NEC's NPN SILICON TRANSISTOR | NE894M03

FEATURES

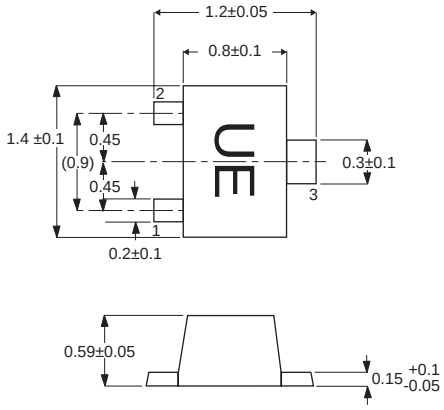
- **MINIATURE M03 PACKAGE:**
  - Small transistor outline
  - Low profile / 0.59 mm package height
  - Flat lead style for better RF performance
- **IDEAL FOR > 3 GHz OSCILLATORS**
- **LOW NOISE, HIGH GAIN**
- **LOW C_{re}**
- **UHSO 25 GHz PROCESS**

DESCRIPTION

NEC's NE894M03 transistor is designed for oscillator applications above 3 GHz. The NE894M03 features low voltage, low current operation, low noise, and high gain. NEC's low profile/flat lead style "M03" package is ideal for today's portable wireless applications.

OUTLINE DIMENSIONS (Units in mm)

PACKAGE OUTLINE M03



PIN CONNECTIONS

1. Emitter
2. Base
3. Collector

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE		NE894M03 2SC5786 M03			
SYMBOLS	**PARAMETERS AND CONDITIONS**	**UNITS**	**MIN**	**TYP**	**MAX**
f_T	Gain Bandwidth at V_{CE} = 1 V, I_C = 20 mA, f = 2 GHz	GHz	17	20	–
$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = 1 V, I_C = 20 mA, f = 2 GHz	dB	10	12	–
NF	Noise Figure at V_{CE} = 1 V, I_C = 5 mA, f = 2 GHz, $Z_S = Z_{OPT}$	dB	–	1.4	2.5
C_{re}	Reverse Transfer Capacitance[3] at V_{CB} = 0.5 V, I_E = 0 mA, f = 1 MHz	pF	–	0.22	0.30
I_{CBO}	Collector Cutoff Current at V_{CB} = 5 V, I_E = 0	nA	–	–	100
I_{EBO}	Emitter Cutoff Current at V_{EB} = 1 V, I_C = 0	nA	–	–	100
h_{FE}	DC Current Gain[2] at V_{CE} = 1 V, I_C = 5 mA		50	–	100

Notes:
1. Electronic Industrial Association of Japan.
2. Pulsed measurement, pulse width ≤ 350 μs, duty cycle ≤ 2 %.
3. Collector to base capacitance when the emitter is grounded

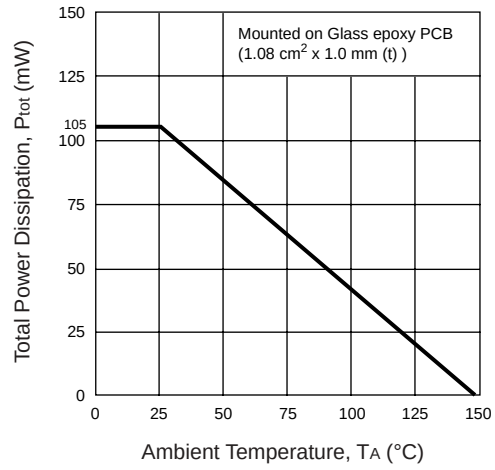
ABSOLUTE MAXIMUM RATINGS[1] (T_A = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	9.0
V_{CEO}	Collector to Emitter Voltage	V	3.0
V_{EBO}	Emitter to Base Voltage	V	1.5
I_C	Collector Current	mA	35
P_T[2]	Total Power Dissipation	mW	105
T_J	Junction Temperature	°C	150
T_{STG}	Storage Temperature	°C	-65 to +150

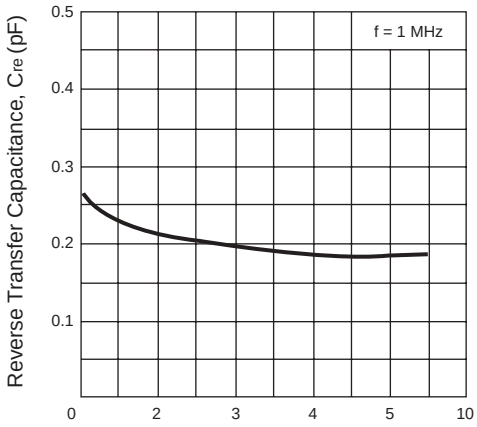
Notes:
1. Operation in excess of any one of these parameters may result in permanent damage.
2. With device mounted on 1.08 cm^2 X 1.0 mm (t) glass epoxy board.

TYPICAL PERFORMANCE CURVES (T_A = 25°C)

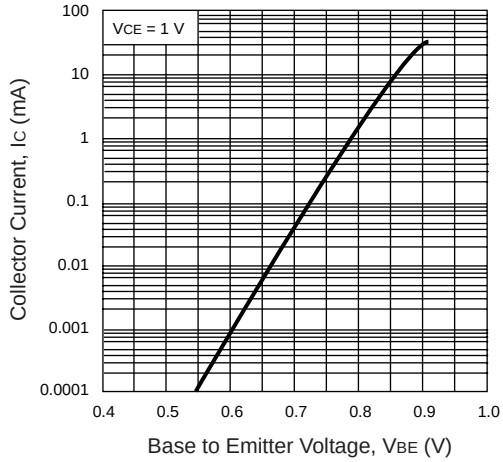
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



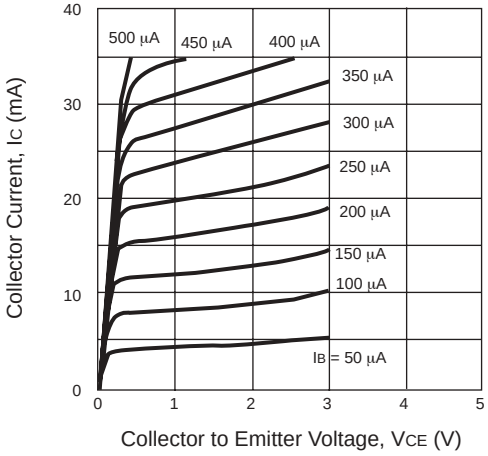
REVERSE TRANSFR CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE

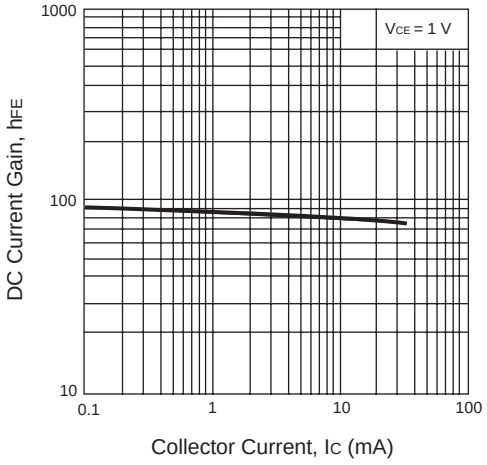


COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE

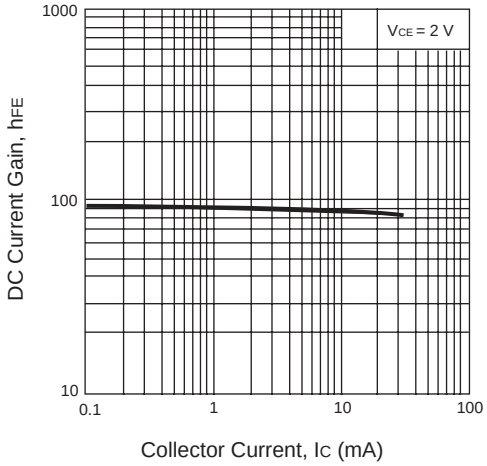


TYPICAL PERFORMANCE CURVES (T_A = 25°C)

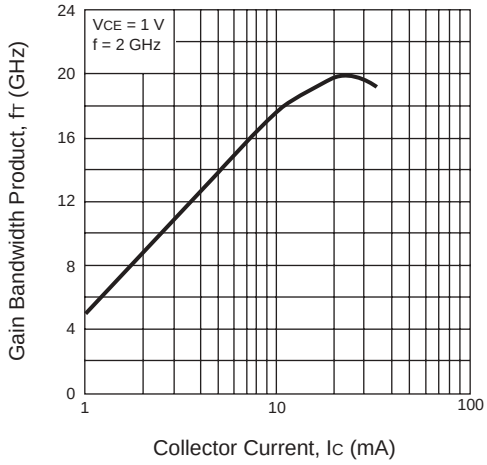
DC CURRENT GAIN vs. COLLECTOR CURRENT



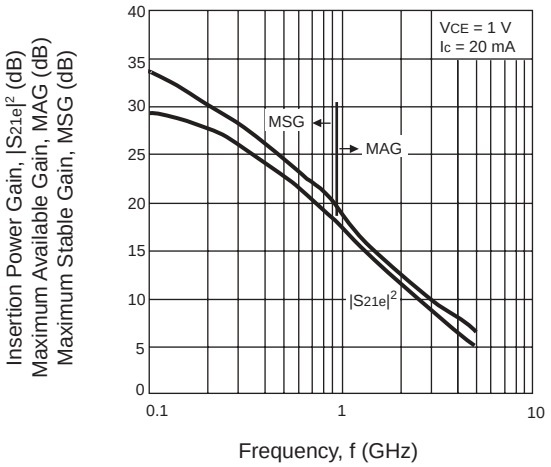
DC CURRENT GAIN vs. COLLECTOR CURRENT



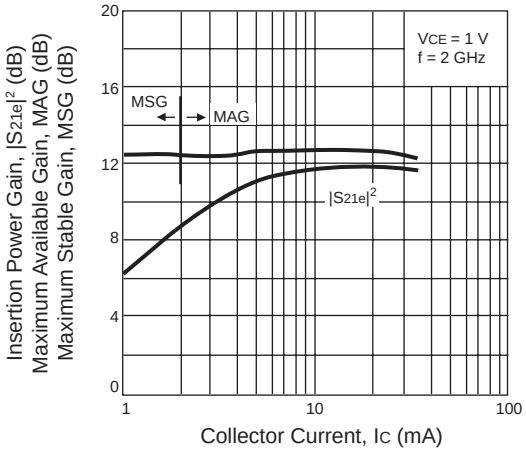
GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



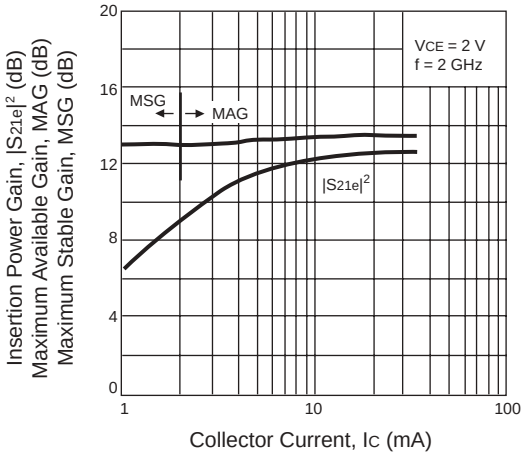
INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY



INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

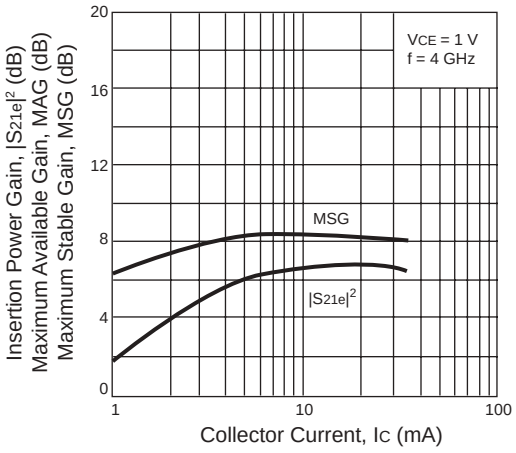


INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

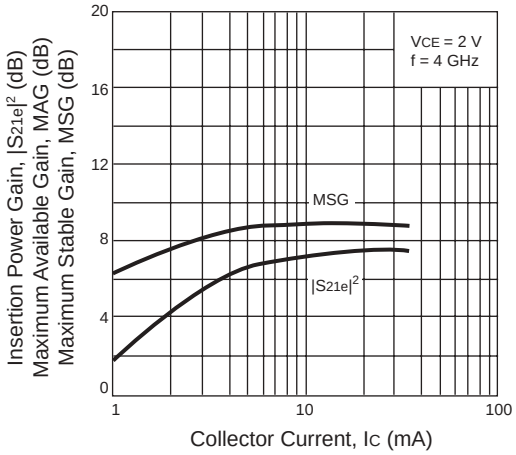


TYPICAL PERFORMANCE CURVES (T_A = 25°C)

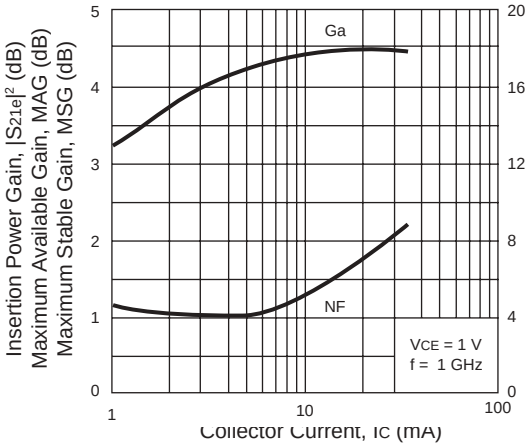
INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



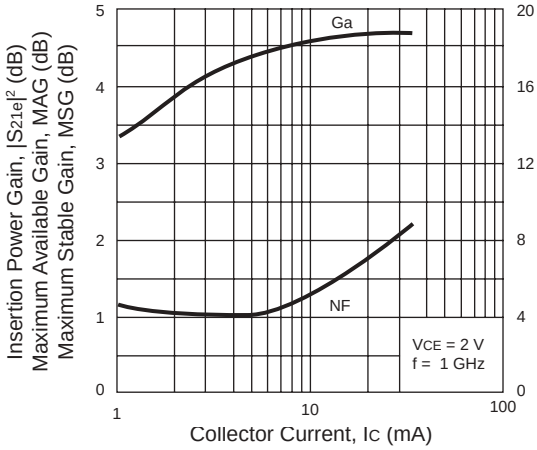
INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



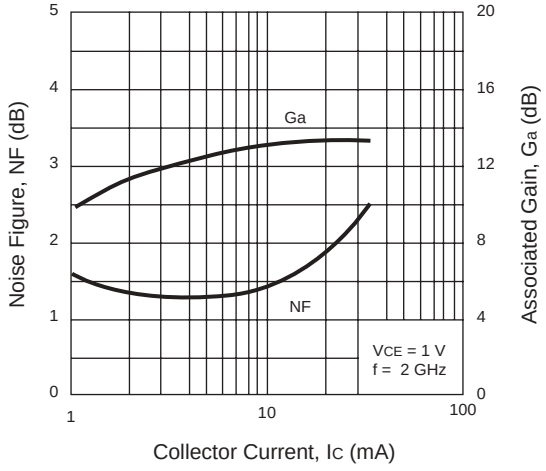
INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



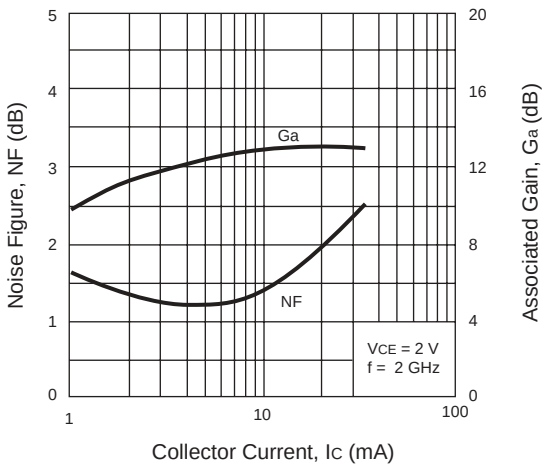
INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



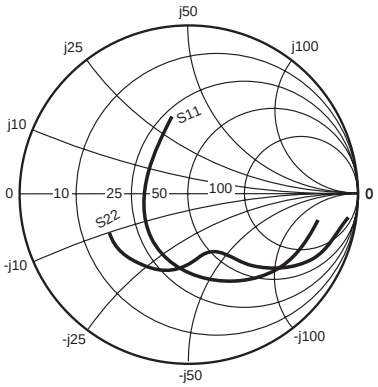
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



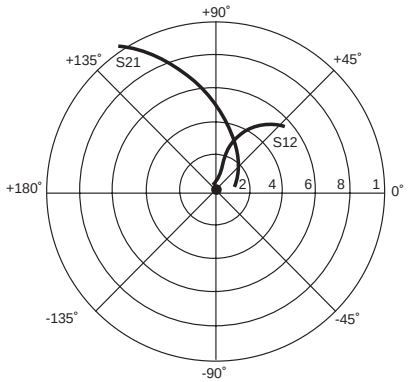
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



0.100 to 8.000 GHz by 0.100



0.100 to 8.000 GHz by 0.100

NE894M03
V_C = 1 V, I_C = 5 mA

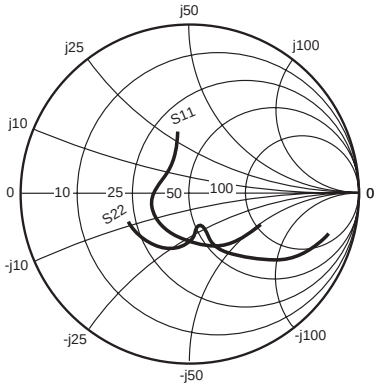
FREQUENCY	S11		S21		S12		S22		K	MAG[1]
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.100	0.804	-12.45	13.456	168.86	0.014	75.71	0.967	-9.33	0.205	29.83
0.200	0.768	-25.33	12.847	157.43	0.026	76.38	0.923	-17.46	0.177	26.94
0.300	0.723	-37.26	12.100	147.50	0.037	69.94	0.870	-24.63	0.250	25.19
0.400	0.674	-48.21	11.246	139.00	0.045	66.46	0.812	-30.66	0.301	23.96
0.500	0.579	-67.93	10.822	127.56	0.054	58.84	0.696	-40.80	0.414	23.00
0.700	0.495	-85.34	8.897	115.63	0.064	55.63	0.584	-48.45	0.555	21.42
1.000	0.417	-105.27	6.919	103.15	0.075	55.15	0.493	-54.53	0.708	19.64
1.200	0.385	-115.35	5.983	96.67	0.082	55.97	0.446	-57.88	0.800	18.65
1.400	0.359	-123.36	5.258	91.25	0.088	57.40	0.417	-60.15	0.876	17.76
1.500	0.348	-127.10	4.958	88.73	0.092	58.17	0.406	-61.38	0.906	17.32
1.600	0.338	-130.59	4.689	86.43	0.095	58.97	0.396	-62.38	0.934	16.92
1.800	0.324	-136.60	4.235	82.15	0.103	60.93	0.386	-64.26	0.973	16.15
2.000	0.311	-142.01	3.870	78.13	0.110	62.36	0.377	-65.92	1.006	14.96
2.200	0.298	-146.87	3.553	74.49	0.119	64.05	0.374	-67.94	1.029	13.72
2.400	0.289	-151.34	3.294	71.02	0.128	65.48	0.372	-69.91	1.038	12.90
2.500	0.285	-153.78	3.179	69.33	0.133	66.11	0.373	-70.77	1.042	12.53
2.600	0.280	-155.92	3.075	67.68	0.138	66.51	0.374	-71.57	1.040	12.25
2.800	0.272	-160.53	2.886	64.51	0.148	67.63	0.377	-73.52	1.043	11.64
3.000	0.264	-164.58	2.717	61.50	0.159	68.38	0.383	-75.40	1.035	11.17
3.500	0.248	-176.37	2.389	54.30	0.190	69.51	0.400	-79.74	1.004	10.64
4.000	0.237	171.24	2.143	47.62	0.224	69.45	0.420	-84.41	0.965	9.82
4.500	0.236	158.75	1.951	41.26	0.261	68.42	0.440	-90.05	0.924	8.74
5.000	0.245	146.36	1.798	35.18	0.302	66.31	0.459	-96.90	0.886	7.75
5.500	0.265	135.56	1.671	29.34	0.345	63.55	0.477	-104.52	0.852	6.85
6.000	0.292	125.06	1.567	23.87	0.390	60.16	0.492	-112.99	0.829	6.04
6.500	0.331	117.84	1.473	18.43	0.435	56.05	0.503	-122.86	0.809	5.30
7.000	0.370	111.88	1.387	13.28	0.479	51.57	0.512	-132.99	0.798	4.62
7.500	0.410	106.49	1.310	8.53	0.521	46.77	0.520	-143.02	0.793	4.00
8.000	0.445	101.39	1.239	4.23	0.560	42.01	0.523	-153.03	0.799	3.45

Note:
1. Gain Calculations:

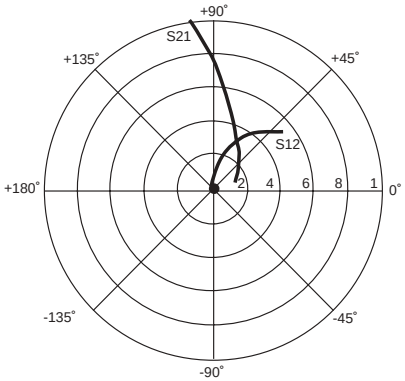
$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right)$. When $K \le 1$, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\,|S_{12}\,S_{21}|}$, $\Delta = S_{11}\,S_{22} - S_{21}\,S_{12}$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



0.100 to 8.000 GHz by 0.100



0.100 to 8.000 GHz by 0.100

NE894M03
V_C = 1 V, I_C = 20 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	MAG[1]
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.100	0.471	-25.95	30.346	158.67	0.012	79.29	0.872	-17.25	0.360	34.13
0.200	0.411	-47.55	26.025	141.49	0.020	75.44	0.757	-30.53	0.470	31.13
0.300	0.354	-65.00	21.817	129.12	0.028	71.06	0.649	-39.26	0.591	28.95
0.400	0.310	-78.61	18.373	120.17	0.034	70.81	0.563	-45.08	0.684	27.33
0.500	0.280	-111.18	15.790	111.09	0.041	67.98	0.428	-58.02	0.790	25.90
0.700	0.253	-128.95	11.932	102.02	0.051	69.48	0.334	-63.82	0.900	23.66
1.000	0.238	-145.67	8.694	93.09	0.069	71.17	0.274	-65.91	0.965	21.00
1.200	0.232	-152.85	7.352	88.51	0.081	71.83	0.246	-68.43	0.993	19.59
1.400	0.224	-158.68	6.372	84.58	0.093	72.24	0.230	-69.29	1.010	17.76
1.500	0.221	-161.38	5.977	82.73	0.099	72.22	0.225	-70.06	1.015	17.06
1.600	0.218	-163.90	5.625	81.05	0.105	72.26	0.222	-70.43	1.020	16.42
1.800	0.213	-167.93	5.047	77.78	0.117	72.11	0.219	-71.10	1.023	15.41
2.000	0.208	-171.63	4.583	74.70	0.129	71.97	0.218	-71.66	1.026	14.50
2.200	0.199	-175.63	4.194	71.82	0.142	71.32	0.221	-73.00	1.028	13.68
2.400	0.193	-178.78	3.877	69.04	0.154	70.68	0.224	-74.14	1.028	12.99
2.500	0.191	179.04	3.738	67.69	0.160	70.44	0.226	-74.60	1.027	12.68
2.600	0.187	177.38	3.609	66.38	0.167	70.18	0.230	-75.18	1.024	12.40
2.800	0.181	173.28	3.378	63.76	0.180	69.53	0.235	-76.50	1.021	11.85
3.000	0.174	169.63	3.178	61.26	0.192	68.63	0.244	-77.71	1.018	11.36
3.500	0.162	158.76	2.783	55.23	0.225	66.58	0.267	-81.03	1.005	10.51
4.000	0.154	146.71	2.490	49.51	0.258	64.25	0.289	-84.82	0.990	9.85
4.500	0.155	135.13	2.265	44.01	0.291	61.57	0.311	-89.72	0.975	8.92
5.000	0.165	124.55	2.089	38.67	0.324	58.73	0.330	-96.17	0.959	8.09
5.500	0.184	117.01	1.949	33.51	0.358	55.74	0.346	-103.31	0.942	7.35
6.000	0.209	109.56	1.834	28.53	0.393	52.51	0.359	-111.43	0.929	6.69
6.500	0.244	106.64	1.734	23.50	0.428	49.06	0.369	-121.23	0.914	6.08
7.000	0.280	104.53	1.647	18.60	0.462	45.43	0.376	-131.20	0.902	5.52
7.500	0.318	102.21	1.570	13.90	0.495	41.62	0.384	-141.17	0.891	5.01
8.000	0.354	99.38	1.498	9.48	0.526	37.89	0.389	-150.59	0.885	4.54

Note:

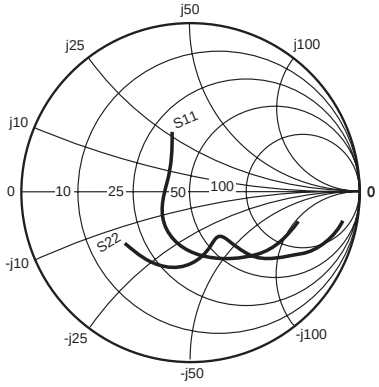
1. Gain Calculations:

$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right)$. When $K \leq 1$, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\,|S_{12}\,S_{21}|}$, $\Delta = S_{11}\,S_{22} - S_{21}\,S_{12}$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



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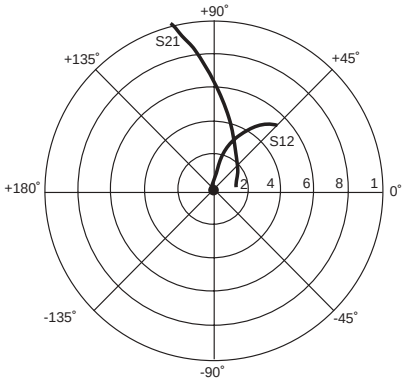


0.100 to 8.000 GHz by 0.100

NE894M03
V_C = 2 V, I_C = 10 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	MAG[1]
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.100	0.676	-15.93	21.954	164.82	0.012	76.68	0.940	-11.43	0.263	32.68
0.200	0.625	-31.00	20.217	151.06	0.020	74.50	0.872	-21.02	0.312	29.96
0.300	0.564	-43.98	18.188	139.76	0.028	71.35	0.794	-28.45	0.397	28.13
0.400	0.503	-55.03	16.169	130.65	0.035	67.71	0.721	-34.01	0.492	26.66
0.500	0.411	-77.55	14.778	120.09	0.041	64.03	0.589	-43.87	0.609	25.55
0.700	0.340	-94.08	11.612	109.37	0.050	63.98	0.481	-49.19	0.756	23.64
1.000	0.282	-112.43	8.695	98.72	0.064	66.11	0.407	-51.87	0.873	21.36
1.200	0.260	-121.15	7.418	93.31	0.073	67.44	0.370	-53.78	0.929	20.10
1.400	0.240	-128.06	6.463	88.76	0.081	68.71	0.349	-54.74	0.970	18.99
1.500	0.232	-131.34	6.073	86.65	0.087	69.06	0.342	-55.53	0.982	18.46
1.600	0.225	-134.30	5.726	84.73	0.091	69.76	0.336	-55.99	0.995	17.98
1.800	0.215	-139.26	5.147	81.08	0.101	70.63	0.331	-57.14	1.006	16.59
2.000	0.205	-143.73	4.682	77.65	0.111	71.10	0.327	-58.09	1.017	15.46
2.200	0.193	-147.60	4.287	74.50	0.121	71.60	0.329	-59.84	1.022	14.56
2.400	0.185	-151.09	3.965	71.49	0.132	71.91	0.331	-61.37	1.023	13.86
2.500	0.181	-153.43	3.824	70.02	0.137	71.98	0.332	-62.06	1.022	13.55
2.600	0.177	-155.06	3.693	68.61	0.143	72.07	0.335	-62.79	1.020	13.26
2.800	0.169	-159.20	3.458	65.81	0.154	72.04	0.340	-64.51	1.015	12.76
3.000	0.160	-162.54	3.251	63.14	0.166	71.89	0.348	-66.18	1.008	12.36
3.500	0.144	-173.30	2.847	56.77	0.195	71.18	0.369	-70.18	0.986	11.63
4.000	0.130	173.99	2.547	50.75	0.227	69.98	0.391	-74.60	0.961	10.49
4.500	0.126	160.13	2.316	44.99	0.261	68.18	0.414	-79.87	0.934	9.49
5.000	0.133	146.05	2.136	39.39	0.297	65.94	0.434	-86.36	0.906	8.57
5.500	0.151	134.79	1.992	33.98	0.334	63.32	0.451	-93.48	0.880	7.76
6.000	0.176	123.99	1.875	28.75	0.373	60.42	0.465	-101.40	0.860	7.01
6.500	0.216	118.84	1.774	23.41	0.414	56.87	0.476	-110.72	0.838	6.32
7.000	0.258	115.06	1.685	18.19	0.456	52.96	0.484	-120.36	0.820	5.68
7.500	0.302	111.27	1.603	13.14	0.497	48.76	0.491	-130.15	0.808	5.09
8.000	0.344	107.28	1.528	8.36	0.535	44.54	0.494	-139.81	0.803	4.55

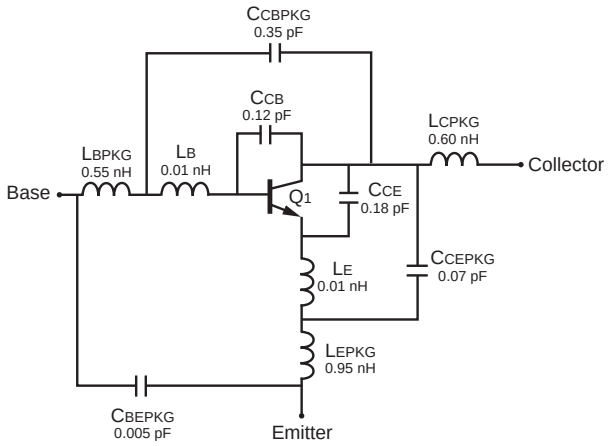
Note:
1. Gain Calculations:

$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right)$. When K ≤ 1, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\,|S_{12}\,S_{21}|}$, $\Delta = S_{11}\,S_{22} - S_{21}\,S_{12}$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

NONLINEAR MODEL

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS(1)

Parameters	Q1	Parameters	Q1
IS	100e-18	MJC	0.76
BF	121.3	XCJC	0.5
NF	1.00	CJS	0
VAF	25	VJS	0.75
IKF	293e-3	MJS	0
ISE	50e-15	FC	0.5
NE	2.111	TF	6.5e-12
BR	30	XTF	0.1
NR	1.0	VTF	10
VAR	2.105	ITF	0.5
IKR	457e-3	PTF	20
ISC	1.155e-15	TR	0
NC	1.288	EG	1.11
RE	1.5	XTB	0
RB	3.0	XTI	3
RBM	1.0	KF*	0
IRB	759e-6	AF*	1
RC	4.0		
CJE	0.6e-12		
VJE	1.049		
MJE	0.226		
CJC	83e-15		
VJC	0.89		

(1) Gummel-Poon Model

ADDITIONAL PARAMETERS

Parameters	NE894M03
CCB	0.12 pF
CCE	0.18 pF
LB	0.01 nH
LE	0.01 nH
CCBPKG	0.35 pF
CBEPKG	0.005 pF
CCEPKG	0.07 pF
LBPKG	0.55 nH
LCPKG	0.60 nH
LEPKG	0.95 nH

AF and KF are 1/f noise parameters and are bias dependent. The appropriate values for the 1/f noise parameters (AF and KF) shall be chosen from the table below, according to the desired current range.

	Ic = 5 mA	Ic = 10 mA	Ic = 15 mA
AF	1.352	2.17	2.19
KF	71.23e-15	231.3e-12	268.9e-12

For a better understanding on AF and KF parameters, please refer to AN1026.

MODEL TEST CONDITIONS
Frequency: 0.1 to 6 GHz
Bias: VCE = 1.5 V, IC = 1 mA to 9 mA
Date: 09/2003