

### FEATURES

- **HIGH INSERTION GAIN:** 18.5 dB at 500 MHz
- **LOW NOISE FIGURE:** 1.5 dB at 500 MHz
- **HIGH POWER GAIN:** 12 dB at 2 GHz
- **LARGE DYNAMIC RANGE:** 19 dBm at 1 dB 2 GHz Gain Compression

### DESCRIPTION AND APPLICATIONS

The NE021 series of NPN silicon transistors provides economical solutions to wide ranges of amplifier and oscillator problems. Low noise and high current capability provide wide dynamic ranges; the excellent linearity of S<sub>21</sub> with collector current assures low intermodulation distortion. The NE021 series is available as a chip or in several package styles. The series uses the NEC gold, platinum, titanium, and platinum-silicide metallization system to provide the utmost in reliability. Most package options are available with Grade C (JANTXV equivalent) and Grade CX (JANTX equivalent) reliability screening. Some packages are available in both common-base and common-emitter configurations. The NE02103 and the NE02107 have been qualified for high-reliability space applications.

### ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V <sub>CBO</sub>	Collector to Base Voltage	V	25
V <sub>CEO</sub>	Collector to Emitter Voltage	V	12 <sup>1</sup>
V <sub>EB0</sub>	Emitter to Base Voltage	V	3
I <sub>C</sub>	Collector Current	mA	70
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 BV<sub>CER</sub> = 25 V for R ≤ 300 Ω.
2. Maximum T<sub>J</sub> for the NE02132, NE02133, NE02136, and NE02137 is +150°C.
3. Maximum storage temperature for the NE02132, NE02135, NE02136 and NE02137 is -65 to +150°C. Maximum storage temperature for the NE02133 is -55 to +150°C.

### NE02135 TYPICAL NOISE PARAMETERS

V<sub>CE</sub> = 10 V, I<sub>C</sub> = 5 mA

FREQUENCY (MHz)	NF <sub>min</sub> (dB)	G <sub>A</sub>	OPT SOURCE	R <sub>N</sub> /50 Ω
500	1.2	18.6	.36 ∠ 69°	.14
1000	1.5	13.9	.31 ∠ 124°	.12
1500	2.0	12.1	.50 ∠ 165°	.05
2000	2.4	9.6	.44 ∠ -175°	.06
2500	2.6	8.9	.52 ∠ -161°	.10
3000	3.6	8.6	.68 ∠ -141°	.14
3500	3.7	6.9	.71 ∠ -139°	.21

V<sub>CE</sub> = 10 V, I<sub>C</sub> = 20 mA

500	1.8	20.6	.16 ∠ 149°	.15
1000	1.9	16.1	.33 ∠ 169°	.13
1500	2.4	13.5	.46 ∠ -179°	.09
2000	2.9	11.5	.53 ∠ -167°	.08
2500	3.2	9.8	.57 ∠ -154°	.14
3000	3.9	9.7	.62 ∠ -139°	.27
3500	4.3	7.6	.67 ∠ -134°	.42

PERFORMANCE SPECIFICATIONS (TA = 25°C)

SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	NE02100 00 (CHIP)			NE02103 2SC1560(C)			NE02107 07			NE02112 2SC1988			NE02132 2SC2570			NE02133 2SC2351			NE02135 2SC2149			NE02137 2SC2369		
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
f <sub>t</sub>	Gain Bandwidth Product at V <sub>CE</sub> = 10 V, I <sub>C</sub> = 20 mA	GHz		4.5			4.5		4.5			4.5			4.5											
S <sub>21</sub>   <sup>2</sup>	Insertion Power Gain at V <sub>CE</sub> = 10 V, I <sub>C</sub> = 20 mA, f = 0.5 GHz	dB		18.5			18.5		18.5			13	15		15											
	f = 1 GHz	dB		13			13		13			10	10		10											
	f = 2 GHz	dB	5.5	6.5			5.5	6.5	5.5	6.5		4	4		4									9	11	
NF <sub>MIN</sub>	Minimum Noise Figure <sup>2</sup> at V <sub>CE</sub> = 10 V, I <sub>C</sub> = 3 mA, f = 0.5 GHz	dB		1.5			1.5		1.5			1.5	2.5													
	V <sub>CE</sub> = 10 V, I <sub>C</sub> = 5 mA, f = 1 GHz	dB		2.7			2.7		2.7			3	3		3											
	f = 2 GHz	dB		4.5			4.5		4.5			4.5	4.5		4.5											
MAG	Maximum Available Gain <sup>3</sup> at V <sub>CE</sub> = 10 V, I <sub>C</sub> = 20 mA, f = 0.5 GHz	dB	22				22		22			17.5														
	f = 1 GHz	dB	18				18		18			12.5														
	f = 2 GHz	dB	12				12		12			7.5														

Notes:

1. Electronic Industrial Association of Japan.
2. Input and output are tuned for optimum noise figures.
3. Maximum Available Gain (MAG) is calculated for the device S-Parameters using the equation,  $MAG = |S_{21}|^2 \cdot \frac{1}{1 - |S_{11}|^2} \cdot \frac{1}{1 - |S_{22}|^2}$

ELECTRICAL SPECIFICATIONS (TA = 25°C)

SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	NE02100 00 (CHIP)			NE02103 2SC1560(C)			NE02107 07			NE02112 2SC1988			NE02132 2SC2570			NE02133 2SC2351			NE02135 2SC2149			NE02137 2SC2369		
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
I <sub>CEO</sub>	Collector Cutoff Current at V <sub>CB</sub> = 15 V, I <sub>E</sub> = 0	μA		1.0			1.0		1.0			1.0			1.0											
I <sub>EB0</sub>	Emitter Cutoff Current at V <sub>EB</sub> = 2 V, I <sub>C</sub> = 0	μA		1.0			1.0		1.0			1.0			1.0											
h <sub>FE</sub>	Forward Current Gain at V <sub>CE</sub> = 10 V, I <sub>C</sub> = 20 mA		20	70	250	20	70	250	20	70	250	20	70	250	20	70	250	40	70	200	20	70	250	20	70	250
C <sub>cb</sub>	Collector to Base Capacitance <sup>2</sup> at V <sub>CB</sub> = 10 V, I <sub>E</sub> = 0, f = 1 MHz	pF		0.6	1.0		0.6	1.0		0.6	1.0		0.6	1.0		0.7	0.9									
R <sub>th</sub>	Thermal Resistance (J-C)	°C/W		70			70		90			90														
R <sub>th</sub>	Thermal Resistance (J-A)			300			300		500			500														
P <sub>T</sub> <sup>3</sup>	Total Power Dissipation	mW	580		700	580		700	350		700	350		700	250											

Notes:

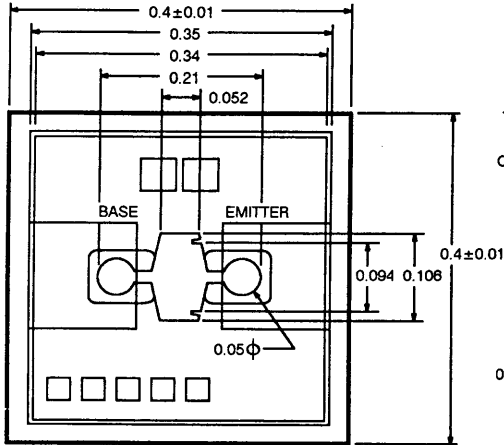
1. Electronic Industrial Association of Japan.
2. C<sub>cb</sub> measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal.
3. Minimum dissipations based on R<sub>th(J-A)</sub> for applications without effective heatsink, maximum dissipations based on R<sub>th(J-C)</sub> for applications with effective heatsink.



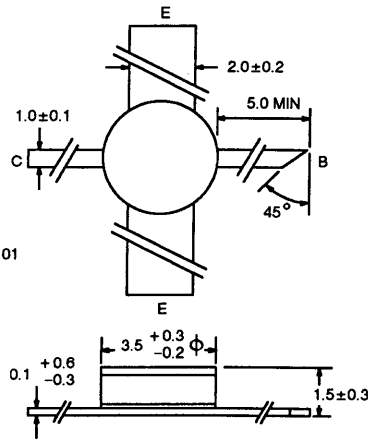
# NE021 SERIES

## OUTLINE DIMENSIONS (Units in mm)

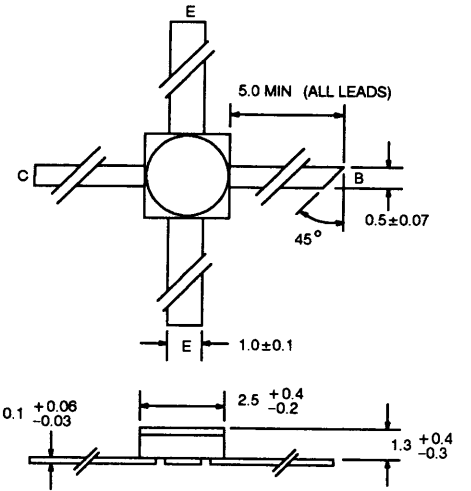
**NE02100 (CHIP)**  
(Chip Thickness: 140  $\mu\text{m}$ )



**OUTLINE 03**

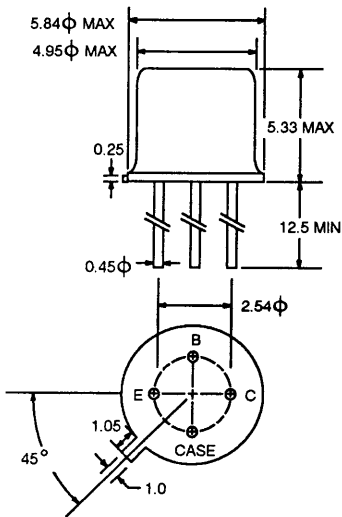


**OUTLINE 07**

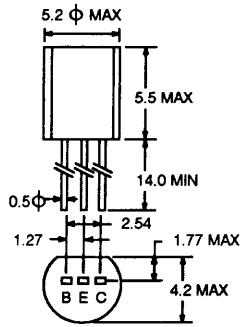


\*07B has emitter and base reversed.

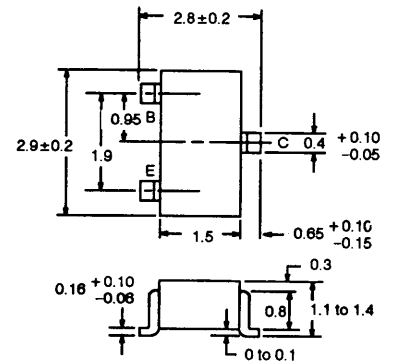
**OUTLINE 12**  
(TO-72)



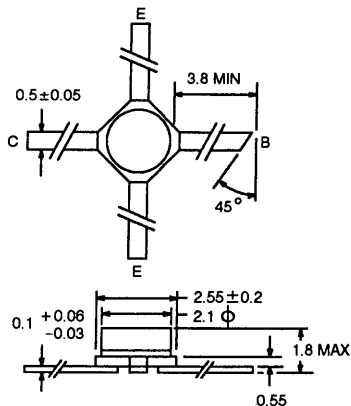
**OUTLINE 32**  
(TO-92)



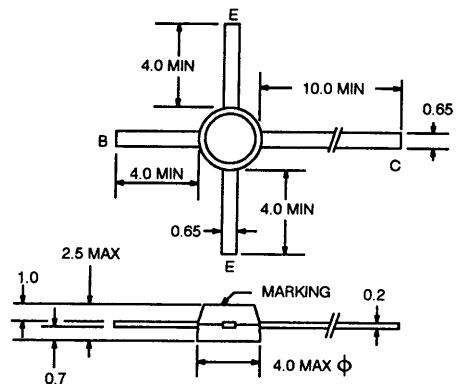
**OUTLINE 33**  
(SOT-23)



**OUTLINE 35**  
(MICRO-X)



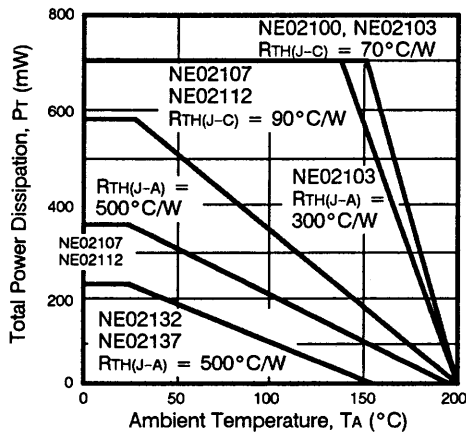
**OUTLINE 37**



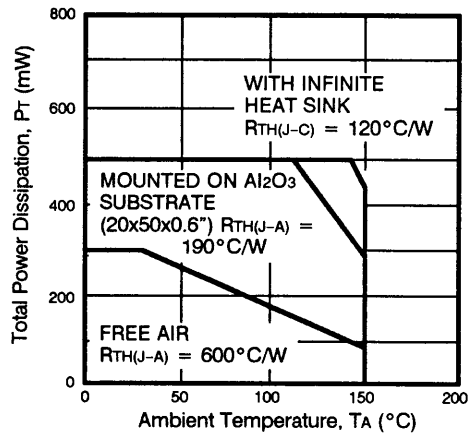
\*The NE02136 is available with only the bottom emitter lead.

TYPICAL DEVICE CHARACTERISTICS (TA = 25°C)

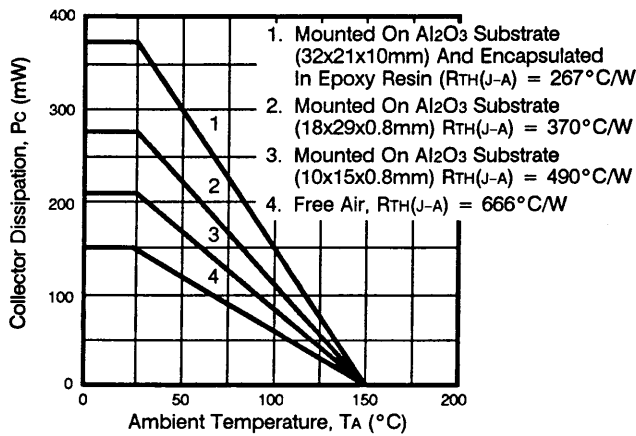
NE02100, NE02103, NE02107,  
NE02112, NE02132, NE02137  
DC POWER DERATING CURVES



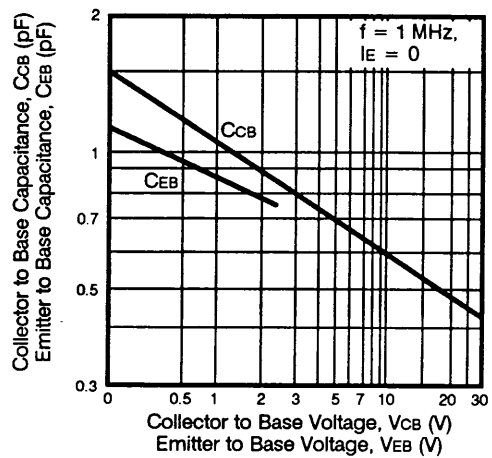
NE02135  
DC POWER DERATING CURVES



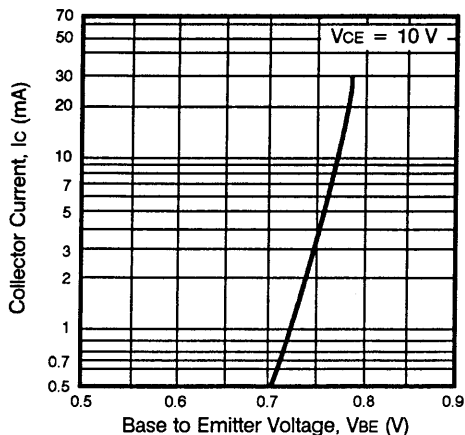
NE02133  
DC POWER DERATING CURVES



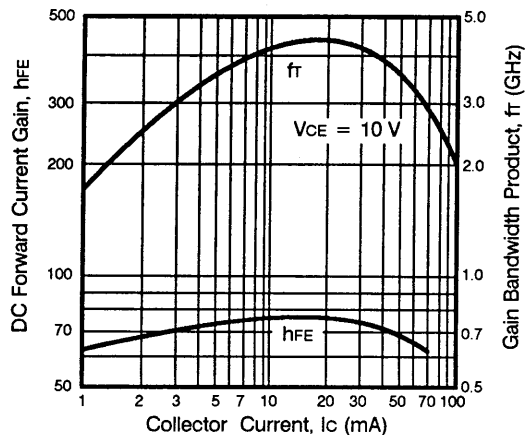
DEVICE CAPACITANCE



VOLTAGE CURRENT  
CHARACTERISTICS



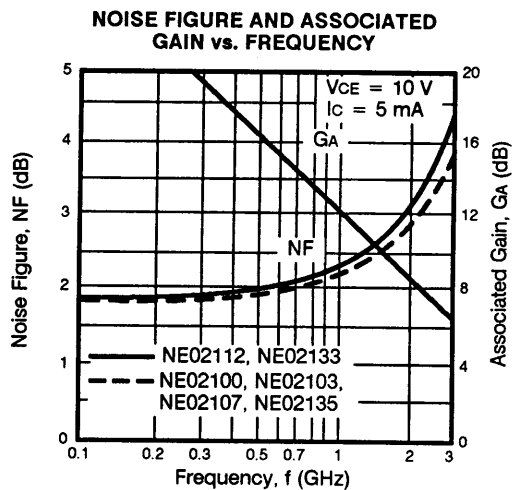
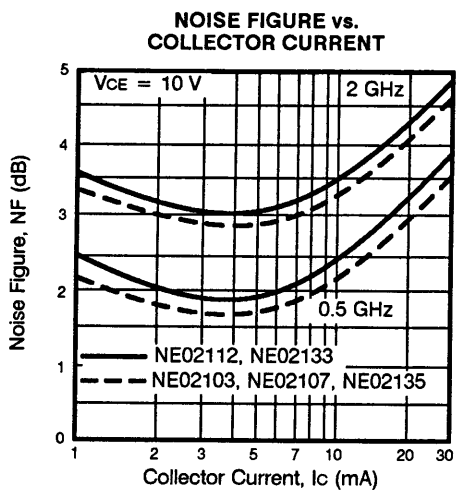
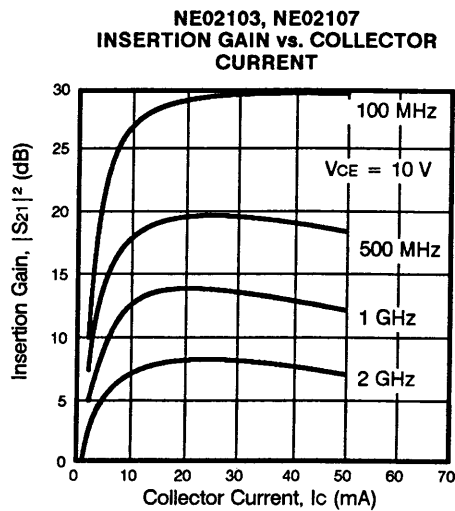
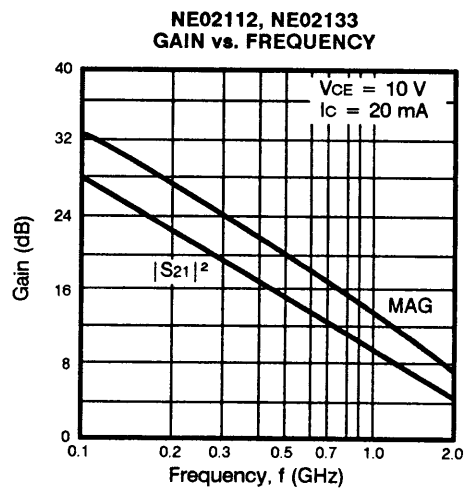
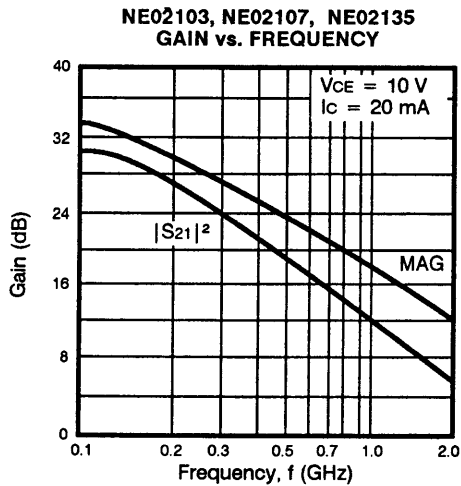
GAIN BANDWIDTH PRODUCT  
AND FORWARD CURRENT GAIN  
vs. COLLECTOR CURRENT



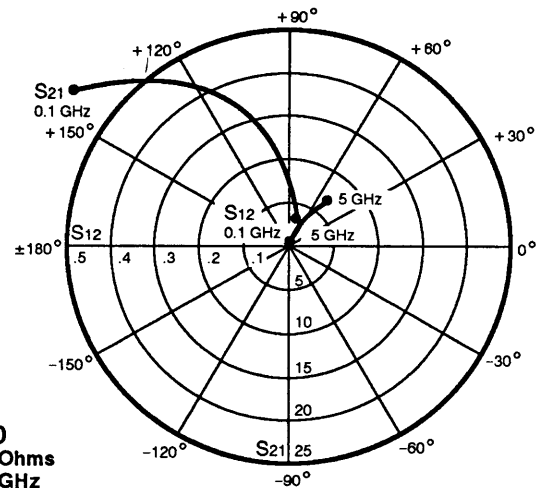
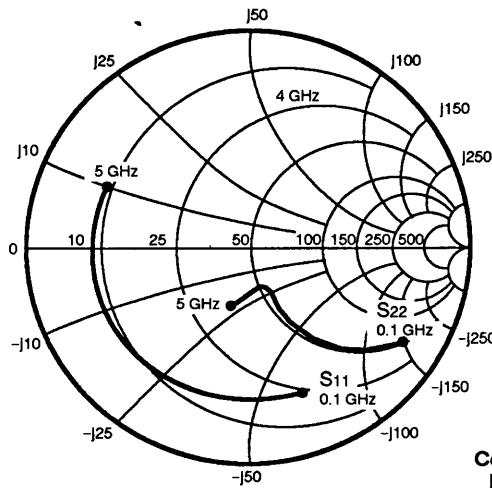
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# NE021 SERIES

## TYPICAL PERFORMANCE CHARACTERISTICS (T<sub>A</sub> = 25°C)



TYPICAL COMMON EMITTER SCATTERING PARAMETERS



**NE02100**  
Coordinates in Ohms  
Frequency in GHz  
(VCE = 10 V, IC = 20 mA)

**S-MAGN AND ANGLES:**

VCE = 10 V, IC = 5 mA

FREQUENCY (MHz)	S11	S21	S12	S22	k	GMA dB
100	.84 -32	11.83 160	.03 70	.94 -16	.11	26.4
500	.75 -114	7.22 113	.07 36	.56 -45	.29	19.9
1000	.73 -150	4.13 89	.09 27	.39 -51	.54	16.9
1500	.71 -164	2.85 76	.09 27	.35 -56	.77	15.0
2000	.71 -173	2.16 66	.10 28	.33 -61	.97	13.5
2500	.71 -179	1.75 57	.10 30	.33 -67	1.14	10.1
3000	.70 176	1.49 49	.11 32	.34 -73	1.25	8.3
3500	.70 172	1.28 42	.12 33	.35 -80	1.35	6.9
4000	.70 168	1.13 34	.12 34	.37 -88	1.41	5.9
4500	.70 165	1.02 27	.13 34	.39 -94	1.47	4.9
5000	.70 161	.92 20	.14 35	.41 -100	1.49	4.2

VCE = 10 V, IC = 10 mA

100	.75 -47	20.04 153	.02 65	.89 -24	.11	29.2
500	.72 -137	9.40 105	.05 34	.41 -57	.39	22.5
1000	.72 -162	4.97 86	.06 34	.27 -62	.69	19.0
1500	.71 -173	3.37 75	.07 38	.23 -66	.92	16.8
2000	.71 -179	2.56 66	.08 41	.22 -71	1.09	13.2
2500	.71 176	2.05 58	.09 43	.23 -76	1.19	10.9
3000	.71 172	1.74 51	.10 44	.24 -82	1.27	9.2
3500	.71 168	1.50 44	.11 44	.25 -88	1.31	7.9
4000	.70 165	1.33 37	.12 44	.27 -95	1.36	6.8
4500	.70 162	1.19 30	.13 44	.29 -100	1.39	5.9
5000	.70 159	1.08 24	.14 43	.31 -106	1.39	5.1

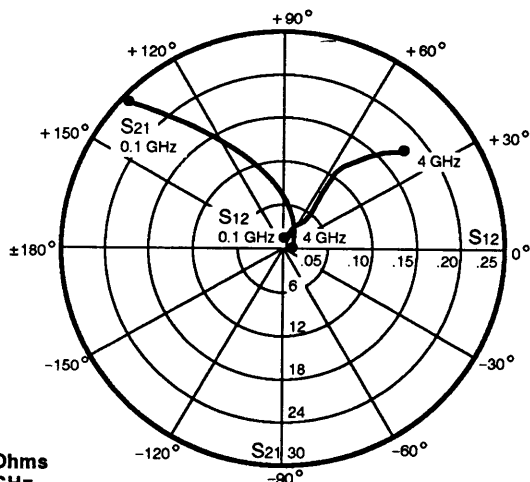
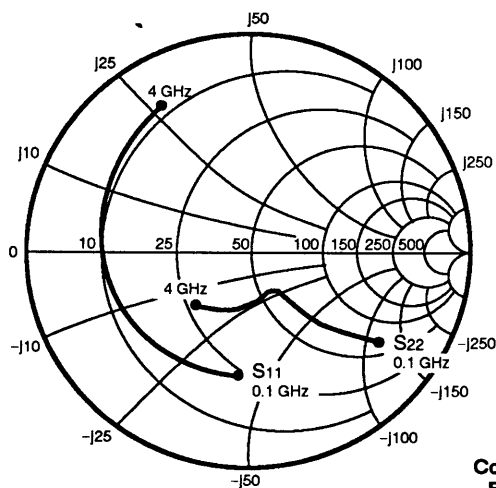
VCE = 10 V, IC = 20 mA

100	.68 -70	29.75 145	.02 59	.81 -33	.14	31.6
500	.72 -152	10.58 99	.04 37	.30 -65	.53	24.3
1000	.72 -170	5.42 84	.05 43	.19 -69	.87	20.4
1500	.72 -178	3.65 74	.06 48	.17 -73	1.05	16.4
2000	.72 177	2.74 66	.07 50	.17 -78	1.17	13.2
2500	.72 172	2.21 58	.09 51	.17 -83	1.23	11.3
3000	.71 169	1.86 51	.10 52	.19 -87	1.27	9.7
3500	.71 166	1.61 44	.11 51	.20 -93	1.30	8.4
4000	.71 162	1.42 38	.12 51	.22 -99	1.34	7.3
4500	.71 160	1.28 31	.13 49	.24 -105	1.33	6.4
5000	.71 157	1.15 25	.14 48	.27 -109	1.34	5.6

NOTE: S-Parameters include bond wires.  
 BASE: Total 1 wire (s), 1 per bond pad, 0.0115" (291 μm) long each wire.  
 COLLECTOR: Total 1 wire (s), 1 per bond pad, 0.0072" (182 μm) long each wire.  
 EMITTER: Total 2 wire (s), 1 per side, 0.015" (393 μm) long each wire.  
 WIRE: 0.0007" (17.7 μm) dia., gold.

# NE021 SERIES

## TYPICAL COMMON EMITTER SCATTERING PARAMETERS



**NE02103**  
Coordinates in Ohms  
Frequency in GHz  
(VCE = 10 V, IC = 20 mA)

### S-MAGN AND ANGLES:

VCE = 10 V, IC = 5 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
100	.82	-41	13.67	154	.02	72	.92	-17
500	.67	-133	6.53	103	.07	34	.51	-43
1000	.66	-167	3.58	79	.08	31	.38	-51
1500	.65	175	2.45	63	.10	32	.37	-61
2000	.66	163	1.85	51	.11	36	.37	-71
2500	.67	151	1.49	38	.12	34	.36	-83
3000	.68	141	1.29	26	.14	35	.38	-98
3500	.69	132	1.09	16	.16	32	.40	-110
4000	.71	124	.96	5	.16	29	.43	-121

VCE = 10 V, IC = 10 mA

100	.69	-62	21.74	145	.01	68	.84	-25
500	.65	-154	7.92	96	.05	39	.36	-49
1000	.65	-179	4.15	76	.07	43	.27	-55
1500	.65	168	2.81	62	.08	47	.27	-63
2000	.66	158	2.12	51	.11	49	.28	-74
2500	.68	146	1.70	39	.12	44	.28	-88
3000	.69	138	1.46	28	.14	43	.30	-102
3500	.71	129	1.23	17	.17	40	.33	-115
4000	.72	121	1.09	7	.17	34	.35	-126

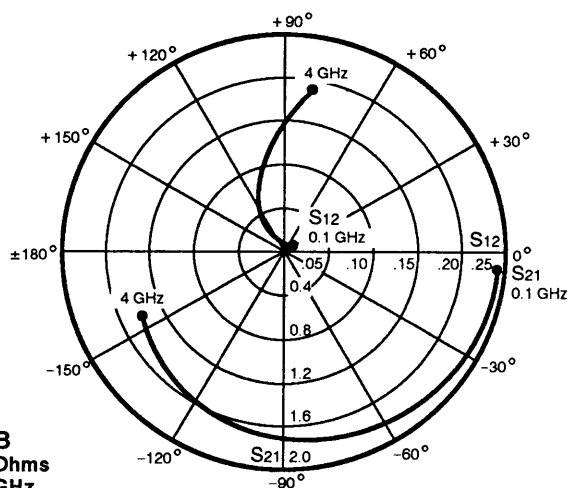
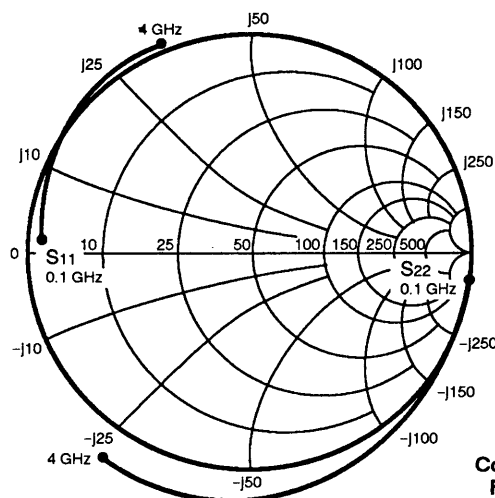
VCE = 10 V, IC = 20 mA

100	.57	-91	29.51	136	.01	65	.74	-33
500	.65	-167	8.77	91	.04	48	.27	-54
1000	.66	175	4.49	74	.06	54	.20	-60
1500	.66	164	3.05	61	.08	54	.21	-68
2000	.68	154	2.27	51	.10	55	.22	-78
2500	.69	144	1.83	39	.13	50	.23	-93
3000	.70	136	1.56	29	.14	45	.25	-107
3500	.72	127	1.30	19	.16	42	.28	-118
4000	.74	120	1.18	9	.18	39	.31	-130

VCE = 10 V, IC = 40 mA

100	.53	-121	34.50	128	.01	66	.66	-38
500	.66	-175	9.00	88	.03	61	.23	-50
1000	.67	171	4.56	72	.05	63	.17	-55
1500	.68	161	3.07	60	.08	59	.19	-64
2000	.69	152	2.30	50	.10	60	.21	-75
2500	.71	142	1.85	39	.13	54	.21	-92
3000	.72	135	1.59	29	.14	47	.24	-108
3500	.74	126	1.33	19	.16	45	.26	-119
4000	.75	119	1.18	8	.17	42	.30	-131

TYPICAL COMMON BASE SCATTERING PARAMETERS



**NE02107B**  
Coordinates in Ohms  
Frequency in GHz  
(V<sub>cb</sub> = 10 V, I<sub>c</sub> = 20 mA)

**S-MAGN AND ANGLES:**

V<sub>CB</sub> = 10 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	.79	175	1.77	-10
500	.79	170	1.78	-24
1000	.79	163	1.72	-44
1500	.83	157	1.71	-64
2000	.83	149	1.57	-87
2500	.87	145	1.53	-99
3000	.87	136	1.40	-122
3500	.87	126	1.21	-140
4000	.86	117	1.12	-164

V<sub>CB</sub> = 10 V, I<sub>C</sub> = 10 mA

	S <sub>11</sub>	S <sub>21</sub>	S <sub>12</sub>	S <sub>22</sub>
100	.88	177	1.84	-6
500	.88	171	1.84	-19
1000	.87	164	1.83	-38
1500	.90	159	1.82	-57
2000	.92	152	1.72	-76
2500	.95	144	1.68	-92
3000	.96	135	1.57	-113
3500	.96	125	1.45	-135
4000	.95	116	1.33	-156

V<sub>CB</sub> = 10 V, I<sub>C</sub> = 20 mA

	S <sub>11</sub>	S <sub>21</sub>	S <sub>12</sub>	S <sub>22</sub>
100	.92	176	1.90	-6
500	.93	171	1.89	-19
1000	.92	164	1.89	-37
1500	.96	159	1.88	-55
2000	.97	152	1.81	-75
2500	1.01	142	1.75	-90
3000	1.02	132	1.67	-110
3500	1.03	121	1.55	-132
4000	1.02	112	1.42	-154

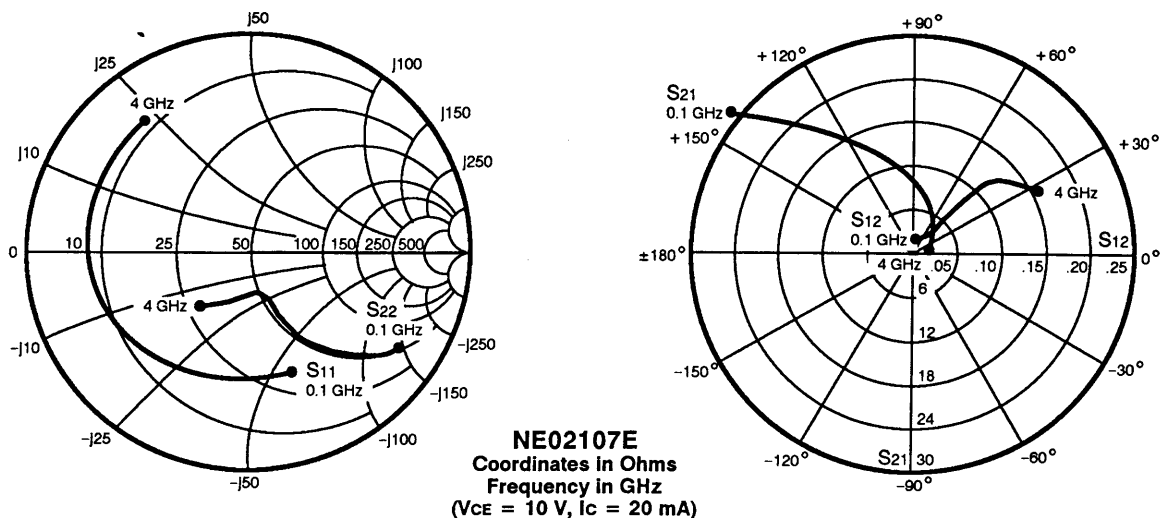
V<sub>CB</sub> = 10 V, I<sub>C</sub> = 40 mA

	S <sub>11</sub>	S <sub>21</sub>	S <sub>12</sub>	S <sub>22</sub>
100	.95	176	1.93	-7
500	.94	171	1.91	-20
1000	.94	163	1.91	-38
1500	.98	158	1.90	-57
2000	.99	151	1.83	-77
2500	1.04	141	1.81	-92
3000	1.05	132	1.72	-115
3500	1.05	120	1.58	-136
4000	1.03	111	1.46	-157





TYPICAL COMMON EMITTER SCATTERING PARAMETERS



**S-MAGN AND ANGLES:**

VCE = 10 V, IC = 5 mA

FREQUENCY (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
100	.82	-36	13.90	157	.01	73	.95	-16
500	.70	-125	7.38	107	.07	35	.54	-47
1000	.68	-161	4.17	82	.08	25	.39	-59
1500	.68	-178	2.87	66	.09	24	.38	-68
2000	.68	170	2.18	53	.10	26	.37	-78
2500	.67	159	1.73	40	.11	22	.38	-90
3000	.67	151	1.49	28	.12	23	.40	-102
3500	.68	142	1.27	17	.13	19	.43	-112
4000	.68	134	1.16	6	.14	17	.45	-122

VCE = 10 V, IC = 10 mA

100	.69	-54	22.57	150	.01	69	.89	-23
500	.67	-145	9.37	100	.05	36	.39	-58
1000	.67	-172	5.00	79	.06	36	.27	-70
1500	.67	175	3.40	65	.08	37	.26	-77
2000	.67	165	2.57	53	.09	40	.25	-87
2500	.67	154	2.07	41	.11	35	.28	-97
3000	.67	146	1.80	30	.12	34	.31	-108
3500	.67	137	1.53	20	.14	30	.34	-116
4000	.67	130	1.41	8	.15	23	.36	-125

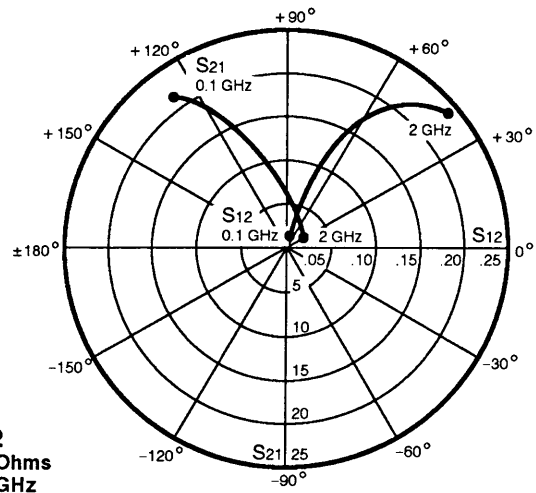
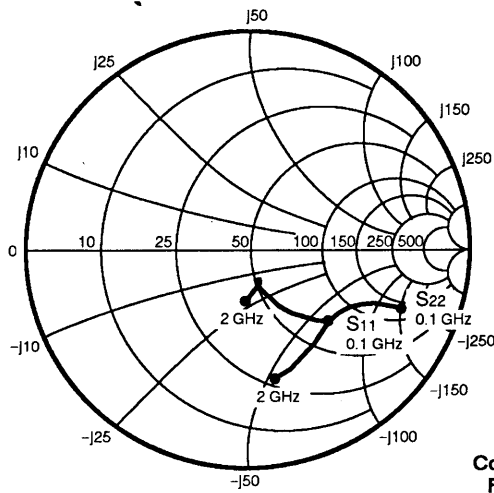
VCE = 10 V, IC = 20 mA

100	.58	-79	31.63	142	.01	65	.81	-32
500	.67	-161	10.57	95	.03	45	.28	-68
1000	.67	179	5.47	77	.04	46	.19	-78
1500	.67	168	3.70	64	.07	46	.19	-84
2000	.67	159	2.78	53	.09	48	.20	-96
2500	.67	150	2.26	42	.11	44	.23	-105
3000	.68	142	1.96	31	.12	39	.25	-114
3500	.67	134	1.68	21	.14	36	.28	-122
4000	.68	127	1.53	9	.16	27	.31	-128

VCE = 10 V, IC = 30 mA

100	.55	-96	35.99	137	.01	63	.75	-37
500	.67	-167	10.79	93	.02	48	.24	-69
1000	.68	176	5.52	75	.04	53	.17	-77
1500	.68	166	3.75	63	.07	52	.17	-83
2000	.68	158	2.81	52	.09	53	.18	-96
2500	.68	148	2.26	41	.11	46	.21	-106
3000	.68	141	1.96	30	.13	42	.24	-115
3500	.68	133	1.66	20	.14	38	.27	-123
4000	.68	126	1.51	9	.16	29	.30	-131

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



**NE02112**  
Coordinates in Ohms  
Frequency in GHz  
(VCE = 10 V, IC = 20 mA)

**S-MAGN AND ANGLES:**

VCE = 10 V, IC = 5 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
100	.76	-31	12.27	147	.01	69	.89	-16
200	.61	-52	9.59	126	.04	64	.78	-25
500	.33	-87	5.07	94	.09	61	.61	-36
1000	.17	-113	2.80	68	.15	60	.55	-47
1500	.14	-112	1.99	48	.20	53	.57	-63
2000	.18	-107	1.52	28	.22	40	.63	-82

VCE = 10 V, IC = 10 mA

100	.61	-37	17.41	136	.01	69	.81	-20
200	.45	-56	11.92	116	.03	69	.68	-26
500	.23	-82	5.64	88	.09	68	.54	-34
1000	.13	-94	3.03	66	.16	63	.51	-45
1500	.14	-90	2.13	47	.21	52	.53	-62
2000	.22	-96	1.62	27	.24	38	.60	-80

VCE = 10 V, IC = 20 mA

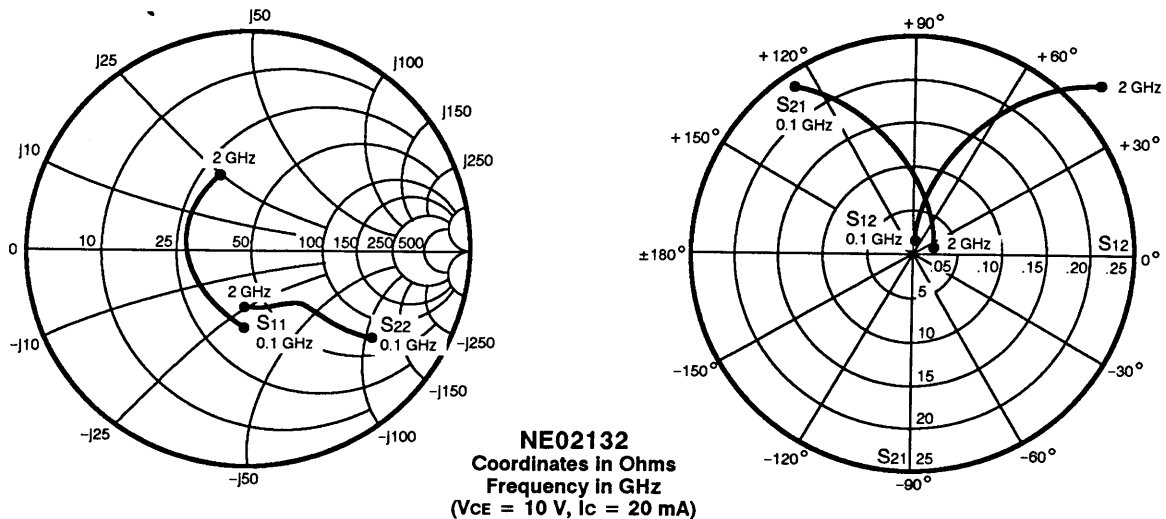
100	.47	-41	21.28	127	.01	76	.73	-21
200	.33	-56	13.15	108	.03	71	.62	-25
500	.18	-76	5.87	85	.09	70	.51	-32
1000	.11	-81	3.12	64	.16	64	.49	-43
1500	.14	-80	2.18	46	.22	53	.53	-61
2000	.23	-91	1.66	26	.24	38	.60	-80

VCE = 10 V, IC = 40 mA

100	.37	-49	21.89	119	.01	71	.68	-19
200	.25	-64	12.81	103	.02	71	.60	-21
500	.13	-89	5.52	82	.09	71	.53	-28
1000	.07	-99	2.93	62	.16	65	.52	-41
1500	.10	-87	2.06	44	.21	53	.55	-59
2000	.18	-94	1.56	24	.23	39	.62	-79

# NE021 SERIES

## TYPICAL COMMON EMITTER SCATTERING PARAMETERS



### S-MAGN AND ANGLES:

VCE = 10 V, IC = 5 mA

FREQUENCY (MHz)

	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
100	.70	-45	12.65	145	.03	71	.88	-21
200	.54	-80	9.63	123	.05	55	.70	-34
500	.39	-136	5.06	92	.09	53	.46	-47
1000	.35	176	2.77	63	.14	52	.40	-57
1500	.36	145	1.97	44	.20	51	.37	-72
2000	.41	120	1.62	25	.26	43	.36	-88

VCE = 10 V, IC = 10 mA

100	.50	-64	18.88	135	.02	69	.78	-29
200	.37	-105	12.46	113	.03	57	.56	-40
500	.31	-155	5.84	86	.09	64	.35	-48
1000	.30	163	3.12	62	.15	58	.32	-57
1500	.32	136	2.20	44	.22	53	.30	-73
2000	.37	114	1.80	26	.28	42	.29	-89

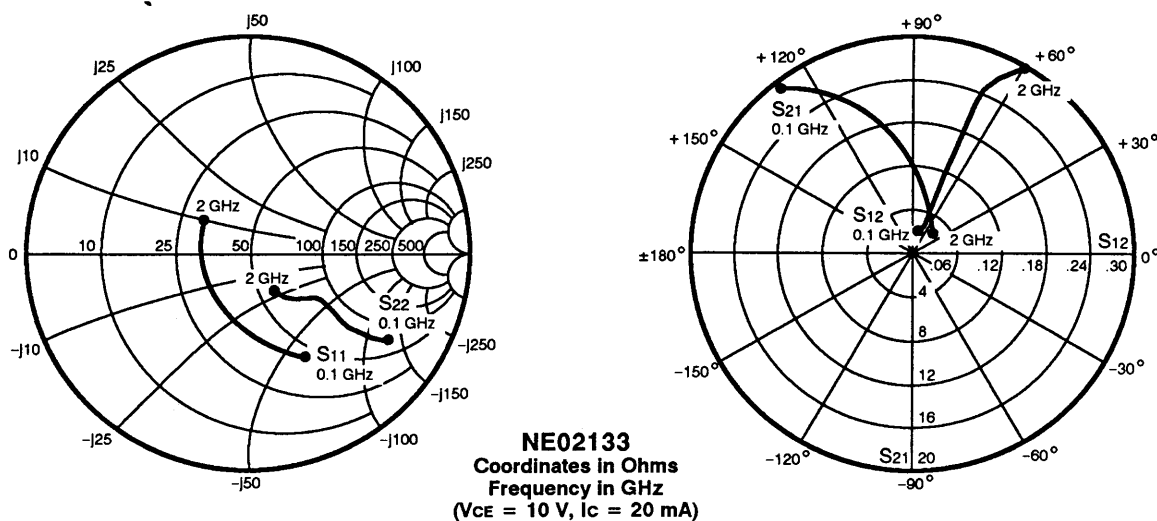
VCE = 10 V, IC = 20 mA

100	.34	-90	23.82	125	.01	71	.67	-34
200	.27	-133	14.23	105	.03	66	.45	-42
500	.27	-171	6.24	83	.09	70	.29	-46
1000	.29	155	3.31	60	.16	62	.28	-55
1500	.30	131	2.32	43	.23	54	.26	-74
2000	.35	111	1.88	26	.29	42	.26	-90

VCE = 10 V, IC = 40 mA

100	.27	-118	26.55	117	.01	73	.57	-36
200	.26	-156	14.82	100	.02	75	.38	-39
500	.27	179	6.32	81	.09	74	.27	-41
1000	.29	151	3.33	59	.16	63	.27	-53
1500	.31	128	2.34	43	.23	55	.26	-71
2000	.36	109	1.89	25	.29	42	.25	-88

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



**S-MAGN AND ANGLES:**

V<sub>CE</sub> = 10 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	.80	-37	13.53	150	.03	73	.91	-18
200	.63	-63	10.48	129	.04	59	.72	-29
500	.37	-114	5.56	99	.09	61	.48	-38
1000	.27	-158	3.02	76	.15	60	.40	-41
1500	.27	172	2.16	63	.21	63	.34	-49
2000	.29	151	1.74	49	.27	58	.31	-62

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

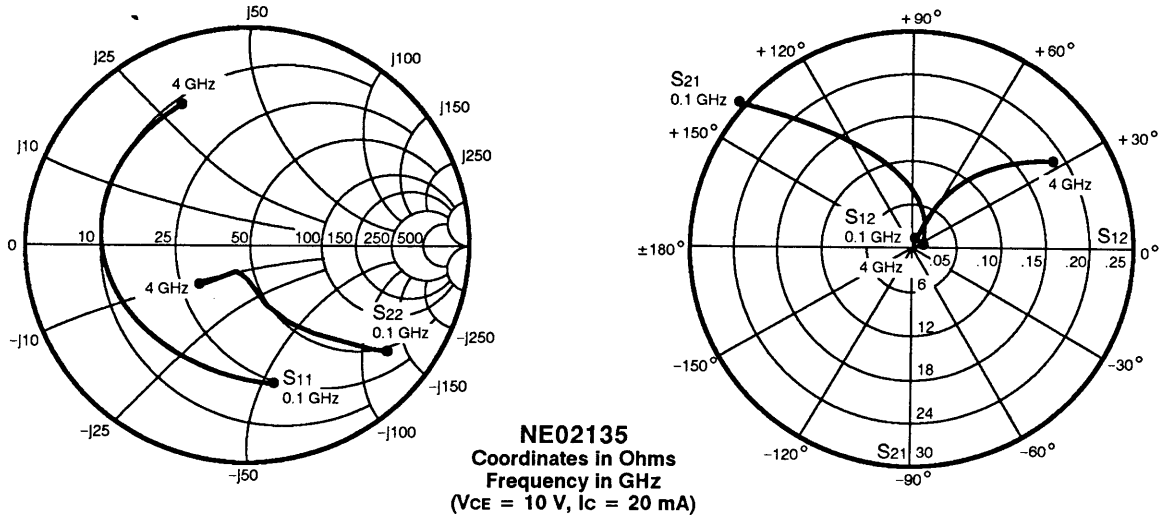
100	.66	-48	19.53	139	.02	79	.81	-27
200	.46	-78	13.52	118	.03	58	.58	-35
500	.27	-129	6.29	93	.09	67	.38	-36
1000	.21	-169	3.31	74	.16	66	.34	-40
1500	.23	165	2.35	62	.23	64	.29	-47
2000	.26	146	1.87	50	.29	59	.26	-62

V<sub>CE</sub> = 10 V, I<sub>C</sub> = 20 mA

100	.51	-61	19.37	129	.02	79	.70	-32
200	.33	-91	15.04	109	.03	64	.48	-35
500	.21	-143	6.57	89	.08	71	.33	-32
1000	.19	-177	3.41	72	.16	69	.32	-37
1500	.21	160	2.41	61	.24	67	.26	-45
2000	.24	142	1.92	49	.30	59	.23	-59

2

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



**S-MAGN AND ANGLES:**

V<sub>CE</sub> = 10 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	.84	-36	13.82	156	.02	73	.94	-18
500	.68	-126	7.18	106	.08	35	.51	-53
1000	.66	-163	4.02	81	.09	27	.34	-66
1500	.65	178	2.75	64	.10	27	.31	-74
2000	.65	163	2.10	52	.12	30	.31	-83
2500	.66	151	1.68	39	.13	26	.31	-95
3000	.66	141	1.46	27	.14	26	.33	-106
3500	.67	129	1.24	17	.16	26	.36	-116
4000	.68	121	1.14	5	.17	23	.38	-127

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

100	.73	-55	22.55	148	.02	65	.87	-27
500	.64	-148	8.90	98	.06	37	.36	-66
1000	.64	-176	4.71	77	.07	39	.23	-82
1500	.64	169	3.19	63	.09	40	.21	-87
2000	.65	156	2.42	52	.11	42	.21	-97
2500	.65	145	1.95	40	.13	37	.22	-108
3000	.66	135	1.69	29	.15	35	.25	-118
3500	.66	125	1.43	19	.17	32	.27	-127
4000	.68	117	1.34	8	.19	28	.29	-137

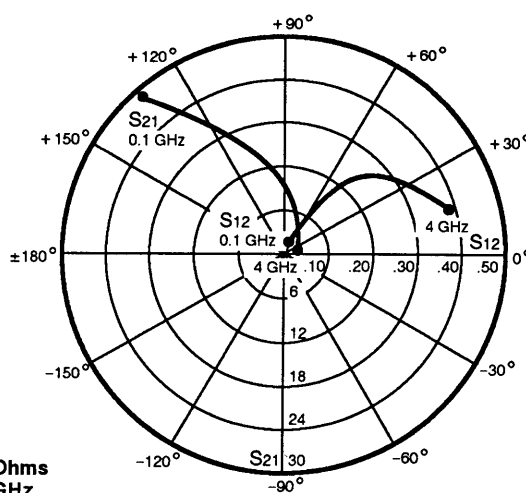
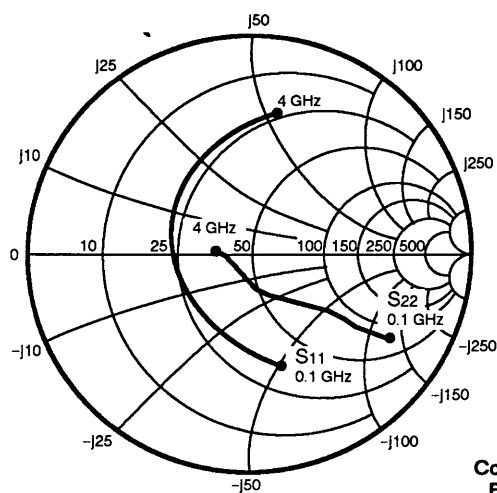
V<sub>CE</sub> = 10 V, I<sub>C</sub> = 20 mA

100	.62	-80	31.13	139	.01	60	.77	-37
500	.64	-163	9.88	93	.04	46	.26	-79
1000	.65	176	5.07	75	.06	49	.16	-95
1500	.64	164	3.45	63	.08	50	.15	-101
2000	.65	154	2.60	52	.11	51	.16	-111
2500	.66	142	2.10	40	.13	43	.18	-121
3000	.66	133	1.81	30	.15	40	.20	-129
3500	.66	122	1.55	20	.17	36	.22	-136
4000	.68	115	1.43	8	.19	31	.25	-144

V<sub>CE</sub> = 10 V, I<sub>C</sub> = 30 mA

100	.58	-95	35.35	134	.01	59	.72	-40
500	.64	-169	10.11	91	.03	50	.22	-82
1000	.65	173	5.15	74	.06	55	.14	-97
1500	.65	162	3.49	62	.08	53	.14	-103
2000	.66	152	2.63	52	.11	54	.15	-112
2500	.66	141	2.10	39	.13	46	.17	-122
3000	.66	132	1.82	29	.15	42	.19	-129
3500	.67	122	1.54	20	.17	38	.22	-137
4000	.68	115	1.44	9	.20	31	.24	-146

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



**NE02137**  
Coordinates in Ohms  
Frequency in GHz  
(VCE = 10 V, IC = 20 mA)

**S-MAGN AND ANGLES:**

VCE = 10 V, IC = 5 mA

FREQUENCY (MHz)

	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
100	.81	-36	13.62	152	.02	72	.92	-17
500	.46	-127	6.36	98	.08	48	.50	-39
1000	.42	-176	3.51	72	.11	48	.38	-46
1500	.43	154	2.43	53	.15	46	.35	-54
2000	.46	133	1.87	39	.19	44	.33	-65
2500	.53	113	1.54	23	.23	37	.24	-86
3000	.58	100	1.33	9	.27	31	.23	-112
3500	.61	88	1.15	-1	.31	23	.21	-144
4000	.65	79	1.04	-16	.35	16	.26	-155

VCE = 10 V, IC = 10 mA

100	.66	-52	21.54	142	.02	72	.83	-24
500	.37	-149	7.49	91	.07	56	.38	-39
1000	.37	170	3.96	69	.11	57	.29	-45
1500	.39	146	2.71	53	.16	52	.27	-53
2000	.43	128	2.08	39	.21	47	.24	-67
2500	.51	109	1.70	24	.25	38	.17	-91
3000	.56	97	1.46	10	.29	30	.15	-123
3500	.60	86	1.25	-0	.32	22	.15	-159
4000	.63	77	1.15	-14	.36	14	.19	-171

VCE = 10 V, IC = 20 mA

100	.51	-73	28.85	131	.01	69	.72	-30
500	.34	-167	8.09	87	.06	64	.31	-36
1000	.36	161	4.18	67	.11	63	.24	-42
1500	.38	140	2.85	52	.17	54	.22	-52
2000	.41	124	2.19	38	.22	50	.20	-66
2500	.50	107	1.78	24	.26	39	.12	-94
3000	.55	96	1.52	11	.30	30	.12	-133
3500	.58	84	1.31	0	.32	22	.12	177
4000	.62	77	1.20	-13	.37	14	.17	179

VCE = 10 V, IC = 30 mA

100	.45	-88	31.67	125	.01	70	.66	-32
500	.33	-174	8.10	85	.06	67	.29	-33
1000	.36	158	4.16	66	.11	64	.24	-40
1500	.39	139	2.84	51	.16	56	.22	-50
2000	.42	123	2.18	38	.22	50	.20	-63
2500	.50	106	1.77	23	.26	39	.12	-91
3000	.55	95	1.51	9	.30	30	.11	-130
3500	.58	85	1.29	0	.32	24	.07	-163
4000	.62	76	1.20	-12	.36	14	.16	-180



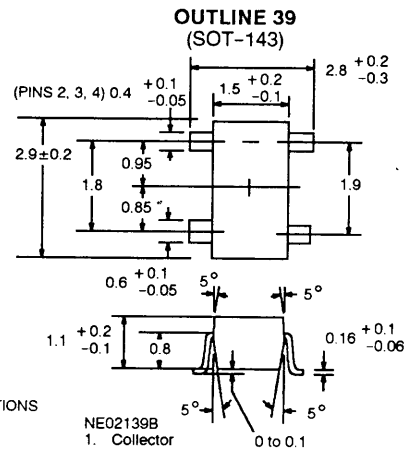
### FEATURES

- **LOW NOISE FIGURE**  
1.5 dB at 1.0 GHz (TYP)
- **HIGH INSERTION GAIN**  
10 dB at 1.0 GHz (TYP)
- **HIGH POWER GAIN**  
14 dB at 1.0 GHz (TYP)
- **HIGH GAIN BANDWIDTH PRODUCT:**  
4.0 GHz (TYP)
- **SURFACE MOUNT COMMON BASE OR COMMON EMITTER PACKAGE**
- **AVAILABLE IN TAPE & REEL AND BULK**
- **HIGH RELIABILITY METALLIZATION**
- **LOW COST**

### DESCRIPTION AND APPLICATIONS

The NE02139 and NE02139B NPN silicon transistors provide an economical solution to a wide range of amplifier and oscillator applications requiring surface mount technologies. The devices feature a low noise figure and high current capability providing wide dynamic ranges. The 4-leaded mini mold package provides superior mechanical stability and is available either individually or on tape & reel in two configurations. The NE02139 has two emitter leads to help reduce emitter inductance and the NE02139B has two base leads making it a superior choice for oscillator applications.

### OUTLINE DIMENSIONS (Units in mm)



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

SYMBOLS	PARAMETERS	UNITS	RATINGS
V <sub>CB0</sub>	Collector to Base Voltage	V	25
V <sub>CE0</sub>	Collector to Emitter Voltage	V	12
V <sub>EB0</sub>	Emitter to Base Voltage	V	3
I <sub>c</sub>	Collector Current	mA	70
P <sub>T</sub>	Total Power Dissipation	mW	200
T <sub>J</sub>	Junction Temperature	°C	150
T <sub>STG</sub>	Storage Temperature	°C	-65 to +150

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

PART NUMBER EIAJ* REGISTERED NUMBER PACKAGE OUTLINE			NE02139 2SC4092 39			NE02139B 2SC4089 39B		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX
I <sub>CB0</sub>	Collector Cutoff Current at V <sub>CB</sub> = 15 V, I <sub>E</sub> = 0	μA			1.0			1.0
I <sub>EB0</sub>	Emitter Cutoff Current at V <sub>EB</sub> = 2 V, I <sub>C</sub> = 0	μA			1.0			1.0
h <sub>FE</sub> **	Forward Current Gain at V <sub>CE</sub> = 10 V, I <sub>C</sub> = 20 mA		40	70	200	40	70	200
V <sub>CE(SAT)</sub>	Collector Saturation Voltage at I <sub>C</sub> = 10 mA, I <sub>B</sub> = 1.0 mA	V					0.09	0.5
f <sub>T</sub>	Gain Bandwidth Product at V <sub>CE</sub> = 10 V, I <sub>E</sub> = 5.0 mA, I <sub>E</sub> = 20 mA	GHz		4 4.5		2.5	4 4.5	
S <sub>21E</sub>   <sup>2</sup>	Insertion Power Gain at V <sub>CE</sub> = 10 V, I <sub>C</sub> = 20 mA, f = 1 GHz	dB	9	10				
MAG	Maximum Available Gain at V <sub>CE</sub> = 10 V, I <sub>C</sub> = 20 mA, F = 1 GHz	dB		14				
NF	Noise Figure at V <sub>CE</sub> = 10 V, I <sub>C</sub> = 20 mA, F = 1 GHz	dB		1.5				
C <sub>OB</sub>	Output Capacitance at F = 1.0 MHz, V <sub>CB</sub> = 10 V, I <sub>E</sub> = 0	pF					0.95	
C <sub>C</sub> *R <sub>B</sub> 'B	Collector to Base Time Constant at F = 31.9 MHz, V <sub>CE</sub> = 10 V, I <sub>E</sub> = 50 mA	pS					4	
R <sub>TH</sub>	Thermal Resistance (Junction-to-Ambient)	°C/W			500			500

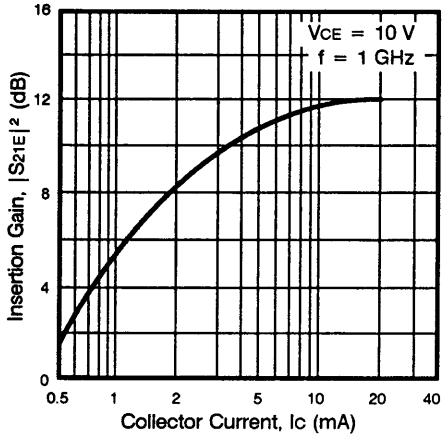
\*Electronic Industrial Association of Japan

\*\*h<sub>FE</sub> Classification

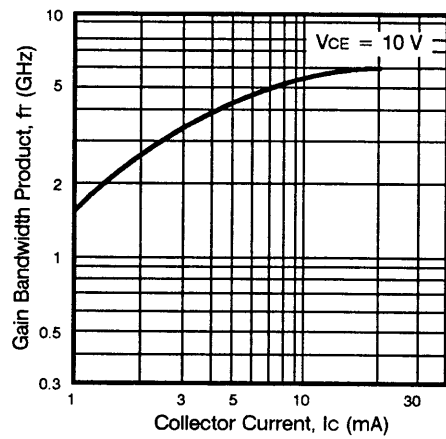
MARKING	R4	R5
HFE	49 to 120	100 to 200

TYPICAL PERFORMANCE CHARACTERISTICS (TA = 25°C)

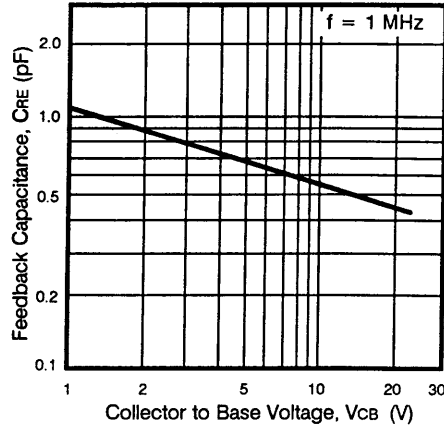
INSERTION GAIN vs. COLLECTOR CURRENT



GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



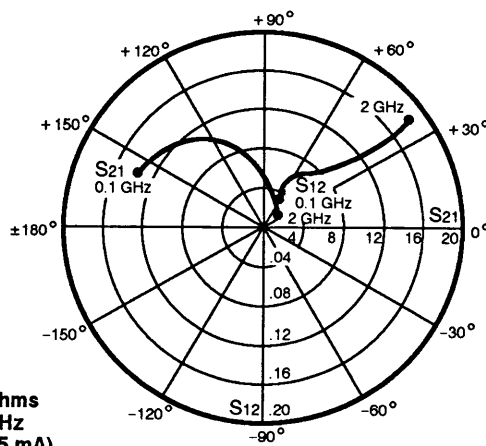
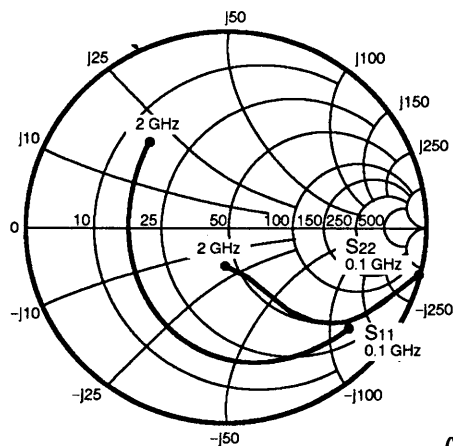
FEEDBACK CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



2



TYPICAL COMMON EMITTER SCATTERING PARAMETERS



**NE02139**  
Coordinates in Ohms  
Frequency in GHz  
(VCE = 10 V, IC = 5 mA)

**S-MAGN AND ANGLES:**

VCE = 10 V, IC = 5 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
100	.78	-39	13.96	156	.027	63	.91	-21
200	.71	-74	11.81	131	.058	62	.77	-36
400	.57	-114	7.51	107	.081	42	.54	-50
600	.50	-143	5.68	93	.093	39	.42	-56
800	.49	-164	4.16	72	.104	37	.35	-59
1000	.49	-180	3.50	81	.117	37	.30	-63
1200	.51	168	2.83	55	.129	37	.27	-66
1400	.52	160	2.59	63	.144	36	.25	-73
1600	.53	150	2.19	49	.155	38	.22	-79
1800	.53	142	2.09	42	.173	36	.21	-88
2000	.56	135	1.79	36	.181	36	.19	-98

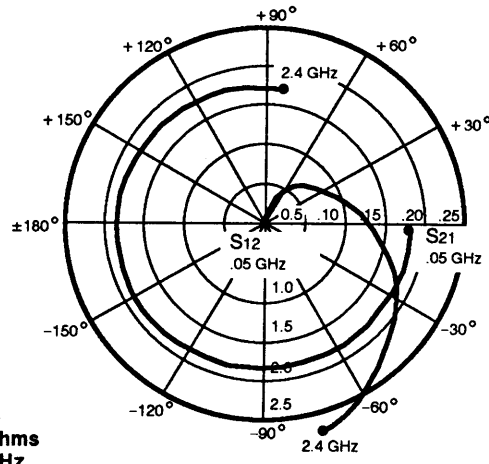
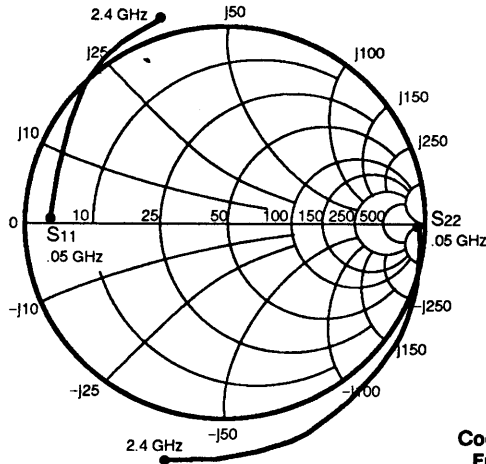
VCE = 10 V, IC = 10 mA

100	.63	-58	20.38	145	.025	58	.81	-31
200	.56	-98	15.27	119	.039	60	.61	-45
400	.47	-139	8.90	98	.062	44	.39	-57
600	.45	-164	6.48	87	.073	50	.30	-60
800	.45	180	4.66	76	.091	49	.25	-63
1000	.47	168	3.89	69	.109	50	.21	-68
1200	.48	157	3.13	61	.126	48	.18	-71
1400	.50	152	2.86	54	.143	44	.17	-80
1600	.51	143	2.41	48	.160	46	.14	-88
1800	.52	136	2.30	42	.181	42	.14	-99
2000	.54	130	1.97	36	.191	41	.12	-113

VCE = 10 V, IC = 20 mA

100	.53	-82	25.86	136	.021	35	.72	-41
200	.47	-121	17.23	110	.033	61	.48	-51
400	.43	-157	9.44	92	.051	50	.30	-58
600	.44	-177	6.74	83	.069	57	.23	-60
800	.45	170	4.82	74	.090	55	.20	-61
1000	.46	161	4.01	67	.107	54	.16	-66
1200	.48	152	3.23	39	.127	54	.14	-71
1400	.50	147	2.95	53	.149	50	.13	-80
1600	.51	139	2.48	47	.164	50	.10	-91
1800	.52	133	2.36	41	.187	45	.10	-104
2000	.55	127	2.02	36	.197	44	.09	-121

TYPICAL COMMON BASE SCATTERING PARAMETERS



NE02139B  
Coordinates in Ohms  
Frequency in GHz  
(V<sub>cb</sub> = 10 V, I<sub>c</sub> = 10 mA)

S-MAGN AND ANGLES:  
VCB = 10 V, IC = 5 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
50	.78	178	1.77	-6	.001	69	.99	-2
100	.78	177	1.77	-11	.002	80	1.00	-3
200	.78	174	1.77	-22	.005	85	1.00	-6
300	.79	171	1.77	-33	.008	85	1.00	-10
400	.79	168	1.77	-44	.012	84	1.01	-13
500	.79	165	1.77	-55	.016	81	1.01	-16
600	.80	162	1.77	-66	.020	77	1.02	-20
700	.81	159	1.77	-77	.026	72	1.03	-23
800	.82	156	1.77	-88	.033	66	1.04	-27
900	.83	153	1.78	-100	.040	60	1.04	-30
1000	.84	150	1.78	-111	.048	53	1.06	-34
1100	.86	147	1.78	-123	.058	45	1.07	-38
1200	.87	144	1.78	-134	.068	38	1.08	-42
1300	.89	141	1.78	-146	.079	29	1.10	-46
1400	.90	138	1.78	-158	.092	21	1.11	-51
1500	.92	135	1.78	-170	.106	12	1.13	-55
1600	.94	132	1.77	178	.120	3	1.14	-60
1700	.96	129	1.77	166	.136	-6	1.16	-65
1800	.97	125	1.76	153	.153	-16	1.18	-70
1900	.99	122	1.74	140	.171	-26	1.19	-76
2000	1.00	119	1.72	128	.189	-36	1.21	-81
2100	1.02	116	1.70	115	.209	-46	1.23	-87
2200	1.03	112	1.67	101	.228	-57	1.24	-93
2300	1.04	109	1.64	88	.248	-68	1.25	-99
2400	1.04	106	1.60	74	.268	-78	1.26	-105

VCB = 10 V, IC = 10 mA

50	.87	178	1.85	-5	.001	64	.99	-2
100	.87	177	1.85	-11	.002	81	1.00	-3
200	.87	174	1.85	-22	.004	92	1.00	-6
300	.87	171	1.85	-32	.006	97	1.00	-10
400	.88	168	1.85	-43	.009	96	1.01	-13
500	.88	165	1.85	-54	.014	93	1.01	-16
600	.88	161	1.85	-65	.019	88	1.02	-19
700	.90	159	1.86	-76	.025	83	1.02	-23
800	.90	156	1.86	-87	.031	76	1.03	-26
900	.92	153	1.86	-98	.039	69	1.04	-30
1000	.93	150	1.86	-109	.048	62	1.05	-34
1100	.94	147	1.86	-120	.058	53	1.07	-38
1200	.95	144	1.87	-131	.069	45	1.08	-42
1300	.97	141	1.87	-143	.081	36	1.09	-46
1400	.99	138	1.87	-154	.094	27	1.11	-50
1500	1.00	135	1.87	-166	.108	18	1.12	-55
1600	1.02	132	1.86	-178	.124	8	1.14	-59
1700	1.04	129	1.86	170	.140	-2	1.16	-64
1800	1.06	126	1.85	158	.158	-12	1.17	-69
1900	1.07	123	1.84	146	.176	-22	1.19	-74
2000	1.09	120	1.82	133	.196	-32	1.21	-80
2100	1.10	117	1.81	121	.216	-43	1.22	-85
2200	1.12	113	1.78	108	.236	-53	1.24	-91
2300	1.13	110	1.75	95	.257	-64	1.25	-97
2400	1.14	106	1.72	82	.278	-75	1.26	-103

