

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 (α 450 MHz —
 - NF = 3.0 dB (Max) — 2N4957
 - = 3.3 dB (Max) — 2N4958
 - = 3.8 dB (Max) — 2N4959
- High Power Gain (α 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) (α $I_E = -2.0$ mA dc) — 2N4957
 - = 1.0 GHz (Min) (α $I_E = -2.0$ mA dc) — 2N4958, 2N4959

$I_C = -30$ mA
HIGH FREQUENCY
TRANSISTORS

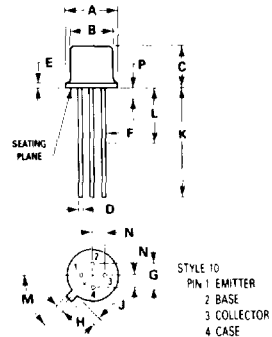
PNP SILICON



***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	mA dc
Total Power Dissipation (α $T_A = 25^\circ\text{C}$ Derate above 25°C)	P_D	200 1.14	mW mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.



NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72
 OUTLINE SHALL APPLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.196
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-206AF
(TO-72)

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***ELECTRICAL CHARACTERISTICS** ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = -1.0\text{ mA}, I_E = 0$)	$V_{(BR)CEO}$	-30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = -100\ \mu\text{A}, I_E = 0$)	$V_{(BR)CBO}$	-30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = -100\ \mu\text{A}, I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = -10\text{ Vdc}, I_E = 0$) ($V_{CB} = -10\text{ Vdc}, I_E = 0, T_A = 150^\circ\text{C}$)	I_{CBO}	—	—	0.1 -100	μA
ON CHARACTERISTICS					
DC Current Gain ($I_C = -2.0\text{ mA}, V_{CE} = -10\text{ Vdc}$)	h_{FE}	20	40	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (1) ($I_E = -2.0\text{ mA}, V_{CE} = -10\text{ Vdc}, f = 100\text{ MHz}$)	f_T	1200 1000	1600 1500	2500 2500	MHz
Collector-Base Capacitance ($V_{CB} = -10\text{ Vdc}, I_E = 0, f = 1.0\text{ MHz}$)	C_{cb}	—	0.4	0.8	pF
Small-Signal Current Gain ($I_C = -2.0\text{ mA}, V_{CE} = -10\text{ Vdc}, f = 1.0\text{ kHz}$)	h_{fe}	20	—	200	—
Collector-Base Time Constant ($I_E = 2.0\text{ mA}, V_{CB} = 10\text{ Vdc}, f = 63.6\text{ MHz}$)	$r_b'C_c$	1.0	—	8.0	ps
Noise Figure ($I_C = -2.0\text{ mA}, V_{CE} = 10\text{ Vdc}, f = 450\text{ MHz}$)	NF	—	2.6 2.9 3.2	3.0 3.3 3.8	dB
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = -10\text{ Vdc}, I_C = -2.0\text{ mA}, f = 450\text{ MHz}$)	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.

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FIGURE 1 — NOISE FIGURE AND POWER GAIN TEST CIRCUIT

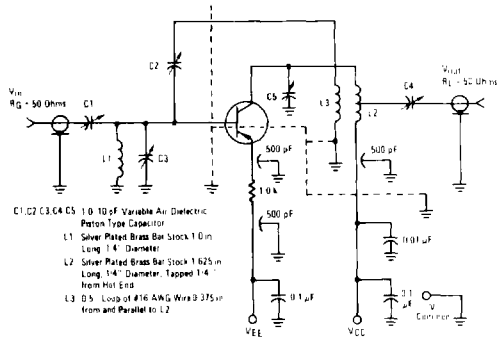


FIGURE 2 — UNILATERALIZED POWER GAIN versus FREQUENCY

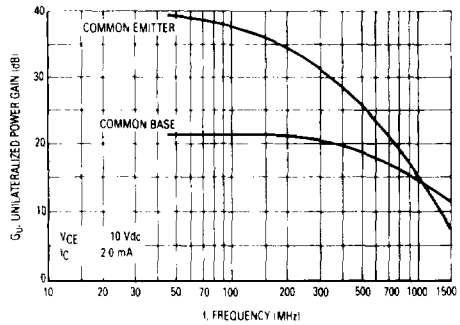


FIGURE 3 — NOISE FIGURE versus FREQUENCY

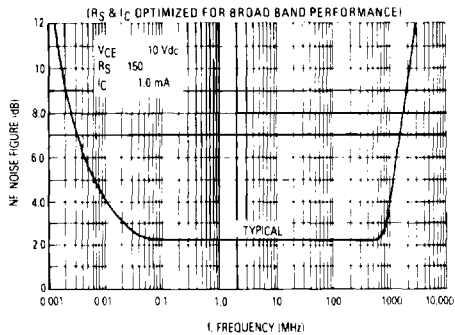


FIGURE 4 — NOISE FIGURE AND POWER GAIN versus COLLECTOR CURRENT

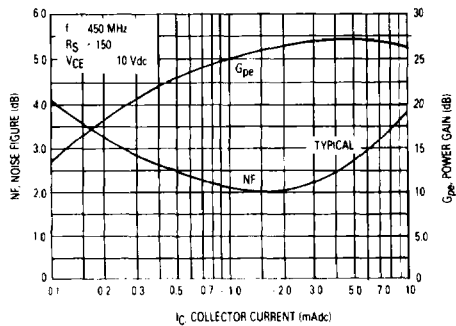


FIGURE 5 — CONTOURS OF NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT

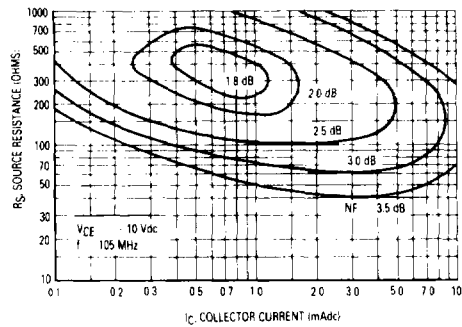
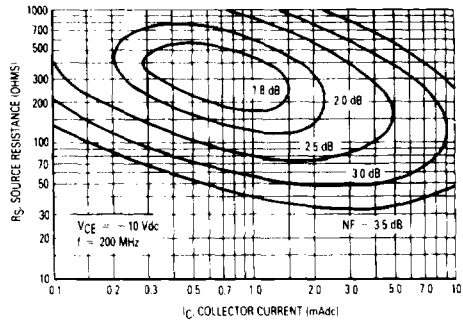


FIGURE 6 — CONTOURS OF NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT

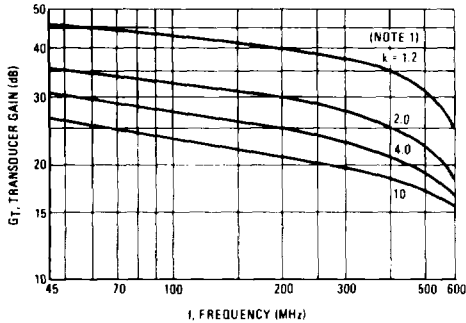


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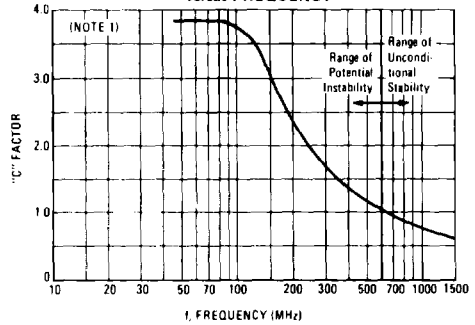
COMMON EMITTER CIRCUIT DESIGN DATA

$V_{CE} = -10 \text{ Vdc}$ $I_C = -2.0 \text{ mA}$

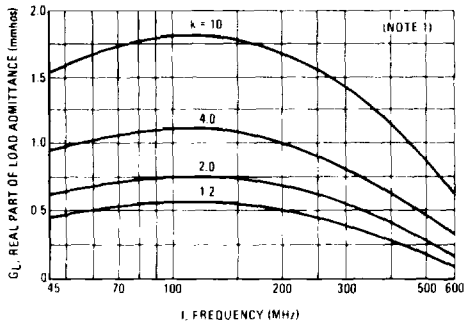
**FIGURE 7 – TRANSDUCER GAIN
versus FREQUENCY**



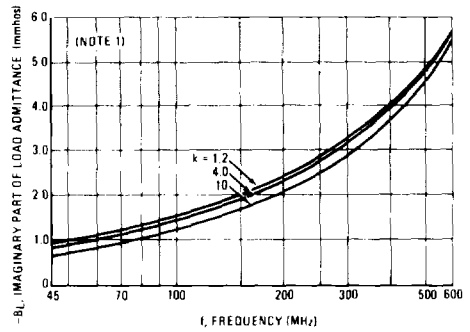
**FIGURE 8 – LINVILL STABILITY FACTOR
versus FREQUENCY**



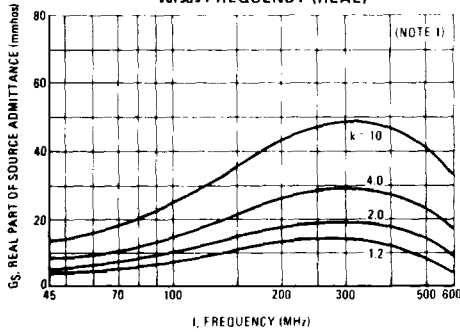
**FIGURE 9 – LOAD ADMITTANCE
versus FREQUENCY (REAL)**



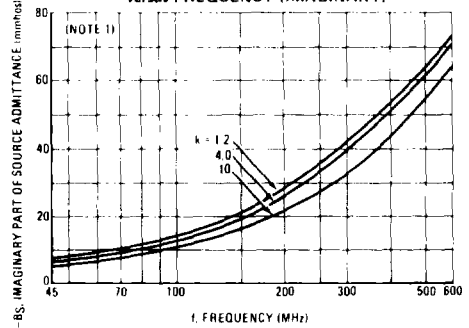
**FIGURE 10 – LOAD ADMITTANCE
versus FREQUENCY (IMAGINARY)**



**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.

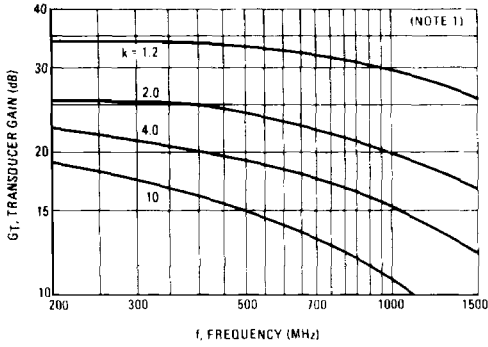
"Stability and Power Gain of Tuned Transistor Amplifiers," Arthur P. Stern, Proc. I.R.E., March, 1967.

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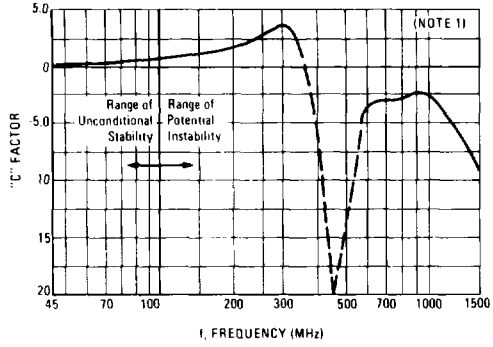
COMMON BASE CIRCUIT DESIGN DATA

$V_{CE} = -10 \text{ Vdc}$ $I_C = -2.0 \text{ mA}$

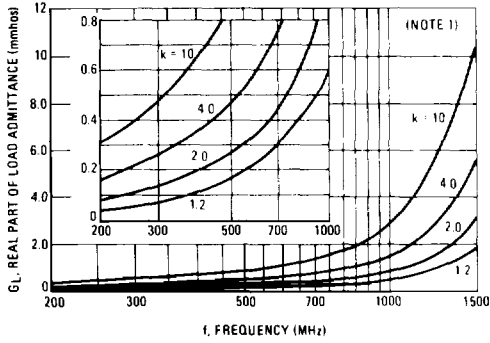
**FIGURE 13 – TRANSDUCER GAIN
versus FREQUENCY**



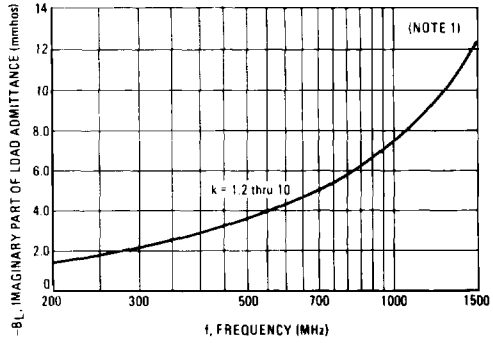
**FIGURE 14 – LINVILL STABILITY FACTOR
versus FREQUENCY**



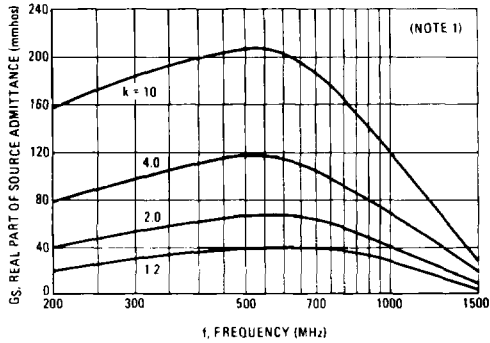
**FIGURE 15 – LOAD ADMITTANCE
versus FREQUENCY (REAL)**



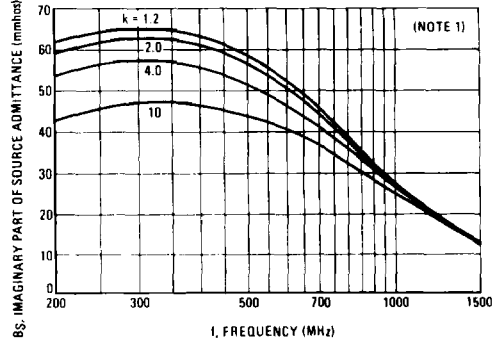
**FIGURE 16 – LOAD ADMITTANCE
versus FREQUENCY (IMAGINARY)**



**FIGURE 17 – SOURCE ADMITTANCE
versus FREQUENCY (REAL)**



**FIGURE 18 – SOURCE ADMITTANCE
versus FREQUENCY (IMAGINARY)**



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FIGURE 19 — SMALL-SIGNAL CURRENT GAIN versus FREQUENCY

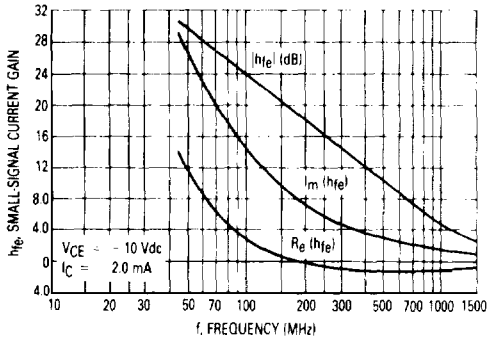


FIGURE 20 — POLAR h_{fe}

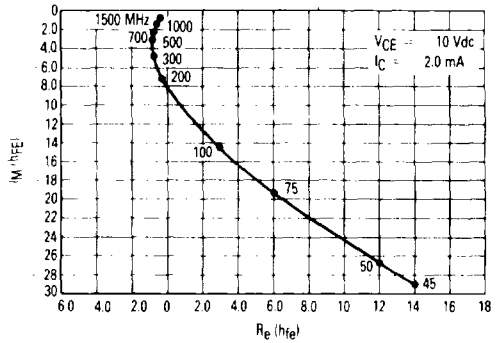


FIGURE 21 — f_T versus COLLECTOR CURRENT

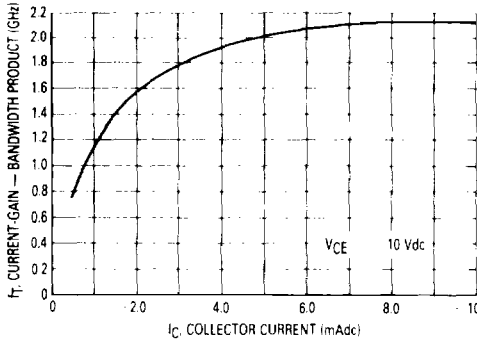


FIGURE 22 — DC CURRENT GAIN

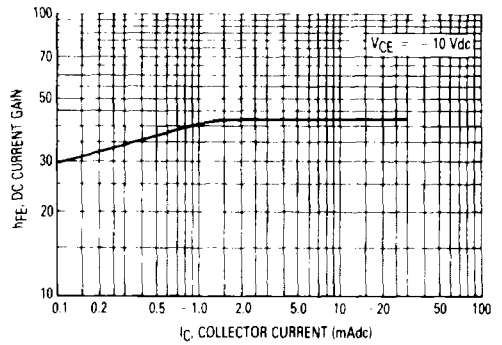


FIGURE 23 — CAPACITANCE

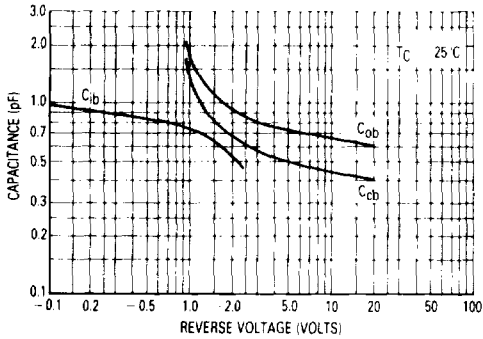
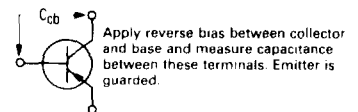
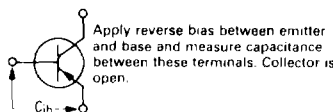
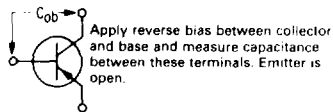
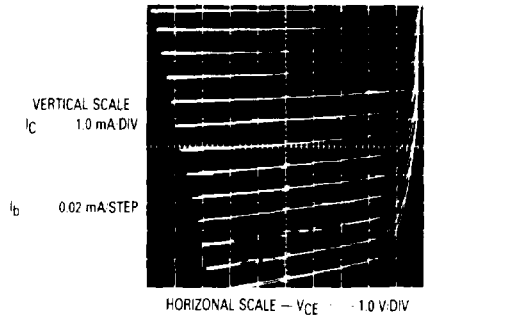


FIGURE 24 — COLLECTOR CHARACTERISTICS



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Y PARAMETERS versus CURRENT (f = 450 MHz)

COMMON BASE

$V_{CB} = -10 \text{ Vdc}$ ——— $V_{CB} = -15 \text{ Vdc}$ - - -

FIGURE 25 – INPUT ADMITTANCE

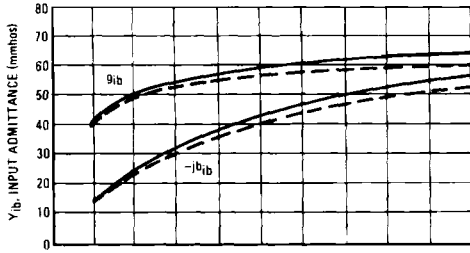


FIGURE 27 – FORWARD TRANSFER ADMITTANCE

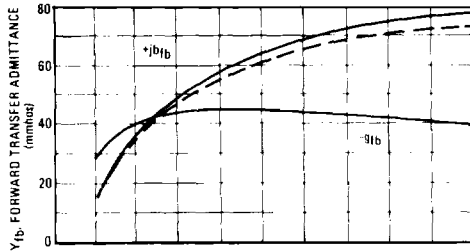


FIGURE 29 – OUTPUT ADMITTANCE

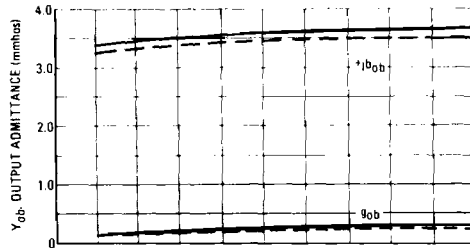
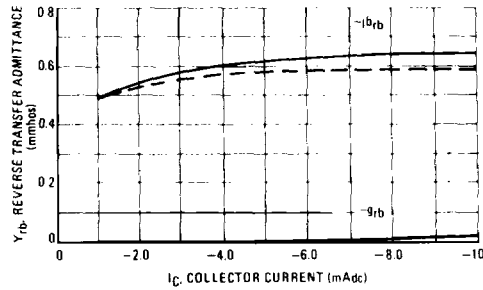


FIGURE 31 – REVERSE TRANSFER ADMITTANCE



COMMON EMITTER

$V_{CE} = -10 \text{ Vdc}$ ——— $V_{CE} = -15 \text{ Vdc}$ - - -

FIGURE 26 – INPUT ADMITTANCE

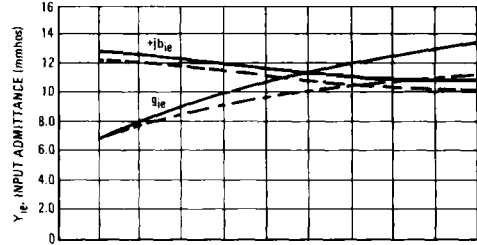


FIGURE 28 – FORWARD TRANSFER ADMITTANCE



FIGURE 30 – OUTPUT ADMITTANCE

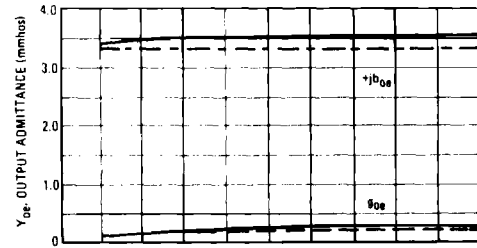
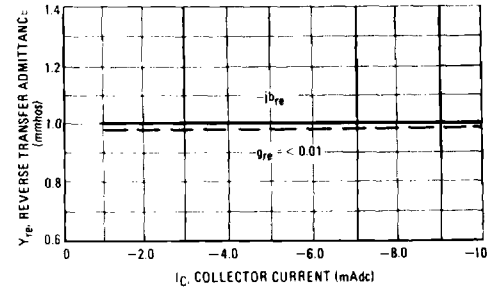


FIGURE 32 – REVERSE TRANSFER ADMITTANCE



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COMMON BASE γ PARAMETER VARIATIONS

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

γ PARAMETERS versus FREQUENCY

FIGURE 33 - y_{ib} INPUT ADMITTANCE

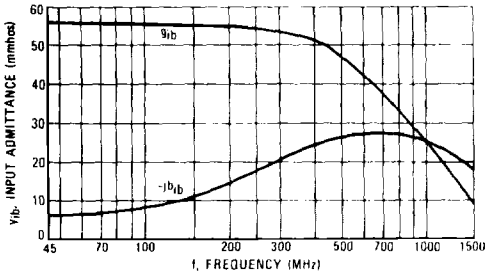


FIGURE 35 - y_{fb} FORWARD TRANSFER ADMITTANCE

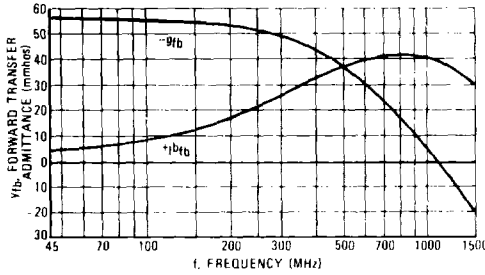


FIGURE 37 - y_{ob} OUTPUT ADMITTANCE

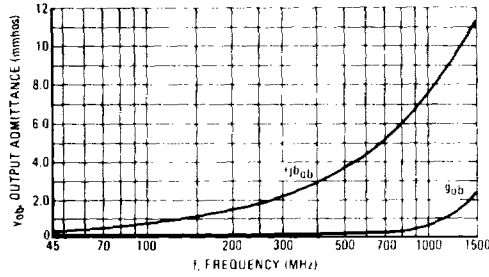
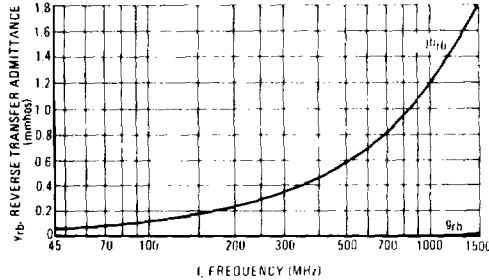


FIGURE 39 - γ_{rb} REVERSE TRANSFER ADMITTANCE



POLAR γ PARAMETERS versus FREQUENCY

FIGURE 34 - y_{ib} INPUT ADMITTANCE

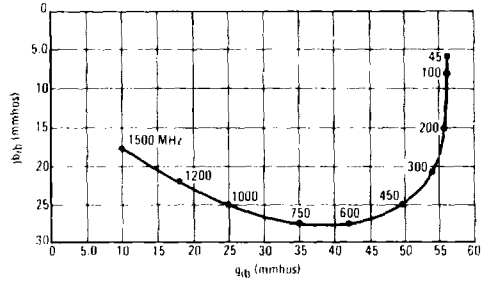


FIGURE 36 - y_{fb} FORWARD TRANSFER ADMITTANCE

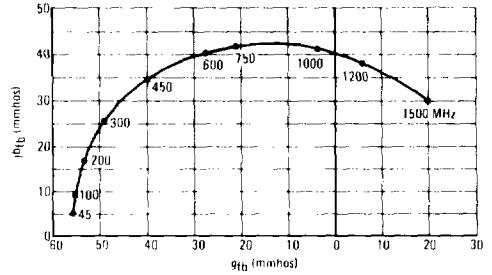


FIGURE 38 - y_{ob} OUTPUT ADMITTANCE

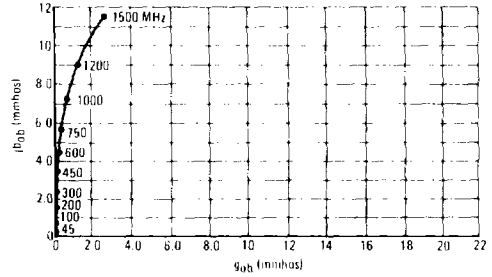
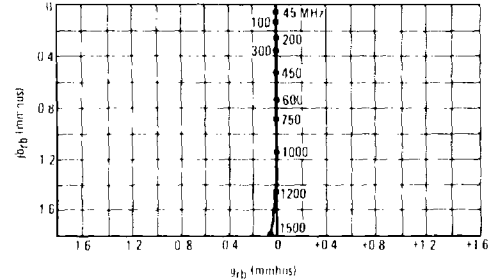


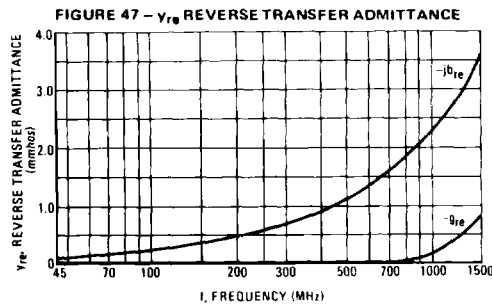
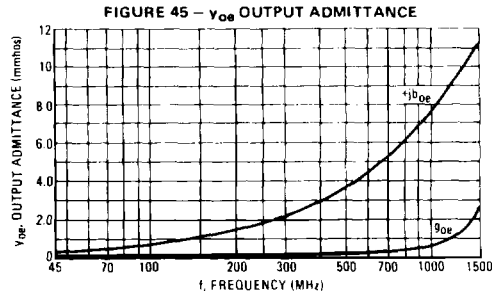
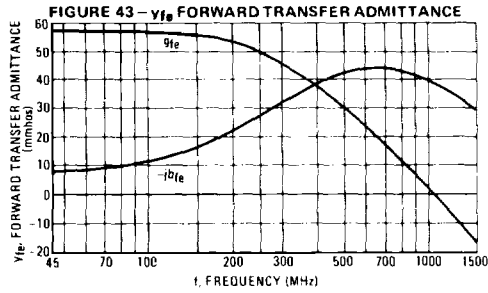
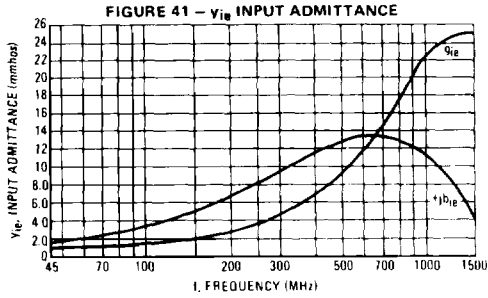
FIGURE 40 - γ_{rb} REVERSE TRANSFER ADMITTANCE



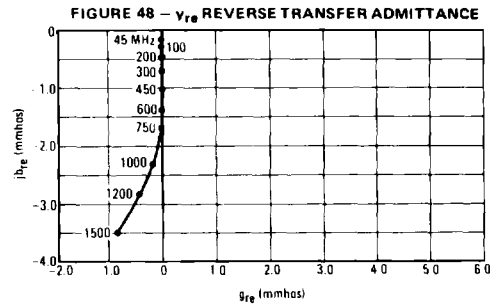
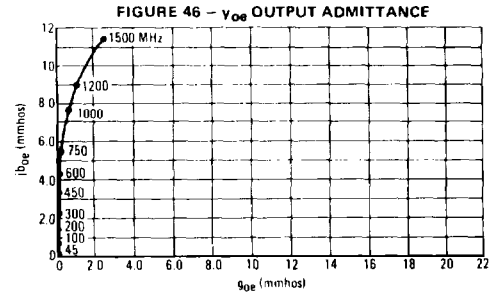
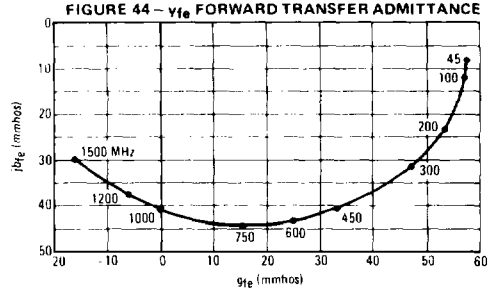
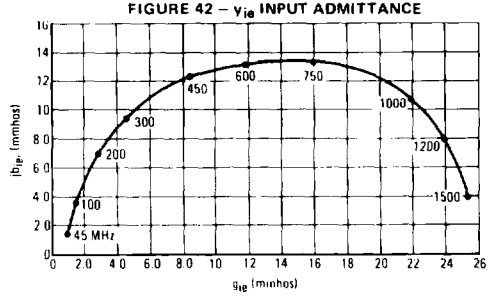
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COMMON EMITTER γ PARAMETER VARIATIONS ($V_{CE} = -10$ Vdc, $I_C = -2.0$ mAdc)

γ PARAMETERS versus FREQUENCY



POLAR γ PARAMETERS versus FREQUENCY



2