NEC®

NPN SILICON MICROWAVE TRANSISTOR

NE87100 NE87112

FEATURES

- **HIGH GAIN BANDWIDTH PRODUCT:** f_T = 2 GHz
- **LOW NOISE FIGURE:** NF = 1.5 dB at 70 MHz
- **HIGH BREAKDOWN VOLTAGE:** V_{CBO} = 45 V

DESCRIPTION AND APPLICATIONS

The NE871 NPN Silicon Transistor series is designed for low-noise IF and RF amplifier applications up to 2 GHz. High input impedance, low noise figure and high f_T make this series well adapted to mixer applications and general purpose amplifiers. The series is available in either chip form or in the economical TO-72 package. The series uses NEC's platinum-silicide, titanium, platinum and gold metallization system to assure performance reliability and consistency.

PERFORMANCE SPECIFICATIONS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE87112 2SC1260 12 (TO-72)		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX
f_T	Gain Bandwidth Product at V_{CE} = 6 V, I_C = 6 mA	GHz	1.5	2	
$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = 6 V, I_C = 6 mA f = 0.2 GHz f = 0.5 GHz f = 1 GHz	 dB dB dB		 17 11 5	
NF_{MIN}	Minimum Noise Figure at V_{CE} = 6 V, I_C = 2 mA, R_G = 200 Ω f = 70 MHz R_G = 50 Ω f = 0.5 GHz	 dB dB		 1.5 3	 4
MAG	Maximum Available Gain[2] at V_{CE} = 6 V, I_C = 6 mA f = 0.2 GHz f = 0.5 GHz f = 1 GHz	 dB dB dB		 22 13 8	

Notes:

1. Electronic Industrial Association of Japan.
2. Maximum Available Gain (MAG) is calculated from the device S-Parameters using the equation, $MAG = |S_{21E}|^2 \cdot \frac{1}{1-|S_{11E}|^2} \cdot \frac{1}{1-|S_{22E}|^2}$

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE87112 2SC1260 12 (TO-72)		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX
I_{CBO}	Collector Cutoff Current at V_{CB} = 30 V, I_E = 0	μA			0.1
I_{EBO}	Emitter Cutoff Current at V_{EB} = 2 V, I_C = 0	μA			0.1
h_{FE}	Forward Current Gain at V_{CE} = 6 V, I_C = 6 mA		40	100	200
C_{CB}	Collector to Base Capacitance[3] at V_{CB} = 6 V, I_E = 0, f = 1 MHz	pF		0.5	0.7
R_{TH}	Thermal Resistance (Junction-to-Case)	°C/W			300
P_T	Total Power Dissipation	mW			250

Notes:

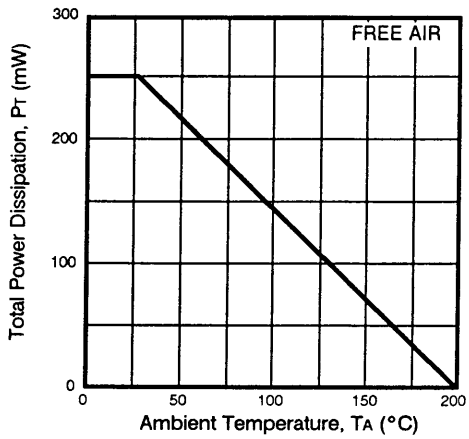
1. Electronic Industrial Association of Japan.
2. C_{CB} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal.

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

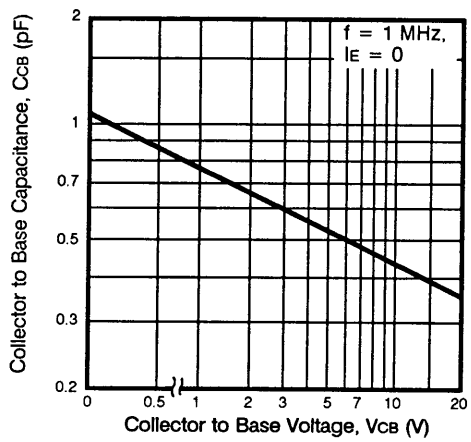
SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	45
V_{CEO}	Collector to Emitter Voltage	V	25
V_{EBO}	Emitter to Base Voltage	V	4
I_C	Collector Current	mA	30
T_J	Junction Temperature	°C	200
T_{STG}	Storage Temperature	°C	-65 to +200

TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

POWER DERATING CURVE

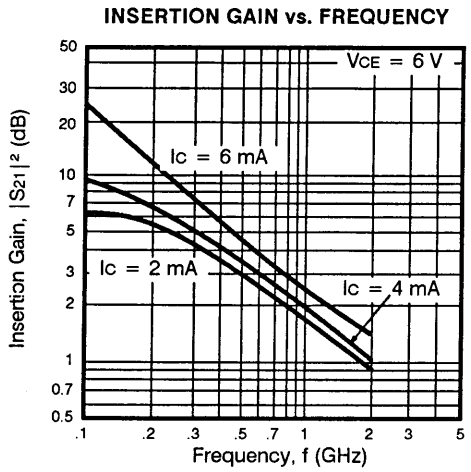


COLLECTOR TO BASE CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE

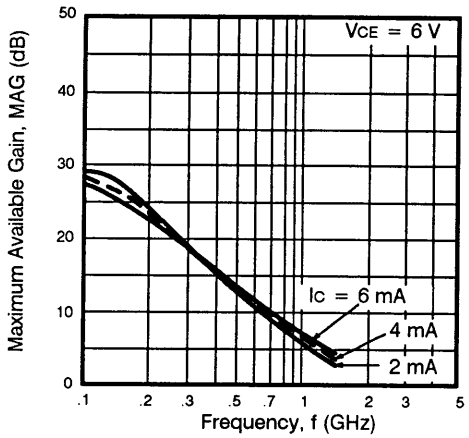


TYPICAL GAIN CHARACTERISTICS (T_A = 25°C)

INSERTION GAIN vs. FREQUENCY

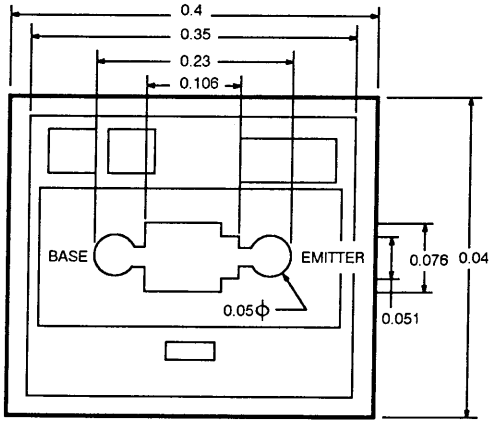


MAXIMUM AVAILABLE GAIN² vs. FREQUENCY

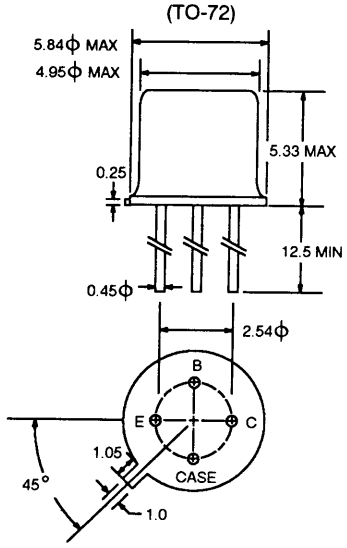


OUTLINE DIMENSIONS (Units in mm)

NE87100 (CHIP)
(Chip Thickness: 140 µm to 160 µm)

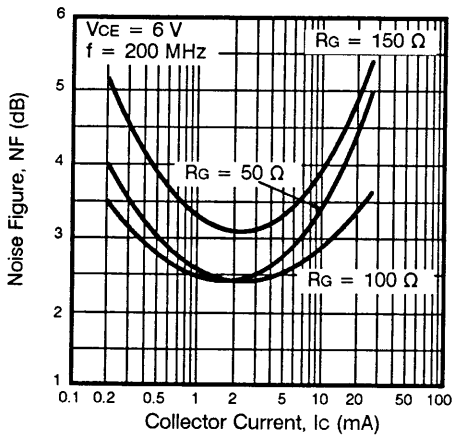


OUTLINE 12
(TO-72)

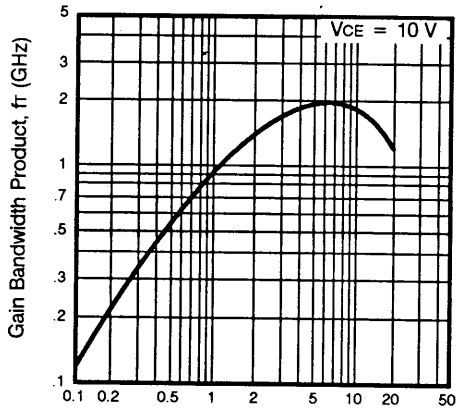


TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

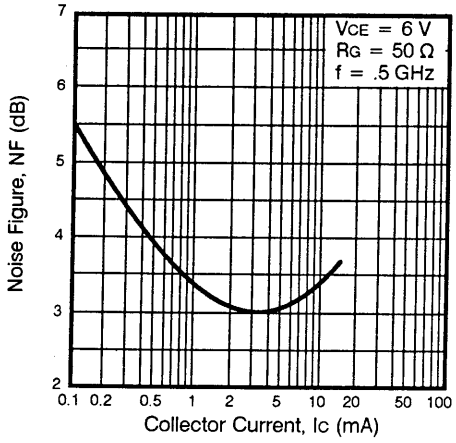
NOISE FIGURE vs. COLLECTOR CURRENT



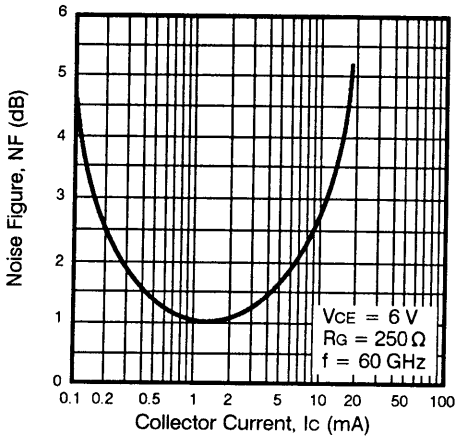
GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



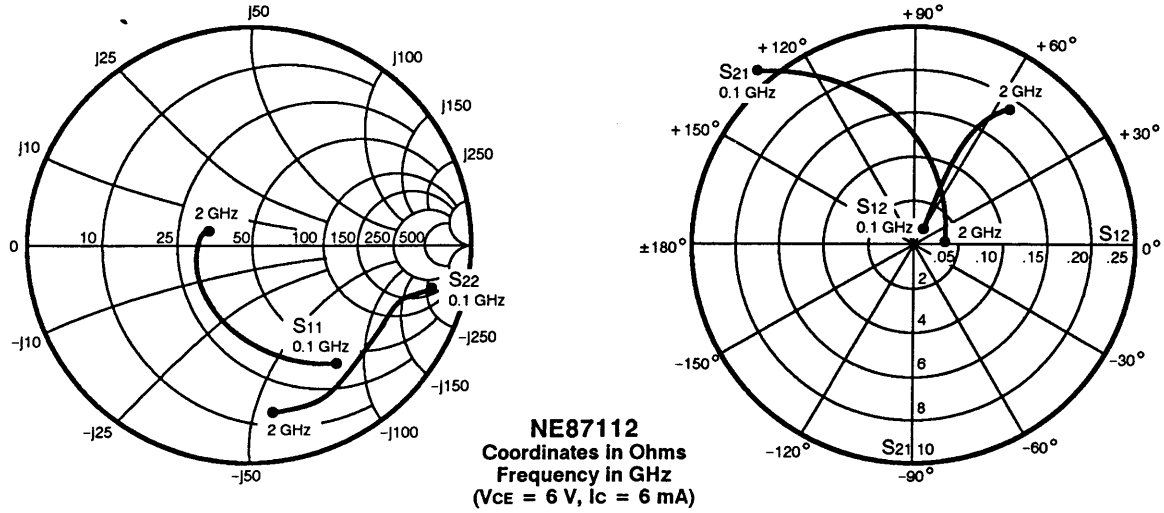
NOISE FIGURE vs. COLLECTOR CURRENT



NOISE FIGURE vs. COLLECTOR CURRENT



TYPICAL COMMON EMITTER SCATTERING PARAMETERS



NE87112
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 6 V, I_C = 6 mA)

S-MAGN AND ANGLES:

VCE = 6 V, IC = 2 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	.86	-30	5.61	150	.02	71	.94	-11
200	.73	-54	4.73	130	.05	62	.88	-18
500	.46	-99	2.79	93	.08	53	.77	-29
1000	.30	-142	1.63	61	.11	57	.72	-44
1500	.25	-169	1.20	37	.15	59	.75	-64
2000	.20	171	0.92	14	.18	56	.79	-84

VCE = 6 V, IC = 4 mA

100	.75	-43	8.89	138	.02	71	.89	-13
200	.56	-70	6.51	117	.04	60	.81	-18
500	.32	-113	3.25	84	.07	61	.72	-27
1000	.24	-154	1.81	57	.12	64	.70	-43
1500	.22	-178	1.32	34	.16	60	.74	-62
2000	.17	166	0.99	12	.18	56	.77	-83

VCE = 6 V, IC = 6 mA

100	.65	-52	10.62	131	.02	66	.86	-14
200	.46	-79	7.19	109	.03	65	.77	-18
500	.28	-124	3.36	81	.07	64	.71	-26
1000	.23	-162	1.85	54	.12	65	.70	-42
1500	.22	173	1.33	32	.16	62	.74	-61
2000	.17	157	0.99	10	.19	57	.78	-83

VCE = 6 V, IC = 10 mA

100	.51	-68	11.76	121	.02	68	.82	-13
200	.35	-97	7.18	102	.03	66	.76	-15
500	.26	-142	3.21	76	.07	68	.72	-24
1000	.25	-177	1.74	51	.11	70	.71	-41
1500	.25	158	1.25	30	.16	67	.75	-62
2000	.20	135	0.93	7	.20	61	.79	-84

NEC®

PNP SILICON HIGH FREQUENCY TRANSISTOR

NE88900
NE88912
NE88933
NE88935

FEATURES

- **PNP COMPLEMENT TO NE327**
- **HIGH GAIN BANDWIDTH PRODUCT:** f_T = 4 GHz
- **HIGH GAIN:** 18 dB at 500 MHz
- **LOW NOISE:** 2 dB at 500 MHz
- **RELIABLE:** Gold Metallization and Rugged Packages

DESCRIPTION AND APPLICATIONS

The NE889 series of PNP silicon transistors is designed for ultra high speed current mode switching applications and microwave amplifiers up to 2 GHz. The NE889 is available in several package styles and in chip form (NE88900). The NE88935 is an economical metal ceramic stripline version which features low parasitic elements and is ideal for low cost hybrid circuits. Reliability is assured by NEC's stringent production controls, which are patterned after MIL-S-19500 and Pt/Si-Ti-Pt-Au metallization.

2

PERFORMANCE SPECIFICATIONS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE88900 00 (CHIP)			NE88912 2SA1228 12 (TO-72)			NE88933 2SA1424 33 (MINI-MOLD)			NE88935 2SA1223 35 (MICRO-X)		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
f_T	Gain Bandwidth Product at V_{CE} = -5 V, I_C = -15 mA	GHz		4			4		3	4		3	4	
$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = -10 V, I_C = -15 mA, f = 0.5 GHz f = 1 GHz f = 2 GHz	 dB dB dB					 13 7.2 2			 6			 16 10 4.2	
NF_{MIN}	Minimum Noise Figure[2] at V_{CE} = -10 V, I_C = -3 mA, f = 0.2 GHz f = 0.5 GHz f = 1 GHz	 dB dB dB		 2.5			 2 2.5 3			 3	 4		 1.8 2 2.5	 3.5 4
MAG	Maximum Available Gain[3] at V_{CE} = -10 V, I_C = -15 mA, f = 0.5 GHz f = 1 GHz f = 2 GHz	 dB dB dB		 12			 14.5 9 3			 9.3			 18 12 7	

Notes:

1. Electronic Industrial Association of Japan.
2. Output and Input are tuned for minimum noise figure.
3. Maximum Available Gain (MAG) is calculated from the device S-Parameters using the following equation,

$$MAG = |S_{21E}|^2 \cdot \frac{1}{1-|S_{11E}|^2} \cdot \frac{1}{1-|S_{22E}|^2}$$

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE88900 00 (CHIP)			NE88912 2SA1228 12 (TO-72)			NE88933 2SA1424 33 (MINI-MOLD)			NE88935 2SA1223 35 (MICRO-X)		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
I_{CBO}	Collector Cutoff Current at V_{CB} = -10 V, I_E = 0	μA			-0.1			-0.1			-0.1			-0.1
I_{EBO}	Emitter Cutoff Current at V_{EB} = -2 V, I_C = 0	μA			-0.1			-0.1			-0.1			-0.1
h_{FE}	Forward Current Gain at V_{CE} = -10 V, I_C = -15 mA		20	90	200	20	90	200	20	90	200	20	90	200
C_{CB}	Collector to Base Capacitance[2] at V_{CB} = -5 V, I_E = 0 mA, f = 1 MHz	pF		1.2	1.5		1.2	1.5		1.1	3		1	1.5
R_{TH}	Thermal Resistance (Junction-to-Case)	°C/W			31			500			700			620
P_T	Total Power Dissipation	mW						300			200			250

Notes:
1. Electronic Industrial Association of Japan.
2. Capacitance is measured with emitter and case connected to the guard terminal at the bridge.

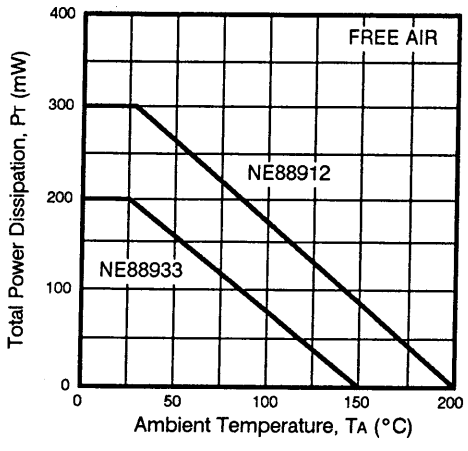
ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	-20
V_{CEO}	Collector to Emitter Voltage	V	-12
V_{EBO}	Emitter to Base Voltage	V	-3
I_C	Collector Current	mA	-50
T_J	Junction Temperature	°C	200
T_{STG}	Storage Temperature	°C	-65 to +200*

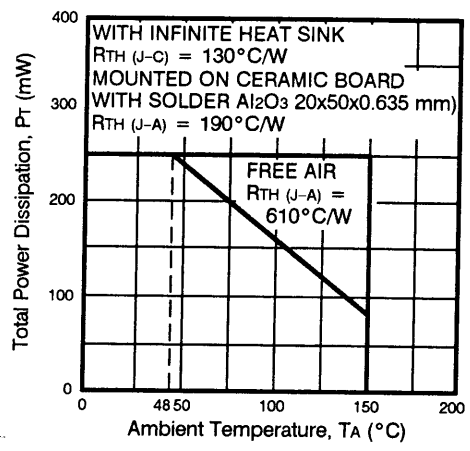
*The NE88935 Grade D (Industrial) version has a T_{STG} of -65 to +150°C.

TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

DC POWER DERATING CURVES

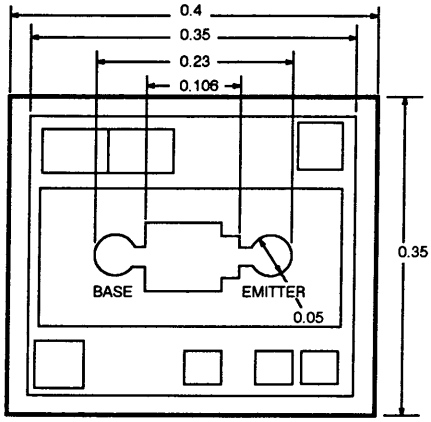


NE88935
DC POWER DERATING CURVES

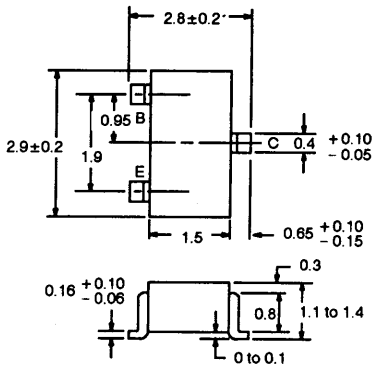


OUTLINE DIMENSIONS (Units in mm)

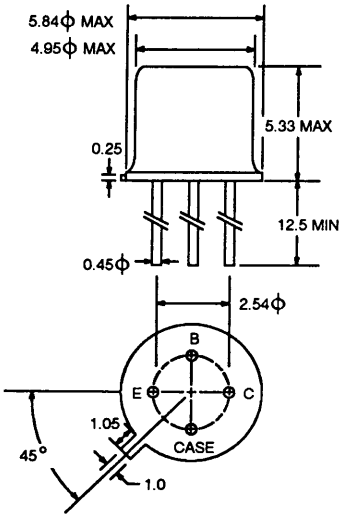
NE88900 (CHIP)
Chip Thickness: 160 µm TYP



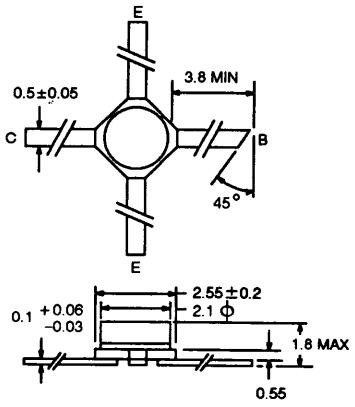
OUTLINE 33
(SOT-23)



OUTLINE 12
(TO-72)

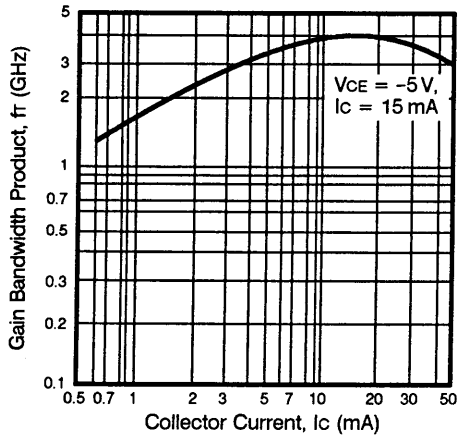


OUTLINE 35
(MICRO-X)

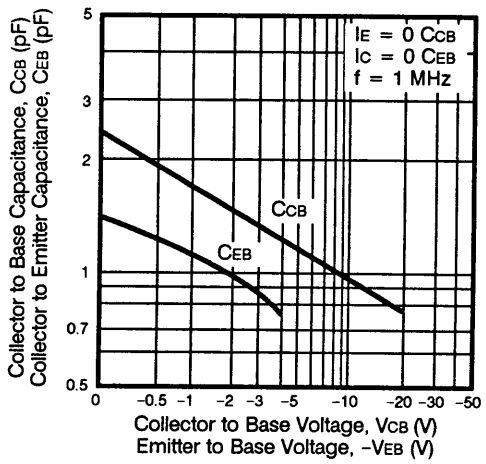


TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

GAIN BANDWIDTH vs. COLLECTOR CURRENT

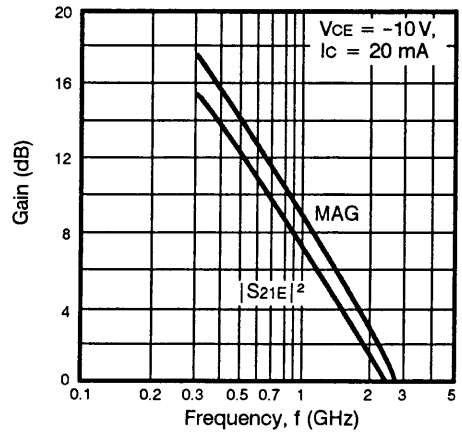


DEVICE CAPACITANCE

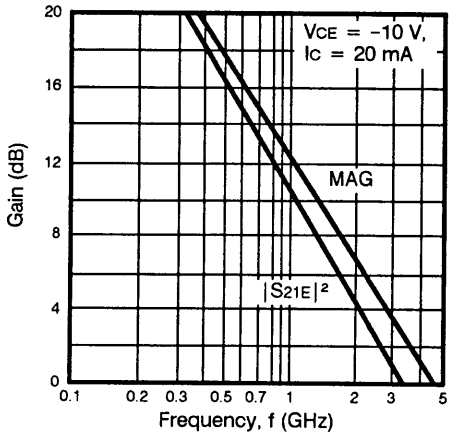


TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

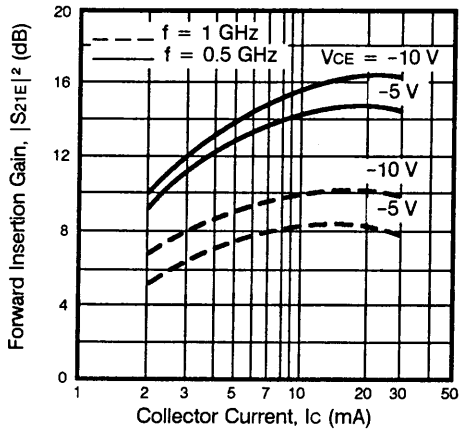
NE88912
GAIN vs. FREQUENCY



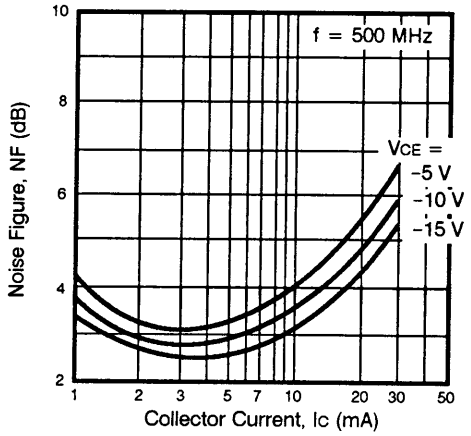
NE88935
GAIN vs. FREQUENCY



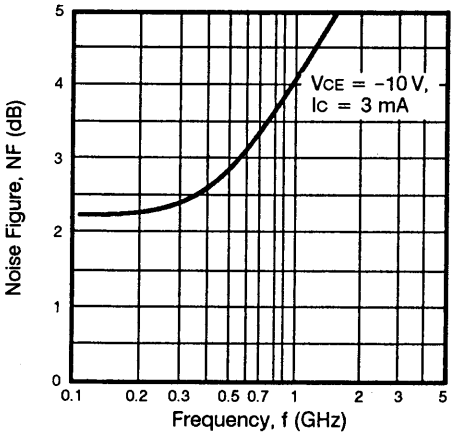
NE88935
INSERTION GAIN vs.
COLLECTOR CURRENT



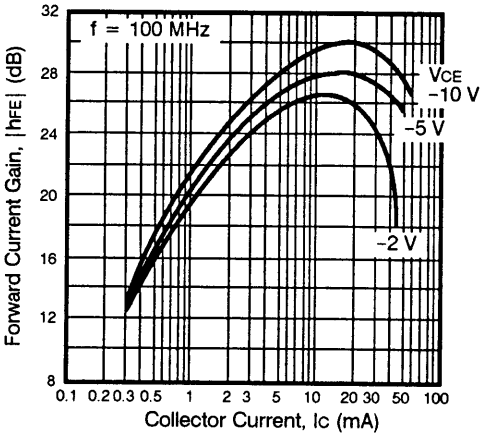
NE88935
NOISE FIGURE vs.
COLLECTOR CURRENT



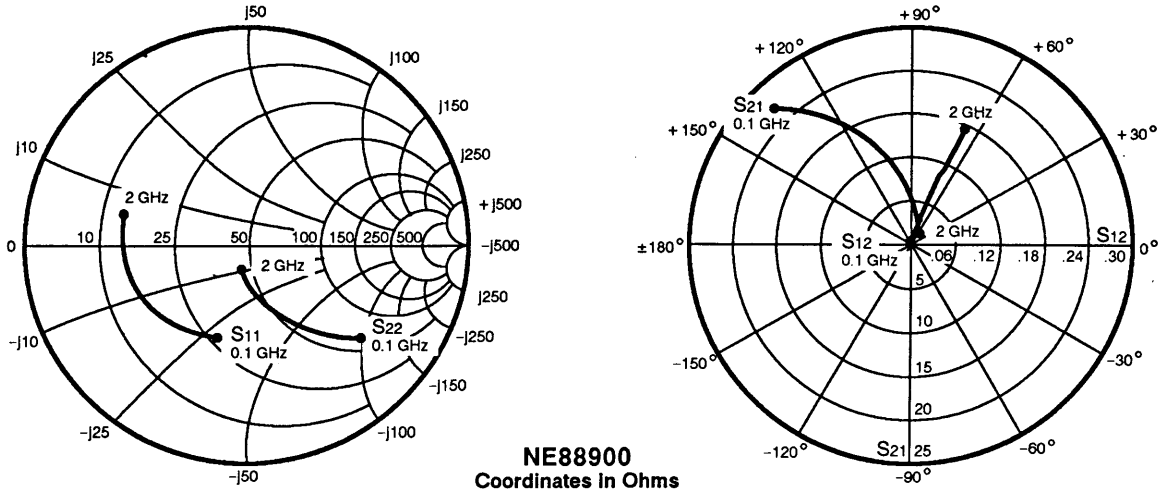
NE88912, NE88935
NOISE FIGURE vs. FREQUENCY



CURRENT GAIN vs.
COLLECTOR CURRENT



TYPICAL COMMON EMITTER SCATTERING PARAMETERS

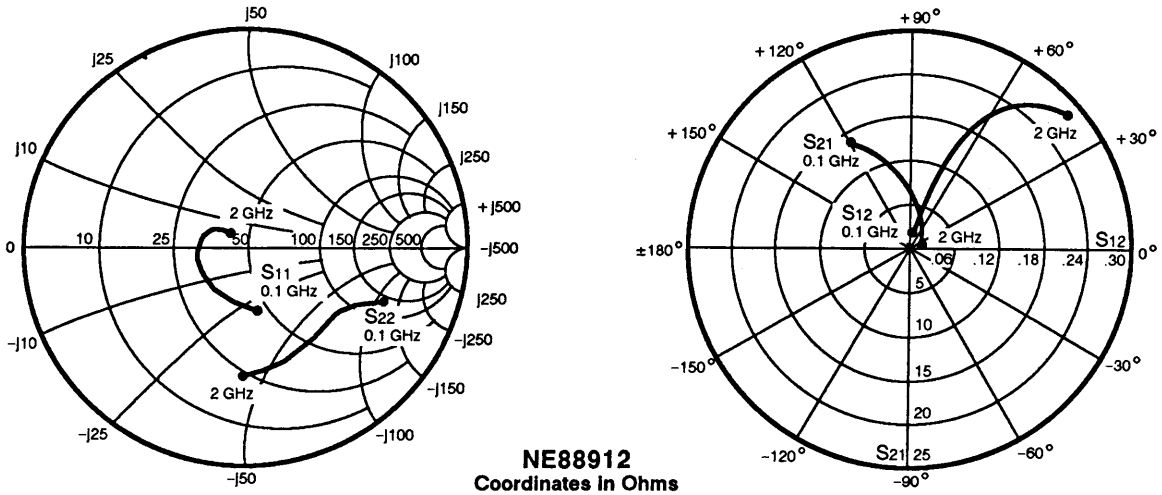


NE88900
Coordinates in Ohms
Frequency in GHz
(V_{CE} = -10 V, I_C = -30 mA)

S-MAGN AND ANGLES:

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
VCE = -10 V, IC = -5 mA								
100	.75	-39	11.69	154	.021	78	.90	-21
500	.55	-128	5.34	103	.097	44	.40	-64
1000	.49	-155	2.89	84	.128	47	.27	-74
1500	.49	-173	2.03	72	.160	48	.20	-80
2000	.53	176	1.60	63	.195	51	.19	-89
VCE = -10 V, IC = -10 mA								
100	.60	-60	17.27	146	.016	71	.82	-30
500	.53	-149	6.10	98	.066	50	.28	-78
1000	.50	-168	3.21	82	.107	57	.19	-91
1500	.51	178	2.24	71	.146	58	.14	-99
2000	.55	170	1.74	63	.186	59	.13	-108
VCE = -10 V, IC = -20 mA								
100	.48	-88	21.54	138	.007	70	.72	-38
500	.54	-162	6.39	94	.045	58	.21	-87
1000	.51	-175	3.31	80	.093	64	.15	-99
1500	.53	173	2.29	70	.139	63	.10	-105
2000	.57	166	1.77	62	.182	65	.11	-115
VCE = -10 V, IC = -30 mA								
100	.44	-105	22.51	135	.004	78	.68	-39
500	.55	-166	6.25	92	.044	61	.18	-84
1000	.53	-178	3.22	79	.090	68	.14	-92
1500	.54	172	2.22	69	.134	66	.09	-94
2000	.59	165	1.71	61	.177	66	.11	-106

TYPICAL COMMON EMITTER SCATTERING PARAMETERS

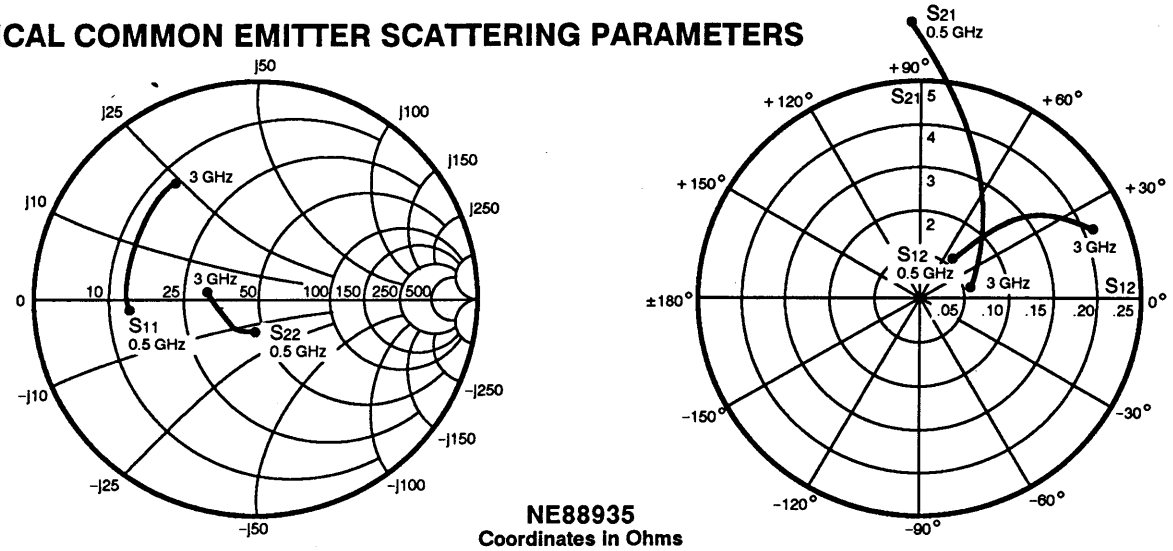


NE88912
Coordinates in Ohms
Frequency in GHz
(V_{CE} = -10 V, I_C = -30 mA)

S-MAGN AND ANGLES:

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
V_{CE} = -10 V, I_C = -5 mA								
100	.65	-40	10.20	141	.035	70	.85	-20
500	.30	-114	3.95	88	.112	59	.55	-41
1000	.20	-154	2.23	62	.178	56	.49	-54
1500	.16	-173	1.62	41	.237	49	.51	-72
2000	.12	-164	1.30	21	.281	37	.57	-89
V_{CE} = -10 V, I_C = -10 mA								
100	.49	-51	13.51	132	.031	73	.78	-23
500	.22	-128	4.25	83	.106	64	.49	-38
1000	.17	-166	2.34	60	.182	59	.46	-51
1500	.14	179	1.70	40	.244	50	.49	-69
2000	.09	-167	1.36	21	.290	38	.54	-87
V_{CE} = -10 V, I_C = -20 mA								
100	.36	-65	14.73	123	.027	72	.70	-24
500	.19	-145	4.11	79	.103	67	.49	-34
1000	.17	-179	2.25	57	.179	61	.47	-49
1500	.14	166	1.63	37	.246	52	.50	-68
2000	.08	-179	1.29	17	.287	39	.57	-87
V_{CE} = -10 V, I_C = -30 mA								
100	.30	-80	13.70	119	.021	70	.68	-22
500	.22	-159	3.62	77	.099	69	.51	-31
1000	.21	168	1.99	54	.174	63	.51	-49
1500	.18	150	1.44	34	.238	54	.54	-68
2000	.10	140	1.15	14	.282	42	.59	-89

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



NE88935
Coordinates in Ohms
Frequency in GHz
(V_{CE} = -10 V, I_C = -20 mA, Z_O = 50 Ω)

2

S-MAGN AND ANGLES:

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
VCE = -10 V, IC = -5 mA								
500	.46	-133	5.08	104	.11	40	.30	-56
1000	.54	-170	2.82	72	.14	29	.25	-96
2000	.56	153	1.51	38	.19	22	.19	-133
3000	.59	130	1.05	12	.24	10	.23	-168
VCE = -10 V, IC = -10 mA								
500	.50	-160	6.11	97	.08	43	.18	-76
1000	.57	177	3.12	70	.11	38	.19	-117
2000	.59	147	1.63	38	.17	31	.16	-156
3000	.62	126	1.12	14	.22	18	.22	175
VCE = -10 V, IC = -20 mA								
500	.56	-176	6.53	93	.06	50	.10	-95
1000	.59	170	3.19	68	.09	47	.15	-128
2000	.62	144	1.65	38	.16	38	.15	-163
3000	.65	125	1.12	13	.21	24	.21	172
VCE = -10 V, IC = -30 mA								
500	.59	178	6.44	91	.06	54	.07	-94
1000	.60	168	3.10	67	.09	51	.14	-122
2000	.63	143	1.59	37	.16	40	.14	-157
3000	.66	124	1.07	12	.21	26	.21	178