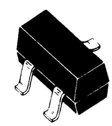
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

BFS17

RF TRANSISTOR

NPN SILICON



CASE 318-02/03, STYLE 6
SOT-23
(TO-236AA/AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25°C$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μA)	$V_{(BR)CBO}$	25	—	Vdc
Collector Cutoff Current ($V_{CE} = 10$ V)	I_{CEO}	—	25	nA
Collector Cutoff Current ($V_{CB} = 10$ V)	I_{CBO}	—	25	nA
Emitter Cutoff Current ($V_{EB} = 4.0$ V)	I_{EBO}	—	100	μA
ON CHARACTERISTICS				
DC Current Gain ($I_C = 2.0$ mA, $V_{CE} = 1.0$ V) ($I_C = 25$ mA, $V_{CE} = 1.0$ V)	h_{FE}	 20 20	 150 —	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mA, $I_B = 1.0$ mA)	$V_{CE(sat)}$	—	0.4	V
Base-Emitter Saturation Voltage ($I_C = 10$ mA, $I_B = 1.0$ mA)	$V_{BE(sat)}$	—	1.0	V
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 2.0$ mA, $V_{CE} = 5.0$ V, f = 500 MHz) ($I_C = 25$ mA, $V_{CE} = 5.0$ V, f = 500 MHz)	f_T	 1.0 1.3*	 — —	GHz
Output Capacitance ($V_{CB} = 10$ V, f = 1.0 MHz)	CCB	—	1.0*	pF
Noise Figure ($I_C = 2.0$ mA, $V_{CE} = 5.0$ V, $R_S = 50\ \Omega$, f = 30 MHz)	NF	—	5.0*	dB

*Typ

BFW92A

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTORS

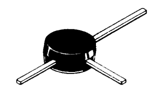
. . . designed primarily for use in MATV/CATV amplifiers and other broadband linear applications demanding high power gain with low noise over a wide current range.

- High Power Gain — MAG = 16 dB (Typ) @ f = 0.5 GHz
- Low Noise Figure — NF = 2.7 dB (Typ) @ f = 0.5 GHz
- Ion-Implanted Arsenic Emitters
- Gold Top Metal
- Silicon Nitride Passivation
- Industry Standard Plastic Macro-T Package
- Compatible with Other BFW92 Types

f_T = 4.5 GHz @ 10 mA

HIGH FREQUENCY TRANSISTOR

NPN SILICON



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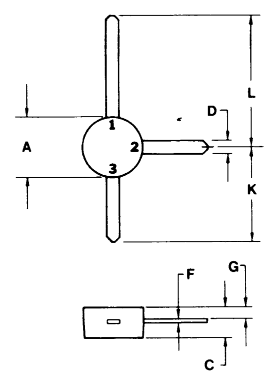
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector-Current — Continuous	I_C	35	mAdc
Total Device Dissipation @ T_C = 105°C Derate Above 105°C	P_D	180 4.0	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction to Case (2)	$R_{\theta JC}$	250	°C/W

Note: Case temperature measured on collector lead immediately adjacent to body of package



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

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.94	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450

CASE 317A-01

ELECTRICAL CHARACTERISTICS (T_C = 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)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	20	50	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	f_T	—	4.5	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, f = 1.0 MHz, Emitter Guarded)	C_{cb}	—	0.5	1.0	pF
FUNCTIONAL PERFORMANCE					
Optimum Noise Figure (Tuned) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	NF_{opt}	—	2.7	—	dB
Noise Figure (Untuned, R_S = R_L = 50 Ω) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	NF	—	3.0	—	dB
Maximum Available Gain (1) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	MAG	—	16	—	dB
Insertion Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	$\lvert S_{21}\rvert^2$	—	14	—	dB

(1) $G_{max} = \dfrac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

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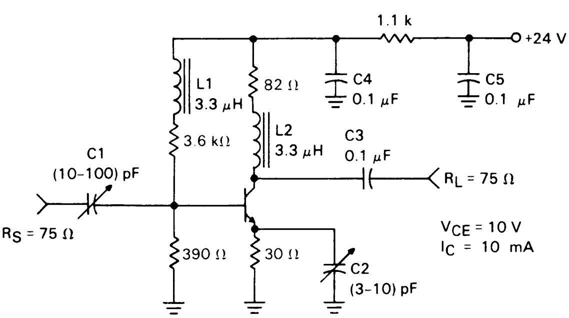
FIGURE 1 — 30-900 MHz BROADBAND AMPLIFIER



C3, C4, C5 — 0.1 μF Chip Capacitor
L1, L2 — 3.3 μH Molded Inductor

All Resistors 1/4 W, 20%

FIGURE 2 — BROADBAND GAIN (Circuit Figure 1)

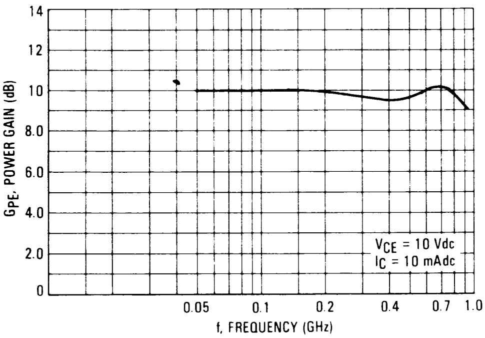


FIGURE 3 — 2nd AND 3rd ORDER INTERCEPT POINTS

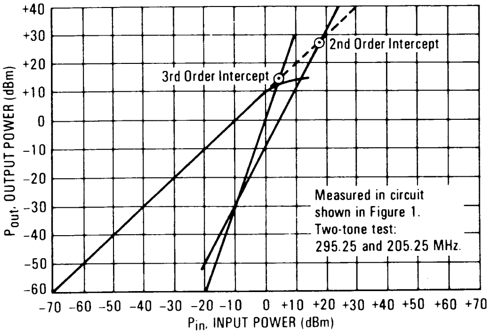


FIGURE 4 — MAXIMUM AVAILABLE GAIN versus FREQUENCY

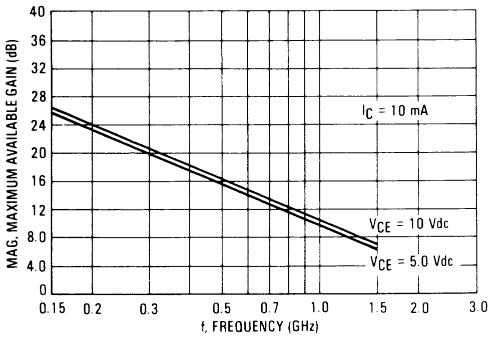


FIGURE 5 — $|S_{21}|^2$ versus FREQUENCY

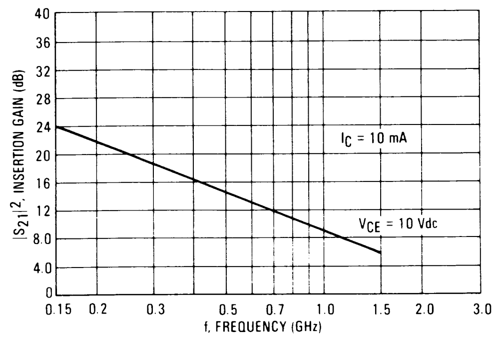


FIGURE 6 — MAXIMUM AVAILABLE GAIN versus COLLECTOR CURRENT

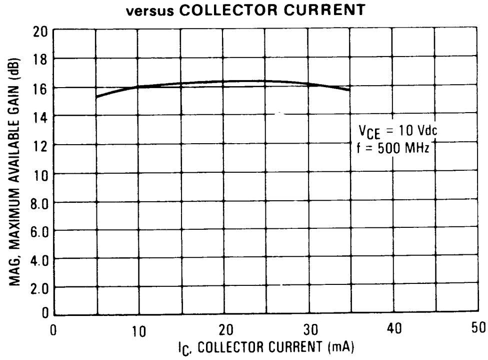


FIGURE 7 — GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT

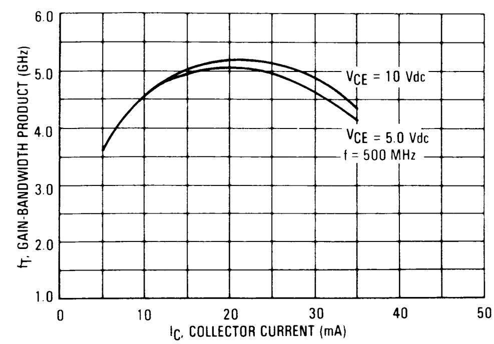


FIGURE 8 — NOISE FIGURE versus COLLECTOR CURRENT

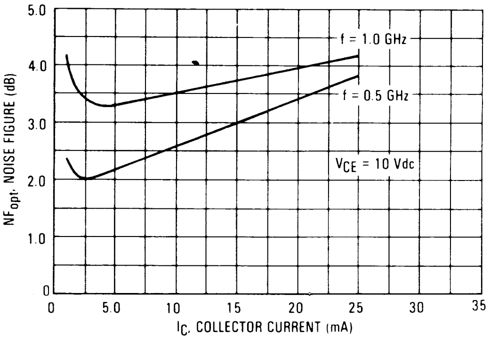


FIGURE 9 — NOISE FIGURE versus COLLECTOR CURRENT Untuned, $R_S = R_L = 50\ \Omega$

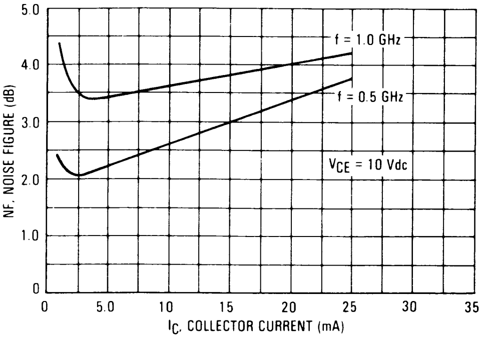


FIGURE 10 — NOISE FIGURE versus FREQUENCY

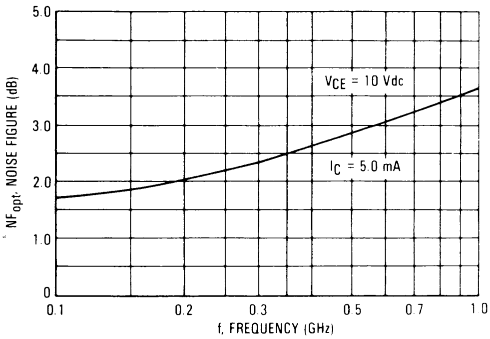


FIGURE 11 — NOISE FIGURE versus FREQUENCY Untuned $R_S = R_L = 50\ \Omega$

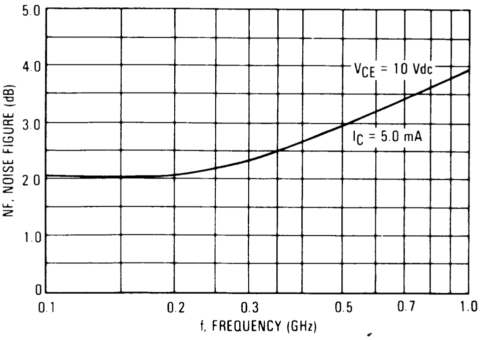


FIGURE 12 — C_{ib} INPUT CAPACITANCE versus EMITTER BASE VOLTAGE

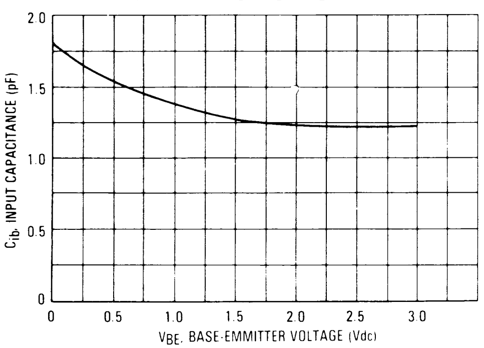
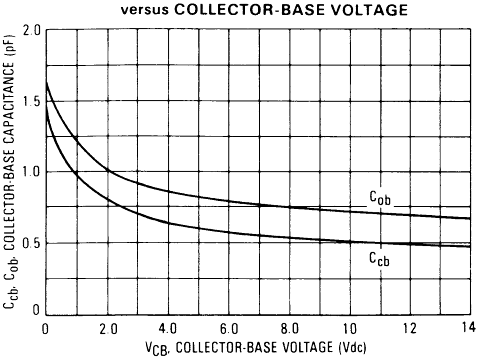


FIGURE 13 — COLLECTOR-BASE CAPACITANCE versus COLLECTOR-BASE VOLTAGE



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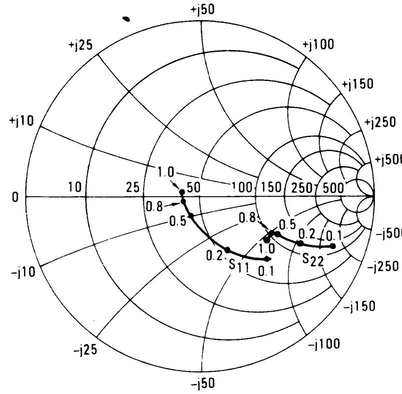
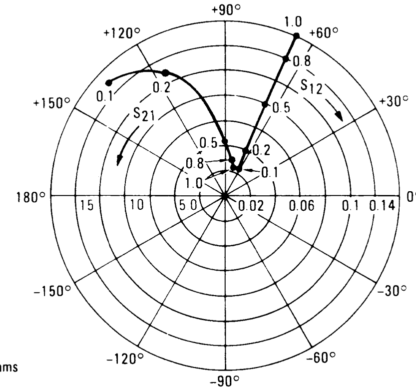
BFW92A COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 10 mA)



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 10 mA)



Coordinates in Ohms

V_{CE} (Volts)	I_C (mA)	f (MHz)	S11 $\|S_{11}\|$	S11 ∠φ	S21 $\|S_{21}\|$	S21 ∠φ	S12 $\|S_{12}\|$	S12 ∠φ	S22 $\|S_{22}\|$	S22 ∠φ
5.0	5.0	100	0.71	-33	11.2	145	0.031	69	0.87	-18
		200	0.49	-60	8.6	122	0.052	62	0.70	-26
		500	0.21	-119	4.5	92	0.094	61	0.48	-30
		800	0.17	-161	3.0	78	0.137	60	0.44	-36
		1000	0.16	176	2.5	71	0.164	60	0.44	-40
	10	100	0.52	-46	16.6	135	0.027	67	0.78	-23
		200	0.31	-75	11.2	113	0.044	65	0.58	-29
		500	0.14	-150	5.2	88	0.089	67	0.40	-29
		800	0.15	173	3.3	76	0.135	65	0.37	-34
		1000	0.16	154	2.8	70	0.164	64	0.37	-38
	15	100	0.40	-55	19.7	129	0.025	69	0.72	-26
		200	0.22	-88	12.1	109	0.041	68	0.52	-29
		500	0.14	-170	5.4	86	0.087	70	0.36	-27
		800	0.16	161	3.5	76	0.134	68	0.34	-33
		1000	0.17	145	2.9	69	0.164	66	0.35	-37
	20	100	0.33	-62	21.1	125	0.023	69	0.68	-27
		200	0.18	-99	12.5	106	0.039	69	0.49	-28
		500	0.14	178	5.5	85	0.086	72	0.35	-26
		800	0.17	155	3.5	75	0.133	69	0.33	-32
		1000	0.18	142	2.9	69	0.164	67	0.34	-37
	25	100	0.27	-69	21.9	122	0.022	70	0.65	-27
		200	0.15	-111	12.7	104	0.038	71	0.47	-27
		500	0.16	172	5.5	85	0.085	73	0.35	-25
		800	0.19	153	3.5	75	0.132	70	0.33	-31
		1000	0.20	140	2.9	69	0.163	68	0.33	-36
10	5.0	100	0.73	-30	11.1	146	0.026	71	0.90	-14
		200	0.53	-52	8.8	124	0.044	63	0.75	-21
		500	0.21	-98	4.7	94	0.082	62	0.57	-25
		800	0.14	-136	3.1	80	0.120	62	0.53	-30
		1000	0.11	-161	2.6	73	0.143	62	0.53	-34
	10	100	0.57	-39	16.7	137	0.023	70	0.82	-18
		200	0.35	-62	11.5	115	0.038	66	0.65	-23
		500	0.12	-117	5.4	89	0.078	69	0.50	-23
		800	0.09	-163	3.5	78	0.118	67	0.47	-28
		1000	0.09	168	2.9	71	0.144	66	0.48	-32
	15	100	0.46	-46	19.9	130	0.021	70	0.77	-20
		200	0.26	-68	12.6	110	0.035	68	0.60	-22
		500	0.09	-137	5.6	87	0.076	71	0.47	-21
		800	0.09	177	3.7	77	0.117	69	0.45	-27
		1000	0.10	153	3.0	71	0.143	68	0.46	-31
	20	100	0.39	-50	21.5	126	0.020	70	0.74	-21
		200	0.21	-73	13.0	107	0.034	71	0.58	-21
		500	0.08	-154	5.7	86	0.075	72	0.46	-20
		800	0.10	168	3.7	76	0.117	70	0.45	-27
		1000	0.11	148	3.0	71	0.142	69	0.45	-31
	25	100	0.34	-54	22.3	123	0.019	70	0.71	-20
		200	0.17	-79	13.0	105	0.033	71	0.57	-20
		500	0.08	-166	5.7	86	0.075	73	0.47	-19
		800	0.11	162	3.7	76	0.116	70	0.45	-26
		1000	0.13	144	3.0	70	0.141	69	0.46	-30

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

BFX89
BFY90

The RF Line

f_T = 2.0 GHz @ 10 mA

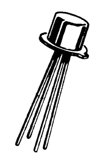
HIGH FREQUENCY TRANSISTORS

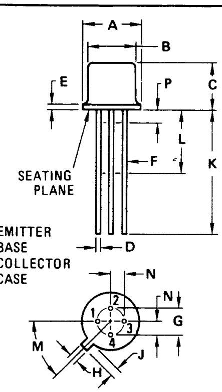
NPN SILICON

NPN SILICON HIGH-FREQUENCY TRANSISTORS

. . . designed for VHF and UHF applications where high-gain, low-noise and good intermodulation characteristics are required. Particularly suited for wideband MATV amplifiers.

- High Current-Gain — Bandwidth Product — f_T
  1.2 GHz (Min) @ I_C = 25 mAdc — BFX89
  1.3 GHz (Min) @ I_C = 25 mAdc — BFY90
- Low Noise Figure — NF
  6.5 dB (Max) @ f = 500 MHz — BFX89
  5.0 dB (Max) @ f = 500 MHz — BFY90
- High Power Gain — G_{pe}
  19 dB (Min) @ f = 200 MHz — BFX89
  21 dB (Typ) @ f = 200 MHz — BFY90
- JEDEC Equivalents — 2N6304, 2N6305





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

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	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

ALL JEDEC dimensions and notes apply

CASE 20-3
TO-72

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	50	mAdc
Total Continuous Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)		$V_{(BR)CEO}$	15	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)		I_{CBO}	—	—	10	nAdc
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 2.0 mAdc, V_{CE} = 1.0 Vdc)			25	—	150	
(I_C = 25 mAdc, V_{CE} = 1.0 Vdc)			20	—	125	
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (1)	BFX89	C_{cbo}	—	0.85	1.7	pF
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	BFY90		—	0.85	1.5	
Emitter-Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	BFY90	C_{ibo}	—	—	2.0	pF
Current-Gain-Bandwidth Product (2)		f_T				GHz
(I_C = 2.0 mA, V_{CE} = 5.0 Vdc, f = 500 MHz)	BFX89		—	1.0	—	
	BFY90		1.0	—	—	
(I_C = 25 mA, V_{CE} = 5.0 Vdc, f = 500 MHz)	BFX89		1.2	1.1	—	
	BFY90		1.3	—	—	
FUNCTIONAL TEST						
Common-Emitter Amplifier Power Gain (2)	BFX89	G_{pe}	19	—	—	dB
(V_{CE} = 10 Vdc, I_C = 8.0 mA, f = 200 MHz)	BFY90		—	21	—	
Spot Noise Figure (R_S = Optimum) (2)	BFX89	NF	—	2.5	6.5	dB
(V_{CE} = 5.0 Vdc, I_C = 2.0 mA, f = 500 MHz)	BFY90		—	2.5	5.0	

Notes 1. Pin 4 is not grounded.
2. Pin 4 is grounded.
3. $G_u(max)$ is calculated from the S-Parameters using the equation $G_u(max) = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

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FIGURE 1 — POWER GAIN versus FREQUENCY

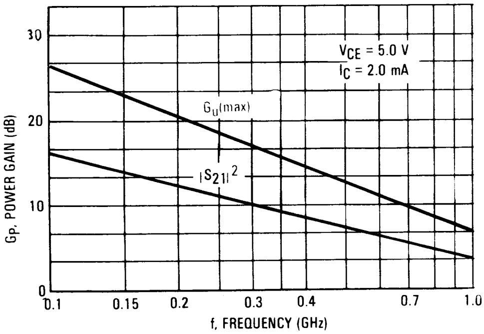


FIGURE 2 — POWER GAIN versus COLLECTOR CURRENT

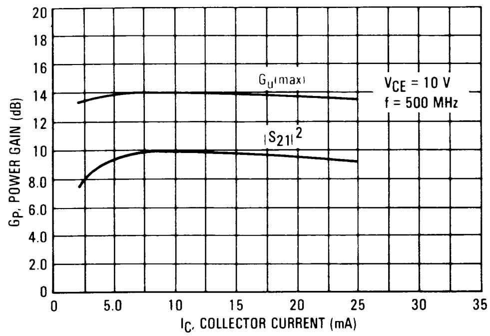


FIGURE 3 — NOISE FIGURE versus FREQUENCY

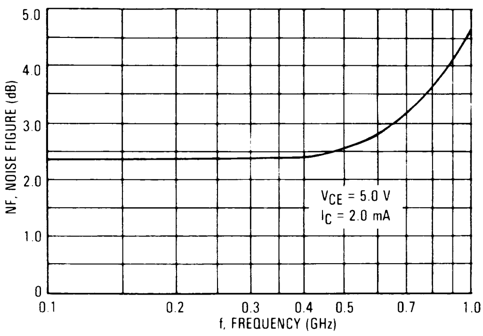


FIGURE 4 — NOISE FIGURE versus COLLECTOR CURRENT

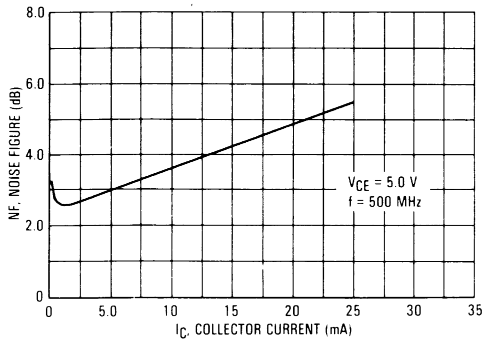


FIGURE 5 — CURRENT GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT

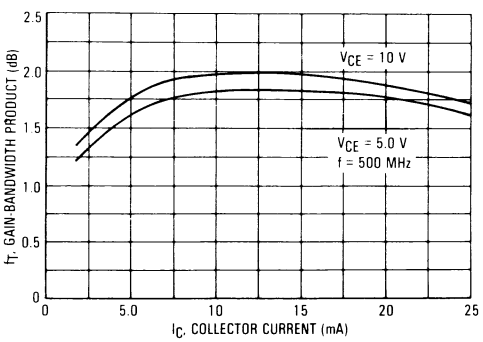
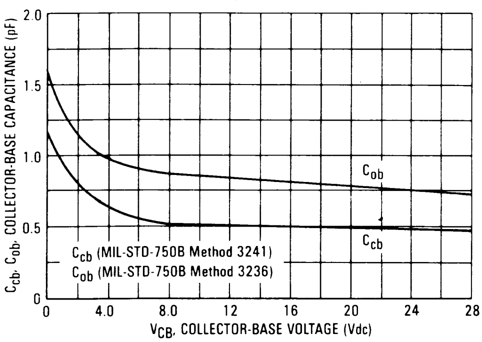


FIGURE 6 — OUTPUT CAPACITANCE versus VOLTAGE



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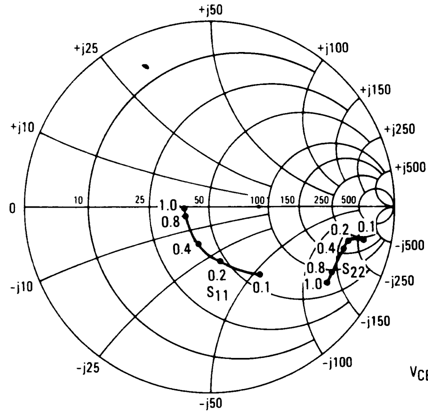
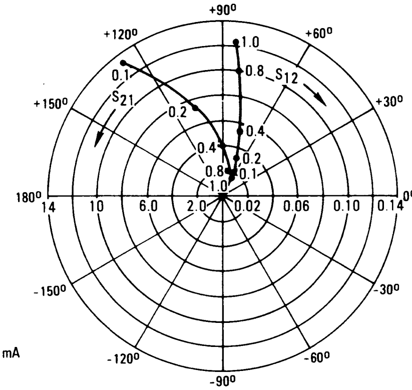
COMMON EMITTER SCATTERING PARAMETERS

FIGURE 7 — INPUT AND OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY



Coordinates in Ohms

FIGURE 8 — FORWARD AND REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY



V_{CE} = 10 V, I_C = 10 mA

S — PARAMETERS

V_{CE} (Volts)	I_C (mA)	Frequency (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
5.0	2.0	100	0.81	-37	5.76	148	0.031	72	0.95	-11
		200	0.64	-66	4.56	127	0.050	63	0.87	-17
		400	0.41	-105	2.91	102	0.071	62	0.79	-23
		800	0.26	-157	1.63	77	0.105	74	0.75	-34
		1000	0.23	179	1.38	68	0.129	80	0.74	-41
	5.0	100	0.60	-54	9.73	133	0.026	68	0.87	-13
		200	0.41	-84	6.33	112	0.040	66	0.78	-17
		400	0.26	-121	3.54	92	0.064	72	0.73	-21
		800	0.19	-169	1.89	72	0.112	80	0.72	-31
		1000	0.17	168	1.59	64	0.140	82	0.71	-39
	10	100	0.71	-66	12.13	122	0.022	70	0.81	-14
		200	0.28	-96	7.11	104	0.036	71	0.73	-15
		400	0.19	-133	3.85	88	0.064	77	0.70	-19
		800	0.18	-178	2.00	69	0.115	83	0.71	-30
		1000	0.17	160	1.66	61	0.143	84	0.70	-37
	25	100	0.26	-88	12.79	112	0.019	73	0.76	-13
		200	0.20	-122	7.04	97	0.034	76	0.71	-13
		400	0.20	-156	3.68	83	0.062	81	0.70	-18
		800	0.23	165	1.88	65	0.114	86	0.71	-30
		1000	0.24	146	1.56	58	0.145	88	0.70	-38
10	2.0	100	0.83	-34	5.82	150	0.025	73	0.96	-9
		200	0.66	-61	4.60	129	0.042	65	0.89	-15
		400	0.42	-97	2.98	104	0.059	64	0.83	-20
		800	0.25	-147	1.69	79	0.088	77	0.80	-31
		1000	0.20	-172	1.42	70	0.108	82	0.79	-38
	5.0	100	0.63	-48	9.94	135	0.021	70	0.90	-11
		200	0.43	-76	6.54	114	0.034	68	0.82	-15
		400	0.26	-108	3.72	94	0.054	73	0.77	-19
		800	0.16	-155	1.98	74	0.095	83	0.77	-24
		1000	0.14	180	1.65	66	0.119	85	0.76	-36
	10	100	0.47	-57	12.42	125	0.019	70	0.85	-12
		200	0.30	-83	7.43	106	0.031	72	0.78	-14
		400	0.19	-113	4.04	90	0.054	78	0.75	-18
		800	0.14	-160	2.09	71	0.098	84	0.75	-28
		1000	0.13	173	1.73	64	0.121	86	0.75	-35
	25	100	0.32	-71	13.05	114	0.017	72	0.81	-11
		200	0.21	-99	7.27	99	0.029	76	0.77	-12
		400	0.16	-135	3.81	85	0.052	81	0.76	-16
		800	0.17	177	1.96	68	0.096	87	0.76	-28
		1000	0.18	154	1.62	61	0.120	89	0.76	-35

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