MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF660

The RF Line

NPN SILICON RF POWER TRANSISTOR

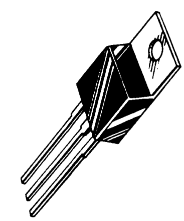
. . . designed for 12.5 volt UHF large signal power amplifier applications in commercial and industrial FM equipment.

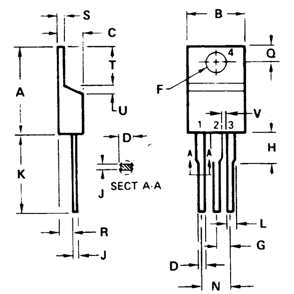
- Low Cost Common Emitter TO-220 Package
- Specified 12.5 V, 470 MHz Performance
  Output Power = 7.0 W
  Power Gain = 5.4 dB Min
  Efficiency — 60% Min
- Load Mismatch Capability at High Line and
  RF Input Overdrive

7.0 W 470 MHz

RF POWER
TRANSISTOR

NPN SILICON





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

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

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	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
TO-220AB

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	2.4	Adc
Total Device Dissipation @ $T_C = 25^oC$ (1) Derate above 25^oC	P_D	25 143	Watts $mW/^oC$
Storage Temperature Range	T_{stg}	-65 to +150	^oC

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	7.0	$^oC/W$

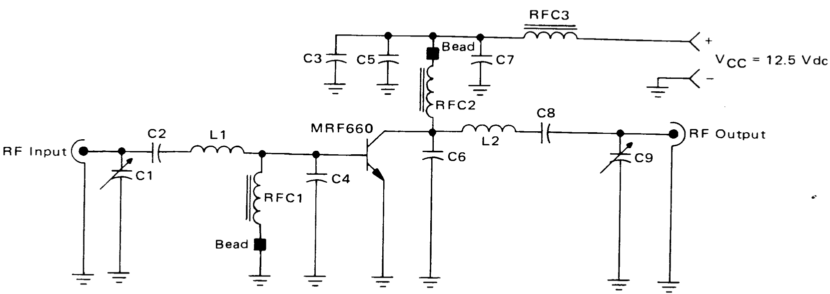
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

3

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 = 20 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_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	90	160	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	17	25	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 7.0 W, f = 470 MHz)	G_{PE}	5.4	6.0	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 7.0 W, f = 470 Mhz)	η	60	–	–	%

FIGURE 1 – TEST CIRCUIT



C1, C9 – 1-10 pF Johanson
C2, C8 – 15 pF Underwood Elect. Co. Type J101
C3 – 270 pF, ATC Chip Capacitor Case B
C4, C6 – 24 pF ELMENCO MCN01/010
C5 – 0.1 μF Ceramic, Erie
C7 – 1.0 μF, 35 V, Tantalum
L1 – 27 nH Copper Strap 0.150″ X 0.025″ X 1.5″ (See Note)
L2 – 16 nH Copper Strap 0.150″ X 0.025″ X 1.0″ (See Note)
RFC1 – 0.68 μH Molded Choke, Cambion
RFC2 – 4 Turns #20 AWG, 0.312″ ID X 0.25″ Long
RFC3 – Ferrite Choke, Ferroxcube #VK200-20/4B
Bead – Ferrite Bead, Ferroxcube #56-590-65-3B
Printed Circuit Board Material – 3M #K6098-22062, Teflon Fiberglass or equivalent

NOTE:

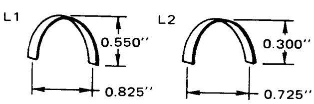


FIGURE 2 – OUTPUT POWER versus INPUT POWER

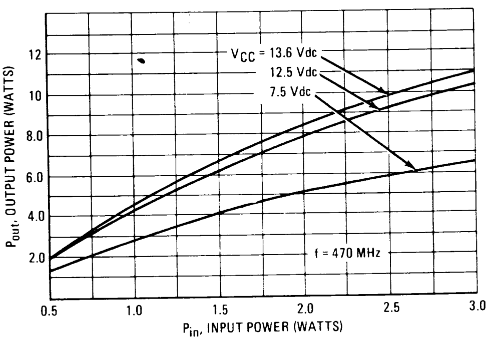


FIGURE 3 – OUTPUT POWER versus FREQUENCY

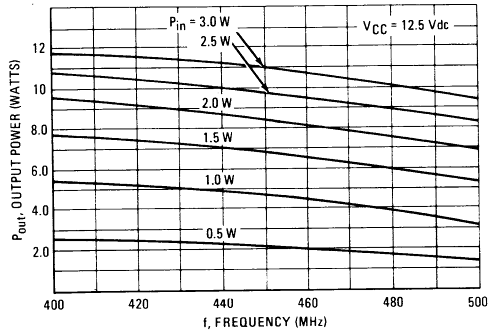


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

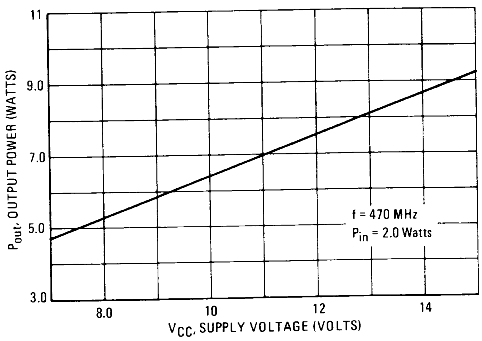
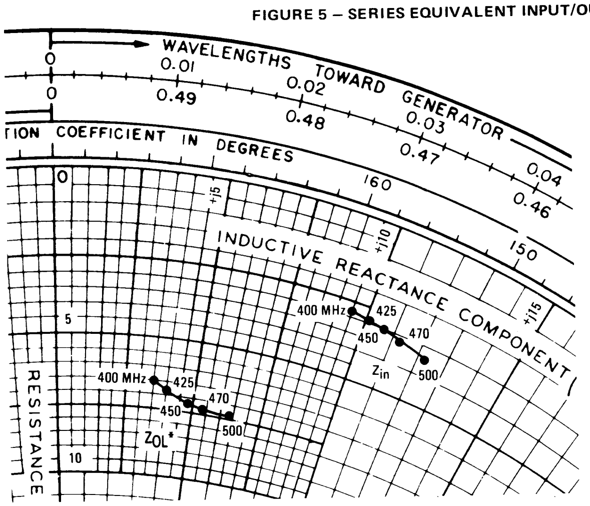


FIGURE 5 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



P_{in} = 2.0 W, V_{CC} = 12.5 V

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
400	2.8 + j9.0	6.5 + j3.5
425	2.9 + j10.1	6.8 + j4.0
450	3.0 + j10.5	7.2 + j4.8
470	3.1 + j11.2	7.3 + j5.4
500	3.4 + j12.2	7.3 + j6.4

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

FIGURE 6 – UHF TEST AMPLIFIER

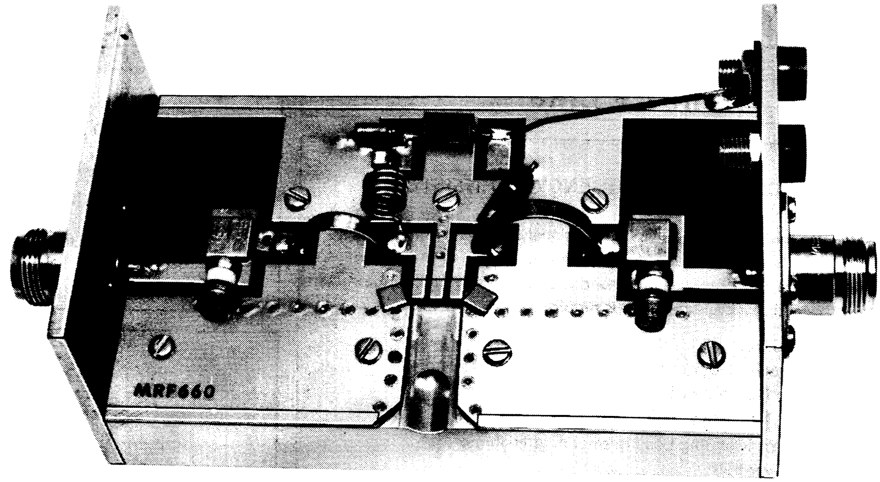
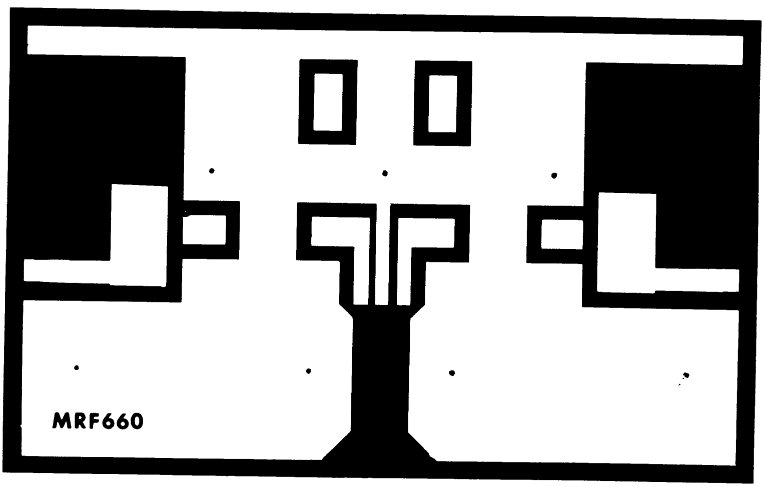


FIGURE 7 – PRINTED CIRCUIT BOARD



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

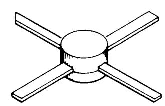
MRF750

The RF Line

0.5 W — 470 MHZ — 7.5 V

HIGH FREQUENCY TRANSISTOR

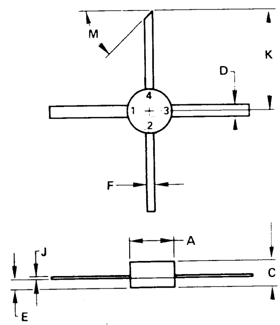
NPN SILICON



NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed for 5.0 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 407 to 512 MHz range. Ideally suited for handheld radios and other equipment where high packaging density is required.

- Specified 7.5 Volt, 470 MHz Characteristics —
  Output Power = 0.5 Watts
  Minimum Gain = 10 dB
  Minimum Efficiency = 55%
- Capable of Withstanding Load Mismatch at Highline and RF Overdrive
- Silicon Nitride Passivation



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

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.08	5.59	0.200	0.220
C	2.41	3.30	0.095	0.130
D	1.40	1.65	0.055	0.065
E	1.02	1.27	0.040	0.050
F	0.64	0.89	0.025	0.035
J	0.08	0.18	0.003	0.007
K	11.05	–	0.435	–
M	45° NOM		45° NOM	

Case 305A-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current-Continuous	I_C	200	mAdc
Total Device Dissipation @ T_C = 25°C (1) Derate Above 25°C	P_D	2.5 35	Watts mW/°C
Storage Temperature Range	T_{stg}	–65 to +150°C	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	28.5	°C/W

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

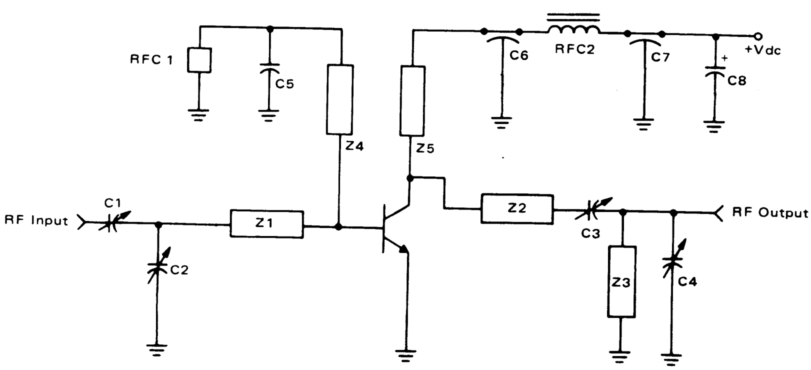
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	13	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	25	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 9.0 Vdc, I_E = 0)	I_{CBO}	–	–	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	65	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 7.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	3.0	5.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 7.5 Vdc, P_{out} = 0.5 W, f = 470 MHz)	G_{PE}	10	11	–	dB
Collector Efficiency (V_{CC} = 7.5 Vdc, P_{out} = 0.5 W, f = 470 MHz)	η	55	–	–	%

3

FIGURE 1 – 470 MHz TEST CIRCUIT



C1, C2, C3, C4, – Johanson Trimmer, JMC#5501
C5 – J101, 100 pF Unelco
C6, C7 – 680 pF Allen Bradley Feedthru
C8 – 1.0 µF Tantalum
RFC1 – Ferroxcube Bead, 56-590-65-3B
RFC2 – Choke, VK 200/4B

Z1, Z2 – Microstrip W = 0.26″, L = 2.9″
Z3 – Microstrip W = 0.5″, L = 1.2″
Z4 – Microstrip W = 0.055″, L = 3.9″
Z5 – Microstrip W = 0.055″, L = 2.9″
Board Material – Glass Teflon, t = 0.062
ϵ_r = 2.5

FIGURE 2 — POWER GAIN versus FREQUENCY

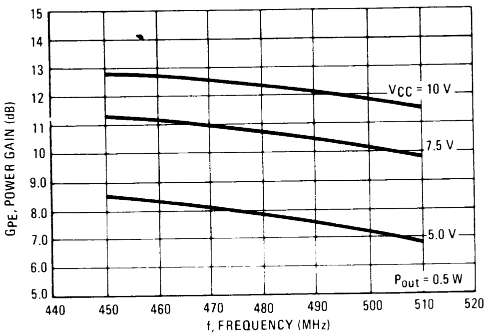


FIGURE 3 — OUTPUT POWER versus INPUT POWER 450 MHz

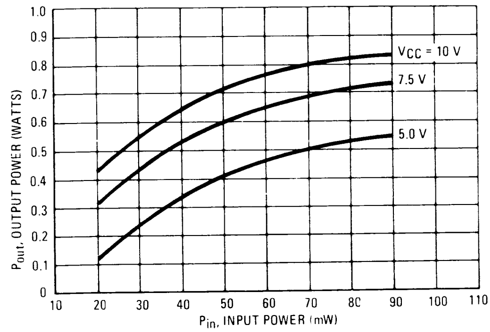


FIGURE 4 — OUTPUT POWER versus INPUT POWER 470 MHz

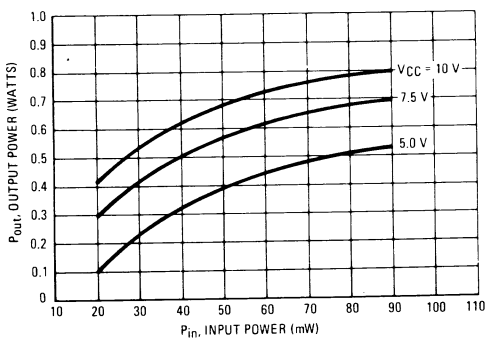


FIGURE 5 — OUTPUT POWER versus INPUT POWER 512 MHz

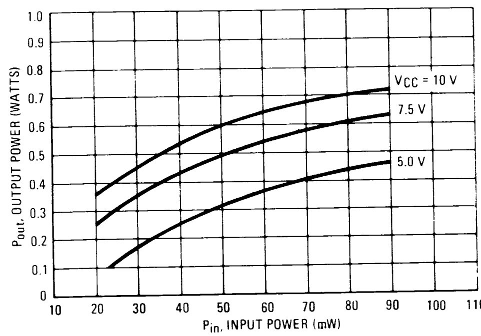
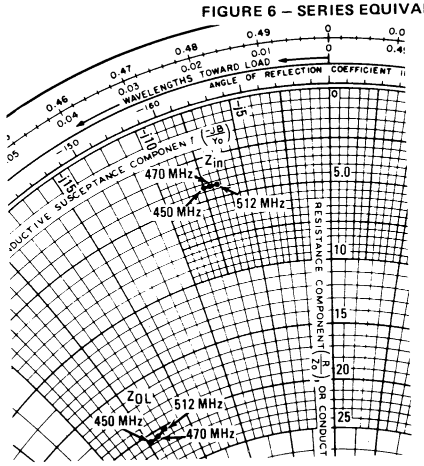


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

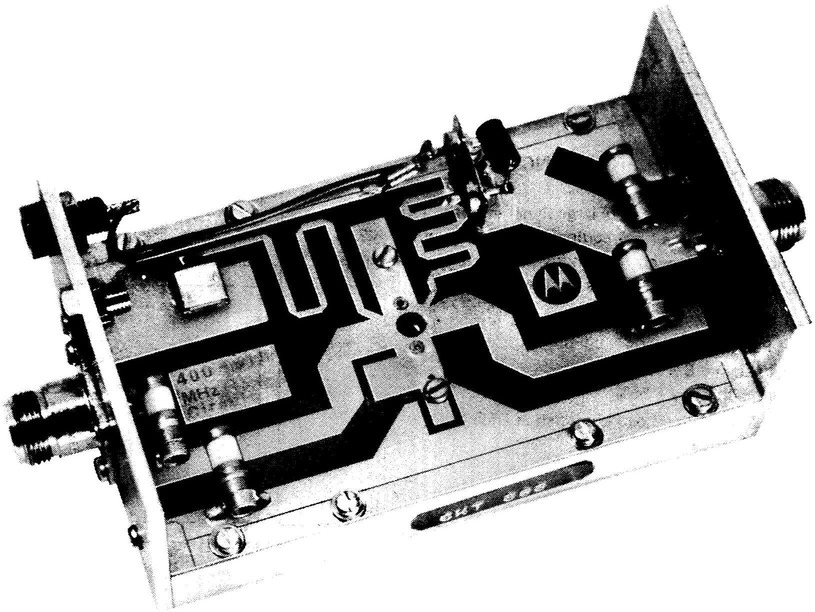


f MHz	Z_{in} Ohms	Z_{OL}* Ohms
450	4.4 -j7.5	20.9 -j19.7
470	4.4 -j7.1	20.7 -j18.9
512	4.4 -j6.7	20.1 -j17.6

P_{out} = 0.5 W V_{CC} = 7.5 V

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

FIGURE 7 — 470 MHz TEST CIRCUIT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF752

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

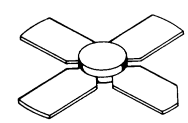
. . . designed for 5.0 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 407 to 512 MHz range. Ideally suited for handheld radios and other equipment where high packaging density is required.

- Specified 7.5 Volt, 470 MHz Characteristics –
  Output Power = 2.5 Watts
  Minimum Gain = 8.0 dB
  Minimum Efficiency = 55%
- Capable of Withstanding Load Mismatch at High Line and RF Overdrive

2.5 W — 470 MHZ — 7.5 V

HIGH FREQUENCY TRANSISTOR

NPN SILICON



MAXIMUM RATINGS

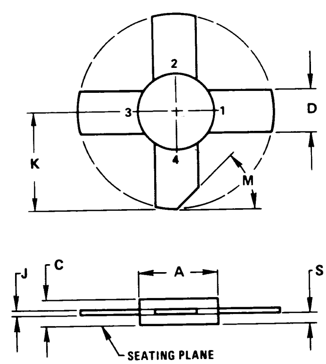
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current-Continuous	I_C	1.2	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate Above 25°C	P_D	15 85.5	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150°C	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	11.7	°C/W

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

(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	7.06	7.26	0.278	0.286
C	2.84	3.45	0.112	0.136
D	5.46	5.97	0.215	0.235
J	0.08	0.18	0.003	0.007
K	11.05	–	0.435	–
M	45° NOM		45° NOM	
S	1.40	1.65	0.055	0.065

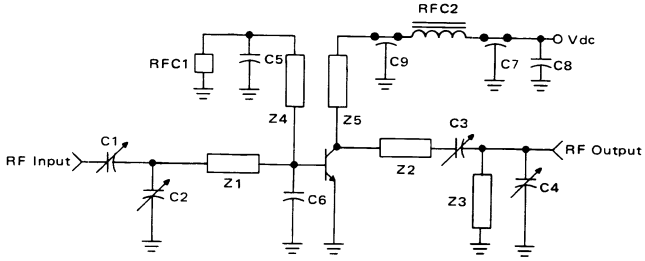
CASE 249-05

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	13	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	25	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 3.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 9.0 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	85	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 7.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	27	35	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 7.5 Vdc, P_{out} = 2.5 W, f = 470 MHz)	G_{PE}	8.0	9.0	–	dB
Collector Efficiency (V_{CC} = 7.5 Vdc, P_{out} = 2.5 W, f = 470 MHz)	η	55	–	–	%

3

FIGURE 1 — 470 MHz TEST CIRCUIT



C1, C2, C3, C4 — Johanson Trimmer JMC#5501
C5 — J101, 100 pF Unelco
C6 — J101, 15 pF Unelco
C7, C9 — 680 pF Allen Bradley Feedthru
C8 — 1.0 μF Tantalum

Z1, Z2 — Microstrip W = 0.26″, L = 2.9″
Z3 — Microstrip W = 0.5″, L = 1.2″
Z4 — Microstrip W = 0.055″, L = 3.9″
Z5 — Microstrip W = 0.055″, L = 2.9″

RFC1 — Ferroxcube Bead, 56-590-65-3B
RFC2 — Choke, VK 200/4B

Board Material — Glass Teflon
t = 0.062
ϵ_r = 2.5

FIGURE 2 – POWER GAIN versus FREQUENCY

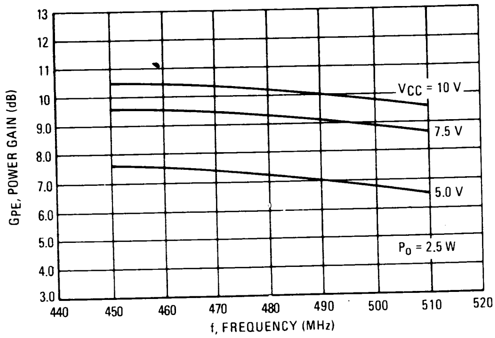


FIGURE 3 – OUTPUT POWER versus INPUT POWER
450 MHz

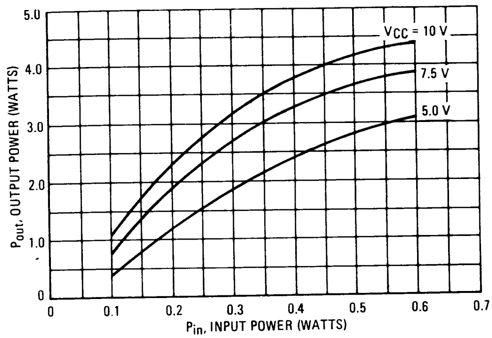


FIGURE 4 – OUTPUT POWER versus INPUT POWER
470 MHz

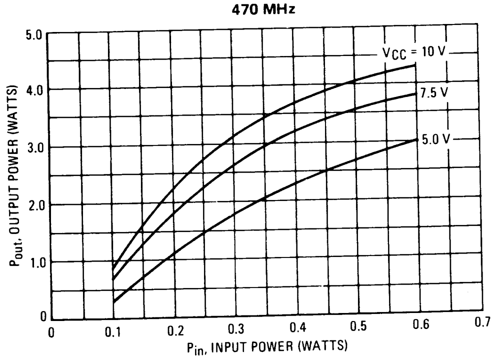


FIGURE 5 – OUTPUT POWER versus INPUT POWER
512 MHz

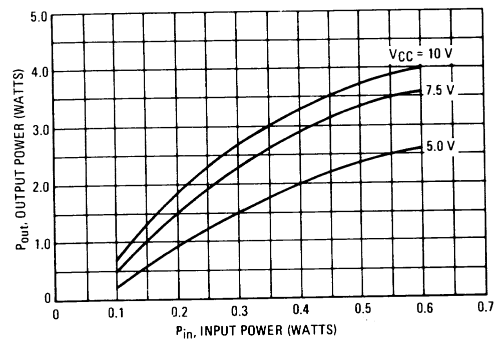
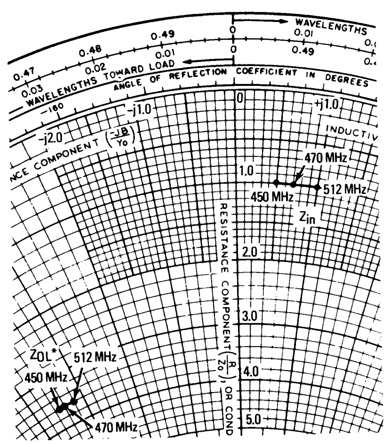


FIGURE 6 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

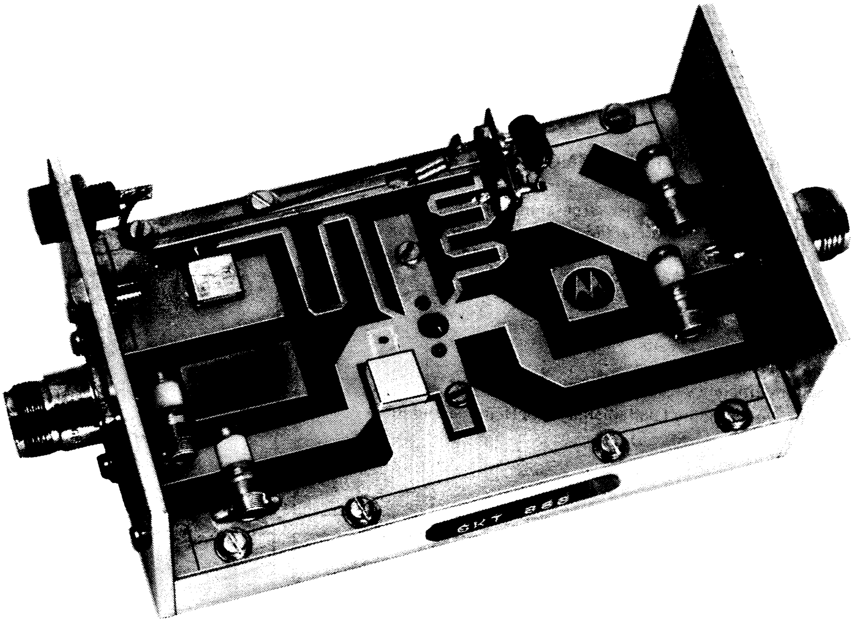


P_{out} = 2.5 W, V_{CC} = 7.5 V

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
450	1.0 +j0.5	3.6 -j3.5
470	1.0 +j0.7	3.6 -j3.4
512	1.0 +j1.0	3.6 -j3.2

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

FIGURE 7 — 470 MHz TEST CIRCUIT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

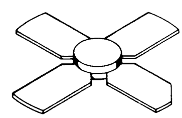
MRF754

The RF Line

8.0 W — 470 MHz — 7.5 V

HIGH FREQUENCY TRANSISTOR

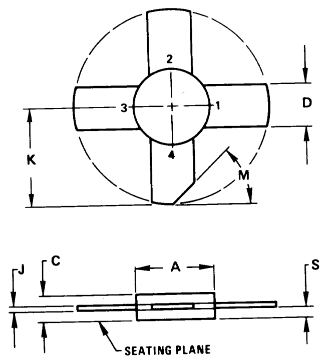
NPN SILICON



NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed for 5.0 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 407 to 512 MHz range. Ideally suited for handheld radios and other equipment where high packaging density is required.

- Specified 7.5 Volt, 470 MHz Characteristics —
  Output Power = 8.0 Watts
  Minimum Gain = 6.0 dB
  Minimum Efficiency = 55%
- Capable of Withstanding Load Mismatch at Highline and RF Overdrive



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

SEATING PLANE = GROUND AND IS CONNECTED TO PIN 1 AND PIN 3.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	7.06	7.26	0.278	0.286
C	2.84	3.45	0.112	0.136
D	5.46	5.97	0.215	0.235
J	0.08	0.18	0.003	0.007
K	11.05	–	0.435	–
M	45° NOM		45° NOM	
S	1.40	1.65	0.055	0.065

CASE 249-05

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	3.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D	37.5 214	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150°C	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	4.7	°C/W

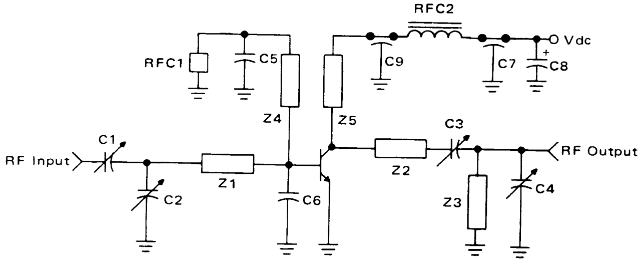
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

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

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 3.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 9.0 Vdc, I_E = 0)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	85	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 7.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	50	65	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 7.5 Vdc, P_{out} = 8.0 W, f = 470 MHz)	G_{PE}	6.0	7.0	—	dB
Collector Efficiency (V_{CC} = 7.5 Vdc, P_{out} = 8.0 W, f = 470 MHz)	η	55	—	—	%

FIGURE 1 — 470 MHz TEST CIRCUIT



C1, C2, C3, C4 — Johanson Trimmer JMC#5501
C5 — J101, 100 pF Unelco
C6 — J101, 15 pF Unelco
C7, C9 — 680 pF Allen Bradley Feedthru
C8 — 1.0 µF Tantalum

Z1, Z2 — Microstrip W = 0.26″, L = 2.9″
Z3 — Microstrip W = 0.5″, L = 1.2″
Z4 — Microstrip W = 0.055″, L = 3.9″
Z5 — Microstrip W = 0.055″, L = 2.9″

RFC1 — Ferroxcube Bead, 56-590-65-3B
RFC2 — Choke, VK 200/4B

Board Material — Glass Teflon
t = 0.062
ϵ_r = 2.5

3

FIGURE 2 — POWER GAIN versus FREQUENCY

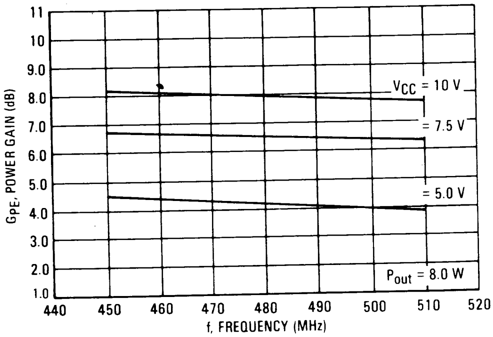


FIGURE 3 — OUTPUT POWER versus INPUT POWER
450 MHz

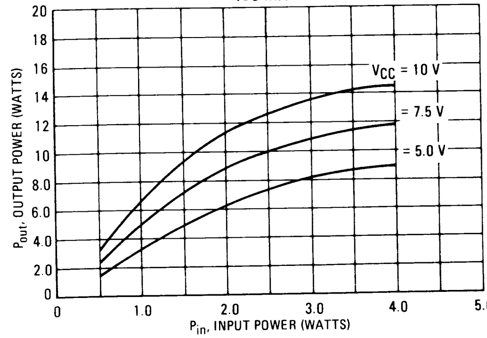


FIGURE 4 — OUTPUT POWER versus INPUT POWER
470 MHz

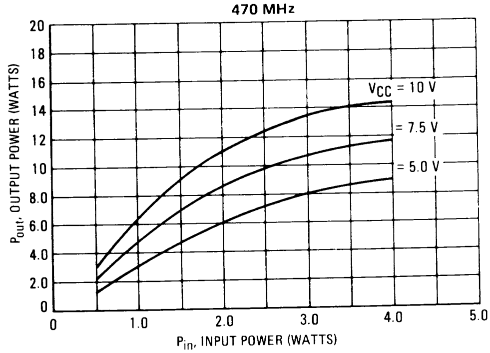


FIGURE 5 — OUTPUT POWER versus INPUT POWER
512 MHz

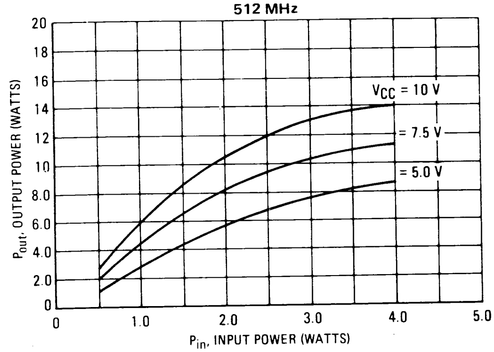
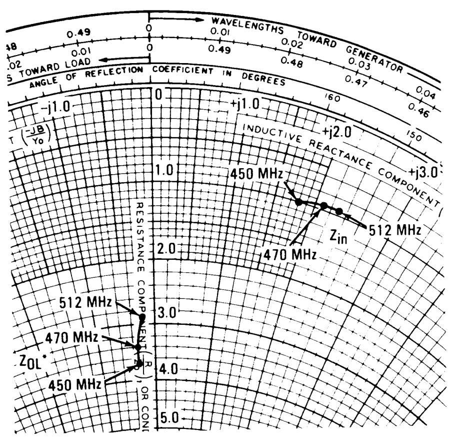


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

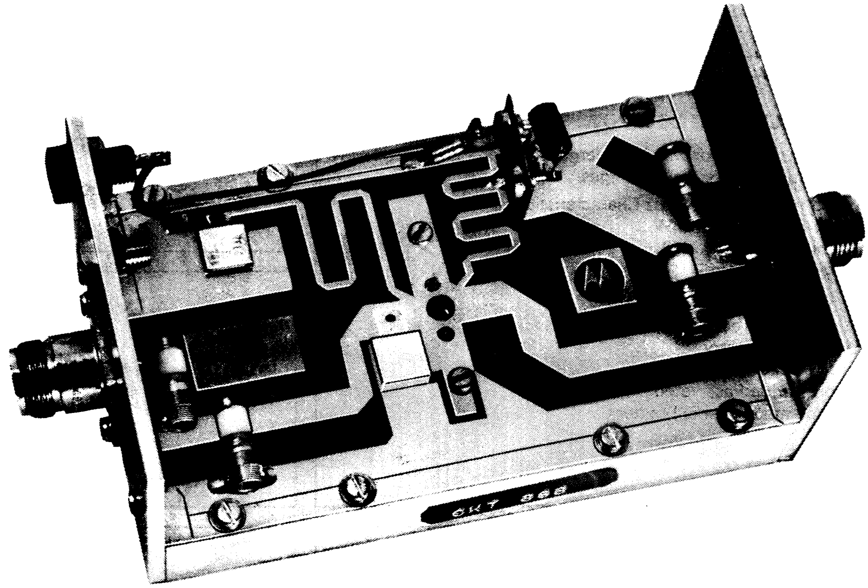


P_{out} = 8.0 W, V_{CC} = 7.5 V

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
450	1.0 + j1.8	3.7 – j0.3
470	0.9 + j2.1	3.4 – j0.3
512	0.9 + j2.3	2.9 – j0.2

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

FIGURE 7 — 470 MHz TEST CIRCUIT



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