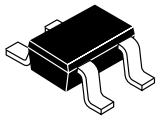
CEL

NEC'S SURFACE MOUNT NPN SILICON HIGH FREQUENCY TRANSISTOR

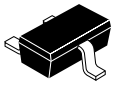
NE685 SERIES

FEATURES

- **LOW COST**
- **SMALL AND ULTRA SMALL SIZE PACKAGES**
- **LOW VOLTAGE/LOW CURRENT OPERATION**
- **HIGH GAIN BANDWIDTH PRODUCT:** f_T of 12 GHz
- **NOISE FIGURES OF 1.5 dB AT 2.0 GHZ**



18 (SOT 343 STYLE)



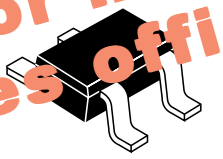
19 (3 PIN ULTRA SUPER MINI MOLD)



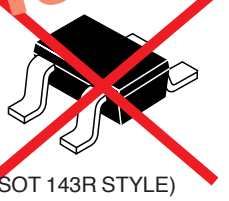
30 (SOT 323 STYLE)



33 (SOT 23 STYLE)



39 (SOT 143 STYLE)



39R (SOT 143R STYLE)

PLEASE NOTE:
The following part numbers from this datasheet are not recommended for new design.
Please call sales office for details:
NE68539R
NE68530
NE68533

DESCRIPTION

NEC's family of high frequency, low cost, surface mount devices are well suited for portable wireless communications and cellular radio applications.

The NE685 series of high f_T (12 GHz) devices is suitable for very low voltage/low current, low noise applications. These products are ideal for applications up to 2.4 GHz where low cost, high gain, low voltage, and low current are prime concerns.

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER[1] / EIAJ[2] REGISTERED NUMBER / PACKAGE OUTLINE			NE68518 2SC5015 18			NE68519 2SC5010 19			NE68530 2SC4959 30			NE68533 2SC4955 33			NE68539/39R 2SC4957 39		
SYMBOLS	**PARAMETERS AND CONDITIONS**	**UNITS**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**
f_T	Gain Bandwidth Product at V_{CE} = 3V, I_C = 10 mA, f = 2.0 GHz	GHz		12			12			12			12			12	
NF_{MIN}	Minimum Noise Figure at V_{CE} = 3 V, I_C = 3 mA, f = 2.0 GHz	dB		1.5	2.5		1.5	2.5		1.5	2.5		1.5	2.5		1.5	2.5
G_{NF}	Associated Gain at V_{CE} = 3V, I_C = 3 mA, f = 2.0 GHz	dB		8.5			7.5			7			7			7.5	
MAG	Maximum Available Gain at V_{CE} = 3 V, I_C = 10 mA, f = 2.0 GHz	dB		12			11			10			10.5			11	
$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = 3V, I_C =10 mA, f = 2.0 GHz	dB	9	11		7	9		7	8.5		7	8		9	10	
h_{FE}	Forward Current Gain[3] at V_{CE} = 3 V, I_C = 10 mA		75	110	150	75	110	150	75	110	150	75	110	150	75	110	150
I_{CBO}	Collector Cutoff Current at V_{CB} = 5 V, I_E = 0 mA	µA			0.1			0.1			0.1			0.1			0.1
I_{EBO}	Emitter Cutoff Current at V_{EB} = 1 V, I_C = 0 mA	µA			0.1			0.1			0.1			0.1			0.1
C_{RE}[4]	Feedback Capacitance at V_{CB} = 3 V, I_E = 0 mA, f = 1 MHz	pF		0.3	0.5		0.4	0.7		0.4	0.7		0.4	0.7		0.3	0.5
P_T	Total Power Dissipation	mW			150			125			150			180			180
$R_{TH(J-A)}$	Thermal Resistance (Junction to Ambient)	°C/W			833			1000			833			620			620
$R_{TH(J-C)}$	Thermal Resistance(Junction to Case)	°C/W			200			200			200			200			200

Notes: 1. Precaution: Devices are ESD sensitive. Use proper handling procedures.
2. Electronic Industrial Association of Japan.
3. Pulsed measurement, PW≤350 µs, duty cycle ≤2%.
4. The emitter terminal should be connected to the ground terminal of the 3 terminal capacitance bridge.

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

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	9
V_{CEO}	Collector to Emitter Voltage	V	6
V_{EBO}	Emitter to Base Voltage	V	2.0
I_C	Collector Current	mA	30
T_J	Junction Temperature	°C	150
T_{STG}	Storage Temperature	°C	-65 to +150

Note: 1.Operation in excess of any one of these parameters may result in permanent damage.

NE68518
TYPICAL NOISE PARAMETERS (T_A = 25˚C)

FREQ. (MHz)	NF_{OPT} (dB)	G_A (dB)	Γ_{OPT} MAG	Γ_{OPT} ANG	Rn/50
V_{CE} = 3 V, I_C = 3 mA					
500	1.00	21.32	0.63	26	0.56
800	1.15	16.29	0.59	31	0.44
1000	1.20	14.66	0.56	39	0.40
1500	1.35	11.02	0.52	48	0.37
2000	1.50	8.67	0.47	53	0.33
2500	1.65	7.24	0.40	65	0.23
V_{CE} = 3 V, I_C = 5 mA					
500	1.20	21.15	0.55	19	0.47
800	1.25	17.29	0.51	31	0.42
1000	1.35	15.47	0.49	37	0.38
1500	1.45	11.87	0.46	44	0.35
2000	1.60	9.57	0.42	53	0.33
2500	1.75	7.90	0.36	60	0.22
V_{CE} = 3 V, I_C = 10 mA					
500	1.55	21.70	0.44	15	0.44
800	1.60	18.13	0.40	30	0.41
1000	1.65	16.20	0.38	36	0.39
1500	1.80	12.85	0.34	44	0.37
2000	1.90	10.60	0.30	50	0.34
2500	2.00	8.82	0.27	55	0.23

NE68519
TYPICAL NOISE PARAMETERS (T_A = 25˚C)

FREQ. (MHz)	NF_{OPT} (dB)	G_A (dB)	Γ_{OPT} MAG	Γ_{OPT} ANG	Rn/50
V_{CE} = 2.5 V, I_C = 0.3 mA					
500	1.07	12.6	0.80	17	1.70
800	1.25	8.6	0.79	32	1.55
1000	1.55	6.7	0.75	42	1.41
V_{CE} = 2.5 V, I_C = 1.0 mA					
500	0.87	16.9	0.73	14	0.80
800	0.99	12.8	0.67	27	0.65
1000	1.08	11.0	0.64	36	0.62
1500	1.31	7.5	0.60	52	0.52
2000	1.65	5.0	0.54	65	0.42
V_{CE} = 3 V, I_C = 10 mA					
500	1.05	19.3	0.65	14	0.57
800	1.12	15.8	0.58	27	0.50
1000	1.17	13.4	0.55	33	0.45
1500	1.31	9.9	0.50	47	0.38
2000	1.51	7.5	0.43	58	0.32
2500	1.75	5.5	0.32	69	0.21
V_{CE} = 3 V, I_C = 5.0 mA					
500	1.33	19.4	0.58	13	0.54
800	1.40	15.3	0.52	26	0.49
1000	1.45	13.5	0.50	33	0.46
1500	1.57	10.0	0.43	46	0.42
2000	1.71	7.5	0.36	54	0.38
2500	1.90	5.6	0.29	60	0.31

NE68530
TYPICAL NOISE PARAMETERS (T_A = 25˚C)

FREQ. (MHz)	NF_{OPT} (dB)	G_A (dB)	Γ_{OPT} MAG	Γ_{OPT} ANG	Rn/50
V_{CE} = 0.5 V, I_C = 0.5 mA					
500	0.95	10.87	0.81	15	1.20
800	1.05	7.82	0.75	24	1.02
1000	1.20	6.92	0.72	34	0.86
V_{CE} = 0.75 V, I_C = 0.5 mA					
500	0.97	11.28	0.82	14	1.15
800	1.15	8.64	0.76	24	1.00
1000	1.25	7.62	0.73	33	0.84
V_{CE} = 1.0 V, I_C = 0.25 mA					
500	1.10	8.73	0.85	13	1.69
800	1.20	6.83	0.80	25	1.65
1000	1.45	6.67	0.75	36	1.64
V_{CE} = 1.0 V, I_C = 0.5 mA					
500	0.95	11.93	0.78	12	1.02
800	1.12	8.71	0.76	22	0.99
1000	1.28	8.35	0.69	32	0.86
V_{CE} = 1.0 V, I_C = 0.75 mA					
500	0.90	12.92	0.77	11	0.92
800	1.02	10.03	0.73	21	0.84
1000	1.18	9.23	0.67	30	0.69
V_{CE} = 1.0 V, I_C = 1.0 mA					
500	0.88	14.48	0.75	13	0.82
800	1.00	10.96	0.71	21	0.76
1000	1.14	9.83	0.66	29	0.62
V_{CE} = 1.0 V, I_C = 3.0 mA					
500	0.98	17.29	0.60	10	0.52
800	1.07	13.62	0.57	18	0.50
1000	1.15	12.01	0.54	25	0.47
2000	1.52	6.41	0.43	27	0.38
V_{CE} = 2.5 V, I_C = 0.3 mA					
500	1.10	10.77	0.85	14	1.49
800	1.30	7.48	0.81	22	1.45
1000	1.47	6.76	0.78	30	1.37
V_{CE} = 2.5 V, I_C = 1 mA					
500	0.85	15.44	0.73	12	0.91
800	1.04	11.52	0.72	19	0.75
1000	1.16	10.45	0.69	27	0.68
2000	1.60	5.16	0.54	33	0.47
V_{CE} = 2.5 V, I_C = 3 mA					
500	1.08	18.11	0.65	11	0.60
800	1.15	14.37	0.60	17	0.53
1000	1.22	12.76	0.58	23	0.49
2000	1.68	7.19	0.48	20	0.41
V_{CE} = 3 V, I_C = 3 mA					
500	1.10	18.10	0.65	10	0.58
800	1.19	14.27	0.61	14	0.50
1000	1.25	12.77	0.60	23	0.49
2000	1.48	7.20	0.50	20	0.42
3000	1.74	5.22	0.32	28	0.22

NE68533
TYPICAL NOISE PARAMETERS (T_A = 25°C)

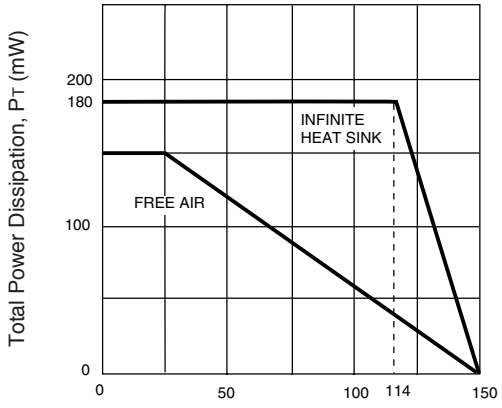
FREQ. (MHz)	NF_{OPT} (dB)	G_A (dB)	Γ_{OPT} MAG	Γ_{OPT} ANG	Rn/50
V_{CE} = 0.5 V, I_C = 0.5 mA					
500	0.9	12.03	0.76	19	1.19
800	1.1	10.22	0.72	37	0.84
1000	1.3	9.24	0.67	50	0.72
V_{CE} = 1.0 V, I_C = 0.5 mA					
500	0.9	13.19	0.75	18	1.23
800	1.0	10.87	0.73	35	0.89
1000	1.2	10.16	0.68	47	0.77
V_{CE} = 1.0 V, I_C = 1.0 mA					
500	0.9	14.57	0.73	17	0.74
800	1.0	12.04	0.67	33	0.54
1000	1.2	10.94	0.64	45	0.50
V_{CE} = 2.5 V, I_C = 1 mA					
500	0.9	15.67	0.73	16	0.77
800	1.0	12.73	0.68	30	0.57
1000	1.1	11.79	0.65	42	0.58
2000	1.6	4.73	0.59	53	0.36
V_{CE} = 2.5 V, I_C = 3 mA					
500	1.07	18.37	0.61	14	0.54
800	1.13	14.40	0.55	19	0.39
1000	1.30	13.15	0.56	35	0.40
2000	1.43	7.48	0.42	40	0.34
2500	1.63	6.59	0.24	69	0.22

NE68539
TYPICAL NOISE PARAMETERS (T_A = 25°C)

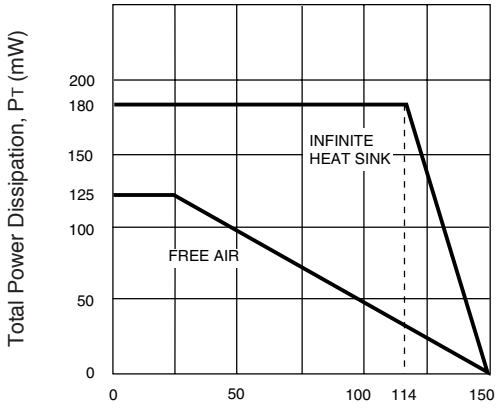
FREQ. (MHz)	NF_{OPT} (dB)	G_A (dB)	Γ_{OPT} MAG	Γ_{OPT} ANG	Rn/50
V_{CE} = 2.5 V, I_C = 0.3 mA					
500	1.42	13.3	0.80	18	2.52
800	1.58	9.7	0.72	32	1.40
1000	1.70	8.0	0.64	43	1.29
V_{CE} = 2.5 V, I_C = 1.0 mA					
500	0.85	16.3	0.72	17	0.66
800	0.98	12.6	0.61	29	0.50
1000	1.07	11.0	0.51	40	0.48
1500	1.29	7.8	0.38	55	0.39
2000	1.52	6.2	0.30	67	0.32
V_{CE} = 2.5 V, I_C = 3.0 mA					
500	1.17	18.2	0.63	19	0.46
800	1.30	14.9	0.51	29	0.38
1000	1.39	13.2	0.34	33	0.34
1500	1.69	10.0	0.23	28	0.30
2000	2.00	7.6	0.17	13	0.25
2500	2.33	5.8	0.16	-13	0.21
V_{CE} = 3 V, I_C = 5.0 mA					
500	1.27	19.5	0.57	17	0.44
800	1.40	15.8	0.41	25	0.38
1000	1.50	14.1	0.31	26	0.35
1500	1.81	10.9	0.23	21	0.29
2000	2.13	8.6	0.19	10	0.26
2500	2.47	6.8	0.17	-10	0.22

TYPICAL PERFORMANCE CURVES (TA = 25°C)

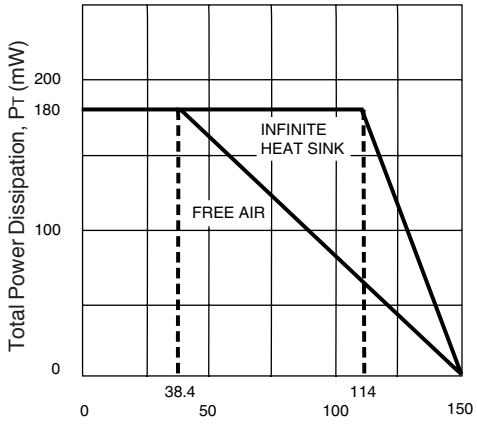
NE68518, NE68530
D.C. POWER DERATING CURVE



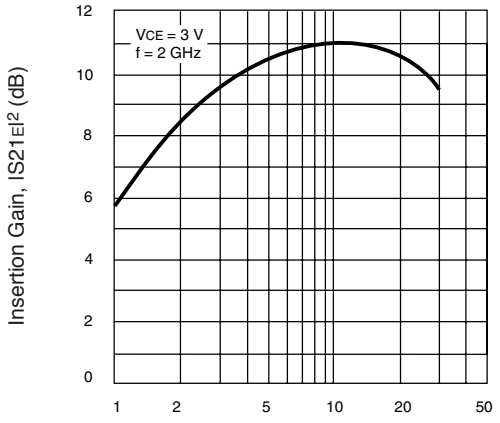
NE68519
D.C. POWER DERATING CURVE



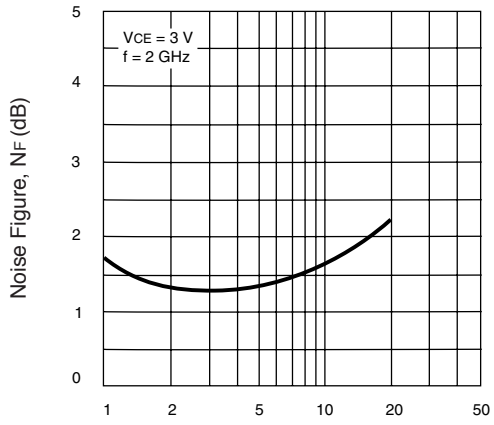
NE68533, NE68539
D.C. POWER DERATING CURVE



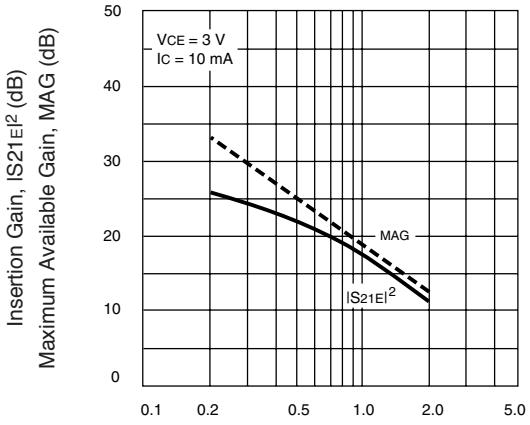
INSERTION GAIN vs.
COLLECTOR CURRENT



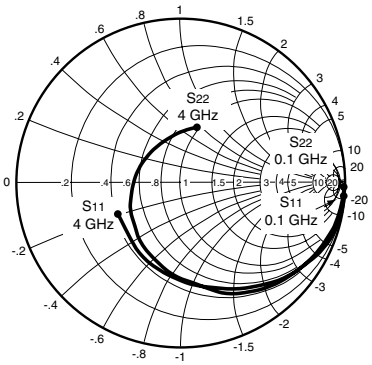
NOISE FIGURE
vs. COLLECTOR CURRENT



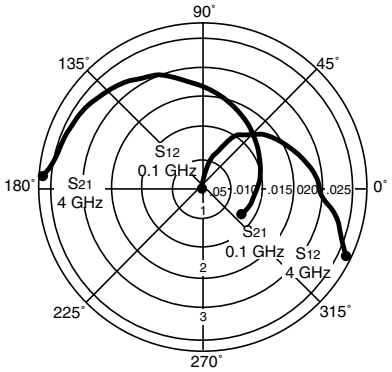
FORWARD INSERTION GAIN
AND MAXIMUM AVAILABLE GAIN
vs. FREQUENCY



TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



Coordinates in Ohms
Frequency in GHz
(V_{CE} = 2.5 V, I_C = 1 mA)



NE68518

V_{CE} = 0.5 V, I_C = 0.5 mA

FREQUENCY	S11		S21		S12		S22		K	MAG[1]
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.1	0.995	-7.200	1.819	170.500	0.030	88.600	0.997	-3.900	0.024	17.827
0.4	0.941	-29.200	1.756	148.100	0.107	67.200	0.969	-22.000	0.168	12.151
0.8	0.844	-56.800	1.619	119.000	0.193	45.300	0.893	-42.700	0.331	9.237
1.0	0.783	-69.300	1.530	106.100	0.225	35.800	0.853	-51.500	0.410	8.325
1.5	0.644	-99.500	1.331	77.200	0.263	15.800	0.750	-69.200	0.610	7.042
2.0	0.542	-126.400	1.163	53.400	0.279	-0.100	0.675	-84.400	0.792	6.200
2.5	0.469	-152.900	1.054	32.400	0.280	-13.000	0.629	-96.600	0.952	5.757
3.0	0.421	-179.100	0.965	14.800	0.283	-23.900	0.582	-108.400	1.097	3.431

V_{CE} = 1.0 V, I_C = 1.0 mA

0.1	0.985	-8.500	3.481	169.900	0.023	82.400	0.985	-5.500	0.108	21.800
0.4	0.917	-32.500	3.293	146.500	0.086	66.300	0.956	-24.300	0.172	15.831
0.8	0.771	-62.700	2.879	117.800	0.144	44.100	0.847	-45.300	0.347	13.009
1.0	0.696	-76.000	2.653	105.300	0.165	35.500	0.789	-53.300	0.440	12.063
1.5	0.536	-105.900	2.160	78.600	0.191	21.800	0.675	-70.500	0.634	10.534
2.0	0.430	-133.000	1.798	56.600	0.210	7.200	0.601	-83.800	0.831	9.326
2.5	0.361	-160.200	1.559	37.700	0.214	-0.900	0.554	-94.000	0.998	8.624
3.0	0.310	173.400	1.385	21.000	0.229	-7.500	0.513	-104.500	1.118	5.724
4.0	0.303	116.300	1.173	-10.100	0.255	-20.700	0.436	-130.100	1.253	3.601

V_{CE} = 2.5 V, I_C = 1.0 mA

0.1	0.986	-7.100	3.465	170.500	0.018	83.900	0.996	-4.400	0.103	22.844
0.4	0.926	-29.800	3.301	148.800	0.063	67.000	0.970	-21.200	0.174	17.193
0.8	0.799	-57.100	2.949	121.700	0.116	47.000	0.878	-39.900	0.345	14.052
1.0	0.728	-69.600	2.743	109.700	0.139	39.100	0.834	-47.800	0.419	12.952
1.5	0.573	-98.500	2.275	83.400	0.161	24.100	0.732	-63.800	0.610	11.502
2.0	0.455	-123.900	1.921	61.500	0.180	11.100	0.671	-76.200	0.789	10.283
2.5	0.364	-150.100	1.664	42.300	0.189	4.400	0.628	-85.500	0.944	9.447
3.0	0.311	-174.900	1.471	25.900	0.196	-4.300	0.586	-96.200	1.102	6.805
4.0	0.270	124.900	1.252	-5.200	0.226	-11.500	0.520	-118.800	1.207	4.685

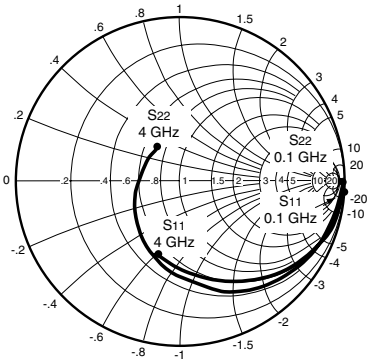
V_{CE} = 3.0 V, I_C = 10 mA

0.1	0.759	-22.200	22.471	157.900	0.018	81.900	0.906	-15.600	0.205	30.963
0.4	0.451	-68.600	13.915	114.600	0.047	62.800	0.646	-40.900	0.597	24.714
0.8	0.249	-101.700	8.120	88.400	0.068	51.600	0.472	-51.300	0.890	20.770
1.0	0.184	-116.600	6.664	79.400	0.079	50.400	0.435	-55.200	0.965	19.261
1.5	0.111	-153.200	4.559	61.500	0.114	45.400	0.398	-63.600	1.024	15.071
2.0	0.080	169.100	3.474	46.300	0.143	39.500	0.382	-73.500	1.072	12.212
2.5	0.078	130.600	2.832	31.700	0.172	30.800	0.372	-80.700	1.094	10.294
3.0	0.084	95.900	2.402	18.900	0.203	21.100	0.367	-90.700	1.100	8.809
4.0	0.149	68.500	1.921	-6.500	0.268	2.500	0.311	-112.900	1.080	6.829
5.0	0.282	46.400	1.635	-32.300	0.322	-17.000	0.208	-155.700	1.070	5.438

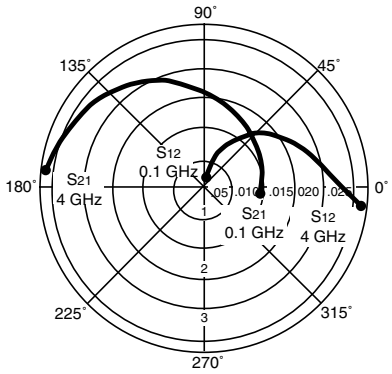
Note: 1. Gain Calculations:

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

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



Coordinates in Ohms
Frequency in GHz
(V_{CE} = 2.5 V, I_C = 1 mA)



NE68519

V_{CE} = 0.5 V, I_C = 0.5 mA

FREQUENCY	S11		S21		S12		S22		K	MAG[1]
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.1	0.983	-7.500	1.790	169.200	0.034	85.200	0.999	-6.200	0.064	17.214
0.4	0.944	-31.700	1.711	146.200	0.117	66.600	0.967	-22.300	0.169	11.651
0.8	0.838	-59.400	1.539	116.800	0.194	44.600	0.884	-41.400	0.359	8.994
1.0	0.779	-71.400	1.444	104.200	0.221	35.800	0.844	-49.300	0.443	8.152
1.5	0.646	-98.900	1.254	77.100	0.264	17.600	0.757	-64.300	0.644	6.767
2.0	0.531	-123.400	1.125	54.600	0.290	3.700	0.686	-77.100	0.816	5.888
2.5	0.438	-149.700	1.041	33.900	0.289	-6.300	0.622	-87.200	1.000	5.533
3.0	0.371	178.600	0.972	16.200	0.293	-16.600	0.568	-98.700	1.132	2.997

V_{CE} = 1.0 V, I_C = 1.0 mA

0.1	0.974	-7.900	3.439	169.200	0.024	81.200	0.998	-5.000	0.156	21.562
0.4	0.905	-35.600	3.225	144.300	0.087	63.200	0.943	-24.600	0.210	15.690
0.8	0.757	-65.100	2.742	115.500	0.150	46.000	0.829	-44.700	0.354	12.620
1.0	0.687	-77.600	2.500	103.600	0.167	36.900	0.775	-52.100	0.459	11.752
1.5	0.536	-104.500	2.026	78.200	0.198	22.500	0.674	-65.600	0.680	10.100
2.0	0.417	-127.700	1.711	57.400	0.216	13.000	0.607	-76.000	0.873	8.988
2.5	0.322	-155.300	1.511	38.400	0.228	5.000	0.546	-84.000	1.047	6.892
3.0	0.254	172.200	1.367	21.800	0.252	-0.500	0.496	-94.000	1.127	5.176
4.0	0.280	104.200	1.171	-9.300	0.283	-11.200	0.387	-120.900	1.240	3.217

V_{CE} = 2.5 V, I_C = 1.0 mA

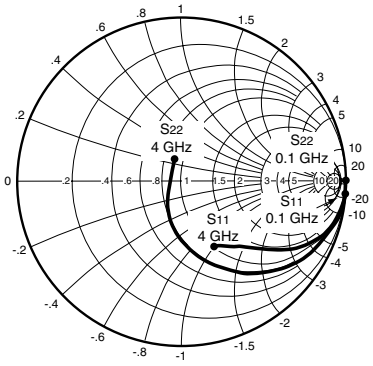
0.1	0.983	-9.100	3.424	169.500	0.020	83.400	0.996	-6.000	0.070	22.335
0.4	0.913	-31.900	3.197	147.200	0.078	66.500	0.961	-21.800	0.190	16.126
0.8	0.784	-59.700	2.774	119.400	0.127	48.500	0.864	-39.700	0.347	13.393
1.0	0.714	-71.600	2.548	107.600	0.144	39.600	0.818	-46.700	0.450	12.478
1.5	0.566	-97.300	2.102	82.700	0.173	25.900	0.727	-59.900	0.653	10.846
2.0	0.448	-119.900	1.783	62.000	0.190	17.100	0.659	-69.500	0.844	9.724
2.5	0.346	-142.800	1.564	43.800	0.201	10.000	0.609	-77.700	1.022	7.997
3.0	0.272	-169.700	1.425	27.300	0.217	4.500	0.564	-86.900	1.127	6.005
4.0	0.242	121.300	1.229	-3.600	0.258	-5.400	0.465	-110.900	1.216	3.974

V_{CE} = 3.0 V, I_C = 10 mA

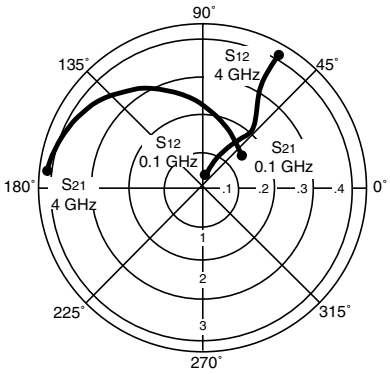
0.1	0.768	-24.000	22.184	155.700	0.020	73.100	0.903	-17.800	0.300	30.450
0.4	0.433	-70.300	12.973	112.600	0.048	61.600	0.612	-41.800	0.645	24.318
0.8	0.234	-98.400	7.396	87.200	0.076	55.200	0.451	-49.200	0.915	19.882
1.0	0.183	-107.300	6.039	78.700	0.089	53.500	0.424	-51.300	0.979	18.316
1.5	0.103	-121.300	4.147	61.400	0.126	47.300	0.399	-56.300	1.046	13.865
2.0	0.056	-130.100	3.169	46.700	0.161	40.900	0.388	-62.200	1.081	11.202
2.5	0.011	-162.800	2.593	33.400	0.198	33.300	0.382	-68.200	1.086	9.379
3.0	0.022	82.000	2.234	20.700	0.234	24.600	0.357	-76.700	1.090	7.974
4.0	0.129	68.400	1.809	-4.400	0.306	6.100	0.260	-102.000	1.078	6.017
5.0	0.249	49.800	1.548	-29.200	0.375	-14.000	0.164	-146.600	1.052	4.760

See note on previous page.

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



Coordinates in Ohms
Frequency in GHz
(V_{CE} = 2.5 V, I_C = 1 mA)



NE68530

V_{CE} = 0.5 V, I_C = 0.5 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	MAG[1]
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.1	0.986	-6.400	1.839	171.000	0.030	84.600	0.997	-4.000	0.098	17.875
0.4	0.938	-24.300	1.763	152.600	0.121	72.200	0.963	-15.800	0.207	11.635
0.8	0.821	-47.300	1.612	128.100	0.213	57.300	0.873	-29.300	0.384	8.790
1.0	0.749	-58.200	1.542	117.000	0.246	51.000	0.821	-35.000	0.472	7.971
1.5	0.581	-82.800	1.356	93.900	0.298	38.700	0.695	-46.100	0.685	6.580
2.0	0.457	-106.100	1.198	76.100	0.313	30.900	0.607	-54.900	0.863	5.829
2.5	0.368	-130.100	1.091	61.700	0.310	27.300	0.542	-63.100	1.030	4.410
3.0	0.323	-155.200	1.007	51.400	0.302	27.500	0.501	-71.000	1.162	2.791

V_{CE} = 1.0 V, I_C = 1.0 mA

0.1	0.986	-7.300	3.516	170.100	0.025	85.700	0.993	-4.800	0.082	21.481
0.4	0.900	-28.100	3.231	150.600	0.098	71.400	0.939	-18.100	0.220	15.181
0.8	0.735	-52.300	2.766	126.000	0.167	58.000	0.812	-32.000	0.418	12.191
1.0	0.651	-63.100	2.541	115.400	0.190	52.900	0.747	-37.300	0.516	11.263
1.5	0.463	-87.200	2.070	94.800	0.228	45.400	0.609	-46.400	0.741	9.580
2.0	0.339	-109.400	1.735	79.200	0.248	42.300	0.521	-52.900	0.922	8.448
2.5	0.258	-135.300	1.517	66.600	0.265	42.400	0.458	-59.300	1.053	6.169
3.0	0.219	-160.300	1.358	57.100	0.285	43.800	0.419	-65.400	1.131	4.582
4.0	0.220	149.000	1.143	41.200	0.341	46.700	0.377	-79.400	1.163	2.803

V_{CE} = 2.5 V, I_C = 1.0 mA

0.1	0.975	-6.900	3.412	171.000	0.022	83.700	0.990	-4.700	0.106	21.906
0.4	0.905	-26.200	3.207	151.400	0.078	72.200	0.948	-16.300	0.220	16.140
0.8	0.756	-48.000	2.779	128.300	0.138	60.800	0.841	-28.000	0.410	13.040
1.0	0.682	-57.100	2.569	118.500	0.156	56.100	0.792	-32.300	0.506	12.166
1.5	0.509	-75.600	2.098	100.000	0.188	51.600	0.679	-38.900	0.727	10.476
2.0	0.387	-89.500	1.762	85.500	0.208	50.400	0.616	-43.100	0.909	9.279
2.5	0.289	-102.100	1.550	74.500	0.223	53.100	0.577	-45.600	1.042	7.169
3.0	0.207	-114.700	1.397	65.200	0.247	55.100	0.548	-47.900	1.118	5.439
4.0	0.079	-165.800	1.190	51.000	0.315	61.100	0.510	-53.000	1.133	3.557

V_{CE} = 3.0 V, I_C = 10 mA

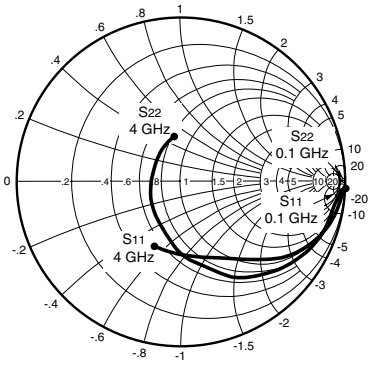
0.1	0.764	-21.200	20.910	154.700	0.020	82.600	0.910	-15.900	0.241	30.193
0.4	0.414	-54.500	11.575	114.900	0.052	72.800	0.590	-31.900	0.732	23.475
0.8	0.224	-63.500	6.493	96.100	0.091	71.000	0.457	-31.300	0.946	18.534
1.0	0.181	-63.500	5.306	90.300	0.109	70.500	0.433	-30.900	0.989	16.873
1.5	0.112	-57.800	3.640	80.700	0.157	73.300	0.396	-30.600	1.035	12.510
2.0	0.090	-42.600	2.805	72.600	0.202	70.700	0.389	-32.300	1.054	10.009
2.5	0.086	-27.100	2.314	66.400	0.250	69.600	0.392	-34.300	1.048	8.331
3.0	0.090	-16.300	2.002	60.500	0.292	67.100	0.389	-36.400	1.047	7.030
4.0	0.098	6.000	1.619	50.800	0.379	63.200	0.374	-41.800	1.033	5.200
5.0	0.119	48.700	1.441	42.600	0.464	57.500	0.307	-49.900	1.009	4.333

Note:

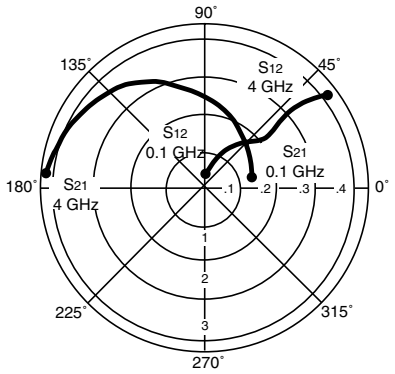
1. Gain Calculation:

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

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



Coordinates in Ohms
Frequency in GHz
(V_{CE} = 2.5 V, I_C = 1 mA)



NE68533

V_{CE} = 0.5 V, I_C = 0.5 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	MAG[1]
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.1	0.972	-5.500	1.901	170.500	0.035	85.600	0.998	-5.200	0.089	17.349
0.4	0.932	-27.300	1.813	149.900	0.129	69.000	0.955	-19.900	0.202	11.478
0.8	0.803	-52.500	1.670	122.400	0.222	52.000	0.856	-36.200	0.396	8.764
1.0	0.730	-63.900	1.582	110.500	0.254	45.100	0.803	-42.800	0.486	7.944
1.5	0.560	-90.700	1.382	85.700	0.299	31.600	0.686	-56.800	0.681	6.648
2.0	0.434	-116.300	1.218	66.500	0.310	22.800	0.604	-67.900	0.855	5.943
2.5	0.355	-143.400	1.095	51.200	0.305	17.500	0.558	-77.900	1.000	5.449
3.0	0.322	-171.000	1.020	39.300	0.291	17.400	0.522	-89.000	1.125	3.302

V_{CE} = 1.0 V, I_C = 1.0 mA

0.1	0.968	-7.000	3.509	170.100	0.029	84.200	0.995	-5.800	0.103	20.828
0.4	0.887	-31.300	3.234	147.200	0.103	68.200	0.928	-21.900	0.231	14.969
0.8	0.708	-58.800	2.767	119.700	0.170	52.700	0.790	-37.900	0.443	12.116
1.0	0.618	-70.000	2.533	108.800	0.192	47.400	0.727	-43.700	0.544	11.203
1.5	0.432	-96.400	2.036	86.400	0.223	39.300	0.601	-55.000	0.767	9.605
2.0	0.304	-122.100	1.711	69.000	0.243	36.000	0.521	-63.300	0.948	8.476
2.5	0.233	-150.700	1.482	55.100	0.260	35.300	0.473	-71.100	1.071	5.929
3.0	0.208	178.200	1.339	43.600	0.283	36.100	0.439	-79.700	1.122	4.625
4.0	0.243	125.700	1.142	25.100	0.358	36.500	0.396	-100.200	1.097	3.140

V_{CE} = 2.5 V, I_C = 1.0 mA

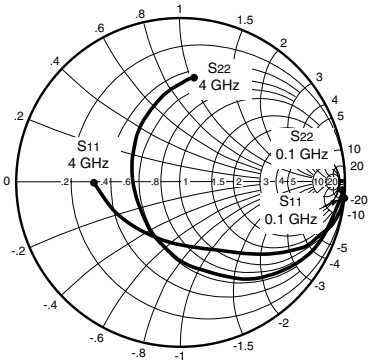
0.1	0.965	-6.600	3.502	170.700	0.024	83.800	0.997	-4.900	0.112	21.641
0.4	0.899	-28.400	3.250	149.500	0.087	70.400	0.942	-18.800	0.222	15.724
0.8	0.735	-53.600	2.835	123.300	0.146	55.900	0.823	-33.100	0.429	12.882
1.0	0.647	-64.000	2.618	112.700	0.166	50.800	0.767	-38.300	0.529	11.979
1.5	0.459	-88.200	2.135	90.500	0.196	43.200	0.651	-48.400	0.751	10.371
2.0	0.320	-110.600	1.797	73.100	0.216	40.500	0.576	-55.900	0.934	9.201
2.5	0.233	-137.000	1.559	59.000	0.234	40.400	0.531	-62.900	1.053	6.834
3.0	0.185	-167.900	1.404	47.600	0.258	41.900	0.498	-70.400	1.106	5.378
4.0	0.201	131.100	1.194	28.900	0.337	42.900	0.459	-88.600	1.062	3.973

V_{CE} = 3.0 V, I_C = 10 mA

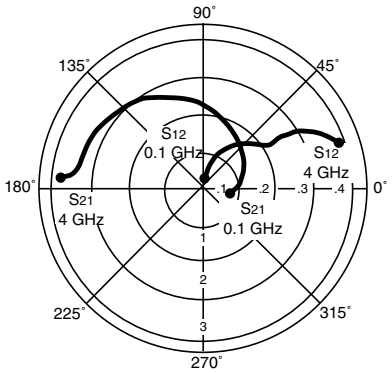
0.1	0.719	-23.600	21.206	153.800	0.020	77.800	0.909	-16.700	0.289	30.254
0.4	0.370	-58.400	11.262	112.100	0.056	68.700	0.570	-34.900	0.762	23.034
0.8	0.180	-70.900	6.280	91.400	0.096	68.900	0.428	-36.300	0.960	18.157
1.0	0.130	-71.700	5.142	85.100	0.117	68.400	0.400	-36.900	0.994	16.429
1.5	0.055	-66.900	3.540	72.600	0.168	65.900	0.363	-40.600	1.033	12.121
2.0	0.019	16.800	2.757	62.400	0.220	62.100	0.341	-45.900	1.037	9.798
2.5	0.045	61.700	2.272	53.100	0.270	57.600	0.324	-52.500	1.038	8.062
3.0	0.072	68.000	1.983	45.000	0.319	52.800	0.310	-60.200	1.027	6.928
4.0	0.127	71.700	1.625	30.200	0.410	43.000	0.283	-80.800	1.008	5.448
5.0	0.197	70.300	1.421	16.400	0.493	32.800	0.244	-108.000	0.993	4.597

See notes on previous page.

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



Coordinates in Ohms
Frequency in GHz
(V_{CE} = 2.5 V, I_C = 1 mA)



NE68539

V_{CE} = 0.5 V, I_C = 0.5 mA

FREQUENCY	S11		S21		S12		S22		K	MAG[1]
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.1	0.983	-4.600	1.823	172.300	0.028	83.300	0.996	-3.000	0.144	18.136
0.4	0.949	-24.900	1.773	153.300	0.111	71.600	0.977	-15.000	0.194	12.034
0.8	0.839	-49.500	1.684	129.000	0.204	56.000	0.882	-29.200	0.349	9.167
1.0	0.771	-61.500	1.629	117.900	0.243	47.900	0.832	-35.600	0.435	8.263
1.5	0.599	-93.900	1.483	91.400	0.299	31.300	0.687	-50.600	0.624	6.955
2.0	0.477	-126.900	1.320	69.800	0.320	18.900	0.572	-63.000	0.786	6.154
2.5	0.424	-160.200	1.180	52.000	0.310	9.800	0.486	-75.500	0.944	5.805
3.0	0.425	171.800	1.042	37.100	0.294	4.300	0.430	-88.700	1.107	3.506

V_{CE} = 1.0 V, I_C = 1.0 mA

0.1	0.965	-6.400	3.534	171.400	0.025	86.300	0.994	-3.900	0.082	21.503
0.4	0.906	-29.000	3.355	151.200	0.088	71.600	0.951	-17.600	0.186	15.812
0.8	0.753	-56.200	3.000	126.600	0.156	55.400	0.823	-32.200	0.379	12.840
1.0	0.667	-69.300	2.801	116.000	0.179	48.400	0.757	-38.400	0.469	11.945
1.5	0.478	-103.100	2.346	91.800	0.217	36.900	0.600	-51.500	0.674	10.339
2.0	0.369	-138.400	1.960	73.000	0.236	28.900	0.488	-62.100	0.846	9.193
2.5	0.339	-173.000	1.682	57.500	0.238	25.800	0.405	-73.300	1.006	8.021
3.0	0.359	160.600	1.457	44.300	0.247	23.100	0.349	-85.900	1.119	5.613
4.0	0.452	126.000	1.171	22.900	0.268	23.000	0.304	-117.800	1.199	3.709

V_{CE} = 2.5 V, I_C = 1.0 mA

0.1	0.982	-4.000	3.461	173.900	0.017	84.600	0.998	-2.900	0.109	23.088
0.4	0.921	-24.700	3.323	154.500	0.071	73.000	0.966	-14.200	0.195	16.703
0.8	0.775	-48.800	3.034	131.200	0.125	60.000	0.875	-25.800	0.363	13.851
1.0	0.700	-60.600	2.877	121.000	0.145	53.700	0.816	-30.800	0.452	12.976
1.5	0.502	-89.800	2.460	97.900	0.182	42.900	0.684	-41.100	0.658	11.309
2.0	0.364	-122.500	2.089	79.200	0.197	37.100	0.583	-49.700	0.834	10.255
2.5	0.300	-157.800	1.805	64.200	0.207	33.300	0.501	-58.100	0.996	9.405
3.0	0.309	170.700	1.578	50.800	0.216	33.300	0.448	-68.100	1.100	6.713
4.0	0.401	130.100	1.274	29.000	0.249	34.000	0.386	-94.100	1.146	4.768

V_{CE} = 3.0 V, I_C = 10 mA

0.1	0.729	-20.700	21.452	158.500	0.016	80.400	0.933	-12.700	0.233	31.273
0.4	0.417	-58.000	12.831	117.900	0.044	68.700	0.639	-31.100	0.689	24.648
0.8	0.196	-81.600	7.430	96.000	0.077	67.000	0.472	-33.200	0.927	19.845
1.0	0.133	-92.600	6.128	89.300	0.092	65.700	0.426	-33.900	0.984	18.235
1.5	0.060	-155.000	4.250	76.100	0.133	64.000	0.357	-37.400	1.033	13.938
2.0	0.101	144.800	3.281	65.500	0.171	61.200	0.303	-44.600	1.054	11.406
2.5	0.164	125.900	2.687	56.400	0.207	57.300	0.249	-54.500	1.068	9.535
3.0	0.230	117.000	2.295	47.600	0.246	53.400	0.208	-67.800	1.055	8.262
4.0	0.349	104.600	1.808	31.300	0.311	44.000	0.160	-112.500	1.035	6.491
5.0	0.450	93.100	1.506	16.700	0.367	33.500	0.199	-160.400	1.011	5.500

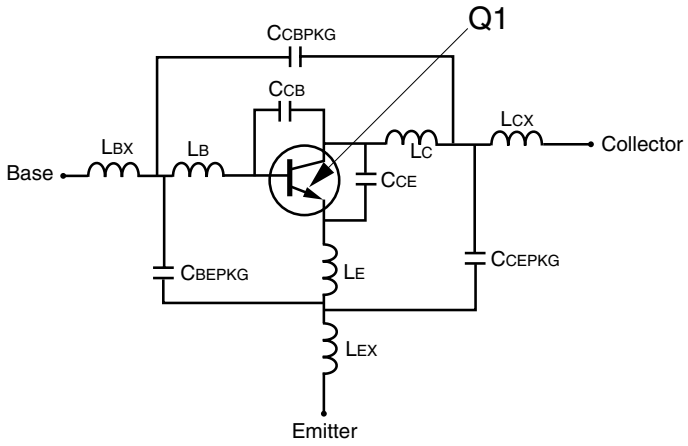
Note:
1. Gain Calculation:

$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right)$. 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

NE68518 NONLINEAR MODEL

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS (1)

Parameters	Q1	Parameters	Q1
IS	7e-16	MJC	0.34
BF	109	XCJC	0
NF	1	CJS	0
VAF	15	VJS	0.75
IKF	0.19	MJS	0
ISE	7.9e-13	FC	0.5
NE	2.19	TF	2e-12
BR	1	XTF	5.2
NR	1.08	VTF	4.58
VAR	12.4	ITF	0.011
IKR	Infinity	PTF	0
ISC	0	TR	1e-9
NC	2	EG	1.11
RE	1.3	XTB	0
RB	10	XTI	3
RBM	8.34	KF	0
IRB	0.009	AF	1
RC	10		
CJE	0.4e-12		
VJE	0.81		
MJE	0.5		
CJC	0.18e-12		
VJC	0.75		

(1) Gummel-Poon Model

UNITS

Parameter	Units
time	seconds
capacitance	farads
inductance	henries
resistance	ohms
voltage	volts
current	amps

ADDITIONAL PARAMETERS

Parameters	NE68518
C_{CB}	0.13e-12
C_{CE}	0.14e-12
L_B	1.55e-9
L_C	1.25e-9
L_E	0.94e-9
C_{CBPKG}	0.066e-12
C_{CEPKG}	0.44e-12
C_{BEPKG}	0.36e-12
L_{BX}	0.18e-9
L_{CX}	0.18e-9
L_{EX}	0.09e-9

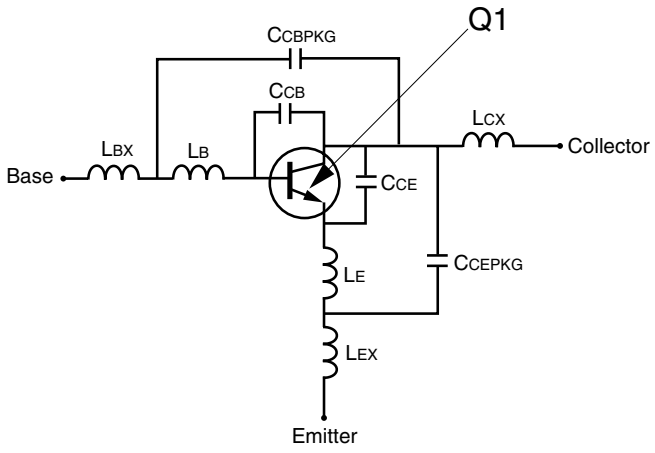
MODEL RANGE

Frequency: 0.05 to 3.0 GHz

Bias: V_{CE} = 0.5 V to 3.0 V, I_C = 0.5 mA to 20 mA

NE68519 NONLINEAR MODEL

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS (1)

Parameters	Q1	Parameters	Q1
IS	7.0e-16	MJC	0.34
BF	109	XCJC	0
NF	1	CJS	0
VAF	15	VJS	0.75
IKF	0.19	MJS	0
ISE	7.90e-13	FC	0.5
NE	2.19	TF	2.0e-12
BR	1	XTF	5.2
NR	1.08	VTF	4.58
VAR	12.4	ITF	0.011
IKR	Infinity	PTF	0
ISC	0	TR	1.0e-9
NC	2	EG	1.11
RE	1.3	XTB	0
RB	10	XTI	3
RBM	8.34	KF	0
IRB	0.009	AF	1
RC	10		
CJE	0.4e-12		
VJE	0.81		
MJE	0.5		
CJC	0.18e-12		
VJC	0.75		

(1) Gummel-Poon Model

UNITS

Parameter	Units
time	seconds
capacitance	farads
inductance	henries
resistance	ohms
voltage	volts
current	amps

ADDITIONAL PARAMETERS

Parameters	68519
C_{CB}	0.13e-12
C_{CE}	0.14e-12
L_B	0.9e-9
L_E	0.9e-9
C_{CBPKG}	0.17e-12
C_{CEPKG}	0.21e-12
L_{BX}	0.19e-9
L_{CX}	0.19e-9
L_{EX}	0.19e-9

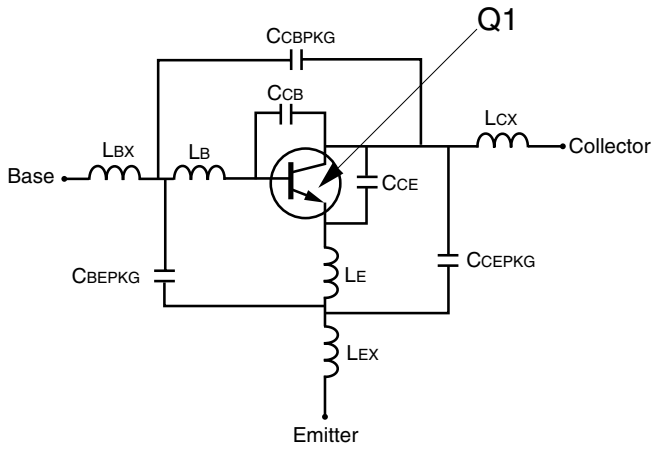
MODEL RANGE

Frequency: 0.05 to 3.0 GHz

Bias: V_{CE} = 0.5 V to 3.0 V, I_C = 0.5 mA to 20 mA

NE68530 NONLINEAR MODEL

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS (1)

Parameters	Q1	Parameters	Q1
IS	7e-16	MJC	0.34
BF	109	XCJC	0
NF	1	CJS	0
VAF	15	VJS	0.75
IKF	0.19	MJS	0
ISE	7.9e-13	FC	0.5
NE	2.19	TF	2e-12
BR	1	XTF	5.2
NR	1.08	VTF	4.58
VAR	12.4	ITF	0.011
IKR	Infinity	PTF	0
ISC	0	TR	1e-9
NC	2	EG	1.11
RE	1.3	XTB	0
RB	10	XTI	3
RBM	8.34	KF	0
IRB	0.009	AF	1
RC	10		
CJE	0.40e-12		
VJE	0.81		
MJE	0.5		
CJC	0.18e-12		
VJC	0.75		

(1) Gummel-Poon Model

UNITS

Parameter	Units
time	seconds
capacitance	farads
inductance	henries
resistance	ohms
voltage	volts
current	amps

ADDITIONAL PARAMETERS

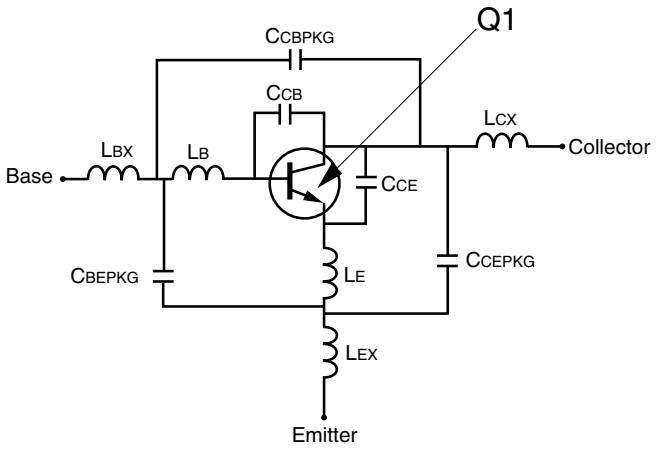
Parameters	68530
C_{CB}	0.13e-12
C_{CE}	0.14e-12
L_B	0.41e-9
L_E	1.43e-9
C_{CBPKG}	0.12e-12
C_{CEPKG}	0.04e-12
C_{BEPKG}	0.04e-12
L_{BX}	0.2e-9
L_{CX}	0.2e-9
L_{EX}	0.2e-9

MODEL RANGE

Frequency: 0.05 to 3.0 GHz
Bias: V_{CE} = 0.5 V to 3 V, I_C = 0.5 mA to 10 mA
Date: 10/25/96

NE68533 NONLINEAR MODEL

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS (1)

Parameters	Q1	Parameters	Q1
IS	7e-16	MJC	0.34
BF	109	XCJC	0
NF	1	CJS	0
VAF	15	VJS	0.75
IKF	0.19	MJS	0
ISE	7.9e-13	FC	0.5
NE	2.19	TF	2e-12
BR	1	XTF	5.2
NR	1.08	VTF	4.58
VAR	12.4	ITF	0.011
IKR	Infinity	PTF	0
ISC	0	TR	1e-9
NC	2	EG	1.11
RE	1.3	XTB	0
RB	10	XTI	3
RBM	8.34	KF	0
IRB	0.009	AF	1
RC	10		
CJE	0.40e-12		
VJE	0.81		
MJE	0.5		
CJC	0.18e-12		
VJC	0.75		

(1) Gummel-Poon Model

UNITS

Parameter	Units
time	seconds
capacitance	farads
inductance	henries
resistance	ohms
voltage	volts
current	amps

ADDITIONAL PARAMETERS

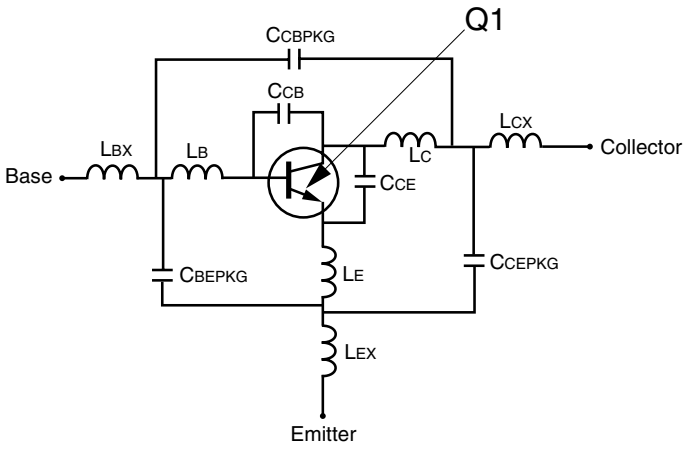
Parameters	68533
C_{CB}	0.13e-12
C_{CE}	0.14e-12
L_B	0.85e-9
L_E	1.15e-9
C_{CBPKG}	0.15e-12
C_{CEPKG}	0.1e-12
C_{BEPKG}	0.05e-12
L_{BX}	0.3e-9
L_{CX}	0.3e-9
L_{EX}	0.3e-9

MODEL RANGE

Frequency: 0.05 to 3.0 GHz
Bias: V_{CE} = 0.5 V to 6 V, I_C = 0.5 mA to 20 mA
Date: 7/97

NE68539 NONLINEAR MODEL

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS (1)

Parameters	Q1	Parameters	Q1
IS	7e-16	MJC	0.34
BF	109	XCJC	0
NF	1	CJS	0
VAF	15	VJS	0.75
IKF	0.19	MJS	0
ISE	7.9e-13	FC	0.5
NE	2.19	TF	2e-12
BR	1	XTF	5.2
NR	1.08	VTF	4.58
VAR	12.4	ITF	0.011
IKR	Infinity	PTF	0
ISC	0	TR	1e-9
NC	2	EG	1.11
RE	1.3	XTB	0
RB	10	XTI	3
RBM	8.34	KF	0
IRB	0.009	AF	1
RC	10		
CJE	0.4e-12		
VJE	0.81		
MJE	0.5		
CJC	0.18e-12		
VJC	0.75		

(1) Gummel-Poon Model

UNITS

Parameter	Units
time	seconds
capacitance	farads
inductance	henries
resistance	ohms
voltage	volts
current	amps

ADDITIONAL PARAMETERS

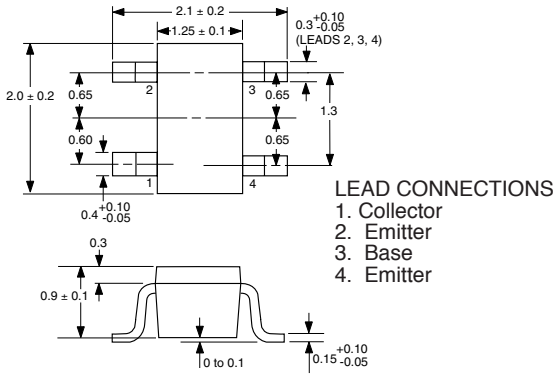
Parameters	68539
C_{CB}	0.13e-12
C_{CE}	0.14e-12
L_B	1.34e-9
L_C	0.7e-9
L_E	0.99e-9
C_{CBPKG}	0.08e-12
C_{CEPKG}	0.08e-12
C_{BEPKG}	0.01e-12
L_{BX}	0.39e-9
L_{CX}	0.39e-9
L_{EX}	0.2e-9

MODEL RANGE

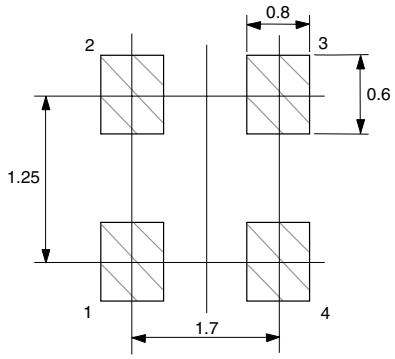
Frequency: 0.05 to 3.0 GHz
Bias: V_{CE} = 0.5 V to 3.0 V, I_C = 0.5 mA to 20 mA
Date: 6/12/96

OUTLINE DIMENSIONS[1] (Units in mm)

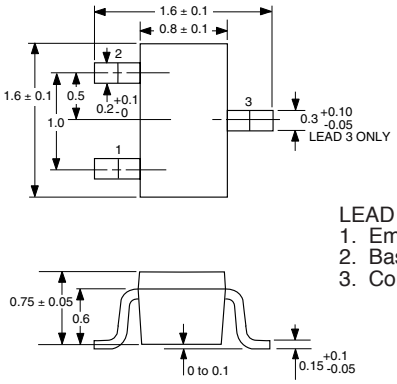
PACKAGE OUTLINE 18
(SOT-343)



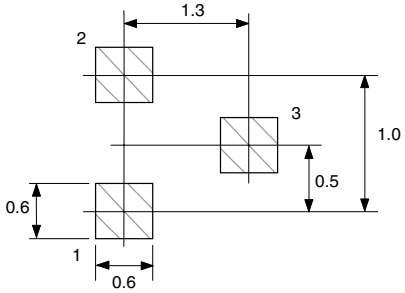
OUTLINE 18
RECOMMENDED P.C.B. LAYOUT



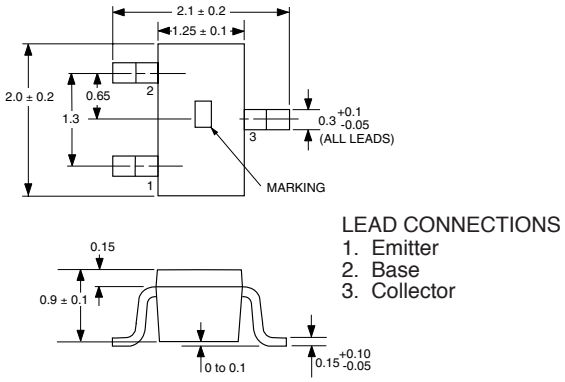
PACKAGE OUTLINE 19



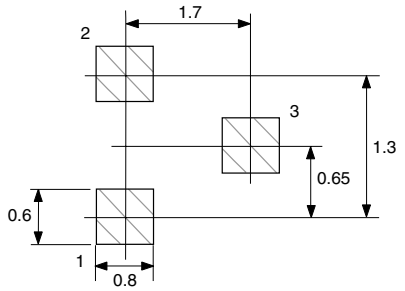
OUTLINE 19
RECOMMENDED P.C.B. LAYOUT



PACKAGE OUTLINE 30
(SOT-323)

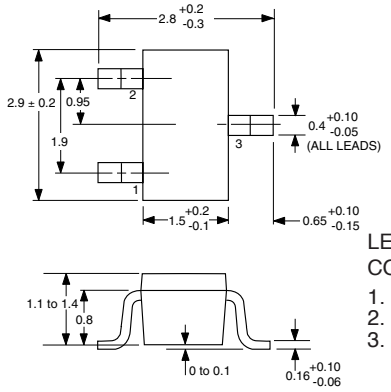


OUTLINE 30
RECOMMENDED P.C.B. LAYOUT



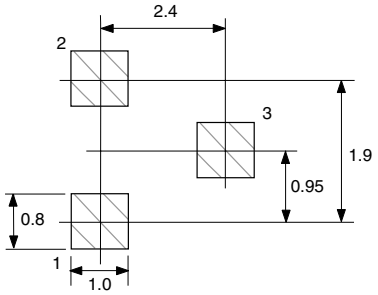
OUTLINE DIMENSIONS[1] (Units in mm)

PACKAGE OUTLINE 33
(SOT-23)

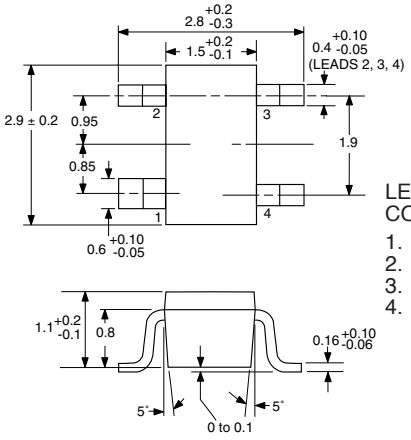


LEAD CONNECTIONS
1. Emitter
2. Base
3. Collector

OUTLINE 33
RECOMMENDED P.C.B. LAYOUT

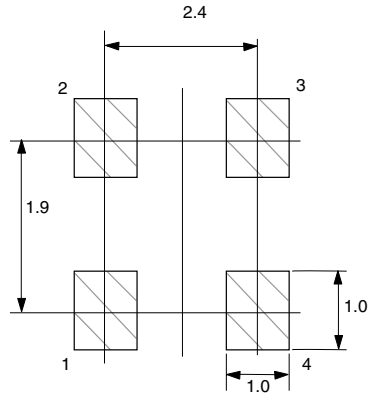


PACKAGE OUTLINE 39
(SOT-143)

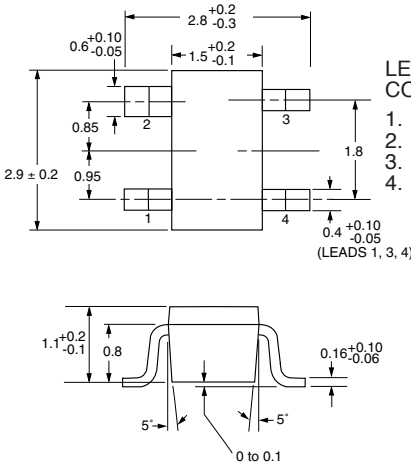


LEAD CONNECTIONS
1. Collector
2. Emitter
3. Base
4. Emitter

OUTLINE 39
RECOMMENDED P.C.B. LAYOUT

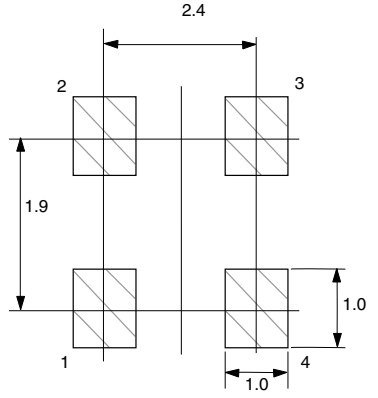


PACKAGE OUTLINE 39R
(SOT-143)



LEAD CONNECTIONS
1. Emitter
2. Collector
3. Emitter
4. Base

OUTLINE 39R
RECOMMENDED P.C.B. LAYOUT



ORDERING INFORMATION

PART NUMBER	QUANTITY	PACKAGING
NE68518-T1-A	3000	Tape & Reel
NE68519-T1-A	3000	Tape & Reel
NE68530-T1-A	3000	Tape & Reel
NE68533-T1-A	3000	Tape & Reel
NE68539-T1-A	3000	Tape & Reel
NE68539R-T1	3000	Tape & Reel

Note:

1. Lead material: Cu
   Lead plating: PbSn

Life Support Applications
These NEC products are not intended for use in life support devices, appliances, or systems where the malfunction of these products can reasonably be expected to result in personal injury. The customers of CEL using or selling these products for use in such applications do so at their own risk and agree to fully indemnify CEL for all damages resulting from such improper use or sale.

CEL California Eastern Laboratories

4590 Patrick Henry Drive
Santa Clara, CA 95054-1817
Telephone: (408) 919-2500
Facsimile: (408) 988-0279

Subject: Compliance with EU Directives

CEL certifies, to its knowledge, that semiconductor and laser products detailed below are compliant with the requirements of European Union (EU) Directive 2002/95/EC Restriction on Use of Hazardous Substances in electrical and electronic equipment (RoHS) and the requirements of EU Directive 2003/11/EC Restriction on Penta and Octa BDE.

CEL Pb-free products have the same base part number with a suffix added. The suffix –A indicates that the device is Pb-free. The –AZ suffix is used to designate devices containing Pb which are exempted from the requirement of RoHS directive (*). In all cases the devices have Pb-free terminals. All devices with these suffixes meet the requirements of the RoHS directive.

This status is based on CEL's understanding of the EU Directives and knowledge of the materials that go into its products as of the date of disclosure of this information.

Restricted Substance per RoHS	Concentration Limit per RoHS (values are not yet fixed)	Concentration contained in CEL devices	
Lead (Pb)	< 1000 PPM	-A	-AZ
		Not Detected	(*)
Mercury	< 1000 PPM	Not Detected	
Cadmium	< 100 PPM	Not Detected	
Hexavalent Chromium	< 1000 PPM	Not Detected	
PBB	< 1000 PPM	Not Detected	
PBDE	< 1000 PPM	Not Detected	

If you should have any additional questions regarding our devices and compliance to environmental standards, please do not hesitate to contact your local representative.

Important Information and Disclaimer: Information provided by CEL on its website or in other communications concerting the substance content of its products represents knowledge and belief as of the date that it is provided. CEL bases its knowledge and belief on information provided by third parties and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. CEL has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. CEL and CEL suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.
In no event shall CEL's liability arising out of such information exceed the total purchase price of the CEL part(s) at issue sold by CEL to customer on an annual basis.
See CEL Terms and Conditions for additional clarification of warranties and liability.