MOTOROLA

MRF212

The RF Line

10 W — 175 MHz

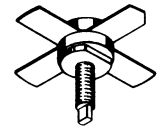
RF POWER TRANSISTOR

NPN SILICON

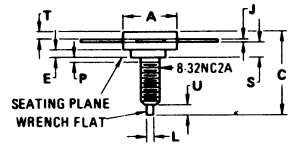
NPN SILICON RF POWER TRANSISTOR

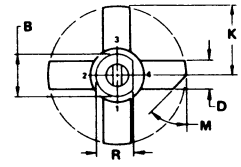
. . . designed for 12.5 volt VHF large-signal power amplifier applications required in commercial and industrial equipment operating to 300 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —
  Output Power = 10 Watts
  Minimum Gain = 9.0 dB
  Efficiency = 50%



4.2





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

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	–	0.070	–
J	0.08	0.18	0.003	0.007
K	12.45	–	0.490	–
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	–	1.27	–	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

145A-09

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ T_A = 25°C (1) Derate above 25°C	P_D	37.5 0.214	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.67	°C/W

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

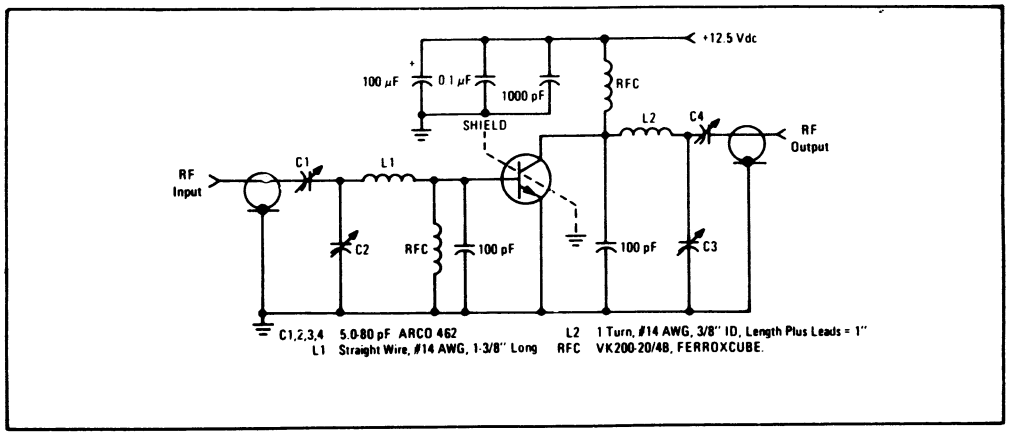
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 15 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mA, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	50	150	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	35	50	pF
FUNCTIONAL TESTS (FIGURE 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 10 W, f = 175 MHz)	G_{PE}	9.0	11	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 10 W, f = 175 MHz)	η	50		–	%

4.2

SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE
(V_{CC} = 12.5 Vdc, P_{out} = 10 W, f = 175 MHz)

Z_{in} Ohms	Z_{OL} Ohms
1.74 - j3.93	5.86 - j7.37

FIGURE 1 – 175 MHz TEST CIRCUIT



MOTOROLA

MRF238

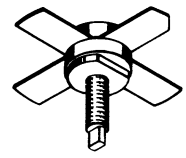
The RF Line

NPN SILICON RF POWER TRANSISTOR

. . . designed for 13.6 Volt VHF large-signal amplifier applications in industrial and commercial FM equipment operating to 175 MHz. Ideally suited for marine radio applications.

- Specified 13.6 Volt, 160 MHz Characteristics –
  Output Power = 30 Watts
  Minimum Gain = 9.0 dB
  Efficiency = 60%

30 W – 160 MHz
RF POWER TRANSISTOR
NPN SILICON

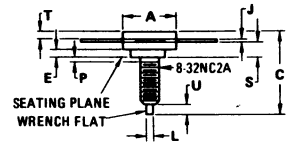


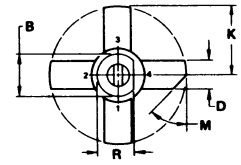
4.2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	5.0	Adc
Total Device Dissipation @ $T_C = 25^oC$ Derate Above 25^oC	P_D	65 0.37	Watts $W/^oC$
Storage Temperature Range	T_{stg}	−65 to +150	^oC
Stud Torque (1)	–	6.5	In. Lb.

(1) For Repeated Assembly use 5 In. Lb.





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

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	–	0.070	–
J	0.08	0.18	0.003	0.007
K	11.05	–	0.435	–
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	–	1.27	–	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

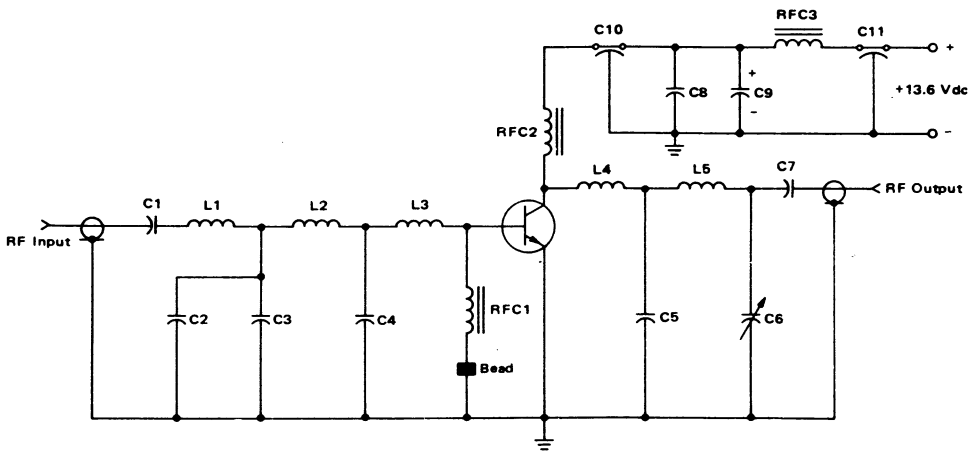
CASE 145A-07

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 15 mAdc, I_E = 0)	$V_{(BR)CBO}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	110	130	pF
FUNCTIONAL TEST (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 13.6 Vdc, P_{out} = 30 W, f = 160 MHz)	G_{pe}	9.0	10	–	dB
Collector Efficiency (V_{CC} = 13.6 Vdc, P_{out} = 30 W, f = 160 MHz)	η	60	–	–	%

4.2

FIGURE 1 – 160 MHz TEST CIRCUIT SCHEMATIC



C1	200 pF, 350 Vdc, UNELCO
C2	100 pF, 350 Vdc, UNELCO
C3	40 pF, 350 Vdc, UNELCO
C4,C5	80 pF, 350 Vdc, UNELCO
C6	1.0-20 pF, 4 oz. ARCO Trimmer
C7	100 pF 350 Vdc, UNELCO
C8	0.1 μF ERIE Disc Ceramic
C9	0.1 μF TANTALUM
C10,C11	680 pF ALLEN BRADLEY Feedthru
RFC1	0.15 μH Molded Choke
RFC2	10 Turns, #18 AWG on 470 Ohm, 1 Watt Resistor
Bead	FERROXCUBE Bead
RFC3	FERROXCUBE Choke, VK200-4B

L1	3.3 x 0.2 cm AIRLINE Inductor
L2	1.0 x 0.2 cm AIRLINE Inductor
L3	1.2 x 0.6 cm Brass Pad
L4	1.2 x 0.6 cm Brass Pad and 2.0 x 0.2 cm AIRLINE Inductor
Board:	G10, ϵ_r = 5, t = 62 mils 2 sided, 2 oz. Clad
Connectors:	Type N

FIGURE 2 – OUTPUT POWER versus INPUT POWER

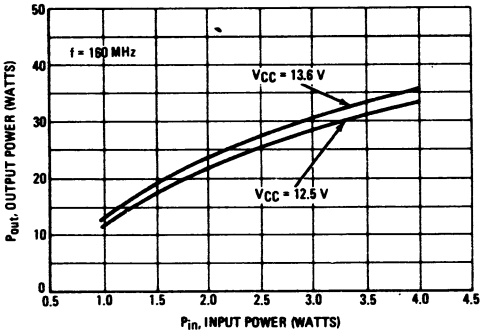


FIGURE 3 – OUTPUT POWER versus FREQUENCY

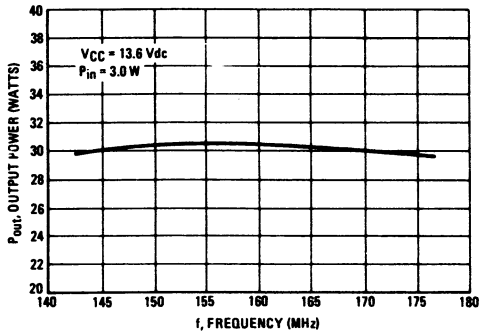


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

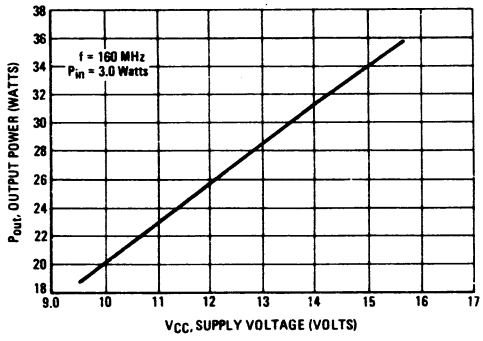
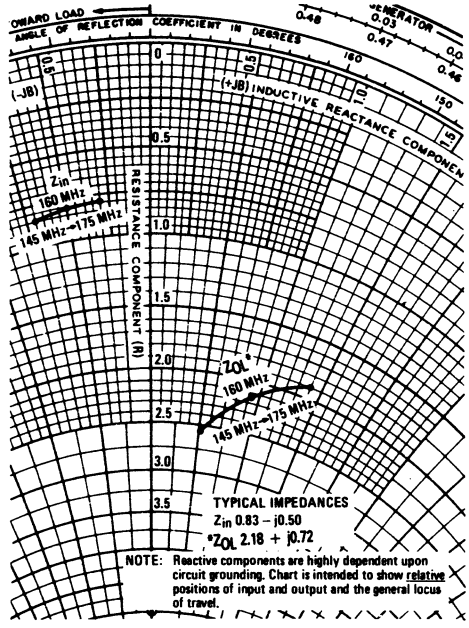


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



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

4.2

MRF239

MOTOROLA

The RF Line

NPN SILICON RF POWER TRANSISTOR

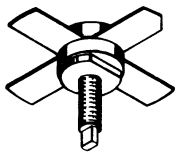
.. designed for 13.6 volt VHF large-signal class C and class AB linear power amplifier applications in commercial and industrial equipment.

- High Common Emitter Power Gain
- Specified 13.6 V, 160 MHz Performance:
  Output Power = 30 Watts
  Power Gain = 10 dB Min
  Efficiency = 65% Typ
- Silicon Nitride Passivated
- Low Intermodulation Distortion, d_3 = -35 dB Typ

30 W – 136–175 MHz

RF POWER TRANSISTOR

NPN SILICON



4.2

MAXIMUM RATINGS

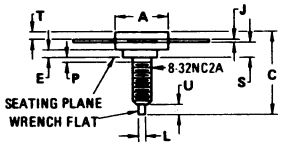
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	6.0	Adc
Total Device Dissipation @ T_C = 25°C (1)	P_D	75	Watts
Derate above 25°C		430	mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

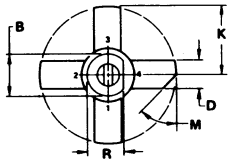
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	2.33	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.





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

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	–	0.070	–
J	0.08	0.18	0.003	0.007
K	12.45	–	0.490	–
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	–	1.27	–	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

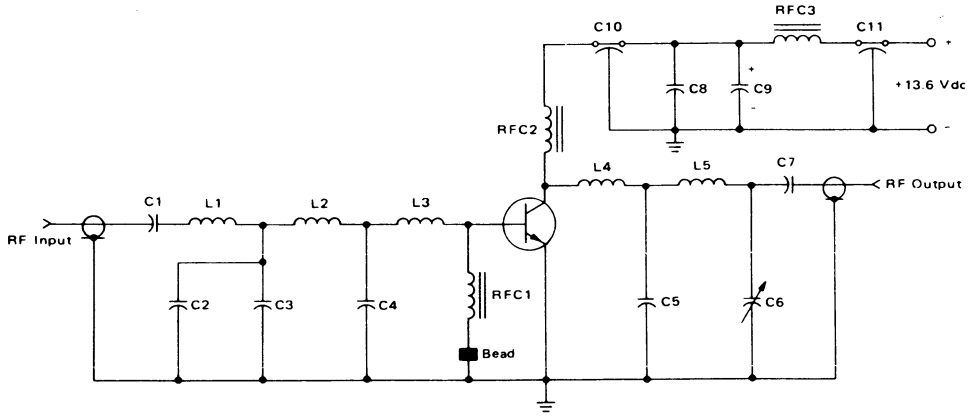
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CES}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0A, V_{CE} = 5.0 Vdc)	h_{FE}	20	–	150	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz	C_{ob}	–	65	90	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 13.6 Vdc, P_{out} = 30 W, f = 160 MHz)	G_{PE}	10	11.5	–	dB
Collector Efficiency (V_{CC} = 13.6 Vdc, P_{out} = 30 W, f = 160 MHz)	η	55	65	–	%
TYPICAL SSB PERFORMANCE					
Intermodulation Distortion (1) (V_{CC} = 13.6 Vdc, P_{out} = 30 W (PEP), f1 = 146 MHz f2 = 146.002 MHz, I_{CQ} = 30 mAdc)	IMD(d_3)	–	-35	–	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

4.2

FIGURE 1 – 160 MHz TEST CIRCUIT SCHEMATIC



C1	200 pF, 350 Vdc, UNELCO	C10,C11	680 pF ALLEN BRADLEY Feedthru
C2	100 pF, 350 Vdc, UNELCO	RFC1	0.15 μH Molded Choke
C3	40 pF, 350 Vdc, UNELCO	RFC2	10 Turns, #18 AWG on 470 Ohm, 1 Watt Resistor
C4,C5	80 pF, 350 Vdc, UNELCO	Bead	FERROXCUBE Bead
C6	1.0–20 pF, ARCO Trimmer	RFC3	FERROXCUBE Choke, VK200-4B
C7	100 pF 350 Vdc, UNELCO	L1	3.3 x 0.2 cm AIRLINE Inductor
C8	0.1 μF ERIE Disc Ceramic	L2	1.0 x 0.2 cm AIRLINE Inductor
C9	1.0 μF TANTALUM	L3	1.2 x 0.6 cm Brass Pad
		L4	1.2 x 0.6 cm Brass Pad and 2.0 x 0.2 cm AIRLINE Inductor

Board: G10, ϵ_r = 5, t = 62 mils 2 sided, 2 oz. Clad

Connectors: Type N

FIGURE 2 – POWER GAIN versus FREQUENCY

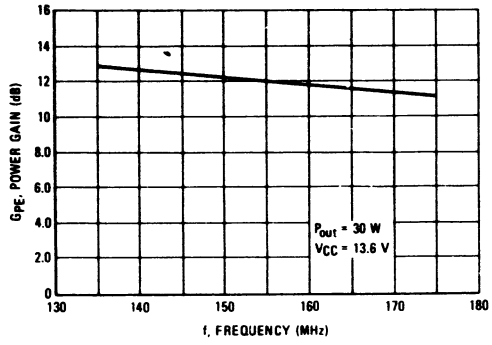


FIGURE 3 – OUTPUT POWER versus INPUT POWER

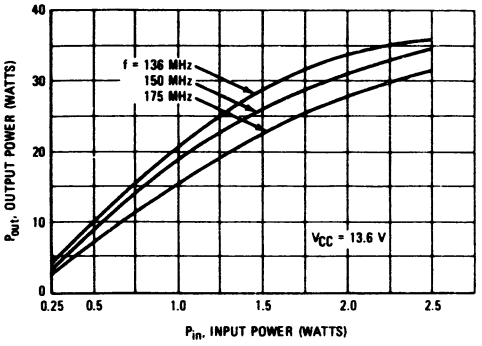


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE
136 MHz

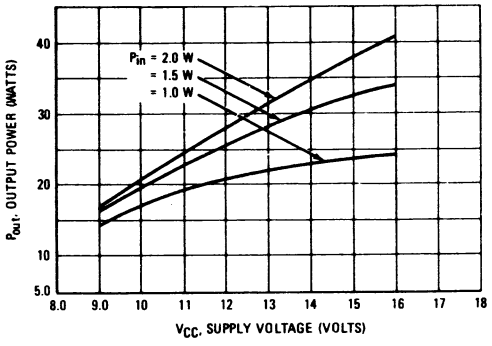


FIGURE 5 – OUTPUT POWER versus SUPPLY VOLTAGE
150 MHz

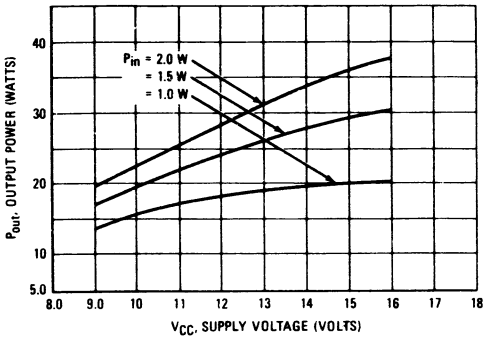


FIGURE 6 – OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz

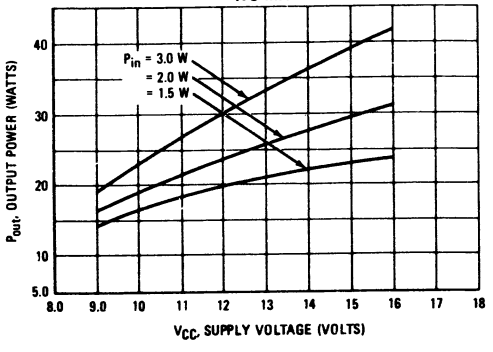
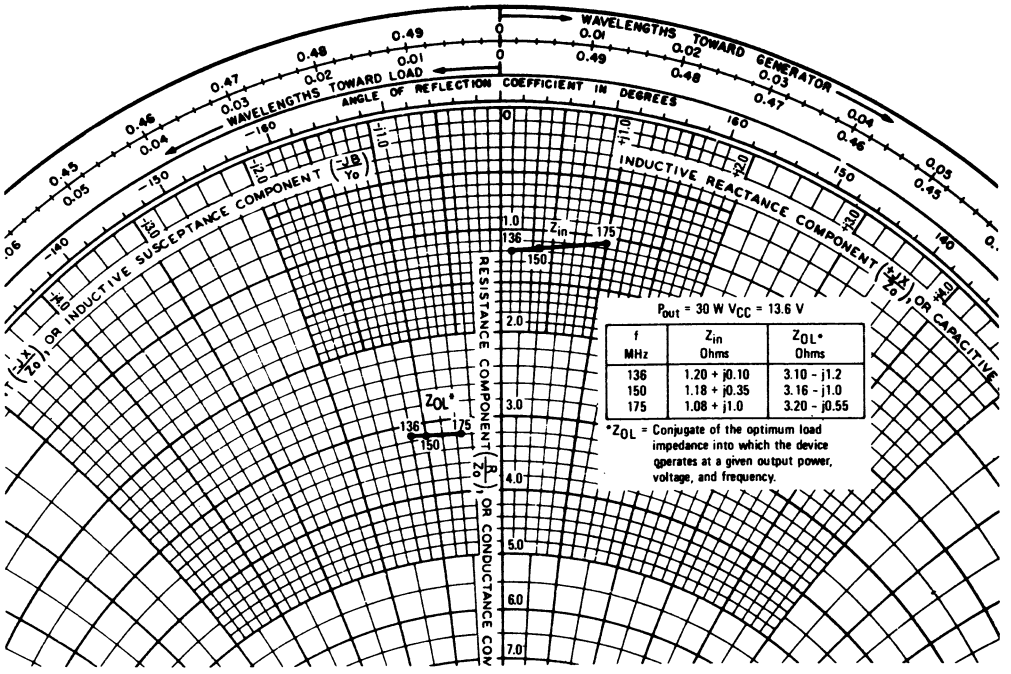


FIGURE 7 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



4.2

MOTOROLA

MRF342

The RF Line

NPN SILICON RF POWER TRANSISTOR

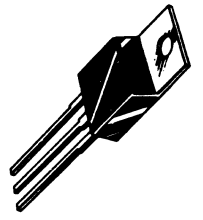
. . . designed primarily for use in VHF amplifiers with amplitude modulation and other communications equipment operating to 150 MHz.

- Low Cost Common Emitter TO-220 Package
- Specified 27 V, 136 MHz Performance:
  Output Power = 24 W
  Power Gain = 11 dB Min
  Efficiency = 50% Min
- 20:1 VSWR Load Mismatch Capability at Rated Output Power and Supply Voltage
- Other Devices in the Series:
  MRF340 8.0 W
  MRF344 60 W

24 W 100–150 MHz

RF POWER TRANSISTOR

NPN SILICON



4.2

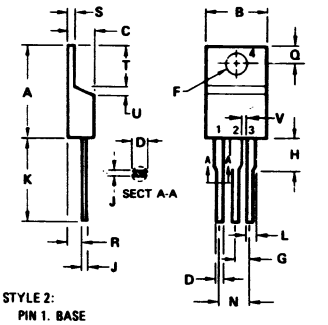
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous Peak	I_C	2.2 3.0	Adc
Total Device Dissipation — $T_C = 25^oC$ (1) Derate above 25^oC	P_D	55 310	Watts mW/^oC
Storage Temperature Range	T_{stg}	−65 to +150	^oC

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.2	$^oC/W$

1. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.



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

NOTE:
1. DIM. L & H APPLIES TO ALL LEADS.

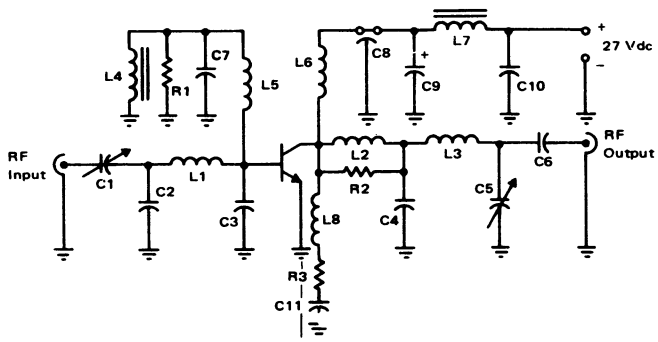
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	15.11	15.75	0.595	0.620
B	9.65	10.29	0.380	0.405
C	4.06	4.82	0.160	0.190
D	0.64	0.89	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.41	2.67	0.095	0.105
H	2.79	3.30	0.110	0.130
J	0.36	0.56	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.14	1.27	0.045	0.050
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.14	1.39	0.045	0.055
T	5.97	6.48	0.235	0.255
U	0.76	1.27	0.030	0.050
V	1.14	-	0.045	-

CASE 221A-02

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 27 Vdc, V_{BE} = 0)	I_{CES}	–	–	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	100	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 27 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	20	30	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 13.5 Vdc, P_{out} = 6.0 W, f = 136 MHz)	G_{PE}	10	11.5	–	dB
Common-Emitter Amplifier Power Gain (V_{CC} = 27 Vdc, P_{out} = 24 W, f = 136 MHz)	G_{PE}	11	12.3	–	dB
Collector Efficiency (V_{CC} = 27 Vdc, P_{out} = 24 W, f = 136 MHz)	η	50	60	–	%
Load Mismatch (V_{CC} = 27 Vdc, P_{out} = 24 W (peak), f = 136 MHz Drive modulated with 1.0 kHz square wave, 50% duty cycle. Load VSWR ≥ 20:1, all phase angles)	ψ	No Degradation in Power Output			

FIGURE 1 – 136 MHz TEST CIRCUIT



C1 – Arco 404
C2 – 25 pF UNELCO
C3, C7 – 200 pF UNELCO
C4 – 40 pF UNELCO
C5 – Arco 462
C6 – 510 pF Dipped Mica
C8 – 680 pF Feedthru
C9 – 1.0 μF 50 V Tantalum
C10, C11 – 0.1 μF Erie Redcap 100 V

L1, L2 – 3 Turns #18 AWG, 1/8" ID
L3 – 5 Turns #18 AWG, 1/8 ID
L4, L7 – VK-200-19/4B
L5 – 0.15 μH Molded Choke
L6 – 0.22 μH Molded Choke
L8 – 0.47 μH Molded Choke

R1 – 22 Ω, 2 Watt
R2 – 910 Ω, 1 Watt
R3 – 12 Ω, 1 Watt

FIGURE 2 – POWER GAIN versus FREQUENCY

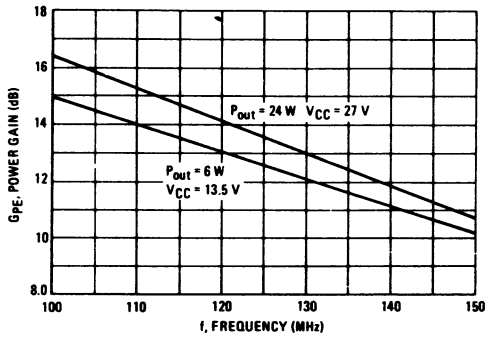
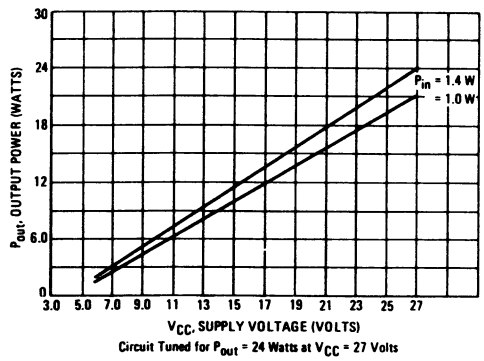


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE
(f = 136 MHz)



Circuit Tuned for P_{out} = 24 Watts at V_{CC} = 27 Volts

FIGURE 4 – OUTPUT POWER versus INPUT POWER
(V_{CC} = 27 V)

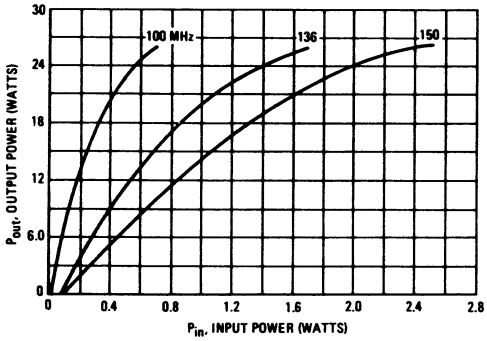


FIGURE 5 – OUTPUT POWER versus INPUT POWER
(V_{CC} = 13.5 V)

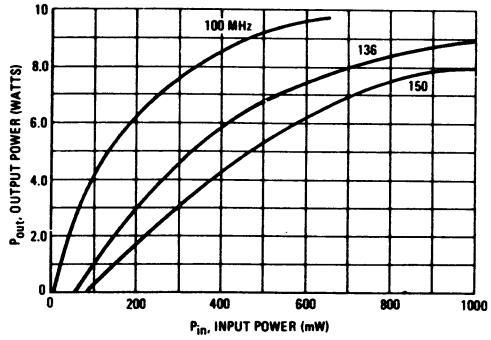
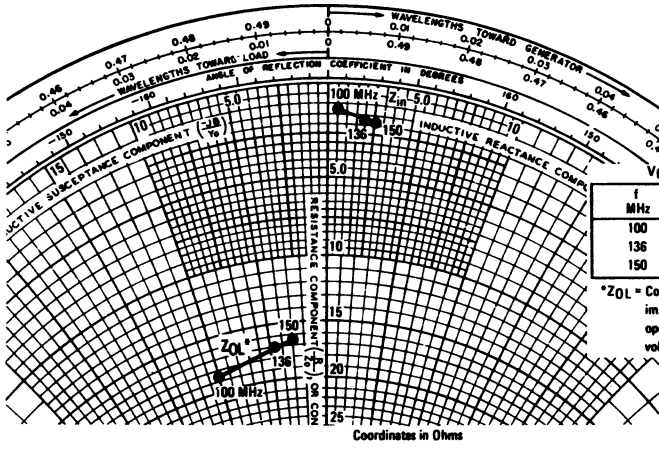


FIGURE 6 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

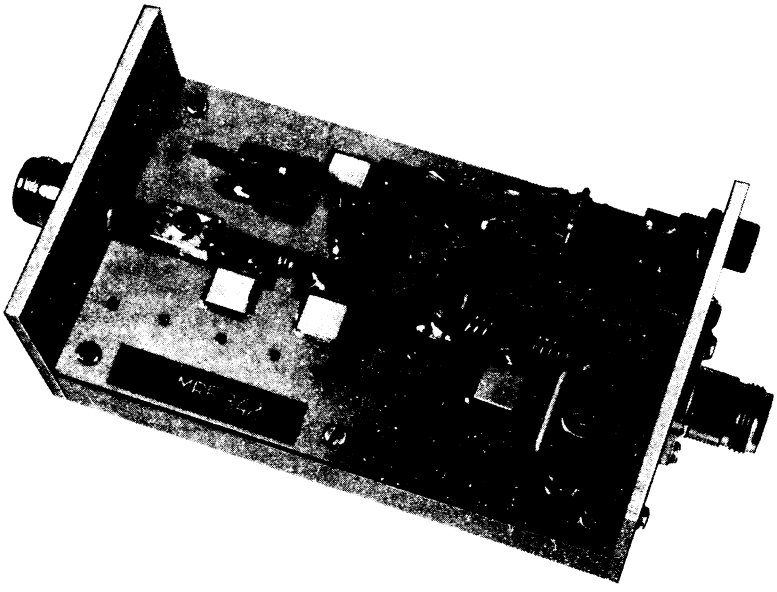


V_{CC} = 27 V P_{out} = 24 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
100	1.25 + j0.5	18.5 – j10
136	1.75 + j2.0	17 – j4.7
150	1.9 + j2.5	16.5 – j3.0

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

FIGURE 7 – 136 MHz TEST AMPLIFIER



4.2

FIGURE 8 – PRINTED CIRCUIT BOARD LAYOUT – 136 MHz TEST CIRCUIT