NEC

NPN SILICON OSCILLATOR AND MIXER TRANSISTOR

NE944 SERIES

FEATURES

- **LOW COST**
- **HIGH GAIN BANDWIDTH PRODUCT:** f_T = 2000 MHz TYP
- **LOW COLLECTOR TO BASE TIME CONSTANT:** $C_C \bullet r_{b'b}$ = 5 ps TYP
- **LOW FEEDBACK CAPACITANCE:** C_{RE}= 0.55 pF TYP

DESCRIPTION

The NE944 series of NPN silicon epitaxial bipolar transistors is intended for use in general purpose UHF oscillator and mixer applications. It is suitable for automotive keyless entry and TV tuner designs.

The device features stable oscillation and small frequency drift during changes in the supply voltage and over the ambient temperature range.

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE CODE			NE94430 2SC4184 30			NE94433 2SC3545 33		
SYMBOLS	**PARAMETERS AND CONDITIONS**	**UNITS**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**
I_{CBO}	Collector Cutoff Current, V_{CB} = 12 V, I_E = 0	µA			0.1			0.1
h_{FE}	DC Current Gain, V_{CE} = 10 V, I_C = 5.0 mA		40	100	200	50	100	250
$V_{CE(sat)}$	Collector Saturation Voltage, I_C = 10 mA, I_B = 1.0 mA	V			0.5			0.5
f_T	Gain Bandwidth Product, V_{CE} = 3 V, I_E = 5 mA	GHz	1.2	2.0			1.3	2.0
C_{OB}	Output Capacitance, V_{CB} = 3 V, I_E = 0 mA, f = 1.0 MHz	pF		0.7	1.2			
$C_C \bullet r_{b'b}$	Collector to Base Time Constant, V_{CE} = 3 V, I_E = -5.0 mA, f = 31.9 MHz	ps		3.5	8.0		5.0	
C_{RE}	Feedback Capacitance, V_{CB} = 10 V, I_E = 0 mA, f = 1.0 MHz	pF				0.55	1.0	
$R_{TH\ (J\text{-}C)}$	Thermal Resistance, Junction to Case (infinite heat sink)	°C/W			200			200
$R_{TH\ (J\text{-}A)}$	Thermal Resistance, Junction to Ambient (free air)	°C/W			833			620
P_T	Power Dissipation	mW			150			150

Note:
1. Electronic Industrial Association of Japan.

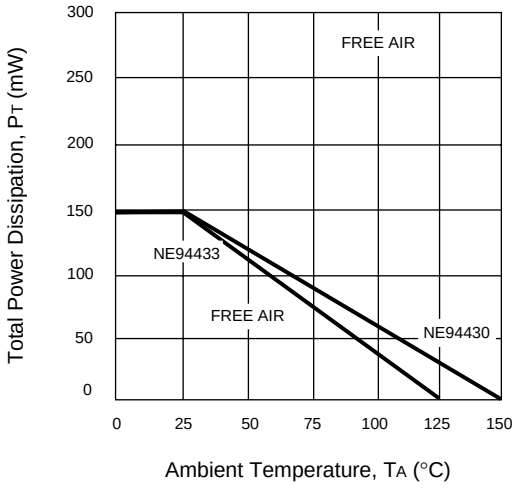
ABSOLUTE MAXIMUM RATINGS[1] (T_A = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	30
V_{CEO}	Collector to Emitter Voltage	V	15
V_{EBO}	Emitter to Base Voltage	V	3.0
I_C	Collector Current	mA	50
T_J	Junction Temperature NE94432, NE94433 NE94430	 °C °C	 125 150
T_{STG}	Storage Temperature	°C	-55 to +125

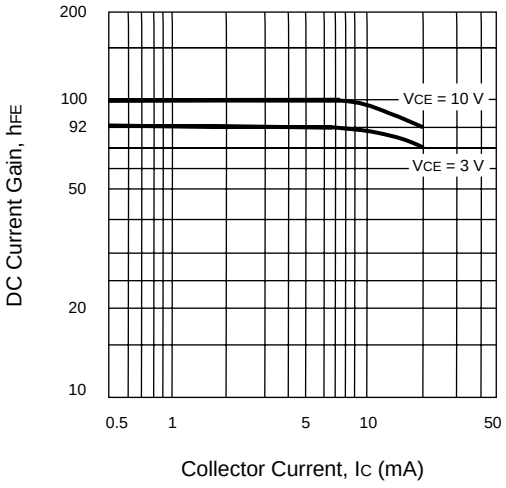
Note:
1. Operation in excess of any one of these parameters may result in permanent damage.

TYPICAL PERFORMANCE CURVES (T_A = 25°C)

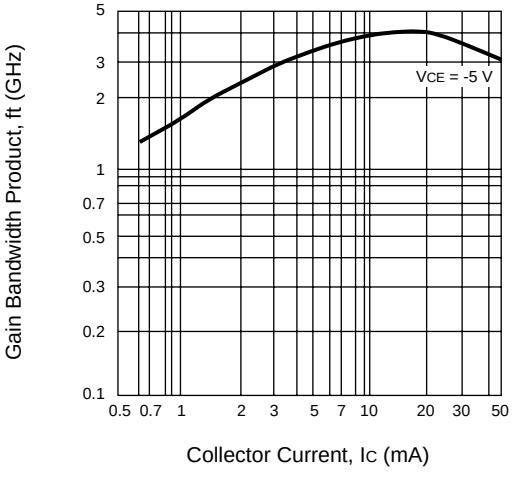
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



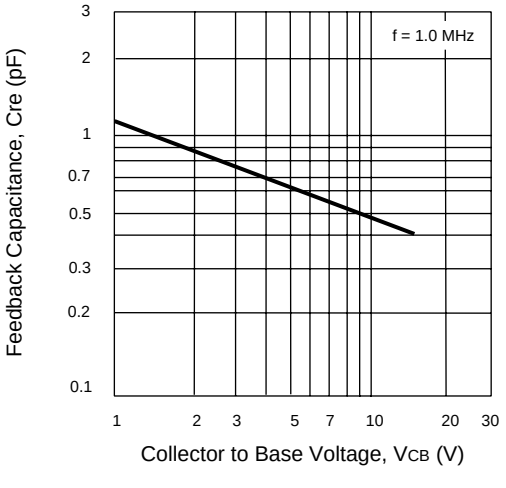
DC CURRENT GAIN vs. COLLECTOR CURRENT



GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



TYPICAL DEVICE CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



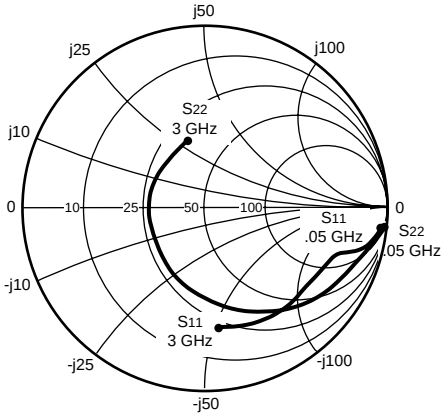
NE94430
TYPICAL NOISE PARAMETERS (T_A = 25°C)

FREQ. (MHz)	NF_{OPT} (dB)	G_A (dB)	Γ_{OPT} MAG	Γ_{OPT} ANG	Rn/50
V_{CE} = 2.5 V, I_C = 2.5 mA					
500	3.2	11.34	0.33	63	0.75
1000	5.4	7.22	0.29	142	0.45
1500	6.7	4.44	0.32	165	0.64
V_{CE} = 3 V, I_C = 5 mA					
500	3.8	12.67	0.27	79	0.70
1000	6.3	8.28	0.28	168	0.48
1500	8.3	5.58	0.38	-175	0.55
V_{CE} = 10 V, I_C = 5 mA					
500	3.8	13.88	0.27	69	0.75
1000	6.3	9.53	0.27	160	0.58
1500	8.3	6.63	0.32	174	0.68

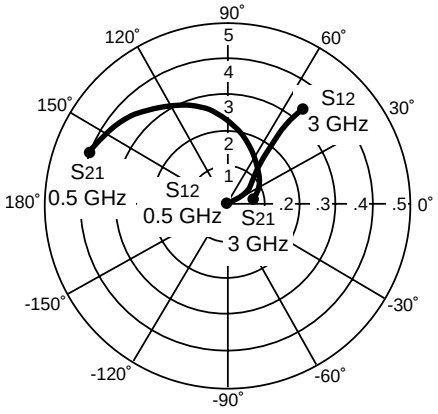
NE94433
TYPICAL NOISE PARAMETERS (T_A = 25°C)

FREQ. (MHz)	NF_{OPT} (dB)	G_A (dB)	Γ_{OPT} MAG	Γ_{OPT} ANG	Rn/50	V_{CE} (V)	I_C (mA)
V_{CE} = 8 V, I_C = 5 mA							
500	3.6	13.00	.43	51	1.0	8	5
1000	5.8	9.34	.29	113	0.7	8	5
V_{CE} = 10 V, I_C = 5 mA							
500	3.6	12.90	.44	.51	1.04	10	5
1000	6.0	8.90	.32	117	.70	10	5

TYPICAL COMMON EMITTER SCATTERING PARAMETERS (T_A = 25°C)



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



NE94430

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

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	S_{21}	MAG[1]
(MHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)	(dB)
50	.929	-13.0	4.051	160.3	.017	89.3	.977	-6.0	0.10	12.2	23.8
100	.854	-24.4	3.892	148.7	.030	66.4	.936	-10.9	0.47	11.8	21.1
200	.735	-50.1	3.591	129.9	.049	56.9	.843	-16.2	0.65	11.1	18.7
300	.608	-74.2	3.285	114.9	.060	53.8	.788	-18.4	0.78	10.3	17.4
400	.498	-96.3	2.956	102.1	.069	52.3	.756	-19.9	0.89	9.4	16.3
500	.423	-113.8	2.607	92.2	.076	52.4	.738	-21.8	0.99	8.3	15.4
600	.382	-126.3	2.273	84.7	.084	53.1	.728	-23.7	1.06	7.1	12.8
700	.355	-136.7	2.013	78.4	.091	54.1	.721	-25.7	1.13	6.1	11.3
800	.338	-145.4	1.803	72.9	.099	54.6	.717	-28.0	1.17	5.1	10.1
900	.327	-152.6	1.630	68.0	.107	55.3	.713	-30.2	1.21	4.2	9.1
1000	.318	-159.5	1.490	63.5	.115	56.0	.710	-32.6	1.22	3.5	8.2
1500	.308	172.6	1.071	45.4	.157	58.2	.704	-43.9	1.25	0.6	5.4
2000	.315	148.6	0.851	31.3	.201	58.7	.702	-56.4	1.20	-1.4	3.7
2500	.340	125.9	0.710	21.1	.257	58.2	.691	-69.1	1.14	-3.0	2.1
3000	.379	105.4	0.614	14.8	.326	55.2	.670	-82.8	1.11	-4.2	0.8

V_{CE} = 3 V, I_{CE} = 5 mA

50	.819	-19.8	7.561	154.4	.014	88.3	.946	-8.5	0.20	17.6	27.3
100	.740	-38.0	6.980	138.9	.025	63.8	.874	-13.2	0.57	16.9	24.5
200	.511	-76.6	5.906	117.4	.037	59.4	.771	-15.6	0.77	15.4	22.0
300	.414	-106.3	4.762	101.6	.046	58.2	.732	-16.4	0.92	13.6	20.2
400	.354	-125.6	3.819	91.5	.052	59.9	.713	-17.5	1.07	11.6	17.0
500	.326	-138.4	3.152	84.3	.064	60.3	.705	-19.2	1.09	10.0	15.1
600	.313	-147.8	2.671	78.4	.072	61.7	.701	-21.1	1.15	8.5	13.3
700	.306	-155.6	2.318	73.3	.081	62.4	.699	-23.2	1.18	7.3	12.0
800	.303	-162.1	2.050	68.7	.089	62.7	.697	-25.4	1.21	6.2	10.8
900	.302	-167.8	1.839	64.4	.098	63.2	.696	-27.7	1.22	5.3	9.9
1000	.303	-173.3	1.669	60.4	.106	63.5	.695	-30.1	1.24	4.4	9.0
1500	.316	163.0	1.169	43.8	.151	64.6	.696	-41.4	1.19	1.4	6.3
2000	.333	141.1	0.914	30.2	.198	64.3	.699	-53.8	1.12	-0.8	4.6
2500	.361	119.9	0.751	20.2	.259	62.8	.691	-66.3	1.05	-2.5	3.3
3000	.401	100.9	0.642	13.9	.332	58.7	.672	-79.9	1.02	-3.8	2.0

Note:

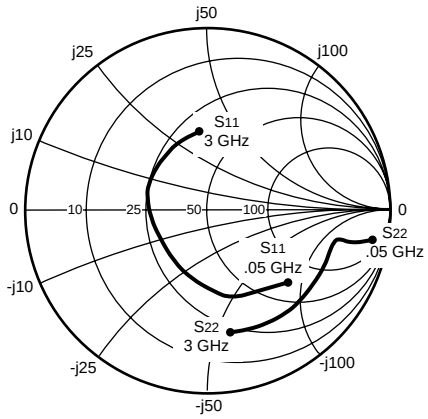
1. Gain Calculations:

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 = $\frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\,|S_{12}\,S_{21}|}$, $\Delta = S_{11}\,S_{22} - S_{21}\,S_{12}$

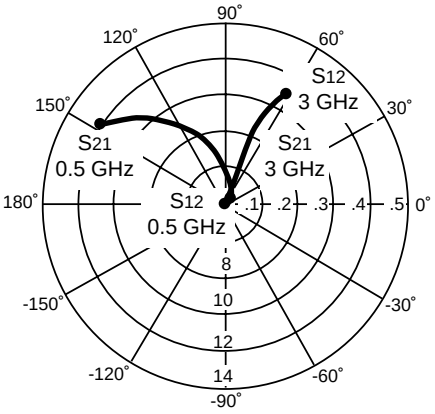
MAG = Maximum Available Gain

MSG = Maximum Stable Gain

TYPICAL COMMON EMITTER SCATTERING PARAMETERS (T_A = 25°C)



Coordinates in Ohms
Frequency in GHz
(V_{CE} = 3 V, I_C = 10 mA)



NE94430

V_{CE} = 3 V, I_C = 10 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	S_{21}	MAG
(MHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)	(dB)
50	.585	-42.0	12.113	141.5	.010	70.5	.896	-11.0	0.64	21.7	30.8
100	.496	-76.7	10.005	124.0	.015	60.1	.799	-13.5	0.95	20.0	28.2
200	.354	-119.1	6.964	102.0	.028	63.7	.721	-13.4	1.05	16.9	22.5
300	.320	-138.2	5.042	91.6	.039	65.1	.702	-14.0	1.12	14.0	19.1
400	.313	-150.2	3.910	84.5	.049	66.7	.693	-15.4	1.16	11.8	16.6
500	.310	-158.3	3.184	78.7	.058	66.7	.690	-17.3	1.21	10.1	14.6
600	.313	-164.8	2.680	73.6	.067	67.6	.689	-19.5	1.23	8.6	13.1
700	.317	-170.5	2.316	69.1	.076	68.2	.689	-21.8	1.24	7.3	11.9
800	.322	-175.4	2.040	64.8	.084	68.2	.689	-24.2	1.26	6.2	10.8
900	.326	-179.9	1.824	60.8	.093	68.6	.690	-26.6	1.26	5.2	9.9
1000	.330	175.5	1.652	57.1	.101	68.7	.690	-29.1	1.27	4.4	9.0
1500	.354	154.6	1.145	41.2	.148	70.1	.694	-41.0	1.18	1.2	6.3
2000	.374	134.2	0.887	28.1	.202	69.0	.697	-53.8	1.07	-1.0	4.8
2500	.402	114.4	0.722	18.6	.269	66.2	.689	-66.7	1.01	-2.8	3.7
3000	.438	96.2	0.613	13.2	.347	60.7	.668	-80.6	1.01	-4.3	2.1

V_{CE} = 10 V, Ic = 5 mA

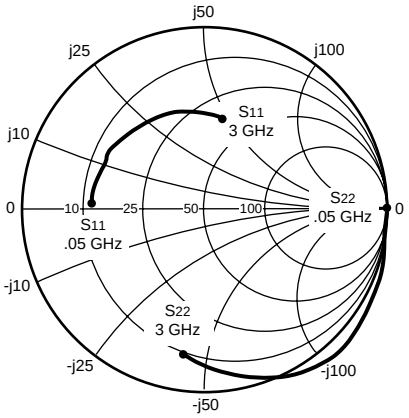
50	.860	-17.7	7.577	156.2	.012	79.9	.960	-6.1	0.30	17.6	28.0
100	.788	-35.1	6.982	141.8	.021	60.9	.909	-10.2	0.57	16.9	25.2
200	.574	-68.0	6.049	120.3	.033	60.0	.826	-12.6	0.71	15.6	22.6
300	.428	-95.6	4.966	104.4	.039	59.9	.792	-13.6	0.86	13.9	21.0
400	.349	-114.9	4.020	93.9	.045	61.9	.776	-14.7	0.98	12.1	19.5
500	.312	-127.9	3.329	86.6	.053	62.5	.768	-16.3	1.04	10.4	16.7
600	.293	-138.0	2.823	80.7	.060	63.9	.765	-18.1	1.09	9.0	14.9
700	.282	-146.3	2.450	75.6	.067	64.5	.763	-19.9	1.13	7.8	13.5
800	.277	-153.6	2.165	70.9	.074	65.0	.762	-22.0	1.15	6.7	12.3
900	.274	-159.8	1.941	66.7	.082	66.0	.761	-24.0	1.15	5.8	11.4
1000	.273	-165.8	1.759	62.8	.088	66.3	.760	-26.1	1.18	4.9	10.4
1500	.283	168.0	1.223	46.3	.126	68.6	.763	-36.0	1.12	1.7	7.8
2000	.301	144.3	0.949	32.5	.167	69.7	.768	-46.8	1.03	-0.5	6.6
2500	.334	121.7	0.772	22.0	.221	69.6	.766	-57.6	0.93	-2.2	5.4
3000	.380	101.5	0.649	15.0	.290	66.7	.755	-69.3	0.87	-3.8	3.5

Note:
1. Gain Calculations:

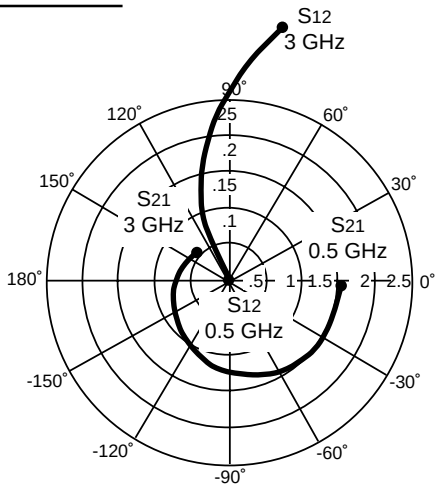
MAG = $\frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right)$. When K ≤ 1, MAG is undefined and MSG values are used. MSG = $\frac{|S_{21}|}{|S_{12}|}$, K = $\frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\,|S_{12}\,S_{21}|}$, $\Delta = S_{11}\,S_{22} - S_{21}\,S_{12}$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

TYPICAL COMMON BASE SCATTERING PARAMETERS (TA = 25°C)



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



NE94430

V_{CB} = 2.5 V, I_C = 2.5 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	S_{21}	MAG[1]
(MHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)	(dB)
50	.622	178.7	1.602	-2.4	.001	60.6	0.996	-0.6	-0.104	4.1	27.2
100	.623	176.6	1.599	-5.5	.004	101.3	0.999	-1.6	-0.114	4.1	25.8
200	.622	172.6	1.601	-11.7	.009	101.2	1.004	-4.1	-0.280	4.1	22.5
400	.615	164.8	1.567	-25.0	.019	106.4	1.015	-9.4	-0.470	3.9	19.2
600	.604	157.0	1.525	-38.5	.033	111.8	1.038	-15.1	-0.610	3.7	16.6
800	.598	149.4	1.467	-52.0	.051	112.8	1.047	-21.2	-0.620	3.3	14.6
1000	.592	141.9	1.395	-66.1	.070	113.7	1.061	-27.6	-0.620	2.9	13.0
1500	.570	124.2	1.166	-102.4	.140	106.9	1.076	-45.6	-0.410	1.3	9.2
2000	.543	107.4	0.923	-142.3	.215	97.1	1.024	-64.7	-0.010	-0.7	6.3

V_{CB} = 3 V, I_C = 5 mA

50	.777	178.6	1.751	-2.2	.002	45.9	1.000	-0.5	-0.154	4.9	29.4
100	.771	176.4	1.752	-5.1	.002	102.8	1.002	-1.6	-0.400	4.9	29.4
200	.774	172.6	1.747	-11.2	.006	97.8	1.003	-4.1	-0.220	4.8	24.6
400	.767	164.6	1.727	-24.0	.017	114.2	1.015	-9.0	-0.520	4.7	20.1
600	.753	156.7	1.704	-36.9	.031	121.1	1.035	-14.2	-0.680	4.6	17.4
800	.741	149.1	1.657	-50.2	.049	122.1	1.052	-20.2	-0.680	4.4	15.3
1000	.735	141.5	1.595	-64.5	.073	120.6	1.069	-26.5	-0.630	4.1	13.4
1500	.710	122.8	1.368	-101.3	.144	111.4	1.090	-44.9	-0.430	2.7	9.8
2000	.670	104.8	1.094	-141.3	.226	99.5	1.034	-64.1	-0.040	0.8	6.8

V_{CE} = 3 V, I_C = 10 mA

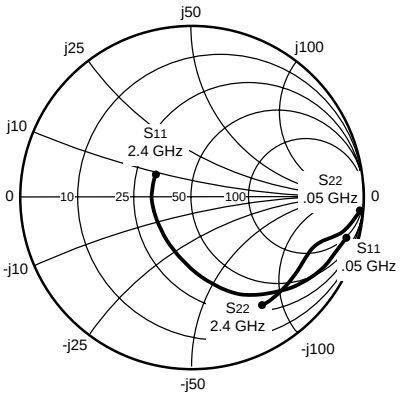
50	.866	178.6	1.834	-2.2	.001	16.5	0.999	-0.4	-0.097	5.3	32.6
100	.861	176.6	1.840	-5.3	.003	92.7	1.000	1.6	-0.030	5.3	27.9
200	.859	172.5	1.833	-11.5	.006	107.3	1.003	- 4.1	-0.320	5.3	24.9
400	.846	164.4	1.818	-24.6	.017	122.3	1.017	-9.1	-0.600	5.2	20.3
600	.836	156.6	1.799	-37.9	.030	123.9	1.037	-14.5	-0.670	5.1	17.8
800	.826	149.1	1.749	-51.7	.051	123.8	1.057	-20.4	-0.650	4.9	15.4
1000	.819	141.5	1.687	-66.6	.073	123.2	1.074	-27.0	-0.610	4.5	13.6
1500	.793	122.1	1.443	-105.4	.149	112.3	1.090	-45.9	-0.360	3.2	9.9
2000	.738	103.2	1.132	-146.8	.235	99.3	1.018	-65.7	0.040	1.1	6.8

Note:
1. Gain Calculations:

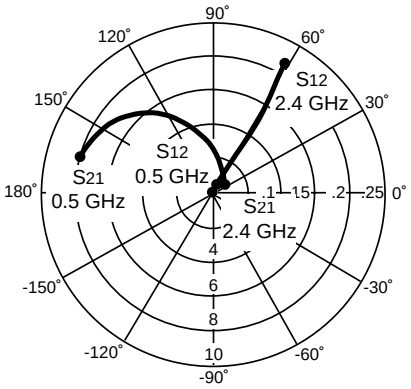
$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right)$. When $K \leq 1$, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\,|S_{12}S_{21}|}$, $\Delta = S_{11}S_{22} - S_{21}S_{12}$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

TYPICAL COMMON EMITTER SCATTERING PARAMETERS (T_A = 25°C)



Coordinates in Ohms
Frequency in GHz
(V_{CE} = 10 V, I_C = 5 mA)



NE94433

V_{CE} = 10 V, I_C = 5 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	MAG[1]
(MHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
50	0.932	-14	8.225	165	0.015	65	0.982	-4	0.42	27.4
100	0.857	-29	7.587	151	0.028	64	0.961	-9	0.40	24.4
200	0.710	-51	6.158	130	0.039	64	0.884	-14	0.47	22.0
400	0.478	-79	4.030	104	0.064	59	0.797	-18	0.74	18.0
600	0.366	-98	2.902	88	0.083	58	0.765	-20	0.89	15.4
800	0.308	-114	2.263	77	0.100	58	0.752	-24	0.97	13.5
1000	0.274	-128	1.867	68	0.115	58	0.748	-28	1.01	11.4
1200	0.254	-141	1.595	59	0.130	58	0.746	-31	1.04	9.7
1400	0.242	-155	1.403	52	0.145	58	0.745	-36	1.04	8.6
1600	0.236	-168	1.256	46	0.160	59	0.745	-39	1.03	7.9
1800	0.234	179	1.142	40	0.175	60	0.744	-44	1.01	7.4
2000	0.239	167	1.050	34	0.193	60	0.743	-48	0.98	7.4
2200	0.247	154	0.970	29	0.212	60	0.742	-53	0.95	6.6
V_{CE} = 10 V, I_C = 10 mA										
50	0.890	-19	10.530	162	0.014	62	0.967	-5	0.44	28.7
100	0.796	-35	9.392	145	0.025	60	0.942	-10	0.46	25.7
200	0.629	-60	7.081	123	0.037	62	0.851	-14	0.55	22.8
400	0.417	-89	4.323	99	0.059	60	0.772	-17	0.81	18.6
600	0.332	-109	3.043	85	0.079	60	0.750	-20	0.92	15.9
800	0.291	-126	2.349	74	0.095	60	0.739	-23	0.99	13.9
1000	0.270	-141	1.927	65	0.109	61	0.738	-27	1.03	11.4
1200	0.258	-155	1.639	57	0.125	61	0.736	-31	1.04	10.0
1400	0.254	-169	1.438	50	0.141	62	0.738	-35	1.02	9.3
1600	0.254	179	1.283	44	0.156	62	0.738	-39	1.00	8.7
1800	0.257	167	1.165	38	0.173	63	0.738	-43	0.98	8.3
2000	0.264	156	1.070	33	0.194	64	0.737	-48	0.94	7.4
2200	0.273	144	0.987	28	0.214	64	0.736	-53	0.91	6.6
2400	0.286	134	0.916	23	0.239	63	0.732	-57	0.87	5.8
V_{CE} = 10 V, I_C = 20 mA										
50	0.828	-28	10.472	156	0.014	65	0.969	-5	0.36	28.7
100	0.685	-48	8.553	136	0.024	64	0.915	-10	0.45	25.6
200	0.445	-74	5.730	115	0.035	59	0.840	-12	0.72	22.2
400	0.347	-105	3.358	95	0.055	62	0.790	-16	0.96	17.9
600	0.302	-128	2.394	83	0.073	61	0.773	-19	1.06	13.7
800	0.285	-146	1.877	72	0.089	63	0.763	-23	1.11	11.2
1000	0.278	-161	1.558	63	0.105	64	0.758	-27	1.13	9.5
1200	0.278	-175	1.337	55	0.121	66	0.756	-32	1.12	8.3
1400	0.281	173	1.178	48	0.139	66	0.754	-36	1.10	7.4
1600	0.286	162	1.055	42	0.158	67	0.753	-41	1.07	6.6
1500	0.295	151	0.959	36	0.178	68	0.752	-45	1.03	6.3
2000	0.304	142	0.882	31	0.202	68	0.748	-50	0.99	6.4
2200	0.317	132	0.813	26	0.225	67	0.744	-55	0.96	5.6
2400	0.329	123	0.753	22	0.254	66	0.737	-60	0.94	4.7

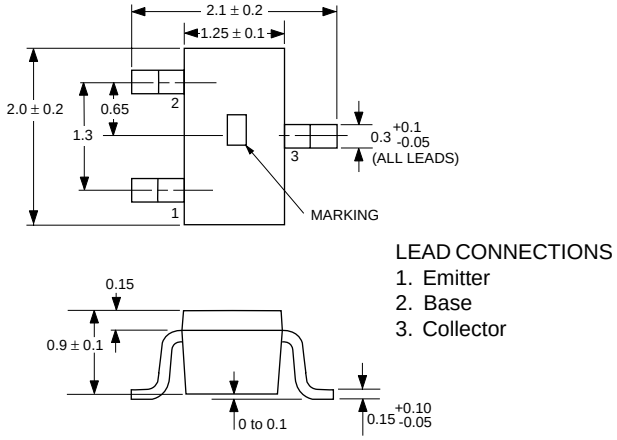
Note:
1. Gain Calculations:

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

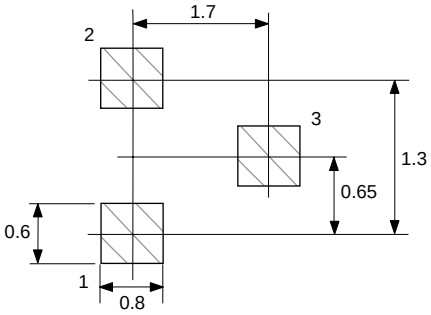
OUTLINE DIMENSIONS (Units in mm)

PACKAGE OUTLINE 30

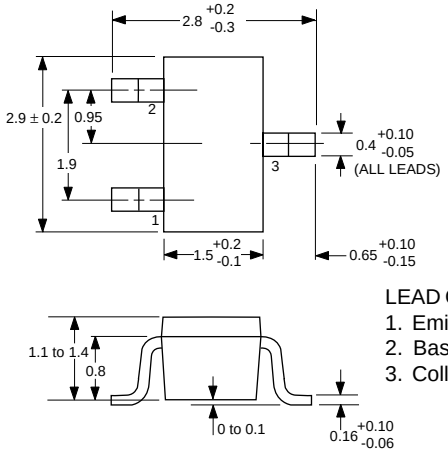


LEAD CONNECTIONS
1. Emitter
2. Base
3. Collector

PACKAGE OUTLINE 30
RECOMMENDED P.C.B. LAYOUT

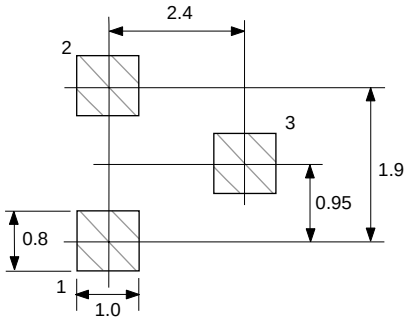


PACKAGE OUTLINE 33



LEAD CONNECTIONS
1. Emitter
2. Base
3. Collector

PACKAGE OUTLINE 33
RECOMMENDED P.C.B. LAYOUT



ORDERING INFORMATION

PART NUMBER	QUANTITY	PACKAGING
NE94430-T2	3000	Tape & Reel
NE94433-T1B	3000	Tape & Reel