NEC®

NPN SILICON HIGH SPEED SWITCHING TRANSISTOR

NE98100
NE98108
NE98141

FEATURES

- **HIGH GAIN BANDWIDTH PRODUCT:** f_T = 7 GHz
- **LOW OUTPUT CAPACITANCE:** C_{CB} = 0.35 pF
- **ULTRA HIGH SPEED SWITCHING:** T_X = 0.4 ηs
- **AVAILABLE IN BOTH SINGLE AND DUAL CHIP CONFIGURATIONS**
- **HIGHLY RELIABLE METALLIZATION AND RUGGED METAL-CERAMIC STRIPLINE PACKAGES**

DESCRIPTION AND APPLICATIONS

The NE981 series of NPN silicon transistors is designed for microwave amplifiers up to 6 GHz and ultrahigh speed switching applications. The series is available in chip form and two packaged versions. The NE98108 is a single chip packaged in a metal-ceramic stripline, and the NE98141 is a dual chip package designed for differential amplifiers and CML circuit applications. Both configurations are screened to NEC's Grade C level of reliability which is patterned after MIL-S-19500, and meets or exceeds most of the QC requirements for military applications. The series employs NEC's unique Pt/Si-Ti-Pt-Au hi-rel metallization system which yields the utmost in performance consistency and reliability.

PERFORMANCE SPECIFICATIONS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE98108 2SC1656 (Grd C) 08			NE98141 2SC1658 (Grd C) 41		
SYMBOLS	**PARAMETERS AND CONDITIONS**	**UNITS**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**
f_T	Gain Bandwidth Product at V_{CE} = 5 V, I_C = 20 mA	GHz	6	7		6	7	
$\lvert S_{21E}\rvert^2$	Insertion Power Gain at V_{CE} = 6 V, I_C = 10 mA, f = 0.5 GHz f = 1 GHz f = 2 GHz	 dB dB dB		 19 14 9			 19 14 9	
NF_{MIN}	Minimum Noise Figure at V_{CE} = 6 V, I_C = 5 mA, f = 0.5 GHz	dB		3			3	
T_X	Switching Time[2] at V_{CE} = 6 V, I_C = 10 mA	ηs		0.4			0.4	
MAG	Maximum Available Gain[3] at V_{CE} = 6 V, I_C = 10 mA, f = 0.5 GHz f = 1 GHz f = 2 GHz	 dB dB dB		 21 16 10			 21 16 10	
P_{OSC}	Oscillator Power Output at V_{CE} = 6 V, I_C = 20 mA, f = 7 GHz	mW		10				

Notes:

1. Electronic Industrial Association of Japan.
2. Measured in an ECL circuit.
3. Maximum Available Gain (MAG) is calculated from the device S-Parameters using the equation, $MAG = |S_{21E}|^2 \cdot \frac{1}{1-|S_{11E}|^2} \cdot \frac{1}{1-|S_{22E}|^2}$

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE98108 2SC1656 (Grd C) 08			NE98141 2SC1658 (Grd C) 41		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX
I_{CBO}	Collector Cutoff Current at V_{CB} = 10 V, I_E = 0	µA			0.1			0.1
I_{EBO}	Emitter Cutoff Current at V_{EB} = 2 V, I_C = 0	µA			0.1			0.1
h_{FE}	Forward Current Gain[2] at V_{CE} = 3 V, I_C = 10 mA		30	100	300	30	100	300
$\frac{h_{FE1}}{h_{FE2}}$	Forward Current Gain Delta[3] at V_{CE} = 3 V, I_C = 10 mA					0.6		1
V_{BE}	Base to Emitter Voltage V_{CE} = 3 V, I_C = 10 mA	V			0.95			0.95
ΔV_{BE}	Base to Emitter Voltage Delta V_{CE} = 3 V, I_C = 10 mA	mV						20
C_{CB}	Collector to Base Capacitance[4] at V_{CB} = 6 V, I_E = 0, f = 1 MHz	pF		0.35	0.5		0.35	0.5
R_{TH}	Thermal Resistance (Junction-to-Case)	°C/W			110			110
P_T	Total Power Dissipation Per Device	mW/Unit						150
P_T	Total Device Dissipation	mW			150			300

Notes:

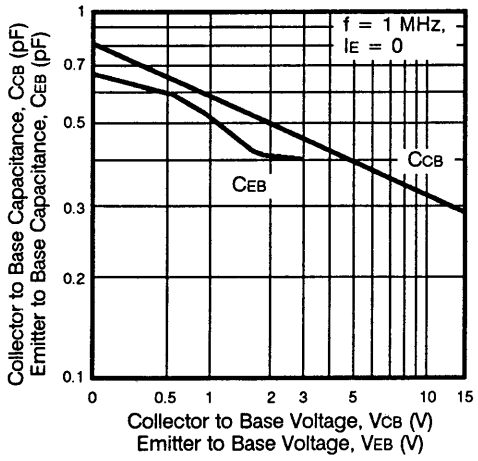
1. Electronic Industrial Association of Japan.
2. Pulse Width ≤ 350 µs, Duty Cycle ≤ 2%/pulsed.
3. h_{FE2} is the smallest of the two.
4. C_{CB} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal.

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

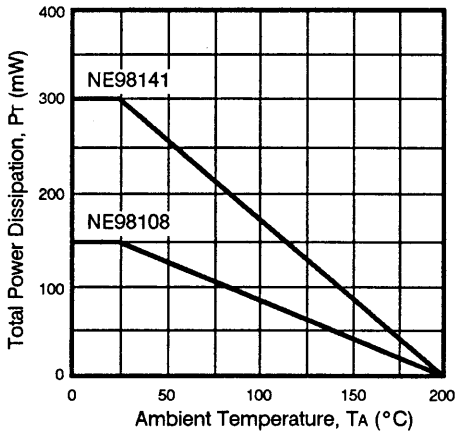
SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	10
V_{CEO}	Collector to Emitter Voltage	V	6
V_{EBO}	Emitter to Base Voltage	V	3
I_C	Collector Current	mA	30
T_J	Junction Temperature	°C	200
T_{STG}	Storage Temperature	°C	-65 to +200

TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

DEVICE CAPACITANCE

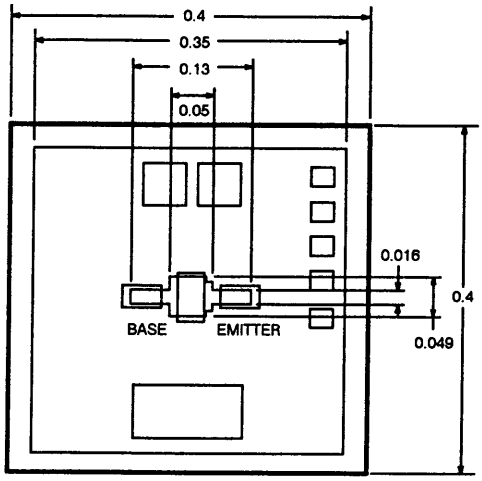


DC POWER DERATING CURVES

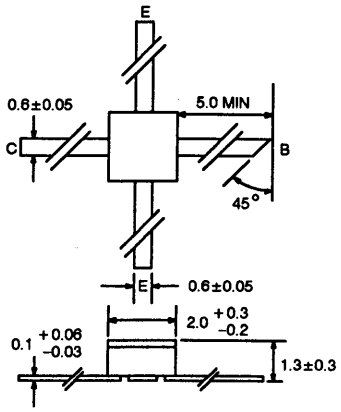


OUTLINE DIMENSIONS (Units in mm)

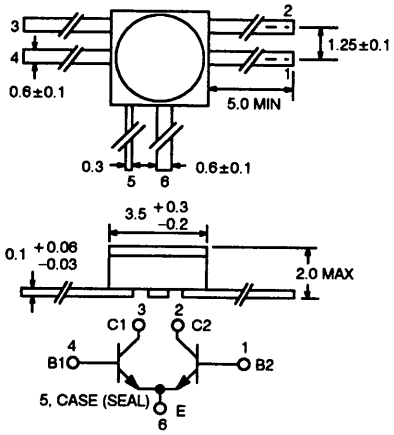
NE98100 (CHIP)
(Chip Thickness: 140 to 160 µm)



OUTLINE 08



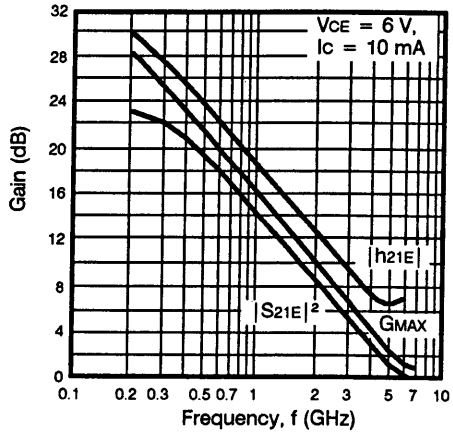
OUTLINE 41



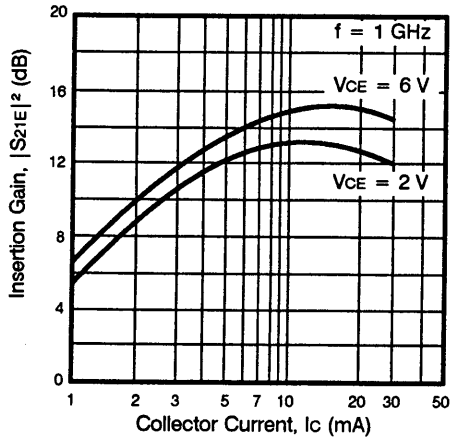
*Lead 5 is only used in manufacturing the device and has no electrical significance.

TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

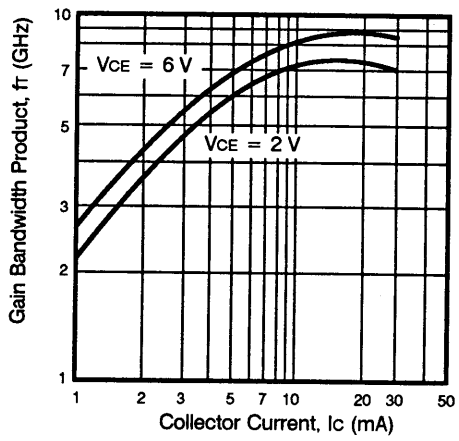
GAIN CHARACTERISTICS vs. FREQUENCY



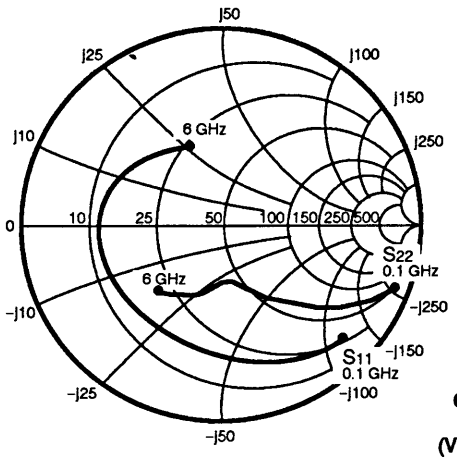
INSERTION GAIN vs. COLLECTOR CURRENT

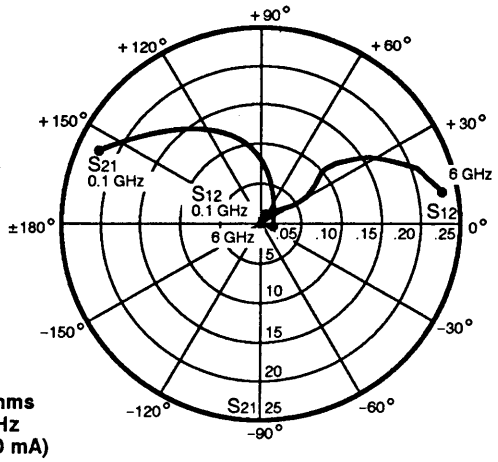


GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



TYPICAL COMMON EMITTER SCATTERING PARAMETERS





NE98108
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 6 V, I_C = 10 mA)

S-MAGN AND ANGLES:

VCE = 6 V, IC = 5 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	.90	-25	14.10	161	.01	77	.96	-13
500	.67	-101	8.58	116	.08	43	.60	-47
1000	.60	-141	5.17	92	.09	33	.41	-62
2000	.55	-175	2.73	65	.12	32	.35	-75
3000	.52	163	1.93	43	.14	27	.35	-93
4000	.50	145	1.53	24	.17	21	.39	-107
5000	.47	129	1.27	7	.20	13	.44	-118
6000	.43	112	1.07	-8	.22	6	.48	-128

VCE = 6 V, IC = 10 mA

100	.82	-39	22.93	154	.01	71	.91	-20
500	.61	-127	10.55	106	.06	41	.44	-56
1000	.58	-160	5.83	86	.07	40	.29	-67
2000	.56	174	3.01	62	.10	43	.27	-78
3000	.54	157	2.12	42	.14	36	.29	-95
4000	.52	141	1.67	24	.17	30	.33	-109
5000	.49	126	1.40	7	.21	20	.38	-120
6000	.43	109	1.17	-7	.23	12	.43	-130

VCE = 6 V, IC = 15 mA

100	.76	-50	28.59	149	.01	70	.87	-24
500	.59	-141	11.23	101	.04	43	.37	-59
1000	.59	-168	6.03	83	.06	46	.25	-67
2000	.56	170	3.08	61	.10	49	.24	-77
3000	.55	153	2.17	42	.13	40	.28	-94
4000	.54	137	1.70	23	.17	32	.32	-107
5000	.50	122	1.42	6	.20	22	.38	-117
6000	.46	105	1.19	-8	.23	14	.43	-126

VCE = 6 V, IC = 20 mA

100	.71	-59	32.32	145	.01	64	.83	-27
500	.59	-148	11.49	99	.04	45	.32	-58
1000	.59	-172	6.05	81	.05	49	.22	-65
2000	.57	168	3.09	60	.10	52	.23	-75
3000	.55	151	2.17	41	.13	43	.27	-93
4000	.54	135	1.70	22	.17	34	.32	-105
5000	.51	119	1.41	5	.20	24	.38	-116
6000	.47	103	1.16	-9	.23	16	.44	-125

NEC®

NPN SILICON HIGH SPEED SWITCHING TRANSISTOR

NE98200
NE98203
NE98208
NE98241
NE98243

FEATURES

- **WIDE DYNAMIC RANGE**
- **HIGH GAIN BANDWIDTH PRODUCT:** f_T = 7 GHz
- **400 PICO SECOND SWITCHING TIME**
- **HIGH RELIABILITY GOLD METALLIZATION**
- **USEFUL AS AN OSCILLATOR UP TO 6 GHz**

DESCRIPTION AND APPLICATIONS

The NE982 series of NPN silicon transistors features a high gain bandwidth product, and wide dynamic range. The series is designed for medium level microwave amplifier and oscillator applications up to 6 GHz and ultrahigh speed switching applications. The NE98203 and NE98208 are single transistors packaged in rugged metal ceramic stripline packages while the NE98241 dual chip version is designed for differential amplifiers and CML circuit applications. Reliability is assured by NEC's high reliability gold metallization system and quality control procedures patterned after MIL-S-19500.

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	8
V_{EBO}	Emitter to Base Voltage	V	3
I_C	Collector Current	mA	80*
T_J	Junction Temperature	°C	200
T_{STG}	Storage Temperature	°C	-65 to +200

*I_C = 200 mA max; PW ≤ 5 µs, duty cycle ≤ 10%.

PERFORMANCE SPECIFICATIONS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED PART NUMBER PACKAGE OUTLINE			NE98203 2SC1660 (Grd C) 03			NE98208 08			NE98241 2SC1662 (Grd C) 41		
SYMBOLS	**PARAMETERS AND CONDITIONS**	**UNITS**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**
f_T	Gain Bandwidth Product at V_{CE} = 6 V, I_C = 30 mA	GHz	6	7		6	7		6	7	
$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = 6 V, I_C = 30 mA, f = 1 GHz f = 2 GHz f = 3 GHz	 dB dB dB	12	 13 7.5 4		12	 13 7.5 4				
T_X	Switching Time[2] at V_{CE} = 6 V, I_C = 20 mA	ηs		0.4			0.4			0.4	
MAG	Maximum Available Gain[3] at V_{CE} = 6 V, I_C = 30 mA, f = 1 GHz f = 2 GHz f = 3 GHz	 dB dB dB		 15 9.5 6			 15 9.5 6			 15 9.5 6	
P_{OSC}	Oscillator Power Output at V_{CE} = 6 V, I_C = 20 mA, f = 6 GHz	mW		20			20				

Notes:

1. Electronic Industrial Association of Japan.
2. In an ECL circuit.
3. Maximum Available Gain (MAG) is calculated from the device S-Parameters using the equation, $MAG = |S_{21E}|^2 \cdot \frac{1}{1-|S_{11E}|^2} \cdot \frac{1}{1-|S_{22E}|^2}$

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

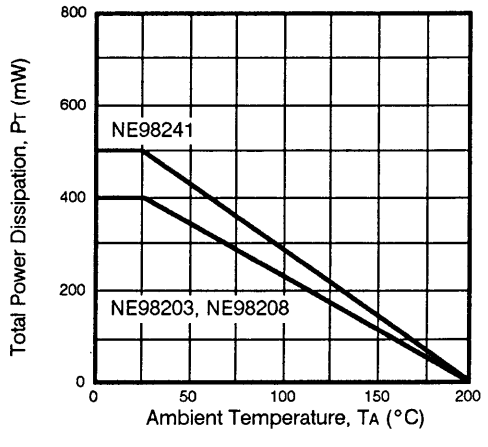
PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE98203 2SC1660 (Grd C) 03			NE98208 08			NE98241 2SC1662 (Grd C) 41		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
I_{CBO}	Collector Cutoff Current at V_{CB} = 6 V, I_E = 0	µA			0.1			0.1			0.1
I_{EBO}	Emitter Cutoff Current at V_{EB} = 2 V, I_C = 0	µA			0.1			0.1			0.1
h_{FE}	Forward Current Gain[2] at V_{CE} = 5 V, I_C = 30 mA		30	100	300	30	100	300	30	100	300
$\frac{h_{FE1}}{h_{FE2}}$	Forward Current Gain Delta[3] at V_{CE} = 5 V, I_C = 30 mA								0.6		1
V_{BE}	Base to Emitter Voltage, V_{CE} = 5 V, I_C = 30 mA	V									0.9
ΔV_{BE}	Base to Emitter Voltage Delta, V_{CE} = 5 V, I_C = 30 mA	mV									20
C_{CB}	Collector to Base Capacitance[4] at V_{CB} = 6 V, I_E = 0, f = 1 MHz	pF		0.6	1		0.6	1		0.6	1
R_{TH}	Thermal Resistance (Juntion-to-Case)	°C/W			70			70			90
P_T	Total Power Dissipation Per Device	mW/Unit									350
P_T	Total Power Dissipation	mW			500			500			400

Notes:

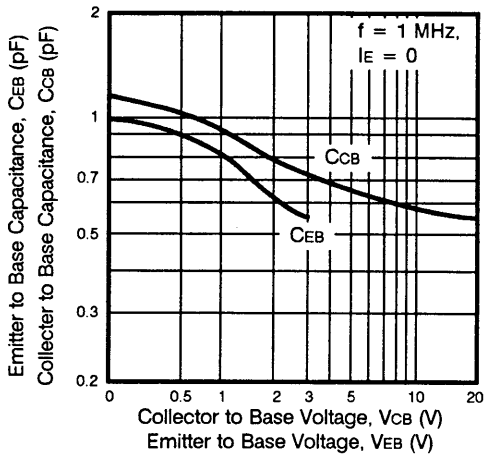
1. Electronic Industrial Association of Japan.
2. Pulse Width ≤ 350 µs, Duty Cycle ≤ 2%/pulsed.
3. h_{FE2} is smallest of the two.
4. C_{CB} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal.

TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

DC POWER DERATING CURVES

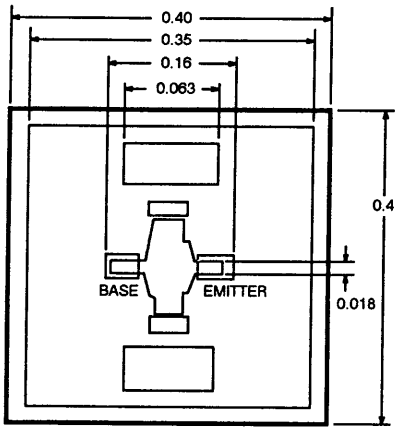


DEVICE CAPACITANCE

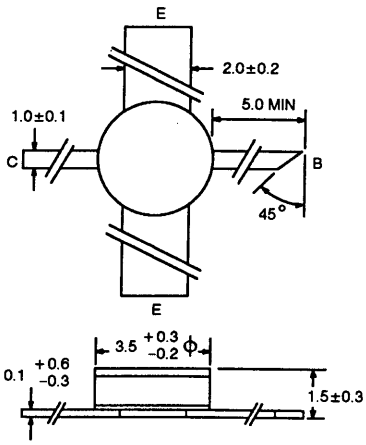


OUTLINE DIMENSIONS (Units in mm)

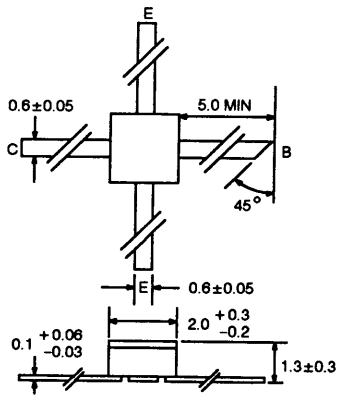
NE98200 (CHIP)
(Chip Thickness: 140 to 160 µm)



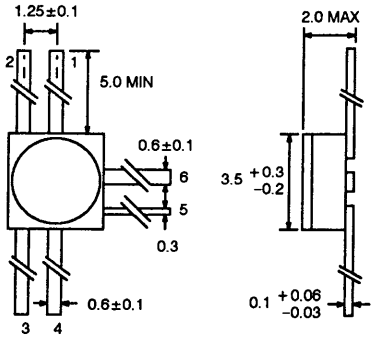
OUTLINE 03

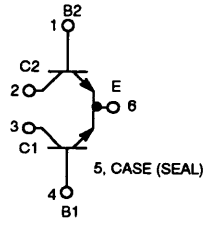


OUTLINE 08



OUTLINE 41

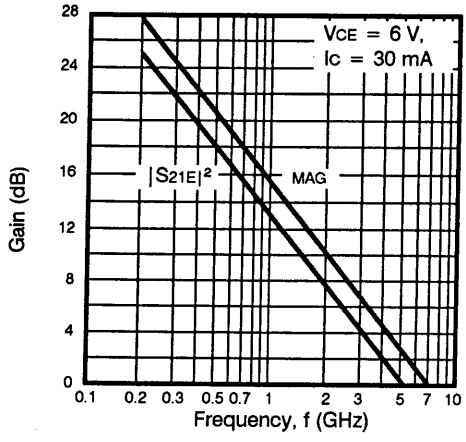




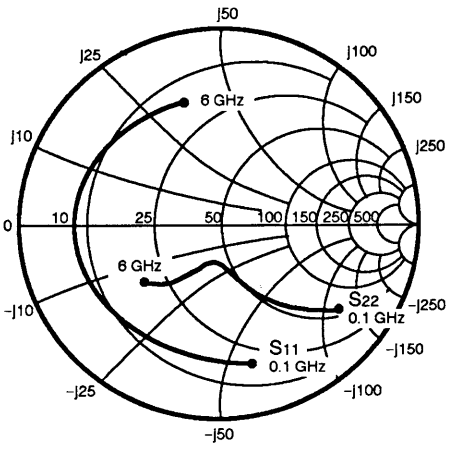
*Lead 5 is only used in manufacturing the device and has no electrical significance.

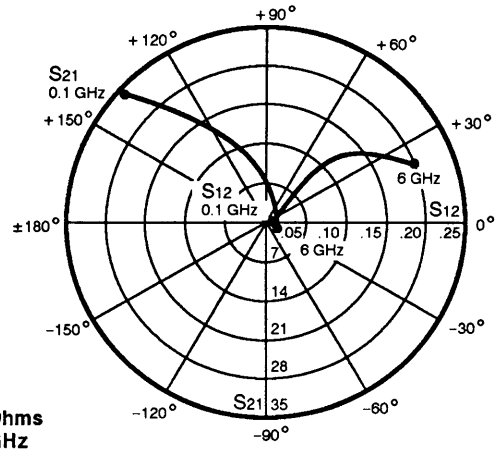
TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

GAIN CHARACTERISTICS vs. FREQUENCY



TYPICAL COMMON EMITTER SCATTERING PARAMETERS





NE98208
Coordinates in Ohms
Frequency in GHz
(V_{CE} = 6 V, I_C = 20 mA)

S-MAGN AND ANGLES:

VCE = 6 V, IC = 5 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
100	.88	-33	14.49	158	.02	75	.95	-18
500	.70	-119	7.68	110	.08	36	.52	-57
1000	.68	-154	4.43	87	.10	26	.36	-74
2000	.66	178	2.31	61	.11	26	.33	-90
3000	.64	158	1.61	39	.13	23	.37	-107
4000	.65	142	1.26	19	.15	20	.42	-120
5000	.62	128	1.04	4	.17	15	.48	-131
6000	.59	112	.86	-12	.20	10	.53	-141

VCE = 6 V, IC = 10 mA

100	.80	-52	23.62	149	.02	65	.88	-27
500	.68	-143	9.30	101	.06	35	.37	-69
1000	.69	-169	5.02	82	.07	34	.25	-84
2000	.67	170	2.56	59	.10	40	.25	-98
3000	.66	151	1.78	39	.12	36	.31	-113
4000	.67	137	1.39	21	.15	31	.37	-124
5000	.64	123	1.16	5	.18	23	.43	-135
6000	.61	108	.97	-10	.20	17	.48	-142

VCE = 6 V, IC = 20 mA

100	.72	-77	33.16	138	.01	58	.78	-36
500	.70	-159	10.11	95	.04	39	.26	-78
1000	.70	-177	5.28	79	.05	45	.18	-92
2000	.69	166	2.67	58	.09	50	.21	-102
3000	.69	148	1.85	39	.12	42	.28	-115
4000	.69	134	1.44	20	.15	37	.34	-125
5000	.66	120	1.19	5	.18	27	.40	-134
6000	.64	106	.98	-10	.21	21	.46	-141

VCE = 6 V, IC = 30 mA

100	.69	-94	36.89	132	.01	56	.71	-40
500	.70	-165	10.15	92	.03	44	.22	-77
1000	.71	179	5.24	77	.04	51	.16	-88
2000	.70	164	2.65	57	.09	53	.20	-98
3000	.69	148	1.83	37	.12	46	.27	-112
4000	.70	134	1.42	19	.15	40	.34	-123
5000	.67	120	1.18	3	.18	30	.41	-133
6000	.65	106	.96	-12	.21	23	.47	-140