MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N4427

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

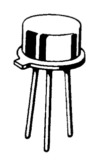
. . . designed for amplifier, frequency multiplier, or oscillator applications in military and industrial equipment. Suitable for use as output driver or pre-driver stages in VHF and UHF equipment.

- Specified 175 MHz, 12 Vdc Characteristics –
  Output Power = 1.0 Watt
  Minimum Gain = 10 dB
  Efficiency = 50%

1 W – 175 MHz

HIGH FREQUENCY TRANSISTOR

NPN SILICON

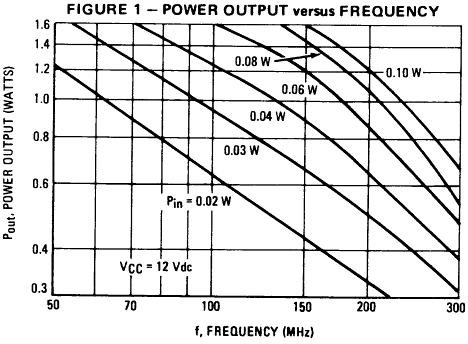


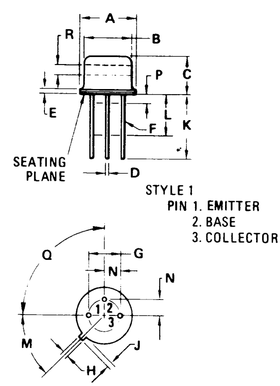
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
*Collector-Emitter Voltage	V_{CEO}	20	Vdc
*Collector-Base Voltage	V_{CB}	40	Vdc
*Emitter-Base Voltage	V_{EB}	2.0	Vdc
*Collector Current – Continuous	I_C	400	mAdc
*Base Current – Continuous	I_B	400	mAdc
Total Device Dissipation @ $T_A = 25^oC$ Derate above 25^oC	P_D	1.0 5.71	Watt $mW/^oC$
*Total Device Dissipation @ $T_C = 25^oC$ Derate above 25^oC	P_D	3.5 20	Watts $mW/^oC$
*Storage Temperature Range	T_{stg}	-65 to + 200	^oC

*Indicates JEDEC Registered Data

FIGURE 1 – POWER OUTPUT versus FREQUENCY





	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	8.89	9.40	0.350	0.370
B	8.00	8.51	0.315	0.335
C	6.10	6.60	0.240	0.260
D	0.406	0.533	0.016	0.021
E	0.229	3.18	0.009	0.125
F	0.406	0.483	0.016	0.019
G	4.83	5.33	0.190	0.210
H	0.711	0.864	0.028	0.034
J	0.737	1.02	0.029	0.040
K	12.70	–	0.500	–
L	6.35	–	0.250	–
M	45° NOM		45° NOM	
P	–	1.27	–	0.050
Q	90° NOM		90° NOM	
R	2.54	–	0.100	–

CASE 79-02
TO-39

All JEDEC dimensions and notes apply.

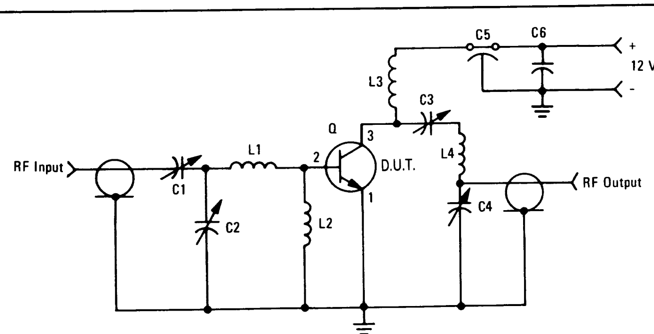
Available in TO-46 Package as MRF604

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
*Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	20	–	Vdc
*Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, R_{BE} = 10 ohms)	$V_{CER(sus)}$	40	–	Vdc
*Collector Cutoff Current (V_{CE} = 12 Vdc, I_B = 0)	I_{CEO}	–	0.02	mAdc
*Collector Cutoff Current (V_{CE} = 40 Vdc, V_{BE} = −1.5 Vdc) (V_{CE} = 12 Vdc, V_{BE} = −1.5 Vdc, T_C = +150°C)	I_{CEV}	– –	0.1 5.0	mAdc
*Emitter Cutoff Current (V_{EB} = 2.0 Vdc, I_C = 0)	I_{EBO}	–	0.1	mAdc
ON CHARACTERISTICS				
*DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc) (I_C = 360 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10 5.0	200 –	–
*Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 20 mAdc)	$V_{CE(sat)}$	–	0.5	Vdc
DYNAMIC CHARACTERISTICS				
*Current-Gain – Bandwidth Product (I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	f_T	500	–	MHz
*Output Capacitance (V_{CB} = 12 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	4.0	pF
FUNCTIONAL TEST				
*Power Input (Figure 2) (P_{out} = 1.0 W, V_{CC} = 12 Vdc, f = 175 MHz)	P_{in}	–	100	mW
Common-Emitter Amplifier Power Gain (P_{in} = 100 mW, V_{CC} = 12 Vdc, f = 175 MHz)	G_{pe}	10	–	dB
*Collector Efficiency (Figure 2) (P_{out} = 1.0 W, V_{CC} = 12 Vdc, f = 175 MHz)	η	50	–	%

*Indicates JEDEC Registered Data

FIGURE 2 – 175 MHz RF AMPLIFIER CIRCUIT FOR POWER-OUTPUT TEST



C1, C2, C3, and C4: 3-30 pF
C5: 1,000 pF
C6: 0.01 μF
L1: 2 turns No. 16 wire, 3/16" ID, 1/4" long
L2: Ferrite choke, Z = 450 ohms
L3: 2 turns No. 16 wire, 1/4" ID, 1/4" long
L4: 4 turns No. 16 wire, 3/8" ID, 3/8" long
Q: 2N4427

2N4428

The RF Line

NPN SILICON RF POWER TRANSISTOR

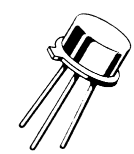
. . . designed primarily for use in large signal VHF and UHF amplifier output stages in military and industrial communications applications.

- Specified 28 Volt, 500 MHz Characteristics –
  Output Power = 750 mW
  Typical Gain = 10 dB
  Efficiency = 35%

0.75 W – 500 MHz

RF POWER TRANSISTOR

NPN SILICON



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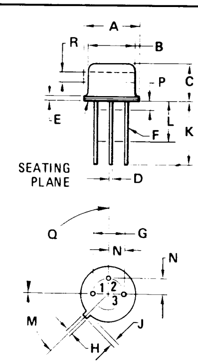
*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	55	Vdc
Emitter-Base Voltage	V_{EB}	3.5	Vdc
Collector Current – Continuous	I_C	425	mAdc
Base Current – Continuous	I_B	150	mAdc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	3.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.



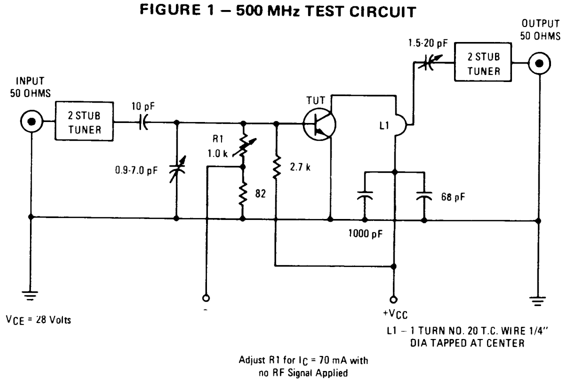
STYLE 1
PIN 1. EMITTER
2. BASE
3. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.89	9.40	0.350	0.370
B	8.00	8.51	0.315	0.335
C	6.10	6.60	0.240	0.260
D	0.406	0.533	0.016	0.021
E	0.229	3.18	0.009	0.125
F	0.406	0.483	0.016	0.019
G	4.83	5.33	0.190	0.210
H	0.711	0.864	0.028	0.034
J	0.737	1.02	0.029	0.040
K	12.70	–	0.500	–
L	6.35	–	0.250	–
M	45° NOM		45° NOM	
P	–	1.27	–	0.050
Q	90° NOM		90° NOM	
R	2.54	–	0.100	–

All JEDEC dimensions and notes apply.

CASE 79-02
TO-39

FIGURE 1 – 500 MHz TEST CIRCUIT



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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO(sus)}$	35	–	–	Vdc
Collector-Emitter Sustaining Voltage (I_C = 20 mAdc, R_{BE} = 10 ohms)	$V_{(BR)CER(sus)}$	55	–	–	Vdc
Collector Cutoff Current (V_{CE} = 55 Vdc, $V_{BE(on)}$ = -1.5 Vdc)	I_{CEX}	–	–	1.0	mAdc
Emitter Cutoff Current (V_{EB} = 3.5 Vdc, I_C = 0)	I_{EBO}	–	–	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	–	200	–
(I_C = 400 mAdc, V_{CE} = 5.0 Vdc)		5.0	–	–	
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 200 MHz)	f_T	700	1000	–	MHz
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	1.2	3.5	pF
FUNCTIONAL TEST					
Power Input (Figure 1) (P_{out} = 750 mW, V_{CE} = 28 Vdc, R_S = 50 Ohms, f = 500 MHz)	P_{in}	–	–	75	mW
Collector Efficiency (Figure 1) (P_{out} = 750 mW, V_{CE} = 28 Vdc, R_S = 50 Ohms, f = 500 MHz)	η	35	–	–	%

*Indicates JEDEC Registered Data.

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FIGURE 2 — CURRENT-GAIN—BANDWIDTH PRODUCT

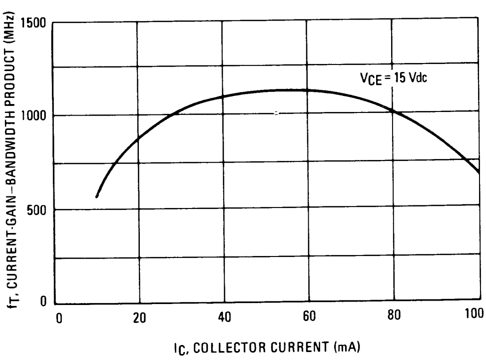
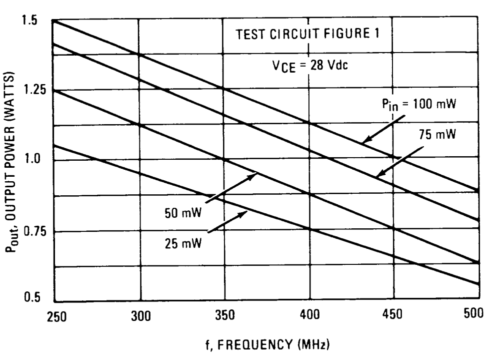


FIGURE 3 — OUTPUT POWER versus FREQUENCY



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N4957
2N4958
2N4959

The RF Line

PNP SILICON HIGH FREQUENCY TRANSISTORS

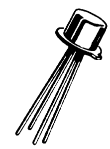
. . . designed for high-gain, low-noise amplifier, oscillator and mixer applications.

- Low Noise Figure @ 450 MHz –
  NF = 3.0 dB (Max) – 2N4957
  = 3.3 dB (Max) – 2N4958
  = 3.8 dB (Max) – 2N4959
- High Power Gain @ 450 MHz –
  G_{pe} = 17 dB (Min) – 2N4957
  = 16 dB (Min) – 2N4958
  = 15 dB (Min) – 2N4959
- High Current-Gain—Bandwidth Product –
  f_T = 1.2 GHz (Min) @ I_E = 2.0 mAdc – 2N4957
  = 1.0 GHz (Min) @ I_E = 2.0 mAdc – 2N4958, 2N4959

1.2 GHz @ 2.0 mAdc – 2N4957
1.0 GHz @ 2.0 mAdc – 2N4958, 2N4959

HIGH FREQUENCY TRANSISTORS

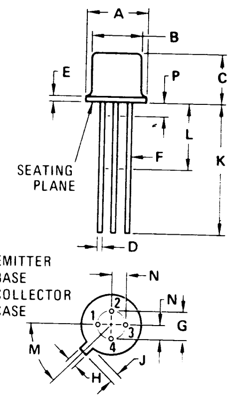
PNP SILICON



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current – Continuous	I_C	30	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.



STYLE 10
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.34	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	–	0.76	–	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	–	0.500	–
L	6.35	–	0.250	–
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	–	1.27	–	0.050

ALL JEDEC dimensions and notes apply

CASE 20-03
TO-72

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0) (V_{CB} = 10 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	– –	– –	0.1 100	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	20	40	150	–
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (1) (I_E = 2.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz) 2N4957 2N4958, 2N4959	f_T	1200 1000	1600 1500	2500 2500	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	0.4	0.8	pF
Small-Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	20	–	200	–
Collector-Base Time Constant (I_E = 2.0 mAdc, V_{CB} = 10 Vdc, f = 63.6 MHz)	$r_b'C_c$	1.0	–	8.0	ps
Noise Figure (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 450 MHz) 2N4957 2N4958 2N4959	NF	– – – –	2.3 2.6 2.9 3.2	2.5 3.0 3.3 3.8	dB
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 10 Vdc, I_C = 2.0 mAdc, f = 450 MHz) 2N4957 2N4958 2N4959	G_{pe}	17 16 15	– – –	25 25 25	dB

*Indicates JEDEC Registered Data.

(1) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

3

FIGURE 1 — NOISE FIGURE AND POWER GAIN TEST CIRCUIT

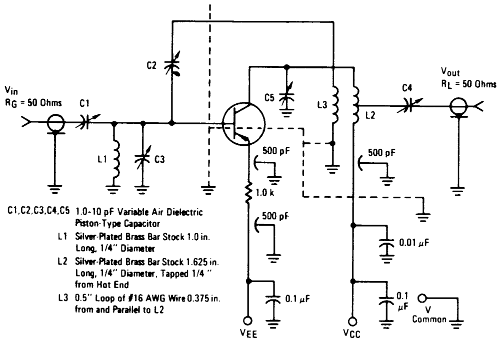


FIGURE 2 — UNILATERALIZED POWER GAIN versus FREQUENCY

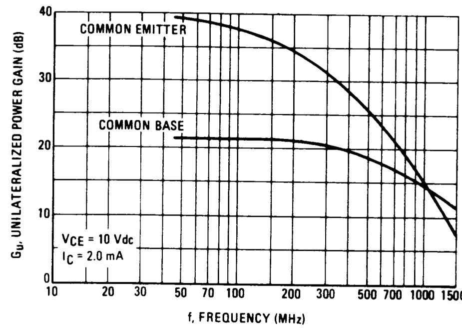


FIGURE 3 — NOISE FIGURE versus FREQUENCY

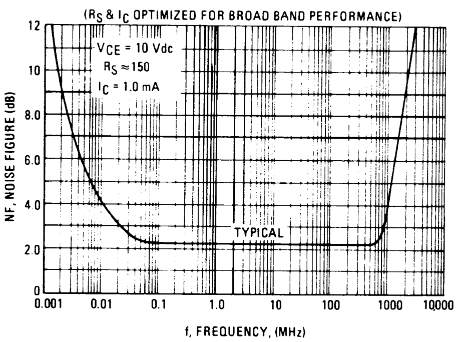


FIGURE 4 — NOISE FIGURE AND POWER GAIN versus COLLECTOR CURRENT

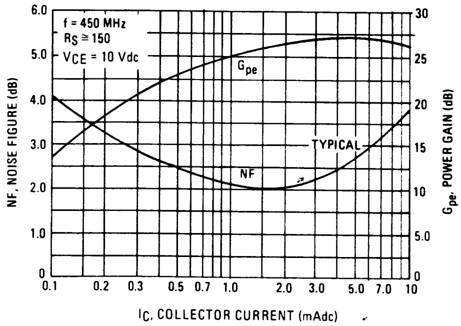


FIGURE 5 — CONTOURS OF NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT

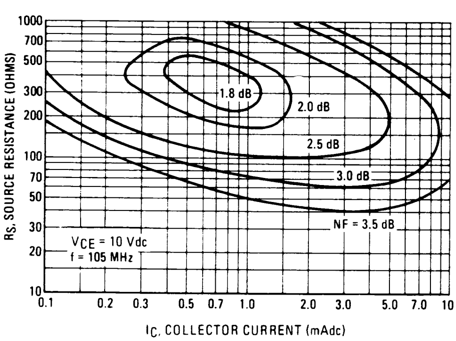
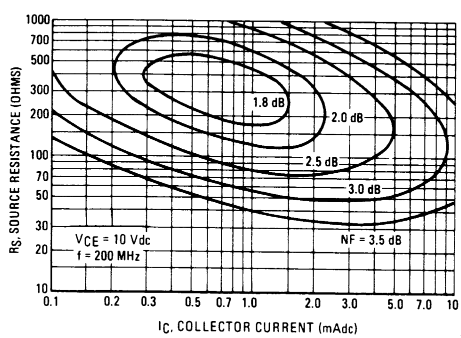


FIGURE 6 — CONTOURS OF NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT



COMMON EMITTER CIRCUIT DESIGN DATA

(V_{CE} = 10 Vdc, I_C = 2.0 mAdc)

FIGURE 7 – TRANSDUCER GAIN versus FREQUENCY

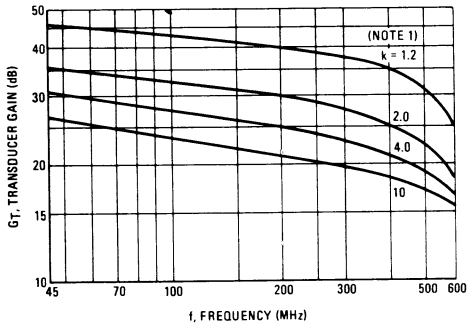


FIGURE 8 – LINVILL STABILITY FACTOR versus FREQUENCY

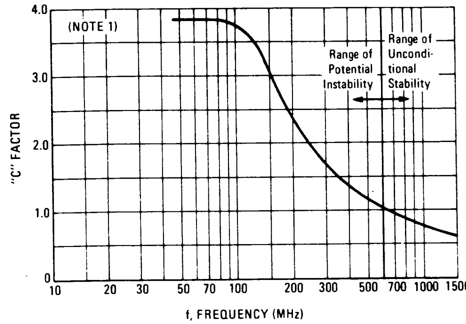


FIGURE 9 – LOAD ADMITTANCE versus FREQUENCY (REAL)

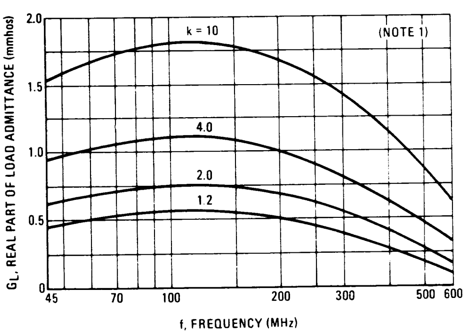


FIGURE 10 – LOAD ADMITTANCE versus FREQUENCY (IMAGINARY)

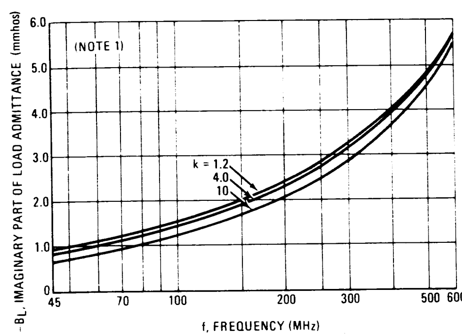


FIGURE 11 – SOURCE ADMITTANCE versus FREQUENCY (REAL)

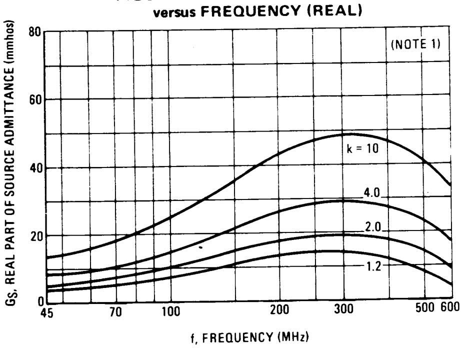
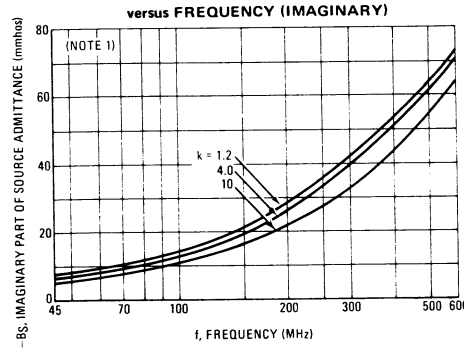


FIGURE 12 – SOURCE ADMITTANCE versus FREQUENCY (IMAGINARY)



NOTE 1

Figures 7 through 18 are included to assist the circuit designer in determining the stability of his particular circuit. Two stability criteria are given in these figures.

The Linvill "C" factor* is a measure of transistor stability when the input and output are terminated in the worst-case (open circuit) condition. When "C" is less than 1.0, the circuit is unconditionally stable. When "C" is greater than 1.0, the circuit is potentially unstable.

The Stern "K" factor† has been defined to determine the stability of a practical amplifier terminated in finite load and source admittances. If "K" is greater than 1.0, the circuit will be stable. If less than 1.0, the circuit will be unstable. For further details, see Application Note AN-215A.

* "Transistors and Active Circuits," Linvill and Gibbons, McGraw-Hill, 1961.

† "Stability and Power Gain of Tuned Transistor Amplifiers," Arthur P. Stern, Proc. I.R.E., March 1967.

COMMON BASE CIRCUIT DESIGN DATA

(V_{CB} = 10 Vdc, I_C = 2.0 mAdc)

FIGURE 13 – TRANSDUCER GAIN versus FREQUENCY

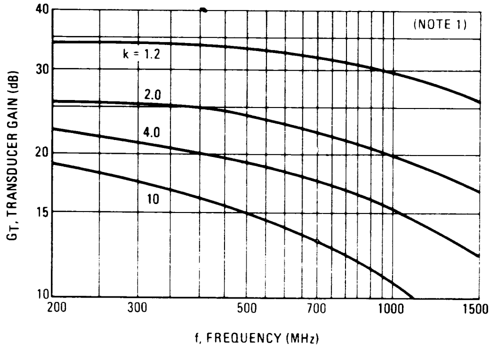


FIGURE 14 – LINVILL STABILITY FACTOR versus FREQUENCY

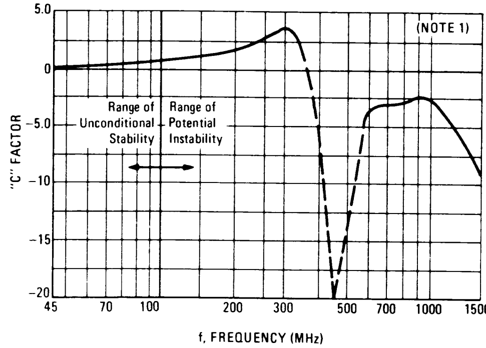


FIGURE 15 – LOAD ADMITTANCE versus FREQUENCY (REAL)

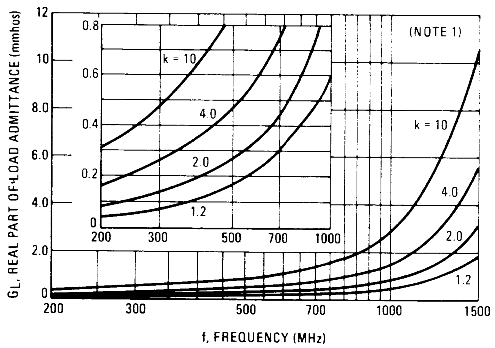


FIGURE 16 – LOAD ADMITTANCE versus FREQUENCY (IMAGINARY)

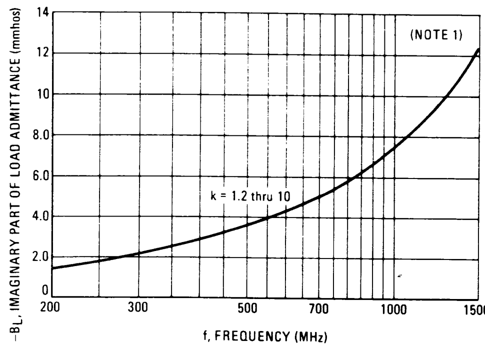


FIGURE 17 – SOURCE ADMITTANCE versus FREQUENCY (REAL)

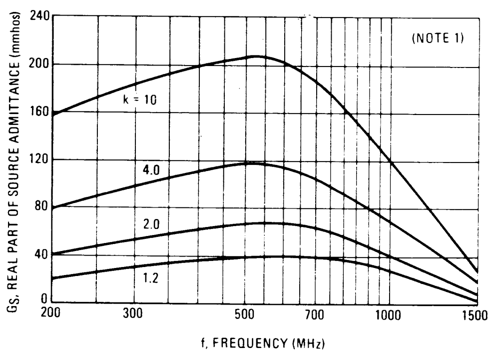
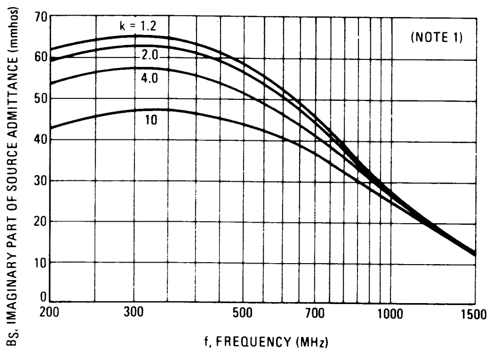


FIGURE 18 – SOURCE ADMITTANCE versus FREQUENCY (IMAGINARY)



3

FIGURE 19 – SMALL-SIGNAL CURRENT GAIN versus FREQUENCY

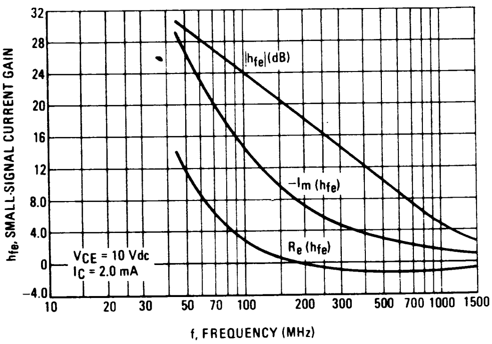


FIGURE 20 – POLAR h_{fe}

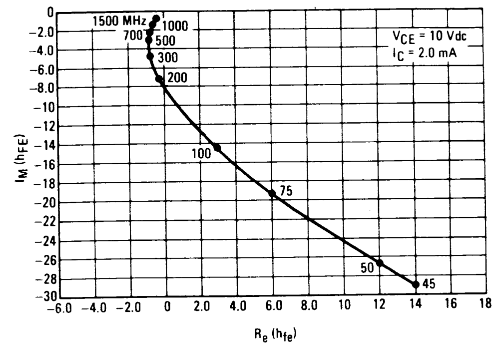


FIGURE 21 – f_T versus COLLECTOR CURRENT

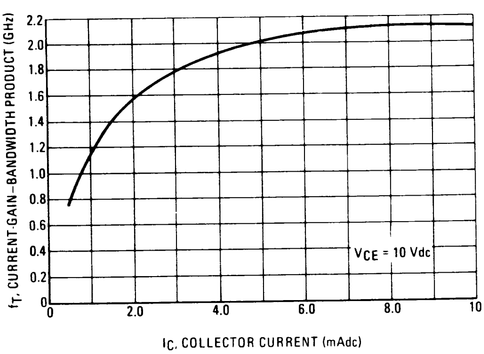


FIGURE 22 – DC CURRENT GAIN

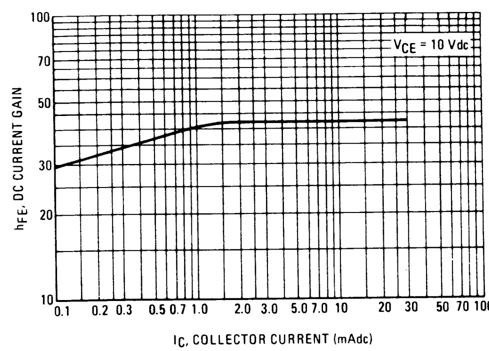


FIGURE 23 – CAPACITANCE

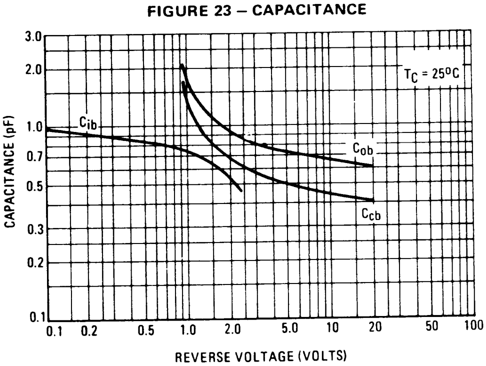
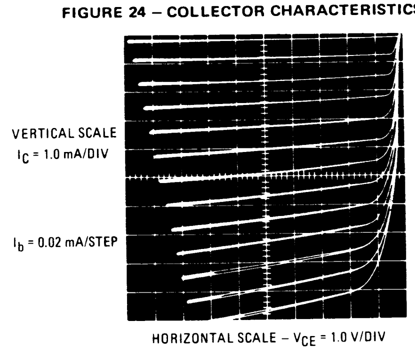
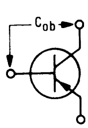
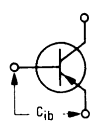


FIGURE 24 – COLLECTOR CHARACTERISTICS

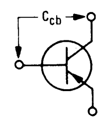




Apply reverse bias between collector and base and measure capacitance between these terminals. Emitter is open.



Apply reverse bias between emitter and base and measure capacitance between these terminals. Collector is open.



Apply reverse bias between collector and base and measure capacitance between these terminals. Emitter is guarded.

Y PARAMETERS versus CURRENT
(f = 450 MHz)

COMMON BASE

V_{CB} = 10 Vdc ——— V_{CB} = 15 Vdc – – –

COMMON EMITTER

V_{CE} = 10 Vdc ——— V_{CE} = 15 Vdc – – –

FIGURE 25 – INPUT ADMITTANCE

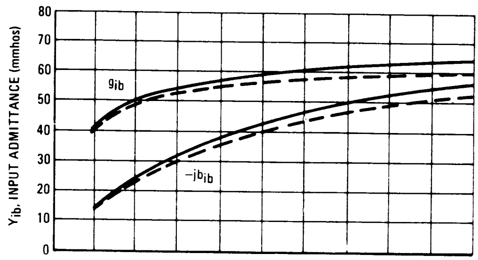


FIGURE 26 – INPUT ADMITTANCE

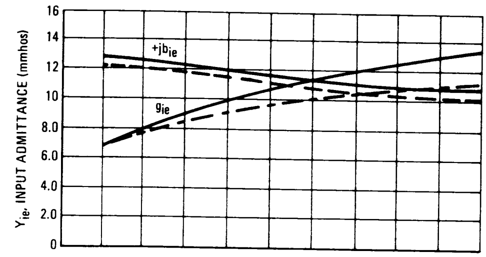


FIGURE 27 – FORWARD TRANSFER ADMITTANCE

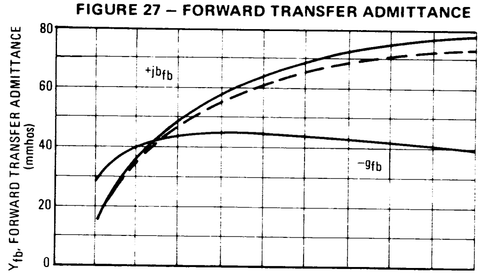


FIGURE 28 – FORWARD TRANSFER ADMITTANCE

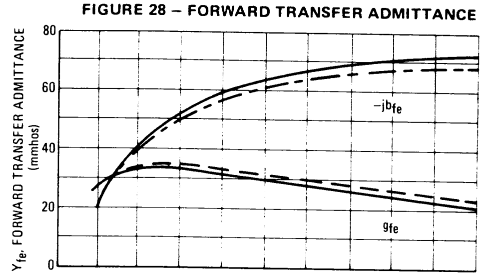


FIGURE 29 – OUTPUT ADMITTANCE

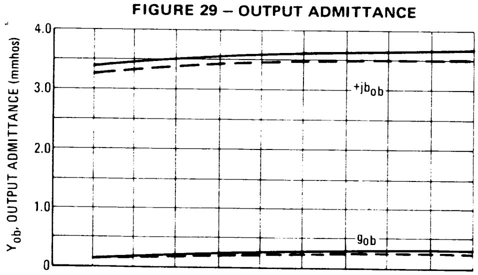


FIGURE 30 – OUTPUT ADMITTANCE

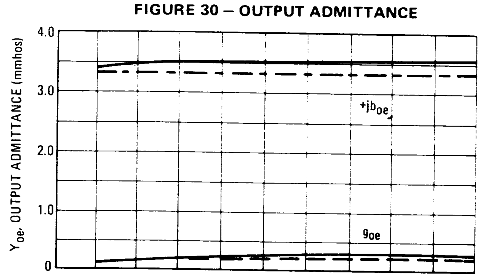


FIGURE 31 – REVERSE TRANSFER ADMITTANCE

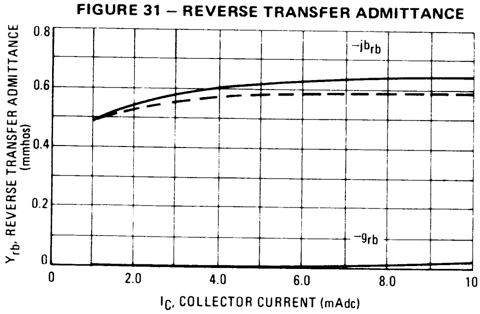
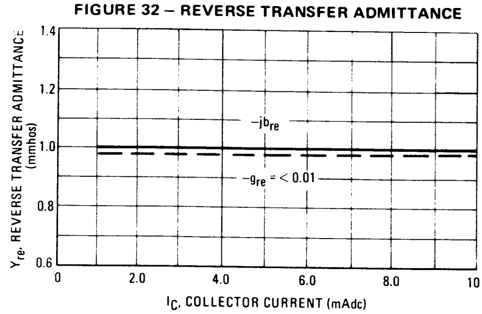


FIGURE 32 – REVERSE TRANSFER ADMITTANCE



COMMON BASE y PARAMETER VARIATIONS

(V_{CB} = 10 Vdc, I_C = 2.0 mAdc)

y PARAMETERS versus FREQUENCY

FIGURE 33 – y_{ib} INPUT ADMITTANCE

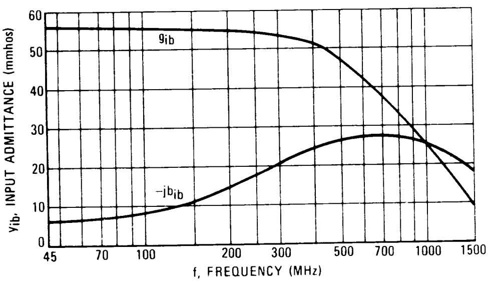


FIGURE 35 – y_{fb} FORWARD TRANSFER ADMITTANCE

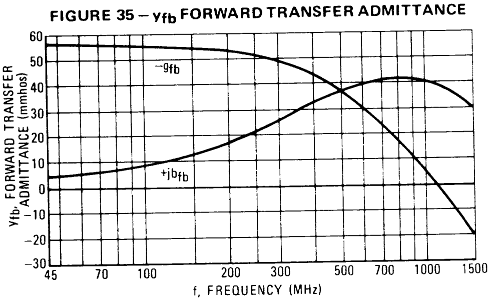


FIGURE 37 – y_{ob} OUTPUT ADMITTANCE

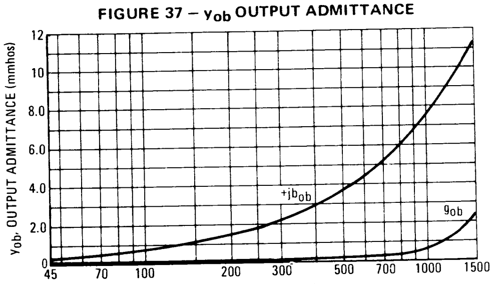
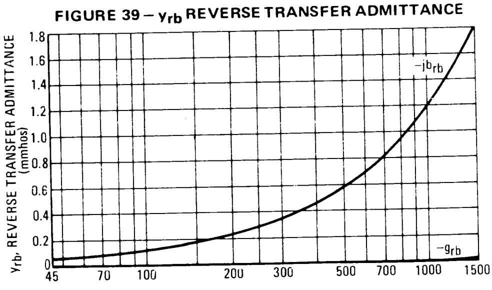


FIGURE 39 – y_{rb} REVERSE TRANSFER ADMITTANCE



POLAR y PARAMETERS versus FREQUENCY

FIGURE 34 – y_{ib} INPUT ADMITTANCE

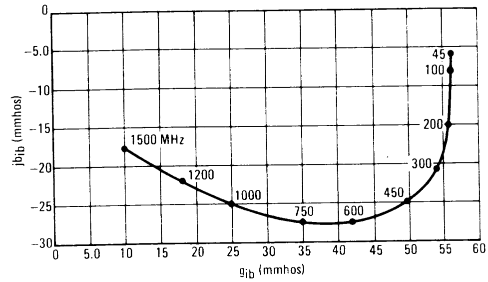


FIGURE 36 – y_{fb} FORWARD TRANSFER ADMITTANCE

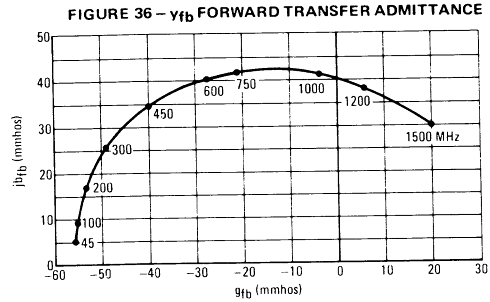


FIGURE 38 – y_{ob} OUTPUT ADMITTANCE

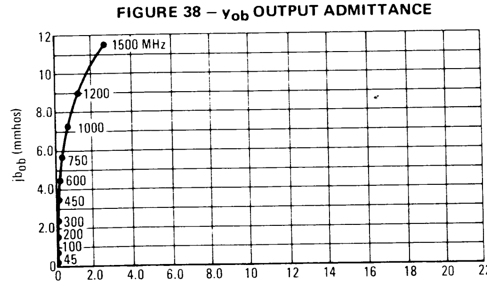
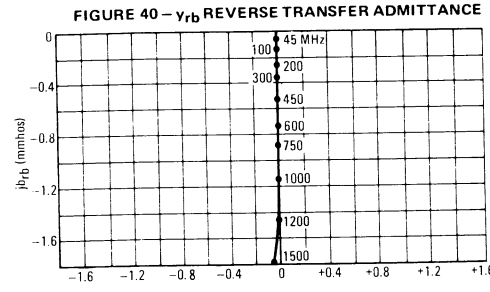


FIGURE 40 – y_{rb} REVERSE TRANSFER ADMITTANCE



COMMON EMITTER y PARAMETER VARIATIONS

(V_{CE} = 10 Vdc, I_C = 2.0 mAdc)

y PARAMETERS versus FREQUENCY

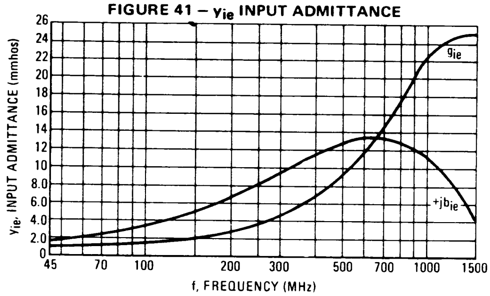


FIGURE 41 – y_{ie} INPUT ADMITTANCE

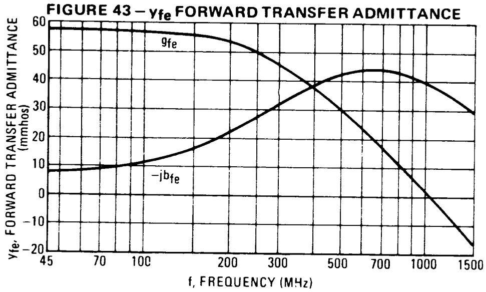


FIGURE 43 – y_{fe} FORWARD TRANSFER ADMITTANCE

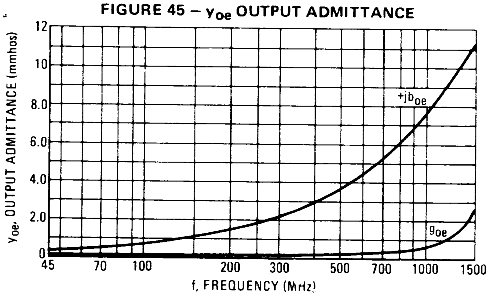


FIGURE 45 – y_{oe} OUTPUT ADMITTANCE

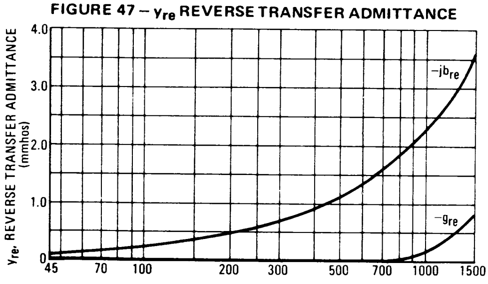


FIGURE 47 – y_{re} REVERSE TRANSFER ADMITTANCE

POLAR y PARAMETERS versus FREQUENCY

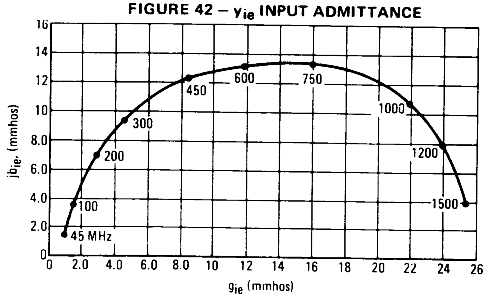


FIGURE 42 – y_{ie} INPUT ADMITTANCE

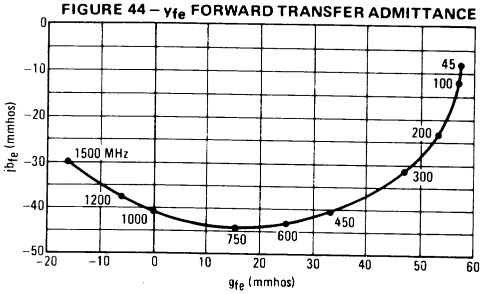


FIGURE 44 – y_{fe} FORWARD TRANSFER ADMITTANCE

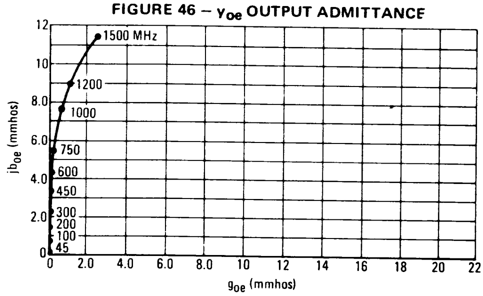


FIGURE 46 – y_{oe} OUTPUT ADMITTANCE

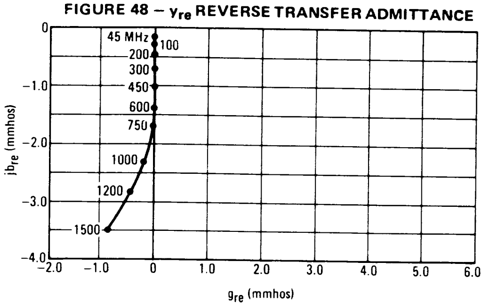


FIGURE 48 – y_{re} REVERSE TRANSFER ADMITTANCE

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5031
2N5032

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTORS

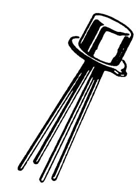
. . . designed primarily for use in high-gain, low-noise, small-signal amplifiers.

- High Current-Gain – Bandwidth Product –
  f_T = 1000 MHz (Min) @ I_C = 5.0 mAdc
- Low Noise Figure @ f = 450 MHz –
  NF = 2.5 dB (Max) – 2N5031
  = 3.0 dB (Max) – 2N5032
- High Power Gain –
  G_{pe} = 14 dB (Min) @ f = 450 MHz

2.5 dB @ 450 MHz – 2N5031
3.0 dB @ 450 MHz – 2N5032

HIGH FREQUENCY TRANSISTORS

NPN SILICON

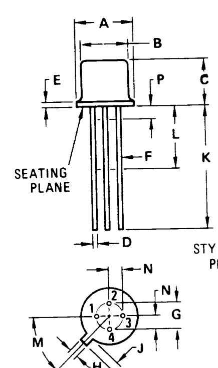


3

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current – Continuous	I_C	20	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.



STYLE 10
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	–	0.76	–	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	–	0.500	–
L	6.35	–	0.250	–
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	–	1.27	–	0.050

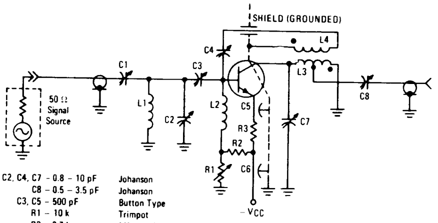
CASE 20-03
TO-72

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
*Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	10	–	–	Vdc
*Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	15	–	–	Vdc
*Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
*Collector Cutoff Current (V_{CB} = 6.0 Vdc, I_E = 0)	I_{CBO}	–	1.0	10	nAdc
ON CHARACTERISTICS					
*DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc)	h_{FE}	25	–	300	–
DYNAMIC CHARACTERISTICS					
*Current-Gain—Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	1000	–	3500	MHz
*Output Capacitance (V_{CE} = 6.0 Vdc, I_E = 0, f = 0.1 MHz)	C_{cb}	–	1.3	1.5	pF
Collector-Base Time Constant (I_C = 6.0 mAdc, V_{CE} = 6.0 Vdc, f = 31.8 MHz)	$r_b'C_c$	–	5.0	–	ps
*Noise Figure (Figure 1) (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz) 2N5031	NF	–	–	2.5	dB
2N5032		–	–	3.0	
FUNCTIONAL TEST					
*Common-Emitter Amplifier Power Gain (Figure 1) (V_{CE} = 6.0 Vdc, I_C = 1.0 mAdc, f = 450 MHz)	G_{pe}	14	17	25	dB

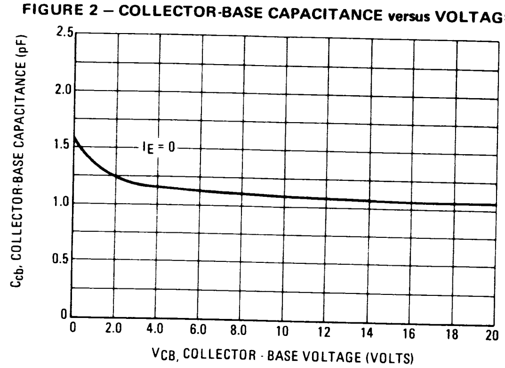
*Indicates JEDEC Registered Data.
(1) Tuned for Minimum Noise.

FIGURE 1 — POWER GAIN AND NOISE FIGURE TEST CIRCUIT



C1, C2, C4, C7 – 0.8 – 10 pF Johanson
C8 – 0.5 – 3.5 pF Johanson
C3, C5 – 500 pF Button Type
R1 – 10 k Trimpot
R2 – 2.7 k 1/4 watt 5%
R3 – 1.0 k 1/4 watt 5%
L1 – 1/4" Brass Rod, Solder Plated, 1-1/8" long. Placed 5/8" from the socket and in parallel with the shield, which bisects the socket. The ungrounded side is soldered directly to the ungrounded side of C2.
L2 – 0.22 μH
L3 – 1/4" Brass Rod, Solder Plated, 1-1/2" long. Placed 1/2" from the socket and in parallel with shield, which bisects the socket. The ungrounded side is soldered directly to the ungrounded side of C7. Output tap is 15/16" from ground.
L4 – 1/2 Turn #16, 5/16" above L3 and 5/8" long, (over L3).

FIGURE 2 — COLLECTOR-BASE CAPACITANCE versus VOLTAGE



3

FIGURE 3 – CURRENT-GAIN–BANDWIDTH PRODUCT

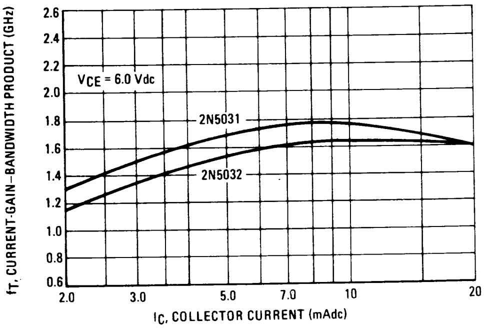


FIGURE 4 – S_{11} AND S_{22}

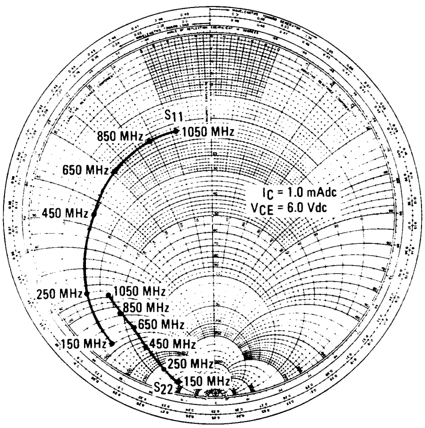


FIGURE 5 – S_{12}

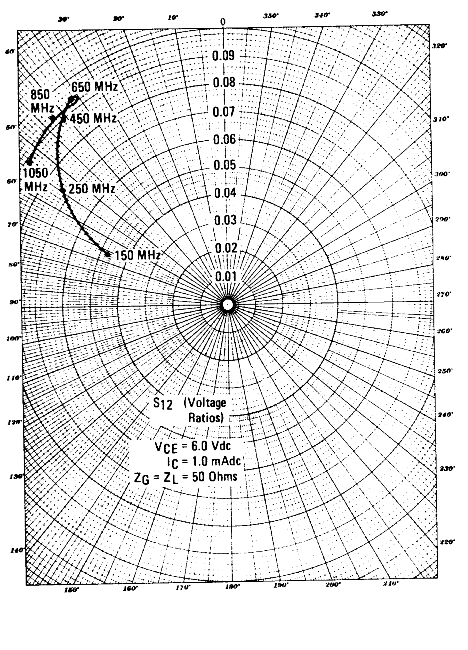


FIGURE 6 – S_{21}

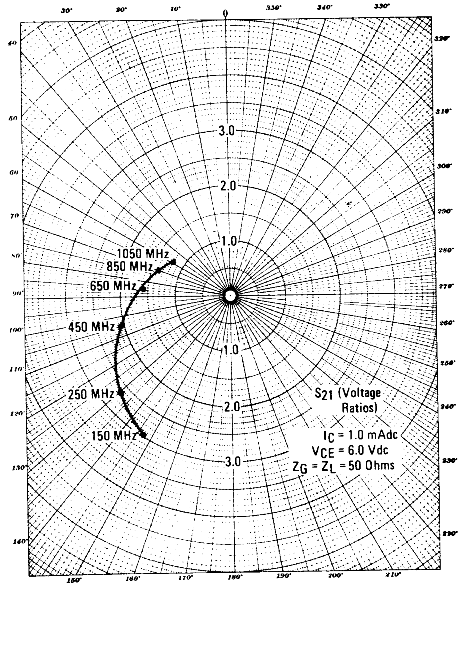


FIGURE 7 — NOISE FIGURE versus FREQUENCY

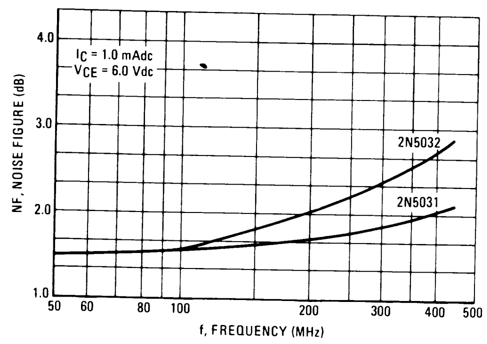


FIGURE 8 — POWER GAIN versus FREQUENCY

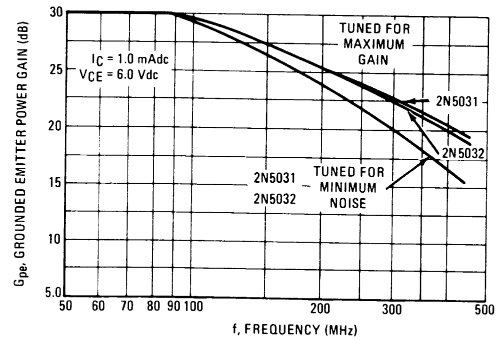


FIGURE 9 — INPUT ADMITTANCE versus FREQUENCY

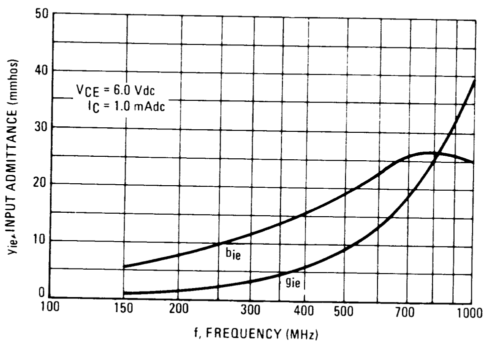


FIGURE 10 — OUTPUT ADMITTANCE versus FREQUENCY

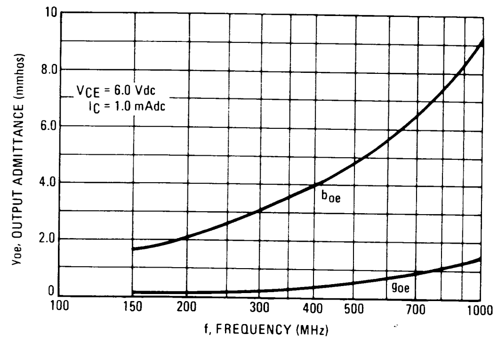


FIGURE 11 — FORWARD TRANSFER ADMITTANCE versus FREQUENCY

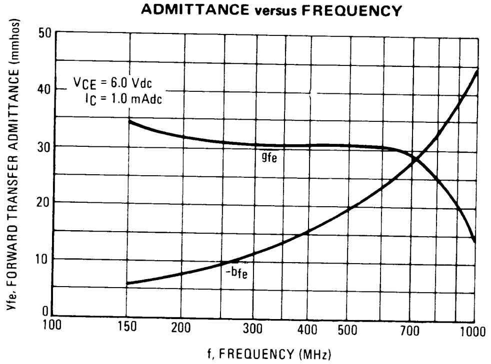
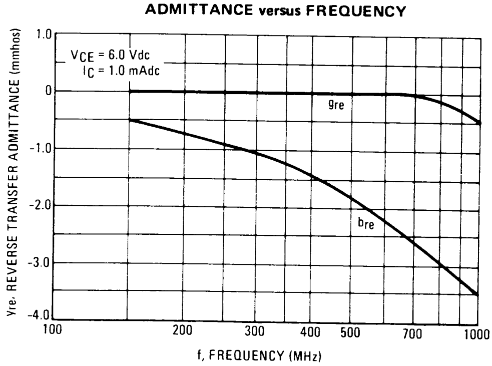


FIGURE 12 — REVERSE TRANSFER ADMITTANCE versus FREQUENCY



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5108

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

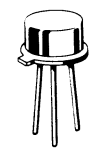
. . . designed for amplifier, frequency multiplier, or oscillator applications in military and industrial equipment. Suitable for use as output, driver, or pre-driver stages in UHF equipment and as a fundamental frequency oscillator at 1.68 GHz.

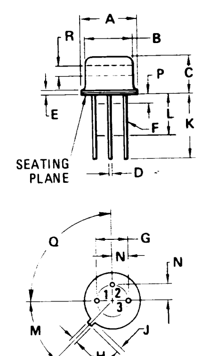
- Specified 1 GHz, 28 Vdc Characteristics –
  Output Power = 1.0 Watt
  Minimum Gain = 5.0 dB
  Efficiency = 35%
- Typical 1.68 GHz, 28 Vdc Characteristics –
  Output Power = 0.3 Watt
  Efficiency = 15%

1.0 W - 1 GHz

HIGH FREQUENCY TRANSISTOR

NPN SILICON





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

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.89	9.40	0.350	0.370
B	8.00	8.51	0.315	0.335
C	6.10	6.60	0.240	0.260
D	0.406	0.533	0.016	0.021
E	0.229	3.18	0.009	0.125
F	0.406	0.483	0.016	0.019
G	4.83	5.33	0.190	0.210
H	0.711	0.864	0.028	0.034
J	0.737	1.02	0.029	0.040
K	12.70	–	0.500	–
L	6.35	–	0.250	–
M	45° NOM		45° NOM	
P	–	1.27	–	0.050
Q	90° NOM		90° NOM	
R	2.54	–	0.100	–

All JEDEC dimensions and notes apply.

CASE 79-02
TO-39

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
*Collector-Emitter Voltage (R_{BE} = 10 Ohms)	V_{CER}	55	Vdc
*Collector-Base Voltage	V_{CB}	55	Vdc
*Emitter-Base Voltage	V_{EB}	3.0	Vdc
*Collector Current – Continuous	I_C	0.4	Adc
*Total Device Dissipation @ $T_C = 25^oC$ Derate above 25°C	P_D	3.5 0.02	Watts W/°C
*Storage Temperature Range	T_{stg}	-65 to +200	°C

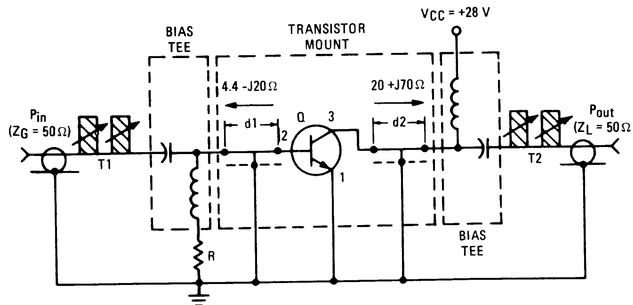
*Indicates JEDEC Registered Data.

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
*Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, R_{BE} = 10 ohms)	$V_{CER(sus)}$	55	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	55	–	–	Vdc
*Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
*Collector Cutoff Current (V_{CE} = 15 Vdc, I_B = 0)	I_{CEO}	–	–	20	µAdc
*Collector Cutoff Current (V_{CE} = 50 Vdc, V_{BE} = 0) (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 150°C)	I_{CES}	– –	– –	1.0 10	µAdc mAdc
ON CHARACTERISTICS					
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	–	0.5	Vdc
DYNAMIC CHARACTERISTICS					
*Current-Gain—Bandwidth Product (I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	f_T	1200	–	–	MHz
*Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	1.3	3.0	pF
FUNCTIONAL TEST					
*Common-Emitter Amplifier Power Gain (Figure 1) (P_{out} = 1.0 W, V_{CC} = 28 Vdc, I_C = 102 mAdc, f = 1.0 GHz)	G_{PE}	5.0	–	–	dB
Power Output (Figure 1) (P_{in} = 316 mW, V_{CE} = 28 Vdc, f = 1.0 GHz)	P_{out}	1.0	–	–	Watt
*Collector Efficiency (P_{in} = 316 mW, V_{CE} = 28 Vdc, f = 1.0 GHz)	η	35	–	–	%
Power Output (Oscillator) (Figure 2) (V_{CE} = 20 Vdc, V_{EB} = 1.5 Vdc, f = 1.68 GHz) (Minimum Efficiency = 15%)	P_{out}	–	0.3	–	Watt

*Indicates JEDEC Registered Data.

FIGURE 1 – 1 GHz RF AMPLIFIER OUTPUT POWER TEST CIRCUIT



d1: 1" Input line, center conductor width = 0.280"
d2: 1" Output line, center conductor width = 0.125"
Q: 2N5108
R: 3.9 ohms
T1, T2: Microlab Double Stub Tuner, or Equivalent
Bias Tee: Microlab 08N, or Equivalent
Transistor Mount: 1/32" Microstrip board

Note: Impedance measurements are made at transistor socket pins.

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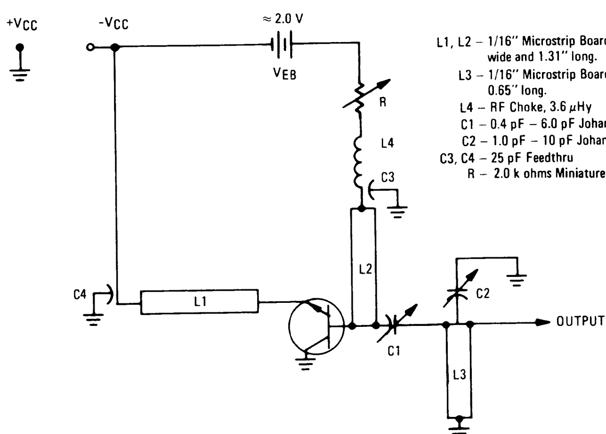
FIGURE 2 – 1.68 GHz RF OSCILLATOR OUTPUT POWER TEST CIRCUIT



L1, L2 – 1/16" Microstrip Board. Lines are 0.16" wide and 1.31" long.
L3 – 1/16" Microstrip Board. 0.16" wide and 0.65" long.
L4 – RF Choke, 3.6 μHy
C1 – 0.4 pF – 6.0 pF Johanson 4640
C2 – 1.0 pF – 10 pF Johanson 4355
C3, C4 – 25 pF Feedthru
R – 2.0 k ohms Miniature Trim pot

FIGURE 3 – OUTPUT POWER versus INPUT POWER

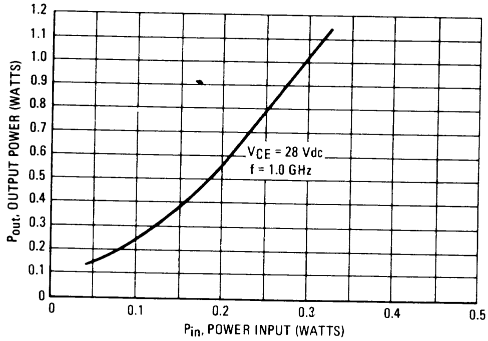


FIGURE 4 – OUTPUT POWER versus FREQUENCY

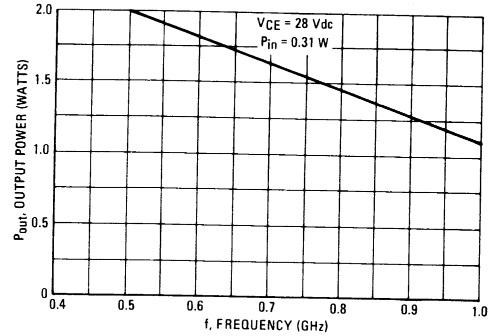


FIGURE 5 – OUTPUT POWER versus COLLECTOR-EMITTER VOLTAGE

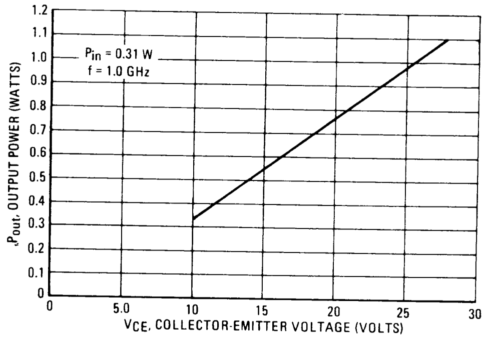


FIGURE 6 – OSCILLATOR OUTPUT POWER versus COLLECTOR CURRENT

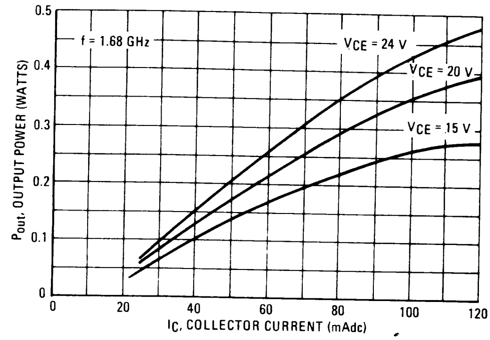


FIGURE 7 CURRENT-GAIN–BANDWIDTH PRODUCT versus CURRENT

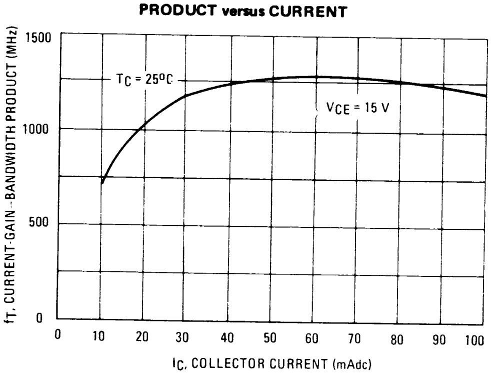
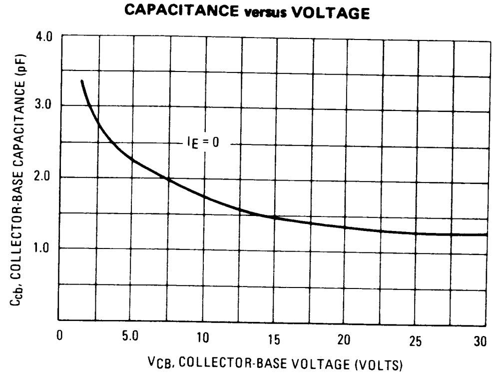


FIGURE 8 COLLECTOR BASE CAPACITANCE versus VOLTAGE



2N5109

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

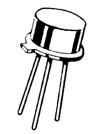
. . . designed specifically for broadband applications requiring good linearity. Useable as a high frequency current mode switch to 200 mA.

- Low Noise Figure — @ f = 200 MHz
  NF = 3.0 dB (Typ)
- High Current-Gain — Bandwidth Product —
  f_T = 1200 MHz (Min) @ I_C = 50 mAdc

1.2 GHz @ 50 mAdc

HIGH FREQUENCY TRANSISTOR

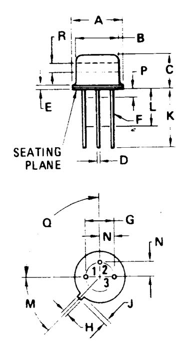
NPN SILICON



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Base Current — Continuous	I_B	400	mAdc
Collector Current — Continuous	I_C	400	mAdc
Total Device Dissipation @ T_C = 75°C (1) Derate above 25°C	P_D	2.5 20	Watt mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

(1) Total Device Dissipation at T_A = 25°C is 1.0 Watt.
• Indicates JEDEC Registered Data.



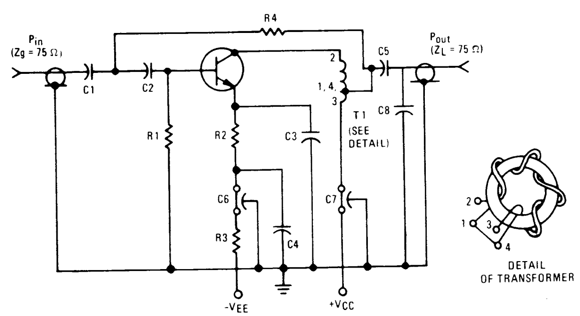
STYLE 1
PIN 1. EMITTER
2. BASE
3. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.89	9.40	0.350	0.370
B	8.00	8.51	0.315	0.335
C	6.10	6.60	0.240	0.260
D	0.406	0.533	0.016	0.021
E	0.229	3.18	0.009	0.125
F	0.406	0.483	0.016	0.019
G	4.83	5.33	0.190	0.210
H	0.711	0.864	0.028	0.034
J	0.737	1.02	0.029	0.040
K	12.70	–	0.500	–
L	6.35	–	0.250	–
M	45° NOM		45° NOM	
P	–	1.27	–	0.050
Q	90° NOM		90° NOM	
R	2.54	–	0.100	–

All JEDEC dimensions and notes apply.

CASE 79-02
TO-39

FIGURE 1 — RF AMPLIFIER FOR VOLTAGE GAIN TEST CIRCUIT



C1, C2, C3, C5	0.002 μF	R3	330 Ω, 1 W
C4	0.03 μF	R4	200 Ω, 1/4 W
C6, C7	1500 pF	T1	4 Turns #30 Wire
C8	18 pF		Bifilar wound on "Indiana General"
R1	4.7 k, 1/4 W		Core #CF-102-Q1, or equivalent
R2	6.8 Ω, 1/2 W		

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

Characteristic	Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**					
Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	20	–	–	Vdc
Collector-Emitter Sustaining Voltage (1) (I_C = 5.0 mAdc, R_{BE} = 10 Ω)	$V_{CER(sus)}$	40	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, I_B = 0)	I_{CEO}	–	–	20	μAdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = -1.5 V, T_C = 150°C)	I_{CEX}	–	–	5.0	mAdc
(V_{CE} = 35 Vdc, V_{BE} = -1.5 V)		–	–	5.0	mAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	–	–	100	μAdc
***ON CHARACTERISTICS**					
DC Current Gain (I_C = 360 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
(I_C = 50 mAdc, V_{CE} = 15 Vdc)		40	–	120	–
DYNAMIC CHARACTERISTICS					
*Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	f_T	1200	–	–	MHz
*Collector-Base Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	1.8	3.5	pF
Noise Figure (I_C = 10 mAdc, V_{CE} = 15 Vdc, f = 200 MHz) (Figure 2)	NF	–	3.0	–	dB
FUNCTIONAL TEST					
*Common-Emitter Amplifier Voltage Gain (Figure 1) (I_C = 50 mAdc, V_{CC} = 15 Vdc, f = 50 to 216 MHz)	G_{ve}	11	–	–	dB
*Power Input (Figure 2) (I_C = 50 mAdc, V_{CC} = 15 Vdc, R_S = 50 ohms, P_{out} = 1.26 mW, f = 200 MHz)	P_{in}	–	–	0.1	mW

*Indicates JEDEC Registered Data.
(1) Pulsed thru a 25 mH Inductor; 50% Duty Cycle

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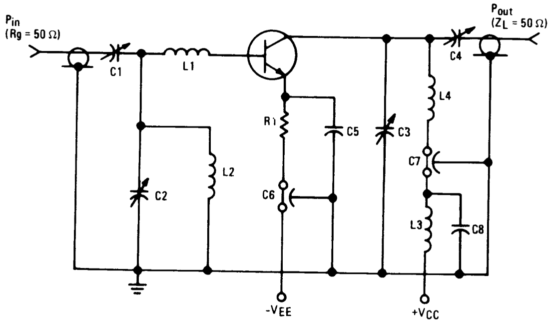
FIGURE 2 – 200 MHz TEST CIRCUIT



C1, C2, C3 1.0 – 30 pF
C4 1.0 – 20 pF
C5 10,000 pF
C6, C7 1,000 pF
C8 0.01 μF
L1 4-1/2 turns, No. 22 wire, 3/16" I.D.
L4 3-1/2 turns, No. 22 wire, 3/16" I.D.
L2, L3 0.82 μH RFC
R1 240 OHMS, 2 WATTS

FIGURE 3 – CURRENT-GAIN – BANDWIDTH PRODUCT

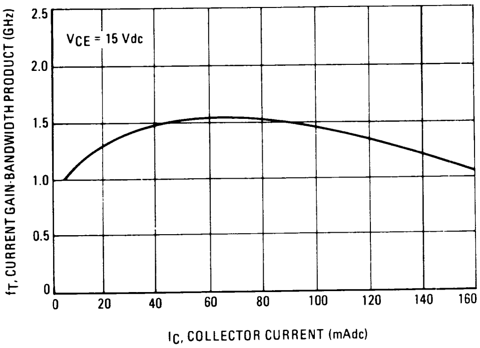


FIGURE 4 – COLLECTOR-BASE TIME CONSTANT

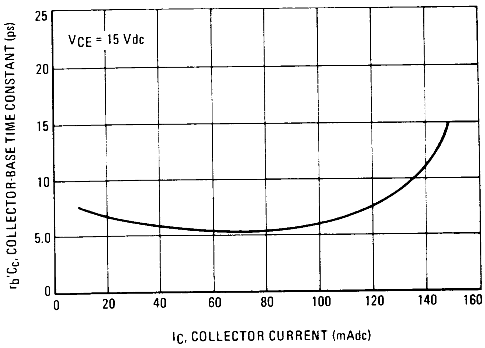


FIGURE 5 – SATURATION VOLTAGES

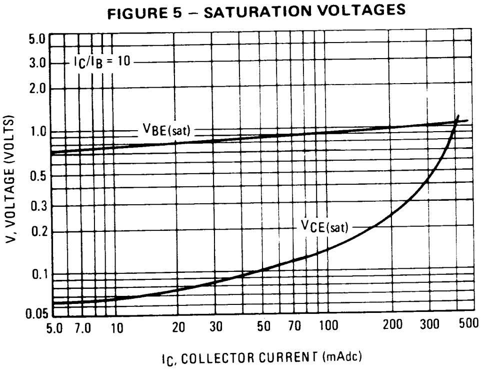


FIGURE 6 – CAPACITANCES versus REVERSE VOLTAGE

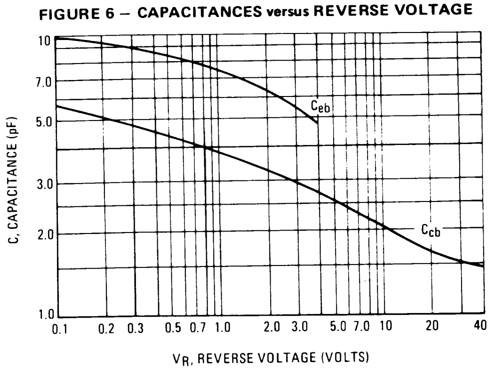


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FIGURE 7 – INPUT ADMITTANCE versus FREQUENCY

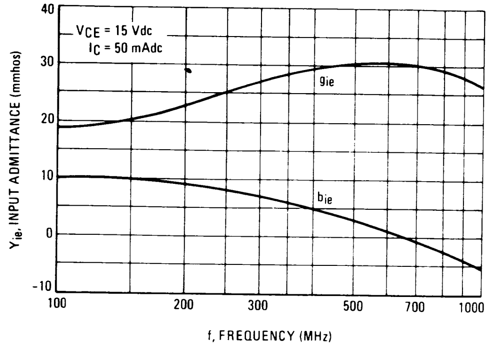

FIGURE 8 – INPUT ADMITTANCE versus COLLECTOR CURRENT

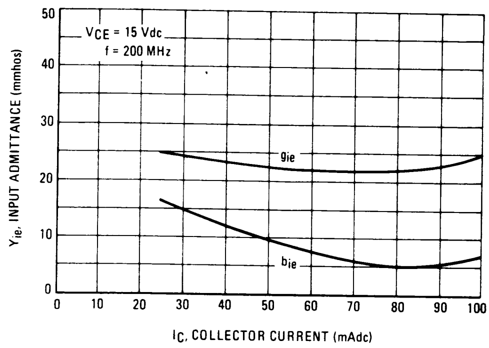

FIGURE 9 – REVERSE TRANSFER ADMITTANCE versus FREQUENCY

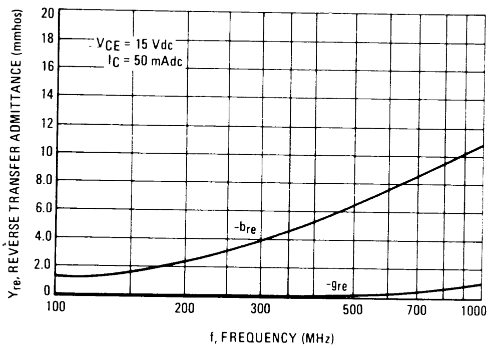

FIGURE 10 – REVERSE TRANSFER ADMITTANCE versus COLLECTOR CURRENT

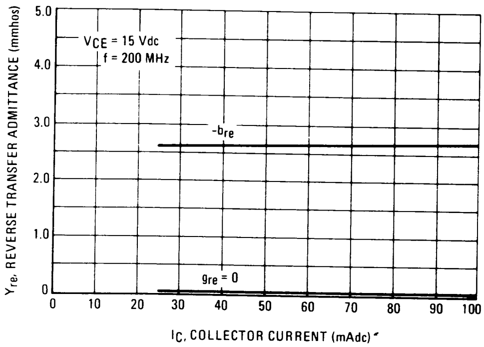

FIGURE 11 – FORWARD TRANSFER ADMITTANCE versus FREQUENCY

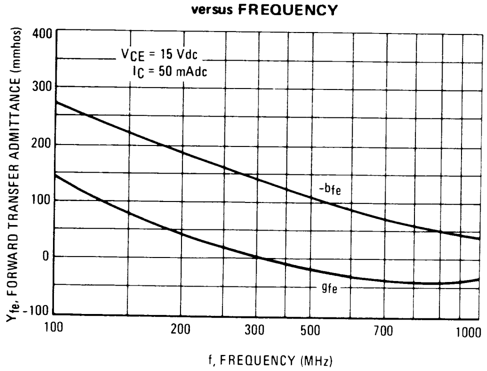

FIGURE 12 – FORWARD TRANSFER ADMITTANCE versus COLLECTOR CURRENT

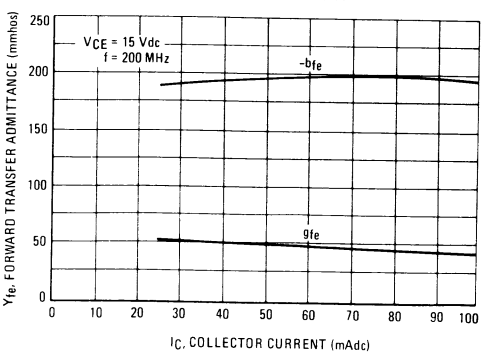

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FIGURE 13 — OUTPUT ADMITTANCE versus FREQUENCY

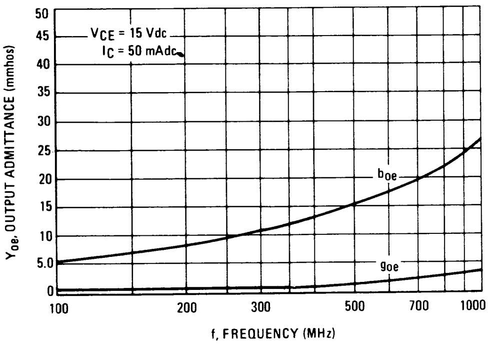

FIGURE 14 — OUTPUT ADMITTANCE versus COLLECTOR CURRENT

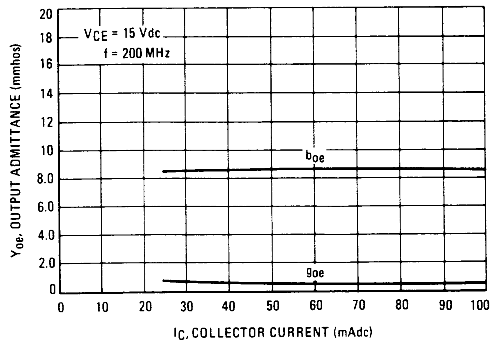

FIGURE 15 — INPUT REFLECTION COEFFICIENT versus FREQUENCY

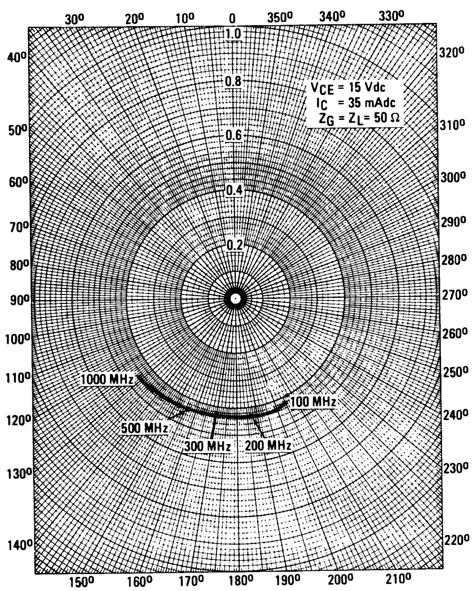

FIGURE 16 — OUTPUT REFLECTION COEFFICIENT versus FREQUENCY

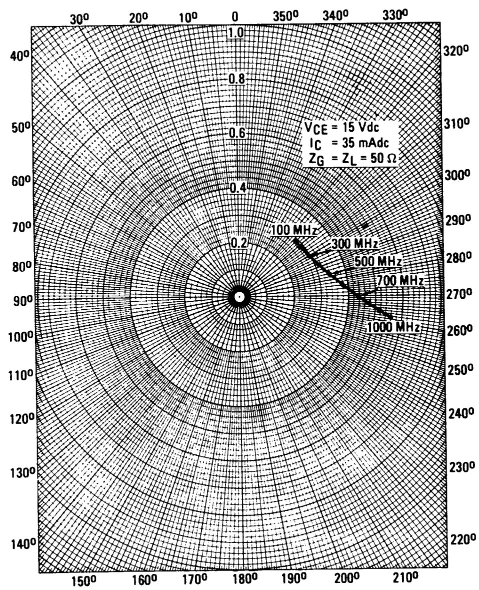

FIGURE 17 – REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY

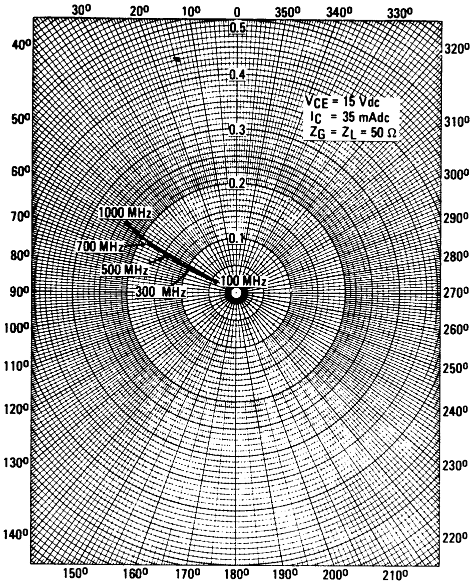

FIGURE 18 – FORWARD TRANSMISSION COEFFICIENT versus FREQUENCY

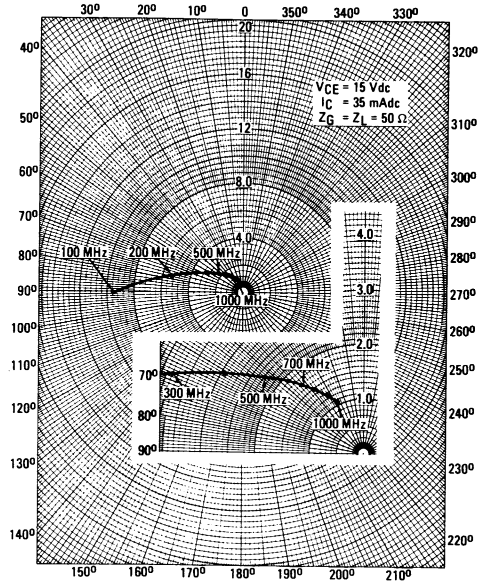

FIGURE 19 – INPUT REFLECTION COEFFICIENT AND OUTPUT REFLECTION COEFFICIENT versus FREQUENCY