MRF2001
MRF2001B

The RF Line

NPN SILICON MICROWAVE POWER TRANSISTOR

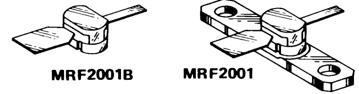
. . . designed for Class B and C amplifier or oscillator applications in the 1.0 to 2.3 GHz frequency range.

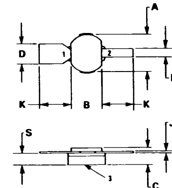
- Guaranteed Performance @ 2 GHz, 28 Vdc
  Output Power = 1.0 Watt
  Minimum Gain = 9.0 dB
- 100% Tested for Load Mismatch at All Phase Angles With 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Older 2001 Types
- Other Devices in the 2000 Series:
  MRF2003 3 W
  MRF2005 5 W
  MRF2010 10 W

1.0 W 2 GHz

MICROWAVE POWER TRANSISTOR

NPN SILICON

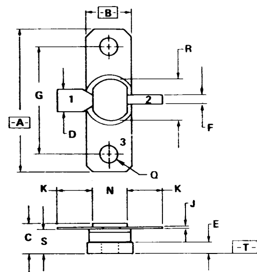




DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.72	5.97	0.225	0.235
B	4.44	4.70	0.175	0.185
C	2.29	2.74	0.090	0.108
D	2.92	3.18	0.115	0.125
F	1.14	1.40	0.045	0.055
J	0.08	0.15	0.003	0.006
K	—	9.52	—	0.375
S	1.52	1.78	0.060	0.070

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

CASE 328-02



NOTES:
1. -A- AND -B- ARE DATUMS.
2. -T- IS SEATING PLANE.
3. POSITIONAL TOLERANCE FOR MOUNTING HOLES: "Q"
   | ⌖ | 0.15 (0.006) | T | A Ⓜ B Ⓜ |
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.19	20.57	0.795	0.810
B	6.22	6.48	0.245	0.255
C	3.68	4.19	0.145	0.165
D	2.92	3.18	0.115	0.125
E	1.40	1.65	0.055	0.065
F	1.14	1.40	0.045	0.055
G	14.22 BSC		0.560 BSC	
J	0.08	0.15	0.003	0.006
K	–	9.52	–	0.375
N	4.44	4.70	0.175	0.185
Q	3.25	3.35	0.128	0.132
R	5.72	5.97	0.225	0.235
S	2.92	3.43	0.115	0.135

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

CASE 328A-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	250	mAdc
Total Device Dissipation @ $T_C = 25^{\circ}C$ (1) Derate above $25^{\circ}C$	P_D	7.0 40	Watts $mW/^{\circ}C$
Storage Temperature Range	T_{stg}	−65 to +200	$^{\circ}C$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	$^{\circ}C/W$

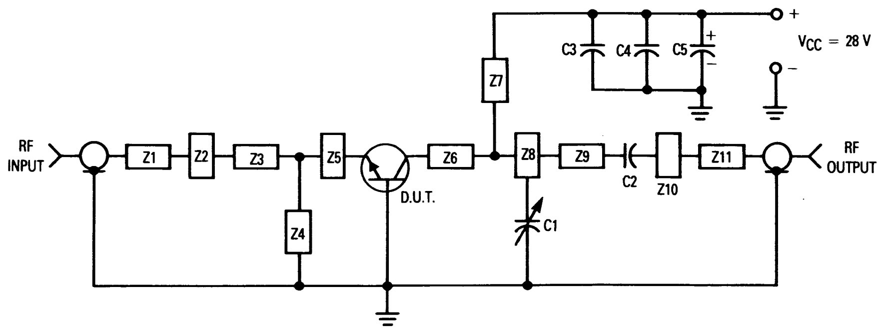
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

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

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0$ mAdc, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	45	–	–	Vdc
Collector-Base Breakdown Voltage ($I_C = 5.0$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	45	–	–	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current ($V_{CB} = 28$ Vdc, $I_E = 0$)	I_{CBO}	–	–	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100$ mAdc, $V_{CE} = 5.0$ Vdc)	h_{FE}	10	–	100	–
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{ob}	–	2.5	5.0	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain ($V_{CC} = 28$ Vdc, $P_{out} = 1.0$ W, f = 2.0 GHz)	G_{PB}	9.0	10	–	dB
Collector Efficiency ($V_{CC} = 28$ Vdc, $P_{out} = 1.0$ W, f = 2.0 GHz)	η	30	35	–	%
Load Mismatch ($V_{CC} = 28$ Vdc, $P_{out} = 1.0$ W, f = 2.0 GHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1. 2 GHz TEST CIRCUIT



Z1–Z11 — Microstrip
C1 — 0.4–2.5 pF Johanson 7285
C2, C3 — 56 pF Chip Capacitor
C4 — 0.1 μF
C5 — 10 μF 50 V Electrolytic
Board Material — 0.062″ Glass Teflon

FIGURE 2 — OUTPUT POWER versus INPUT POWER (f = 1 GHz)

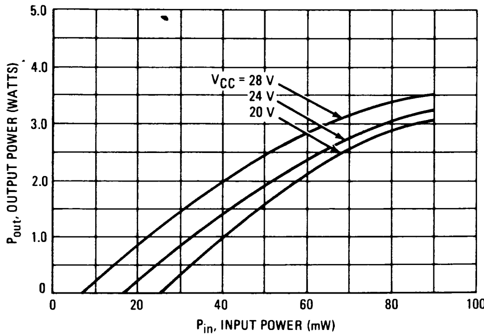


FIGURE 3 — OUTPUT POWER versus INPUT POWER (f = 2 GHz)

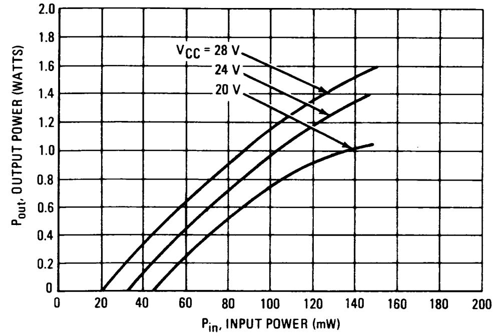


FIGURE 4 — OUTPUT POWER versus FREQUENCY

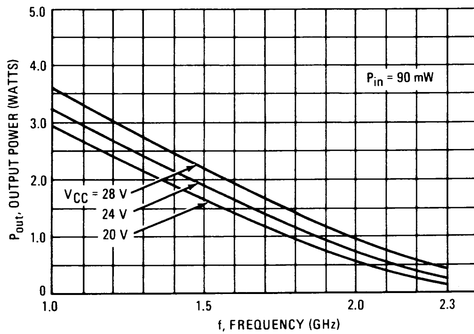


FIGURE 5 — POWER GAIN versus FREQUENCY

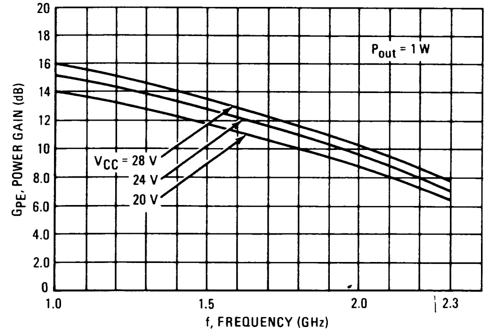
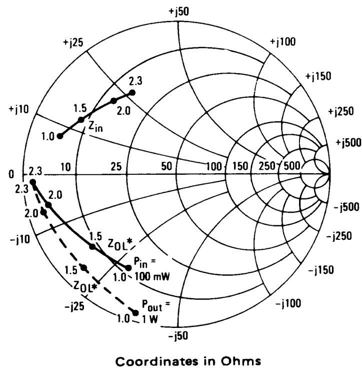


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



Coordinates in Ohms

V_{CC} = 28 V

f GHz	Z_{in} Ohms	Z_{OL}* Ohms P_{in} = 100 mW	Z_{OL}* Ohms P_{out} = 1 W
1.0	6.6 + j8.4	11 - j28.9	4.9 - j37.4
1.5	8.5 + j12.2	8.1 - j17.3	4.6 - j21.0
2.0	11.5 + j19.5	4.2 - j6.0	3.5 - j7.0
2.3	13.4 + j26.0	3.4 - j1.8	3.4 - j1.8

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

FIGURE 7 – 2 GHz TEST AMPLIFIER

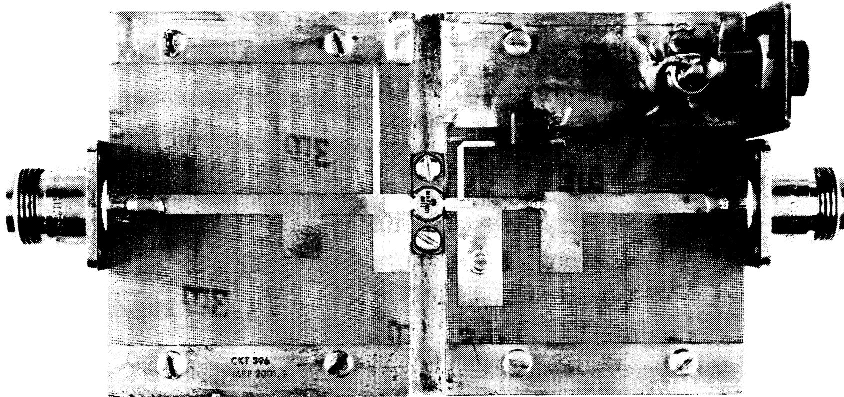
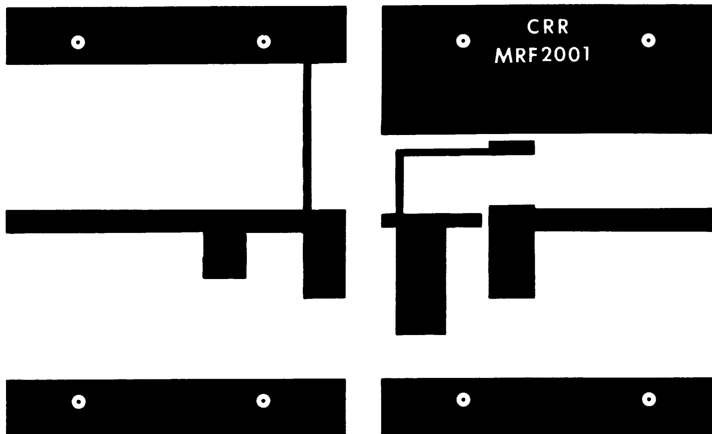


FIGURE 8 – PRINTED CIRCUIT BOARD LAYOUT – 2 GHz TEST CIRCUIT



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

MRF2001M

The RF Line

NPN SILICON MICROWAVE POWER TRANSISTOR

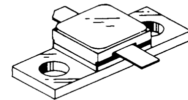
. . . designed for Class B and C *common base* broadband amplifier applications in the 1.7 to 2.3 GHz frequency range.

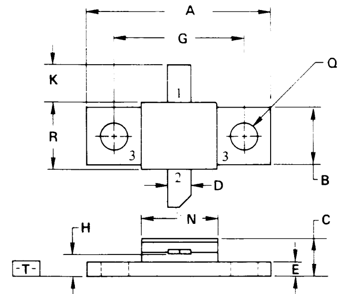
- Internal Input Matching for Broadband Operation
- Guaranteed Performance @ 2 GHz, 24 Vdc
  Output power = 1.0 Watt
  Minimum Gain = 8.5 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivation
- Characterized for Operation from 20 V to 28 V Supply Voltages

1.0 W 2 GHz

MICROWAVE POWER TRANSISTOR

NPN SILICON





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

NOTES:
1. DIMENSIONS -A- AND -B- ARE DATUMS.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES: ⊕ Ø.13(0.005) Ⓜ T A Ⓜ B Ⓜ
3. -T- IS SEATING PLANE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	20.07	20.57	0.790	0.810
B	6.22	6.48	0.245	0.255
C	3.68	4.06	0.145	0.160
D	2.29	2.79	0.090	0.110
E	1.42	1.73	0.056	0.068
G	14.27 BSC		0.560 BSC	
H	2.29	2.79	0.090	0.110
K	3.43	4.19	0.135	0.165
N	7.87	8.38	0.310	0.330
Q	3.05	3.30	0.120	0.130
R	7.24	7.49	0.285	0.295

CASE 337-02

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	250	mAdc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	7.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	°C/W

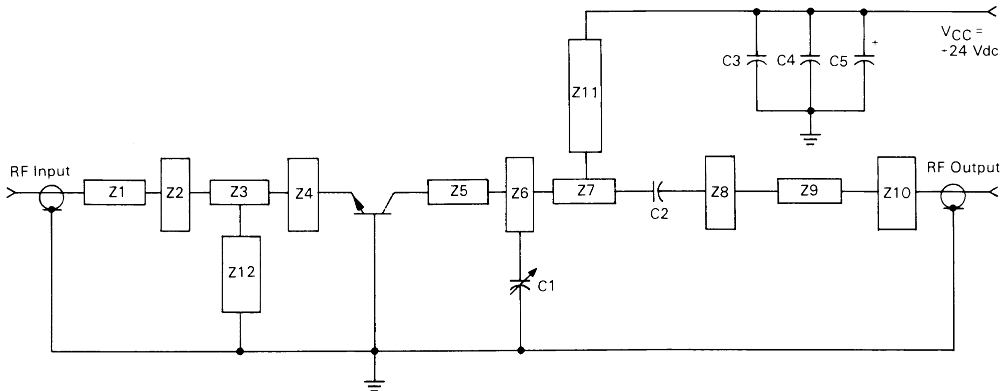
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 Vdc, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	4.0	6.0	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 24 Vdc, P_{out} = 1.0 W, f = 2.0 GHz)	G_{PB}	8.5	9.5	—	dB
Collector Efficiency (V_{CC} = 24 Vdc, P_{out} = 1.0 W, f = 2.0 GHz)	η	35	40		
Load Mismatch (V_{CC} = 24 Vdc, P_{out} = 1.0 W, f = 2.0 GHz) VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

3

FIGURE 1 — 2.0 GHz TEST CIRCUIT



Z1-Z12 — Microstrip, See Photomaster
C1 — 0.6-4.5 pF Johanson 7271
C2, C3 — 56 pF Chip Capacitor
C4 — 0.1 μF
C5 — 10 μF, 35 V
Board Material — 0.0312″ Teflon Fiberglass
ϵ_r = 2.5 ± 0.05

FIGURE 2 — OUTPUT POWER versus INPUT POWER (f = 1.7 GHz)

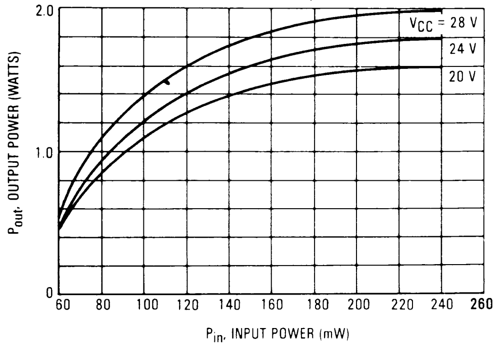


FIGURE 3 — OUTPUT POWER versus INPUT POWER (f = 2.0 GHz)

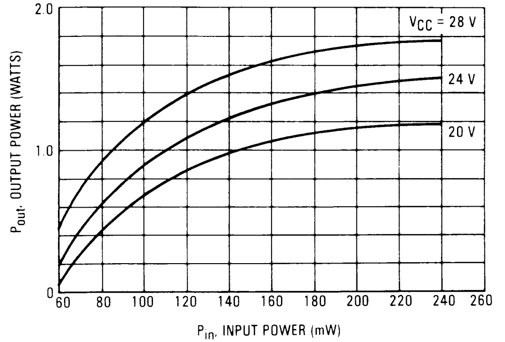


FIGURE 4 — OUTPUT POWER versus INPUT POWER (f = 2.3 GHz)

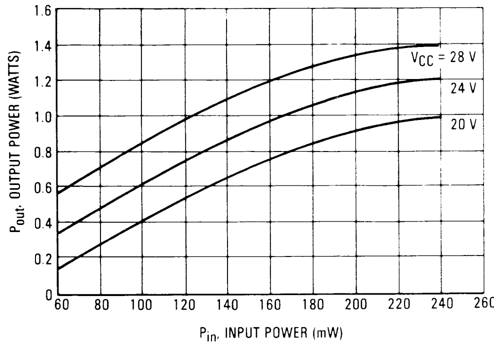


FIGURE 5 — POWER GAIN versus FREQUENCY

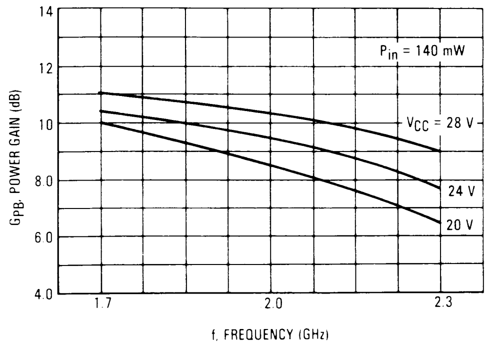
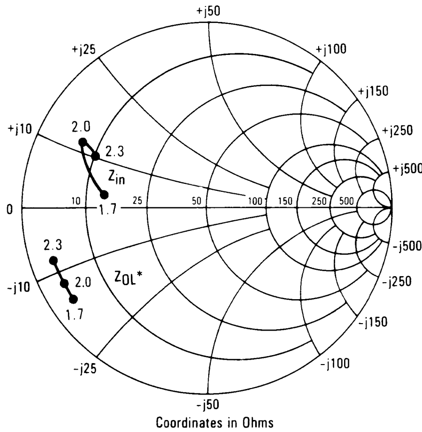


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



V_{CC} = 24 V, P_{in} = 140 mW

f GHz	Z_{in} Ohms	Z_{OL}* Ohms
1.7	15.5 + j 3.0	4.5 − j15.0
2.0	7.5 + j11.0	4.0 − j12.0
2.3	10.0 + j10.0	3.0 − j 7.0

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

FIGURE 7 — 2 GHz TEST AMPLIFIER

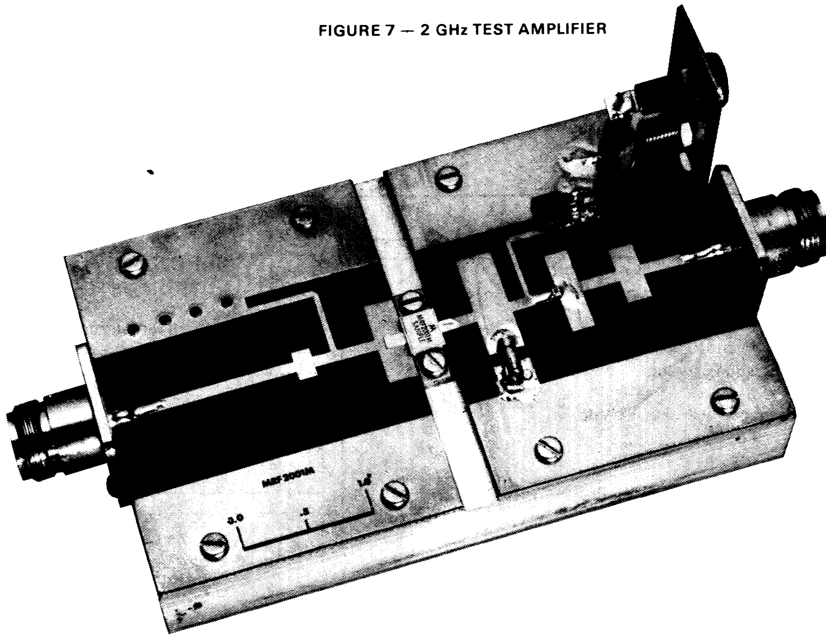
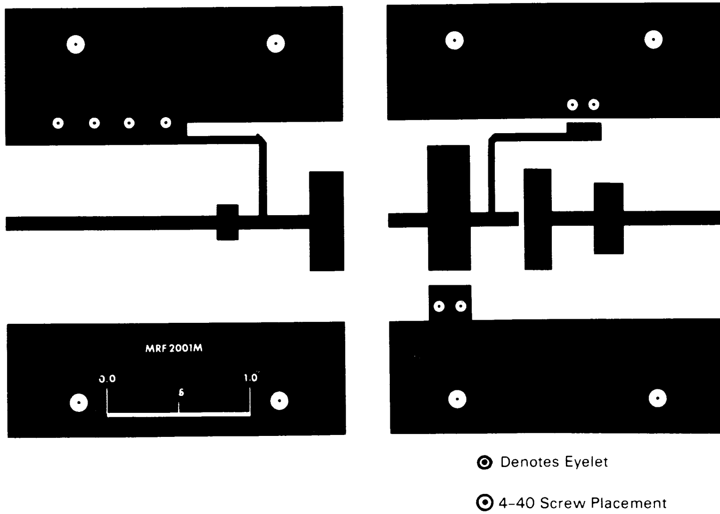


FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2.0 GHz TEST CIRCUIT



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

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF2003
MRF2003B

The RF Line

NPN SILICON MICROWAVE POWER TRANSISTOR

. . . designed for Class B and C amplifier or oscillator applications in the 1.0 to 2.3 GHz frequency range.

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  Minimum Gain = 7.8 dB
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- Hermetically Sealed Industry Standard Package
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- Other Devices in the 2000 Series:
  MRF2001 1 W
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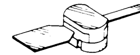
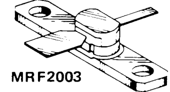
  MRF2010 10 W

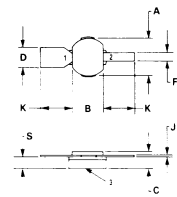
3.0 W 2 GHz

MICROWAVE POWER TRANSISTOR

NPN SILICON

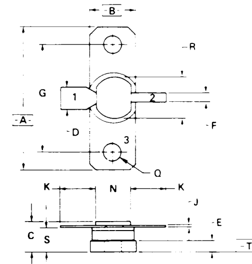
MRF2003B MRF2003



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.72	5.97	0.225	0.235
B	4.44	4.70	0.175	0.185
C	2.29	2.74	0.090	0.108
D	2.92	3.18	0.115	0.125
F	1.14	1.40	0.045	0.055
J	0.08	0.15	0.003	0.006
K	—	9.52	—	0.375
S	1.52	1.78	0.060	0.070

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

CASE 328-02



NOTES
1. -A- AND -B- ARE DATUMS.
2. -T- IS SEATING PLANE.
3. POSITIONAL TOLERANCE FOR MOUNTING HOLES "Q"
⊕ 0.15 (0.006) Ⓜ T A Ⓢ B Ⓢ
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	20.19	20.57	0.795	0.810
B	6.22	6.48	0.245	0.255
C	3.68	4.19	0.145	0.165
D	2.92	3.18	0.115	0.125
E	1.40	1.65	0.055	0.065
F	1.14	1.40	0.045	0.055
G	14.22 BSC		0.560 BSC	
J	0.08	0.15	0.003	0.006
K	–	9.52	–	0.375
N	4.44	4.70	0.175	0.185
Q	3.25	3.35	0.128	0.132
R	5.72	5.97	0.225	0.235
S	2.92	3.43	0.115	0.135

STYLE 1
1. EMITTER
2. COLLECTOR
3. BASE

CASE 328A-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	0.5	Adc
Total Device Dissipation @ $T_C = 25^{\circ}C$ (1) Derate above $25^{\circ}C$	P_D	11.6 67	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	15	°C/W

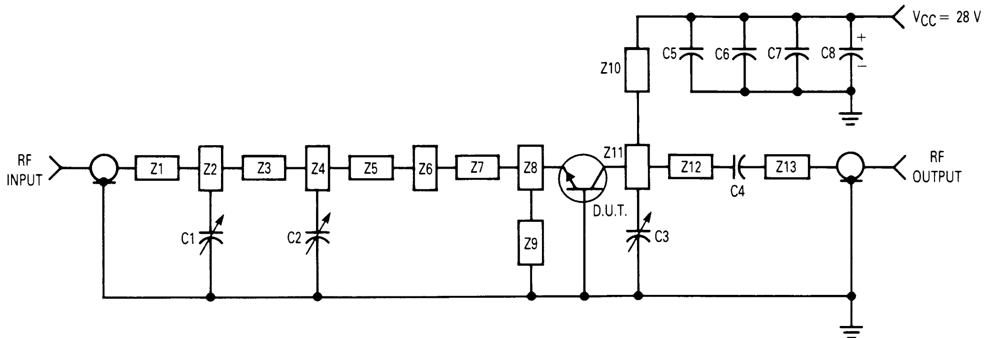
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, R_{BE} = 10 Ω)	$V_{(BR)CER}$	45	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	45	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current (V_{CB} = 28 Vdc, I_E = 0)	I_{CBO}	–	–	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 150 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	100	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	4.0	6.0	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 3.0 W, f = 2.0 GHz)	G_{PB}	7.8	8.9	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 3.0 W, f = 2.0 GHz)	η	30	35		
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 3.0 W, f = 2.0 GHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

3

FIGURE 1 — 2 GHz TEST CIRCUIT



Z1–Z13 — Microstrip
C1, C2, C3 — 0.4–2.5 pF Johanson
C4, C5, C6 — 56 pF Chip Capacitor
C7 — 0.1 μF
C8 — 10 μF 50 V Electrolytic
Board Material — 0.062″ Glass Teflon

FIGURE 2 — OUTPUT POWER versus INPUT POWER
(f = 1 GHz)

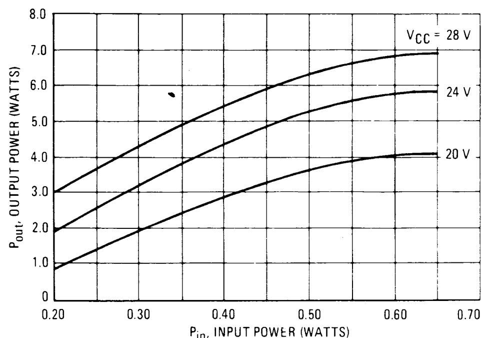


FIGURE 3 — OUTPUT POWER versus INPUT POWER
(f = 2 GHz)

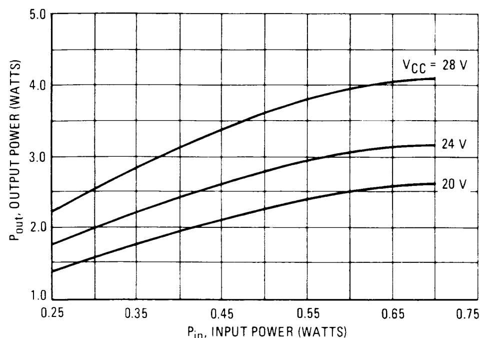


FIGURE 4 — OUTPUT POWER versus FREQUENCY

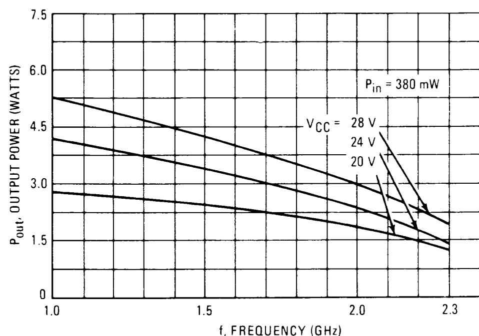


FIGURE 5 — POWER GAIN versus FREQUENCY

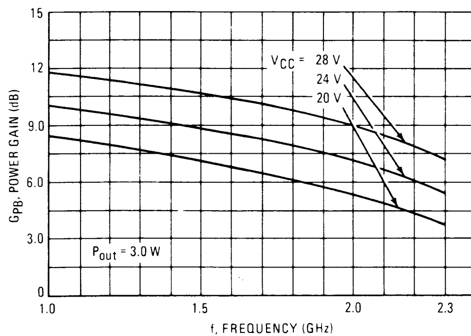
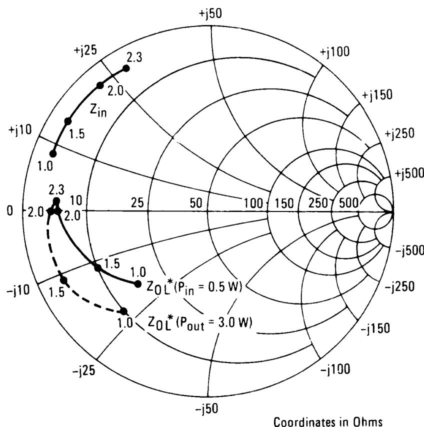


FIGURE 6 — MRF2003 SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



V_{CC} = 28 V

f GHz	Z_{in} Ohms	Z_{OL}* Ohms P_{in} = 0.5 W	Z_{OL}* Ohms P_{out} = 3 W
1.0	2.0 + j9.0	17.5 − j18	10 − j23
1.5	3.0 + j14.5	10 − j10.5	3.0 − j10.5
2.0	4.0 + j23	6.5 + j0	5.0 + j0
2.3	4.5 + j29	5.5 + j1.7	5.5 + j1.7

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

FIGURE 7 — 2 GHz TEST AMPLIFIER

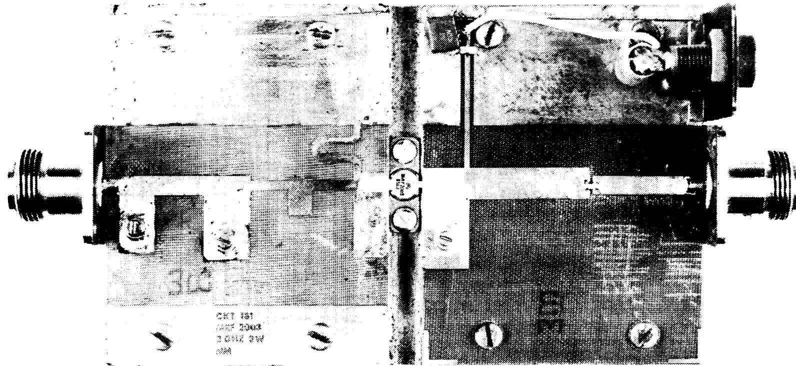
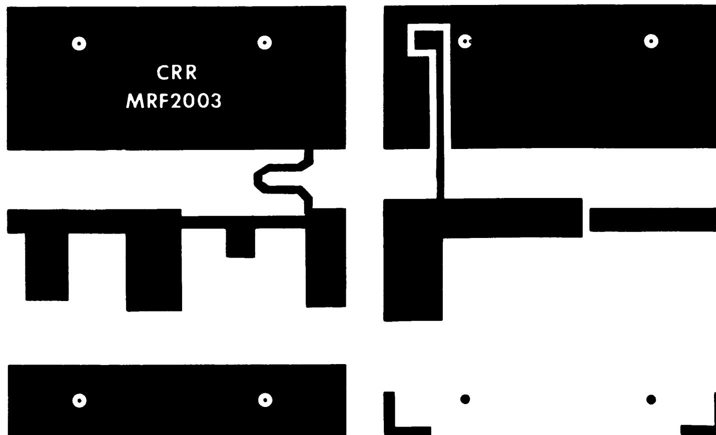


FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT
2 GHz TEST CIRCUIT



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

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

MRF2003M

The RF Line

NPN SILICON MICROWAVE POWER TRANSISTOR

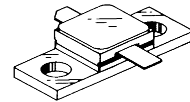
. . . designed for Class B and C *common base* broadband amplifier applications in the 1.7 to 2.3 GHz frequency range.

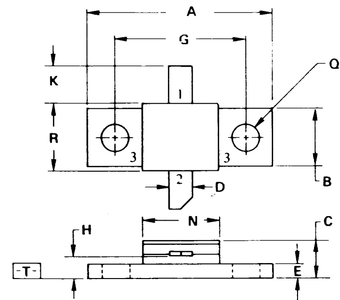
- Internal Input Matching for Broadband Operation
- Guaranteed Performance @ 2 GHz, 24 Vdc
  Output power = 3.0 Watt
  Minimum Gain = 8.0 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivation
- Characterized for Operation from 20 V to 28 V Supply Voltages

3.0 W 2 GHz

MICROWAVE POWER TRANSISTOR

NPN SILICON





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

NOTES:
1. DIMENSIONS -A- AND -B- ARE DATUMS.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES: ⊕ Ø.13(0.005)Ⓜ T AⓂ BⓂ
3. -T- IS SEATING PLANE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	20.07	20.57	0.790	0.810
B	6.22	6.48	0.245	0.255
C	3.68	4.06	0.145	0.160
D	2.29	2.79	0.090	0.110
E	1.42	1.73	0.056	0.068
G	14.27 BSC		0.560 BSC	
H	2.29	2.79	0.090	0.110
K	3.43	4.19	0.135	0.165
N	7.87	8.38	0.310	0.330
Q	3.05	3.30	0.120	0.130
R	7.24	7.49	0.285	0.295

CASE 337-02

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	11 63	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

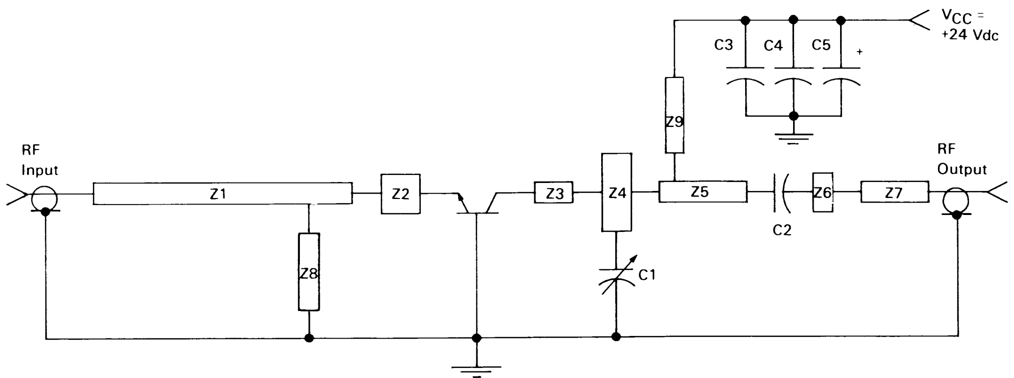
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	16	°C/W

(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 = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 Vdc, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 150 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	4.0	6.0	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 24 Vdc, P_{out} = 3.0 W, f = 2.0 GHz)	G_{PB}	8.0	8.5	—	dB
Collector Efficiency (V_{CC} = 24 Vdc, P_{out} = 3.0 W, f = 2.0 GHz)	η	35	40		
Load Mismatch (V_{CC} = 24 Vdc, P_{out} = 3.0 W, f = 2.0 GHz VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 2.0 GHz TEST CIRCUIT



Z1-Z9 — Microstrip, See Photomaster
C1 — 0.6-4.5 pF Johanson 7271
C2, C3 — 56 pF Chip Capacitor
C4 — 0.1 μF
C5 — 10 μF, 35 V
Board Material — 0.0312″ Teflon Fiberglass
ϵ_r = 2.5 ± 0.05

3

FIGURE 2 — OUTPUT POWER versus INPUT POWER (f = 1.7 GHz)

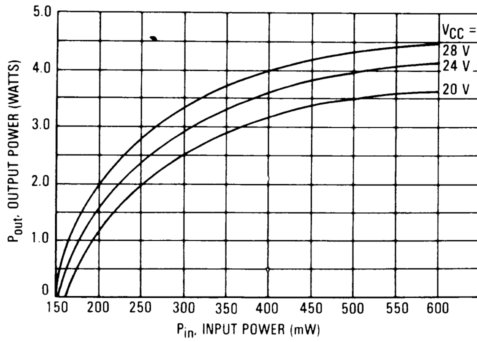


FIGURE 3 — OUTPUT POWER versus INPUT POWER (f = 2.0 GHz)

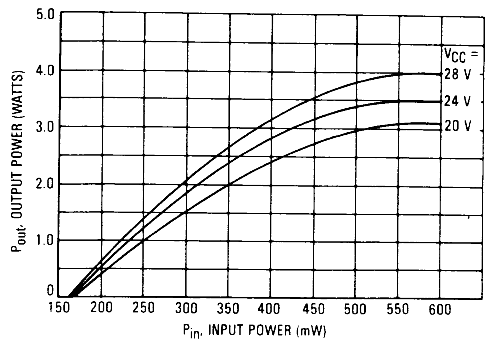


FIGURE 4 — OUTPUT POWER versus INPUT POWER (f = 2.3 GHz)

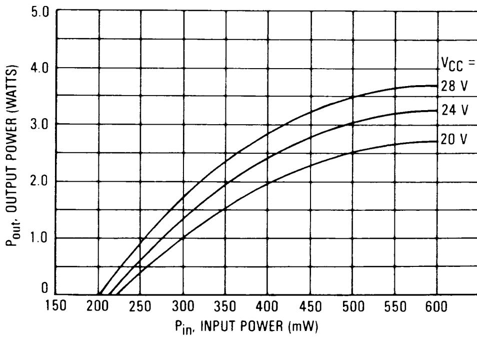


FIGURE 5 — POWER GAIN versus FREQUENCY

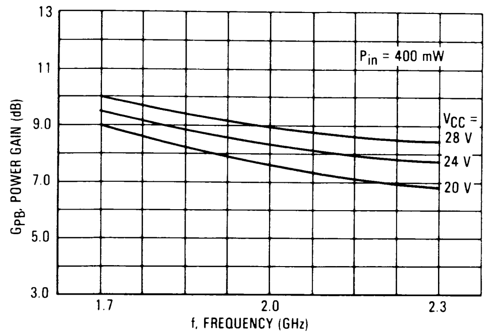
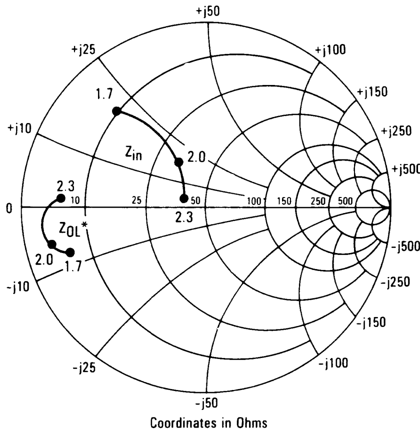


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

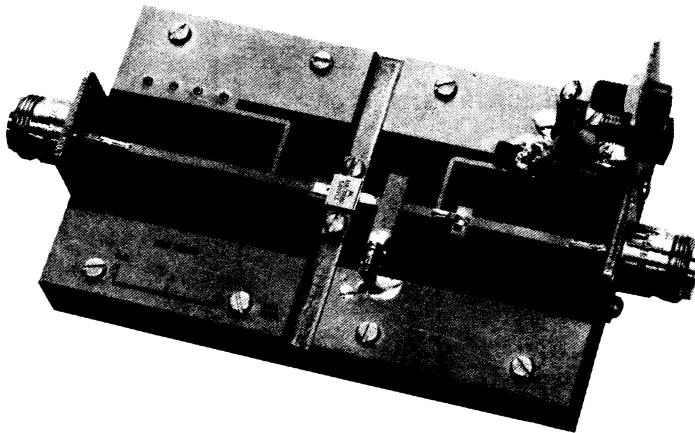


V_{CC} = 24 V, P_{in} = 400 mW

f GHz	Z_{in} Ohms	Z_{OL}* Ohms
1.7	9.5 + j 21	6.5 – j8.5
2.0	35 + j20	4.0 – j5.0
2.3	41 + j3.5	7.0 + j1.5

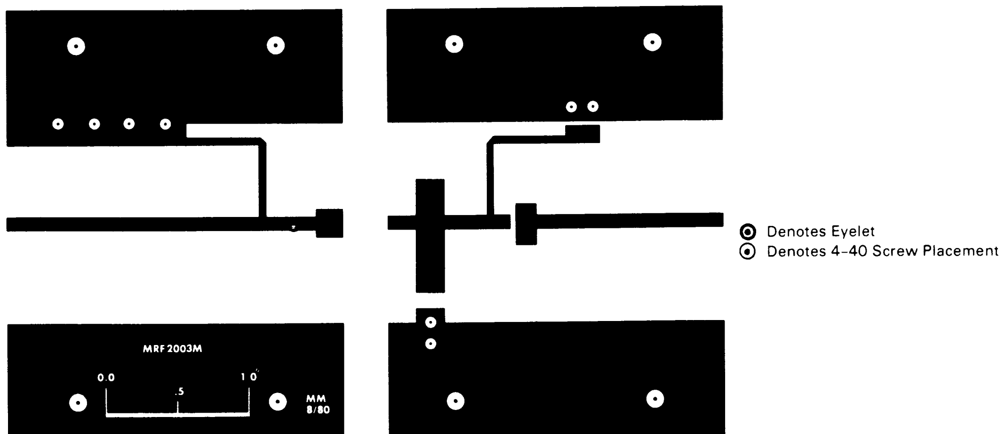
*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 — 2 GHz TEST AMPLIFIER



3

FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2.0 GHz TEST CIRCUIT



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

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF2005
MRF2005B

The RF Line

5.0 W 2 GHz

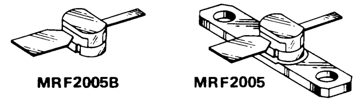
MICROWAVE POWER TRANSISTOR

NPN SILICON

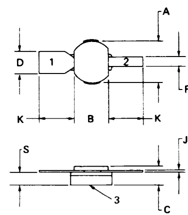
NPN SILICON MICROWAVE POWER TRANSISTOR

. . . designed for Class B and C amplifier or oscillator applications in the 1.0 to 2.3 GHz frequency range.

- Guaranteed Performance @ 2 GHz, 28 Vdc
  Output Power = 5.0 Watts
  Minimum Gain = 8.0 dB
- 100% Tested for Load Mismatch at All Phase Angles With 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Older 2005 Types
- Other Devices in the 2000 Series:
  MRF2001 1 W
  MRF2003 3 W
  MRF2010 10 W



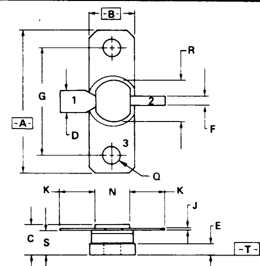
MRF2005B MRF2005



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.72	5.97	0.225	0.235
B	4.44	4.70	0.175	0.185
C	2.29	2.74	0.090	0.108
D	2.92	3.18	0.115	0.125
F	1.14	1.40	0.045	0.055
J	0.08	0.15	0.003	0.006
K	—	9.52	—	0.375
S	1.52	1.78	0.060	0.070

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

CASE 328-02



NOTES:
1. -A- AND -B- ARE DATUMS.
2. -T- IS SEATING PLANE.
3. POSITIONAL TOLERANCE FOR MOUNTING HOLES: "Q"
   ⌖ 0.15 (0.006)Ⓜ T A Ⓜ B Ⓜ
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.19	20.57	0.795	0.810
B	6.22	6.48	0.245	0.255
C	3.68	4.19	0.145	0.165
D	2.92	3.18	0.115	0.125
E	1.40	1.65	0.055	0.065
F	1.14	1.40	0.045	0.055
G	14.22 BSC		0.560 BSC	
J	0.08	0.15	0.003	0.006
K	–	9.52	–	0.375
N	4.44	4.70	0.175	0.185
Q	3.25	3.35	0.128	0.132
R	5.72	5.97	0.225	0.235
S	2.92	3.43	0.115	0.135

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

CASE 328A-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_C = 25^{\circ}C$ (1) Derate above $25^{\circ}C$	P_D	25 140	Watts $mW/^{\circ}C$
Storage Temperature Range	T_{stg}	−65 to +200	$^{\circ}C$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	7.0	$^{\circ}C/W$

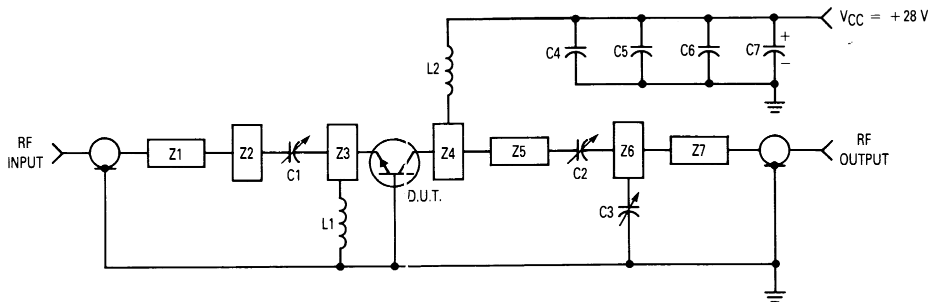
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

(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)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, R_{BE} = 10 Ω)	$V_{(BR)CER}$	45	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mAdc, I_E = 0)	$V_{(BR)CBO}$	45	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current (V_{CB} = 28 Vdc, I_E = 0)	I_{CBO}	–	–	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	100	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	7.5	10	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 5.0 W, f = 2.0 GHz)	G_{PB}	8.0	9.0	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 5.0 W, f = 2.0 GHz)	η	30	35		
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 5.0 W, f = 2.0 GHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 2 GHz TEST CIRCUIT



Z1–Z7 — Microstrip
C1, C2, C3 — 0.6–4.5 pF Johanson
C4, C5 — 220 pF Chip Capacitor
C6 — 0.1 μF
C7 — 10 μF, 35 V Electrolytic
L1 — 3 Turns #22 ⅛″ I.D.
L2 — 2 Turns #24 7/32″ I.D.
Board Material — 0.062″ Glass Teflon

FIGURE 2 — OUTPUT POWER versus INPUT POWER (f = 1 GHz)

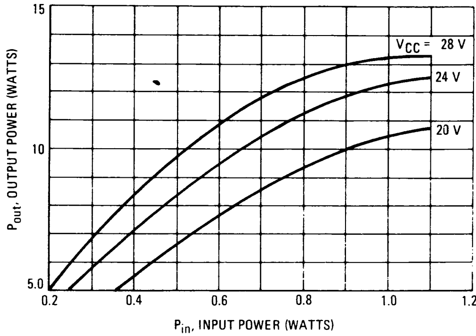


FIGURE 3 — OUTPUT POWER versus INPUT POWER (f = 2 GHz)

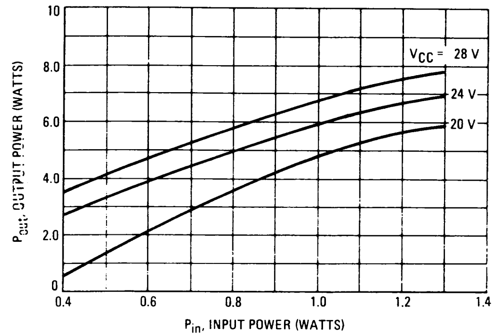


FIGURE 4 — OUTPUT POWER versus FREQUENCY

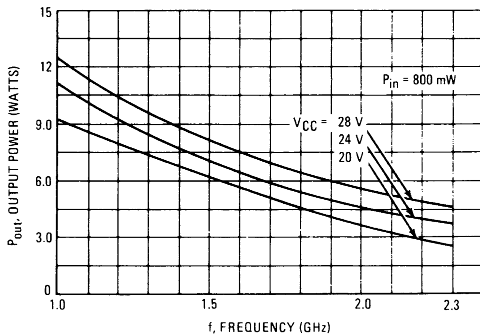


FIGURE 5 — POWER GAIN versus FREQUENCY

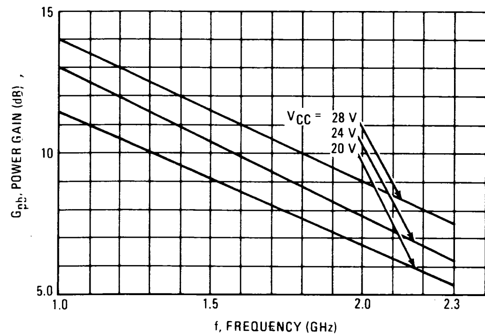
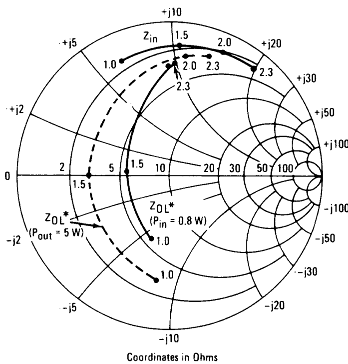


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



V_{CC} = 28 V

f GHz	Z_{in} Ohms	Z_{OL}* P_{in} = 0.8 W Ohms	Z_{OL}* P_{out} = 5 W Ohms
1.0	1.5 + j5.7	6.3 – j5.6	3.2 – j8.8
1.5	1.5 + j10.5	5.6 + j0.4	3.0 + j0
2.0	2.0 + j17	2.5 + j9.0	2.3 + j10.6
2.3	2.2 + j19.5	2.4 + j9.8	2.4 + j14.5

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

FIGURE 7 — 2 GHz TEST AMPLIFIER

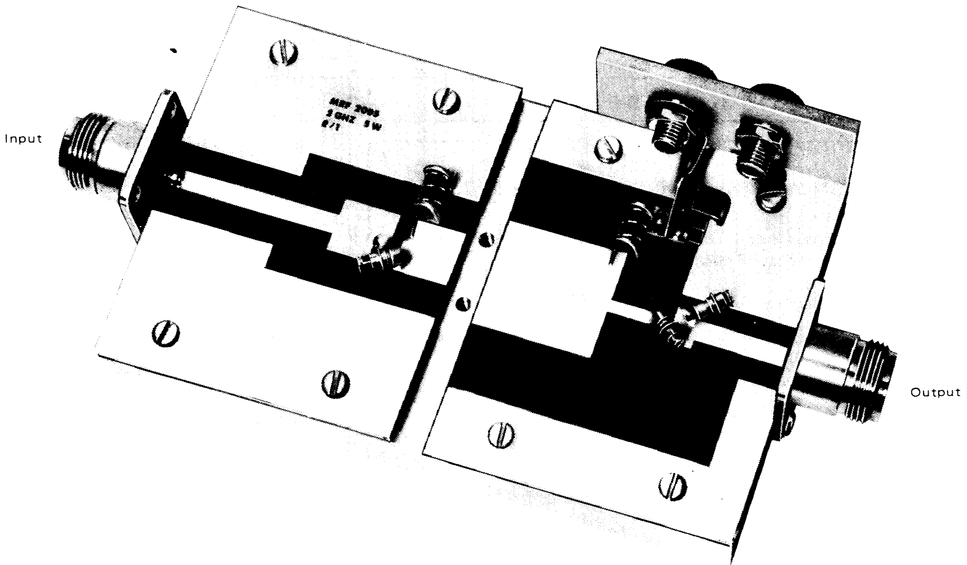


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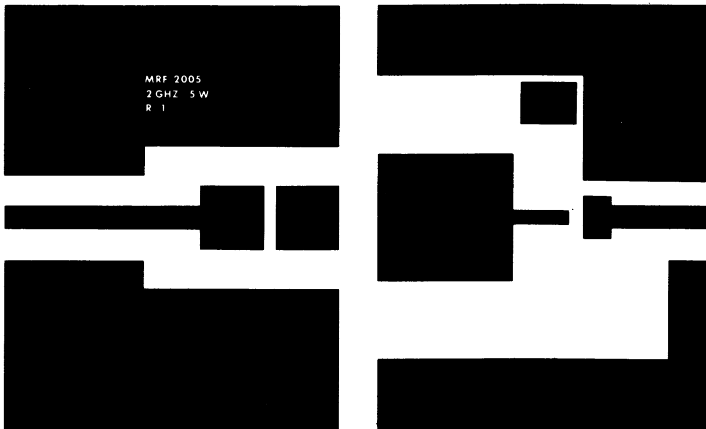
FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2 GHz TEST CIRCUIT



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

MRF2005M

The RF Line

NPN SILICON MICROWAVE POWER TRANSISTOR

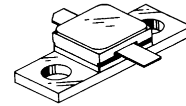
. . . designed for Class B and C *common base* broadband amplifier applications in the 1.7 to 2.3 GHz frequency range.

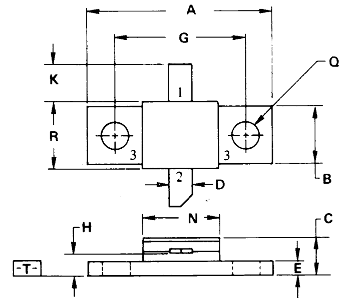
- Internal Input Matching for Broadband Operation
- Guaranteed Performance @ 2 GHz, 24 Vdc
  Output power = 5.0 Watts
  Minimum Gain = 7.5 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivation
- Characterized for Operation from 20 V to 28 V Supply Voltages

5.0 W 2 GHz

MICROWAVE POWER TRANSISTOR

NPN SILICON





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

NOTES:
1. DIMENSIONS -A- AND -B- ARE DATUMS.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES: ⌀ Ø.13(0.005) Ⓜ T A Ⓜ B Ⓜ
3. -T- IS SEATING PLANE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	20.07	20.57	0.790	0.810
B	6.22	6.48	0.245	0.255
C	3.68	4.06	0.145	0.160
D	2.29	2.79	0.090	0.110
E	1.42	1.73	0.056	0.068
G	14.27 BSC		0.560 BSC	
H	2.29	2.79	0.090	0.110
K	3.43	4.19	0.135	0.165
N	7.87	8.38	0.310	0.330
Q	3.05	3.30	0.120	0.130
R	7.24	7.49	0.285	0.295

CASE 337-02

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	22 130	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	8.0	°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.

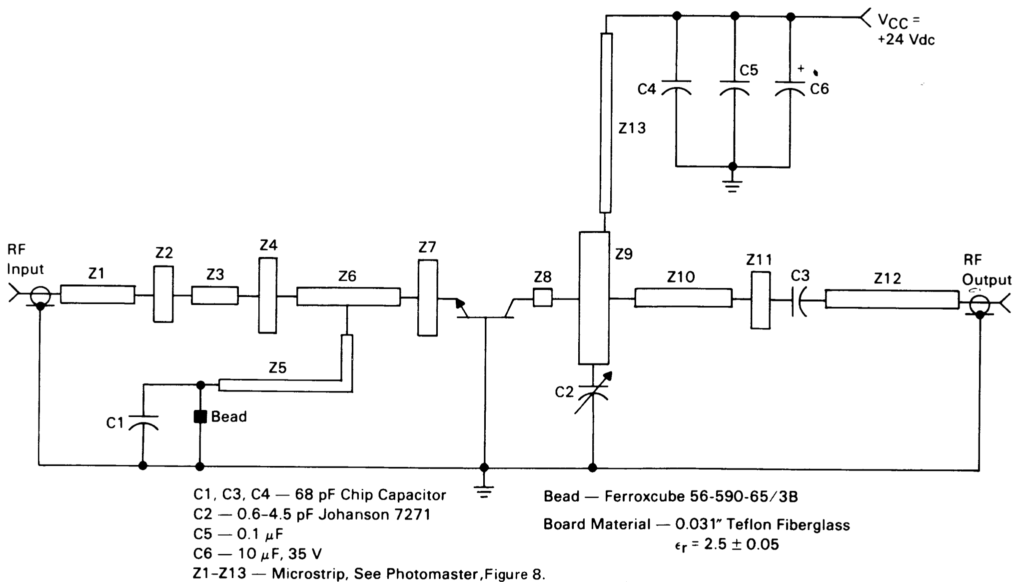
3

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)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mAdc, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 Vdc, I_E = 0)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 300 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	7.5	10	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 24 Vdc, P_{out} = 5.0 W, f = 2.0 GHz)	G_{PB}	7.5	8.0	—	dB
Collector Efficiency (V_{CC} = 24 Vdc, P_{out} = 5.0 W, f = 2.0 GHz)	η	35	40		%
Load Mismatch (V_{CC} = 24 Vdc, P_{out} = 5.0 W, f = 2.0 GHz) VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

3

FIGURE 1 — 2.0 GHz TEST CIRCUIT



C1, C3, C4 — 68 pF Chip Capacitor
C2 — 0.6-4.5 pF Johanson 7271
C5 — 0.1 μF
C6 — 10 μF, 35 V
Z1-Z13 — Microstrip, See Photomaster, Figure 8.

Bead — Ferroxcube 56-590-65/3B
Board Material — 0.031″ Teflon Fiberglass
ϵ_r = 2.5 ± 0.05

FIGURE 2 — OUTPUT POWER versus INPUT POWER (f = 1.7 GHz)

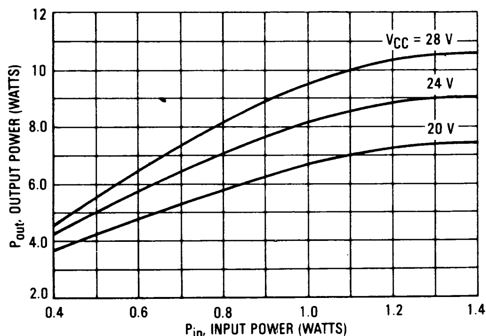


FIGURE 3 — OUTPUT POWER versus INPUT POWER (f = 2.0 GHz)

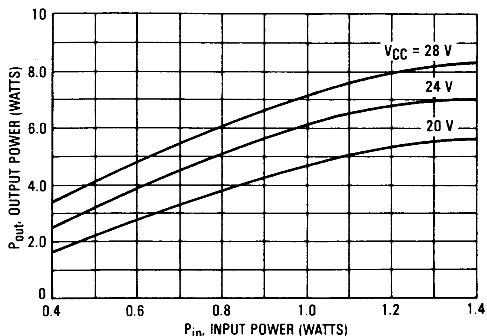


FIGURE 4 — OUTPUT POWER versus INPUT POWER (f = 2.3 GHz)

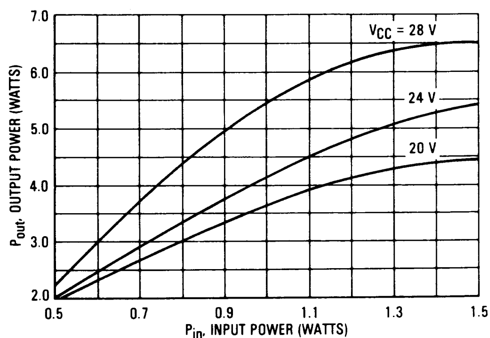
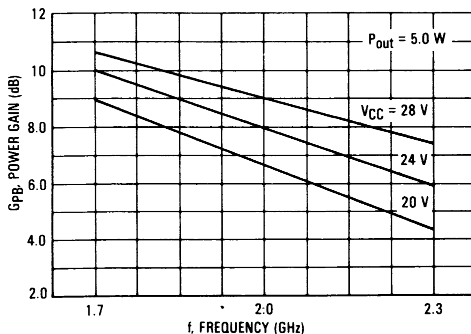
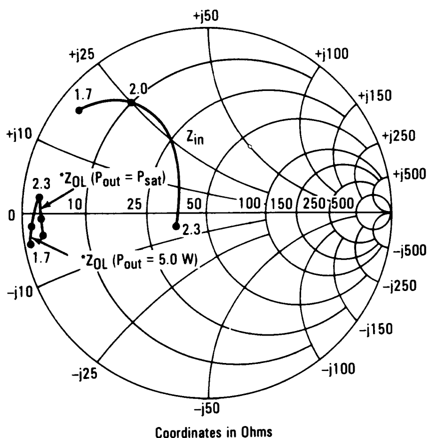


FIGURE 5 — POWER GAIN versus FREQUENCY



3

FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



V_{CC} = 24 V

f GHz	Z_{in} Ohms	Z_{OL}*, Ohms P_{out} = P_{sat}	Z_{OL}*, Ohms P_{out} = 5.0 W
1.7	4.0 + j17	2.9 – j3.5	1.5 – j4.4
2.0	10 + j25	3.1 – j0.85	1.75 – j1.3
2.3	37 – j5.0	2.9 + j2.2	2.90 + j2.2

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

FIGURE 7 — 2 GHz TEST AMPLIFIER

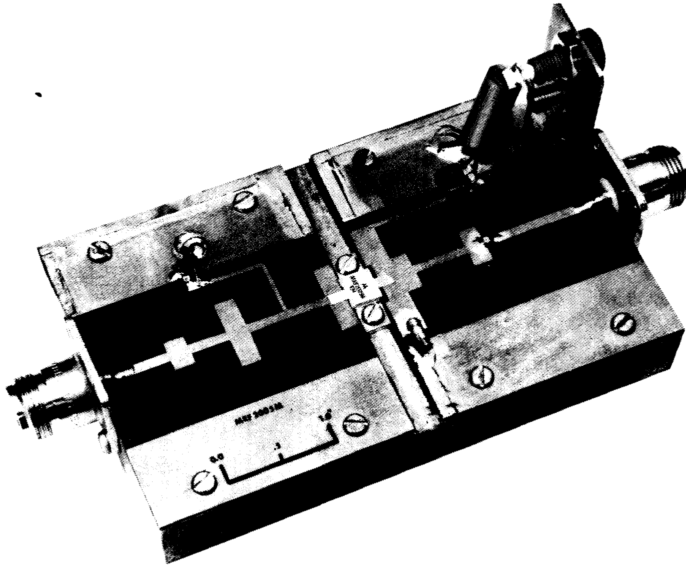
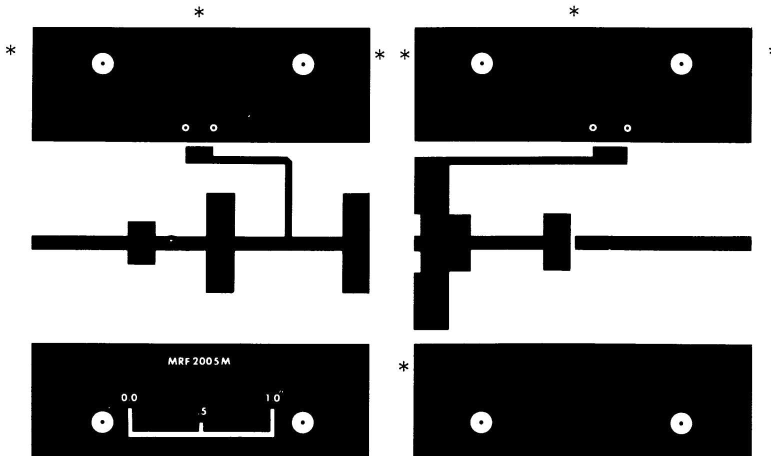


FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2.0 GHz TEST CIRCUIT



⊙ Denotes Eyelet
⊙ 4-40 Screw Placement
* Foil Wrap to Bottom Ground Plane

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

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

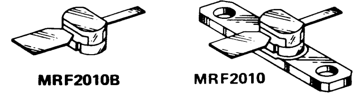
MRF2010
MRF2010B

The RF Line

10 W 2 GHz

MICROWAVE POWER TRANSISTOR

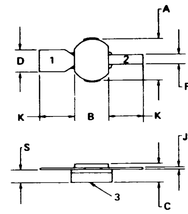
NPN SILICON



NPN SILICON MICROWAVE POWER TRANSISTOR

. . . designed for Class B and C amplifier or oscillator applications in the 1.0 to 2.3 GHz frequency range.

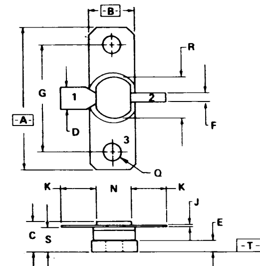
- Guaranteed Performance @ 2 GHz, 28 Vdc
  Output Power = 10 Watts
  Minimum Gain = 6.0 dB
- 100% Tested for Load Mismatch at All Phase Angles With 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Older 2010 Types
- Other Devices in the 2000 Series:
  MRF2001 1 W
  MRF2003 3 W
  MRF2005 5 W



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.72	5.97	0.225	0.235
B	4.44	4.70	0.175	0.185
C	2.29	2.54	0.090	0.100
D	2.92	3.18	0.115	0.125
F	1.14	1.40	0.045	0.055
J	0.08	0.15	0.003	0.006
K	–	9.52	–	0.375
S	1.52	1.78	0.060	0.070

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

CASE 328-02



NOTES:
1. -A- AND -B- ARE DATUMS.
2. -T- IS SEATING PLANE.
3. POSITIONAL TOLERANCE FOR MOUNTING HOLES: "Q"
   ⌖ 0.15 (0.006) Ⓜ | T | A Ⓜ | B Ⓜ
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.19	20.57	0.795	0.810
B	6.22	6.48	0.245	0.255
C	3.68	4.19	0.145	0.165
D	2.92	3.18	0.115	0.125
E	1.40	1.65	0.055	0.065
F	1.14	1.40	0.045	0.055
G	14.22 BSC		0.560 BSC	
J	0.08	0.15	0.003	0.006
K	–	9.52	–	0.375
N	4.44	4.70	0.175	0.185
Q	3.25	3.35	0.128	0.132
R	5.72	5.97	0.225	0.235
S	2.92	3.43	0.115	0.135

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

CASE 328A-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current – Continuous	I_C	2.0	Adc
Total Device Dissipation @ $T_C = 25^oC$ (1) Derate above 25^oC	P_D	35 200	Watts $mW/^oC$
Storage Temperature Range	T_{stg}	-65 to +200	^oC

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	5.0	$^oC/W$

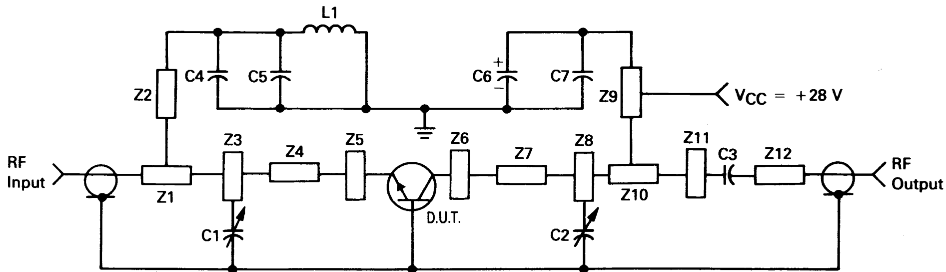
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

(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 = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, R_{BE} = 10 Ω)	$V_{(BR)CER}$	45	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	45	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current (V_{CB} = 28 Vdc, I_E = 0)	I_{CBO}	–	–	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	100	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	12	15	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 10 W f = 2.0 GHz)	G_{PB}	6.0	7.0	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 10 W, f = 2.0 GHz)	η	30	35		
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 10 W, f = 2.0 GHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 2 GHz TEST CIRCUIT



Z1–Z12 — Microstrip
C1, C2 — 0.4–2.5 pF Johanson
C3, C4, C5, C7 — 39 pF Chip Capacitor
C6 — 20 μF, 50 V Electrolytic
L1 — #18 AWG Hairpin
1/8″ 1/8″
Board Material — 0.032″ Glass Teflon

3

FIGURE 2 — OUTPUT POWER versus INPUT POWER
(f = 1.0 GHz)

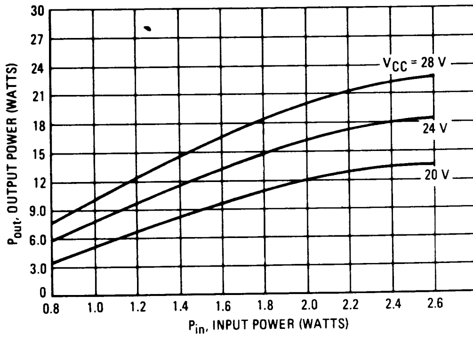


FIGURE 3 — OUTPUT POWER versus INPUT POWER
(f = 2.0 GHz)

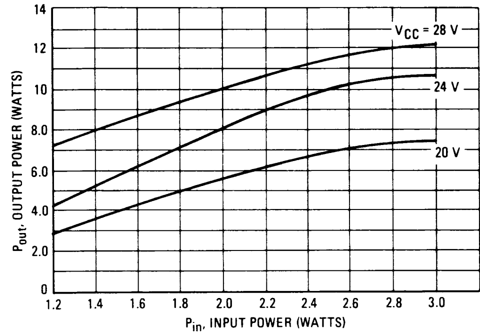


FIGURE 4 — OUTPUT POWER versus FREQUENCY

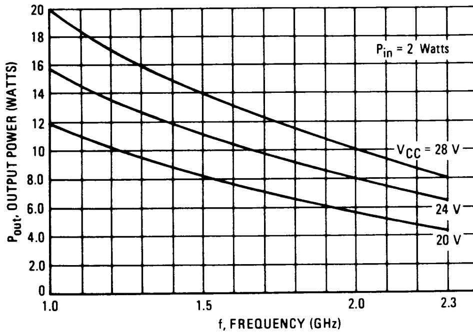


FIGURE 5 — POWER GAIN versus FREQUENCY

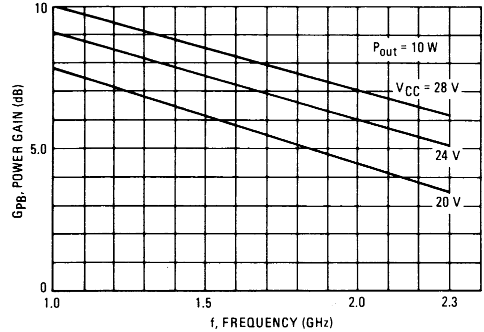


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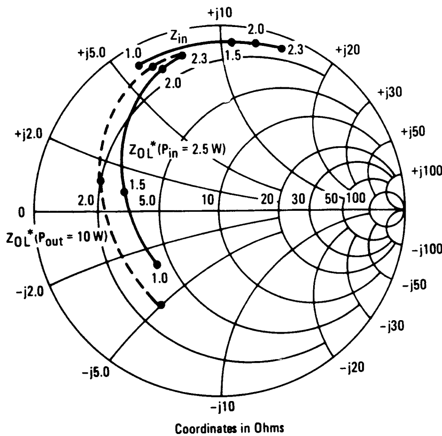
FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



Coordinates in Ohms

V_{CC} = 28 V

f GHz	Z_{in} Ohms	Z_{OL}* P_{in} = 2.5 W Ohms	Z_{OL}* P_{out} = 10 W Ohms
1.0	1.0 + j6.0	4.5 − j3.0	3.2 − j5.0
1.5	1.0 + j11	3.5 + j1.0	2.0 + j1.3
2.0	1.5 + j13	1.5 + j7.0	1.4 + j6.5
2.3	1.5 + j16	1.3 + j8.0	1.3 + j8.0

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

FIGURE 7 — 2 GHz TEST AMPLIFIER

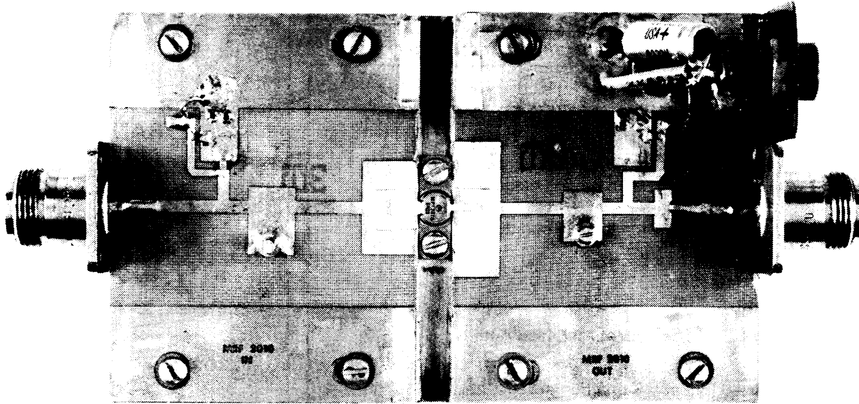
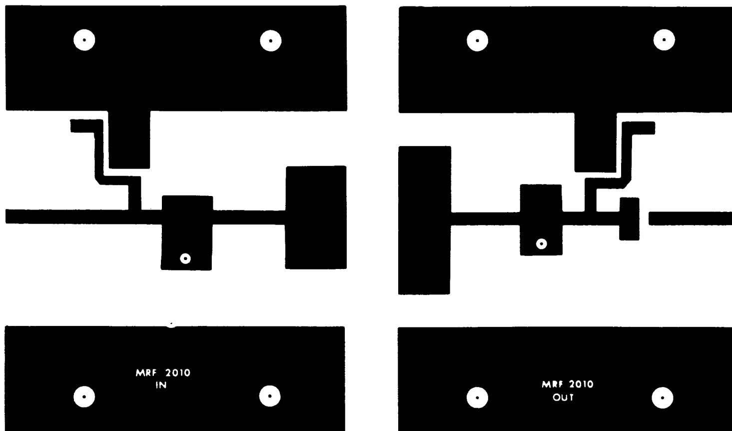


FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2 GHz TEST CIRCUIT



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

MRF2010M

The RF Line

NPN SILICON MICROWAVE POWER TRANSISTOR

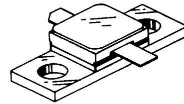
. . . designed for Class B and C *common base* broadband amplifier applications in the 1.7 to 2.3 GHz frequency range.

- Internal Input Matching for Broadband Operation
- Guaranteed Performance @ 2 GHz, 24 Vdc
  Output Power = 10 Watts
  Minimum Gain = 7.0 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivation
- Characterized for Operation from 20 V to 28 V Supply Voltages

10 W 2 GHz

MICROWAVE POWER TRANSISTOR

NPN SILICON



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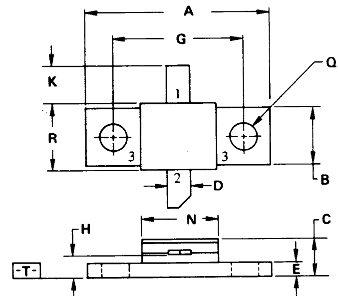


NOTES:
1. DIMENSIONS -A- AND -B- ARE DATUMS.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES: ⌖ ⌀.13(0.005)Ⓜ T AⓂ BⓂ
3. -T- IS SEATING PLANE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

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

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.57	0.790	0.810
B	6.22	6.48	0.245	0.255
C	3.68	4.06	0.145	0.160
D	2.29	2.79	0.090	0.110
E	1.42	1.73	0.056	0.068
G	14.27 BSC		0.560 BSC	
H	2.29	2.79	0.090	0.110
K	3.43	4.19	0.135	0.165
N	7.87	8.38	0.310	0.330
Q	3.05	3.30	0.120	0.130
R	7.24	7.49	0.285	0.295

CASE 337-02

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	35 200	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	5.0	°C/W

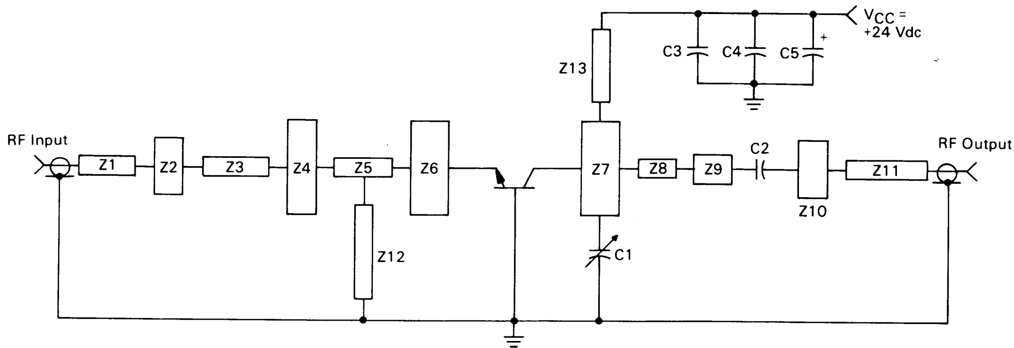
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 Vdc, I_E = 0)	I_{CBO}	—	—	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	14	18	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 24 Vdc, P_{out} = 10 W, f = 2.0 GHz)	G_{PB}	7.0	8.0	—	dB
Collector Efficiency (V_{CC} = 24 Vdc, P_{out} = 10 W, f = 2.0 GHz)	η	35	40		
Load Mismatch (V_{CC} = 24 Vdc, P_{out} = 10 W, f = 2.0 GHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

3

FIGURE 1 — 2 GHz TEST CIRCUIT



Z1-Z13 — Microstrip, See Photomaster, Figure 8.
C2, C3 — 68 pF Chip Capacitor
C4 — 0.1 μF
C5 — 10 μF, 35 V
C1 — 0.6-4.5 pF Johanson 7271
Board Material — 0.0312″ Teflon Fiberglass
ϵ_r = 2.5 ± 0.05

FIGURE 2 — OUTPUT POWER versus INPUT POWER
(f = 1.7 GHz)

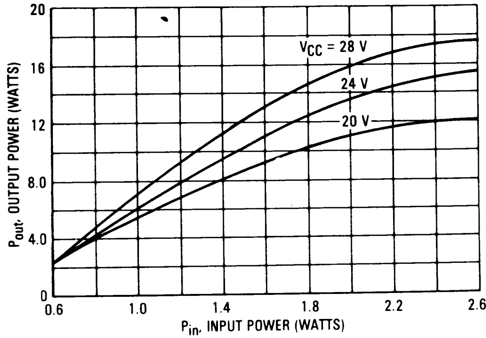


FIGURE 3 — OUTPUT POWER versus INPUT POWER
(f = 2.0 GHz)

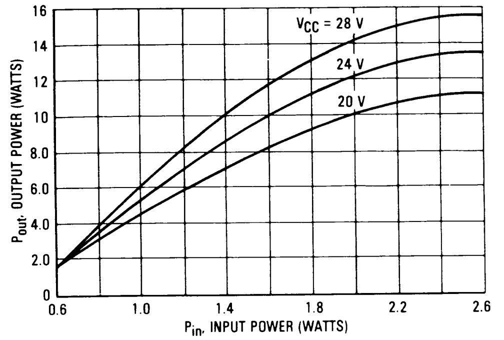


FIGURE 4 — OUTPUT POWER versus INPUT POWER
(f = 2.3 GHz)

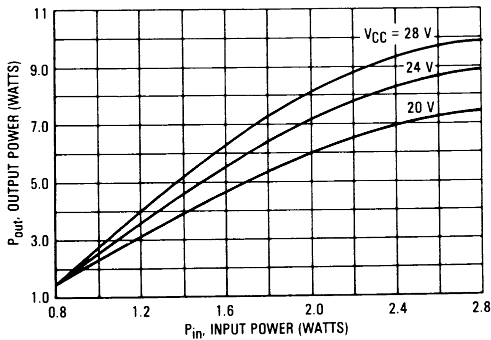


FIGURE 5 — POWER GAIN versus FREQUENCY

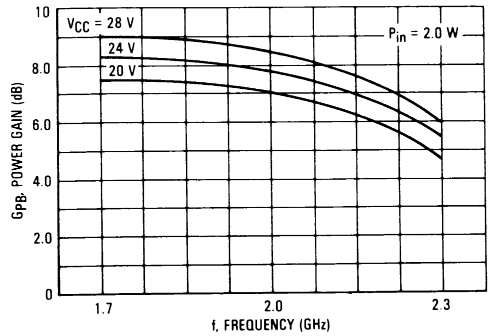
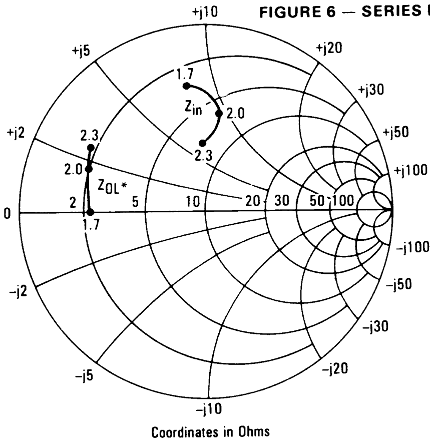


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



V_{CC} = 24 V, P_{in} = 2.0 W

f GHz	Z_{in} Ohms	Z_{OL}* Ohms
1.7	3.5 + j8.0	2.3 + j0
2.0	7.0 + j9.5	2.0 + j1.6
2.3	8.0 + j6.5	1.8 + j2.2

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

FIGURE 7 — 2 GHz TEST AMPLIFIER

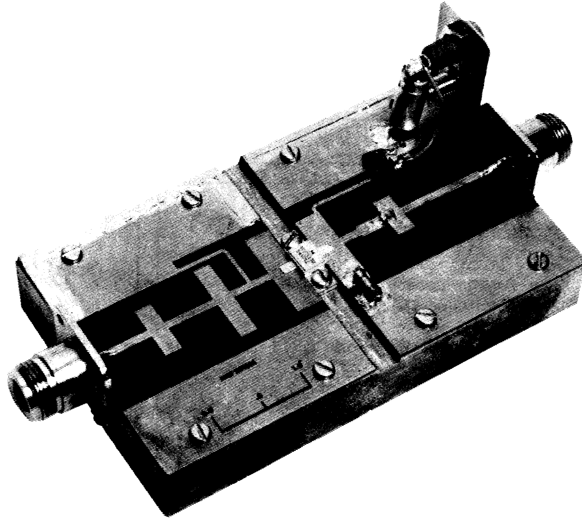
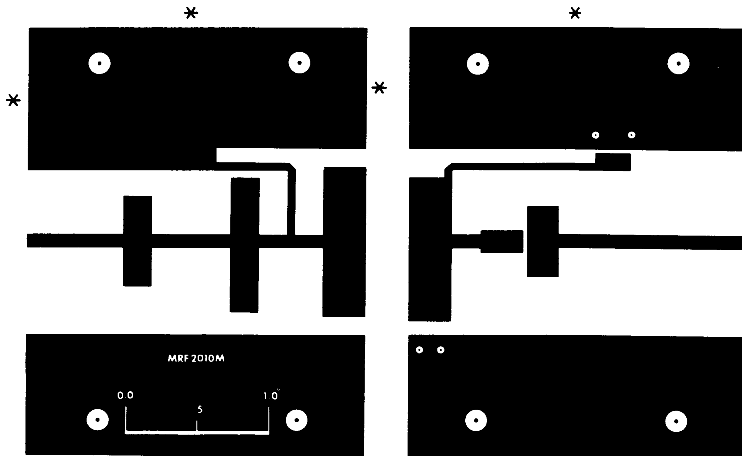


FIGURE 8 — 2 GHz TEST CIRCUIT PHOTOMASTER



⊙ Denotes Eyelet
⨀ Denotes 4-40 Screw Placement
✱ Foil Wrap to Bottom Ground Plane

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

MRF2016M

The RF Line

16 W 2 GHz

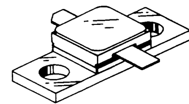
MICROWAVE POWER TRANSISTOR

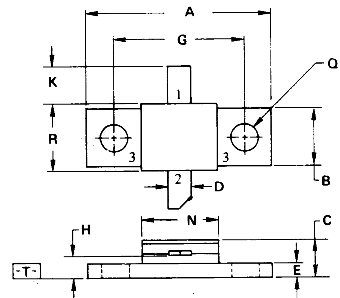
NPN SILICON

NPN SILICON MICROWAVE POWER TRANSISTOR

. . . designed for Class B and C *common base* broadband amplifier applications in the 1.7 to 2.3 GHz frequency range.

- Internal Input Matching for Broadband Operation
- Guaranteed Performance @ 2 GHz, 24 Vdc
  Output power = 16 Watts
  Minimum Gain = 6.5 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivation
- Characterized for Operation from 20 V to 28 V Supply Voltages





NOTES:
1. DIMENSIONS -A- AND -B- ARE DATUMS.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES: ⊕ Ø.13(0.005)Ⓜ T AⓂ BⓂ
3. -T- IS SEATING PLANE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

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

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.57	0.790	0.810
B	6.22	6.48	0.245	0.255
C	3.68	4.06	0.145	0.160
D	2.29	2.79	0.090	0.110
E	1.42	1.73	0.056	0.068
G	14.27 BSC		0.560 BSC	
H	2.29	2.79	0.090	0.110
K	3.43	4.19	0.135	0.165
N	7.87	8.38	0.310	0.330
Q	3.05	3.30	0.120	0.130
R	7.24	7.49	0.285	0.295

CASE 337-02

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	3.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	50 286	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

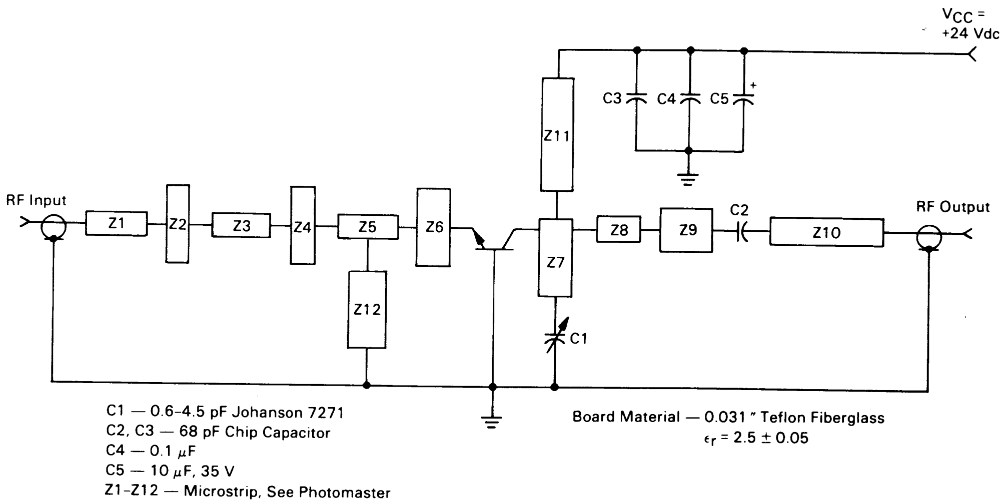
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	3.5	°C/W

(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 = 30 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 30 mAdc, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 Vdc, I_E = 0)	I_{CBO}	—	—	3.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	20	25	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 24 Vdc, P_{out} = 16 W, f = 2.0 GHz)	G_{PB}	6.5	7.0	—	dB
Collector Efficiency (V_{CC} = 24 Vdc, P_{out} = 16 W, f = 2.0 GHz)	η	35	40		%
Load Mismatch (V_{CC} = 24 Vdc, P_{out} = 16 W, f = 2.0 GHz) VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 2 GHz TEST CIRCUIT



3

FIGURE 2 — OUTPUT POWER versus INPUT POWER (f = 1.7 GHz)

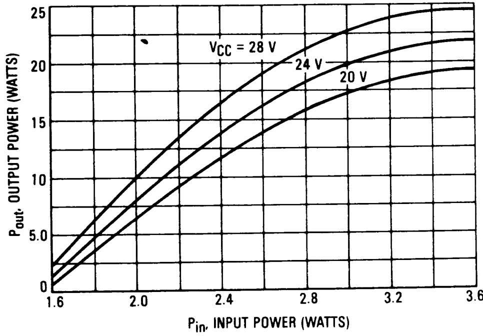


FIGURE 3 — OUTPUT POWER versus INPUT POWER (f = 2.0 GHz)

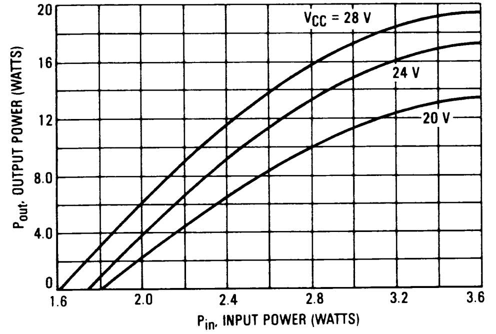


FIGURE 4 — OUTPUT POWER versus INPUT POWER (f = 2.3 GHz)

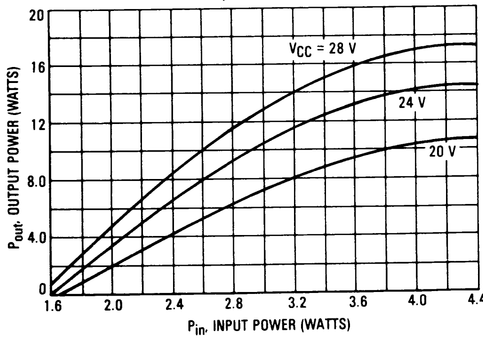
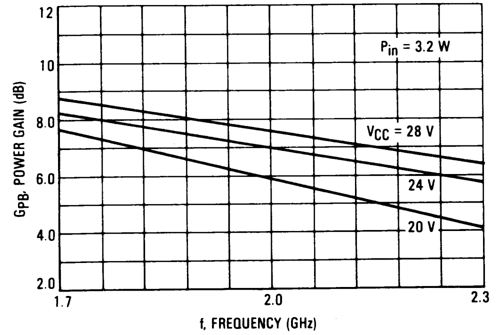


FIGURE 5 — POWER GAIN versus FREQUENCY



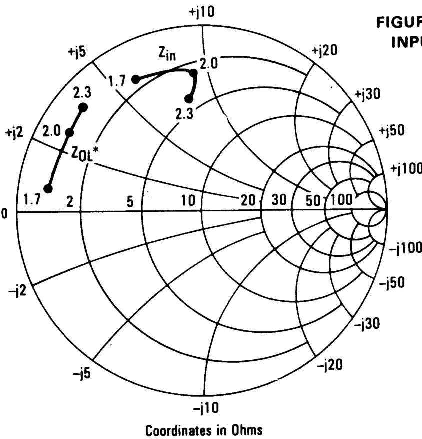


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

V_{CC} = 24 V, P_{in} = 3.2 W

f GHz	Z_{in} Ohms	Z_{OL}* Ohms
1.7	1.8 + j6.1	1.2 + j1.0
2.0	2.4 + j9.2	1.0 + j2.6
2.3	4.4 + j8.3	1.0 + j3.5

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

FIGURE 7 — 2 GHz TEST AMPLIFIER

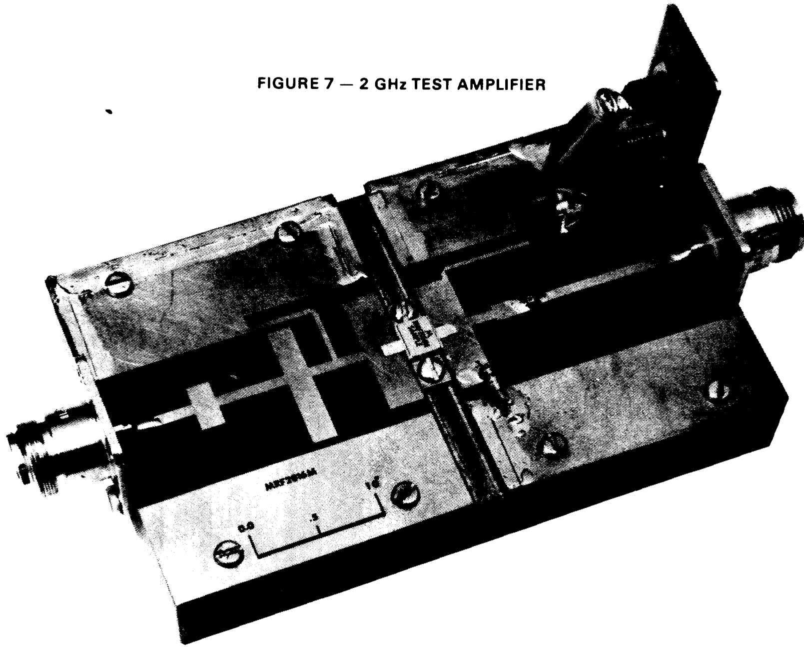
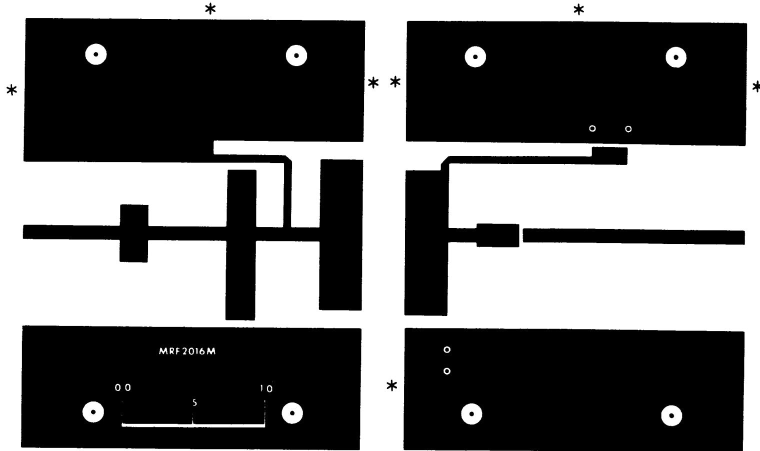


FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2 GHz TEST CIRCUIT



⊙ Denotes Eyelet
⊙ 4-40 Screw Placement
* Foil Wrap to Bottom Ground Plane

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

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