MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

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31. AUG. 1989

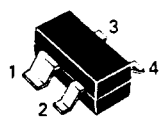
MRF0211
MRF0211L

SURFACE MOUNT
HIGH FREQUENCY
TRANSISTOR
NPN SILICON

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed primarily for use in the high-gain, low-noise small-signal amplifiers for operation up to 3.5 GHz. Also usable in applications requiring fast switching times.

- High Current-Gain-Bandwidth Product — f_T = 5.5 GHz (Typ) @ I_C = 40 mAdc
- Low Noise Figure @ f = 1 GHz — $NF_{(matched)}$ = 1.8 dB (Typ)
- High Power Gain — $G_{pe\ (matched)}$ = 13 dB (Typ)
- Surface Mount SOT-143 Offers Improved RF Performance
  - Lower Package Parasitics
  - Higher Gain
- Available In Both Standard and Low Profile Packages
- Tape and Reel Packaging Options
- Higher Voltage Version of MRF5711
- Electrically Similar to NEC NE 02133



SOT-143
CASE 318B-03
STANDARD PROFILE
(MRF0211)

CASE 318A-04
LOW PROFILE
(MRF0211L)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector-Current — Continuous	I_C	70	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.58 4.64	Watts mW/°C
Total Device Dissipation @ T_C = 75°C (Note 1) Derate above 75°C	P_D	0.58 7.73	Watts mW/°C
Maximum Junction Temperature	T_{Jmax}	150	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	216	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	130	°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 = 1 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 50 μAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	10	μAdc

Note 1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package.

(continued)

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

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain (I_C = 30 mAdc, V_{CE} = 5 Vdc)		h_{FE}	50	—	300	—
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	Figure 1	C_{cb}	—	0.7	1	pF
Current Gain — Bandwidth Product (V_{CE} = 10 Vdc, I_C = 40 mA, f = 1 GHz)	Figure 7	f_T	—	5.5	—	GHz
FUNCTIONAL TESTS						
Gain at Noise Figure (Tuned) (V_{CE} = 10 Vdc, I_C = 5 mAdc)	Figure 4 f = 0.5 GHz f = 1 GHz	G_{NFmin}	 — —	 19 13	 — —	dB
Noise Figure (Tuned) (V_{CE} = 10 Vdc, I_C = 5 mAdc)	Figure 4 f = 0.5 GHz f = 1 GHz f = 2 GHz	NF_{min}	 — — —	 0.9 1.8 3	 — — —	dB
Power Gain in 50 Ω System (V_{CE} = 10 Vdc, I_C = 5 mA, f = 1 GHz)	Figure 2	G_{NF}	—	9.5	—	dB
Noise Figure in 50 Ω System (V_{CE} = 10 Vdc, I_C = 5 mA, f = 1 GHz)	Figure 2	NF	—	2.7	3	dB
Insertion Gain (V_{CE} = 10 Vdc, I_C = 25 mA, f = 1 GHz)		S_{21}^2	11	13.5	—	dB
Maximum Unilateral Gain (V_{CE} = 10 Vdc, I_C = 25 mA, f = 1 GHz)		G_{Umax}	—	15.5	—	dB

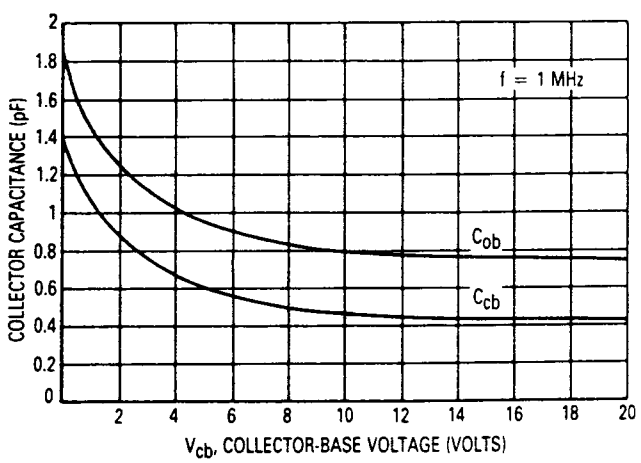


Figure 1. Device Capacitances versus Voltage

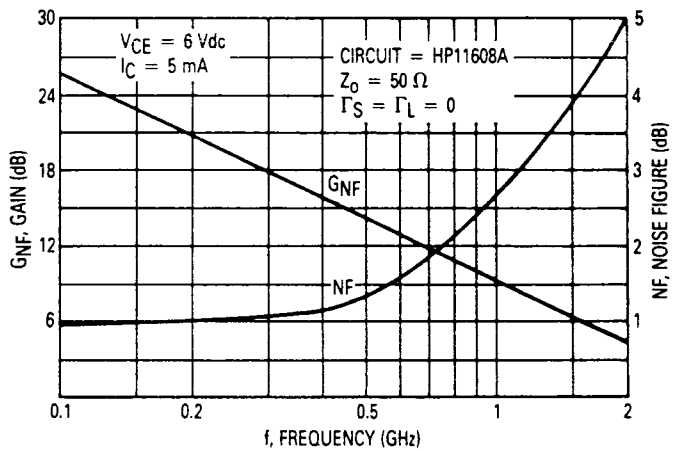


Figure 2. Gain and Noise Figure versus Frequency

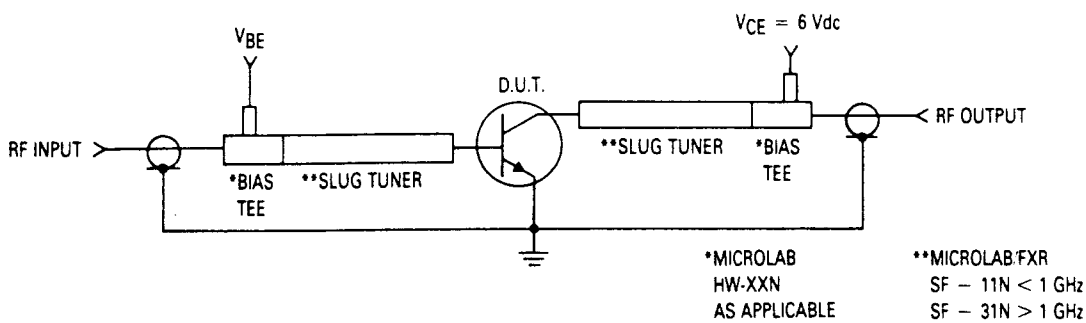


Figure 3. Functional Circuit Schematic

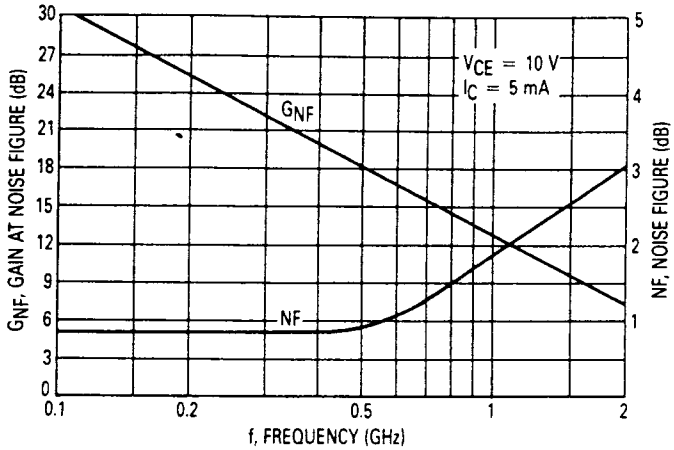


Figure 4. Gain at Noise Figure and Noise Figure versus Frequency

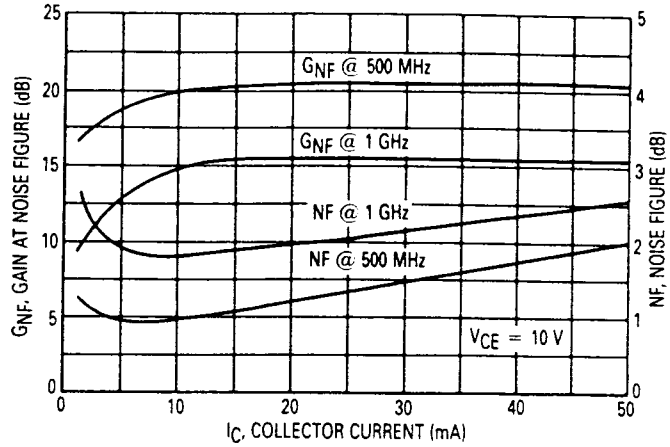


Figure 5. Gain at Noise Figure and Noise Figure versus Collector Current

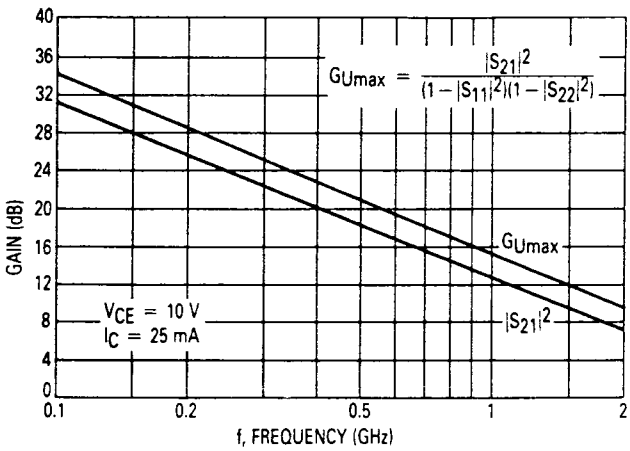


Figure 6. Unilateral-Gain and Insertion Gain versus Frequency

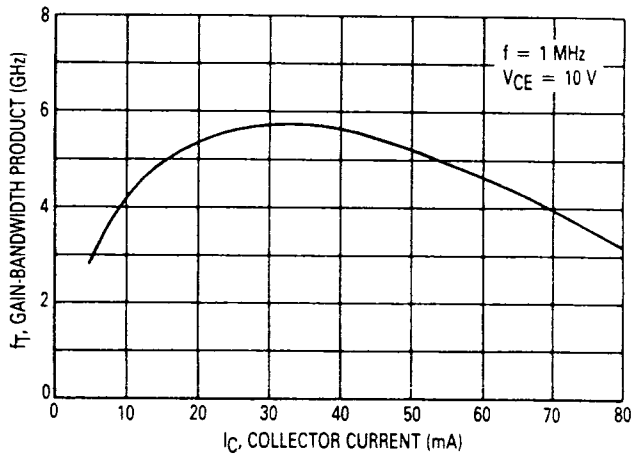
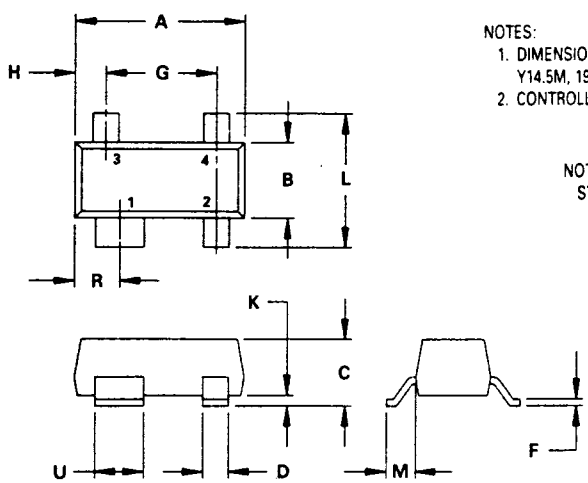


Figure 7. Gain-Bandwidth Product versus Collector Current

OUTLINE DIMENSIONS



NOTES:
1. DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIM: INCH

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

	DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
	A	2.80	3.04	0.110	0.120
	B	1.20	1.39	0.047	0.055
	C	1.05	1.24	0.041	0.049
*	C	0.84	1.14	0.033	0.045
	D	0.38	0.50	0.015	0.020
	F	0.08	0.15	0.003	0.006
	G	1.78	2.03	0.070	0.080
	H	0.445	0.60	0.0175	0.024
	K	0.10	0.25	0.004	0.010
*	K	0.013	0.102	0.0005	0.004
	L	2.11	2.48	0.083	0.098
	M	0.46	0.60	0.018	0.024
	R	0.71	0.83	0.028	0.033
	U	0.79	0.88	0.031	0.035

***Low Profile = CASE 318A-04**

CASE 318B-03
SOT-143

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5	5	100	0.84	−50	13.2	151	0.04	64	0.90	−22
		200	0.81	−87	10.4	130	0.06	49	0.74	−35
		500	0.74	−139	5.6	100	0.07	32	0.50	−48
		1000	0.68	−175	2.9	77	0.09	32	0.42	−58
		1500	0.66	167	2	61	0.09	40	0.44	−67
		2000	0.65	149	1.5	51	0.11	51	0.44	−73
	10	100	0.76	−66	20.6	144	0.03	60	0.83	−32
		200	0.73	−106	14.8	122	0.05	44	0.62	−49
		500	0.69	−153	7.1	96	0.06	37	0.36	−63
		1000	0.65	178	3.7	76	0.08	44	0.28	−71
		1500	0.62	162	2.5	63	0.09	51	0.30	−77
		2000	0.61	145	1.9	54	0.12	59	0.20	−78
	25	100	0.65	−89	28.8	134	0.03	55	0.71	−44
		200	0.67	−126	18.2	114	0.04	45	0.48	−64
		500	0.65	−163	8.3	92	0.05	45	0.27	−80
		1000	0.63	172	4.2	76	0.07	55	0.20	−90
		1500	0.60	158	2.8	64	0.10	60	0.22	−92
		2000	0.59	142	2.2	55	0.13	63	0.20	−90
	50	100	0.62	−110	30.4	126	0.02	51	0.62	−49
		200	0.66	−142	18.0	109	0.03	45	0.41	−65
		500	0.66	−171	7.9	90	0.04	52	0.25	−79
		1000	0.64	168	4.1	75	0.06	62	0.20	−91
		1500	0.62	155	2.7	62	0.10	65	0.20	−93
		2000	0.60	140	2.1	55	0.13	67	0.14	−90
10	5	100	0.86	−46	13.2	153	0.03	69	0.92	−18
		200	0.82	−81	10.6	132	0.05	51	0.80	−28
		500	0.72	−134	5.9	102	0.07	36	0.57	−38
		1000	0.65	−171	3.2	78	0.08	38	0.49	−46
		1500	0.63	169	2.1	62	0.08	47	0.52	−55
		2000	0.61	149	1.6	51	0.10	60	0.53	−61
	10	100	0.77	−60	20.7	145	0.03	62	0.85	−26
		200	0.72	−98	15.2	124	0.04	48	0.66	−38
		500	0.65	−147	7.5	97	0.06	42	0.44	−46
		1000	0.59	−177	3.9	77	0.07	48	0.37	−51
		1500	0.58	165	2.6	64	0.09	56	0.39	−59
		2000	0.56	145	2	54	0.13	65	0.40	−62
	25	100	0.67	−80	29.4	136	0.02	57	0.75	−35
		200	0.66	−118	19.3	116	0.03	47	0.53	−48
		500	0.63	−158	8.9	94	0.05	47	0.33	−55
		1000	0.61	175	4.6	77	0.07	57	0.26	−60
		1500	0.58	161	3.1	64	0.09	61	0.29	−65
		2000	0.57	144	2.3	55	0.12	66	0.30	−65
	50	100	0.65	−99	32.2	129	0.02	54	0.67	−38
		200	0.65	−135	19.5	110	0.03	44	0.45	−48
		500	0.64	−167	8.5	91	0.04	53	0.31	−51
		1000	0.61	170	4.2	75	0.06	62	0.26	−55
		1500	0.59	157	2.9	63	0.09	58	0.30	−61
		2000	0.58	141	2.3	54	0.11	71	0.31	−63

Literature Distribution Centers:

USA: Motorola Literature Distribution; P.O. Box 20912; Phoenix, Arizona 85036.
EUROPE: Motorola Ltd.; European Literature Center; 88 Tanners Drive, Blakelands Milton Keynes, MK145BP, England.
ASIA PACIFIC: Motorola Semiconductors H.K. Ltd.; P.O. Box 80300; Cheung Sha Wan Post Office; Kowloon Hong Kong.

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12/13/04

MOTOROLA Semiconductors

MRF835

The RF Line

15 W – 870 MHz
"CONTROLLED Q"

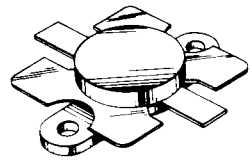
RF POWER
TRANSISTOR

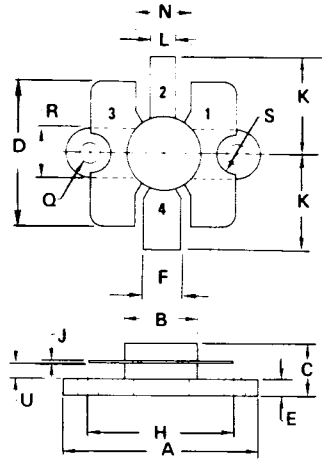
NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 950 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics –
  Output Power = 15 Watts
  Minimum Gain = 7.0 dB
  Efficiency = 50%
- Common-Base Configuration
- Built-In Matching Network for Broadband Operation
- Gold Metallization System





STYLE 2
PIN 1. BASE
2. COLLECTOR
3. BASE
4. EMITTER
FLANGE-ISOLATED

NOTE:
1. DIM "Q" IS DIA
DIM "S" IS RAD

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.51	25.15	0.965	0.990
B	9.47	9.73	0.373	0.383
C	5.97	7.62	0.235	0.300
D	18.29	19.30	0.720	0.760
E	2.16	2.67	0.085	0.105
F	4.32	4.57	0.170	0.180
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	12.19	12.70	0.480	0.500
L	3.05	3.30	0.120	0.130
N	6.86	7.11	0.270	0.280
Q	2.79	3.18	0.110	0.125
R	6.10	6.60	0.240	0.260
S	2.67	3.05	0.105	0.120
U	1.65	1.91	0.065	0.075

CASE 278-02

MAXIMUM RATINGS

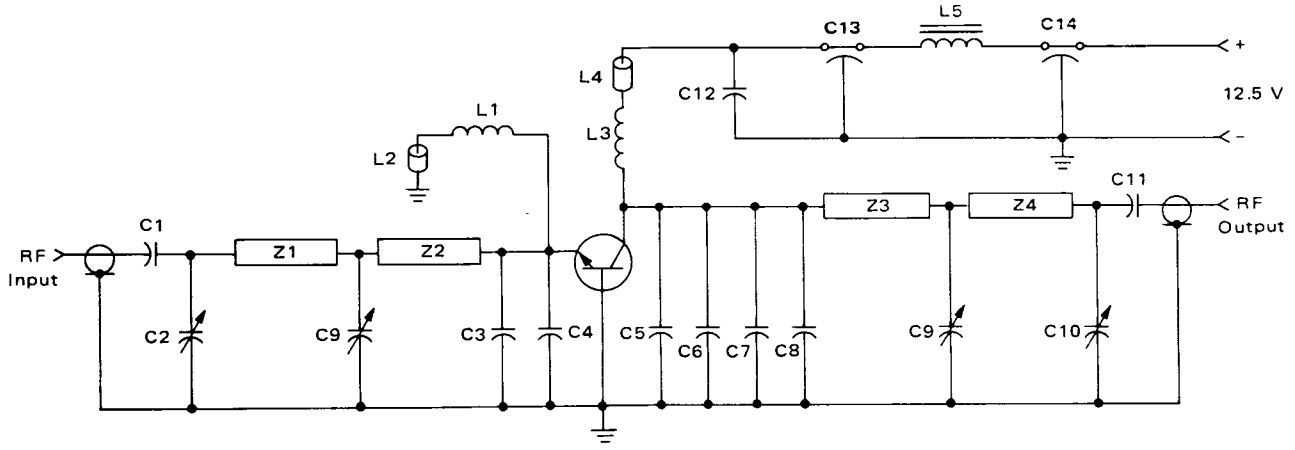
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current	I_C	4.0	Adc
Total Device Dissipation @ $T_C = 25^oC$ Derate above 25^oC	P_D	50 0.276	Watts $W/^oC$
Storage Temperature Range	T_{stg}	-65 to +200°C	°C

10.11.76

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)	BV_{CEO}	16	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	BV_{CES}	32	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mAdc, I_E = 0)	BV_{CBO}	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	BV_{EBO}	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	33	45	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 870 MHz)	G_{PB}	7.0	–	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 870 MHz)	η	50	–	–	%

FIGURE 1 – 870 MHz TEST CIRCUIT SCHEMATIC



C1,C11	39 pF, ATC 100 Mil Chip
C2,C10	1.0-10 pF JOHANSON
C3	8.0 pF, ATC 50 Mil Chip
C4,C5,C6	12 pF, ATC 50 Mil Chip
C7,C8	5.0 pF, ATC 50 Mil Chip
C9	0.8-8.0 pF, JOHANSON Gigatrim
C12	1.0 μF, 35 V, Tantalum
C13,C14	680 pF, ALLEN BRADLEY Feedthru
L1	4 Turns, #22 AWG, 0.25" I.D.
L2,L4	Ferrite Bead, FERROXCUBE 56-590-56-3B
L3	4 Turns, #20 AWG, 0.187" I.D.
L5	Ferrite Choke, FERROXCUBE VK200-20-4B
Z1	Microstrip Line, 1.53" x 0.180"
Z2,Z3	Microstrip Line, 0.39" x 0.180"
Z4	Microstrip Line, 1.15" x 0.180"

Board Glass Teflon, ϵ_R = 2.56, t = 0.062"
Input/Output Connectors – Type N

FIGURE 2 – OUTPUT POWER versus INPUT POWER

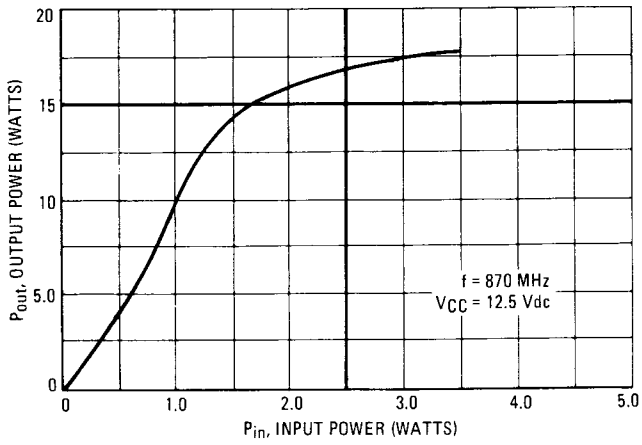


FIGURE 3 – OUTPUT POWER versus FREQUENCY

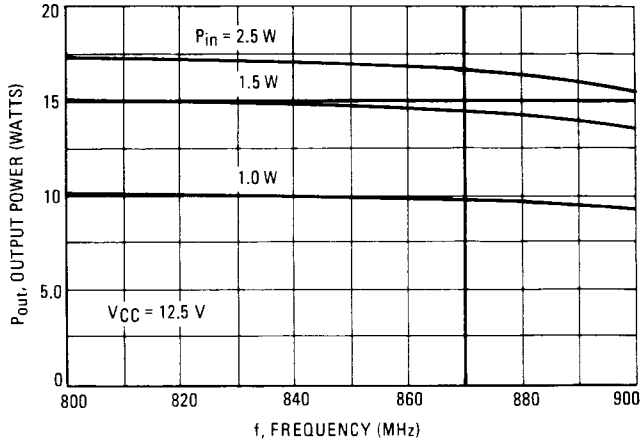


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

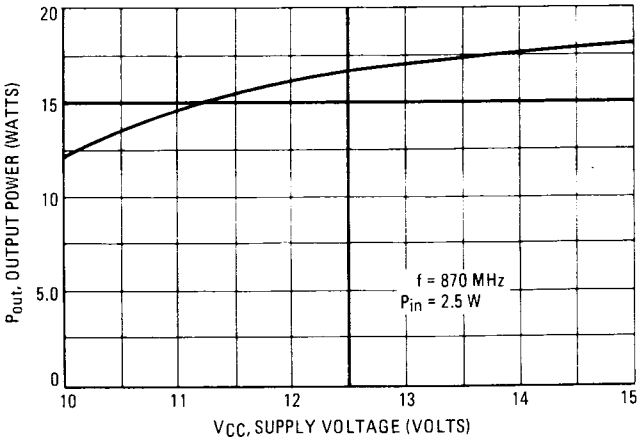
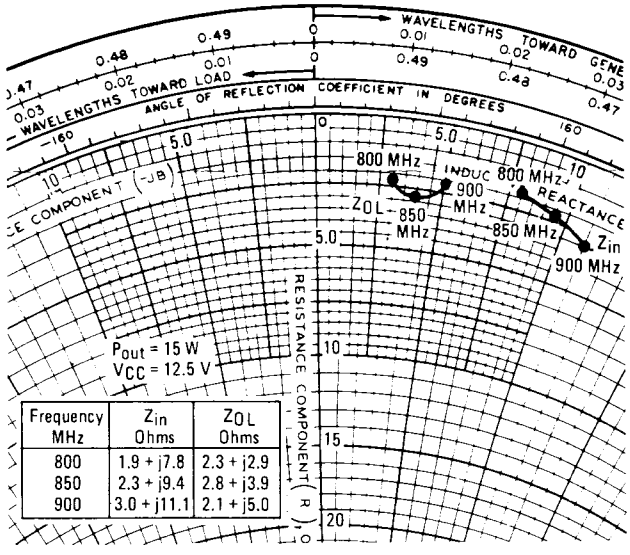


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



Frequency MHz	Z_{in} Ohms	Z_{OL} Ohms
800	1.9 + j7.8	2.3 + j2.9
850	2.3 + j9.4	2.8 + j3.9
900	3.0 + j11.1	2.1 + j5.0

Order this data sheet
by MRF5160/D

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

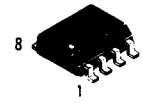
MRF5160

The RF Line
PNP Silicon
High Frequency Transistor

SURFACE MOUNT
RF TRANSISTOR
PNP SILICON

. . . designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a class A, B or C output driver or pre-driver stages in VHF and UHF.

- Complement to MRF3866
- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available



CASE 751-02
SO-8

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	V
Collector-Base Voltage	V_{CBO}	60	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current — Continuous	I_C	0.4	A
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	1 8	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

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

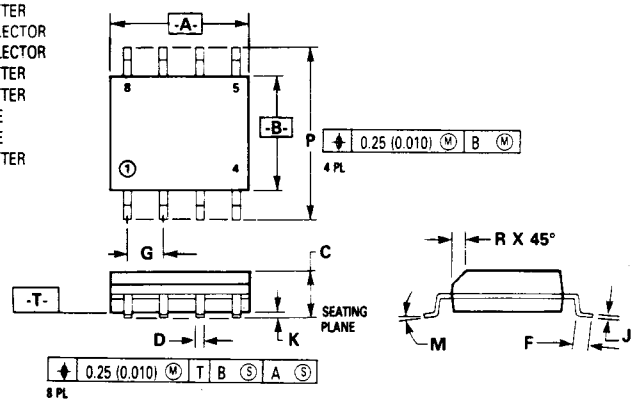
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (I_C = 5 mA)	$V_{CEO(sus)}$	40	—	—	V
Emitter-Base Breakdown Voltage (I_E = 0.1 mA)	$V_{(BR)EBO}$	4	—	—	V
Collector Cutoff Current (V_{CB} = 28 V)	I_{CBO}	—	—	1	μA
Collector Cutoff Current (V_{CE} = 60 V)	I_{CES}	—	—	0.1	mA
Emitter Cutoff Current (V_{CE} = 28 V)	I_{CEO}	—	—	20	μA
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	10	—	—	—
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mA, V_{CE} = 15 V, f = 200 MHz)	f_T	—	800	—	MHz
Insertion Gain (V_{CE} = 15 V, I_C = 50 mA, f = 400 MHz)	$\|S_{21}\|^2$	8	9.8	—	dB

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
15	50	100	0.78	−172	12.27	93	0.011	38	0.34	−29
		200	0.79	178	6.24	82	0.017	54	0.31	−31
		300	0.79	172	4.12	74	0.025	64	0.31	−39
		400	0.80	167	3.07	68	0.031	66	0.33	−48
		500	0.80	163	2.45	61	0.039	70	0.35	−56
		600	0.79	159	2.01	55	0.047	71	0.38	−64
		700	0.78	155	1.71	49	0.054	74	0.40	−71
		800	0.78	151	1.49	44	0.064	75	0.43	−79
		900	0.77	146	1.30	38	0.073	76	0.46	−86
		1000	0.76	142	1.16	33	0.083	77	0.50	−92

OUTLINE DIMENSIONS

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. COLLECTOR
4. EMITTER
5. EMITTER
6. BASE
7. BASE
8. EMITTER



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

NOTES:
1. DIMENSIONS "A" AND "B" ARE DATUMS AND "T" IS A DATUM SURFACE.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
3. CONTROLLING DIM: MILLIMETER.
4. DIMENSION "A" AND "B" DO NOT INCLUDE MOLD PROTRUSION.
5. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.

CASE 751-02
SO-8

MOTOROLA ***Semiconducteurs S.A.***
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