

T-31-21

NEC®

NPN SILICON HIGH FREQUENCY TRANSISTOR

NE856 SERIES

FEATURES

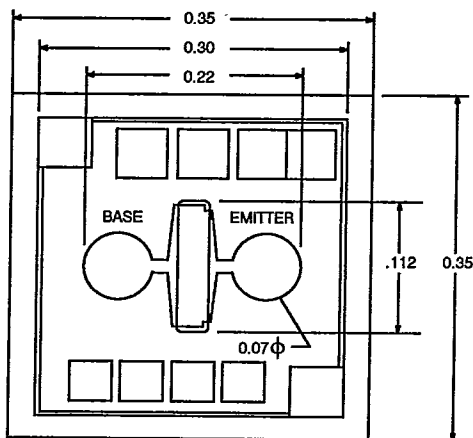
- **HIGH GAIN BANDWIDTH PRODUCT:** $f_T = 7 \text{ GHz}$
- **LOW NOISE FIGURE:** 1.1 dB at 1 GHz
- **HIGH COLLECTOR CURRENT:** 100 mA
- **LOW COST**

DESCRIPTION AND APPLICATIONS

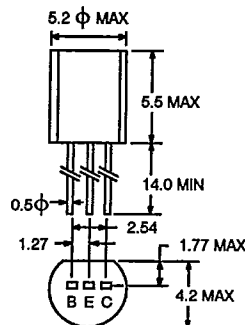
The NE856 series of NPN epitaxial silicon transistors is designed for low noise, high gain amplifiers. Low noise figures, high gain, and high current capability achieve wide dynamic range and excellent linearity. The NE856 series offers excellent performance and reliability at low cost. This is achieved by NEC's titanium, platinum, gold and direct nitride passivated base surface process. The NE856 series is available in chip form and four low cost package styles.

OUTLINE DIMENSIONS (Units in mm)

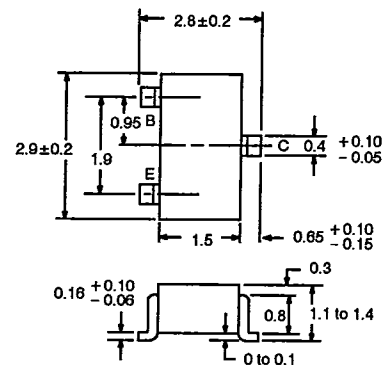
NE85600 (CHIP)
(Chip Thickness: 140 to 160 μm)



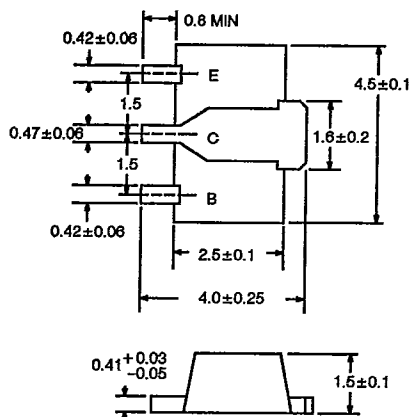
OUTLINE 32
(TO-92)



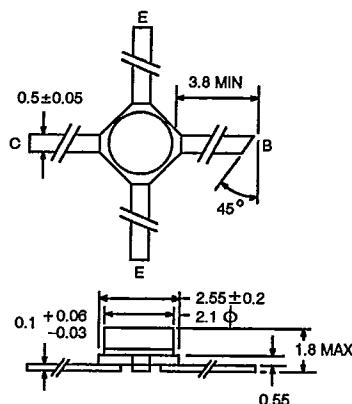
OUTLINE 33 (SOT-23)



OUTLINE 34
(SOT-89)



OUTLINE 35 (MICRO-X)



NE856 SERIES

PERFORMANCE SPECIFICATIONS ($T_A = 25^\circ\text{C}$)

PART NUMBER EIAJ ¹ REGISTERED NUMBER PACKAGE OUTLINE		NE85600 00 (CHIP)		NE85632 2SC3355 32		NE85633 2SC3356 33		NE85634 2SC3357 34		NE85635 2SC3603 35	
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
f_T	Gain Bandwidth Product at $V_{CE} = 10\text{ V}$, $I_C = 20\text{ mA}$	GHz		7.0			7.0			6.5	
$ S_{21E} ^2$	Insertion Power Gain at $V_{CE} = 10\text{ V}$, $I_C = 20\text{ mA}$, $f = 1\text{ GHz}$ $V_{CE} = 10\text{ V}$, $I_C = 20\text{ mA}$, $f = 2\text{ GHz}$	dB dB					11.5			9.0	
MAG	Maximum Available Gain at $V_{CE} = 10\text{ V}$, $I_C = 20\text{ mA}$, $f = 1\text{ GHz}$ $V_{CE} = 10\text{ V}$, $I_C = 20\text{ mA}$, $f = 2\text{ GHz}$	dB dB					13.0				
NF	Noise Figure at $V_{CE} = 10\text{ V}$, $I_C = 7\text{ mA}$, $f = 1\text{ GHz}$ $V_{CE} = 10\text{ V}$, $I_C = 7\text{ mA}$, $f = 2\text{ GHz}$ $V_{CE} = 10\text{ V}$, $I_C = 40\text{ mA}$, $f = 1\text{ GHz}$	dB dB dB					1.1			1.1	
GA	Associated Gain at $V_{CE} = 10\text{ V}$, $I_C = 7\text{ mA}$, $f = 1\text{ GHz}$ $V_{CE} = 10\text{ V}$, $I_C = 7\text{ mA}$, $f = 2\text{ GHz}$ $V_{CE} = 10\text{ V}$, $I_C = 40\text{ mA}$, $f = 1\text{ GHz}$	dB dB dB					9.0				

Note:

1. Electronic Industrial Association of Japan.

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$)

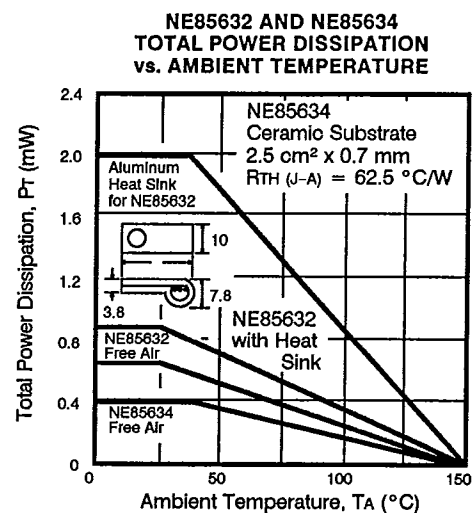
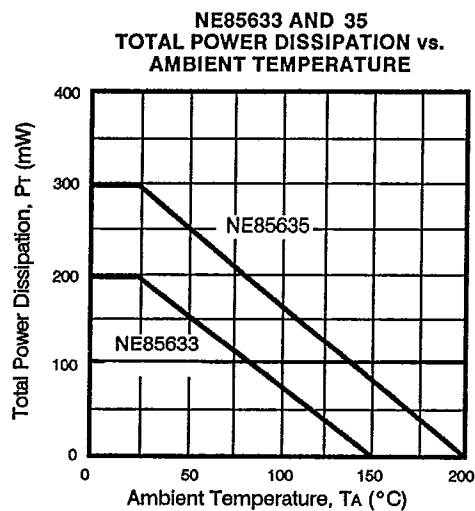
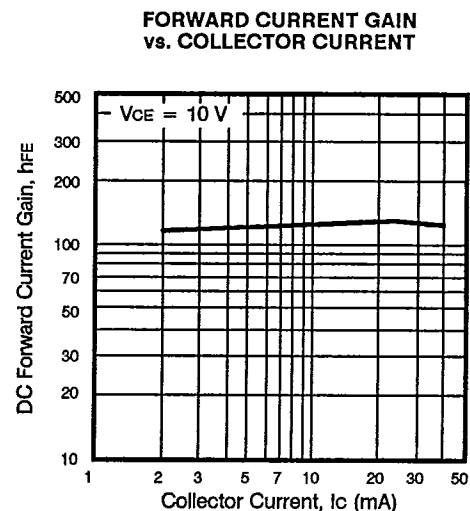
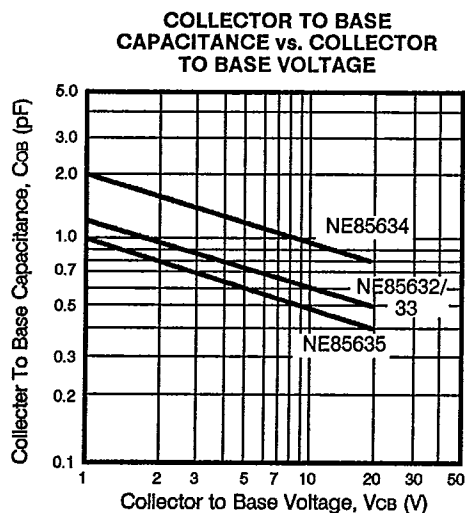
PART NUMBER EIAJ ¹ REGISTERED NUMBER PACKAGE OUTLINE		NE85600 00 (CHIP)		NE85632 2SC3355 32		NE85633 2SC3356 33		NE85634 2SC3357 34		NE85635 2SC3603 35	
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
I_{CBO}	Collector Cutoff Current at $V_{CB} = 10\text{ V}$, $I_E = 0$	μA			1.0			1.0			1.0
I_{EBO}	Emitter Cutoff Current at $V_{EB} = 1\text{ V}$, $I_C = 0$	μA			1.0			1.0			1.0
h_{FE}	Forward Current Gain at ² $V_{CE} = 10\text{ V}$, $I_C = 20\text{ mA}$		50	120	300	50	120	300	50	120	300
C_{ob}	Output Capacitance at ³ $V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$	pF		0.5	1.0		0.65	1.0		1.0	1.5
R_{th}	Thermal Resistance (Junction-to-Ambient)	$^\circ\text{C/W}$			210			625			625 ⁴
P_T	Total Power Dissipation	W		.70	.60		.20			.24	.58

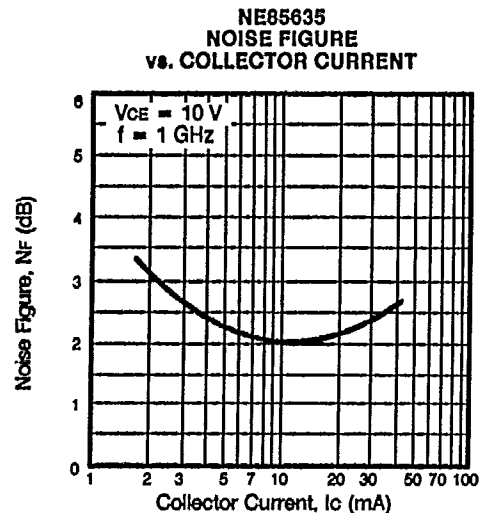
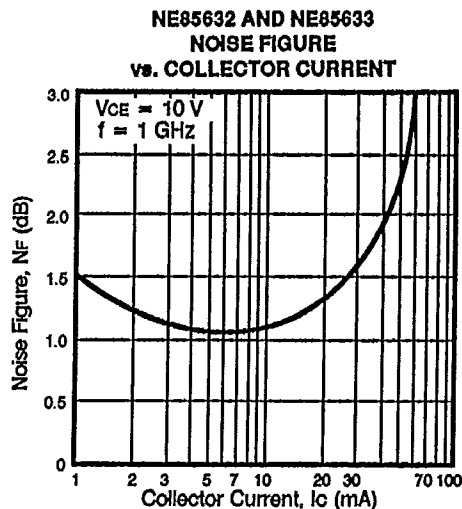
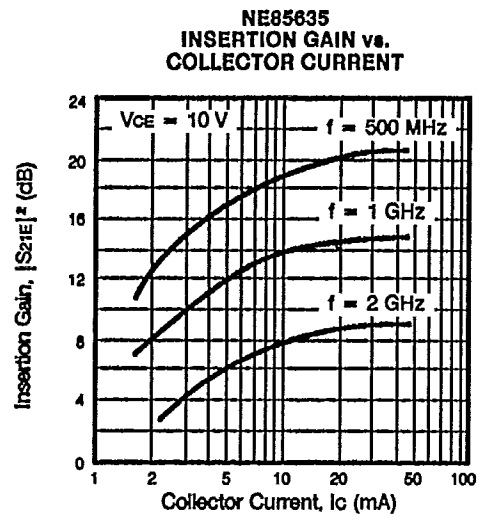
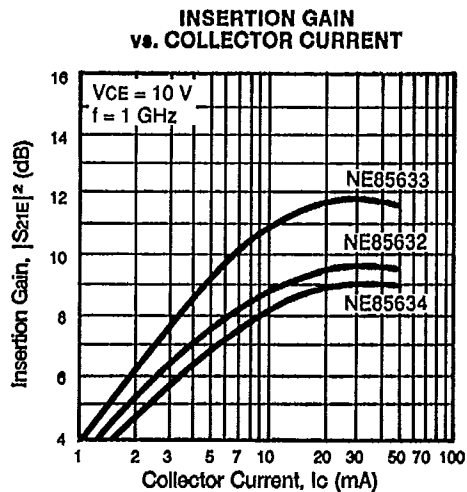
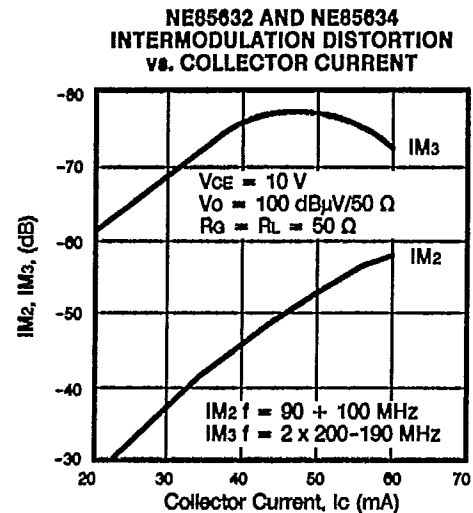
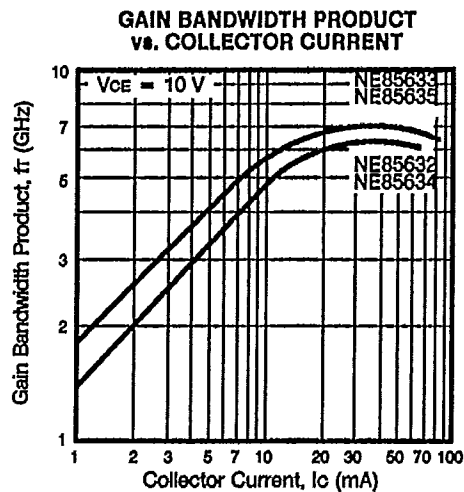
Notes:

- Electronic Industrial Association of Japan.
- Pulse width $\leq 350\text{ }\mu\text{s}$, duty cycle $\leq 2\%$ pulsed.
- C_{ob} measurement employs a three terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal.
- With $2.5\text{ cm}^2 \times 0.7\text{ mm}$ ceramic substrate.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$)

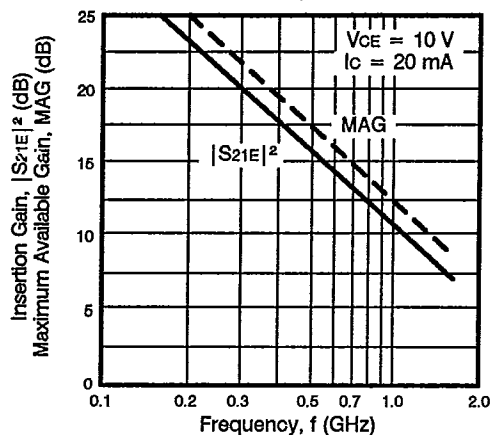
SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CB0}	Collector to Base Voltage	V	20
V_{CE0}	Collector to Emitter Voltage	V	12
V_{EB0}	Emitter to Base Voltage	V	3.0
I_C	Collector Current	mA	100
T_J	Junction Temperature	$^\circ\text{C}$	200*
T_{STG}	Storage Temperature	$^\circ\text{C}$	-65 to +150

*Maximum T_J for the NE85632/33/34 & 37 is $+150^\circ\text{C}$ **TYPICAL DEVICE CHARACTERISTICS** ($T_A = 25^\circ\text{C}$)**TYPICAL PERFORMANCE CHARACTERISTICS** ($T_A = 25^\circ\text{C}$)

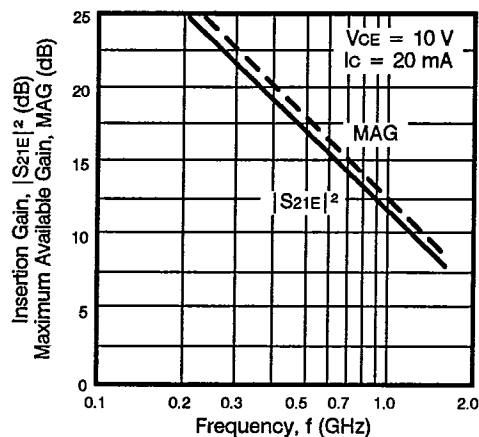
NE856 SERIES**TYPICAL PERFORMANCE CHARACTERISTICS ($T_A = 25^\circ\text{C}$)**

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

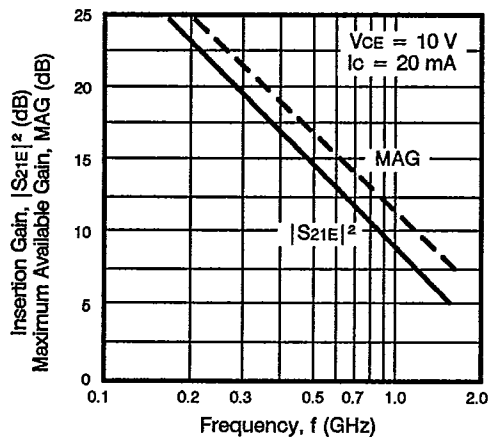
NE85632
FORWARD INSERTION GAIN
AND MAXIMUM AVAILABLE GAIN
vs. FREQUENCY



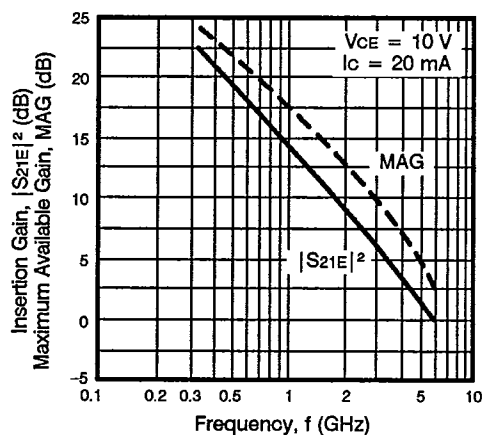
NE85633
FORWARD INSERTION GAIN
AND MAXIMUM AVAILABLE GAIN
vs. FREQUENCY



NE85634
FORWARD INSERTION GAIN
AND MAXIMUM AVAILABLE GAIN
vs. FREQUENCY

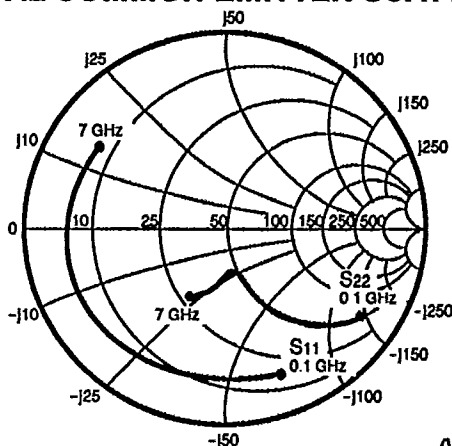


NE85635
FORWARD INSERTION GAIN
AND MAXIMUM AVAILABLE GAIN
vs. FREQUENCY

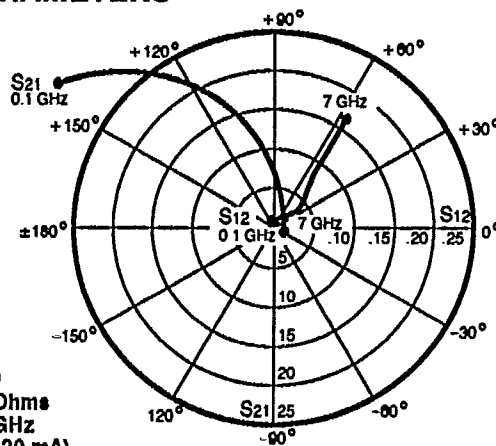


NE856 SERIES

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



NE85600
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 10 V, I_C = 20 mA)



S-MAGN AND ANGLES:

V_{CE} = 10 V, I_C = 7 mA

FREQUENCY (MHz)

	S ₁₁	S ₂₁	S ₁₂	S ₂₂
100	.87 -37	15.42 157	0.02 69	.93 -17
200	.84 -70	13.92 140	0.04 53	.79 -30
300	.81 -96	11.97 127	0.05 43	.67 -38
400	.80 -113	10.14 117	0.06 36	.57 -42
500	.80 -126	8.68 111	0.06 32	.51 -44
600	.79 -135	7.57 105	0.06 29	.46 -46
700	.79 -141	6.52 100	0.06 27	.43 -46
800	.78 -148	5.88 97	0.06 26	.40 -47
900	.78 -152	5.29 94	0.06 25	.38 -48
1000	.78 -156	4.86 91	0.06 25	.36 -49
2000	.78 -176	2.51 72	0.07 29	.33 -55
3000	.78 175	1.67 57	0.08 36	.35 -65
4000	.77 167	1.30 45	0.09 44	.38 -77
5000	.77 160	1.05 33	0.10 50	.42 -89
6000	.77 153	.87 23	0.12 54	.47 -101
7000	.77 147	.75 15	0.15 56	.51 -113

V_{CE} = 10 V, I_C = 20 mA

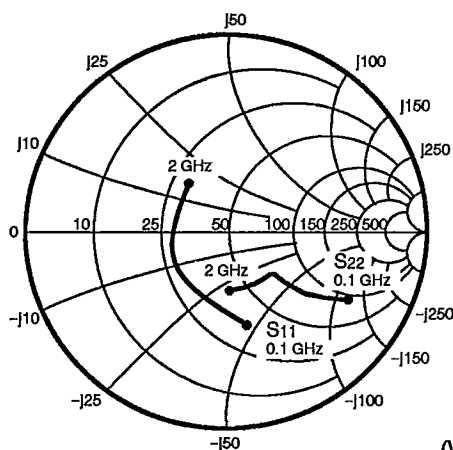
100	.76 -68	32.67 145	0.02 60	.82 -31
200	.75 -107	23.94 125	0.03 43	.60 -48
300	.76 -129	17.83 113	0.03 35	.46 -56
400	.77 -141	14.01 106	0.04 33	.37 -60
500	.76 -149	11.49 101	0.04 31	.31 -62
600	.76 -155	9.73 97	0.04 33	.28 -63
700	.76 -159	8.38 94	0.04 32	.25 -63
800	.76 -163	7.40 91	0.04 33	.23 -64
900	.77 -166	6.60 89	0.04 34	.22 -65
1000	.76 -168	5.97 87	0.04 35	.21 -65
2000	.76 178	3.03 72	0.06 48	.19 -70
3000	.76 171	2.05 59	0.07 53	.21 -79
4000	.76 164	1.58 48	0.09 56	.24 -88
5000	.76 157	1.29 37	0.11 57	.28 -98
6000	.75 151	1.09 27	0.13 58	.33 -106
7000	.76 146	.95 18	0.16 58	.38 -116

V_{CE} = 10 V, I_C = 30 mA

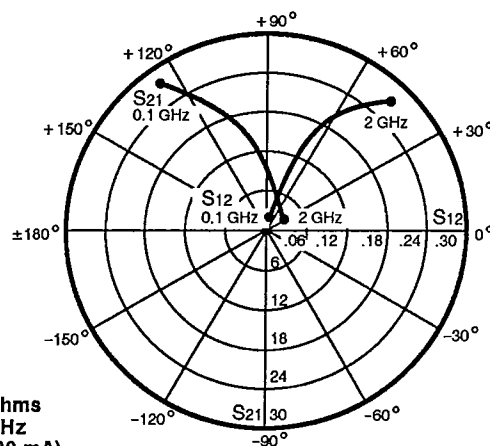
100	.73 -79	37.25 140	0.02 53	.77 -35
200	.75 -118	25.60 120	0.03 41	.53 -52
300	.75 -138	18.54 109	0.03 34	.40 -59
400	.76 -148	14.43 103	0.03 35	.32 -62
500	.76 -155	11.77 98	0.03 33	.27 -63
600	.76 -160	9.89 95	0.03 33	.24 -63
700	.76 -164	8.53 92	0.03 36	.22 -63
800	.76 -167	7.50 90	0.04 38	.20 -64
900	.76 -169	6.68 87	0.04 40	.19 -64
1000	.76 -171	6.04 86	0.04 42	.19 -64
2000	.76 176	3.08 71	0.06 52	.17 -70
3000	.76 170	2.07 59	0.07 57	.19 -78
4000	.75 163	1.60 48	0.09 59	.23 -87
5000	.76 156	1.30 37	0.11 60	.27 -97
6000	.75 151	1.10 27	0.14 60	.31 -106
7000	.76 145	.95 18	0.16 59	.37 -116

Note: S-parameters include bond wires.
Base: Total 1 wire (s), 1 per bond pad, 0.0093" (236 μm) long each wire.
Collector: Total 1 wire (s), 1 per bond pad, 0.0083" (210 μm) long each wire.
Emitter: Total 2 wire (s), 1 per side, 0.0304" (772 μm) long each wire.
Wire: 0.0007" (17.7 μm) Dia., gold.

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



NE85632
Coordinates in Ohms
Frequency in GHz
(VCE = 10 V, IC = 20 mA)



S-MAGN AND ANGLES:

VCE = 10 V, IC = 7 mA

FREQUENCY (MHz)

	S11		S21		S12		S22	
100	.71	-50	16.63	141	.02	70	.85	-22
200	.54	-84	11.97	119	.04	55	.66	-34
500	.40	-134	5.98	91	.08	58	.44	-43
1000	.34	-173	3.26	66	.13	58	.40	-52
1500	.34	163	2.33	48	.18	57	.39	-70
2000	.37	140	1.94	29	.24	47	.39	-88

VCE = 10 V, IC = 10 mA

	S11		S21		S12		S22	
100	.62	-58	20.35	135	.02	70	.80	-26
200	.45	-95	13.62	113	.03	55	.59	-36
500	.35	-141	6.44	89	.07	63	.39	-42
1000	.31	-177	3.46	65	.13	60	.36	-51
1500	.31	160	2.46	48	.19	57	.35	-70
2000	.34	138	2.04	30	.25	46	.35	-88

VCE = 10 V, IC = 20 mA

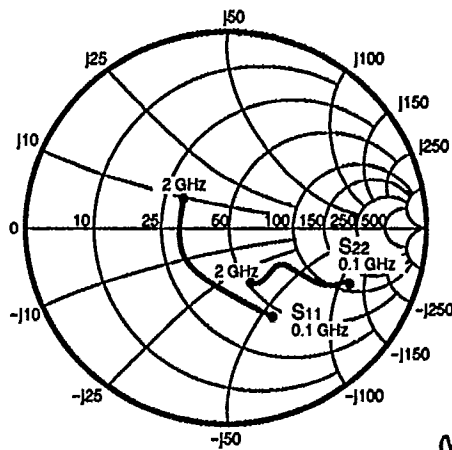
	S11		S21		S12		S22	
100	.45	-78	26.73	125	.01	69	.68	-31
200	.32	-116	15.88	105	.02	62	.47	-37
500	.28	-154	7.03	85	.07	70	.32	-40
1000	.27	175	3.72	64	.14	63	.32	-50
1500	.28	155	2.63	47	.20	58	.31	-70
2000	.30	134	2.17	30	.26	45	.31	-88

VCE = 10 V, IC = 30 mA

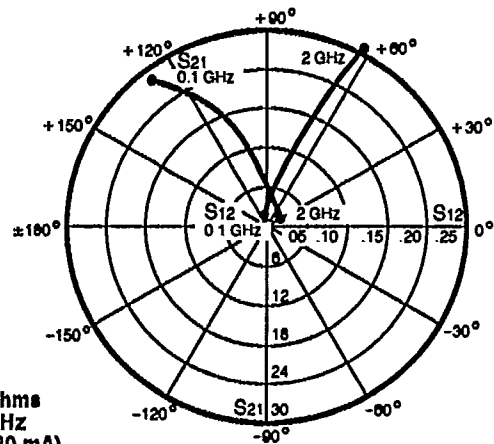
	S11		S21		S12		S22	
100	.37	-90	29.24	120	.01	71	.62	-33
200	.28	-128	16.64	101	.02	64	.42	-36
500	.27	-160	7.19	83	.07	72	.30	-37
1000	.26	172	3.79	63	.14	64	.30	-48
1500	.27	153	2.67	47	.21	58	.29	-69
2000	.30	133	2.20	30	.27	46	.30	-88

VCE = 10 V, IC = 50 mA

	S11		S21		S12		S22	
100	.30	-102	29.24	115	.01	75	.56	-31
200	.23	-144	16.12	99	.01	69	.41	-32
500	.24	-179	6.89	83	.07	73	.31	-33
1000	.26	152	3.63	65	.14	65	.28	-39
1500	.29	132	2.53	51	.19	59	.24	-41
2000	.33	118	2.01	37	.24	49	.23	-49

NE856 SERIES**TYPICAL COMMON EMITTER SCATTERING PARAMETERS**

NE85633
Coordinates in Ohms
Frequency in GHz
(VCE = 10 V, IC = 20 mA)

**S-MAGN AND ANGLES:****VCE = 10 V, IC = 7 mA****FREQUENCY (MHz)**

	S11		S21		S12		S22	
100	.77	-43	16.55	145	.01	71	.88	-18
200	.57	-74	12.28	123	.04	58	.70	-28
500	.36	-126	6.20	95	.08	61	.49	-34
1000	.29	-163	3.38	76	.12	64	.44	-41
1500	.27	171	2.38	62	.18	66	.45	-52
2000	.30	155	1.89	49	.23	62	.45	-64

VCE = 10 V, IC = 10 mA

	S11		S21		S12		S22	
100	.69	-50	20.27	139	.01	74	.83	-22
200	.48	-82	14.10	117	.03	59	.64	-31
500	.30	-134	6.67	93	.07	66	.44	-33
1000	.25	-168	3.59	75	.13	66	.41	-41
1500	.23	168	2.50	62	.19	66	.41	-52
2000	.26	152	2.00	50	.25	62	.42	-64

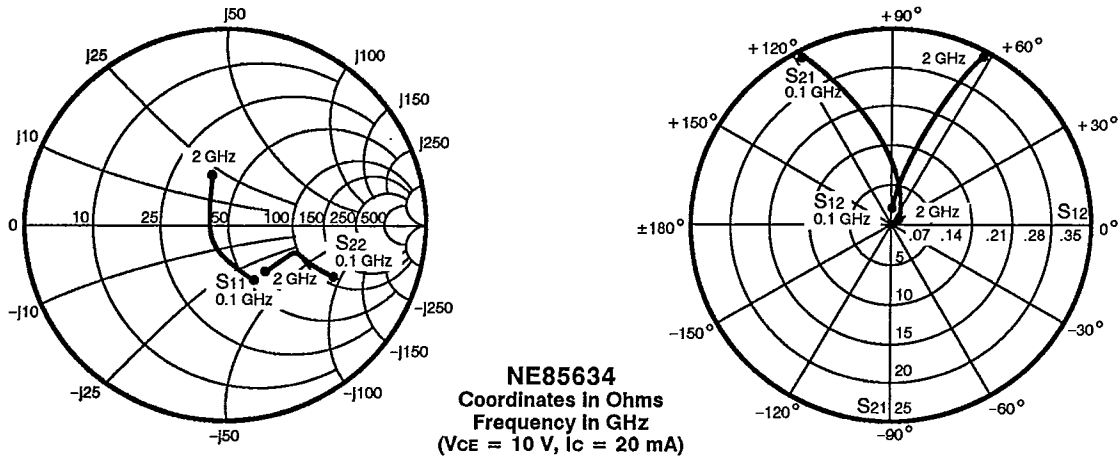
VCE = 10 V, IC = 20 mA

	S11		S21		S12		S22	
100	.56	-64	26.42	129	.01	69	.72	-27
200	.35	-96	16.30	109	.02	64	.53	-32
500	.24	-147	7.22	89	.07	71	.38	-31
1000	.21	-175	3.81	73	.13	69	.37	-40
1500	.20	162	2.64	62	.20	67	.38	-53
2000	.23	149	2.10	49	.26	61	.37	-65

VCE = 10 V, IC = 30 mA

	S11		S21		S12		S22	
100	.49	-72	28.53	124	.01	68	.67	-27
200	.30	-104	16.78	105	.02	66	.49	-30
500	.23	-154	7.25	88	.07	73	.37	-29
1000	.21	-179	3.83	72	.13	70	.36	-39
1500	.20	160	2.64	61	.20	67	.37	-52
2000	.23	147	2.11	49	.26	61	.37	-65

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



S-MAGN AND ANGLES:

 $V_{CE} = 10\text{ V}$, $I_C = 7\text{ mA}$

FREQUENCY (MHz)

	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
100	.64	-50	15.46	136	.03	70	.81	-23
200	.41	-81	10.42	114	.04	61	.61	-30
500	.21	-133	4.90	90	.10	69	.43	-29
1000	.19	166	2.67	70	.17	69	.39	-34
1500	.23	135	1.93	58	.25	68	.37	-46
2000	.31	119	1.62	46	.32	63	.37	-59

 $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$

100	.55	-58	18.40	130	.02	68	.74	-26
200	.32	-89	11.55	109	.04	63	.54	-22
500	.17	-143	5.22	88	.10	72	.39	-20
1000	.16	156	2.83	70	.18	70	.37	-30
1500	.20	127	2.02	58	.26	68	.34	-45
2000	.28	114	1.69	46	.33	62	.34	-59

 $V_{CE} = 10\text{ V}$, $I_C = 20\text{ mA}$

100	.36	-72	23.03	118	.02	72	.61	-29
200	.19	-105	13.04	101	.04	72	.44	-29
500	.11	-163	5.60	85	.10	76	.34	-25
1000	.14	137	3.01	68	.19	71	.33	-32
1500	.19	115	2.15	58	.28	67	.30	-47
2000	.26	106	1.78	47	.34	61	.30	-60

 $V_{CE} = 10\text{ V}$, $I_C = 30\text{ mA}$

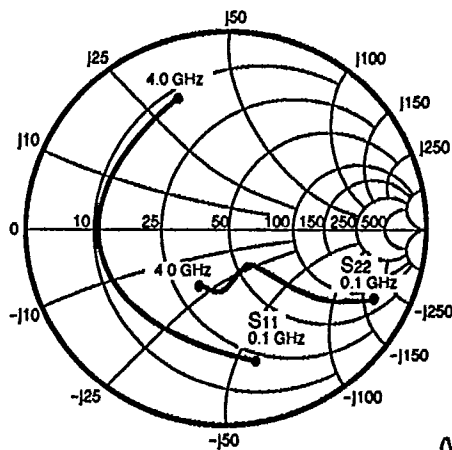
100	.28	-81	24.62	113	.01	72	.55	-28
200	.14	-118	13.40	98	.03	75	.41	-26
500	.11	-176	5.69	84	.11	79	.33	-22
1000	.14	131	3.05	68	.19	72	.32	-31
1500	.19	112	2.16	58	.28	68	.30	-47
2000	.25	104	1.81	47	.35	60	.30	-60

 $V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$

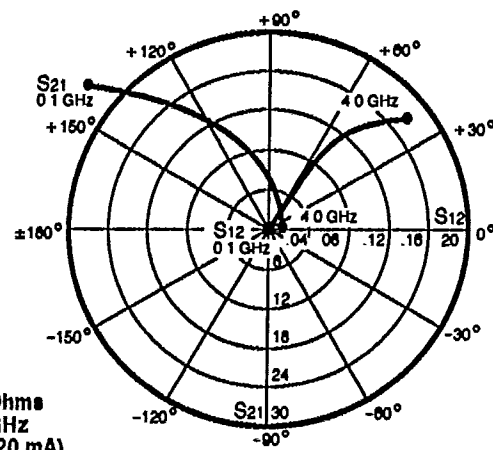
100	.21	-97	24.92	109	.01	80	.50	-26
200	.13	-141	13.24	96	.03	79	.39	-22
500	.13	173	5.56	83	.10	80	.33	-20
1000	.17	134	2.98	67	.19	72	.33	-30
1500	.21	114	2.11	57	.28	68	.31	-45
2000	.28	107	1.77	46	.35	62	.31	-59

NE856 SERIES

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



NE85635
Coordinates in Ohms
Frequency in GHz
(VCE = 10 V, IC = 20 mA)



S-MAGN AND ANGLES:

VCE = 10 V, IC = 7 mA

FREQUENCY (MHz)

	S11		S21		S12		S22	
100	.82	-47	18.86	154	.00	35	.91	-16
500	.68	-141	8.12	100	.02	34	.45	-41
1000	.66	-169	4.29	77	.03	34	.36	-48
1500	.66	174	2.94	64	.04	39	.38	-53
2000	.65	160	2.29	50	.05	42	.34	-61
2500	.67	145	1.81	37	.10	44	.38	-76
3000	.69	134	1.57	24	.12	46	.40	-89
3500	.69	123	1.31	11	.15	39	.41	-100
4000	.71	112	1.20	1	.16	39	.43	-111

VCE = 10 V, IC = 20 mA

	S11		S21		S12		S22	
100	.65	-78	34.20	141	.00	9	.79	-27
500	.64	-162	10.38	93	.00	43	.26	-49
1000	.62	179	5.32	75	.02	52	.21	-56
1500	.62	167	3.62	63	.04	53	.23	-56
2000	.62	153	2.80	50	.06	54	.19	-63
2500	.64	140	2.22	39	.11	50	.25	-82
3000	.65	131	1.92	26	.14	48	.27	-94
3500	.67	120	1.62	14	.16	38	.28	-105
4000	.68	110	1.48	4	.17	38	.30	-115

VCE = 10 V, IC = 30 mA

	S11		S21		S12		S22	
100	.61	-91	38.48	135	.00	7	.73	-31
500	.63	-168	10.75	91	.00	46	.23	-48
1000	.62	176	5.47	74	.02	57	.19	-56
1500	.62	164	3.71	62	.04	59	.21	-55
2000	.62	152	2.86	50	.06	57	.17	-61
2500	.65	139	2.28	38	.12	52	.22	-83
3000	.65	130	1.96	27	.14	49	.22	-94
3500	.67	120	1.66	15	.16	43	.26	-105
4000	.68	110	1.51	5	.18	38	.27	-118