NEC®

NPN SILICON HIGH FREQUENCY TRANSISTOR | NE219 SERIES

FEATURES

- **HIGH f_T:** 8 GHz
- **LOW NOISE:**
  1 dB at 0.5 GHz
  2.2 dB at 2 GHz
- **HIGH COLLECTOR CURRENT:** 80 mA
- **HIGH OSCILLATOR POWER OUTPUT:**
  100 mW at 6 GHz
- **EXCELLENT GENERAL PURPOSE TRANSISTOR**

DESCRIPTION AND APPLICATIONS

The NE219 series of NPN silicon bipolar transistors is designed for small signal amplifier and oscillator applications up to 6 GHz. The series employs arsenic doped emitters and NEC's hi-rel platinum-gold metallization system which permits reliable operation at high temperature operation (100°C) at rated dissipation. The series is available in either chip form (NE21900) or in a variety of packages. Low noise and high current capability provides wide dynamic range and economical solutions to a wide variety of microstrip thick and thin film applications. Quality, performance, uniformity and reliability are assured by NEC's quality assurance program which is patterned after MIL-S-19500. The NE219 is available in Grade C (JANTXV equivalent), Grade CX (JANTX equivalent), and Grade D.

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	10[1]
V_{EBO}	Emitter to Base Voltage	V	1.5
I_C	Collector Current	mA	80
T_J	Junction Temperature	°C	200[2]
T_{STG}	Storage Temperature	°C	-65 to +200[3]

Notes:

1. Typical V_{CER} = 20 V for R = 10 Ω.
2. T_J = 150°C for NE21936 and NE21937.
3. T_{STG} = -65 to +150°C for NE21936, NE21937 and NE21935 Grade D.

NE21935 TYPICAL NOISE PARAMETERS

V_{CE} = 8 V, I_C = 5 mA

FREQUENCY (MHz)	NF_{min}/(dB)	G_a*/dB	OPT SOURCE	R_N/50 Ω
500	1.3	20.7	.15 ∠ 100°	.15
1000	1.4	16.2	.31 ∠ 146°	.12
1500	2.1	13.5	.49 ∠ 178°	.04
2000	2.3	11.8	.48 ∠ -172°	.07
2500	2.7	9.6	.53 ∠ -155°	.13
3000	3.4	9.6	.58 ∠ -133°	.26
3500	3.6	8.0	.66 ∠ -128°	.36

V_{CE} = 8 V, I_C = 20 mA

500	1.6	22.0	.14 ∠ 132°	.17
1000	2.0	17.3	.30 ∠ 176°	.13
1500	2.6	14.9	.47 ∠ -167°	.08
2000	2.9	13.0	.53 ∠ -159°	.12
2500	3.2	11.4	.56 ∠ -150°	.19
3000	3.9	11.4	.58 ∠ -127°	.36
3500	4.3	9.2	.68 ∠ -123°	.28

*Input tuned for minimum Noise Figure, output tuned for Maximum Gain.

PERFORMANCE SPECIFICATIONS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE21903 2SC22174 03			NE21908 2SC2218 08			NE21912 12			NE21935 2SC2367 35			NE21937 2SC2869 37			NE21987 87		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
f_T	Gain Bandwidth Product at V_{CE} = 8 V, I_C = 20 mA	GHz		8.0			8.0			8.0			8.0			8.0			8.0	
$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = 8 V, I_C = 20 mA, f = 0.5 GHz f = 1 GHz f = 2 GHz	 dB dB dB	 8.0	 21.0 15.5 9.6		 8.0	 21.0 15.5 9.6			 15.5			 15.5 9.0			 13.0 7.0			
NF_{MIN}	Minimum Noise Figure[2] at V_{CE} = 8 V, I_C = 5 mA, f = 0.5 GHz f = 1 GHz f = 2 GHz	 dB dB dB		 1.3 2.2	 3.5		 1.3 2.2	 3.5		 1.0 1.3			 1.3 2.2	 3.5		 1.2 2.2	 2.5			
MAG	Maximum Available Gain[3] at V_{CE} = 8 V, I_C = 20 mA, f = 0.5 GHz f = 1 GHz f = 2 GHz	 dB dB dB		 25.0 18.4 12.6			 25.0 18.4 12.6			 23.0 16.4			 25.0 18.4 12.6			 16.0 10.0			
G_{NF}	Associated Gain at Optimum Noise Figure, V_{CE} = 8 V, I_C = 5 mA, f = 0.5 GHz f = 1 GHz f = 2 GHz	 dB dB dB		 15.0 13.0 8.0			 15.0 13.0 8.0			 12.0 10.0			 15.0 13.0 8.0			 12.0				
P_{OSC}	Oscillator Power Output at V_{CE} = 8 V, I_C = 40 mA, f = 6 GHz	mW																	100	

Notes:

1. Electronics Industrial Association of Japan.
2. Input and output are tuned for optimum noise figure.
3. Maximum Available Gain (MAG) is calculated from the device S-Parameters using the equation, $MAG = \frac{|S_{21}|}{|S_{12}|}(K \pm \sqrt{K^2 - 1})$ $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{21}||S_{12}|}$ $\Delta = S_{11}S_{22} - S_{21}S_{12}$
4. EIAJ registered number refers to grade C versions of these devices.

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

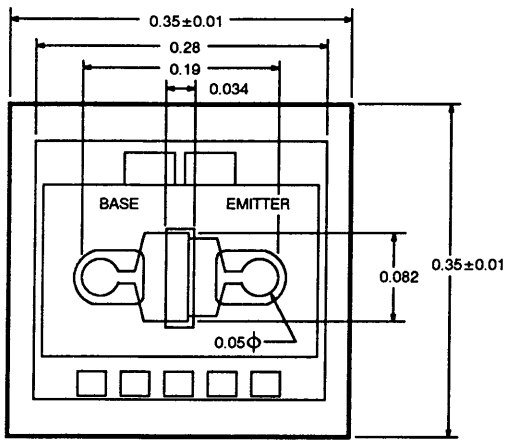
PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE21903 2SC22174 03			NE21908 2SC22184 08			NE21912 12			NE21935 2SC2367 35			NE21937 2SC2869 37			NE21987 87		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
I_{CBO}	Collector Cutoff Current at V_{CB} = 8 V, I_E = 0	μA			1.0			1.0			1.0			1.0			1.0			1.0
I_{EBO}	Emitter Cutoff Current at V_{EB} = 1 V, I_C = 0	μA			1.0			1.0			1.0			1.0			1.0			1.0
h_{FE}	Forward Current Gain at V_{CE} = 8 V, I_C = 20 mA		30	100	300	30	100	300	30	100	300	30	100	300	30	100	300	30	100	300
C_{CB}	Collector to Base Capacitance[2] at V_{CB} = 8 V, I_E = 0	pF		0.4	1.0		0.4	1.0		0.4	1.0		0.4	1.0		0.7	1.0		0.4	1.0
R_{TH}	Thermal Resistance (J-C)	°C/W			70			90			90			80			500[3]			70
P_T	Total Power Dissipation (T_A = 25°C)	mW			580			350			600			580			250			700

Notes:

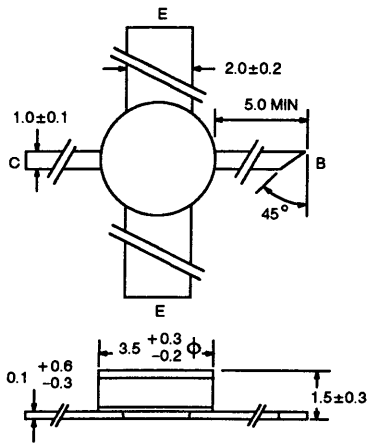
1. Electronic Industrial Association of Japan.
2. C_{CB} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal.
3. R_{TH} (J-A)
4. EIAJ registered number refers to grade C versions of these devices.

OUTLINE DIMENSIONS (Units in mm)

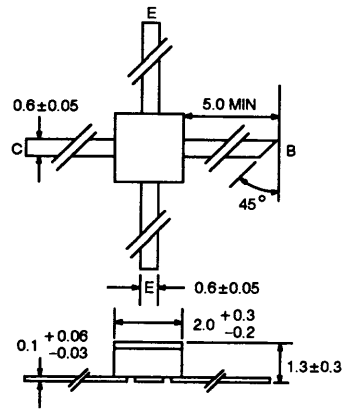
NE21900 (CHIP)
(Chip Thickness: 140 µm)



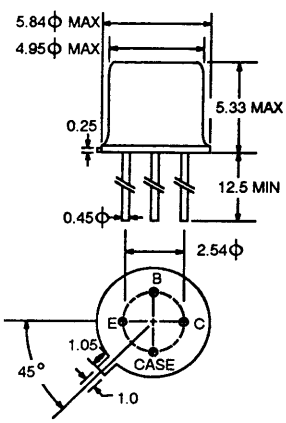
OUTLINE 03



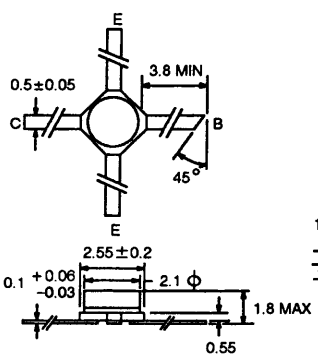
OUTLINE 08



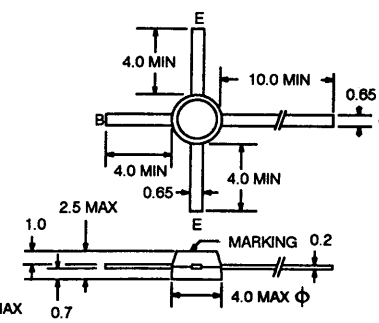
OUTLINE 12
(TO-72)



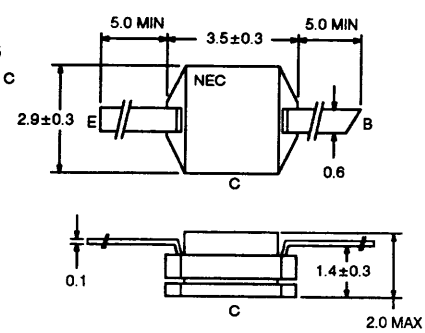
OUTLINE 35
(MICRO-X)



OUTLINE 37
(DISK-MOLD)

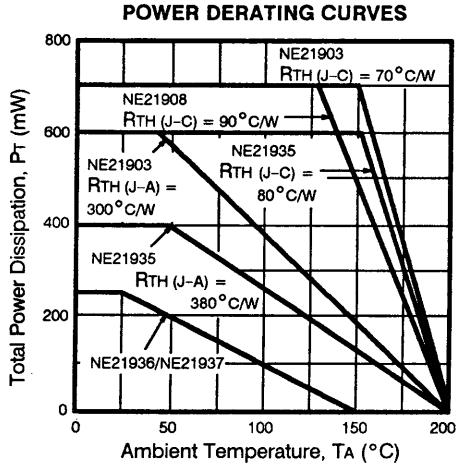


OUTLINE 87

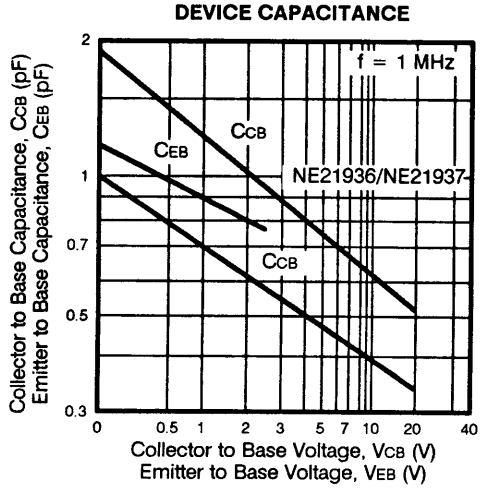


TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

POWER DERATING CURVES

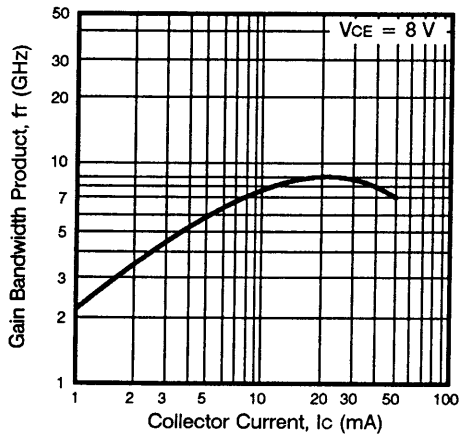


DEVICE CAPACITANCE

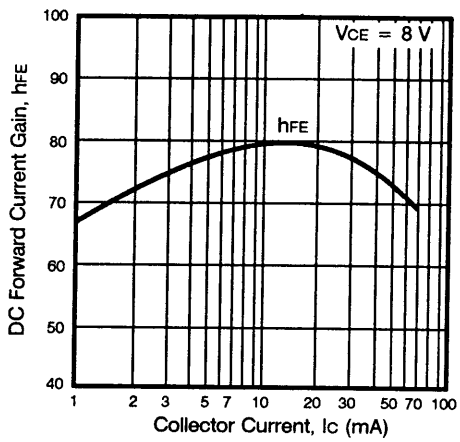


TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

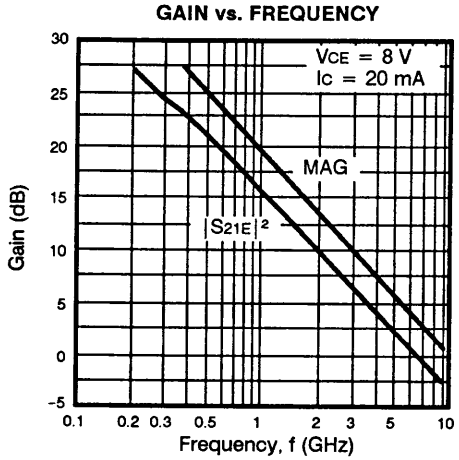
GAIN BANDWIDTH PRODUCT
vs. COLLECTOR CURRENT



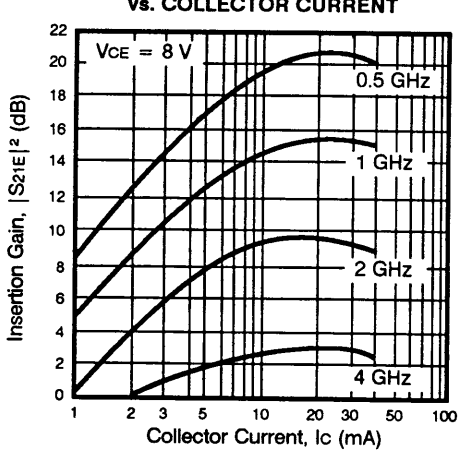
FORWARD CURRENT GAIN
vs. COLLECTOR CURRENT



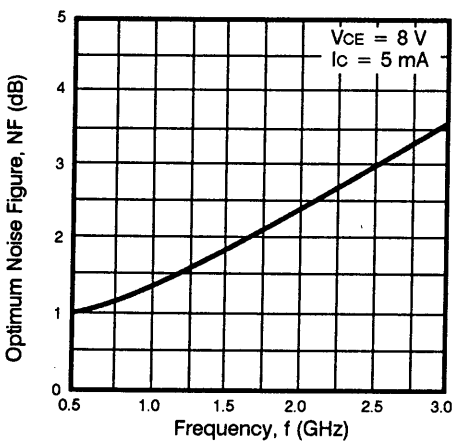
GAIN vs. FREQUENCY



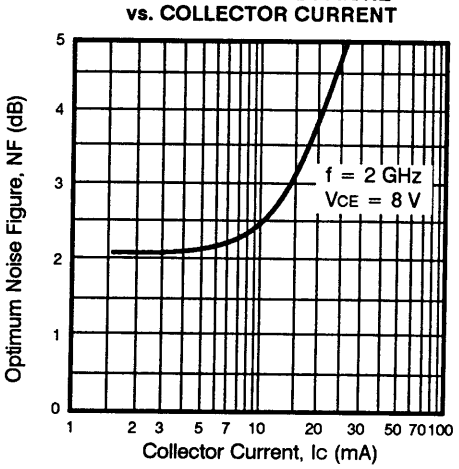
INSERTION GAIN $|S_{21E}|^2$
vs. COLLECTOR CURRENT



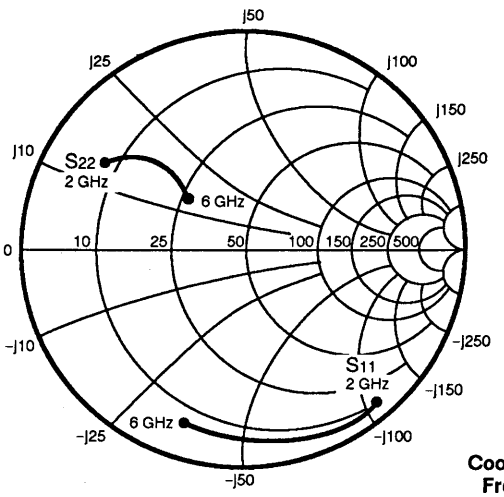
OPTIMUM NOISE FIGURE
vs. FREQUENCY

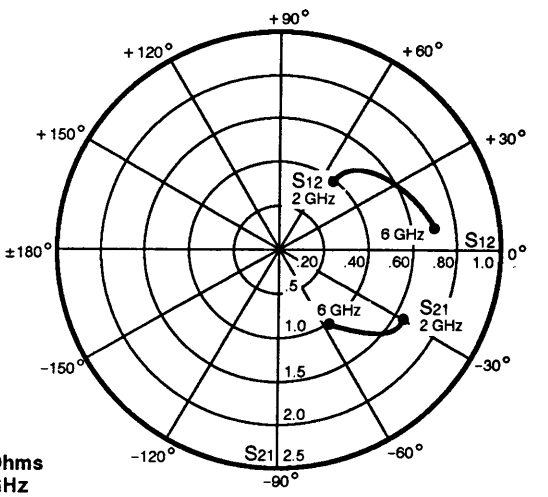


OPTIMUM NOISE FIGURE
vs. COLLECTOR CURRENT



TYPICAL COMMON COLLECTOR SCATTERING PARAMETERS





NE21900
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 8 V, I_C = 20 mA)

S-MAGN AND ANGLES:

V_{CE} = 8 V, I_C = 10 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
2000	.88	-56	1.57	-29	.44	47	.64	143
2500	.87	-67	1.50	-34	.52	41	.60	139
3000	.83	-77	1.39	-42	.58	31	.54	128
3500	.82	-85	1.26	-44	.60	27	.46	131
4000	.80	-93	1.18	-49	.64	21	.43	124
4500	.79	-98	1.12	-52	.67	14	.38	125
5000	.79	-103	1.02	-53	.68	11	.32	130
5500	.77	-109	1.00	-55	.72	7	.31	126
6000	.78	-113	.93	-57	.72	4	.25	142

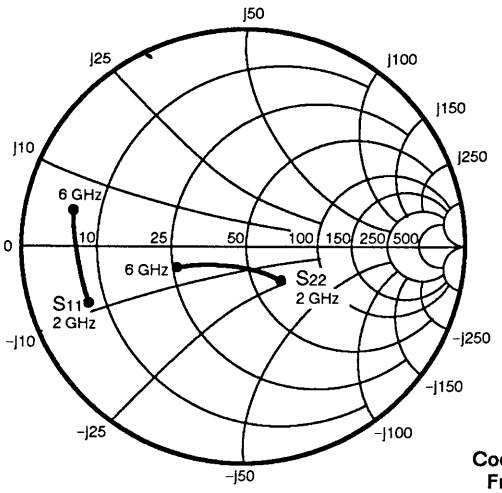
V_{CE} = 8 V, I_C = 20 mA

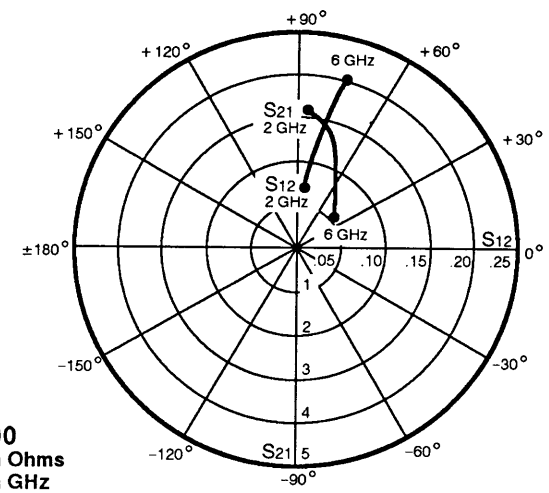
2000	.91	-53	1.66	-29	.40	51	.71	147
2500	.90	-64	1.59	-34	.47	45	.68	143
3000	.87	-74	1.47	-42	.53	35	.62	132
3500	.86	-82	1.35	-43	.55	32	.54	135
4000	.84	-90	1.26	-49	.60	26	.52	128
4500	.84	-95	1.20	-52	.63	19	.47	129
5000	.83	-101	1.09	-54	.64	16	.41	131
5500	.82	-107	1.07	-56	.64	12	.40	127
6000	.82	-111	.99	-59	.69	9	.34	138

V_{CE} = 8 V, I_C = 30 mA

2000	.91	-52	1.67	-29	.39	52	.74	148
2500	.91	-64	1.61	-34	.47	46	.70	144
3000	.87	-74	1.49	-42	.52	36	.64	133
3500	.87	-82	1.36	-44	.55	33	.57	136
4000	.84	-90	1.28	-50	.59	27	.54	129
4500	.85	-95	1.22	-53	.62	20	.50	129
5000	.84	-100	1.10	-55	.64	17	.43	131
5500	.83	-107	1.08	-57	.69	13	.42	127
6000	.84	-111	1.00	-59	.69	11	.36	137

TYPICAL COMMON EMITTER SCATTERING PARAMETERS





NE21900
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 8 V, I_C = 20 mA)

S-MAGN AND ANGLES:

V_{CE} = 8 V, I_C = 10 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
2000	.70	-155	2.78	89	.08	72	.32	-44
2500	.68	-167	2.31	78	.09	72	.27	-45
3000	.72	-173	1.99	70	.11	74	.24	-42
3500	.74	-174	1.77	67	.12	77	.20	-58
4000	.70	176	1.57	55	.14	71	.13	-80
4500	.72	176	1.38	52	.15	74	.15	-101
5000	.76	172	1.26	46	.17	73	.19	-128
5500	.72	168	1.13	41	.19	71	.26	-143
6000	.73	168	.99	38	.19	72	.33	-148

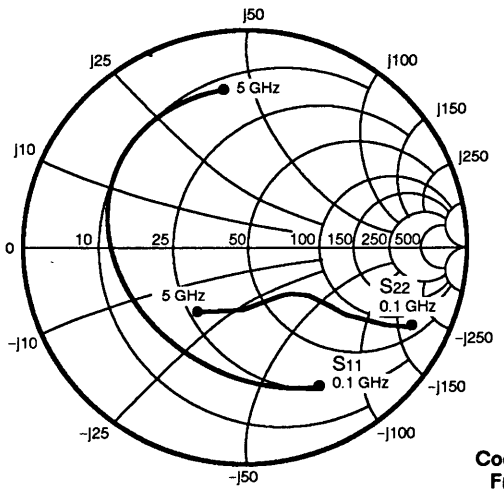
V_{CE} = 8 V, I_C = 20 mA

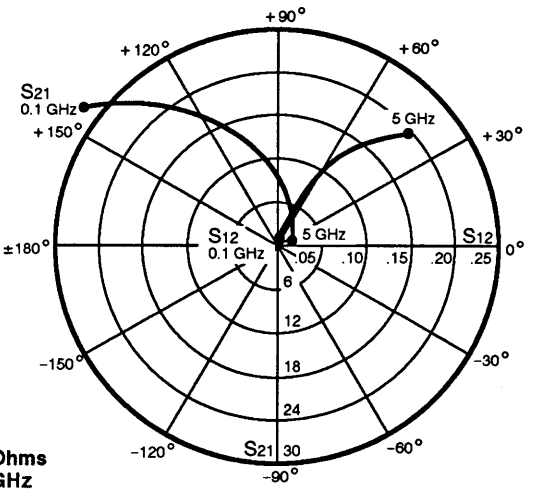
2000	.69	-159	3.03	88	.07	81	.26	-46
2500	.67	-170	2.51	78	.09	79	.21	-44
3000	.72	-175	2.15	70	.11	79	.19	-39
3500	.74	-176	1.90	67	.13	81	.14	-58
4000	.69	175	1.68	56	.15	74	.08	-90
4500	.73	174	1.46	53	.16	77	.11	-115
5000	.76	172	1.34	47	.18	74	.16	-143
5500	.72	167	1.21	42	.19	73	.23	-154
6000	.73	167	1.07	40	.20	74	.30	-155

V_{CE} = 8 V, I_C = 30 mA

2000	.69	-161	3.07	87	.07	84	.25	-45
2500	.67	-171	2.53	77	.09	82	.20	-42
3000	.72	-176	2.16	70	.11	82	.18	-36
3500	.74	-177	1.92	67	.13	83	.13	-55
4000	.70	174	1.68	56	.15	75	.07	-86
4500	.73	174	1.49	52	.16	78	.09	-115
5000	.77	171	1.36	47	.18	75	.15	-144
5500	.73	167	1.22	41	.19	74	.22	-154
6000	.73	166	1.08	40	.20	74	.29	-155

TYPICAL COMMON EMITTER SCATTERING PARAMETERS





NE21903
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 8 V, I_C = 20 mA)

S-MAGN AND ANGLES:

V_{CE} = 8 V, I_C = 10 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	.79	-45	22.62	152	.01	77	.91	-18
500	.63	-140	9.88	102	.04	39	.47	-41
1000	.62	-173	5.30	81	.05	40	.36	-44
1500	.62	169	3.59	67	.07	43	.35	-49
2000	.62	156	2.68	57	.09	51	.35	-57
2500	.64	143	2.17	45	.10	51	.31	-69
3000	.67	134	1.88	35	.13	51	.32	-82
3500	.68	122	1.58	25	.14	44	.32	-94
4000	.70	114	1.40	13	.15	43	.34	-106
4500	.70	106	1.18	6	.17	39	.36	-116
5000	.71	98	1.10	-2	.19	38	.38	-124

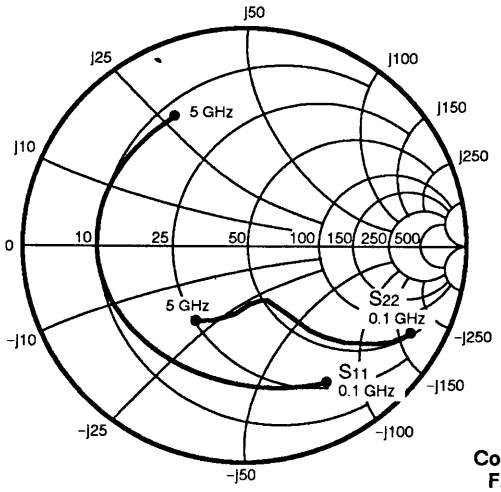
V_{CE} = 8 V, I_C = 20 mA

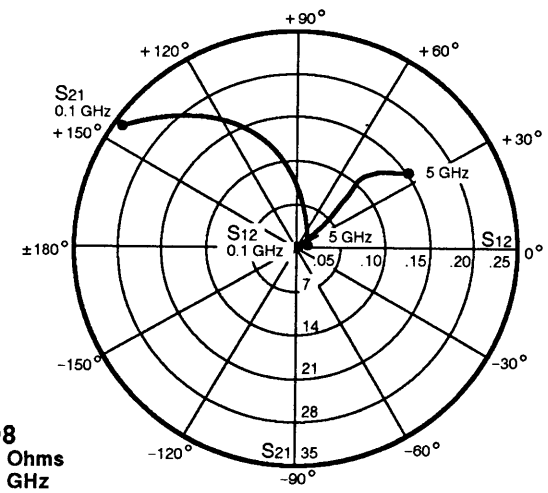
100	.69	-64	32.32	144	.01	71	.84	-24
500	.60	-156	11.17	96	.03	46	.37	-42
1000	.61	178	5.81	78	.04	53	.28	-44
1500	.61	164	3.92	66	.06	55	.28	-50
2000	.62	151	2.93	56	.09	59	.29	-59
2500	.64	140	2.38	46	.11	55	.25	-72
3000	.67	130	2.06	35	.13	51	.25	-85
3500	.68	120	1.73	26	.15	48	.26	-96
4000	.69	112	1.54	14	.16	44	.28	-108
4500	.69	105	1.32	7	.18	42	.31	-115
5000	.70	96	1.19	0	.20	40	.33	-125

V_{CE} = 8 V, I_C = 40 mA

100	.62	-84	39.23	136	.01	57	.76	-29
500	.60	-166	11.61	92	.02	54	.32	-39
1000	.61	173	5.94	76	.04	62	.25	-40
1500	.62	160	3.99	64	.06	59	.26	-47
2000	.62	149	2.98	55	.09	62	.27	-56
2500	.65	138	2.43	45	.11	56	.24	-70
3000	.66	129	2.11	34	.13	55	.24	-83
3500	.68	120	1.78	25	.15	51	.25	-94
4000	.70	112	1.59	13	.16	46	.27	-106
4500	.70	104	1.35	6	.18	43	.30	-113
5000	.71	97	1.26	-1	.20	39	.31	-124

TYPICAL COMMON EMITTER SCATTERING PARAMETERS





NE21908
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 8 V, I_C = 20 mA)

S-MAGN AND ANGLES:

VCE = 8 V, IC = 5 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
100	.91	-29	14.21	160	.01	79	.96	-13
500	.73	-112	8.27	113	.07	38	.61	-40
1000	.68	-149	4.84	89	.08	26	.46	-53
1500	.67	-169	3.34	73	.08	22	.44	-58
2000	.67	180	2.53	62	.08	24	.43	-66
2500	.67	168	2.01	50	.09	24	.42	-76
3000	.67	158	1.73	40	.09	27	.44	-86
3500	.67	149	1.48	30	.10	29	.46	-94
4000	.67	141	1.34	20	.11	30	.49	-103
4500	.66	134	1.16	10	.12	30	.52	-110
5000	.66	125	1.06	3	.13	30	.55	-118

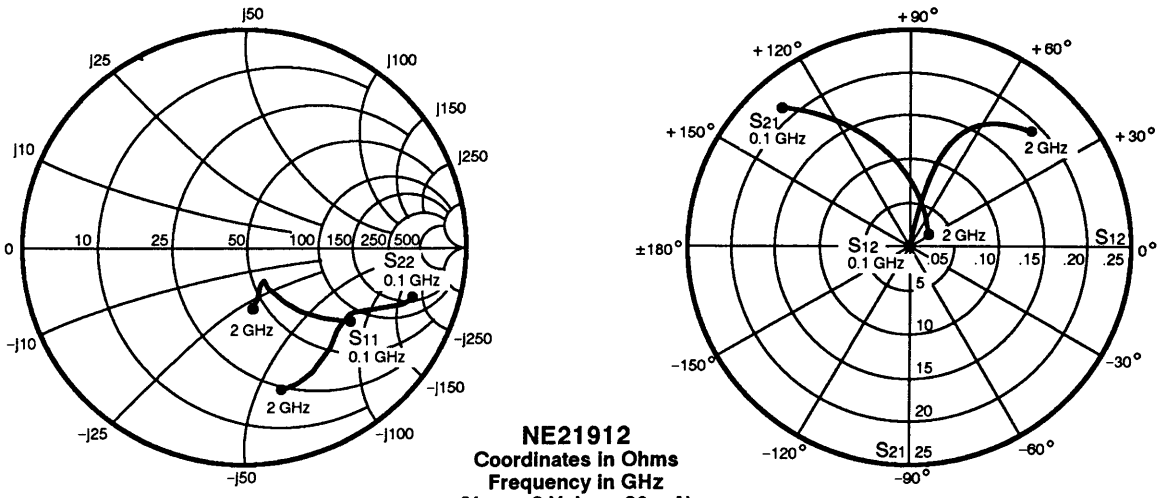
VCE = 8 V, IC = 10 mA

100	.84	-42	23.68	153	.01	78	.91	-19
500	.67	-132	10.89	105	.05	37	.45	-50
1000	.65	-163	5.90	84	.05	33	.32	-58
1500	.63	-178	4.00	71	.07	37	.31	-64
2000	.64	173	3.02	62	.08	42	.32	-71
2500	.65	160	2.47	50	.08	37	.31	-82
3000	.65	152	2.13	41	.09	40	.33	-91
3500	.65	143	1.82	32	.11	40	.35	-98
4000	.66	137	1.64	22	.12	38	.38	-107
4500	.65	130	1.44	13	.13	36	.41	-113
5000	.65	121	1.31	5	.14	32	.44	-121

VCE = 8 V, IC = 20 mA

100	.75	-59	34.58	145	.01	71	.84	-27
500	.65	-148	12.53	99	.03	43	.34	-58
1000	.65	-171	6.56	81	.04	43	.24	-65
1500	.64	176	4.44	69	.06	44	.24	-69
2000	.64	168	3.36	61	.07	49	.25	-77
2500	.65	156	2.73	51	.08	47	.24	-87
3000	.65	149	2.37	42	.10	47	.27	-95
3500	.65	141	2.02	32	.11	46	.30	-101
4000	.66	134	1.82	23	.13	42	.33	-109
4500	.65	127	1.58	13	.14	38	.36	-115
5000	.64	119	1.43	6	.15	35	.39	-123

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



NE21912
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 8 V, I_C = 20 mA)

S-MAGN AND ANGLES:

VCE = 8 V, IC = 5 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
100	.80	-27	12.30	149	.01	74	.92	-13
200	.67	-46	9.87	130	.03	66	.83	-20
500	.37	-78	5.45	97	.07	62	.68	-31
1000	.19	-97	3.03	71	.11	62	.63	-43
1500	.16	-97	2.14	51	.15	57	.66	-59
2000	.20	-98	1.62	31	.16	46	.71	-78

VCE = 8 V, IC = 10 mA

100	.69	-31	17.67	140	.01	74	.86	-15
200	.53	-47	12.60	120	.02	67	.76	-22
500	.29	-66	6.18	92	.07	70	.64	-29
1000	.17	-73	3.34	69	.12	65	.59	-41
1500	.19	-76	2.33	51	.17	56	.62	-58
2000	.26	-87	1.75	31	.18	44	.69	-77

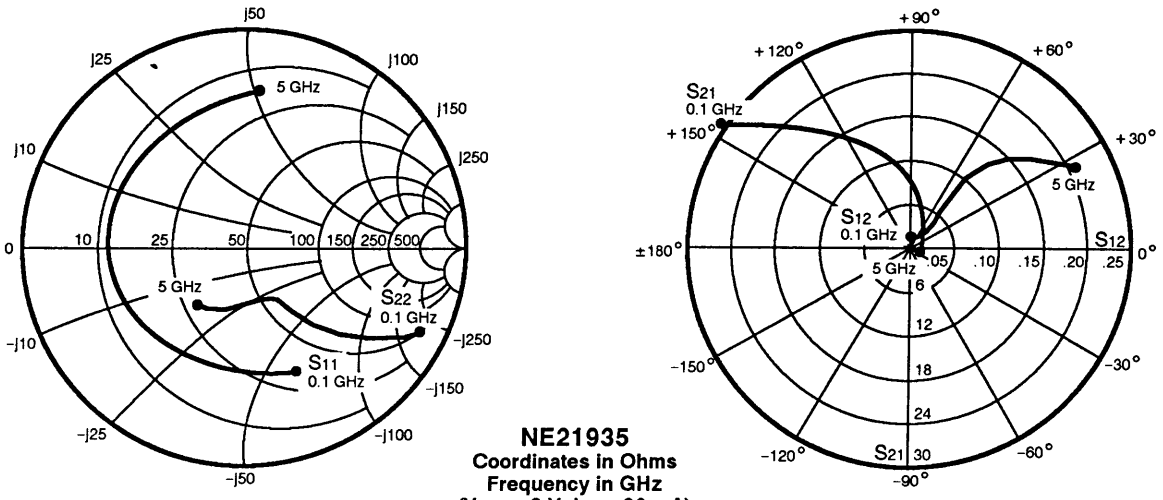
VCE = 8 V, IC = 20 mA

100	.58	-34	22.03	131	.01	70	.80	-17
200	.43	-47	14.19	112	.02	70	.70	-21
500	.24	-60	6.53	88	.07	71	.60	-29
1000	.17	-61	3.49	67	.13	66	.58	-40
1500	.20	-67	2.42	50	.17	56	.61	-57
2000	.29	-84	1.81	30	.18	43	.68	-77

VCE = 8 V, IC = 30 mA

100	.52	-36	23.55	126	.01	70	.77	-17
200	.38	-46	14.52	109	.02	71	.67	-20
500	.22	-58	6.54	86	.07	70	.59	-28
1000	.16	-58	3.48	66	.13	66	.58	-40
1500	.20	-65	2.41	49	.17	56	.61	-58
2000	.28	-83	1.80	29	.18	42	.68	-78

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



NE21935
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 8 V, I_C = 20 mA)

S-MAGN AND ANGLES:

VCE = 8 V, IC = 5 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	.80	-30	13.74	160	.01	80	.96	-12
500	.65	-117	8.05	112	.07	40	.62	-40
1000	.62	-159	4.72	86	.07	30	.45	-50
1500	.62	178	3.24	69	.08	30	.42	-56
2000	.62	162	2.44	56	.09	34	.42	-64
2500	.64	146	1.95	42	.10	28	.39	-76
3000	.65	133	1.67	30	.11	33	.40	-87
3500	.66	120	1.39	20	.13	33	.42	-97
4000	.67	109	1.27	9	.14	32	.43	-108
4500	.68	99	1.11	-1	.16	29	.45	-117
5000	.69	89	1.02	-10	.18	25	.48	-127

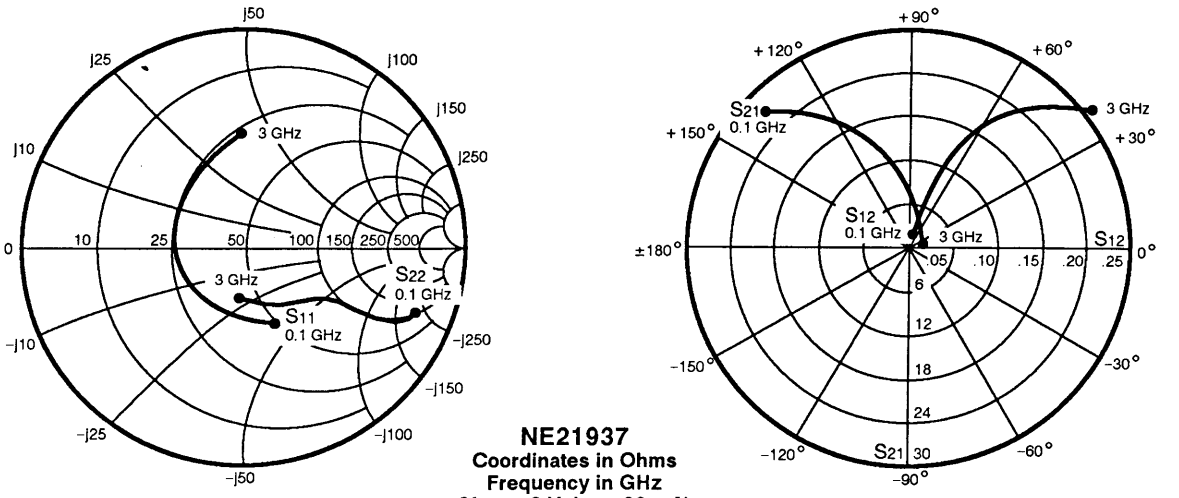
VCE = 8 V, IC = 10 mA

100	.67	-44	22.00	153	.01	76	.92	-18
500	.59	-139	10.21	104	.04	42	.48	-48
1000	.60	-173	5.57	82	.05	41	.34	-55
1500	.59	169	3.78	67	.07	42	.32	-61
2000	.60	155	2.86	56	.09	45	.32	-68
2500	.62	140	2.29	43	.11	43	.30	-80
3000	.63	129	1.96	31	.12	41	.31	-91
3500	.64	117	1.68	22	.14	39	.32	-101
4000	.65	107	1.50	11	.16	35	.34	-112
4500	.66	98	1.30	1	.18	29	.36	-121
5000	.67	87	1.20	-8	.19	25	.38	-131

VCE = 8 V, IC = 20 mA

100	.55	-66	31.47	146	.01	70	.86	-25
500	.57	-157	11.59	98	.03	48	.37	-52
1000	.59	177	6.10	79	.05	51	.26	-58
1500	.59	162	4.13	65	.07	53	.25	-63
2000	.59	150	3.09	55	.09	55	.26	-71
2500	.61	136	2.49	43	.11	46	.24	-84
3000	.62	125	2.13	32	.13	45	.26	-94
3500	.63	114	1.78	22	.15	42	.27	-104
4000	.65	105	1.62	12	.17	37	.29	-115
4500	.66	95	1.41	2	.19	31	.31	-123
5000	.67	85	1.31	-7	.20	26	.33	-132

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



NE21937
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 8 V, I_C = 20 mA)

S-MAGN AND ANGLES:

VCE = 8 V, IC = 5 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
100	.67	-36	12.58	154	.01	76	.95	-13
200	.56	-69	10.71	135	.03	58	.84	-21
500	.43	-132	6.19	102	.06	50	.60	-31
1000	.42	177	3.49	75	.09	51	.49	-40
1500	.44	148	2.41	56	.12	51	.46	-48
2000	.49	125	1.84	42	.16	52	.44	-60
2500	.54	105	1.50	26	.19	45	.37	-71
3000	.59	96	1.29	16	.24	42	.35	-95

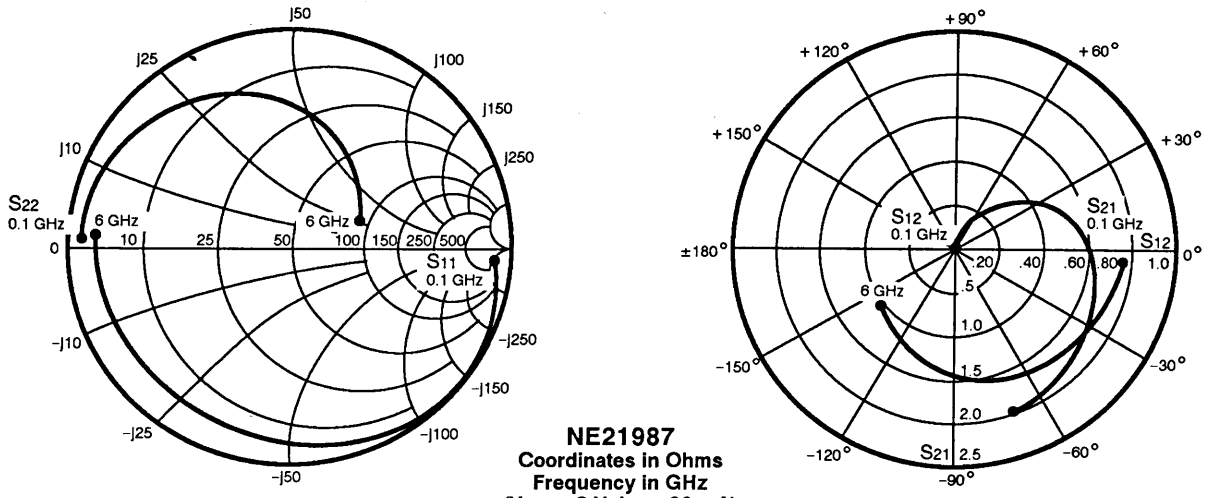
VCE = 8 V, IC = 10 mA

100	.53	-52	19.37	146	.01	72	.89	-17
200	.42	-91	14.71	125	.02	56	.73	-27
500	.36	-153	7.39	95	.05	58	.49	-32
1000	.38	165	3.98	72	.09	60	.41	-38
1500	.41	140	2.71	56	.13	57	.39	-47
2000	.45	122	2.07	42	.17	54	.36	-60
2500	.50	105	1.70	27	.21	47	.31	-73
3000	.55	93	1.44	14	.26	40	.28	-95

VCE = 8 V, IC = 20 mA

100	.39	-71	26.29	137	.01	74	.81	-23
200	.32	-118	17.89	116	.01	60	.62	-30
500	.32	-170	8.16	90	.05	66	.42	-30
1000	.36	156	4.28	70	.09	65	.36	-37
1500	.39	135	2.91	54	.14	59	.34	-46
2000	.43	118	2.22	42	.18	55	.31	-60
2500	.49	102	1.80	27	.22	46	.26	-77
3000	.53	91	1.53	14	.26	38	.23	-96

TYPICAL COMMON COLLECTOR SCATTERING PARAMETERS



NE21987
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 8 V, I_C = 20 mA)

S-MAGN AND ANGLES:

V_{CE} = 8 V, I_C = 10 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	.97	-4	1.81	-3	.03	55	.85	177
500	.96	-20	1.84	-15	.15	65	.86	163
1000	.98	-42	1.82	-30	.29	52	.83	147
1500	.95	-62	1.75	-42	.40	38	.78	133
2000	.91	-80	1.60	-56	.50	22	.70	118
2500	.86	-96	1.51	-67	.59	10	.64	103
3000	.85	-113	1.42	-78	.66	-4	.57	89
3500	.84	-129	1.32	-91	.70	-17	.49	75
4000	.82	-144	1.21	-100	.73	-32	.42	63
4500	.79	-158	1.15	-110	.76	-42	.36	51
5000	.77	-173	1.06	-120	.79	-55	.31	38
5500	.76	176	1.02	-131	.80	-66	.26	24
6000	.73	163	.94	-140	.81	-79	.21	10

V_{CE} = 8 V, I_C = 20 mA

100	.98	-3	1.87	-3	.03	48	.91	177
500	.97	-19	1.89	-15	.13	64	.91	165
1000	1.00	-39	1.88	-28	.24	54	.88	150
1500	.99	-58	1.81	-40	.34	42	.85	138
2000	.94	-75	1.64	-55	.44	27	.78	123
2500	.91	-90	1.60	-66	.52	16	.74	109
3000	.91	-107	1.51	-77	.59	2	.68	95
3500	.90	-122	1.42	-90	.63	-11	.60	82
4000	.89	-137	1.31	-100	.69	-24	.54	70
4500	.87	-150	1.26	-111	.71	-35	.48	59
5000	.85	-165	1.16	-121	.75	-48	.43	46
5500	.84	-176	1.11	-133	.77	-59	.37	34
6000	.82	171	1.02	-143	.78	-72	.32	21

V_{CE} = 8 V, I_C = 40 mA

100	.97	-3	1.88	-3	.03	41	.94	178
500	.97	-19	1.92	-14	.11	64	.93	165
1000	1.00	-38	1.91	-28	.22	55	.91	152
1500	.99	-57	1.85	-39	.32	44	.89	139
2000	.95	-75	1.63	-54	.41	29	.82	125
2500	.93	-91	1.66	-66	.49	19	.79	111
3000	.93	-110	1.59	-78	.57	5	.73	98
3500	.93	-127	1.51	-92	.62	-7	.65	85
4000	.91	-143	1.39	-102	.67	-21	.59	73
4500	.90	-158	1.33	-114	.71	-32	.53	62
5000	.88	-175	1.21	-125	.75	-45	.48	50
5500	.88	172	1.16	-138	.77	-57	.42	36
6000	.85	158	1.04	-148	.79	-70	.35	24