

T-33-11

**MOTOROLA SEMICONDUCTOR TECHNICAL DATA**

**MRF648**

**The RF Line**

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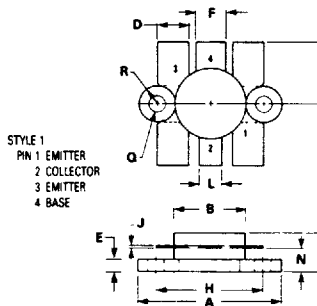
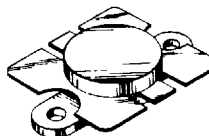
**NPN SILICON RF POWER TRANSISTOR**

designed for 12.5 Volt UHF large signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz

- Specified 12.5 Volt, 470 MHz Characteristics --  
Output Power = 60 Watts  
Minimum Gain = 4.4 dB  
Efficiency = 55%
- Characterized with Series Equivalent Large Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 16 Volt High Line and 20% Overdrive

60 W - 470 MHz

**CONTROLLED Q  
RF POWER  
TRANSISTOR  
NPN SILICON**



STYLE 1  
PIN 1 EMITTER  
2 COLLECTOR  
3 EMITTER  
4 BASE

NOTE  
FLANGE IS ISOLATED IN ALL STYLES

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

**MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V <sub>CEO</sub>	18	Vdc
Collector-Base Voltage	V <sub>CBO</sub>	36	Vdc
Emitter-Base Voltage	V <sub>EBO</sub>	4.0	Vdc
Collector Current — Continuous	I <sub>C</sub>	11.0	Adc
Total Device Dissipation @ T <sub>C</sub> = 25°C Derate above 25°C	P <sub>D</sub>	175 1.0	Watts W/°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

**THERMAL CHARACTERISTICS**

Thermal Resistance, Junction to Case	R <sub>θJC</sub>	1.0	°C/W
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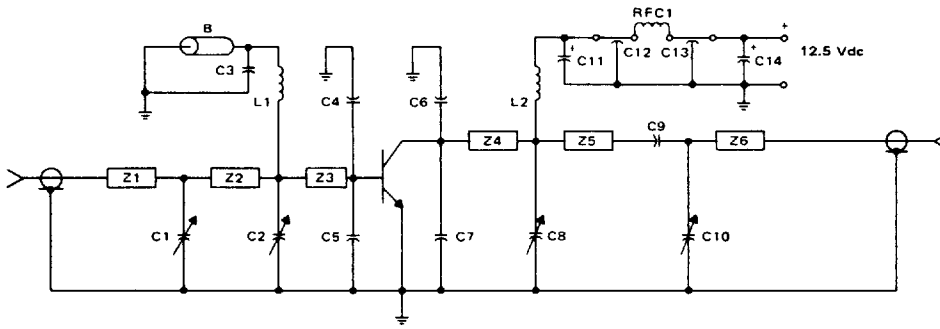
**ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
Collector-Emitter Breakdown Voltage ( $I_C = 50 \text{ mA dc}, I_B = 0$ )	$V_{(BR)CEO}$	16	-	-	Vdc
Collector-Emitter Breakdown Voltage ( $I_C = 50 \text{ mA dc}, V_{BE} = 0$ )	$V_{(BR)CES}$	36	-	-	Vdc
Emitter-Base Breakdown Voltage ( $I_E = 5.0 \text{ mA dc}, I_C = 0$ )	$V_{(BR)EBO}$	4.0	-	-	Vdc
Collector Cutoff Current ( $V_{CE} = 15 \text{ Vdc}, V_{BE} = 0, T_C = 25^\circ\text{C}$ )	$I_{CES}$	-	-	15	mA dc
<b>ON CHARACTERISTICS</b>					
DC Current Gain ( $I_C = 6.0 \text{ A dc}, V_{CE} = 5.0 \text{ Vdc}$ )	$h_{FE}$	20	70	150	-
<b>DYNAMIC CHARACTERISTICS</b>					
Output Capacitance ( $V_{CB} = 12.5 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz}$ )	$C_{ob}$	-	130	150	pF
<b>FUNCTIONAL TESTS</b>					
Common-Emitter Amplifier Power Gain ( $V_{CC} = 12.5 \text{ Vdc}, P_{out} = 60 \text{ W}, f = 470 \text{ MHz}$ )	$G_{dB}$	4.4	5.0	-	dB
Input Power ( $V_{CC} = 12.5 \text{ Vdc}, P_{out} = 60 \text{ W}, f = 470 \text{ MHz}$ )	$P_{in}$	-	19	22	Watts
Collector Efficiency ( $V_{CC} = 12.5 \text{ Vdc}, P_{out} = 60 \text{ W}, f = 470 \text{ MHz}$ )	$\eta$	55	65	-	%
Output Mismatch Stress ( $V_{CC} = 16 \text{ Vdc}, P_{in} = 26 \text{ W}, f = 470 \text{ MHz}, V_{SWR} = 20:1$ , All Phase Angles)	$\psi^*$	No Degradation in Output Power			

Notes

\*  $\psi$  = Mismatch stress factor—the electrical criterion established to verify the device resistance to load mismatch failure. The mismatch stress test is accomplished in the standard test fixture (Figure 1) terminated in a 20:1 minimum load mismatch at all phase angles.

FIGURE 1 - TEST CIRCUIT SCHEMATIC



C1, C2, C8, C10	1-20 pF Johanson	C12, C13	680 pF Feedthrough	Z2	1.39" X 0.190" Microstrip
C3	200 pF Unelco	B	Ferroxcube Bead 56 590 65 3B	Z3, Z4	(0.2 X 0.21/0.25 Alumina
C4, C5	33 pF 100mil ATC	L1	10 Turns #26 AWG 0.1 I.D. X 0.23"	Z5	1.30" X 0.190" Microstrip
C6, C7	36 pF 100mil ATC	L2	10 Turns #20 AWG 0.1 I.D. X 0.50"	Z6	0.330" X 0.190" Microstrip
C9	100 pF 100mil ATC	RFC1	Ferroxcube VR200 19 4B	Board	62.5mil Glass Teflon, $\epsilon_R = 2.55$ , $\lambda = 0.0018$ , Dimension 5.0" X 3.0" X 0.06"
C11, C14	1.0 $\mu$ F 35 V Tantalum	Z1	0.46" X 0.190" Microstrip		

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FIGURE 2 - POWER OUTPUT versus POWER INPUT

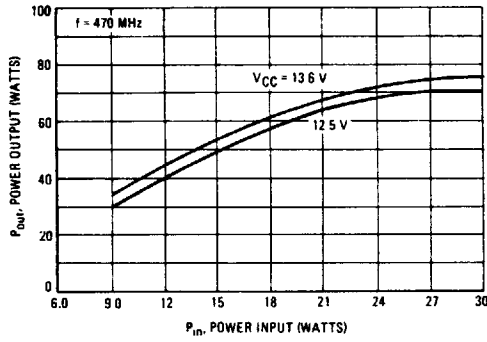


FIGURE 3 - POWER OUTPUT versus FREQUENCY

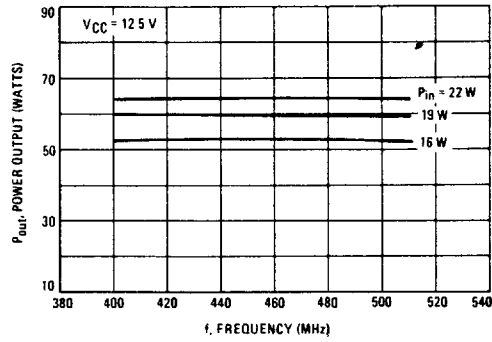


FIGURE 4 - POWER OUTPUT versus SUPPLY VOLTAGE

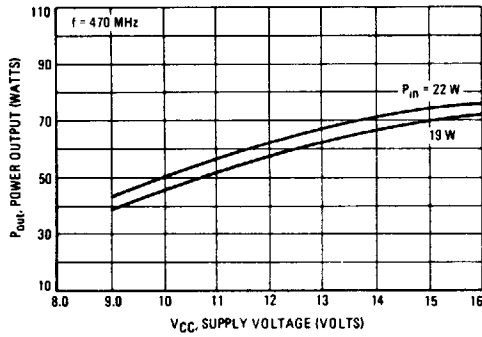


FIGURE 5 - POWER SATURATION PROFILE

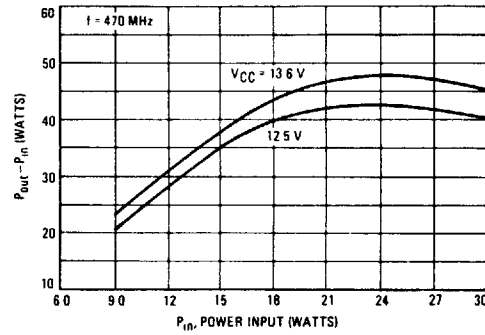
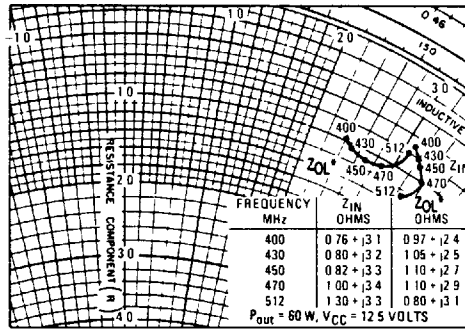
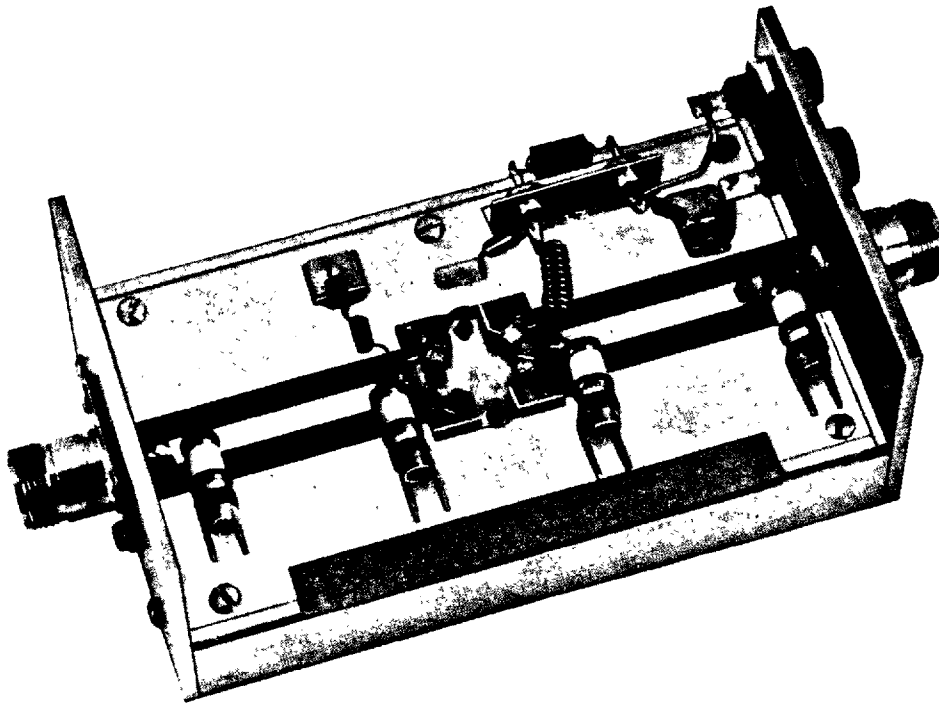


FIGURE 6 - SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE

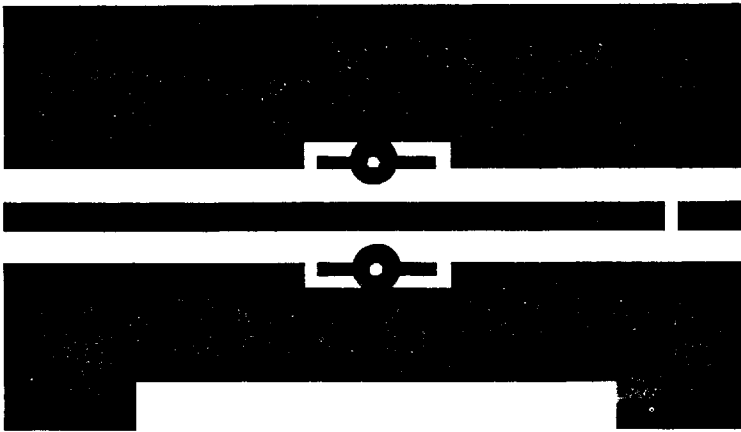


Z<sub>0L</sub>\* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.



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TEST CIRCUIT TEST FIXTURE



NOTE: The Printed Circuit Board shown is 75% of the original.

MOTOROLA RF DEVICE DATA

2-809