NEC®

NPN MEDIUM POWER MICROWAVE TRANSISTOR | NE568 SERIES

FEATURES

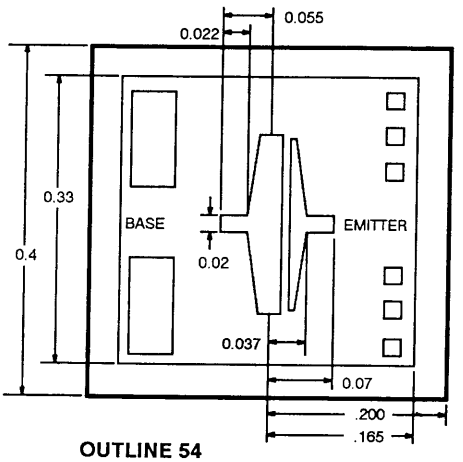
- **HIGH fs:** 4.2 GHz
- **HIGH MAXIMUM AVAILABLE GAIN:** 14 dB at 2 GHz
- **HIGH OSCILLATOR POWER OUTPUT:**
  – 200 mW at 6 GHz
- **HIGH RELIABILITY**
- **ADVANCED SET TECHNOLOGY**

DESCRIPTION AND APPLICATIONS

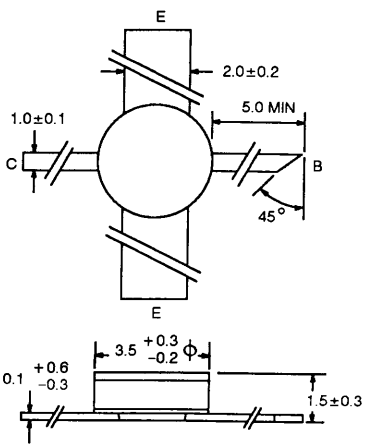
The NE568 series of NPN silicon medium power transistors is designed for medium power S and C band linear amplifiers and oscillators up to 6 GHz. The series takes advantage of NEC's advanced Stepped Electrode Transistor (SET) technology. SET devices provide excellent performance with unusually high reliability because they normally operate at low junction temperatures. The NE568 is available in a variety of package styles to suit your design needs. The transistor is also available in chip form (NE56800).

OUTLINE DIMENSIONS (Units in mm)

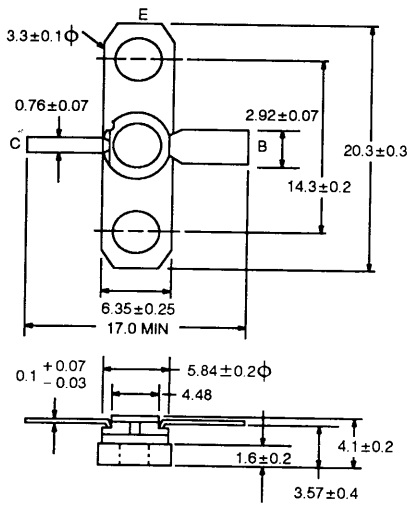
NE56800 (CHIP)
(Chip Thickness: 110 to 160 µm)



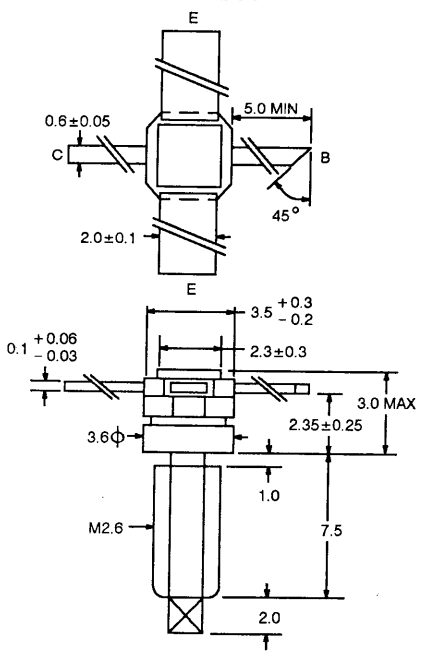
OUTLINE 03



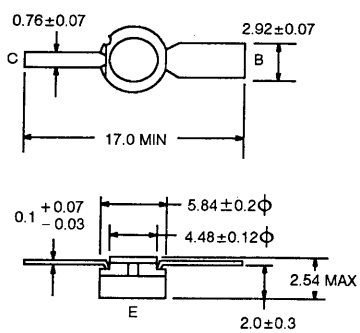
OUTLINE 53E/B*



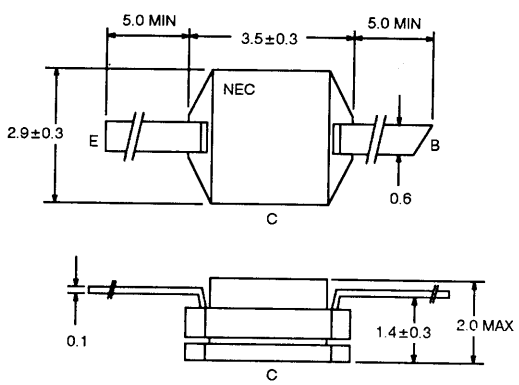
OUTLINE 54



OUTLINE 57E



OUTLINE 87



PERFORMANCE SPECIFICATIONS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE56800 00 (CHIP)			NE56803 03			NE56853 2SC2340 53			NE56854 2SC2339 54			NE56857 57			NE56887 87		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
fs	Frequency where $\|S_{21}\|^2$ = 0 dB	GHz	4	4.2		4	4.2		4	4.2		4	4.2		4	4.2		4	4.2	
$\|S_{21E}\|^2$	Insertion Gain at V_{CE} = 10 V, I_C = 80 mA, f = 2 GHz	dB		6	7.5					7			5.5	7.5		7				
P_{OSC}	Oscillator Power Output at V_{CE} = 10 V, I_C = 80 mA, f = 6 GHz	mW																	200	
MAG	Maximum Available Gain[3] at V_{CE} = 10 V, I_C = 80 mA, f = 2 GHz	dB	12	14.5		12	14		12	14		12	14		12	14				
P_{1dB}	Output Power at the 1 dB Compression Point at V_{CE} = 10 V, I_C = 80 mA, f = 2 GHz f = 4 GHz	 mW mW		 320 255			310			310			 310 250			310				
G_P	Power Gain at V_{CE} = 10 V, I_C = 80 mA, f = 2 GHz f = 4 GHz	 dB dB		 12 6									 11.5 5.5							

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE56800 00 (CHIP)			NE56803 03			NE56853 2SC2340 53			NE56854 2SC2339 54			NE56857 57			NE56887 87		
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			5			5			5			5			5			5
I_{EBO}	Emitter Cutoff Current at V_{EB} = 1 V, I_C = 0	µA			5			5			5			5			5			5
h_{FE}	Forward Current Gain at V_{CE} = 10 V, I_C = 80 mA		20	60	160	20	60	160	20	60	160	20	60	160	20	60	160	20	60	160
C_{OB}	Output Capacitance[2] at V_{CB} = 10 V, I_E = 0, f = 1 MHz	pF		0.55	0.80		0.55	0.80		0.55	0.80		0.55	0.80		0.55	0.80		0.55	0.80
R_{TH}	Thermal Resistance (Junction-to-Case)	°C/W			25			60			28			28[4]						
P_T	Total Power Dissipation (T_C = 25°C)	W			1.5			1.5			1.5			1.5			1.5			1.5

Notes:

1. Electronic Industrial Association of Japan.
2. Emitter is grounded.
3. Maximum Available Gain (MAG) is calculated from the device S-Parameters using the equation,

$$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right) \quad K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}|\,|S_{21}|} \quad \Delta = S_{11}S_{22} - S_{21}S_{12}$$

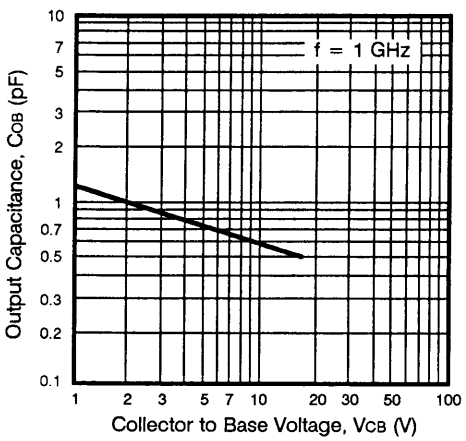
4. $R_{TH\,(J\text{-}C)}$ for the NE56854 is 240°C/W.

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

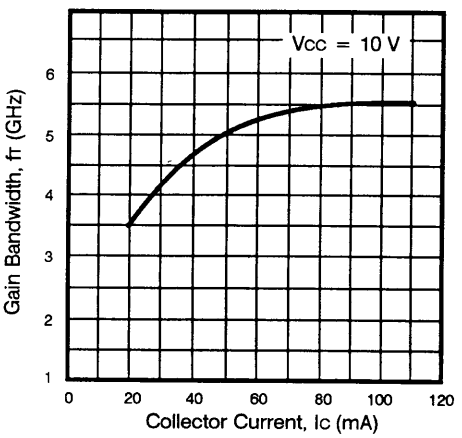
SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	25
V_{CEO}	Collector to Emitter Voltage	V	15
V_{EBO}	Emitter to Base Voltage	V	1.5
I_C	Collector Current	mA	150
T_J	Junction Temperature	°C	200
T_{STG}	Storage Temperature	°C	-65 to +200

TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

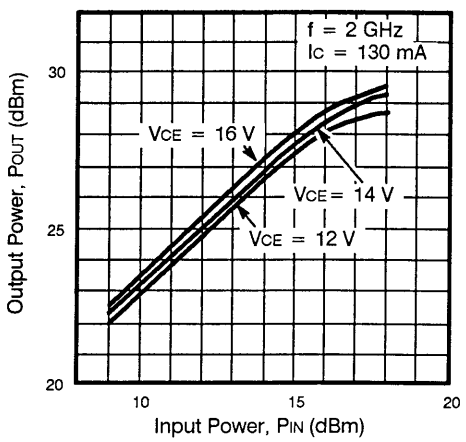
TYPICAL OUTPUT CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



NE56800 GAIN BANDWIDTH vs. COLLECTOR CURRENT

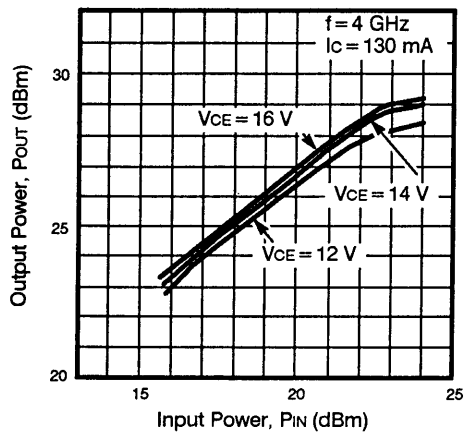


NE56853 OUTPUT POWER vs. INPUT POWER

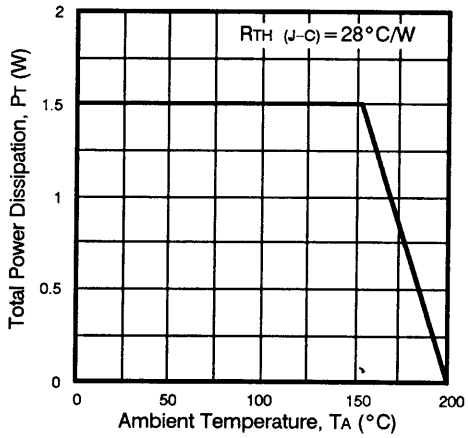


TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

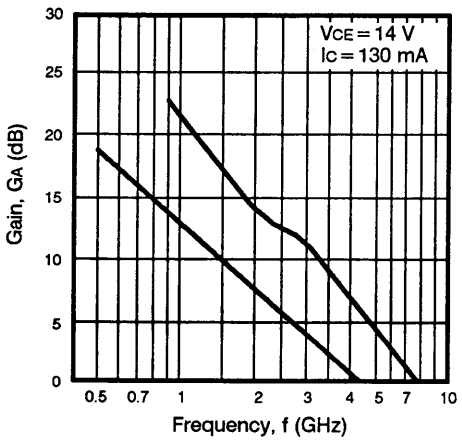
NE56853
OUTPUT POWER vs. INPUT POWER



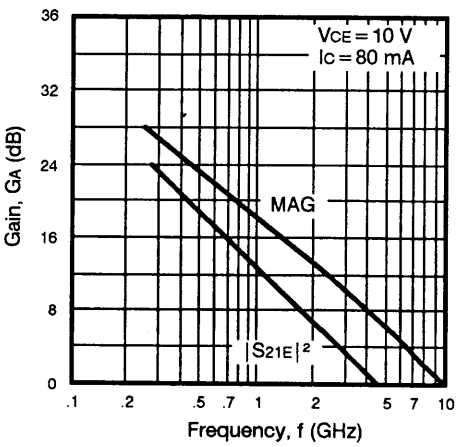
NE56854
POWER DERATING CURVE



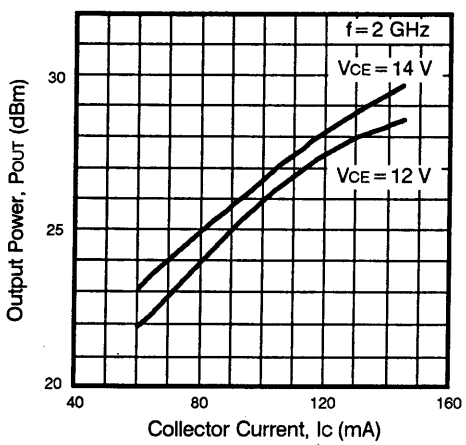
NE56853
INSERTION GAIN AND MAXIMUM AVAILABLE GAIN vs. FREQUENCY



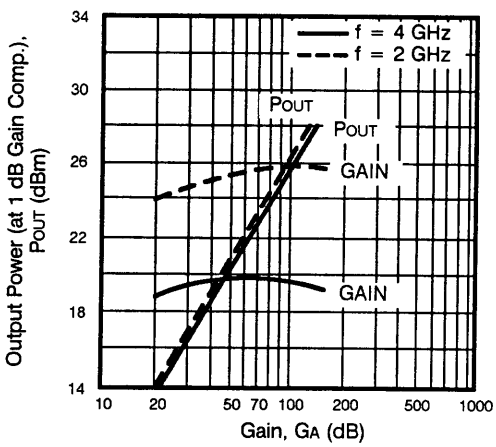
NE56854
INSERTION GAIN AND MAXIMUM AVAILABLE GAIN vs. FREQUENCY



NE56853
OUTPUT POWER AT 1 dB COMPRESSION POINT vs. COLLECTOR CURRENT

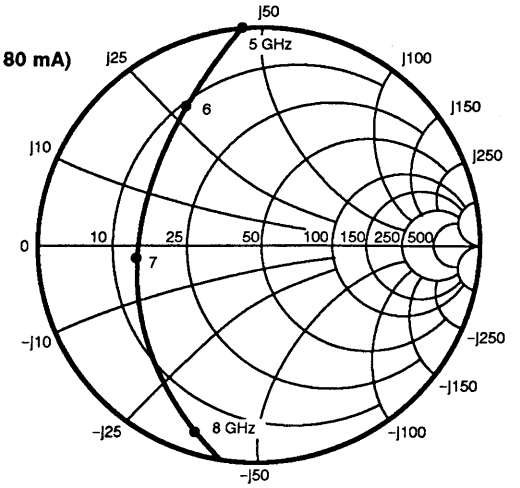


NE56854
OUTPUT POWER AT THE 1 dB COMPRESSION POINT AND GAIN vs. COLLECTOR CURRENT



NEGATIVE RESISTANCE CHARACTERISTICS

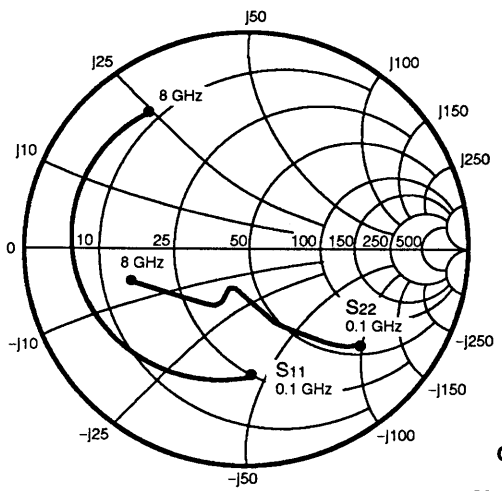
NE56800
(1/ΓPL0T)* (VCE = 10 V, IC = 80 mA)

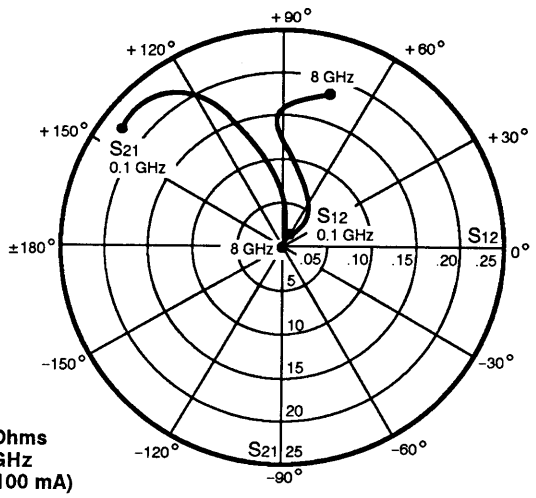


*Negative Resistance Characteristics are calculated by using the following formula:

$$\Gamma = S_{11} + \frac{S_{12}\,S_{21}\,\Gamma_L}{1 - S_{22}\,\Gamma_L}$$, L = Load condition of the Output Terminal

TYPICAL COMMON EMITTER SCATTERING PARAMETERS





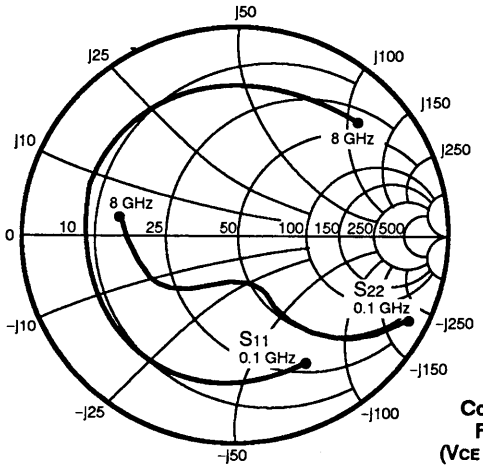
NE56800
Coordinates in Ohms
Frequency in GHz
(VCE = 10 V, IC = 100 mA)

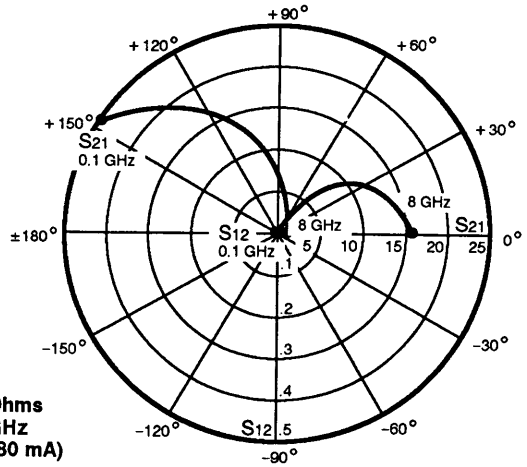
S-MAGN AND ANGLES:

VCE = 10 V, IC = 100 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
100	.60	-85	22	142	.020	58	.77	-40
200	.67	-126	22	123	.030	42	.53	-63
300	.72	-143	16	112	.036	39	.40	-78
400	.74	-154	13	105	.037	38	.33	-86
500	.74	-162	10	103	.039	38	.28	-92
600	.74	-167	8	99	.040	42	.25	-97
700	.73	-170	7	96	.042	44	.23	-101
800	.73	-175	6	94	.043	46	.22	-105
900	.74	-178	6	93	.047	48	.22	-110
1000	.76	-180	5	91	.050	52	.22	-111
2000	.75	173	3	88	.067	74	.25	-115
3000	.76	168	2	78	.093	83	.29	-118
4000	.77	160	1	67	.122	86	.37	-119
5000	.79	147	1	58	.138	87	.37	-123
6000	.78	140	1	53	.164	90	.38	-139
7000	.77	132	1	42	.174	80	.43	-144
8000	.77	125	1	38	.180	76	.52	-163

TYPICAL COMMON EMITTER SCATTERING PARAMETERS



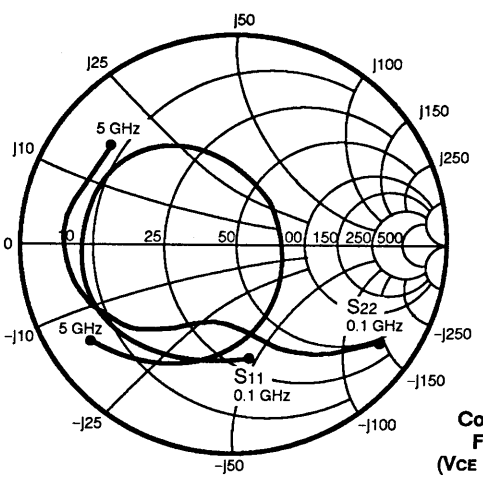


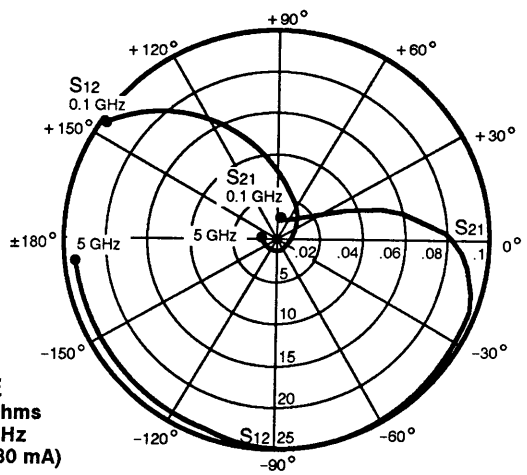
NE56803
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 10 V, I_C = 80 mA)

S-MAGN AND ANGLES:

V_{CE} = 10 V, I_C = 80 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	.71	-60	24.33	148	.007	61	.90	-27
200	.73	-104	18.96	125	.019	49	.68	-47
300	.69	-127	13.93	113	.028	39	.52	-56
400	.71	-142	11.28	103	.030	34	.44	-62
500	.71	-153	9.12	97	.036	34	.35	-65
600	.71	-160	7.88	93	.038	34	.33	-66
700	.73	-167	6.74	89	.039	35	.28	-72
800	.71	-173	6.03	84	.041	35	.27	-70
900	.73	-176	5.20	81	.040	37	.24	-78
1000	.73	178	4.84	77	.049	36	.23	-77
2000	.71	158	2.52	53	.089	46	.23	-99
3000	.73	136	1.72	31	.123	47	.30	-113
4000	.74	118	1.31	12	.163	43	.35	-128
5000	.74	98	1.10	-4	.212	36	.41	-141
6000	.74	79	.88	-20	.252	24	.46	-158
7000	.78	59	.77	-35	.295	14	.49	-172
8000	.80	43	.66	-44	.326	2	.54	173





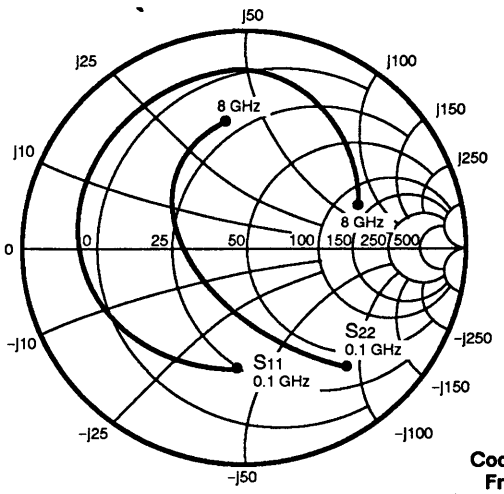
NE56853E
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 10 V, I_C = 80 mA)

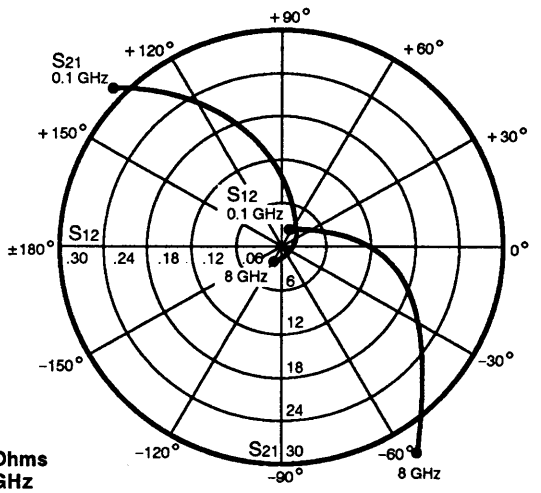
S-MAGN AND ANGLES:

V_{CE} = 10 V, I_C = 80 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	.56	-78	23.66	144	.012	63	.85	-33
200	.62	-121	17.46	121	.017	36	.66	-54
300	.68	-140	13.22	105	.030	36	.54	-69
400	.70	-154	10.57	97	.031	25	.46	-78
500	.71	-162	8.60	88	.041	25	.41	-84
600	.72	-169	7.34	81	.032	21	.40	-90
700	.71	-175	6.35	75	.043	22	.38	-93
800	.72	-179	5.62	71	.036	18	.39	-98
900	.71	176	5.03	65	.044	19	.39	-102
1000	.71	174	4.56	61	.043	18	.39	-104
2000	.60	138	2.53	15	.071	8	.51	-124
3000	.35	77	1.97	-33	.101	-21	.67	-145
4000	.43	-77	1.33	-98	.106	-87	.76	-179
5000	.80	-144	.67	-162	.092	-171	.71	142

TYPICAL COMMON EMITTER SCATTERING PARAMETERS





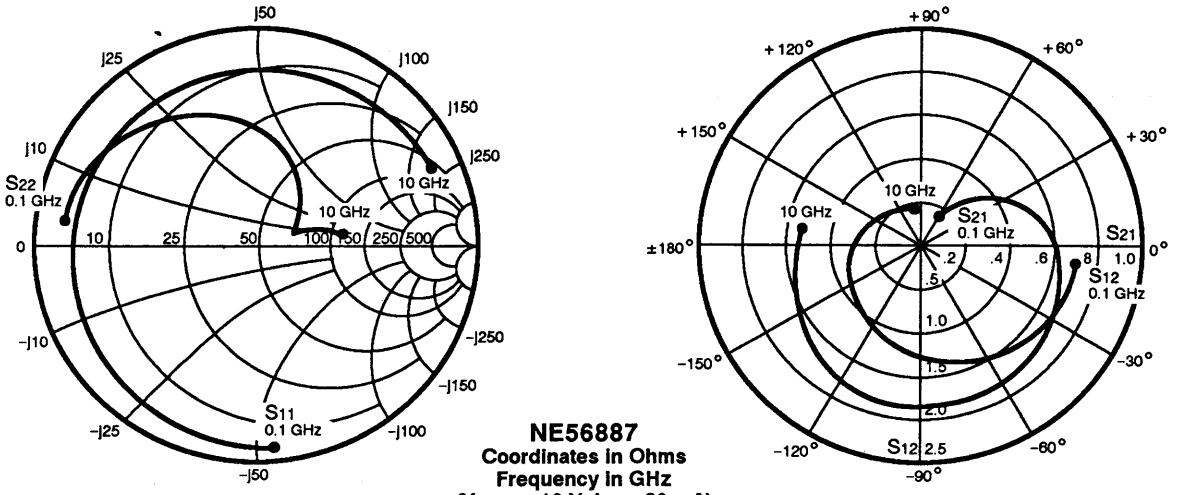
NE56854
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 10 V, I_C = 100 mA)

S-MAGN AND ANGLES:

V_{CE} = 10 V, I_C = 100 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	.59	-95	32.62	136	.022	44	.73	-49
200	.66	-133	21.60	115	.031	35	.47	-75
300	.70	-151	15.40	105	.035	30	.36	-95
400	.69	-163	11.80	94	.037	30	.30	-108
500	.71	-171	9.64	90	.040	28	.26	-117
600	.74	-178	8.00	84	.043	28	.24	-126
700	.77	178	6.97	80	.044	26	.23	-136
800	.74	175	6.08	75	.046	28	.22	-142
900	.72	168	5.34	73	.046	29	.20	-149
1000	.74	164	4.78	68	.048	29	.20	-156
1500	.78	148	3.15	51	.059	27	.23	-179
2000	.80	134	2.38	36	.071	25	.27	163
2500	.81	125	1.84	21	.095	20	.32	153
3000	.84	116	1.51	8	.092	11	.36	144
3500	.84	108	1.27	-4	.102	8	.42	137
4000	.88	100	1.12	-16	.119	2	.48	130
4500	.83	94	.90	-27	.114	-4	.51	125
5000	.85	86	.82	-37	.127	-10	.56	118
5500	.81	78	.73	-46	.135	-17	.57	113
6000	.79	72	.63	-52	.127	-18	.55	106
6500	.78	67	.69	-56	.192	-17	.58	113
7000	.75	56	.67	-70	.216	-30	.61	107
7500	.70	44	.67	-79	.258	-42	.61	102
8000	.59	24	.68	-93	.343	-58	.61	98

TYPICAL COMMON COLLECTOR SCATTERING PARAMETERS



NE56887
Coordinates in Ohms
Frequency in GHz
(VEC = -10 V, IC = 80 mA)

S-MAGN AND ANGLES:

VEC = -10 V, IC = 80 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
100	.97	-6	1.82	-7	.039	39	.86	172
200	.96	-9	1.86	-9	.063	52	.87	170
300	.97	-13	1.87	-13	.090	56	.86	163
400	.97	-18	1.83	-15	.118	57	.85	161
500	.96	-23	1.81	-20	.147	59	.85	158
600	1.00	-26	1.88	-21	.172	55	.84	153
700	.97	-30	1.83	-25	.202	53	.82	152
800	.96	-35	1.82	-28	.223	54	.83	149
900	.97	-39	1.83	-31	.248	48	.81	143
1000	.97	-43	1.78	-33	.283	47	.80	141
1100	.98	-47	1.77	-37	.305	45	.80	138
1200	.96	-53	1.77	-39	.327	41	.77	134
1300	.97	-56	1.74	-42	.350	38	.78	133
1400	.98	-60	1.75	-45	.370	35	.76	129
1500	.97	-65	1.73	-46	.393	32	.74	124
1600	.96	-69	1.68	-52	.419	28	.75	123
1700	.95	-73	1.69	-54	.433	28	.73	120
1800	.93	-76	1.68	-56	.450	23	.72	118
1900	.95	-80	1.65	-57	.470	20	.71	114
2000	.92	-84	1.59	-57	.489	22	.70	118
3000	.88	-119	1.39	-83	.634	-6	.57	88
4000	.87	-151	1.22	-104	.703	-35	.42	62
5000	.85	179	1.07	-127	.735	-60	.32	40
6000	.83	150	.92	-148	.734	-85	.21	22
7000	.83	118	.79	-171	.715	-106	.18	17
8000	.85	88	.69	164	.691	-134	.18	19
9000	.85	53	.54	139	.609	-159	.27	19
10000	.88	27	.43	115	.543	175	.38	11

NEC®

NPN MEDIUM POWER MICROWAVE TRANSISTOR

NE56900
NE56953E
NE56954
NE56987

FEATURES

- **AMPLIFIER PERFORMANCE:**
  550 mW with 11.5 dB Gain at 2 GHz
  425 mW with 7.5 dB Gain at 4 GHz
- **HIGH OSCILLATOR POWER OUTPUT:**
  500 mW at 2 GHz
  300 mW at 6 GHz
- **LOW DISTORTION**
- **12 VOLT OPERATION**
- **HIGH RELIABILITY**
- **HERMETIC PACKAGES**

DESCRIPTION AND APPLICATIONS

The NE569 NPN silicon transistor is designed for medium power linear amplifiers and oscillators up to 8 GHz.

Ideal for medium power applications, the NE569 is available in three package styles. The NE56987 is a common-collector stripline package for oscillator applications. The NE56953E and NE56954 are designed for medium power Class A amplifiers. The transistor is also available in chip form.

Designed with NEC's advanced Stepped Electrode Transistor Technology (SET), the NE569 provides superior performance and unusually high reliability.

The NE569 transistor is suitable for military, industrial and hi-rel applications and offers the engineer the very best in quality, performance and reliability.

PERFORMANCE CHARACTERISTICS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE56900 00 (CHIP)			NE56953E 2SC2340 53			NE56954 54			NE56987 87		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
f_S	Frequency where $\|S_{21E}\|^2$ = 0 dB	GHz		4.5			4.5			4.5			4.5	
$\|S_{21E}\|^2$	Insertion Gain at V_{CE} = 14 V, I_C = 130 mA, f = 2 GHz	dB		6.5			6.5			6.5				
P_{OSC}	Oscillator Output Power at V_{CE} = 14 V, I_C = 130 mA f = 6 GHz	mW											300	
MAG	Maximum Available Gain[2] at V_{CE} = 14 V, I_C = 130 mA f = 2 GHz	dB		16.5			16.5			16.5				
P_{OUT}	Output Power at V_{CE} = 14 V, I_C = 130 mA P_{IN} = 16 dBm, f = 2 GHz	dB	27	28		27	28		27	28				
G_L	Linear Gain at V_{CE} = 14 V, I_C = 130 mA f = 2 GHz	dB		13			13			13				

Notes:

1. Electronic Industrial Association of Japan.
2. Maximum Available Gain (MAG) is calculated from the device S-Parameters using the equation,

$$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right) \qquad K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}|\,|S_{21}|} \qquad \Delta = S_{11}S_{22} - S_{21}S_{12}$$

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE56900 00 (CHIP)			NE56953E 2SC2340 53			NE56954 54			NE56987 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} = 10 V, I_E = 0	μA			5			5			5			5
I_{EBO}	Emitter Cutoff Current at V_{EB} = 1 V, I_C = 0	μA			10			10			10			10
h_{FE}	Forward Current Gain at V_{CE} = 10 V, I_C = 140 mA		20	50	150	20	50	150	20	50	150	20	50	150
C_{OB}	Output Capacitance[2] at V_{CB} = 10 V, I_E = 0, f = 1 MHz	pF		1.5			1.5			1.5			1.5	
R_{TH}	Thermal Resistance (Junction-to-Case)	°C/W			16			20			20			19
P_T	Total Power Dissipation	W			6			6			6			6

Note:
1. Electronic Industrial Association of Japan.
2. Emitter is grounded.

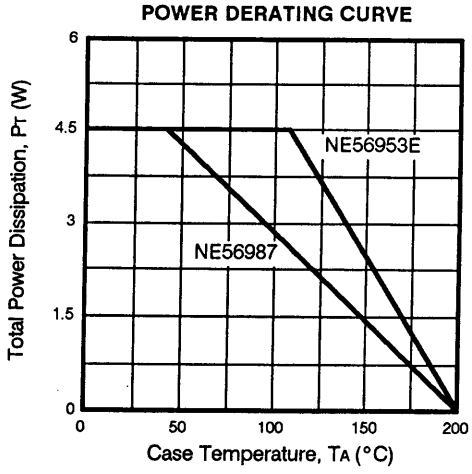
ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	30
V_{CEO}*	Collector to Emitter Voltage	V	20
V_{EBO}	Emitter to Base Voltage	V	1.5
I_C	Collector Current	mA	300
T_J	Junction Temperature	°C	200
T_{STG}	Storage Temperature	°C	-65 to +200

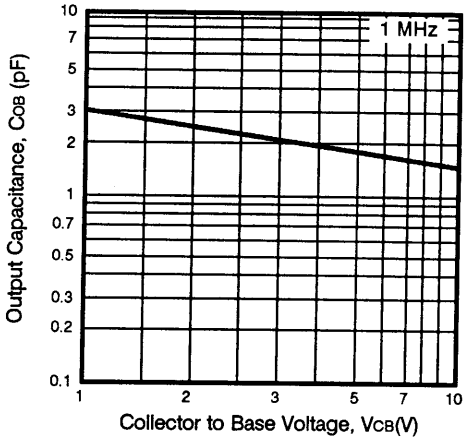
*Minimum V_{CER} = 25 V for $R_{EB} \leq 300\ \Omega$

TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

POWER DERATING CURVE

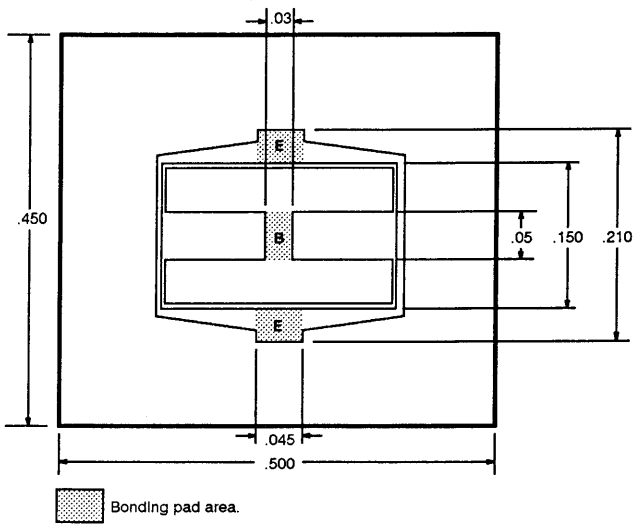


OUTPUT CAPACITANCE vs.
COLLECTOR TO BASE VOLTAGE

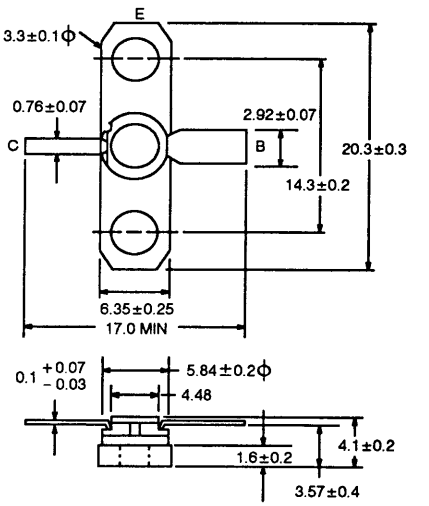


OUTLINE DIMENSIONS (Units in mm)

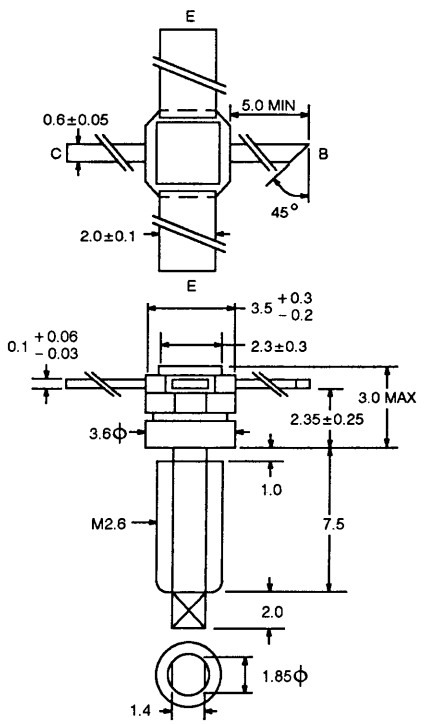
NE56900 (CHIP)
(Units in µm)



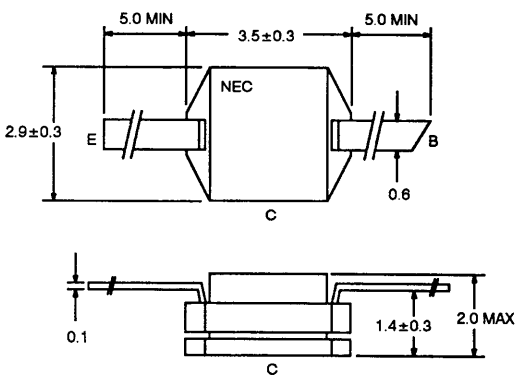
OUTLINE 53



OUTLINE 54

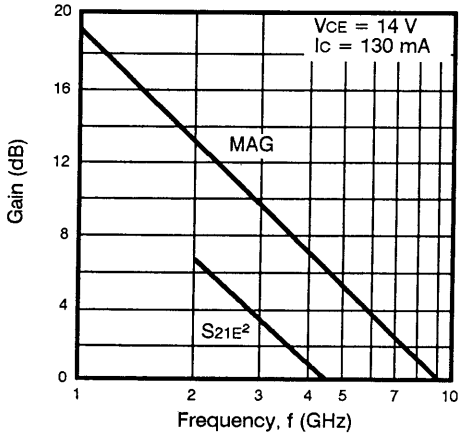


OUTLINE 87

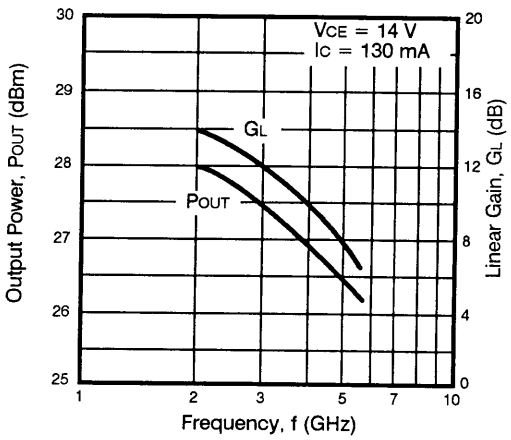


TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

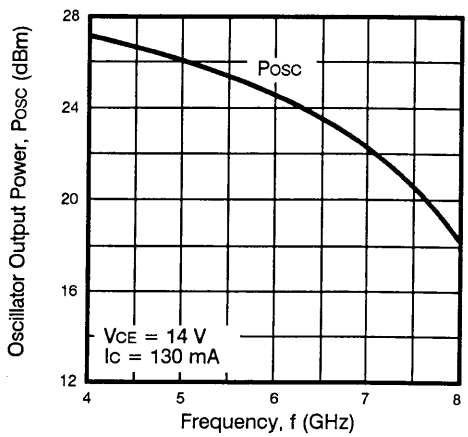
NE56953
INSERTION GAIN AND MAXIMUM AVAILABLE GAIN vs. FREQUENCY



NE56953
OUTPUT POWER AND LINEAR GAIN vs. FREQUENCY

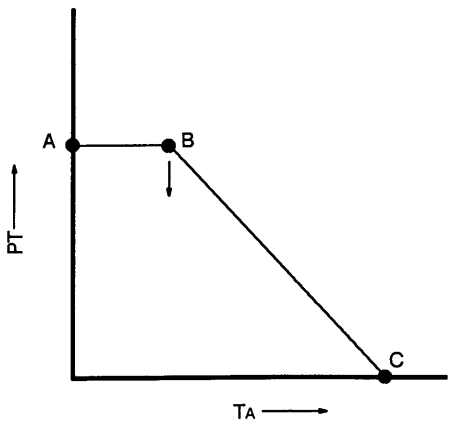


NE56987
OSCILLATOR OUTPUT POWER vs. FREQUENCY



2

DERATING CURVE VALUES



PRODUCT	A	B	C
56900	6 W	104°C	200°C
56953	6 W	80°C	200°C
56987	6 W	86°C	200°C
56954	6 W	80°C	200°C

S-MAGN AND ANGLES:
VCE = 14 V IC = 130 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	.79	-142	36	116	.02	36	.48	-81
200	.85	-162	19	100	.02	29	.30	-109
500	.87	-178	7	84	.02	36	.22	-140
1000	.86	173	4	70	.04	51	.22	-150
2000	.87	160	2	46	.06	58	.29	-155
3000	.86	150	2	25	.09	56	.38	-164
4000	.87	138	1	7	.12	49	.47	-174
5000	.86	127	1	-9	.15	41	.55	174