



# NPN SILICON HIGH FREQUENCY TRANSISTOR

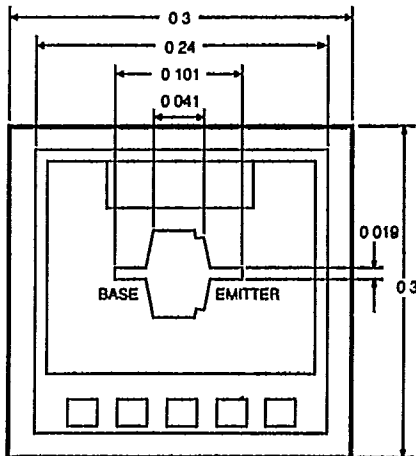
NE64500  
NE64508  
NE64535  
NE64587

## FEATURES

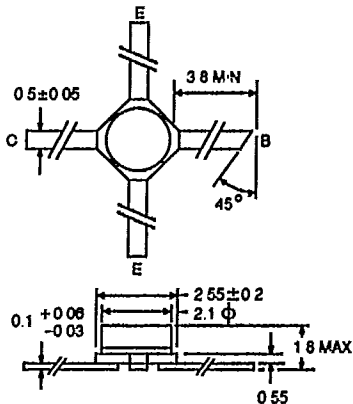
- HIGH  $f_r$   
 $f_r = 8.5$  GHz
- LOW NOISE FIGURE  
1.3 dB at 1.5 GHz  
1.6 dB at 2 GHz
- HIGH ASSOCIATED GAIN  
14 dB at 1.5 GHz  
12 dB at 2 GHz
- SPACE QUALIFIED

## OUTLINE DIMENSIONS (Units in mm)

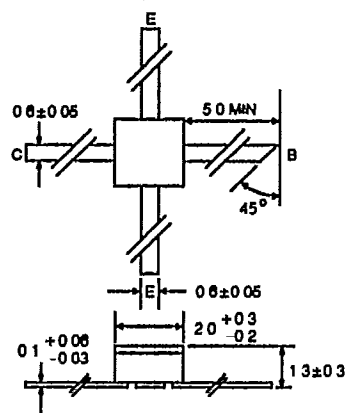
NE64500 (CHIP)  
(Chip Thickness:  $160 \pm 20$   $\mu$ m)



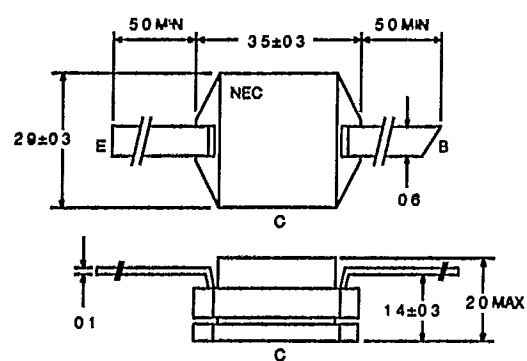
OUTLINE 35



OUTLINE 08



OUTLINE 87



## DESCRIPTION AND APPLICATIONS

The NE645 series of NPN silicon transistors is designed for low-noise amplifier and medium power oscillator applications. The NE645 series employs a new NEC proprietary fabrication technique which provides excellent noise figures at high currents, resulting in superior associated gains and a very wide dynamic range. The NE645 is available in a chip form or three rugged hermetically sealed strip-line packages. Reliability is assured by quality control and test procedures patterned after MIL-S-19500 and MIL-STD-750.

The NE64500 (chip) employs arsenic doped emitters and NEC's reliable Pt/Si-Ti-Pt-Au metallization system. The NE64535 (MICRO-X) is a low cost, hermetically sealed package designed for large volume industrial and military microwave products. The NE64508 is in a low-loss, hi-rel package capable of meeting the rigors of space qualification. The NE64587 is in a common collector configuration suitable for oscillator applications up to 10 GHz.

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

PART NUMBER EIAJ <sup>1</sup> REGISTERED NUMBER PACKAGE OUTLINE			NE64500 00 (CHIP)			NE64508 2SC2273 08			NE64535 2SC2585 35 (MICRO-X)			NE64587 87		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
fr	Gain Bandwidth Product at VCE = 8 V, IC = 20 mA	GHz		8.5			8.5			8.5			8.5	
S21E  <sup>2</sup>	Insertion Power Gain at VCE = 8 V, IC = 20 mA, f = 1 GHz f = 2 GHz f = 4 GHz	dB dB dB	10	18 12 6.5		10	18 12 6.5		10	18 11 6.5				
NFMIN	Minimum Noise Figure <sup>2</sup> at VCE = 8 V, IC = 7 mA, f = 0.5 GHz f = 1.5 GHz f = 2 GHz	dB dB dB		1.6			0.9 1.3 1.6	2		0.9 1.4 1.6	2.5			
GA	Associated Gain at VCE = 8 V, IC = 7 mA, f = 1.5 GHz f = 2 GHz	dB dB	11	14 12		11	14 12		10	13 11				
MAG	Maximum Available Gain <sup>3</sup> at VCE = 8 V, IC = 10 mA, f = 2 GHz f = 4 GHz	dB dB		16			16 11			15 10				
Posc	Oscillator Output Power at VCE = 10 V, IC = 40 mA, f = 6 GHz	mW		110									110	

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

PART NUMBER EIAJ <sup>1</sup> REGISTERED NUMBER PACKAGE OUTLINE			NE64500 00 (CHIP)			NE64508 2SC2273 08			NE64535 2SC2585 35 (MICRO-X)			NE64587 87		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
ICBO	Collector Cutoff Current at VCB = 8 V, IE = 0	μA			0.1			0.1			0.1			0.1
IEBO	Emitter Cutoff Current at VEB = 1 V, IC = 0	μA			1			1			1			1
hFE	Forward Current Gain at VCE = 8 V, IC = 7 mA		50	100	250	50	100	250	50	100	250	50	100	250
CCB	Collector to Base Capacitance <sup>4</sup> at VCB = 10 V, IE = 0, f = 1 MHz	pF		0.2	0.6		0.2	0.6		0.2	0.6		0.2	0.6
RTH	Thermal Resistance (Junction-to-Case)	°C/W			75			85			85			75
PT	Total Power Dissipation <sup>5</sup>	mW			400			400			400			400

**Notes:**

- Electronic 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,

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

- CCB measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal.
- The Case Temperature, Tc, when measuring Total Power Dissipation for the following devices are:  
 NE64535 - Tc = 166°C  
 NE64508 - Tc = 150°C  
 NE64587 - Tc = 170°C



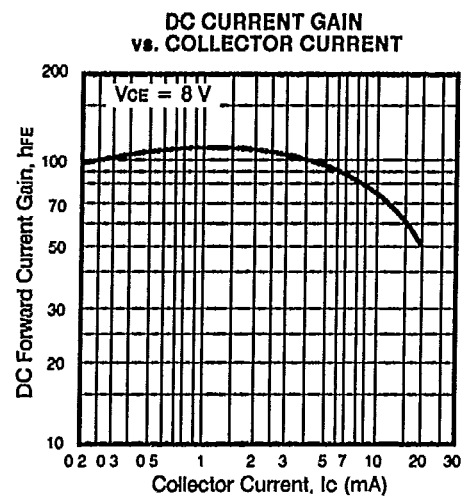
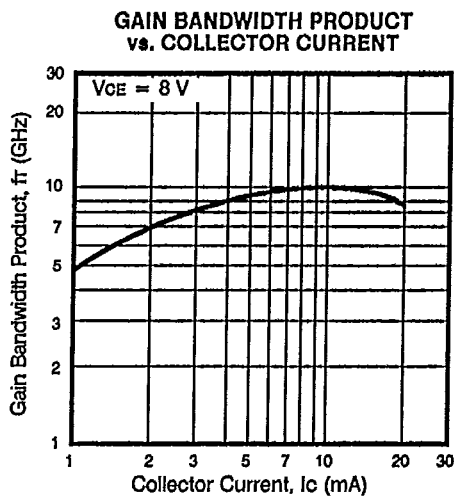
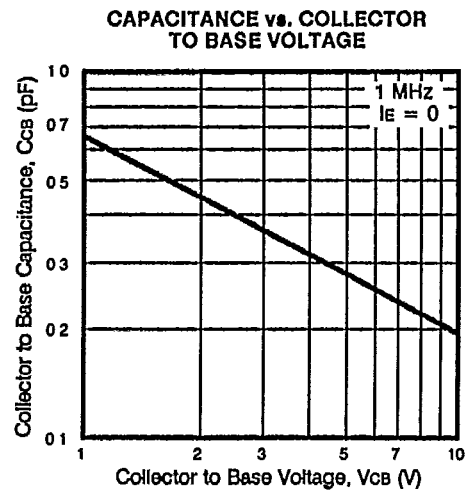
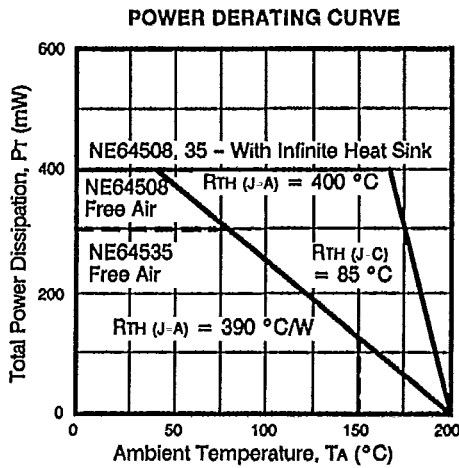
**ABSOLUTE MAXIMUM RATINGS** (TA = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
Vcbo	Collector to Base Voltage	V	25
Vceo	Collector to Emitter Voltage	V	12
Vebo	Emitter to Base Voltage*	V	1.5
Ic	Collector Current	mA	65
Tj	Junction Temperature	°C	200
Tstg	Storage Temperature	°C	-65 to +200**

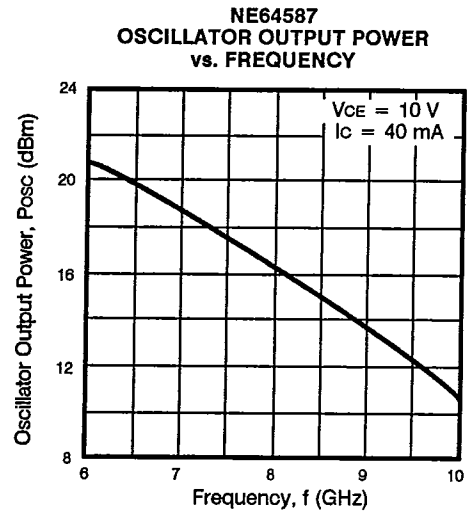
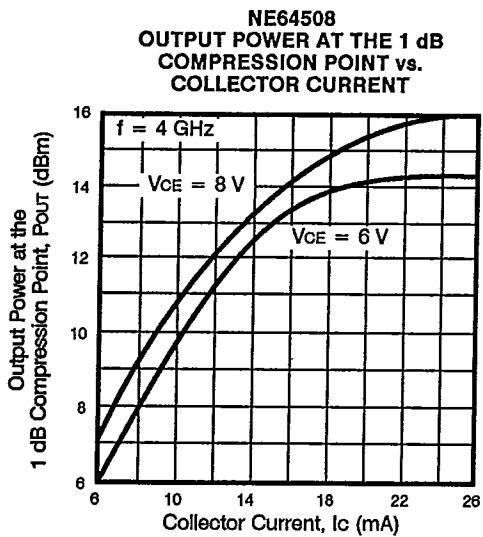
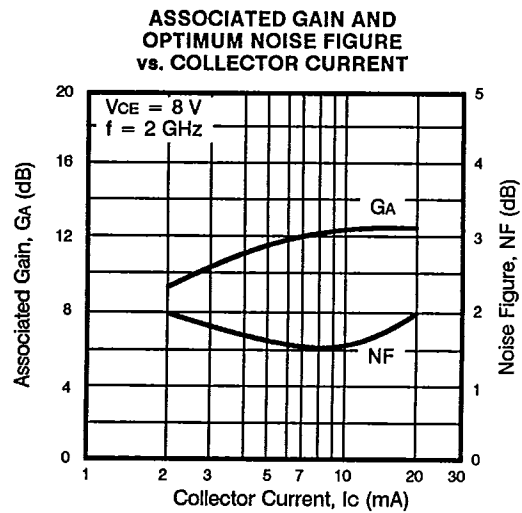
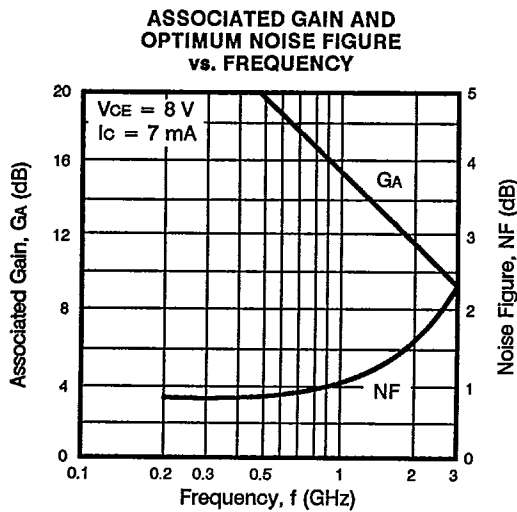
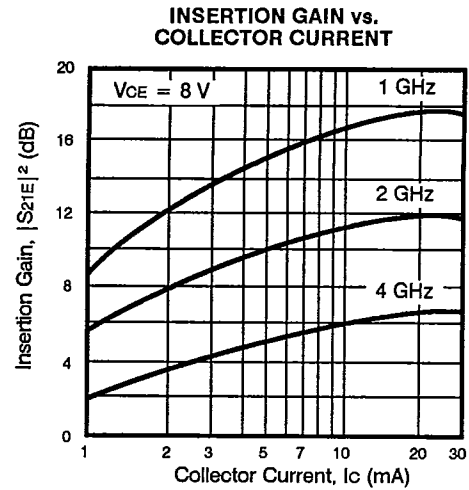
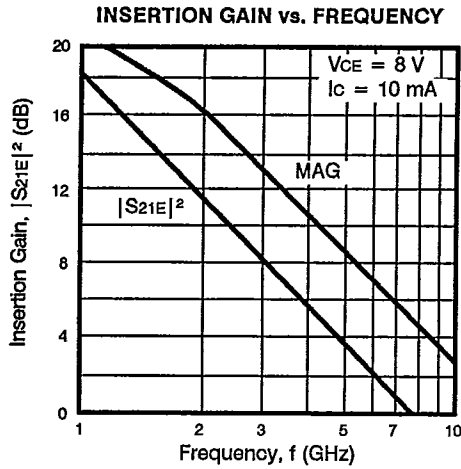
\*Vebo rating for NE64500 and NE64587 is 3 V.

\*\*Tstg for NE64535 is -65°C to 150°C because leads are Sn plated and may tarnish above 150°C. Once soldered into a circuit, the unit can be stored at 200°C.

**TYPICAL DEVICE CHARACTERISTICS** (TA = 25°C)

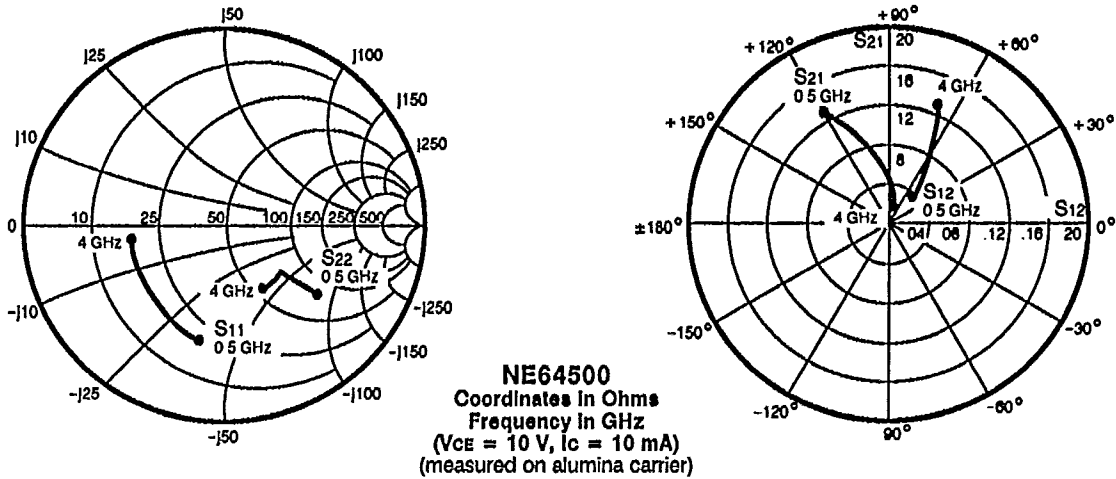


**TYPICAL PERFORMANCE CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$ )



NE64500, NE64508, NE64535, NE64587

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



S-MAGN AND ANGLES:

VCE = 10 V, IC = 5 mA

FREQUENCY (MHz)

FREQUENCY (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
500	.69	-75	10.60	129	.047	55	.72	-29
1000	.58	-112	6.30	108	.061	48	.56	-38
2000	.50	-140	3.44	89	.076	53	.47	-42
3000	.48	-156	2.31	71	.094	58	.47	-56
4000	.49	-166	1.79	62	.118	65	.46	-62

VCE = 10 V, IC = 10 mA

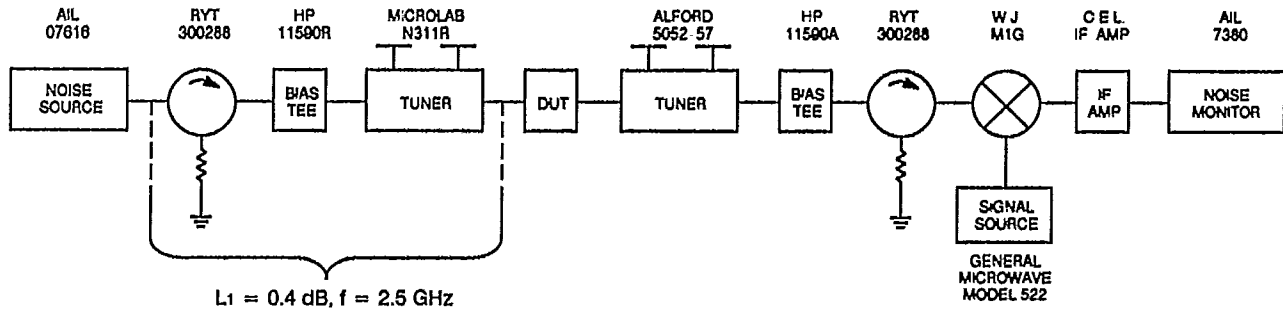
500	.58	-99	13.88	119	.037	54	.59	-36
1000	.51	-130	7.54	101	.049	55	.45	-39
2000	.47	-152	3.97	86	.070	64	.39	-42
3000	.45	-164	2.61	71	.097	68	.40	-56
4000	.46	-172	2.04	62	.128	71	.39	-60

VCE = 10 V, IC = 20 mA

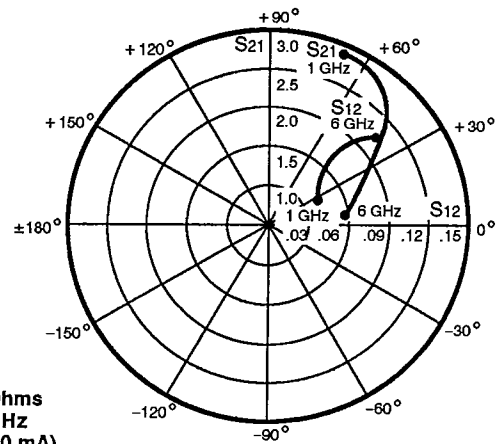
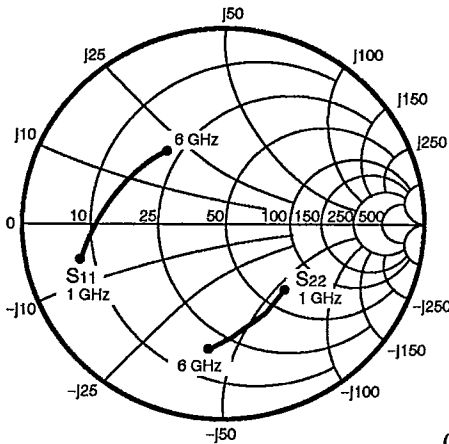
500	.51	-121	15.81	111	.028	57	.48	-38
1000	.48	-144	8.14	97	.042	64	.38	-37
2000	.46	-160	4.21	84	.069	73	.35	-40
3000	.45	-169	2.74	70	.099	74	.36	-55
4000	.46	-175	2.14	61	.132	74	.36	-59

NOISE FIGURE TEST CIRCUIT

TEST CIRCUIT FOR  $f \leq 4$  GHz



**TYPICAL COMMON EMITTER SCATTERING PARAMETERS**



**NE64508**  
Coordinates in Ohms  
Frequency in GHz  
(VCE = 8 V, IC = 10 mA)

**S-MAGN AND ANGLES:**

VCE = 8 V, IC = 7 mA

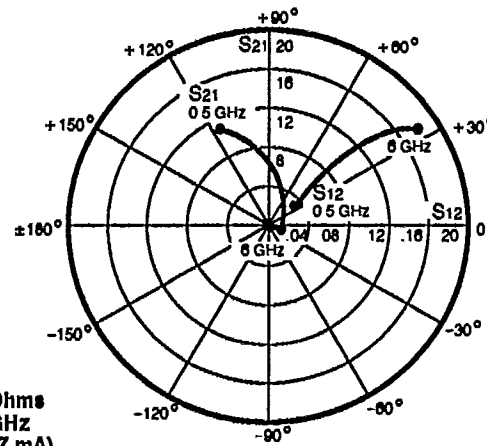
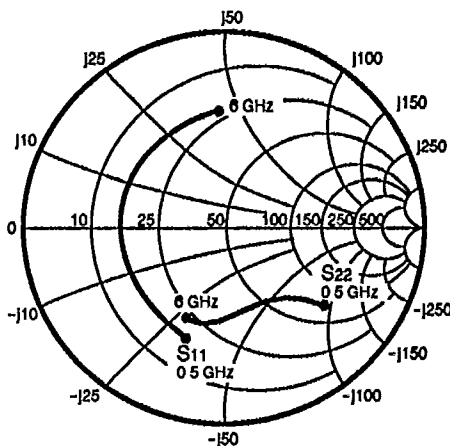
FREQUENCY (MHz)	S11		S21		S12		S22	
500	.82	-84	4.27	128	.042	38	.70	-62
1000	.77	-163	3.76	91	.050	38	.51	-58
2000	.63	-172	2.81	68	.055	33	.51	-60
2500	.60	-179	2.80	57	.069	44	.55	-67
3000	.59	175	2.44	48	.071	22	.56	-72
3500	.60	167	2.15	40	.069	25	.57	-78
4000	.56	160	1.85	30	.072	34	.60	-82
4500	.54	150	1.62	23	.067	31	.60	-85
5000	.51	148	1.49	19	.085	45	.65	-88
5500	.52	142	1.39	10	.103	38	.67	-94
6000	.50	131	1.27	4	.108	36	.68	-97

VCE = 8 V, IC = 10 mA

500	.78	-92	5.82	123	.035	37	.63	-65
1000	.72	-162	5.01	88	.045	24	.46	-58
2000	.63	-177	2.84	67	.052	41	.47	-61
2500	.62	178	2.85	57	.060	45	.49	-66
3000	.60	169	2.66	47	.070	44	.54	-70
3500	.59	162	2.35	39	.082	41	.54	-79
4000	.55	157	2.02	32	.077	45	.56	-83
4500	.51	147	1.75	24	.080	43	.57	-87
5000	.52	146	1.67	20	.080	51	.60	-87
5500	.51	139	1.53	11	.106	44	.63	-93
6000	.50	129	1.42	4	.118	40	.65	-97

**NE64500, NE64508, NE64535, NE64587**

**TYPICAL COMMON EMITTER SCATTERING PARAMETERS**



**NE64535**  
Coordinates in Ohms  
Frequency in GHz  
(V<sub>CE</sub> = 8 V, I<sub>C</sub> = 7 mA)

**S-MAGN AND ANGLES:**

V<sub>CE</sub> = 8 V, I<sub>C</sub> = 7 mA

FREQUENCY (MHz)

	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		k
500	.61	-108	11.03	115	.03	37	.64	-37	0.53
1000	.54	-151	6.36	89	.05	39	.49	-44	0.87
2000	.53	173	3.45	64	.07	43	.44	-50	1.06
3000	.54	149	2.36	42	.10	44	.43	-64	1.16
4000	.56	131	1.79	24	.12	43	.44	-80	1.13
5000	.60	115	1.44	7	.15	39	.46	-98	1.02
6000	.63	95	1.26	-10	.18	33	.48	-113	0.89

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

500	.56	-122	12.34	110	.03	41	.58	-39	0.67
1000	.52	-161	6.83	87	.04	42	.44	-42	1.11
2000	.52	168	3.69	63	.07	48	.40	-49	1.13
3000	.53	146	2.49	42	.10	47	.40	-63	1.16
4000	.56	129	1.89	23	.12	44	.41	-81	1.12
5000	.59	114	1.53	7	.15	39	.44	-98	1.03
6000	.63	94	1.34	-10	.18	32	.46	-112	0.88

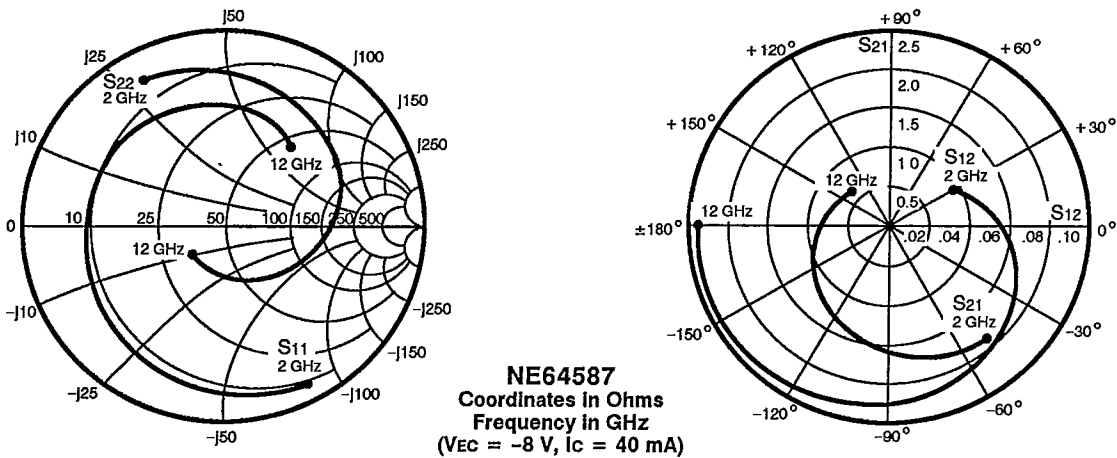
V<sub>CE</sub> = 8 V, I<sub>C</sub> = 20 mA

500	.53	-145	13.79	101	.02	40	.48	-38	0.97
1000	.52	-176	7.26	82	.03	54	.39	-38	1.42
2000	.52	162	3.79	60	.06	62	.39	-46	1.23
3000	.53	125	2.58	23	.10	38	.38	-77	1.12
4000	.56	102	1.96	-0	.13	26	.39	-102	1.07
5000	.60	81	1.62	-23	.16	13	.41	-125	0.94
6000	.64	56	1.37	-47	.19	0	.42	-148	0.86

V<sub>CE</sub> = 8 V, I<sub>C</sub> = 30 mA

500	.52	-156	13.77	97	.02	44	.45	-33	1.19
1000	.53	179	7.13	80	.03	60	.38	-34	1.64
2000	.53	158	3.68	59	.06	63	.40	-44	1.24
3000	.54	140	2.52	39	.10	57	.40	-61	1.15
4000	.55	124	1.89	21	.13	51	.42	-79	1.09
5000	.59	109	1.55	4	.16	44	.43	-96	0.98
6000	.65	89	1.33	-14	.19	37	.44	-113	0.84

**TYPICAL COMMON COLLECTOR SCATTERING PARAMETERS**



**S-MAGN AND ANGLES:**

$V_{EC} = -8\text{ V}$ ,  $I_C = 10\text{ mA}$

FREQUENCY (MHz)	S11		S21		S12		S22	
2000	.92	-59	1.70	-44	.37	40	.79	120
3000	.87	-85	1.58	-64	.50	18	.70	90
4000	.81	-115	1.50	-79	.60	2	.71	78
5000	.72	-135	1.35	-100	.69	-19	.68	43
6000	.66	-163	1.23	-115	.76	-39	.65	22
7000	.60	172	1.09	-135	.84	-63	.61	-1
8000	.60	148	1.02	-152	.90	-79	.55	-18
9000	.58	114	.93	-167	.90	-101	.46	-43
10000	.58	92	.87	180	.94	-119	.39	-59
11000	.56	60	.80	155	.94	-146	.32	-82
12000	.58	40	.73	137	.87	-167	.19	-94

$V_{EC} = -8\text{ V}$ ,  $I_C = 20\text{ mA}$

2000	.92	-60	1.74	-44	.36	41	.85	125
3000	.91	-84	1.65	-64	.49	19	.76	93
4000	.82	-113	1.55	-79	.60	2	.77	80
5000	.74	-133	1.41	-101	.70	-21	.72	42
6000	.67	-160	1.30	-116	.77	-41	.69	20
7000	.60	175	1.14	-136	.81	-66	.64	-4
8000	.58	151	1.08	-153	.86	-82	.59	-20
9000	.57	117	1.00	-169	.85	-103	.51	-43
10000	.56	92	.92	177	.89	-119	.47	-56
11000	.55	58	.83	152	.88	-145	.42	-74
12000	.58	35	.75	135	.84	-168	.33	-82

$V_{EC} = -8\text{ V}$ ,  $I_C = 40\text{ mA}$

2000	.89	-61	1.82	-47	.38	33	.85	118
3000	.83	-91	1.75	-70	.52	11	.81	90
4000	.75	-120	1.62	-90	.62	-9	.77	66
5000	.69	-150	1.36	-112	.71	-32	.71	42
6000	.66	-180	1.21	-132	.79	-52	.64	22
7000	.66	155	1.09	-148	.84	-74	.56	2
8000	.67	129	.98	-168	.88	-93	.47	-15
9000	.63	104	.84	179	.90	-116	.38	-38
10000	.61	84	.76	159	.96	-137	.31	-63
11000	.59	63	.68	144	.95	-166	.23	-95
12000	.54	49	.67	132	.95	177	.20	-140