NEC®

NPN SILICON HIGH FREQUENCY TRANSISTOR | NE856 SERIES

FEATURES

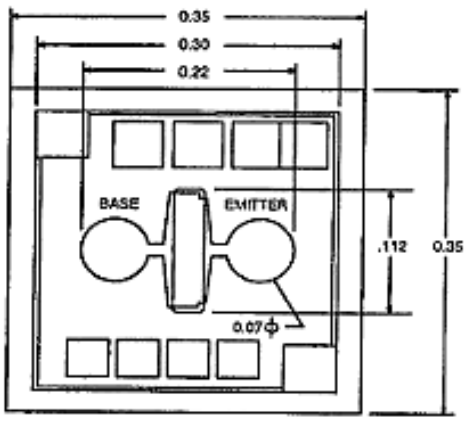
- **HIGH GAIN BANDWIDTH PRODUCT:** fT = 7 GHz
- **LOW NOISE FIGURE:** 1.1 dB at 1 GHz
- **HIGH COLLECTOR CURRENT:** 100 mA
- **LOW COST**

DESCRIPTION AND APPLICATIONS

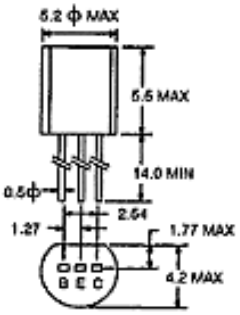
The NE856 series of NPN epitaxial silicon transistors is designed for low noise, high gain amplifiers. Low noise figures, high gain, and high current capability achieve wide dynamic range and excellent linearity. The NE856 series offers excellent performance and reliability at low cost. This is achieved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

OUTLINE DIMENSIONS (Units in mm)

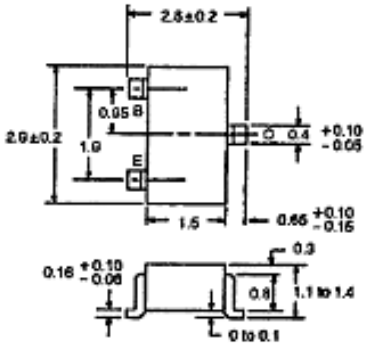
NE85600 (CHIP)
(Chip Thickness: 140 to 160 µm)



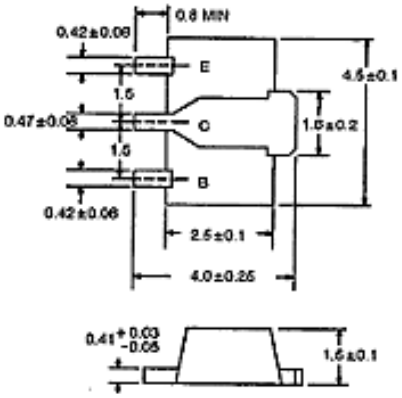
OUTLINE 32
(TO-92)



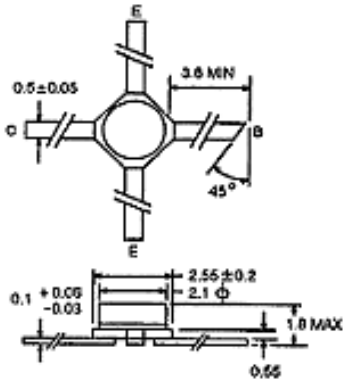
OUTLINE 33
(SOT-23)



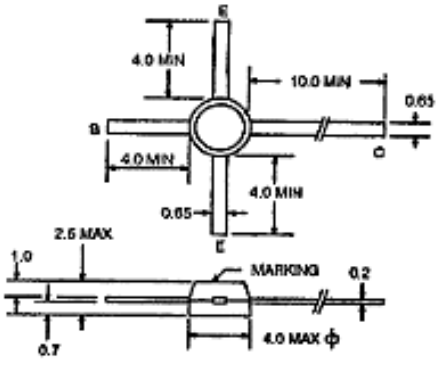
OUTLINE 34
(SOT-89)



OUTLINE 35
(MICRO-X)



OUTLINE 37
(DISK-MOLD)



PERFORMANCE SPECIFICATIONS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE85600 00 (CHIP)			NE85632 2SC3355 32			NE85633 2SC3356 33			NE85634 2SC3357 34			NE85635 2SC3603 35			NE85637 2SC3358 37		
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} = 10 V, I_C = 20 mA	GHz		7.0			6.5			7.0			6.5			7.0			7.0	
$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = 10 V, I_C = 20 mA, f = 1 GHz V_{CE} = 10 V, I_C = 20 mA, f = 2 GHz	 dB dB	 7.0	 9.0			 9.5			 11.5			 9.0			 9.0			 13.0	
MAG	Maximum Available Gain at V_{CE} = 10 V, I_C = 20 mA, f = 1 GHz V_{CE} = 10 V, I_C = 20 mA, f = 2 GHz	 dB dB	 10.0	 12.0			 11.0			 13.0						 12.0			 15.0	
NF	Noise Figure at V_{CE} = 10 V, I_C = 7 mA, f = 1 GHz V_{CE} = 10 V, I_C = 7 mA, f = 2 GHz V_{CE} = 10 V, I_C = 40 mA, f = 1 GHz	 dB dB dB	 2.1	 3.4			 1.1 1.8	 3.0		 1.1	 2.0		 1.1 1.8	 3.0		 2.1	 3.4		 1.1	 2.0
G_A	Associated Gain at V_{CE} = 10 V, I_C = 7 mA, f = 1 GHz V_{CE} = 10 V, I_C = 7 mA, f = 2 GHz V_{CE} = 10 V, I_C = 40 mA, f = 1 GHz	 dB dB dB	 	 10.0			 9.0			 9.0			 11.0			 10.0			 12.0	

Note:
1. Electronic Industrial Association of Japan.

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE85600 00 (CHIP)			NE85632 2SC3355 32			NE85633 2SC3356 33			NE85634 2SC3357 34			NE85635 2SC3603 35			NE85637 2SC3358 37		
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} = 10 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[2] V_{CE} = 10 V, I_C = 20 mA		50	120	300	50	120	300	50	120	300	50	120	300	50	120	300	50	120	300
C_{CB}	Output Capacitance at[3] V_{CB} = 10 V, I_E = 0, f = 1 MHz	pF		0.5	1.0		0.65	1.0		0.65	1.0		1.0	1.5		0.5	1.0		0.65	1.0
R_{TH}	Thermal Resistance (Junction-to-Ambient)	°C/W						210			625			62.5[4]			090			625
P_T	Total Power Dissipation	W			.70			.60			.20			2[4]			.58			.20

Notes:
1. Electronic Industrial Association of Japan.
2. Pulse width ≤ 350 µs, duty cycle ≤ 2% pulsed.
3. C_{CB} measurement employs a three terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal.
4. With 2.5 cm² x 0.7 mm ceramic substrate.

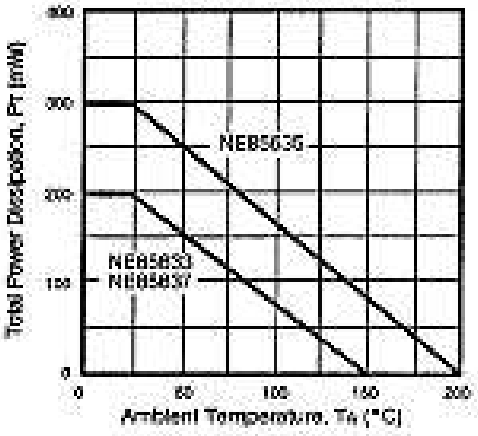
ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	20
V_{CEO}	Collector to Emitter Voltage	V	12
V_{EBO}	Emitter to Base Voltage	V	3.0
I_C	Collector Current	mA	100
T_J	Junction Temperature	°C	200*
T_{STG}	Storage Temperature	°C	-65 to +150

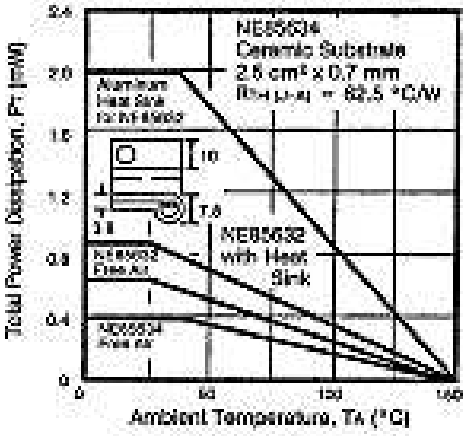
*Maximum T_J for the NE85632/33/34 & 37 is +160°C

TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

NE85633, 35 AND 37
TOTAL POWER DISSIPATION vs.
AMBIENT TEMPERATURE

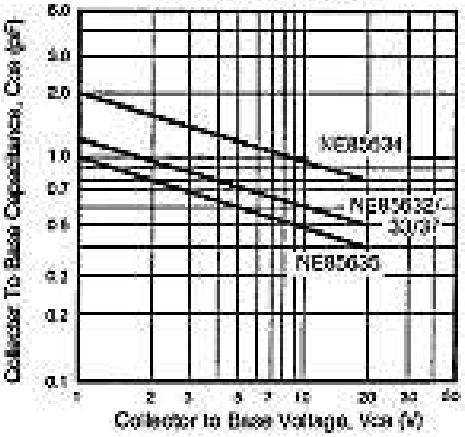


NE85632 AND NE85634
TOTAL POWER DISSIPATION
vs. AMBIENT TEMPERATURE

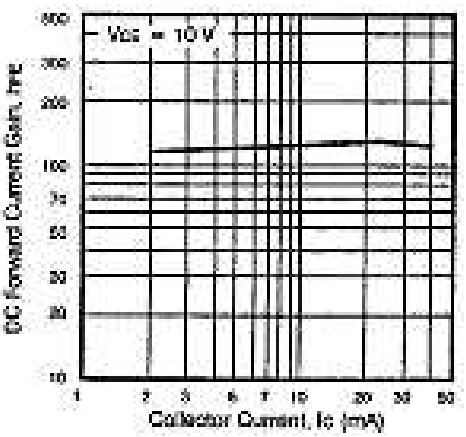


TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

COLLECTOR TO BASE
CAPACITANCE vs. COLLECTOR
TO BASE VOLTAGE

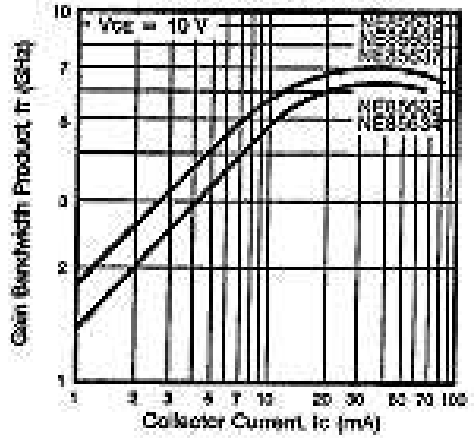


FORWARD CURRENT GAIN
vs. COLLECTOR CURRENT

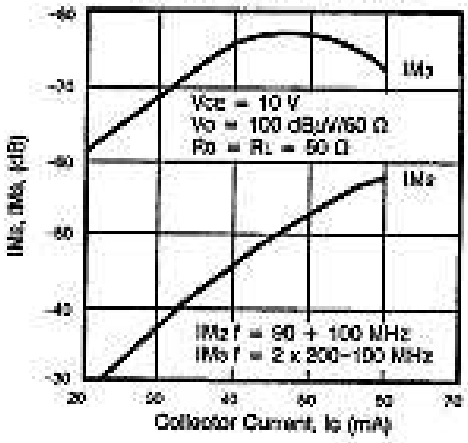


TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

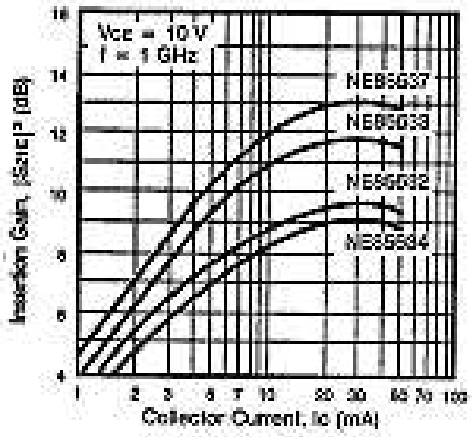
GAIN BANDWIDTH PRODUCT
vs. COLLECTOR CURRENT



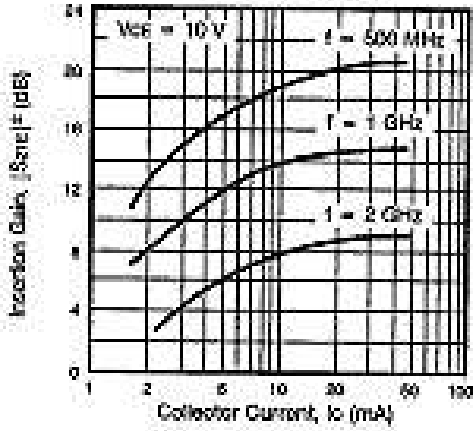
NE85632 AND NE85634
INTERMODULATION DISTORTION
vs. COLLECTOR CURRENT



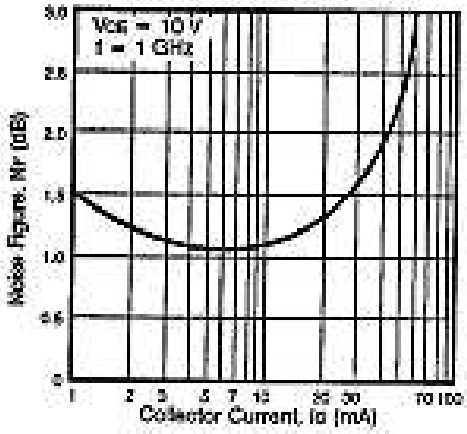
INSERTION GAIN
vs. COLLECTOR CURRENT



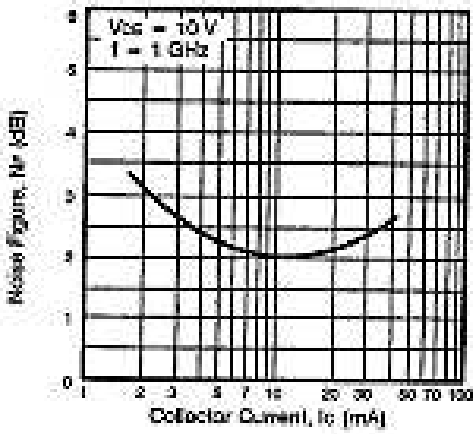
NE85635
INSERTION GAIN vs.
COLLECTOR CURRENT



NE85632, 33 AND 37
NOISE FIGURE
vs. COLLECTOR CURRENT

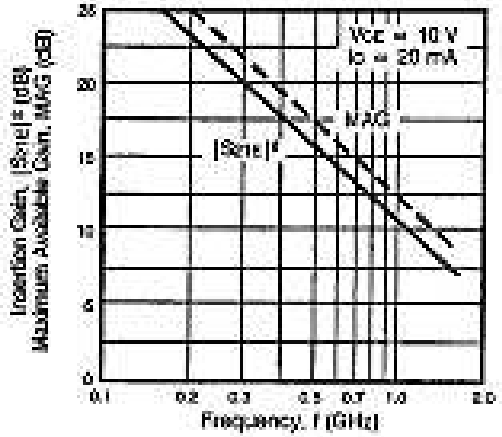


NE85635
NOISE FIGURE
vs. COLLECTOR CURRENT

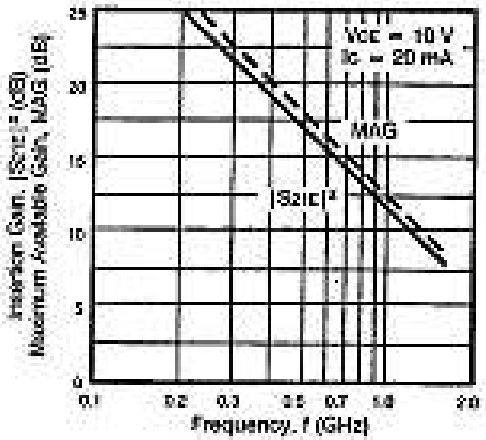


TYPICAL PERFORMANCE CHARACTERISTICS (TA = 25°C)

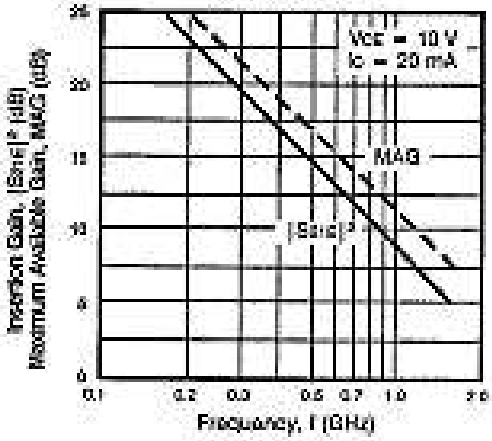
NE85632
FORWARD INSERTION GAIN
AND MAXIMUM AVAILABLE GAIN
vs. FREQUENCY



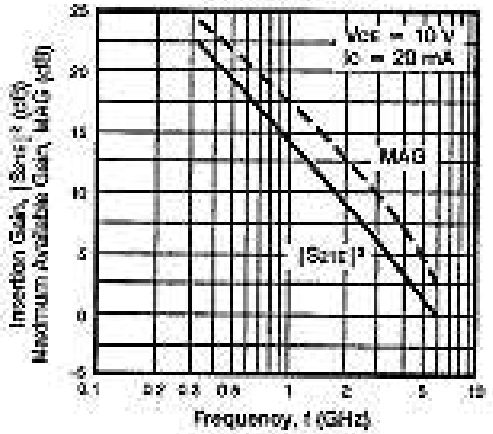
NE85633
FORWARD INSERTION GAIN
AND MAXIMUM AVAILABLE GAIN
vs. FREQUENCY



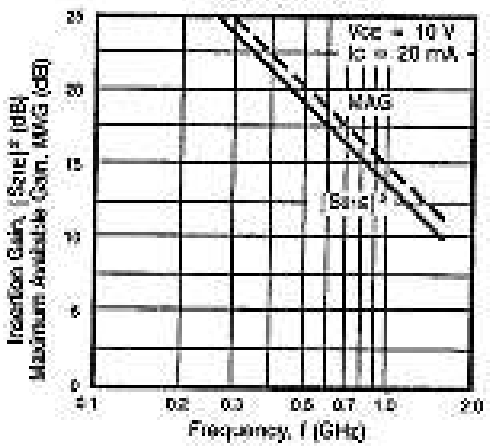
NE85634
FORWARD INSERTION GAIN
AND MAXIMUM AVAILABLE GAIN
vs. FREQUENCY



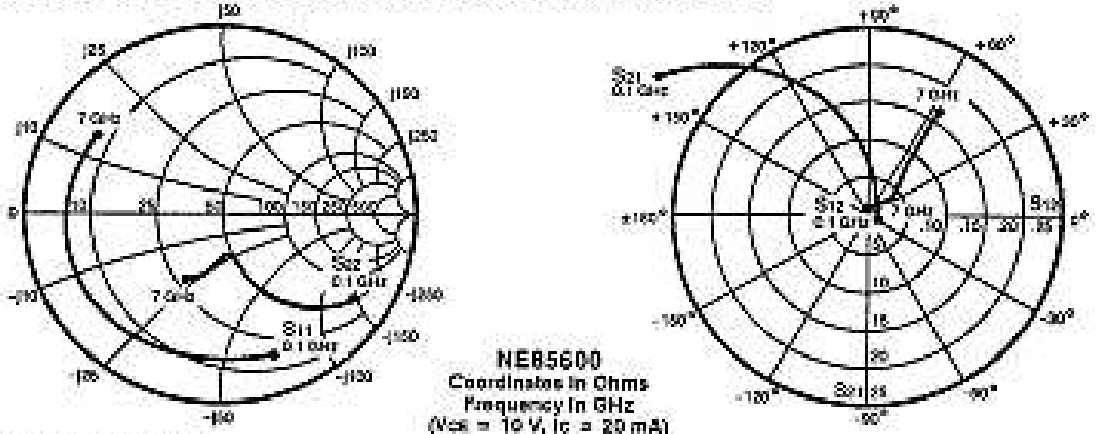
NE85635
FORWARD INSERTION GAIN
AND MAXIMUM AVAILABLE GAIN
vs. FREQUENCY



NE85637
FORWARD INSERTION GAIN
AND MAXIMUM AVAILABLE GAIN
vs. FREQUENCY



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_{12}		S_{21}		S_{22}	
100	.67	-37	15.42	157	0.02	69	.53	-17
200	.64	-70	13.92	140	0.04	53	.70	-30
300	.61	-98	11.97	127	0.05	43	.67	-38
400	.60	-113	10.14	117	0.06	36	.57	-42
500	.60	-125	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	-55
800	.78	-149	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	.76	175	1.67	57	0.08	35	.35	-65
4000	.77	167	1.30	45	0.09	44	.36	-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	58	.51	-113

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

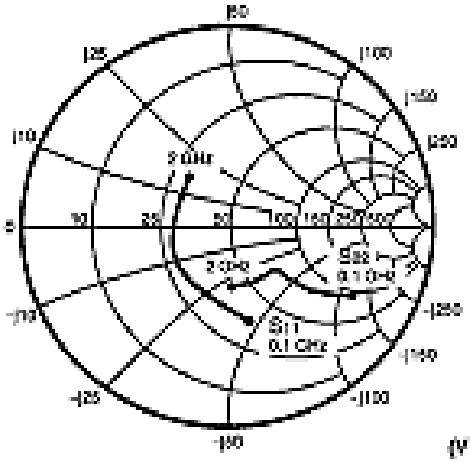
100	.78	-69	32.07	145	0.02	60	.82	-31
200	.75	-107	23.04	125	0.03	43	.60	-48
300	.75	-129	17.60	113	0.03	35	.46	-56
400	.77	-141	14.01	106	0.04	33	.37	-60
500	.76	-148	11.49	101	0.04	31	.31	-62
600	.76	-155	9.73	97	0.04	33	.28	-62
700	.76	-160	8.36	94	0.04	32	.25	-63
800	.76	-163	7.40	91	0.04	33	.23	-64
900	.77	-165	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	.78	171	2.05	59	0.07	53	.21	-79
4000	.78	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

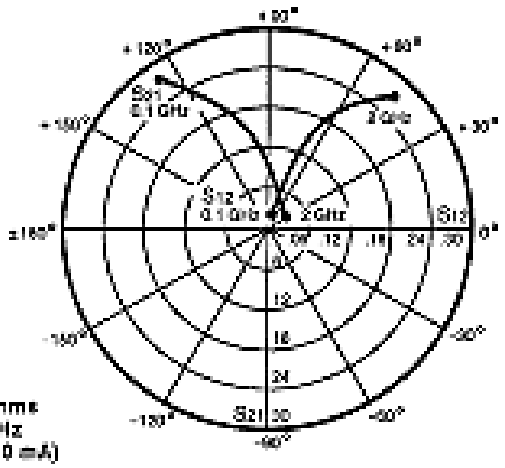
V_{CE} = 10 V, I_C = 30 mA

100	.73	-78	37.25	140	0.02	63	.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	6.93	87	0.04	40	.19	-64
1000	.76	-171	6.04	85	0.04	42	.18	-64
2000	.78	176	3.08	71	0.06	52	.17	-70
3000	.78	170	2.07	59	0.07	57	.19	-79
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 (x), 1 per bond pad, 0.0093" (236 µm) long each wire.
Collector: Total 1 wire (x), 1 per bond pad, 0.0083" (210 µm) long each wire.
Emitter: Total 2 wire (x), 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	6.98	91	.08	58	.44	-43
1000	.34	-173	3.98	68	.13	58	.40	-52
1500	.34	160	2.83	48	.18	57	.39	-70
2000	.37	140	1.94	29	.24	47	.39	-88

VCE = 10 V, IC = 10 mA

100	.62	-38	20.35	136	.02	70	.80	-26
200	.45	-86	13.62	113	.03	65	.59	-38
500	.35	-141	6.44	88	.07	63	.39	-42
1000	.31	-177	3.46	68	.13	60	.35	-51
1500	.31	160	2.40	48	.19	57	.35	-70
2000	.34	138	2.04	30	.25	46	.35	-88

VCE = 10 V, IC = 20 mA

100	.45	-78	26.79	125	.01	69	.68	-31
200	.32	-116	15.88	106	.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	165	2.63	47	.20	58	.31	-70
2000	.30	134	2.17	30	.28	45	.31	-88

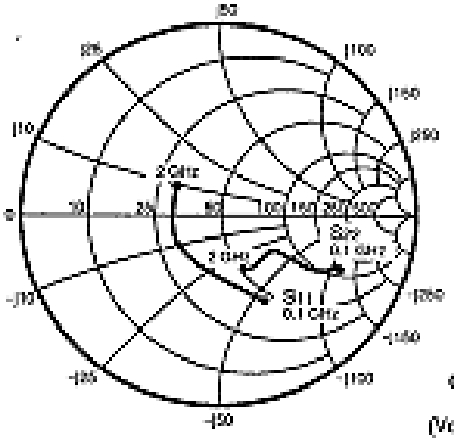
VCE = 10 V, IC = 30 mA

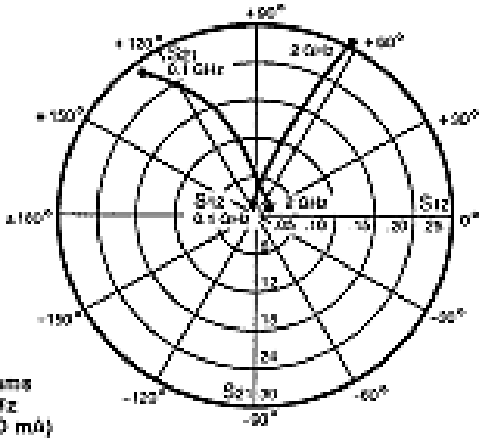
100	.37	-90	29.24	120	.01	71	.62	-33
200	.28	-128	16.64	101	.02	64	.42	-36
500	.27	-160	7.19	83	.07	72	.30	-37
1000	.28	172	3.79	63	.14	64	.30	-46
1500	.27	153	2.67	47	.21	58	.28	-69
2000	.30	133	2.20	30	.27	46	.30	-88

VCE = 10 V, IC = 50 mA

100	.30	-102	29.24	116	.01	75	.58	-31
200	.23	-144	16.12	99	.01	69	.41	-32
500	.24	-176	6.89	83	.07	73	.31	-33
1000	.28	152	3.63	65	.14	65	.28	-39
1500	.29	132	2.59	51	.19	59	.24	-41
2000	.33	116	2.01	37	.24	49	.23	-49

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)	S_{11}		S_{21}		S_{12}		S_{22}	
100	.77	-43	16.56	145	.01	71	.88	-16
200	.57	-74	12.28	123	.04	58	.70	-28
500	.35	-126	6.28	95	.08	61	.69	-34
1000	.29	-163	3.36	76	.12	64	.44	-41
1500	.27	171	2.36	62	.18	69	.45	-52
2000	.30	155	1.89	49	.23	62	.49	-64

VCE = 10 V, IC = 10 mA

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

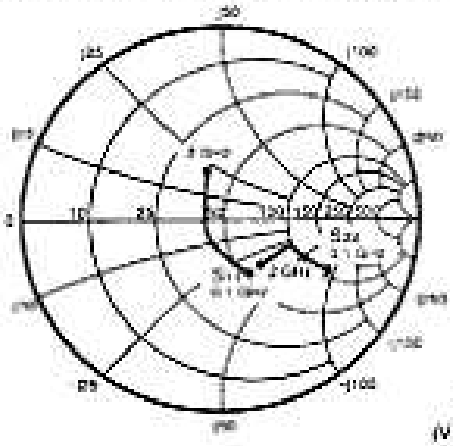
100	.56	-64	26.42	129	.01	69	.72	-27
200	.35	-95	16.90	109	.02	64	.53	-32
500	.24	-147	7.22	89	.07	71	.35	-31
1000	.21	-175	3.81	73	.13	69	.37	-40
1500	.20	162	2.64	62	.20	67	.35	-53
2000	.23	149	2.10	49	.26	61	.37	-65

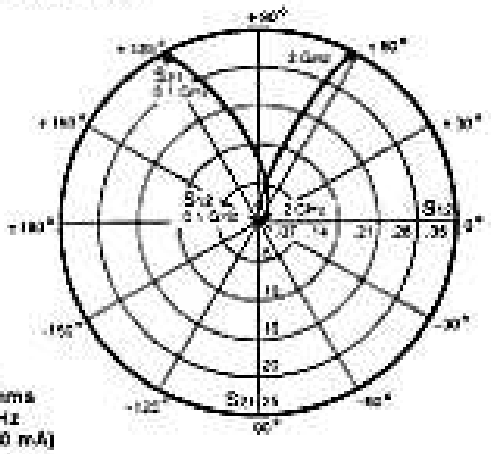
VCE = 10 V, IC = 30 mA

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	85	.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

2

TYPICAL COMMON EMITTER SCATTERING PARAMETERS





NE85634
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	.64	-53	15.46	136	.03	70	.81	-23
200	.41	-81	10.42	114	.04	65	.61	-30
500	.21	-133	4.58	90	.10	69	.43	-29
1000	.19	165	2.67	70	.17	69	.39	-34
1500	.23	135	1.93	58	.23	68	.37	-46
2000	.31	119	1.52	48	.32	63	.37	-59

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

100	.56	-58	18.40	130	.02	68	.74	-26
200	.32	-89	11.66	109	.04	63	.54	-32
500	.17	-143	5.22	88	.10	72	.38	-30
1000	.16	156	2.80	70	.15	70	.37	-39
1500	.20	127	2.02	58	.25	68	.34	-45
2000	.28	114	1.59	46	.33	62	.34	-58

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

100	.36	-72	23.00	118	.02	72	.61	-29
200	.19	-105	13.04	101	.04	72	.44	-29
500	.11	-163	5.66	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	105	1.78	47	.34	61	.30	-60

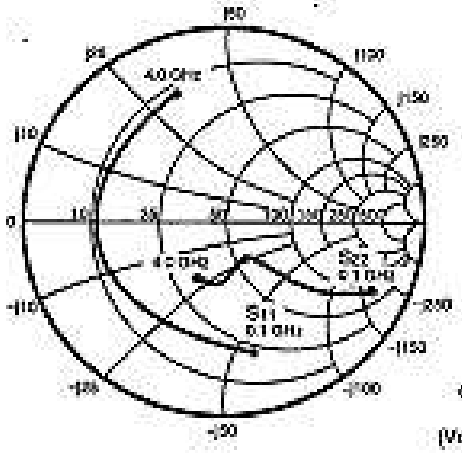
V_{CE} = 10 V, I_C = 30 mA

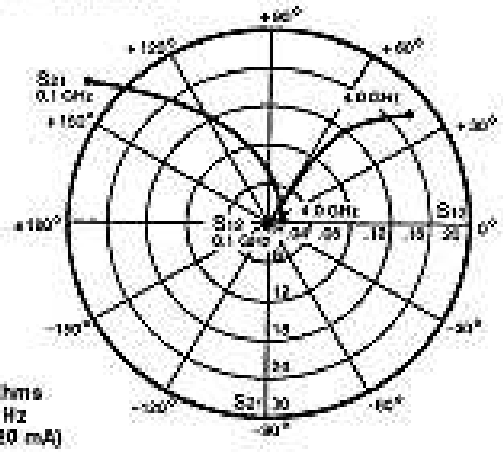
100	.28	-81	24.62	113	.01	72	.55	-28
200	.14	-118	13.40	98	.03	75	.41	-29
500	.11	-176	5.69	84	.11	79	.33	-22
1000	.14	131	3.05	68	.18	72	.32	-31
1500	.19	112	2.16	58	.28	66	.30	-47
2000	.25	104	1.81	47	.35	60	.30	-60

V_{CE} = 10 V, I_C = 50 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	.26	107	1.77	46	.36	62	.31	-59

TYPICAL COMMON EMITTER SCATTERING PARAMETERS





NE85635
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	.82	-47	18.05	154	.00	35	.91	-10
500	.68	-141	8.12	100	.02	34	.45	-41
1000	.66	-169	4.29	77	.03	34	.36	-48
1500	.66	174	2.91	64	.04	39	.38	-53
2000	.66	160	2.23	50	.05	42	.34	-61
2500	.67	145	1.81	37	.10	44	.38	-75
3000	.60	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

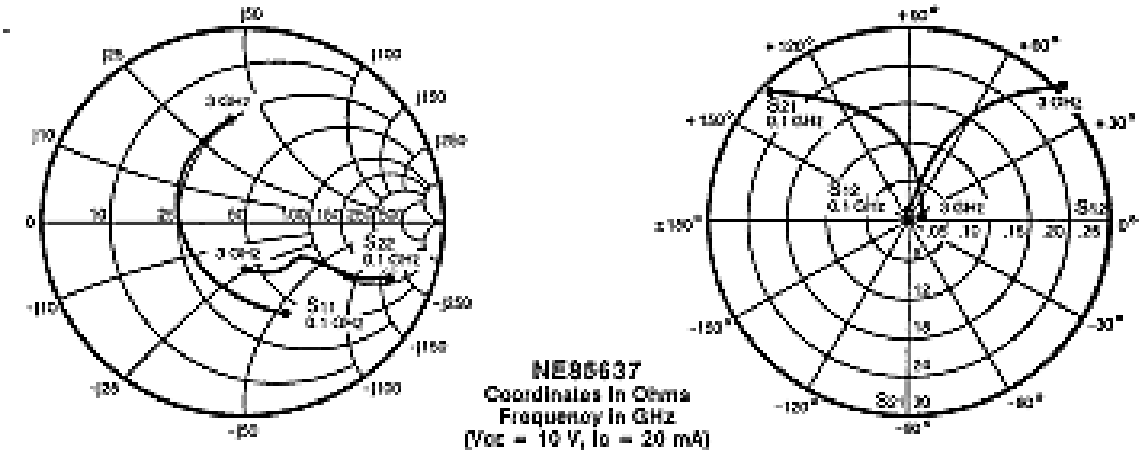
V_{CE} = 10 V, I_C = 20 mA

100	.65	-78	34.20	141	.00	9	.79	-27
500	.61	-102	10.36	83	.00	43	.26	-49
1000	.62	179	5.32	75	.02	52	.21	-58
1500	.62	167	3.62	63	.04	53	.23	-58
2000	.63	153	2.80	50	.08	54	.19	-63
2500	.64	140	2.22	38	.11	50	.25	-82
3000	.66	131	1.92	26	.14	48	.27	-94
3500	.67	120	1.62	14	.15	38	.28	-105
4000	.68	110	1.48	4	.17	38	.30	-115

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

100	.61	-91	38.48	135	.00	7	.70	-31
500	.63	-108	10.75	81	.00	48	.23	-48
1000	.62	176	5.47	74	.02	57	.19	-58
1500	.62	164	3.71	62	.04	59	.21	-65
2000	.62	152	2.86	50	.06	57	.17	-81
2500	.63	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	40	.26	-105
4000	.68	110	1.51	5	.18	38	.27	-116

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



NE85637
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	-42	17.35	149	.01	72	.91	-16
500	.46	-135	7.22	97	.06	50	.53	-31
1000	.44	-179	3.90	73	.08	56	.44	-35
1500	.44	158	2.69	57	.10	55	.43	-44
2000	.47	139	2.05	43	.16	57	.43	-55
2500	.51	121	1.68	28	.19	51	.38	-71
3000	.55	108	1.45	15	.23	48	.38	-89

VCE = 10 V, IC = 10 mA

100	.69	-50	21.85	144	.01	69	.87	-19
500	.41	-143	7.89	93	.05	69	.47	-31
1000	.40	176	4.19	72	.09	61	.40	-35
1500	.41	153	2.88	56	.12	58	.39	-44
2000	.44	135	2.18	41	.16	57	.39	-54
2500	.48	118	1.80	26	.21	50	.34	-69
3000	.52	107	1.54	10	.24	44	.32	-88

VCE = 10 V, IC = 20 mA

100	.55	-68	29.93	134	.01	70	.78	-25
500	.35	-160	8.73	89	.05	64	.40	-28
1000	.37	168	4.52	70	.09	57	.35	-33
1500	.38	150	3.12	55	.10	51	.34	-42
2000	.41	134	2.37	43	.16	58	.33	-53
2500	.45	117	1.96	30	.22	50	.29	-68
3000	.49	106	1.69	17	.26	43	.27	-87

VCE = 10 V, IC = 30 mA

100	.48	-80	33.45	129	.01	69	.72	-25
500	.34	-167	9.08	87	.05	66	.38	-28
1000	.37	165	4.69	69	.09	59	.34	-31
1500	.37	148	3.16	55	.13	52	.33	-41
2000	.40	133	2.40	43	.18	59	.33	-52
2500	.45	116	1.98	29	.22	50	.28	-67
3000	.48	106	1.70	16	.26	43	.26	-86

VCE = 10 V, IC = 40 mA

100	.45	-89	34.26	125	.01	70	.69	-26
500	.35	-171	8.79	86	.05	71	.38	-24
1000	.37	163	4.81	69	.09	70	.34	-30
1500	.38	147	3.09	55	.13	63	.34	-39
2000	.41	131	2.37	42	.18	60	.34	-52
2500	.45	115	1.95	28	.22	49	.29	-66
3000	.49	105	1.68	15	.26	42	.27	-85