

NEC / CALIFORNIA

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T-31-17  
T-31-21  
T-31-23



# NPN SILICON HIGH FREQUENCY TRANSISTOR

## NE219 SERIES

### FEATURES

- HIGH fr: 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 (TA = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V <sub>CB0</sub>	Collector to Base Voltage	V	20
V <sub>CE0</sub>	Collector to Emitter Voltage	V	10 <sup>1</sup>
V <sub>EB0</sub>	Emitter to Base Voltage	V	1.5
I <sub>c</sub>	Collector Current	mA	80
T <sub>J</sub>	Junction Temperature	°C	200 <sup>2</sup>
T <sub>STG</sub>	Storage Temperature	°C	-65 to +200 <sup>3</sup>

#### Notes:

1. Typical V<sub>CEr</sub> = 20 V for R = 10 Ω.
2. T<sub>J</sub> = 150°C for NE21936 and NE21937.
3. T<sub>STG</sub> = -65 to +150°C for NE21936, NE21937 and NE21935 Grade D.

### NE21935 TYPICAL NOISE PARAMETERS

V<sub>CE</sub> = 8 V, I<sub>c</sub> = 5 mA

FREQUENCY (MHz)	NF <sub>min</sub> /(dB)	G <sub>a</sub> <sup>*</sup> /dB	OPT SOURCE	R <sub>n</sub> /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<sub>CE</sub> = 8 V, I<sub>c</sub> = 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.



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**PERFORMANCE SPECIFICATIONS (TA = 25°C)**

SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	NE21903 2SC22174			NE21908 2SC2218			NE21912			NE21935 2SC2367			NE21937 2SC2869			NE21987		
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
fr	Gain Bandwidth Product at Vce = 8 V, Ic = 20 mA	GHZ	8.0			8.0			8.0			8.0			8.0			8.0		
S21E  <sup>2</sup>	Insertion Power Gain at Vce = 8 V, Ic = 20 mA, f = 0.5 GHz f = 1 GHz f = 2 GHz	dB	21.0			21.0			15.5			15.5			13.0			13.0		
		dB	15.5			15.5			9.6			9.0			7.0			7.0		
		dB	8.0			8.0			8.0			8.0			8.0			8.0		
NFMIN	Minimum Noise Figure <sup>2</sup> at Vce = 8 V, Ic = 5 mA, f = 0.5 GHz f = 1 GHz f = 2 GHz	dB	1.3			1.3			1.0			1.3			1.2			1.2		
		dB	2.2			2.2			1.3			2.2			2.2			2.2		
		dB	3.5			3.5			3.5			3.5			2.5			2.5		
MAG	Maximum Available Gain <sup>3</sup> at Vce = 8 V, Ic = 20 mA, f = 0.5 GHz f = 1 GHz f = 2 GHz	dB	25.0			25.0			23.0			25.0			16.0			16.0		
		dB	18.4			18.4			16.4			18.4			10.0			10.0		
		dB	12.6			12.6			12.6			12.6			12.0			12.0		
GNF	Associated Gain at Optimum Noise Figure, Vce = 8 V, Ic = 5 mA, f = 0.5 GHz f = 1 GHz f = 2 GHz	dB	15.0			15.0			12.0			15.0			12.0			12.0		
		dB	13.0			13.0			10.0			13.0			10.0			10.0		
		dB	8.0			8.0			8.0			8.0			8.0			8.0		
Posc	Oscillator Power Output at Vce = 8 V, Ic = 40 mA, f = 6 GHz	mW																		100

Notes:

- Electronics Industrial Association of Japan.
- Input and output are tuned for optimum noise figure.
- Maximum Available Gain (MAG) is calculated from the device S-Parameters using the equation,  $MAG = \frac{|S21|}{|S12|} (K \pm \sqrt{K^2 - 1})$  K =  $\frac{1 + |\Delta|^2 - |S11|^2 - |S22|^2}{2|S21||S12|}$  Δ = S11 S22 - S21 S12
- EIAJ registered number refers to grade C versions of these devices.

**ELECTRICAL CHARACTERISTICS (TA = 25°C)**

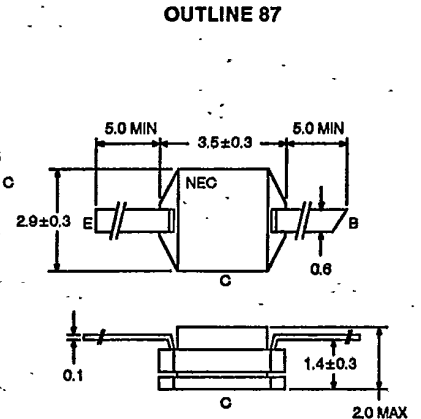
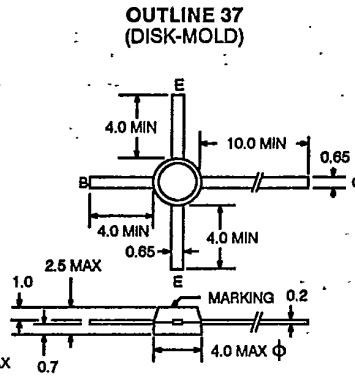
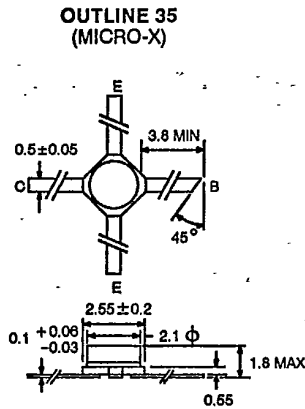
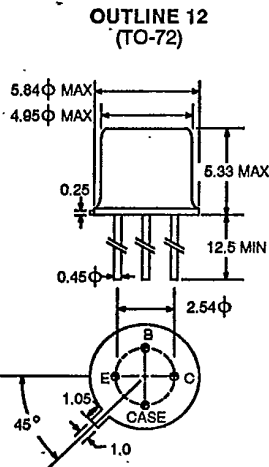
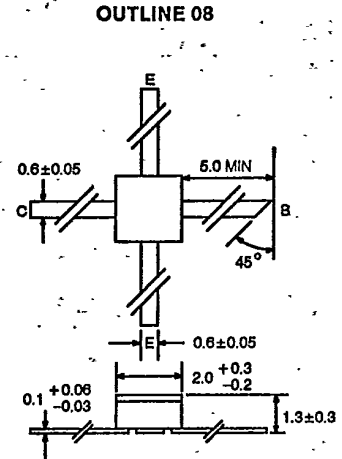
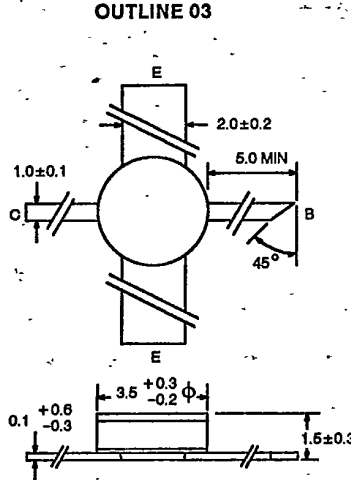
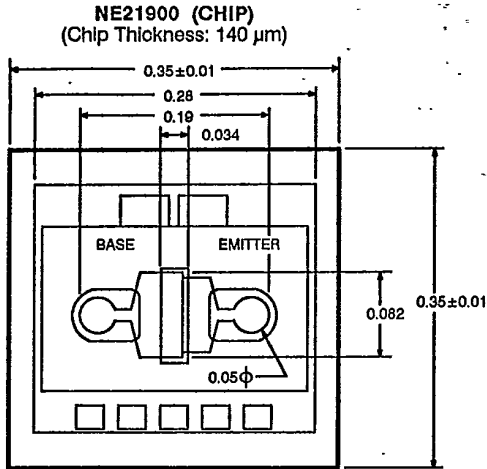
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	NE21903 2SC22174			NE21908 2SC22184			NE21912			NE21935 2SC2367			NE21937 2SC2869			NE21987		
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Icbo	Collector Cutoff Current at Vcb = 8 V, Ie = 0	μA		1.0			1.0						1.0			1.0			1.0	
Iebo	Emitter Cutoff Current at Veb = 1 V, Ic = 0	μA		1.0			1.0						1.0			1.0			1.0	
hFE	Forward Current Gain at Vce = 8 V, Ic = 20 mA		30	100	300	30	100	300	30	100	300	30	100	300	30	100	300	30	100	300
Ccb	Collector to Base Capacitance <sup>2</sup> at Vcb = 8 V, Ie = 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
Rth	Thermal Resistance (J-C)	°C/W		70			90			90			80			500 <sup>3</sup>			70	700
Pt	Total Power Dissipation (TA = 25°C)	mW		580			350			600			580			250			250	700

- Notes:
- Electronic Industrial Association of Japan.
  - Ccb measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal.
  - Rth (J-A)
  - EIAJ registered number refers to grade C versions of these devices.

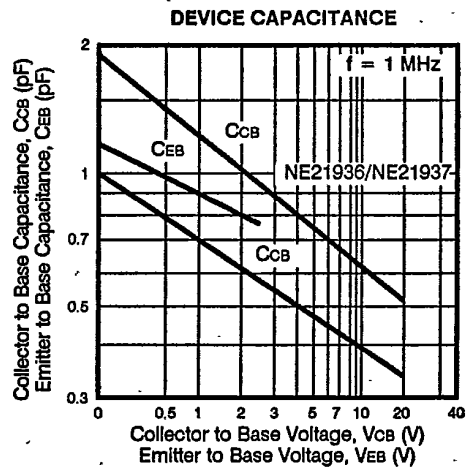
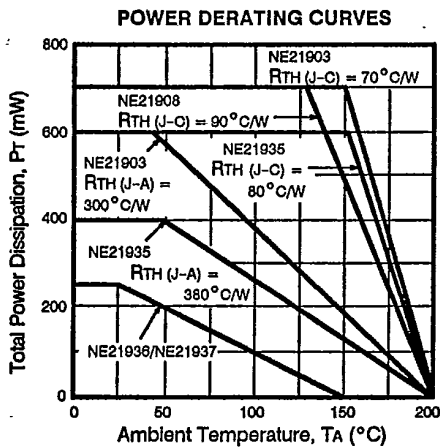


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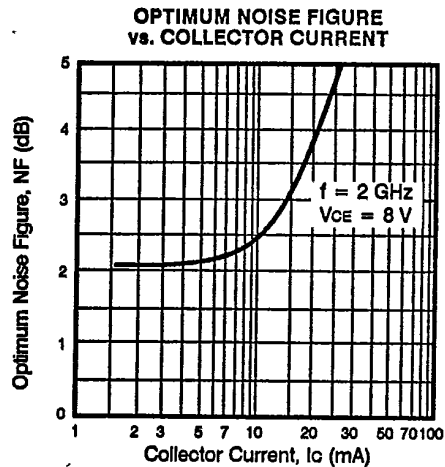
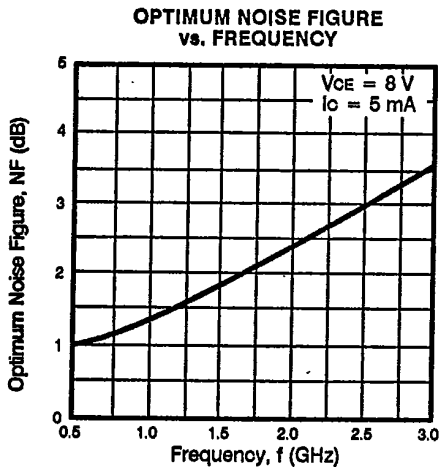
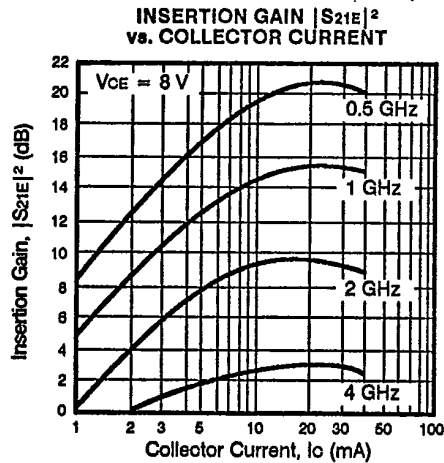
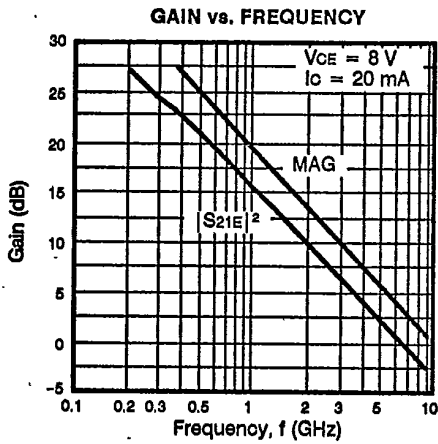
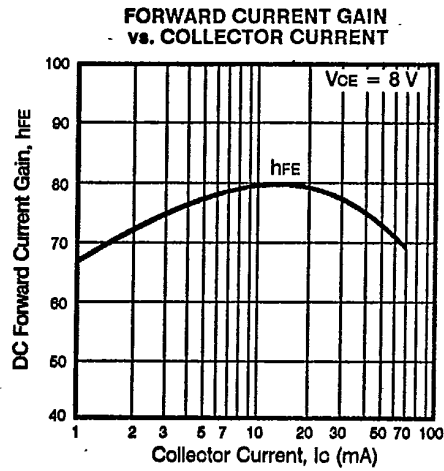
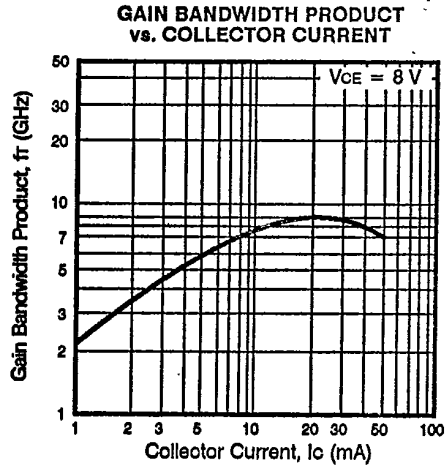
OUTLINE DIMENSIONS (Units in mm)



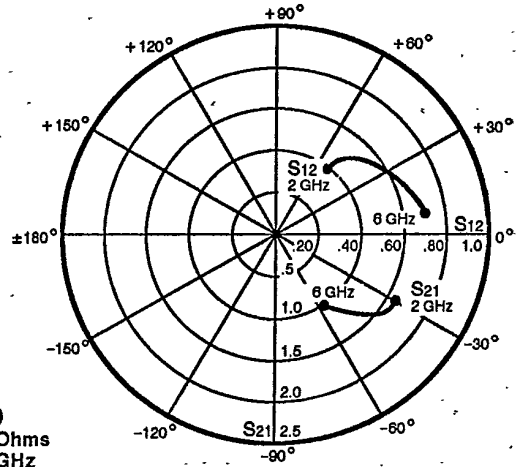
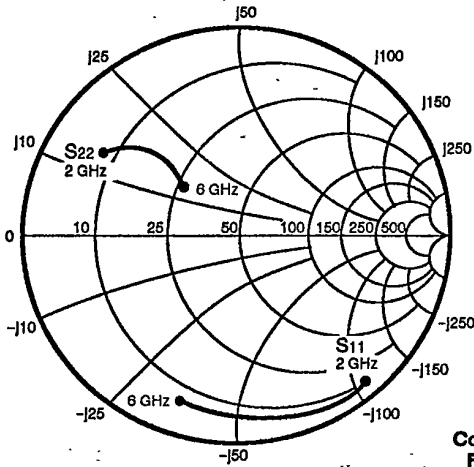
TYPICAL DEVICE CHARACTERISTICS (TA = 25°C)



TYPICAL PERFORMANCE CHARACTERISTICS (TA = 25°C)



TYPICAL COMMON COLLECTOR SCATTERING PARAMETERS



NE21900  
Coordinates in Ohms  
Frequency in GHz  
(VCE = 8 V, IC = 20 mA)

S-MAGN AND ANGLES:

VCE = 8 V, IC = 10 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
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

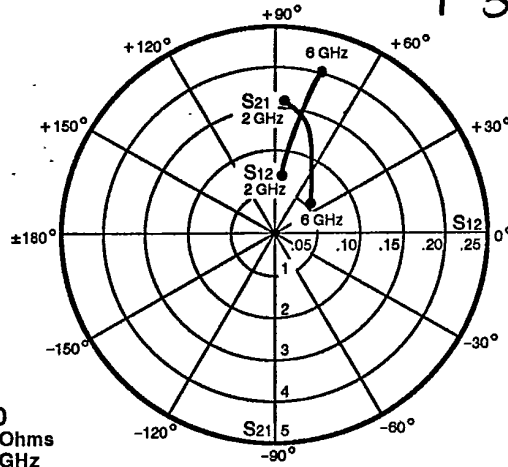
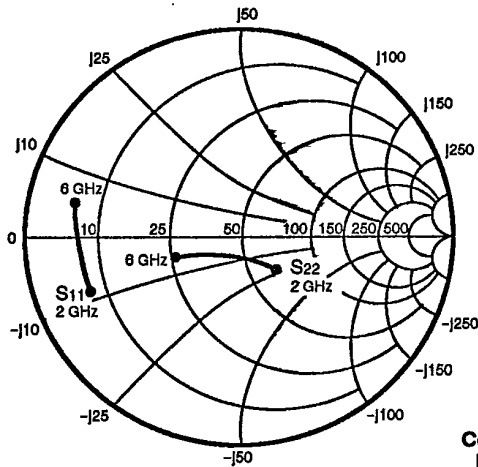
VCE = 8 V, IC = 20 mA

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

VCE = 8 V, IC = 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  
(VCE = 8 V, IC = 20 mA)

S-MAGN AND ANGLES:

VCE = 8 V, IC = 10 mA

FREQUENCY (MHz)

	S11		S21		S12		S22	
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

VCE = 8 V, IC = 20 mA

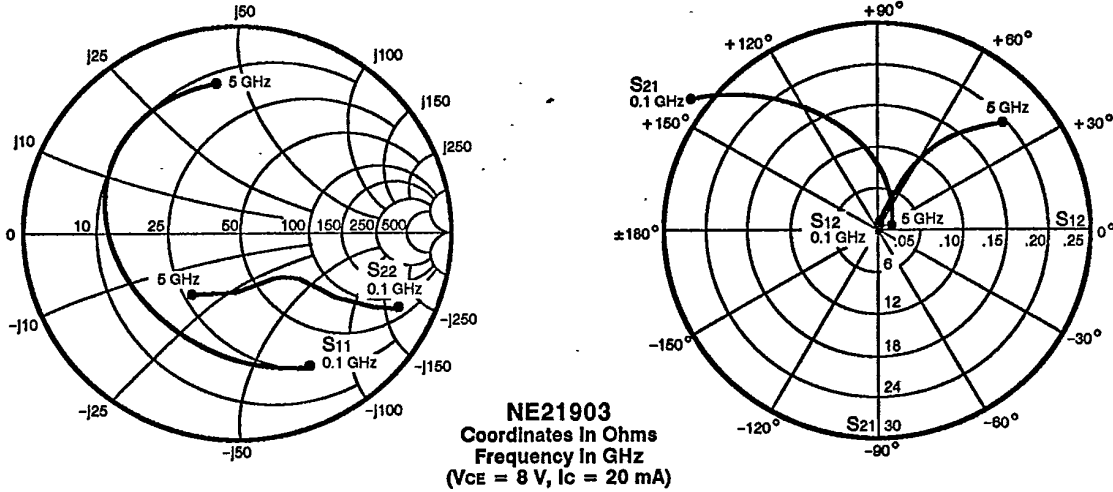
2000	.69	-159	3.03	88	.07	81	.26	-46
2500	.67	-170	2.51	78	.09	79	.21	-44
3000	.72	-175	2.15	70	.11	79	.19	-39
3500	.74	-176	1.90	67	.13	81	.14	-58
4000	.69	175	1.68	56	.15	74	.08	-90
4500	.73	174	1.46	53	.16	77	.11	-115
5000	.76	172	1.34	47	.18	74	.16	-143
5500	.72	167	1.21	42	.19	73	.23	-154
6000	.73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

VCE = 8 V, IC = 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**



**S-MAGN AND ANGLES:**

VCE = 8 V, IC = 10 mA  
FREQUENCY (MHz)

	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
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

VCE = 8 V, IC = 20 mA

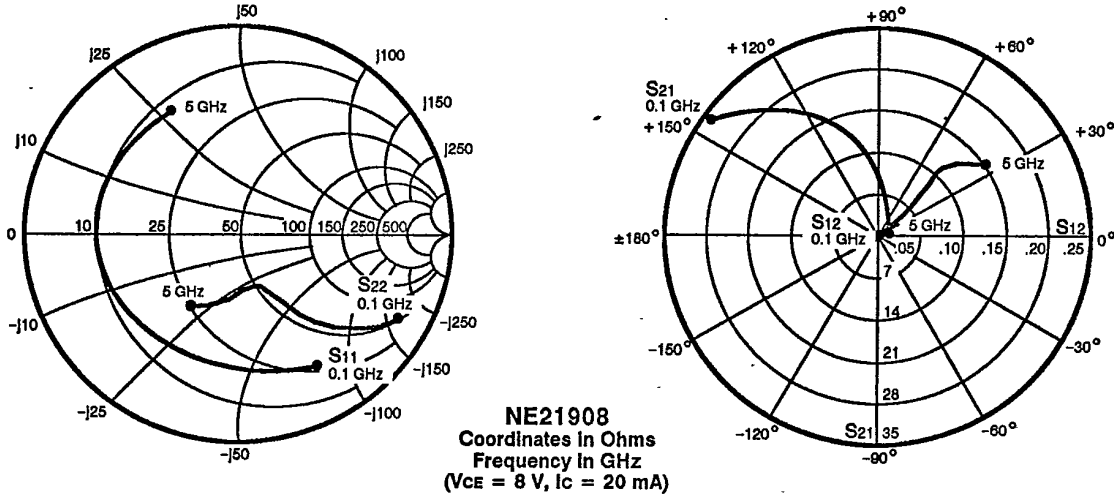
100	.69	-64	32.32	144	.01	71	.84	-24
500	.60	-156	11.17	96	.03	46	.37	-42
1000	.61	178	5.81	78	.04	53	.28	-44
1500	.61	164	3.92	66	.06	55	.28	-50
2000	.62	151	2.93	56	.09	59	.29	-59
2500	.64	140	2.38	46	.11	55	.25	-72
3000	.67	130	2.06	35	.13	51	.25	-85
3500	.68	120	1.73	26	.15	48	.26	-96
4000	.69	112	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

VCE = 8 V, IC = 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

NE219 SERIES

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



S-MAGN AND ANGLES:

V<sub>CE</sub> = 8 V, I<sub>C</sub> = 5 mA  
FREQUENCY (MHz)

	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
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

V<sub>CE</sub> = 8 V, I<sub>C</sub> = 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

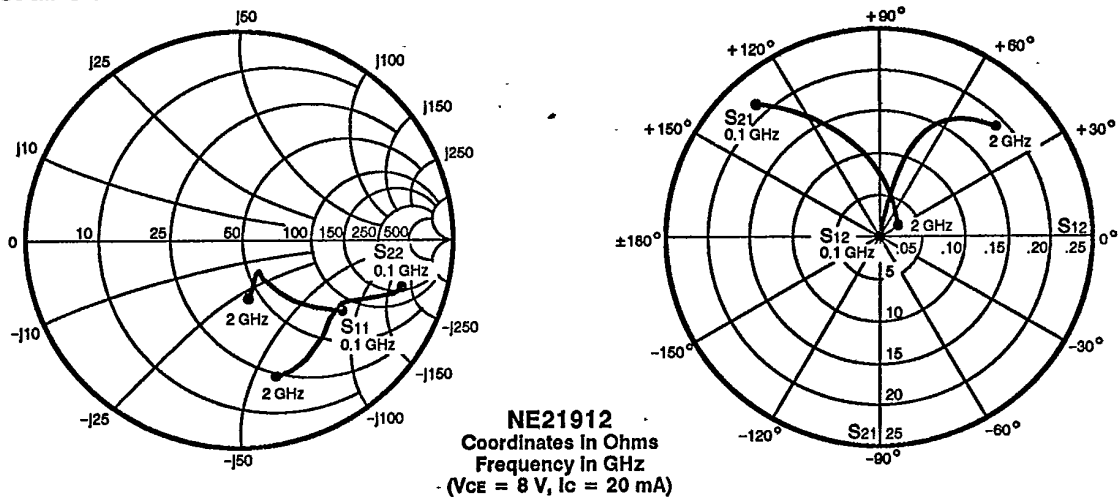
V<sub>CE</sub> = 8 V, I<sub>C</sub> = 20 mA

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

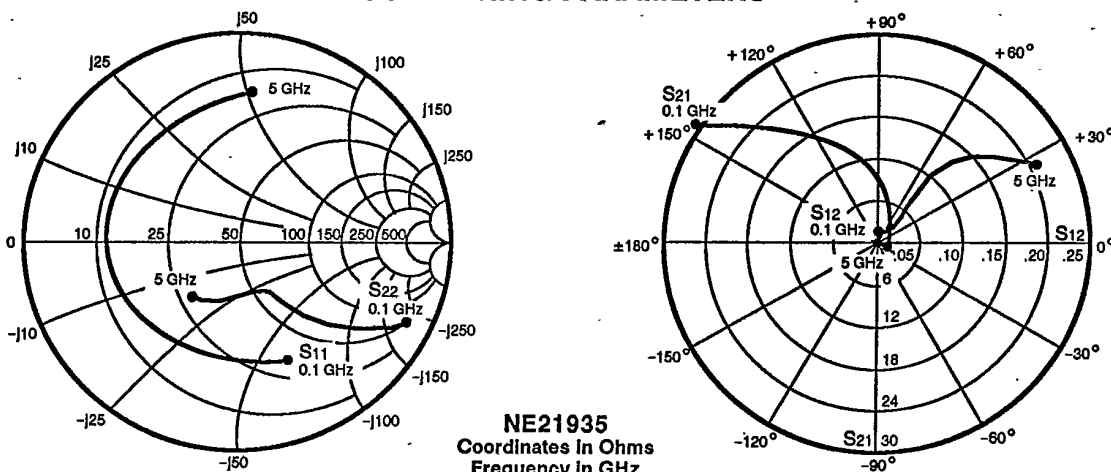


S-MAGN AND ANGLES:

VCE = 8 V, IC = 5 mA	S11		S21		S12		S22	
FREQUENCY (MHz)	Magnitude	Angle	Magnitude	Angle	Magnitude	Angle	Magnitude	Angle
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
<b>VCE = 8 V, IC = 10 mA</b>								
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
<b>VCE = 8 V, IC = 20 mA</b>								
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
<b>VCE = 8 V, IC = 30 mA</b>								
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

NE219 SERIES

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



NE21935  
Coordinates in Ohms  
Frequency in GHz  
(VCE = 8 V, IC = 20 mA)

S-MAGN AND ANGLES:

VCE = 8 V, IC = 5 mA  
FREQUENCY (MHz)

	S11		S21		S12		S22	
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

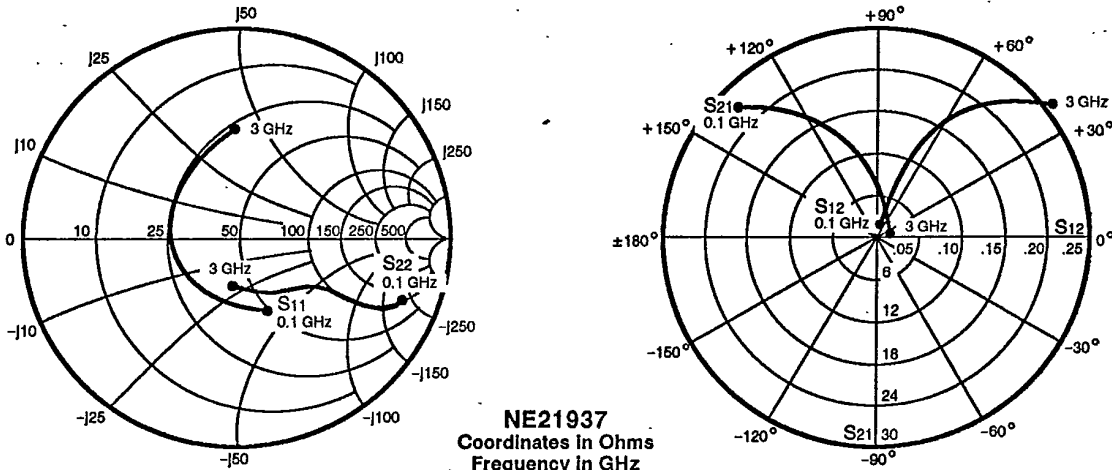
100	.67	-44	22.00	153	.01	76	.92	-18
500	.59	-139	10.21	104	.04	42	.48	-48
1000	.60	-173	5.57	82	.05	41	.34	-55
1500	.59	169	3.78	67	.07	42	.32	-61
2000	.60	155	2.86	56	.09	45	.32	-68
2500	.62	140	2.29	43	.11	43	.30	-80
3000	.63	129	1.96	31	.12	41	.31	-91
3500	.64	117	1.68	22	.14	39	.32	-101
4000	.65	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<sub>CE</sub> = 8 V, I<sub>C</sub> = 20 mA)

**S-MAGN AND ANGLES:**

V<sub>CE</sub> = 8 V, I<sub>C</sub> = 5 mA  
FREQUENCY (MHz)

	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
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

V<sub>CE</sub> = 8 V, I<sub>C</sub> = 10 mA

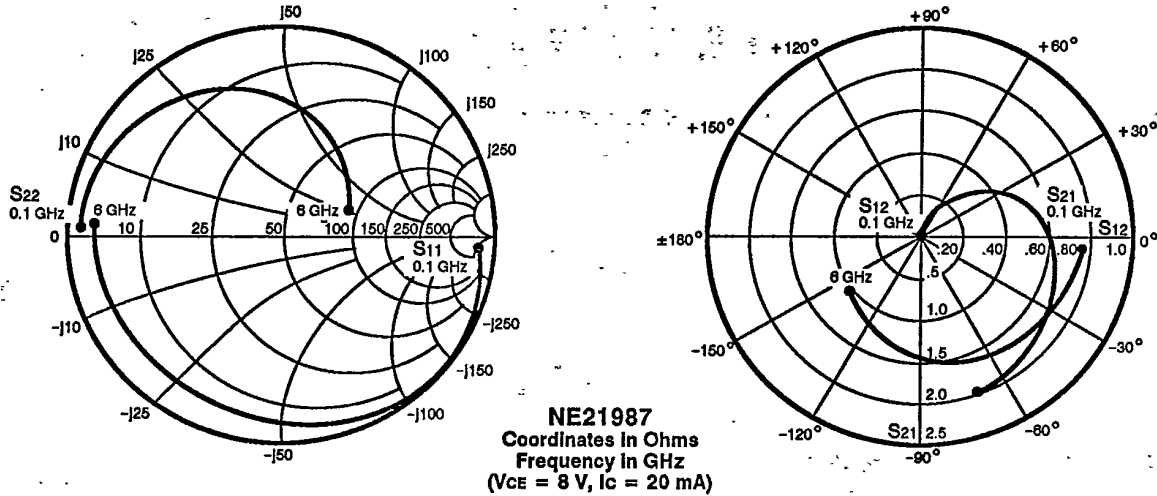
100	.53	-52	19.37	146	.01	72	.89	-17
200	.42	-91	14.71	125	.02	56	.73	-27
500	.36	-153	7.39	95	.05	58	.49	-32
1000	.38	165	3.98	72	.09	60	.41	-38
1500	.41	140	2.71	56	.13	57	.39	-47
2000	.45	122	2.07	42	.17	54	.36	-60
2500	.50	105	1.70	27	.21	47	.31	-73
3000	.55	93	1.44	14	.26	40	.28	-95

V<sub>CE</sub> = 8 V, I<sub>C</sub> = 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

NE219 SERIES

TYPICAL COMMON COLLECTOR SCATTERING PARAMETERS



S-MAGN AND ANGLES:

V<sub>CE</sub> = 8 V, I<sub>C</sub> = 10 mA

FREQUENCY (MHz)	S <sub>11</sub>	S <sub>21</sub>	S <sub>12</sub>	S <sub>22</sub>
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<sub>CE</sub> = 8 V, I<sub>C</sub> = 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<sub>CE</sub> = 8 V, I<sub>C</sub> = 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

