NEC®

NPN SILICON HIGH FREQUENCY TRANSISTOR

NE64400 NE64408

FEATURES

- **LOW NOISE FIGURE:** 2.7 dB at 4 GHz
- **HIGH ASSOCIATED GAIN:** 8.2 dB at 4 GHz
- **WIDE DYNAMIC RANGE:** f_T = 10 GHz
- **RELIABLE**

DESCRIPTION AND APPLICATIONS

The NE644 is the latest in a series of NPN silicon transistors designed for use in low-noise, small signal amplifiers up to 6 GHz. The series features excellent power gain with very low noise figures. NE644 transistors are available in chip form or in a rugged ceramic-metal stripline package. The NE644 series employs an NEC proprietary fabrication technique which provides excellent noise figures at high current values. This allows excellent associated gain and very wide dynamic range. The NE644 chip employs arsenic doped emitters and NEC's reliable Pt-Si/Ti/Pt/Au metallization system. The NE644 is packaged in NEC's BeO package, designed to meet the rigors of space qualification.

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER PACKAGE OUTLINE			NE64400 00 (CHIP)			NE64408 08		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX
I_{CBO}	Collect Cutoff Current at V_{CB} = 8 V, I_E = 0	µA			0.1			0.1
I_{EBO}	Emitter Cutoff Current at V_{EB} = 1 V, I_C = 0	µA			0.1			0.1
h_{FE}	Forward Current Gain at V_{CE} = 6 V, I_C = 5 mA			100		50	100	250
C_{CB}	Collector to Base Capacitance* at V_{CB} = 10 V, I_E = 0, f = 1 MHz	pF		0.2			0.2	
R_{TH}	Thermal Resistance (Junction-to-Case)	°C/W			120			130
P_T	Total Power Dissipation (T_A = 100°C)	mW						260

PERFORMANCE SPECIFICATIONS (T_A = 25°C)

PART NUMBER PACKAGE OUTLINE			NE64400 00 (CHIP)			NE64408 08		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX
f_T	Gain Bandwidth Product at V_{CE} = 6 V, I_C = 5mA	GHz		10			10	
$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = 6 V, I_C = 5 mA, f = 1 GHz f = 2 GHz f = 4 GHz	 dB dB dB					 19 14 8.2	
NF_{MIN}	Minimum Noise Figure at V_{CE} = 6 V, I_C = 5 mA, f = 2 GHz f = 4 GHz	 dB dB		 2.7			 1.7 2.7	 3
GNF	Power Gain at Optimum NF at V_{CE} = 6 V, I_C = 5 mA, f = 2 GHz f = 4 GHz	 dB dB				 8	 13 8.5	
MAG	Maximum Available Gain** at V_{CE} = 6 V, I_C = 10 mA f = 2 GHz f = 4 GHz f = 6 GHz	 dB dB dB		 12			 17 12 9	

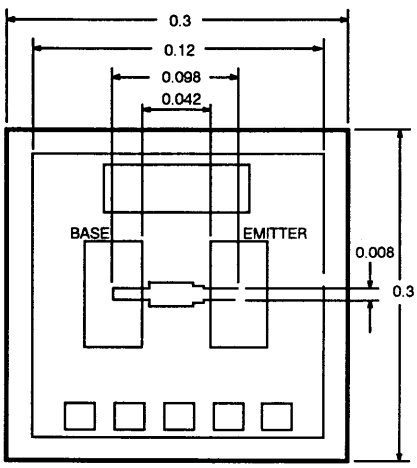
*C_{CB} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emmitter terminal shall be connected to the guard terminal.

**Maximum Available Gain (MAG) is calculated from the device S-Parameters using the equation

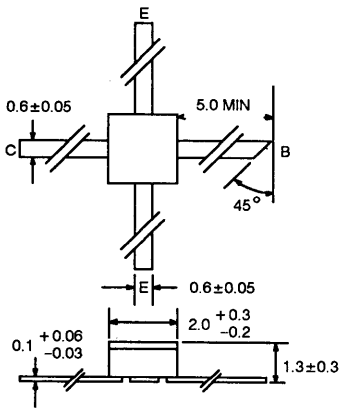
$$MAG = |S_{21E}|^2 \cdot \frac{1}{|1-S_{11}|^2} \cdot \frac{1}{|1-S_{22}|^2}$$

OUTLINE DIMENSIONS (Units in mm)

NE64400 (CHIP)
(Chip Thickness: 110 to 160 µm)



OUTLINE 08

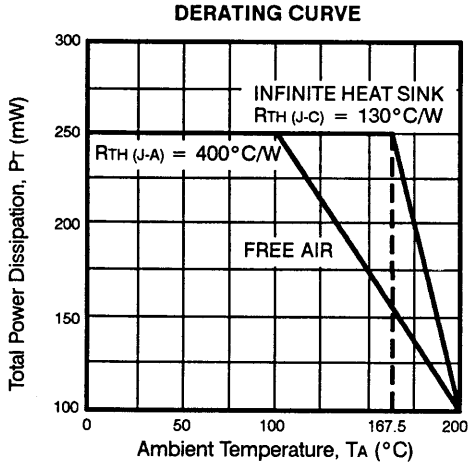


ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

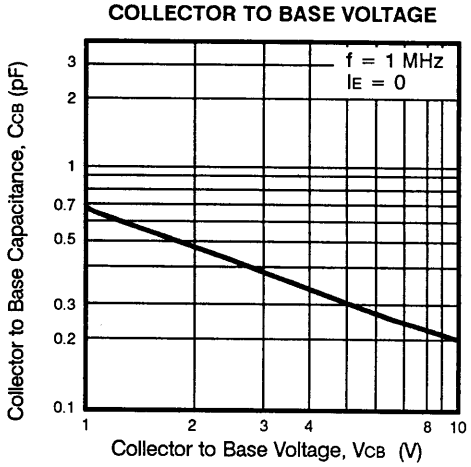
SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	20
V_{CEO}	Collector to Emitter Voltage	V	10
V_{EBO}	Emitter to Base Voltage	V	3.0
I_C	Collector Current	mA	35
T_J	Junction Temperature	°C	200
T_{STG}	Storage Temperature	°C	-65 to +200

TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

NE64408
DERATING CURVE

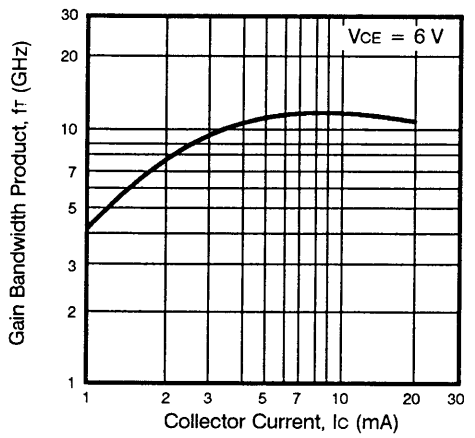


NE64408
CAPACITANCE vs.
COLLECTOR TO BASE VOLTAGE

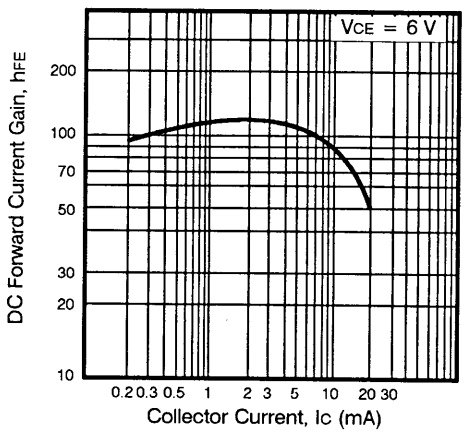


TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

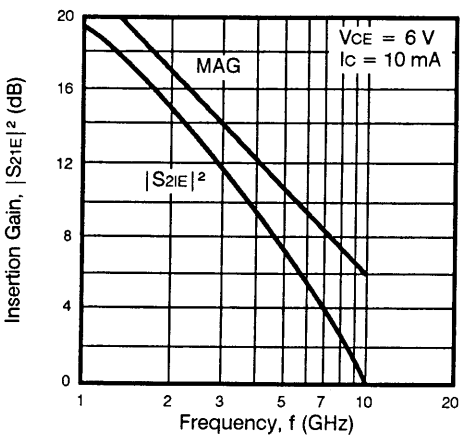
NE64408
GAIN BANDWIDTH PRODUCT
vs. COLLECTOR CURRENT



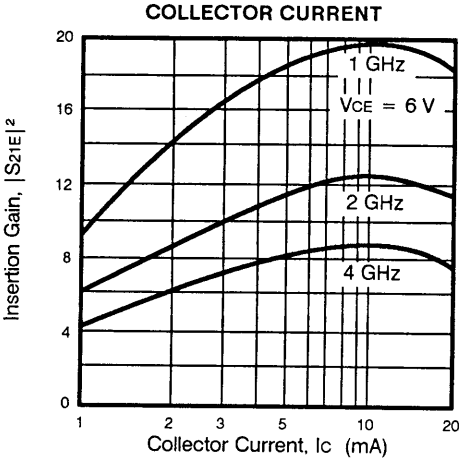
NE64408
FORWARD CURRENT GAIN
vs. COLLECTOR CURRENT



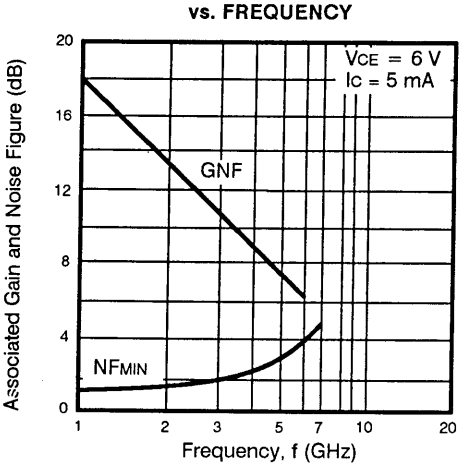
NE64408
INSERTION GAIN vs.
FREQUENCY



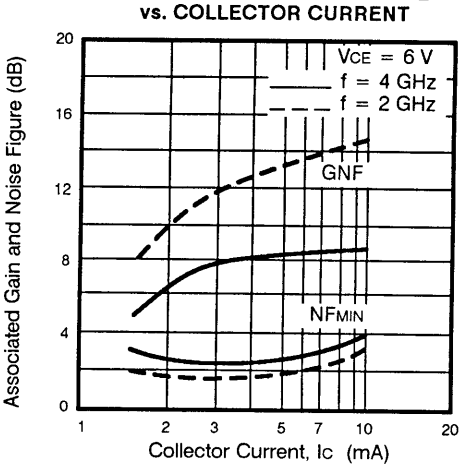
NE64408
INSERTION GAIN vs.
COLLECTOR CURRENT



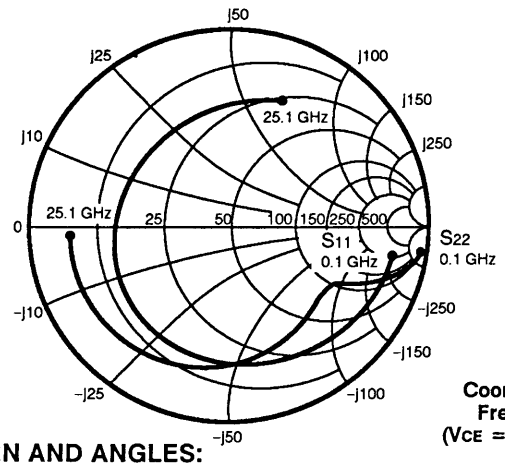
NE64408
ASSOCIATED POWER GAIN
AT OPTIMUM NOISE FIGURE
vs. FREQUENCY

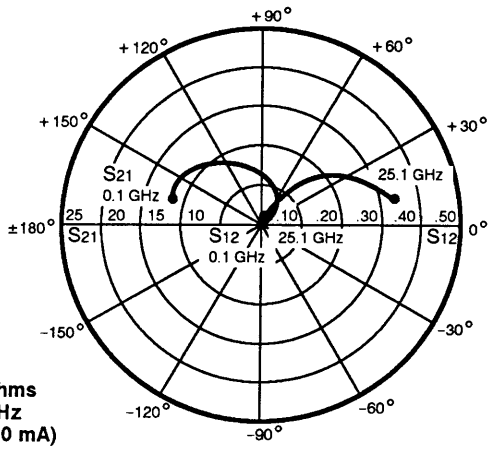


NE64408
ASSOCIATED POWER GAIN
AND OPTIMUM NOISE FIGURE
vs. COLLECTOR CURRENT



TYPICAL COMMON EMITTER SCATTERING PARAMETERS





NE64400
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 10 V, I_C = 10 mA)

S-MAGN AND ANGLES:

V_{CE} = 10 V, I_C = 5 mA

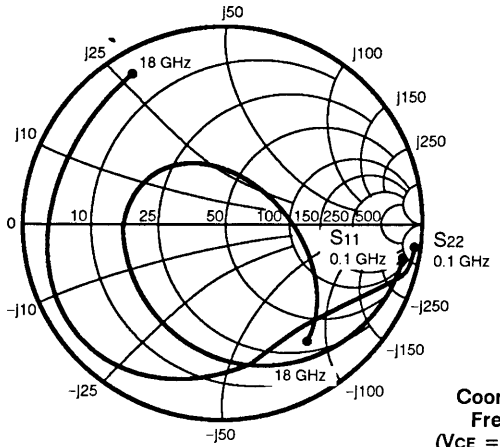
FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}		k	G_{MA}
100	.91	-8	6.24	169	.008	81	.99	-5	.17	29.2
600	.80	-48	5.70	139	.035	56	.83	-20	.45	22.1
1100	.69	-89	5.32	118	.047	45	.72	-26	.57	20.6
2100	.60	-141	4.10	90	.056	39	.62	-31	.77	18.6
3100	.57	-160	2.91	75	.066	40	.62	-37	.94	16.4
4100	.56	-174	2.32	63	.075	43	.61	-44	1.05	13.6
5100	.56	176	1.90	52	.084	44	.61	-50	1.12	11.4
6100	.56	167	1.62	43	.095	45	.62	-58	1.13	10.1
7100	.56	160	1.39	34	.104	44	.63	-64	1.17	8.7
8100	.56	153	1.24	26	.112	45	.65	-70	1.14	8.2
9100	.58	147	1.11	18	.126	45	.66	-77	1.03	8.4
10100	.59	141	1.01	11	.137	44	.68	-85	.94	8.7
11100	.60	135	.93	3	.150	42	.69	-92	.86	7.9
12100	.61	130	.83	-5	.158	41	.70	-99	.85	7.2
13100	.62	125	.75	-12	.174	39	.72	-107	.78	6.3
14100	.61	120	.68	-19	.185	37	.73	-114	.79	5.6
15100	.61	114	.61	-24	.203	36	.76	-121	.71	4.8
16100	.61	109	.55	-29	.214	33	.77	-127	.70	4.1
17100	.61	103	.48	-32	.231	29	.79	-133	.68	3.2
18100	.62	98	.45	-37	.235	26	.79	-139	.71	2.8
19100	.63	93	.40	-38	.254	24	.80	-144	.74	1.9
20100	.64	88	.36	-38	.266	22	.80	-149	.83	1.3
21100	.65	83	.33	-36	.281	18	.80	-154	.87	0.7
22100	.66	78	.30	-34	.290	17	.79	-159	1.04	-1.1
23100	.65	76	.28	-30	.308	13	.79	-165	1.09	-2.2
24100	.70	72	.27	-27	.313	12	.79	-171	1.16	-3.1
25100	.69	68	.27	-23	.325	8	.78	-179	1.30	-4.2

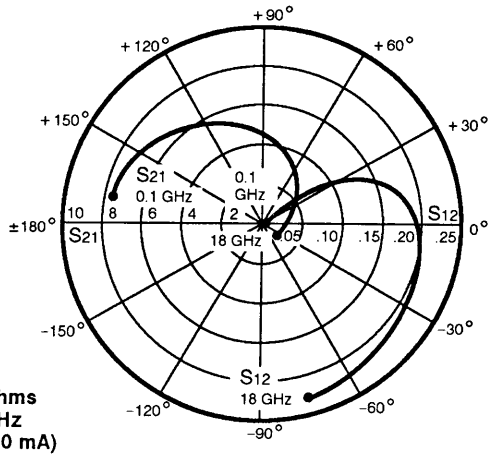
V_{CE} = 10 V, I_C = 10 mA

100	.84	-12	11.32	165	.007	79	.98	-7	.22	32.0
600	.67	-76	10.30	128	.027	50	.74	-23	.53	25.6
1100	.61	-125	7.88	105	.035	44	.63	-25	.64	23.6
2100	.58	-160	4.71	84	.044	47	.58	-29	.93	20.3
3100	.57	-173	3.26	71	.056	51	.57	-35	1.05	16.2
4100	.57	177	2.52	60	.068	53	.58	-42	1.10	13.8
5100	.56	168	2.05	51	.079	54	.59	-49	1.12	12.0
6100	.56	161	1.73	42	.093	53	.60	-56	1.10	10.8
7100	.57	154	1.49	34	.103	52	.61	-62	1.13	9.4
8100	.57	149	1.32	26	.114	52	.63	-69	1.07	9.1
9100	.59	143	1.19	18	.129	51	.64	-76	.96	9.6
10100	.60	138	1.08	11	.140	49	.66	-84	.89	8.9
11100	.61	132	.98	3	.154	47	.67	-91	.81	8.0
12100	.62	127	.89	-5	.163	45	.69	-99	.79	7.3
13100	.62	122	.80	-11	.182	42	.71	-110	.72	6.4
14100	.62	117	.72	-18	.192	41	.72	-113	.72	5.7
15100	.62	112	.65	-23	.211	38	.75	-120	.64	4.9
16100	.62	106	.58	-29	.222	35	.76	-127	.66	4.2
17100	.62	101	.52	-32	.241	31	.77	-132	.62	3.3
18100	.63	96	.48	-37	.244	28	.78	-138	.65	2.9
19100	.64	90	.42	-38	.265	25	.79	-143	.66	2.0
20100	.65	86	.38	-39	.272	23	.79	-148	.78	1.4
21100	.66	81	.35	-37	.290	19	.78	-153	.84	0.8
22100	.67	77	.31	-34	.299	18	.78	-158	.98	0.2
23100	.66	75	.30	-32	.313	13	.78	-164	1.06	-1.7
24100	.70	71	.28	-28	.326	13	.78	-170	1.11	-2.8
25100	.69	67	.27	-24	.332	9	.77	-178	1.29	-4.1

Approx. Bond-wire lengths
Collector C 217 µm
Base B 337 µm
Emitter E 819 µm

TYPICAL COMMON EMITTER SCATTERING PARAMETERS





NE64408
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 10 V, I_C = 10 mA)

S-MAGN AND ANGLES:

VCE = 10 V, IC = 5 mA

FREQUENCY (MHz)	S11		S21		S12		S22		k	GMA
100	.94	-9	7.70	168	.003	67	.99	-6	.40	34.5
200	.92	-20	7.92	159	.014	73	.97	-11	.21	27.7
300	.89	-29	7.35	152	.023	68	.92	-16	.24	25.0
400	.86	-39	7.23	146	.028	61	.90	-20	.29	24.1
500	.82	-47	6.78	138	.032	58	.85	-23	.37	23.2
600	.79	-56	6.79	131	.036	53	.82	-26	.42	22.8
700	.77	-64	6.73	127	.039	49	.78	-28	.46	22.4
800	.74	-72	6.37	122	.041	45	.76	-31	.50	21.9
900	.71	-80	6.27	116	.045	45	.74	-31	.51	21.4
1000	.69	-87	5.95	113	.047	44	.72	-34	.53	21.0
2000	.53	-135	4.00	79	.058	36	.66	-46	.84	18.4
3000	.48	-162	2.93	58	.066	35	.66	-58	1.01	16.0
4000	.46	180	2.25	39	.075	35	.68	-70	1.07	13.1
5000	.43	165	1.82	23	.085	35	.71	-82	1.12	11.2
6000	.40	152	1.56	7	.098	33	.75	-92	1.03	11.0
7000	.35	138	1.30	-8	.110	32	.79	-102	.98	10.7
8000	.30	119	1.16	-20	.127	29	.82	-109	.83	9.6
9000	.25	90	1.03	-36	.144	24	.86	-116	.69	8.5
10000	.26	55	.91	-47	.160	19	.88	-124	.64	7.6
11000	.32	25	.83	-63	.169	10	.88	-132	.61	6.9
12000	.41	4	.75	-78	.190	2	.88	-140	.53	6.0
13000	.50	-12	.64	-91	.200	-5	.88	-148	.54	5.0
14000	.58	-25	.56	-107	.213	-17	.88	-158	.42	4.2
15000	.64	-34	.49	-121	.226	-29	.88	-172	.34	3.3
16000	.70	-42	.43	-135	.228	-42	.85	170	.46	2.7
17000	.73	-48	.36	-158	.232	-58	.83	148	.47	1.9
18000	.72	-54	.14	151	.224	-77	.84	124	1.55	-6.4

VCE = 10 V, IC = 10mA

100	.87	-14	13.99	165	.002	61	.97	-8	.57	38.0
200	.84	-30	13.84	154	.012	68	.93	-14	.26	30.6
300	.79	-43	12.78	145	.020	64	.86	-20	.29	28.1
400	.74	-58	12.18	138	.023	54	.82	-23	.37	27.2
500	.70	-70	11.24	129	.026	53	.76	-26	.45	26.4
600	.66	-82	10.83	121	.028	49	.73	-27	.51	25.9
700	.63	-93	10.37	116	.029	47	.69	-29	.56	25.5
800	.60	-102	9.65	110	.032	45	.67	-31	.60	24.8
900	.58	-111	8.99	105	.035	45	.66	-31	.62	24.1
1000	.56	-118	8.28	101	.036	45	.64	-33	.67	23.6
2000	.48	-158	4.80	73	.047	45	.61	-44	.97	20.1
3000	.46	-178	3.30	54	.060	47	.63	-56	1.05	16.0
4000	.44	167	2.53	37	.074	46	.66	-69	1.04	14.1
5000	.42	154	2.01	21	.086	44	.69	-81	1.05	12.4
6000	.39	142	1.72	6	.102	40	.73	-91	.94	12.3
7000	.34	126	1.43	-9	.117	37	.77	-100	.88	10.9
8000	.30	106	1.27	-21	.135	33	.81	-107	.76	9.7
9000	.27	77	1.12	-37	.152	27	.85	-115	.63	8.7
10000	.29	44	1.00	-48	.168	20	.87	-123	.57	7.7
11000	.36	18	.89	-65	.177	11	.88	-130	.55	7.0
12000	.45	-1	.82	-79	.197	3	.88	-137	.46	6.2
13000	.53	-16	.68	-93	.208	-4	.87	-146	.48	5.1
14000	.61	-28	.59	-109	.221	-16	.88	-155	.34	4.3
15000	.66	-37	.52	-122	.232	-29	.87	-168	.28	3.5
16000	.72	-44	.45	-134	.232	-41	.84	175	.39	2.9
17000	.75	-50	.40	-156	.241	-57	.82	153	.37	2.2
18000	.77	-57	.36	-172	.229	-75	.83	127	.35	2.0

NEC®

NPN SILICON HIGH FREQUENCY TRANSISTOR

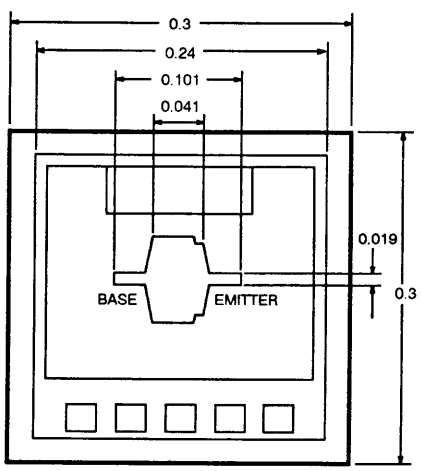
NE64500
NE64508
NE64535
NE64587

FEATURES

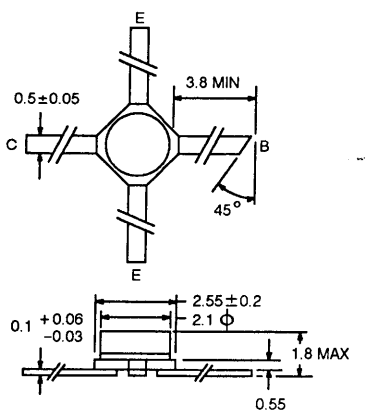
- **HIGH f_T**
  f_T = 8.5 GHz
- **LOW NOISE FIGURE**
  1.3 dB at 1.5 GHz
  1.6 dB at 2 GHz
- **HIGH ASSOCIATED GAIN**
  14 dB at 1.5 GHz
  12 dB at 2 GHz
- **SPACE QUALIFIED**

OUTLINE DIMENSIONS (Units in mm)

NE64500 (CHIP)
(Chip Thickness: 160±20 µm)



OUTLINE 35

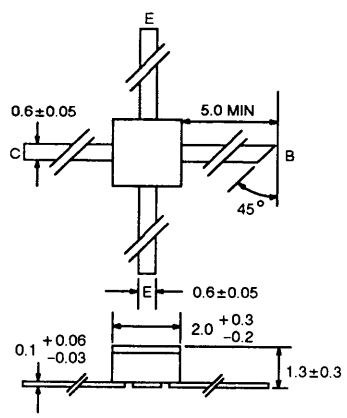


DESCRIPTION AND APPLICATIONS

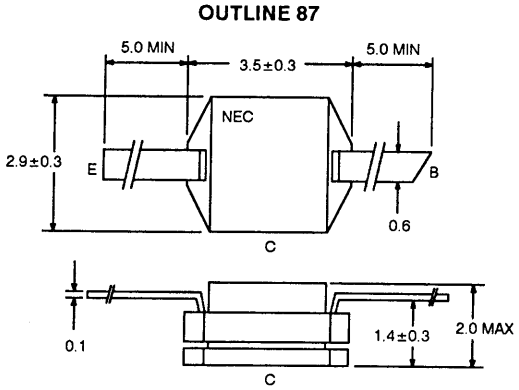
The NE645 series of NPN silicon transistors is designed for low-noise amplifier and medium power oscillator applications. The NE645 series employs a new NEC proprietary fabrication technique which provides excellent noise figures at high currents, resulting in superior associated gains and a very wide 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.

OUTLINE 08



OUTLINE 87



PERFORMANCE SPECIFICATIONS (T_A = 25°C)

PART NUMBER EIAJ[1] 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
f_T	Gain Bandwidth Product at V_{CE} = 8 V, I_C = 20 mA	GHz		8.5			8.5			8.5			8.5	
$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = 8 V, I_C = 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				
NF_{MIN}	Minimum Noise Figure[2] at V_{CE} = 8 V, I_C = 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			
G_A	Associated Gain at V_{CE} = 8 V, I_C = 7 mA, f = 1.5 GHz f = 2 GHz	 dB dB	 11	 14 12		 11	 14 12		 10	 13 11				
MAG	Maximum Available Gain[3] at V_{CE} = 8 V, I_C = 10 mA, f = 2 GHz f = 4 GHz	 dB dB		 16			 16 11			 15 10				
P_{OSC}	Oscillator Output Power at V_{CE} = 10 V, I_C = 40 mA, f = 6 GHz	 mW		 110									 110	

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER EIAJ[1] 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
I_{CBO}	Collector Cutoff Current at V_{CB} = 8 V, I_E = 0	µA			0.1			0.1			0.1			0.1
I_{EBO}	Emitter Cutoff Current at V_{EB} = 1 V, I_C = 0	µA			1			1			1			1
h_{FE}	Forward Current Gain at V_{CE} = 8 V, I_C = 7 mA		50	100	250	50	100	250	50	100	250	50	100	250
C_{CB}	Collector to Base Capacitance[4] at V_{CB} = 10 V, I_E = 0, f = 1 MHz	 pF		0.2	0.6		0.2	0.6		0.2	0.6		0.2	0.6
R_{TH}	Thermal Resistance (Junction-to-Case)	°C/W			75			85			85			75
P_T	Total Power Dissipation[5]	mW			400			400			400			400

Notes:

1. Electronic 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,

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

4. C_{CB} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal.
5. 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

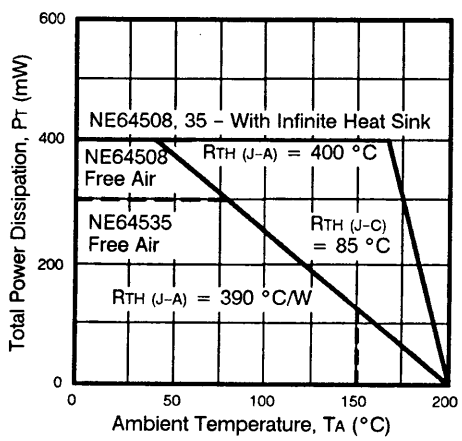
ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	25
V_{CEO}	Collector to Emitter Voltage	V	12
V_{EBO}	Emitter to Base Voltage*	V	1.5
I_C	Collector Current	mA	65
T_J	Junction Temperature	°C	200
T_{STG}	Storage Temperature	°C	-65 to +200**

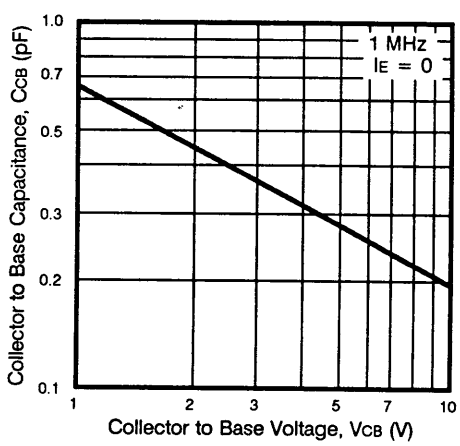
*V_{EBO} rating for NE64500 and NE64587 is 3 V.
**T_{STG} for NE64535 is -65°C to 150°C because leads are Sn plated and may tarnish above 150°C. Once soldered into a circuit, the unit can be stored at 200°C.

TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

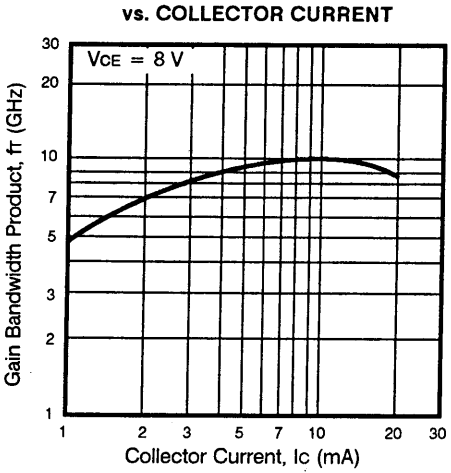
POWER DERATING CURVE



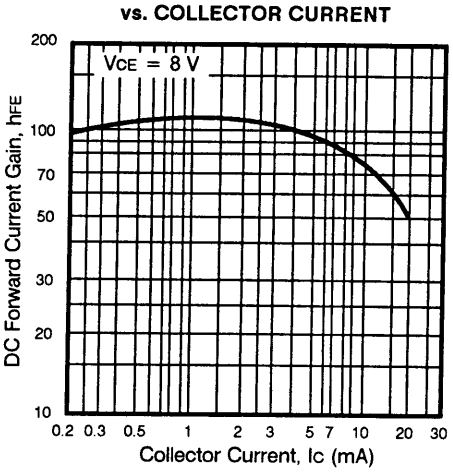
CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT

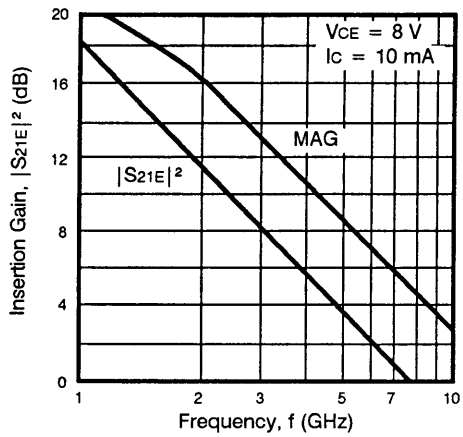


DC CURRENT GAIN vs. COLLECTOR CURRENT

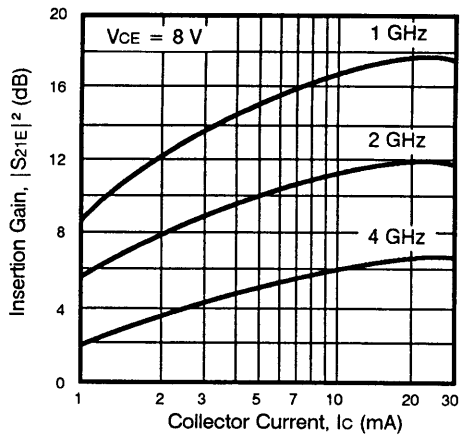


TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

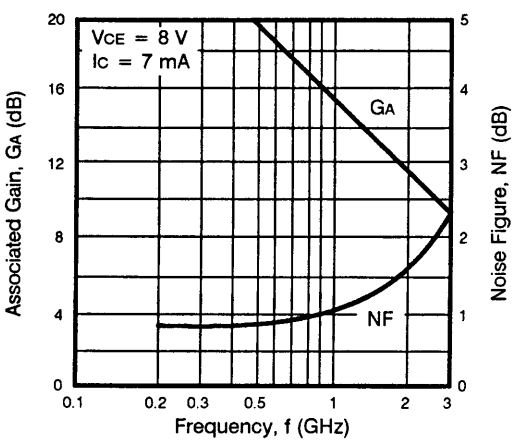
INSERTION GAIN vs. FREQUENCY



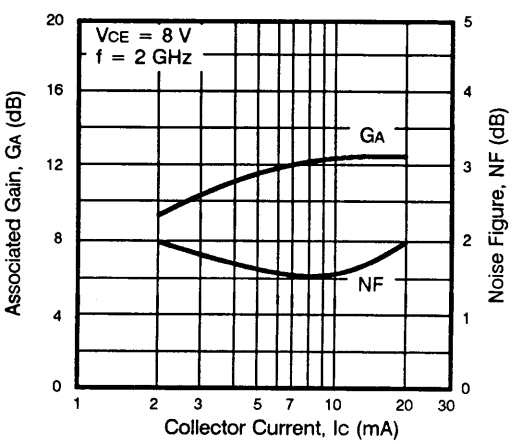
INSERTION GAIN vs. COLLECTOR CURRENT



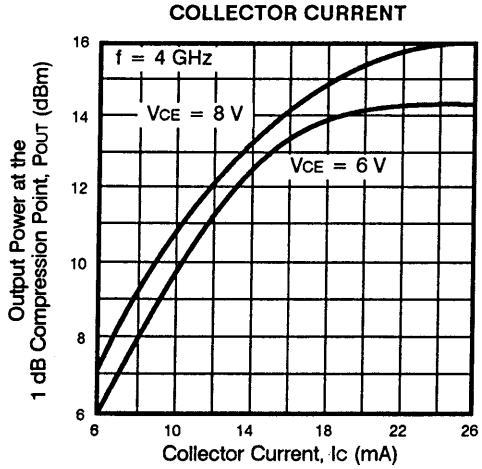
ASSOCIATED GAIN AND OPTIMUM NOISE FIGURE vs. FREQUENCY



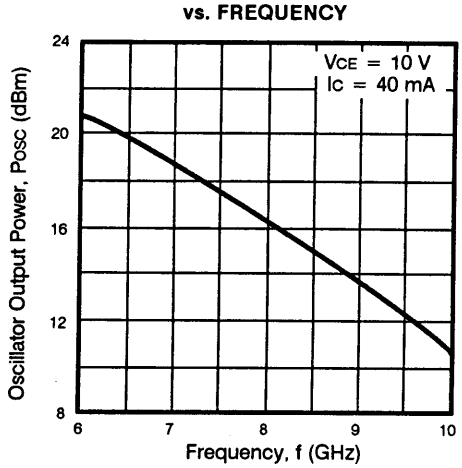
ASSOCIATED GAIN AND OPTIMUM NOISE FIGURE vs. COLLECTOR CURRENT



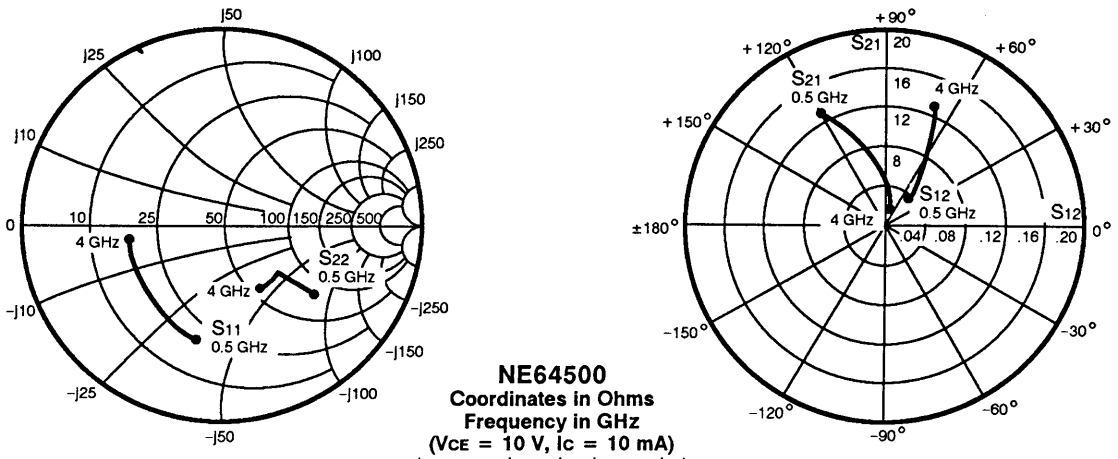
NE64508 OUTPUT POWER AT THE 1 dB COMPRESSION POINT vs. COLLECTOR CURRENT



NE64587 OSCILLATOR OUTPUT POWER vs. FREQUENCY



TYPICAL COMMON EMITTER SCATTERING PARAMETERS



NE64500
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 10 V, I_C = 10 mA)
(measured on alumina carrier)

S-MAGN AND ANGLES:

VCE = 10 V, IC = 5 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
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

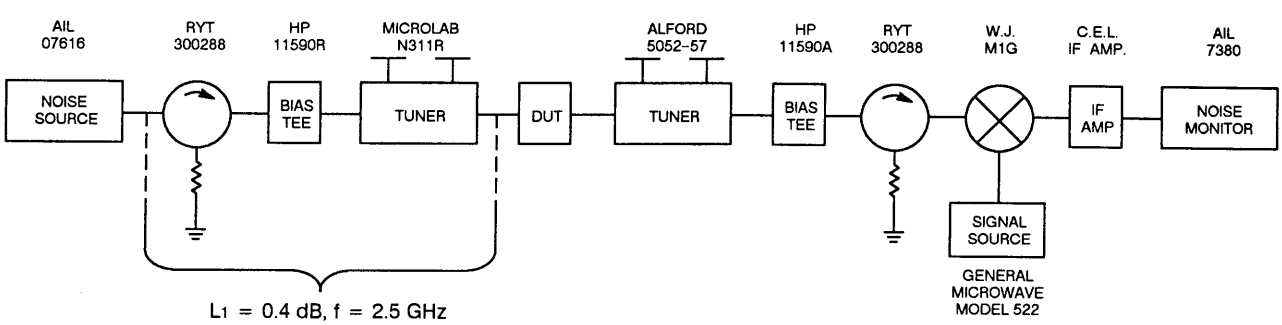
500	.58	-99	13.88	119	.037	54	.59	-36
1000	.51	-130	7.54	101	.049	55	.45	-39
2000	.47	-152	3.97	86	.070	64	.39	-42
3000	.45	-164	2.61	71	.097	68	.40	-56
4000	.46	-172	2.04	62	.128	71	.39	-60

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

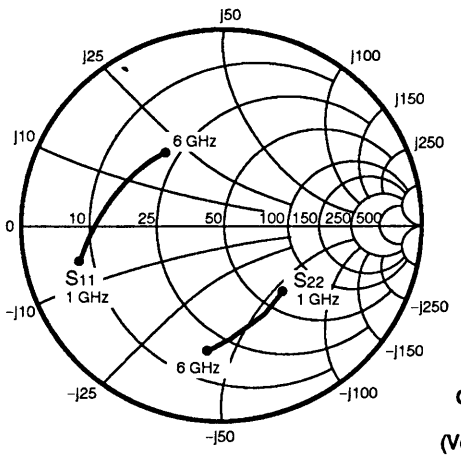
NOISE FIGURE TEST CIRCUIT

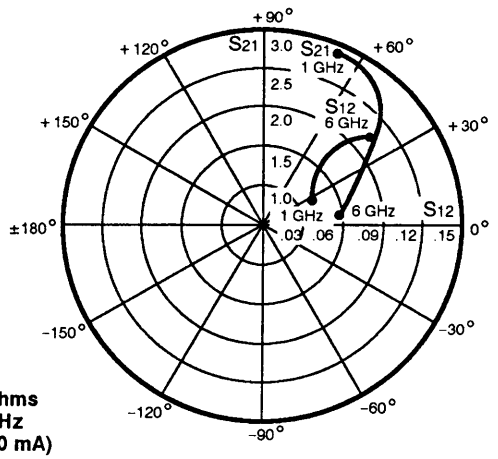
TEST CIRCUIT FOR f ≤ 4 GHz



L_1 = 0.4 dB, f = 2.5 GHz

TYPICAL COMMON EMITTER SCATTERING PARAMETERS





NE64508
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 8 V, I_C = 10 mA)

S-MAGN AND ANGLES:

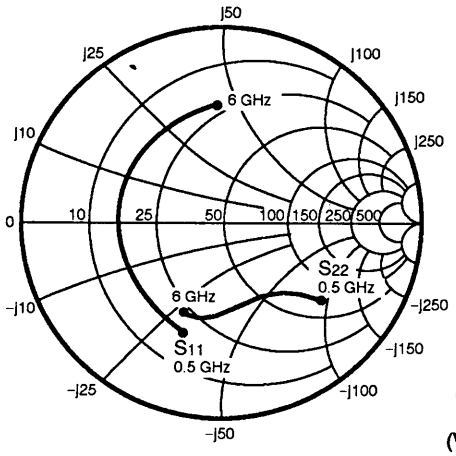
VCE = 8 V, IC = 7 mA

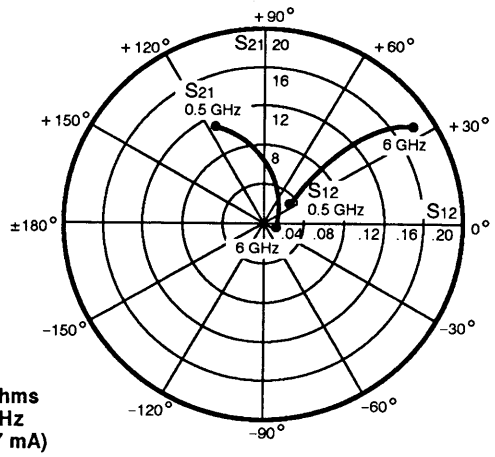
FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
500	.82	-84	4.27	128	.042	38	.70	-62
1000	.77	-163	3.76	91	.050	38	.51	-58
2000	.63	-172	2.81	68	.055	33	.51	-60
2500	.60	-179	2.80	57	.069	44	.55	-67
3000	.59	175	2.44	48	.071	22	.56	-72
3500	.60	167	2.15	40	.069	25	.57	-78
4000	.56	160	1.85	30	.072	34	.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

TYPICAL COMMON EMITTER SCATTERING PARAMETERS





NE64535
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 8 V, I_C = 7 mA)

S-MAGN AND ANGLES:

VCE = 8 V, IC = 7 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}		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

VCE = 8 V, IC = 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

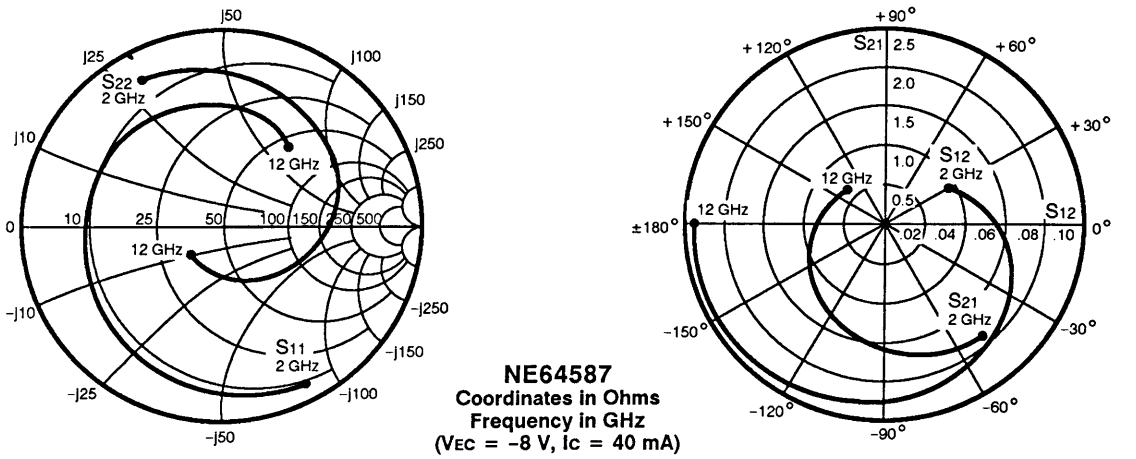
VCE = 8 V, IC = 20 mA

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

VCE = 8 V, IC = 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



NE64587
Coordinates in Ohms
Frequency in GHz
(V_{EC} = -8 V, I_C = 40 mA)

S-MAGN AND ANGLES:

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

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
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 V, I_C = 20 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 V, I_C = 40 mA

2000	.89	-61	1.82	-47	.38	33	.85	118
3000	.83	-91	1.75	-70	.52	11	.81	90
4000	.75	-120	1.52	-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

NEC®

K-BAND BIPOLAR OSCILLATOR TRANSISTOR

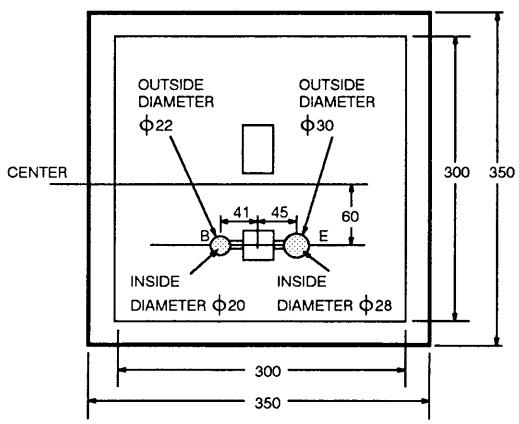
NE64700

FEATURES

- FUNDAMENTAL OSCILLATION GREATER THAN 20 GHz
- LOW PHASE NOISE
- OPERATION OVER MIL-SPEC TEMP RANGES

OUTLINE DIMENSIONS (Units in µm)

NE64700 (CHIP)



E: Emitter B: Base

Bonding Area

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	9
V_{EBO}	Emitter to Base Voltage	V	1.5
I_C	Collector Current	mA	20
P_T	Total Power Dissipation	mW	180
T_J	Junction Temperature	°C	200
T_{STG}	Storage Temperature	°C	-65 to +200

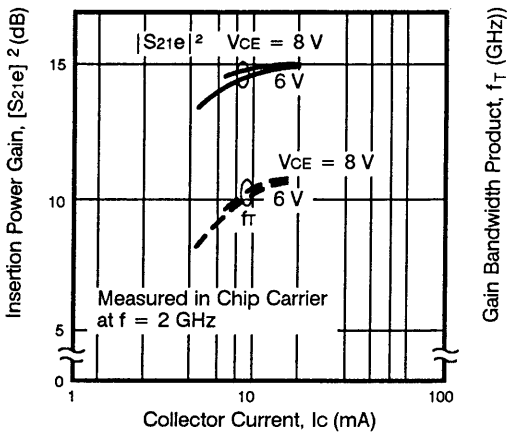
ELECTRICAL CHARACTERISTICS (T_A = 25°C)

SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX
V_{CBO}	Collector to Base Voltage at I_C = 10 µA	V	20	30	
V_{CEO}	Collector to Emitter Voltage at I_C = 1 mA	V	9	11	
V_{EBO}	Emitter to Base Voltage at I_E = 10 µA	V	1.5	2.5	
I_{CBO}	Collector Cutoff Current, at V_{CB} = 10 V	µA			0.1
I_{EBO}	Emitter Cutoff Current at V_{EB} = 1 V	µA			0.1
h_{FE}	DC Current Gain at V_{CE} = 8 V, I_C = 10 mA		40	100	200
C_{OB}	Output Capacitance at V_{CB} = 8 V	pF		0.09	
$\|S_{21e}\|^2$	Insertion Power Gain at V_{CE} = 8 V, I_C = 10 mA, f = 2 GHz	dB	14	15	
MAG	Maximum Available Gain at V_{CE} = 8 V, I_C = 10 mA, f = 2 GHz	dB	20	22	
f_T	Gain Bandwidth Product at V_{CE} = 8 V, I_C = 10 mA, f = 2 GHz	GHz		11	

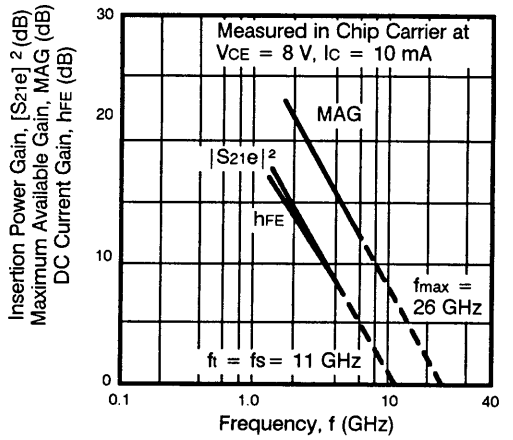
Precaution: devices are ESD sensitive, use proper handling procedures.

TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

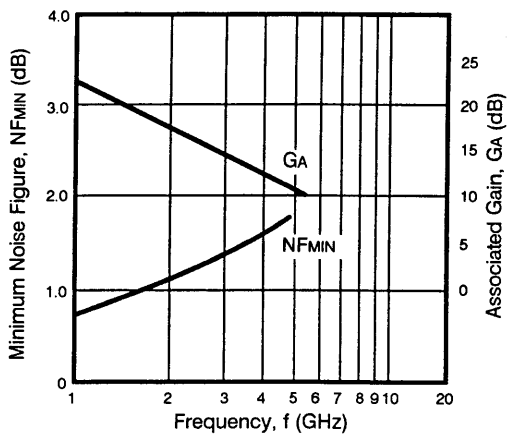
INSERTION POWER GAIN, GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



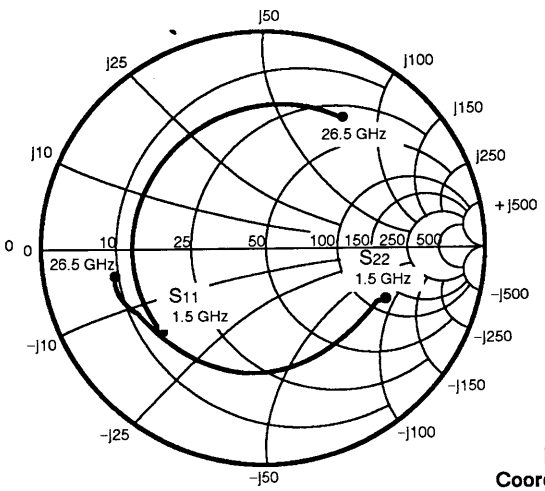
INSERTION POWER GAIN, MAXIMUM AVAILABLE GAIN, DC CURRENT GAIN vs. FREQUENCY

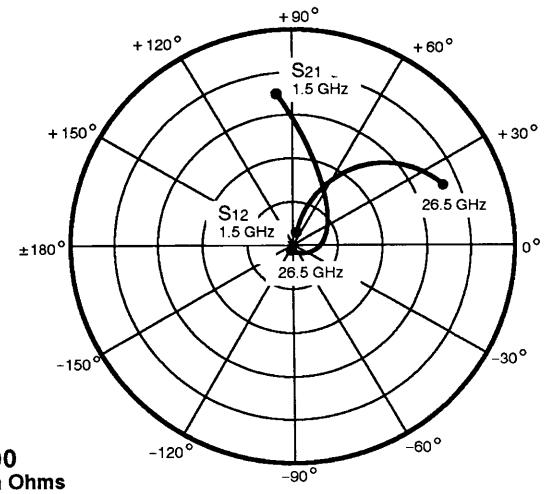


NE64700
GAIN AND NOISE FIGURE vs. FREQUENCY



TYPICAL COMMON EMITTER SCATTERING PARAMETERS





NE64700
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 8 V, I_C = 10 mA)

2

TYPICAL SCATTERING PARAMETERS FOR THE NE64700

S-MAGN AND ANGLES:
VCE = 8 V, IC = 10 mA

FREQUENCY (MHz)	S11		S21		S12		S22		GMAX
1.5	0.62	-137	7.41	97	.04	43	0.59	-25	
2.0	0.60	-152	5.88	87	.04	44	0.57	-26	
2.5	0.59	-163	4.82	79	.04	47	0.55	-28	
3.0	0.59	-171	4.05	72	.05	49	0.54	-30	
3.5	0.58	-176	3.49	67	.05	51	0.54	-33	
4.0	0.58	178	3.07	61	.06	53	0.54	-36	
4.5	0.58	174	2.74	56	.06	55	0.54	-39	
5.0	0.58	170	2.48	51	.06	56	0.53	-42	
5.5	0.58	166	2.26	46	.07	58	0.53	-45	
6.0	0.58	162	2.08	42	.07	58	0.54	-48	
6.5	0.59	159	1.92	37	.08	60	0.54	-50	
7.0	0.59	156	1.78	33	.08	61	0.54	-53	
7.5	0.59	153	1.67	29	.09	61	0.54	-57	
8.0	0.60	150	1.59	25	.10	62	0.55	-61	
8.5	0.60	146	1.48	20	.10	58	0.54	-64	
9.0	0.60	143	1.39	17	.11	59	0.54	-66	
9.5	0.60	140	1.33	12	.11	59	0.55	-70	
10.0	0.61	137	1.26	9	.12	60	0.55	-74	
10.5	0.62	134	1.20	5	.13	60	0.55	-77	
11.0	0.62	131	1.13	1	.13	60	0.55	-80	
11.5	0.62	128	1.09	-2	.14	58	0.55	-83	
12.0	0.63	126	1.03	-5	.15	58	0.56	-86	
13.0	0.64	120	0.92	-12	.16	57	0.57	-92	
14.0	0.64	115	0.86	-18	.18	55	0.57	-98	
15.0	0.65	111	0.78	-23	.19	53	0.59	-104	
16.0	0.65	107	0.74	-29	.21	49	0.59	-111	
17.0	0.66	103	0.66	-35	.22	49	0.60	-117	
18.0	0.66	99	0.64	-39	.23	45	0.60	-123	
19.0	0.67	94	0.55	-46	.25	47	0.60	-129	
20.0	0.67	89	0.51	-47	.26	46	0.60	-135	
21.0	0.67	84	0.47	-48	.29	46	0.60	-140	
22.0	0.68	79	0.44	-49	.31	42	0.60	-145	
23.0	0.68	73	0.40	-51	.34	40	0.63	-150	
24.0	0.69	69	0.37	-52	.35	36	0.65	-156	
25.0	0.70	64	0.36	-45	.39	32	0.66	-162	
26.0	0.72	60	0.33	-52	.39	29	0.66	-169	
26.5	0.73	59	0.34	-49	.39	24	0.68	-174	

Note: S-Parameters include bond wires.
Base: 1 wire, 0.0134″ (340 mm) long.
Collector: 1 wire, 0.0083″ (210 mm) long.
Emitter: 2 wires, 1 per side, 0.0176″ (446 mm) long, each wire.
Wire: 0.0007″ (17.7 mm) dia., gold.

NEC®

K-BAND BIPOLAR OSCILLATOR TRANSISTOR

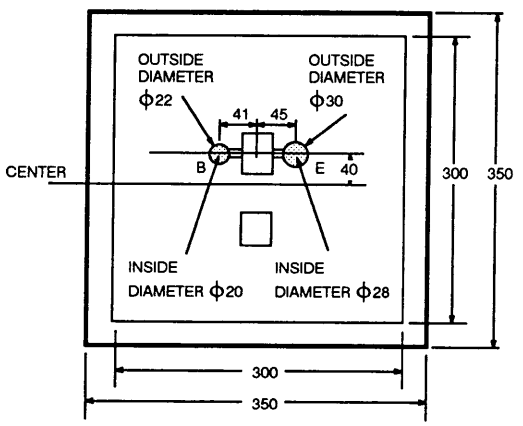
NE64800

FEATURES

- FUNDAMENTAL OSCILLATION GREATER THAN 20 GHz
- LOW PHASE NOISE
- OPERATION OVER MIL-SPEC TEMP RANGES

OUTLINE DIMENSIONS (Units in μm)

NE64800 (CHIP)



E: Emitter B: Base

Bonding Area

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	9
V_{EBO}	Emitter to Base Voltage	V	1.5
I_C	Collector Current	mA	40
P_T	Total Power Dissipation	mW	360
T_J	Junction Temperature	°C	200
T_{STG}	Storage Temperature	°C	-65 to +200

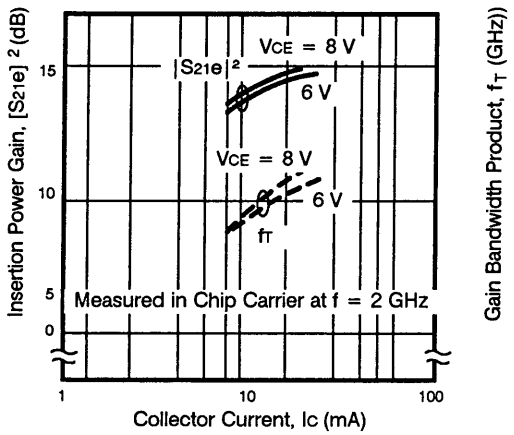
ELECTRICAL CHARACTERISTICS (T_A = 25°C)

SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX
V_{CBO}	Collector to Base Voltage at I_C = 10 μA	V	20	30	
V_{CEO}	Collector to Emitter Voltage at I_C = 1 mA	V	9	11	
V_{EBO}	Emitter to Base Voltage at I_E = 10 μA	V	1.5	2.5	
I_{CBO}	Collector Cutoff Current, at V_{CB} = 10 V	μA			0.1
I_{EBO}	Emitter Cutoff Current at V_{EB} = 1 V	μA			0.1
h_{FE}	DC Current Gain at V_{CE} = 8 V, I_C = 10 mA		40	100	200
C_{OB}	Output Capacitance at V_{CB} = 8 V	pF		0.15	
$\|S_{21e}\|^2$	Insertion Power Gain at V_{CE} = 8 V, I_C = 20 mA, f = 2 GHz	dB	13.5	14.6	
MAG	Maximum Available Gain at V_{CE} = 8 V, I_C = 20 mA, f = 2 GHz	dB	19	21	
f_T	Gain Bandwidth Product at V_{CE} = 8 V, I_C = 20 mA, f = 2 GHz	GHz		11	

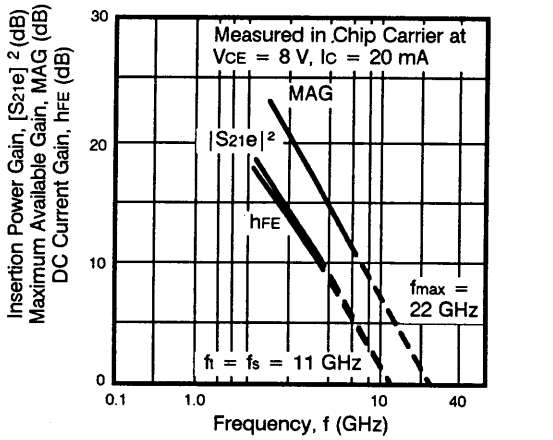
Precaution: devices are ESD sensitive, use proper handling procedures.

TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

INSERTION POWER GAIN, GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT

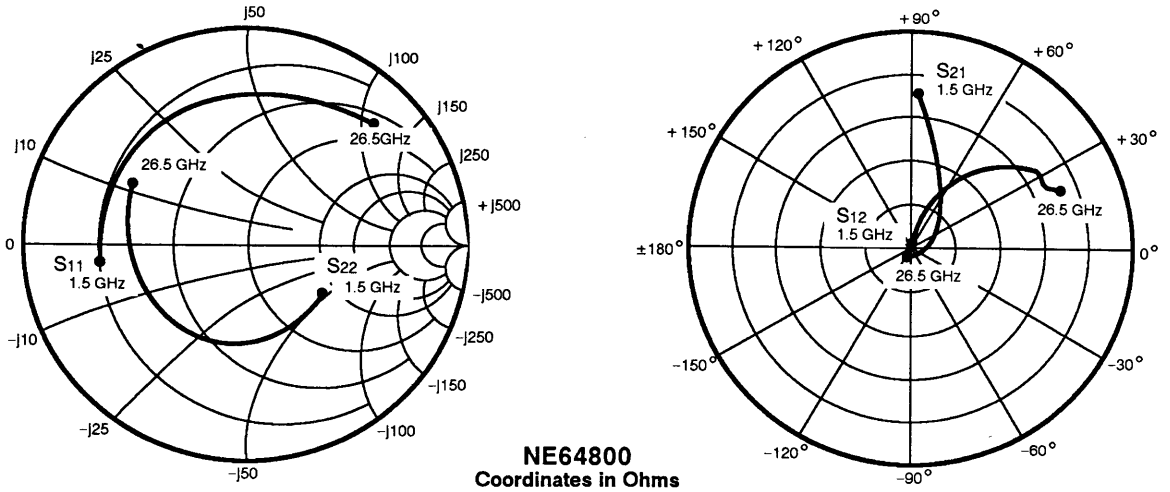


INSERTION POWER GAIN, MAXIMUM AVAILABLE GAIN, DC CURRENT GAIN vs. FREQUENCY



2

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



NE64800
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 8 V, I_C = 20 mA)

TYPICAL SCATTERING PARAMETERS FOR THE NE64800

S-MAGN AND PHASE:
VCE = 8 V, IC = 20 mA

FREQUENCY (GHz)	S11		S21		S12		S22	
1.5	.69	-167	7.34	87	.03	46	.42	-29
2.0	.69	-175	5.60	80	.04	50	.41	-30
2.5	.70	180	4.47	74	.04	54	.40	-32
3.0	.69	173	3.71	70	.05	56	.40	-34
3.5	.69	171	3.22	65	.05	58	.41	-37
4.0	.69	168	2.83	60	.06	59	.41	-40
4.5	.69	165	2.52	56	.06	59	.41	-43
5.0	.70	162	2.27	52	.07	60	.41	-46
5.5	.70	159	2.07	47	.08	60	.41	-49
6.0	.70	157	1.91	43	.08	60	.41	-53
6.5	.70	155	1.77	39	.09	59	.41	-56
7.0	.70	152	1.64	36	.09	58	.41	-59
7.5	.70	150	1.53	32	.10	58	.42	-62
8.0	.70	148	1.44	29	.11	59	.43	-66
8.5	.70	146	1.36	25	.11	59	.42	-71
9.0	.70	143	1.29	21	.12	58	.41	-74
9.5	.70	141	1.24	18	.13	57	.42	-78
10.0	.70	139	1.17	14	.14	56	.42	-83
10.5	.70	136	1.11	11	.15	54	.43	-87
11.0	.70	134	1.07	7	.15	53	.43	-92
11.5	.71	132	1.03	4	.16	51	.43	-96
12.0	.71	129	0.98	1	.16	51	.43	-100
13.0	.71	124	0.89	-4	.18	49	.44	-107
14.0	.71	120	0.82	-10	.19	46	.46	-115
15.0	.71	115	0.74	-15	.21	43	.47	-122
16.0	.70	110	0.68	-19	.22	37	.48	-130
17.0	.70	106	0.60	-23	.23	36	.49	-137
18.0	.70	102	0.57	-25	.24	32	.50	-145
19.0	.70	97	0.49	-30	.25	33	.52	-153
20.0	.69	94	0.44	-28	.26	30	.51	-162
21.0	.68	90	0.42	-30	.29	29	.53	-169
22.0	.69	86	0.38	-30	.31	25	.55	-177
23.0	.69	82	0.35	-27	.34	23	.57	174
24.0	.69	78	0.35	-30	.35	18	.61	168
25.0	.70	73	0.34	-29	.38	15	.61	160
26.0	.73	67	0.31	-33	.38	12	.63	153
26.5	.70	63	0.32	-28	.40	7	.68	147

Note: S-Parameters include bond wires.
Base: 1 wire, 0.0100″ (253 mm) long.
Collector: 1 wire, 0.0074″ (189 mm) long
Emitter: 2 wires, 1 per side, 0.0306″ (776 mm) long, each wire.
Wire: 0.0007″ (17.7 mm) dia., gold.