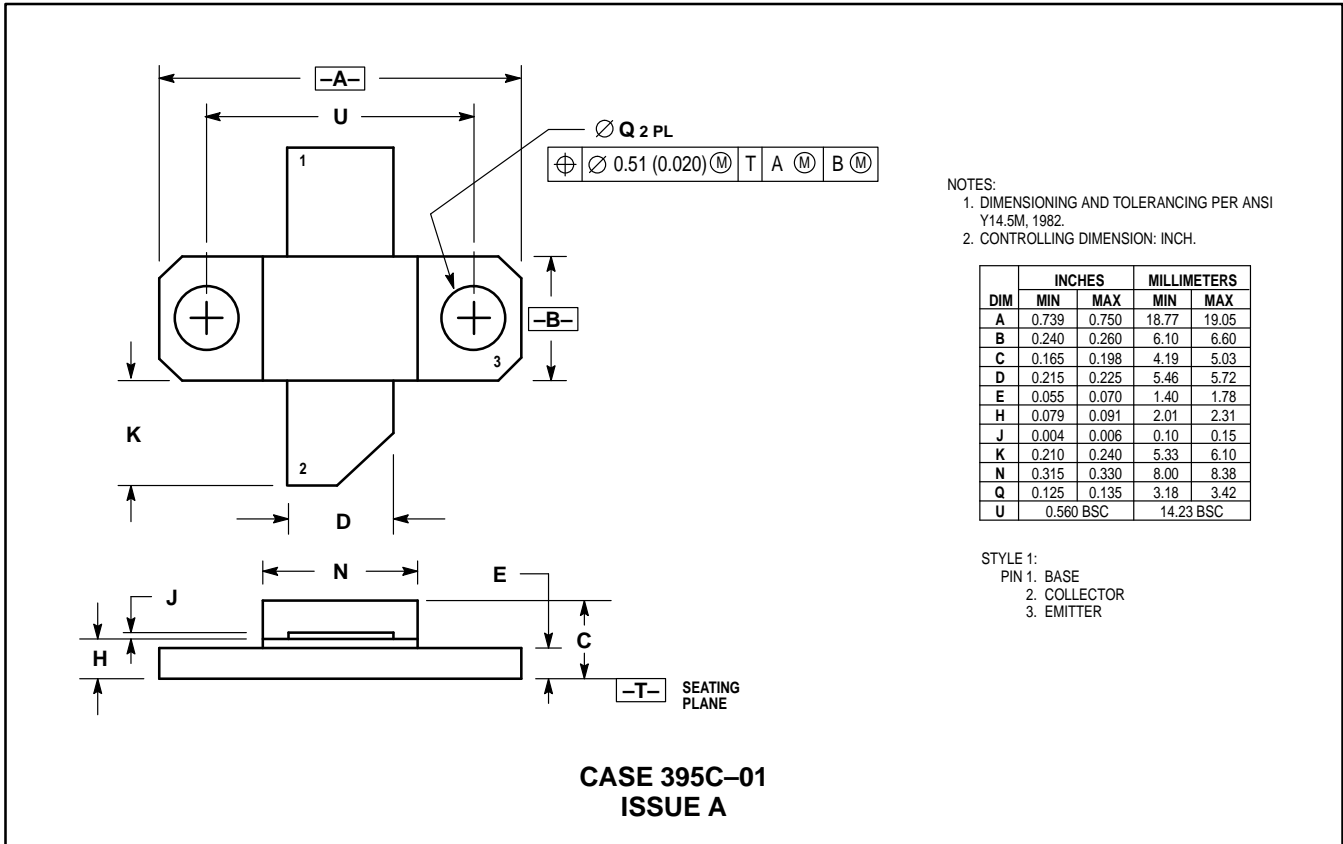


Figure 17. 1.9–2.0 GHz Test Circuit Components Layout

## PACKAGE DIMENSIONS



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.739	0.750	18.77	19.05
B	0.240	0.260	6.10	6.60
C	0.165	0.198	4.19	5.03
D	0.215	0.225	5.46	5.72
E	0.055	0.070	1.40	1.78
H	0.079	0.091	2.01	2.31
J	0.004	0.006	0.10	0.15
K	0.210	0.240	5.33	6.10
N	0.315	0.330	8.00	8.38
Q	0.125	0.135	3.18	3.42
U	0.560 BSC		14.23 BSC	

STYLE 1:  
 PIN 1. BASE  
 PIN 2. COLLECTOR  
 PIN 3. EMITTER

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