NEC

SILICON TRANSISTOR
2SC5009

NPN SILICON EPITAXIAL TRANSISTOR
3 PINS ULTRA SUPER MINI MOLD

DESCRIPTION

The 2SC5009 is an NPN epitaxial silicon transistor designed for use in low noise and small signal amplifiers from VHF band to L band. Low noise figure, high gain, and high current capability achieve a very wide dynamic range and excellent linearity. This is achieved by direct nitride passivated base surface process (NEST3 process) which is an NEC proprietary new fabrication technique.

FEATURES

- Low Voltage Use.
- High f_T : 12.0 GHz TYP. (@ V_{CE} = 3 V, I_C = 5 mA, f = 2 GHz)
- Low C_{re} : 0.3 pF TYP. (@ V_{CE} = 3 V, I_E = 0, f = 1 MHz)
- Low NF : 2.5 dB TYP. (@ V_{CE} = 3 V, I_C = 3 mA, f = 2 GHz)
- High $|S_{21e}|^2$: 8.5 dB TYP. (@ V_{CE} = 3 V, I_C = 5 mA, f = 2 GHz)
- Ultra Super Mini Mold Package.

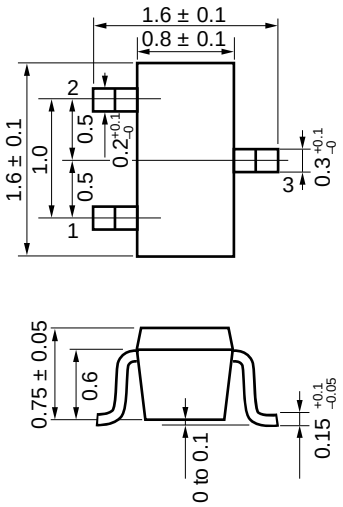
ORDERING INFORMATION

PART NUMBER	QUANTITY	PACKING STYLE
2SC5009	50 pcs./Unit	Embossed tape 8 mm wide. Pin 3 (Collector) face to perforation side of the tape.
2SC5009-T1	3 kpcs./Reel	

***** Please contact with responsible NEC person, if you require evaluation sample. Unit sample quantity shall be 50 pcs.

PACKAGE DIMENSIONS

in milimeters



1. Emitter
2. Base
3. Collector

ABSOLUTE MAXIMUM RATINGS (T_A = 25 °C)

Collector to Base Voltage	V_{CBO}	9	V
Collector to Emitter Voltage	V_{CEO}	6	V
Emitter to Base Voltage	V_{EBO}	2	V
Collector Current	I_C	10	mA
Total Power Dissipation	P_T	60	mW
Junction Temperature	T_j	150	°C
Storage Temperature	T_{stg}	–65 to +150	°C

Document No. P10388EJ2V0DS00 (2nd edition)
(Previous No. TD-2430)
Date Published July 1995 P
Printed in Japan

ELECTRICAL CHARACTERISTICS (T_A = 25 °C)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Collector Cutoff Current	I_{CBO}			0.1	μA	V_{CB} = 5 V, I_E = 0
Emitter Cutoff Current	I_{EBO}			0.1	μA	V_{EB} = 1 V, I_C = 0
DC Current Gain	h_{FE}	75		150		V_{CE} = 3 V, I_C = 5 mA***1**
Gain Bandwidth Product	f_T		12.0		GHz	V_{CE} = 3 V, I_C = 5 mA, f = 2 GHz
Feed–back Capacitance	C_{re}		0.3	0.5	pF	V_{CB} = 3 V, I_E = 0, f = 1 MHz***2**
Insertion Power Gain	$\|S_{21e}\|^2$	7.0	8.5		dB	V_{CE} = 3 V, I_C = 5 mA, f = 2 GHz
Noise Figure	NF		2.5	4.0	dB	V_{CE} = 3 V, I_C = 3 mA, f = 2 GHz

***1** Pulse Measurement PW ≤ 350 μs, Duty Cycle ≤ 2 %

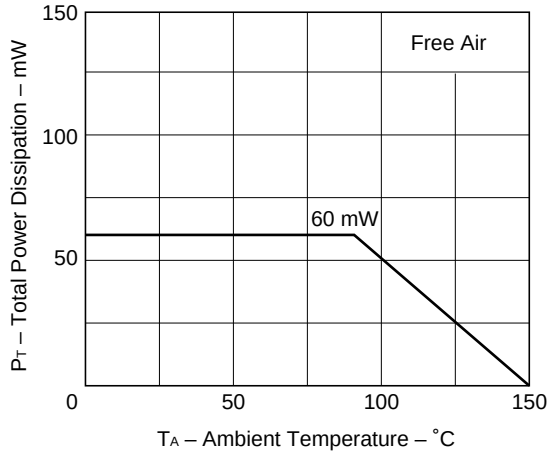
***2** The emitter terminal and the case shall be connected to the guard terminal of the three-terminal capacitance bridge.

h_{FE} Classification

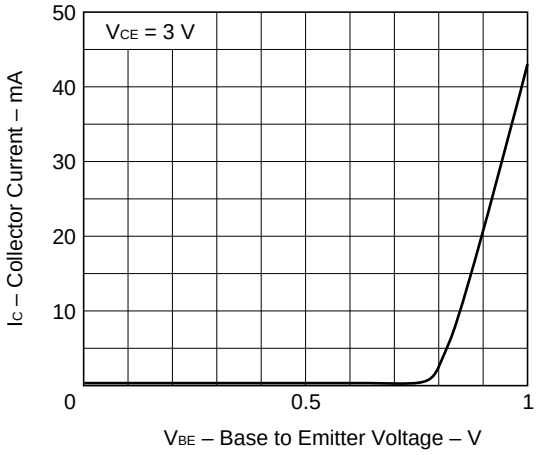
RANK	FB
Marking	82
h_{FE}	75 to 150

TYPICAL CHARACTERISTICS (T_A = 25 °C)

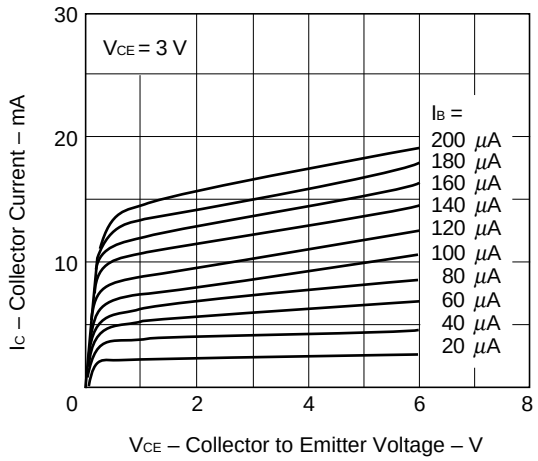
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



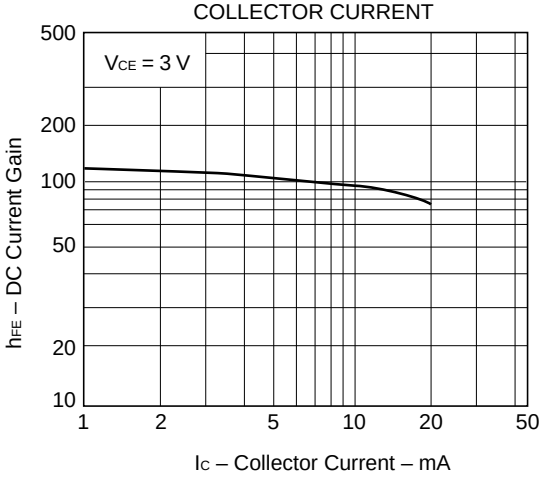
COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



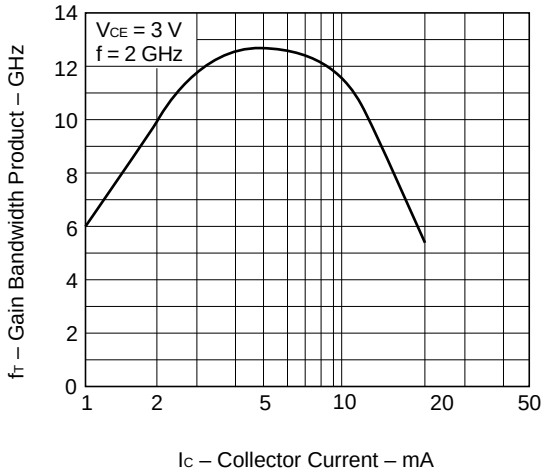
COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE



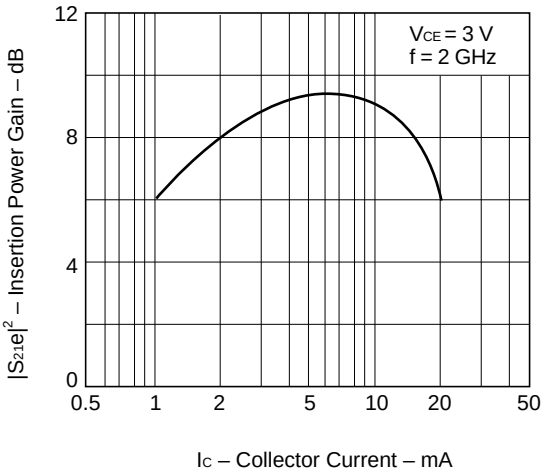
DC CURRENT GAIN vs. COLLECTOR CURRENT



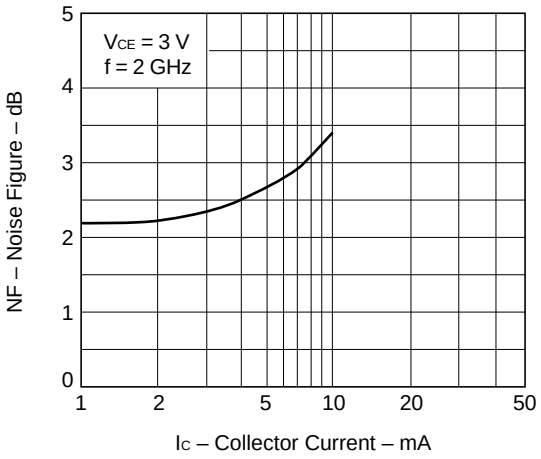
GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



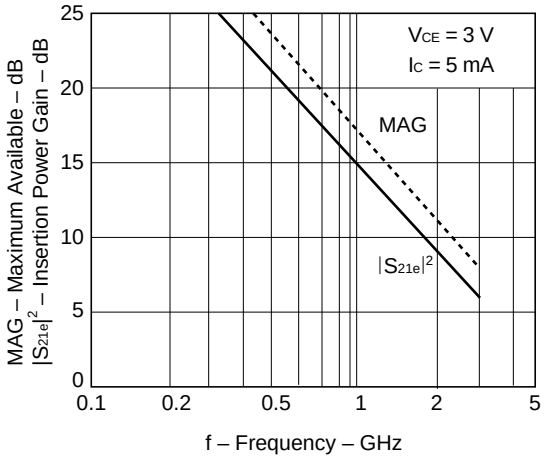
INSERTION POWER GAIN vs. COLLECTOR CURRENT



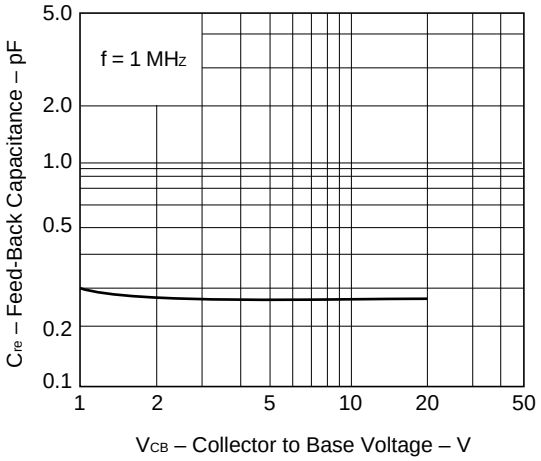
NOISE FIGURE vs.
COLLECTOR CURRENT



MAXIMUM AVAILABLE GAIN,
INSERTION POWER GAIN vs. FREQUENCY



FEED-BACK CAPACITANCE vs.
COLLECTOR TO BASE VOLTAGE



S-PARAMETER

(V_{CE} = 3 V, I_C = 7 mA, Z_O = 50 Ω)

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.00	.823	–7.1	8.540	153.6	.014	86.5	.979	–6.6
200.00	.791	–16.4	8.151	150.6	.028	77.4	.950	–12.5
300.00	.749	–24.5	7.885	144.1	.041	74.4	.904	–17.8
400.00	.701	–32.0	7.524	136.7	.051	70.2	.857	–22.2
500.00	.648	–38.6	7.149	129.8	.061	67.4	.810	–25.5
600.00	.596	–44.6	6.672	123.2	.069	65.1	.768	–28.4
700.00	.545	–49.6	6.267	117.1	.077	63.0	.728	–30.7
800.00	.499	–54.7	5.890	111.3	.084	61.3	.693	–32.5
900.00	.453	–58.8	5.505	106.4	.092	60.5	.662	–34.4
1000.00	.413	–62.5	5.185	101.6	.099	59.6	.636	–35.6
1100.00	.375	–66.1	4.873	97.2	.106	58.7	.612	–36.9
1200.00	.341	–69.3	4.595	93.2	.113	57.4	.590	–38.2
1300.00	.308	–72.3	4.335	89.2	.120	56.9	.574	–39.2
1400.00	.280	–75.6	4.088	85.7	.126	56.0	.556	–40.5
1500.00	.254	–78.3	3.882	82.1	.134	55.3	.540	–41.5
1600.00	.230	–81.2	3.691	78.9	.141	54.6	.526	–42.9
1700.00	.207	–84.3	3.521	75.8	.147	53.8	.515	–44.1
1800.00	.186	–87.4	3.366	72.9	.154	53.2	.503	–45.5
1900.00	.166	–90.7	3.222	70.0	.161	52.3	.491	–46.8
2000.00	.151	–95.2	3.093	67.1	.169	51.3	.470	–47.7
2100.00	.134	–99.4	2.980	64.5	.177	50.3	.457	–49.1
2200.00	.119	–104.0	2.870	62.0	.184	49.3	.445	–50.6
2300.00	.105	–110.4	2.772	59.3	.191	48.5	.434	–52.1
2400.00	.091	–118.3	2.686	56.8	.198	47.3	.421	–53.8
2500.00	.080	–127.7	2.594	54.2	.206	46.3	.411	–55.4
2600.00	.073	–139.6	2.521	52.0	.214	45.2	.398	–57.5
2700.00	.067	–152.7	2.447	49.5	.222	44.2	.386	–59.3
2800.00	.065	–168.2	2.379	47.1	.227	43.3	.374	–61.1
2900.00	.067	–178.3	2.317	44.7	.235	42.1	.361	–62.8
3000.00	.071	–166.7	2.253	42.6	.242	40.7	.349	–64.8

(V_{CE} = 3 V, I_C = 5 mA, Z_O = 50 Ω)

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.00	.866	–5.7	6.885	155.4	.015	83.5	.985	–5.8
200.00	.844	–13.2	6.690	154.2	.029	79.3	.966	–11.2
300.00	.816	–20.0	6.614	149.0	.041	75.3	.932	–16.2
400.00	.780	–26.5	6.457	142.7	.053	72.0	.896	–20.7
500.00	.740	–32.8	6.310	136.7	.064	68.2	.855	–24.4
600.00	.698	–38.5	5.990	130.4	.074	65.8	.816	–27.9
700.00	.650	–44.0	5.766	124.5	.083	63.5	.777	–30.8
800.00	.607	–49.3	5.537	118.6	.092	61.5	.740	–33.3
900.00	.560	–53.8	5.266	113.2	.098	59.9	.706	–35.6
1000.00	.513	–58.4	5.033	108.0	.105	58.9	.674	–37.4
1100.00	.471	–62.4	4.800	103.2	.113	57.1	.647	–39.0
1200.00	.430	–66.2	4.571	98.5	.120	55.6	.621	–40.7
1300.00	.395	–69.7	4.345	94.5	.126	55.1	.599	–41.9
1400.00	.361	–73.3	4.123	90.5	.133	53.8	.578	–43.3
1500.00	.330	–76.4	3.924	86.7	.139	52.9	.561	–44.7
1600.00	.300	–79.6	3.751	83.1	.146	52.2	.543	–46.1
1700.00	.274	–82.8	3.592	79.7	.152	51.2	.526	–47.1
1800.00	.250	–85.9	3.435	76.5	.159	50.4	.514	–48.7
1900.00	.226	–89.3	3.300	73.5	.166	49.9	.499	–50.1
2000.00	.208	–92.9	3.178	70.6	.174	48.7	.476	–51.1
2100.00	.188	–97.0	3.055	67.7	.181	47.9	.460	–52.5
2200.00	.170	–101.1	2.946	64.9	.188	47.1	.448	–54.1
2300.00	.151	–105.7	2.849	62.1	.195	46.1	.434	–55.6
2400.00	.136	–111.3	2.757	59.4	.201	44.9	.419	–57.3
2500.00	.121	–118.4	2.670	56.8	.210	43.9	.408	–58.9
2600.00	.109	–126.0	2.594	54.3	.216	43.0	.395	–60.9
2700.00	.099	–135.3	2.521	51.8	.223	41.9	.382	–62.9
2800.00	.090	–145.5	2.450	49.4	.229	40.8	.368	–64.4
2900.00	.086	–156.8	2.381	46.9	.236	40.1	.355	–66.1
3000.00	.083	–168.1	2.317	44.6	.243	38.7	.341	–68.1

S-PARAMETER

(V_{CE} = 3 V, I_C = 3 mA, Z_O = 50 Ω)

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.00	.907	–4.4	4.749	157.0	.015	86.0	.990	–4.8
200.00	.891	–9.9	4.677	157.3	.029	80.9	.979	–9.4
300.00	.877	–15.1	4.716	153.6	.042	77.6	.956	–13.9
400.00	.855	–20.5	4.696	148.3	.056	74.2	.933	–18.1
500.00	.828	–25.7	4.688	143.6	.068	70.9	.903	–21.9
600.00	.800	–30.4	4.513	138.2	.079	67.7	.875	–25.5
700.00	.767	–35.4	4.450	132.9	.089	64.7	.842	–28.8
800.00	.736	–40.4	4.370	127.5	.099	62.2	.810	–31.8
900.00	.697	–44.8	4.233	122.5	.107	60.2	.776	–34.8
1000.00	.656	–49.9	4.195	117.2	.115	57.5	.745	–37.0
1100.00	.610	–54.6	4.117	112.2	.123	56.3	.715	–39.3
1200.00	.568	–59.0	4.021	107.0	.129	54.4	.684	–41.3
1300.00	.528	–63.1	3.871	102.5	.137	52.7	.661	–43.1
1400.00	.489	–67.1	3.749	98.0	.143	51.8	.637	–44.8
1500.00	.454	–70.6	3.612	93.8	.151	50.5	.615	–46.5
1600.00	.419	–73.9	3.484	89.8	.156	49.6	.594	–48.1
1700.00	.386	–77.7	3.369	86.0	.162	48.7	.575	–49.7
1800.00	.356	–81.0	3.232	82.5	.169	47.6	.558	–51.3
1900.00	.328	–84.2	3.127	79.0	.175	46.7	.540	–52.9
2000.00	.302	–88.1	3.029	75.7	.184	45.5	.514	–54.3
2100.00	.279	–91.5	2.928	72.6	.189	44.4	.497	–55.9
2200.00	.256	–95.1	2.832	69.5	.197	43.4	.482	–57.5
2300.00	.233	–99.3	2.755	66.4	.203	42.5	.466	–59.2
2400.00	.213	–103.7	2.669	63.5	.209	41.6	.449	–61.0
2500.00	.193	–108.2	2.588	60.6	.216	40.6	.436	–62.6
2600.00	.178	–114.1	2.526	58.0	.222	39.8	.421	–63.9
2700.00	.160	–119.7	2.455	55.2	.229	38.4	.405	–66.5
2800.00	.146	–126.7	2.390	52.5	.235	37.6	.389	–68.4
2900.00	.134	–134.5	2.331	49.8	.241	36.6	.376	–70.1
3000.00	.123	–142.0	2.269	47.4	.248	35.1	.361	–72.1

(V_{CE} = 3 V, I_C = 1 mA, Z_O = 50 Ω)

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.00	.955	–2.7	1.800	158.4	.014	86.4	.994	–3.3
200.00	.943	–6.1	1.806	161.4	.029	83.2	.995	–6.4
300.00	.943	–9.2	1.859	159.5	.045	80.9	.985	–9.4
400.00	.932	–12.6	1.885	155.9	.059	77.8	.979	–12.7
500.00	.928	–15.8	1.941	152.5	.074	74.8	.968	–15.6
600.00	.920	–19.0	1.900	148.4	.086	72.2	.960	–18.6
700.00	.908	–22.2	1.911	144.3	.100	69.5	.947	–21.7
800.00	.900	–25.6	1.912	139.9	.113	66.5	.931	–24.6
900.00	.883	–28.6	1.867	135.4	.126	63.7	.914	–27.8
1000.00	.866	–32.2	1.910	131.6	.136	61.5	.896	–30.5
1100.00	.845	–36.0	1.954	127.5	.148	58.6	.875	–33.3
1200.00	.822	–40.0	1.989	123.3	.157	56.1	.851	–35.9
1300.00	.798	–43.5	1.998	118.9	.167	54.2	.833	–38.4
1400.00	.772	–47.5	2.018	114.9	.175	51.6	.810	–41.0
1500.00	.748	–50.8	2.008	110.7	.185	49.8	.792	–43.4
1600.00	.722	–54.3	1.974	106.7	.192	47.5	.770	–45.8
1700.00	.693	–58.2	1.992	102.5	.200	45.8	.749	–48.0
1800.00	.672	–61.2	1.935	98.8	.207	44.2	.731	–50.5
1900.00	.642	–64.8	1.929	95.2	.213	42.7	.708	–52.6
2000.00	.610	–69.2	1.946	91.2	.223	40.8	.683	–54.7
2100.00	.582	–72.4	1.915	87.7	.230	39.1	.662	–57.0
2200.00	.550	–76.5	1.906	83.8	.238	37.4	.643	–59.1
2300.00	.516	–80.4	1.925	79.9	.242	36.1	.621	–61.4
2400.00	.493	–84.0	1.887	76.7	.249	34.4	.602	–63.7
2500.00	.466	–87.9	1.866	73.2	.253	32.9	.586	–65.8
2600.00	.438	–91.6	1.864	69.7	.259	32.0	.554	–68.1
2700.00	.408	–96.0	1.838	66.2	.265	29.9	.547	–70.6
2800.00	.380	–100.2	1.815	62.8	.269	28.5	.530	–73.0
2900.00	.353	–105.2	1.806	59.4	.274	27.3	.508	–75.0
3000.00	.330	–109.4	1.781	56.4	.279	25.9	.492	–77.4

S-PARAMETER

(V_{CE} = 3 V, I_C = 5 mA, Z_O = 50 Ω)

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.00	.848	–7.5	6.214	154.0	.017	81.7	.976	–6.2
200.00	.815	–16.8	5.946	152.2	.033	78.1	.956	–12.0
300.00	.783	–25.0	5.820	146.4	.048	73.3	.922	–17.5
400.00	.741	–32.7	5.623	139.7	.062	68.6	.883	–22.4
500.00	.698	–40.2	5.466	133.3	.073	64.7	.837	–26.5
600.00	.647	–47.1	5.176	126.5	.083	61.5	.793	–30.1
700.00	.596	–53.6	4.962	120.2	.092	59.5	.752	–33.3
800.00	.549	–60.0	4.751	114.1	.101	56.8	.710	–35.9
900.00	.501	–65.5	4.506	108.3	.108	55.4	.673	–38.3
1000.00	.453	–71.2	4.304	103.1	.114	53.0	.639	–40.0
1100.00	.409	–76.2	4.089	98.0	.121	52.4	.609	–41.6
1200.00	.369	–81.3	3.886	93.3	.127	51.1	.583	–43.0
1300.00	.332	–85.7	3.680	89.1	.134	50.5	.559	–44.3
1400.00	.298	–90.3	3.495	84.9	.139	49.6	.540	–45.6
1500.00	.266	–95.2	3.318	81.1	.146	49.1	.520	–46.6
1600.00	.237	–99.6	3.163	77.4	.153	48.3	.504	–47.8
1700.00	.213	–104.6	3.024	74.0	.158	47.5	.487	–49.1
1800.00	.190	–110.0	2.885	70.7	.164	47.3	.476	–50.6
1900.00	.168	–116.0	2.770	67.6	.171	46.5	.461	–51.8
2000.00	.154	–121.6	2.658	64.5	.180	45.9	.437	–52.9
2100.00	.139	–129.2	2.557	61.6	.186	44.9	.423	–54.1
2200.00	.125	–136.5	2.467	58.6	.194	44.4	.412	–55.6
2300.00	.115	–146.2	2.386	56.0	.200	43.1	.399	–57.1
2400.00	.108	–155.8	2.308	53.3	.207	42.5	.384	–59.0
2500.00	.104	–166.9	2.231	50.5	.215	41.7	.375	–60.5
2600.00	.103	–177.4	2.172	48.0	.222	40.6	.363	–62.5
2700.00	.105	171.6	2.104	45.5	.228	39.9	.349	–64.6
2800.00	.110	162.0	2.045	43.1	.236	38.7	.337	–66.4
2900.00	.117	154.2	1.990	40.6	.242	37.8	.324	–68.4
3000.00	.124	146.9	1.939	38.3	.250	36.5	.313	–70.2

(V_{CE} = 3 V, I_C = 3 mA, Z_O = 50 Ω)

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.00	.901	–5.2	4.504	156.3	.017	85.9	.987	–5.1
200.00	.883	–11.4	4.431	156.9	.033	80.5	.978	–10.1
300.00	.867	–17.2	4.464	153.0	.049	76.5	.956	–14.8
400.00	.842	–23.0	4.442	147.8	.063	73.1	.932	–19.5
500.00	.816	–28.8	4.434	142.8	.077	69.4	.900	–23.8
600.00	.787	–34.1	4.278	137.2	.090	65.6	.870	–27.9
700.00	.753	–39.7	4.215	131.7	.101	62.2	.836	–31.6
800.00	.719	–45.3	4.151	126.0	.111	59.3	.799	–35.0
900.00	.678	–50.3	4.031	120.9	.120	56.7	.760	–38.4
1000.00	.635	–56.2	3.993	115.3	.128	54.5	.725	–41.1
1100.00	.590	–61.6	3.920	109.9	.136	52.5	.690	–43.5
1200.00	.544	–66.7	3.816	104.7	.143	50.5	.659	–45.7
1300.00	.502	–71.5	3.683	99.9	.149	49.1	.629	–47.7
1400.00	.461	–76.2	3.566	95.2	.156	47.9	.602	–49.6
1500.00	.424	–80.4	3.421	90.9	.162	46.4	.577	–51.4
1600.00	.387	–84.7	3.293	86.7	.167	45.6	.554	–53.1
1700.00	.353	–89.1	3.185	82.7	.174	44.6	.530	–54.7
1800.00	.324	–93.2	3.051	79.1	.179	43.7	.513	–56.5
1900.00	.293	–97.7	2.949	75.4	.185	43.1	.494	–58.1
2000.00	.270	–102.3	2.850	72.1	.193	41.7	.465	–59.5
2100.00	.245	–106.9	2.750	68.8	.199	40.8	.445	–61.1
2200.00	.225	–111.8	2.661	65.8	.206	40.0	.429	–62.9
2300.00	.204	–117.4	2.581	62.5	.213	39.1	.412	–64.4
2400.00	.186	–123.5	2.500	59.6	.218	37.8	.395	–66.3
2500.00	.169	–130.5	2.420	56.7	.225	37.2	.382	–67.8
2600.00	.156	–137.7	2.353	53.9	.231	36.2	.365	–70.2
2700.00	.146	–146.1	2.288	51.2	.238	35.2	.351	–72.0
2800.00	.137	–155.0	2.223	48.5	.244	34.4	.336	–74.0
2900.00	.133	–164.2	2.165	45.8	.249	33.5	.320	–75.8
3000.00	.130	–173.1	2.108	43.4	.257	32.1	.306	–78.1

S-PARAMETER

(V_{CE} = 3 V, I_C = 1 mA, Z_O = 50 Ω)

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.00	.950	–2.9	1.790	158.9	.017	87.7	.994	–3.5
200.00	.942	–6.4	1.783	161.5	.033	83.8	.995	–6.8
300.00	.942	–9.7	1.832	159.5	.050	81.1	.984	–10.2
400.00	.930	–13.4	1.863	155.8	.067	77.2	.978	–13.7
500.00	.926	–16.8	1.914	152.3	.082	74.3	.967	–16.9
600.00	.917	–20.1	1.873	147.9	.097	71.5	.958	–20.2
700.00	.903	–23.7	1.886	143.8	.112	68.3	.944	–23.4
800.00	.897	–27.2	1.893	139.1	.127	65.2	.927	–26.6
900.00	.876	–30.6	1.850	134.6	.140	62.1	.910	–30.1
1000.00	.861	–34.4	1.891	130.3	.152	59.2	.887	–33.2
1100.00	.837	–38.5	1.933	126.1	.165	56.2	.865	–36.2
1200.00	.815	–42.8	1.979	121.8	.175	53.7	.837	–39.2
1300.00	.787	–46.5	1.975	117.2	.186	51.3	.818	–41.9
1400.00	.762	–50.7	1.992	112.9	.195	48.8	.792	–44.7
1500.00	.735	–54.5	1.983	108.6	.204	46.7	.769	–47.4
1600.00	.707	–58.1	1.953	104.4	.212	44.6	.747	–50.1
1700.00	.675	–62.3	1.972	100.2	.220	42.5	.723	–52.5
1800.00	.652	–65.6	1.909	96.3	.227	40.8	.703	–55.2
1900.00	.621	–69.5	1.900	92.5	.233	39.0	.677	–57.4
2000.00	.587	–74.2	1.919	88.3	.243	36.9	.650	–59.7
2100.00	.559	–77.9	1.887	84.6	.249	35.0	.625	–62.3
2200.00	.528	–82.4	1.880	80.7	.256	33.5	.605	–64.5
2300.00	.491	–86.7	1.894	76.7	.261	32.0	.580	–67.0
2400.00	.465	–90.8	1.856	73.3	.267	30.4	.561	–69.4
2500.00	.438	–95.0	1.829	69.8	.272	28.7	.541	–71.7
2600.00	.408	–99.7	1.817	66.2	.277	27.1	.519	–74.6
2700.00	.380	–104.1	1.797	62.7	.282	25.7	.499	–77.0
2800.00	.353	–109.1	1.769	59.3	.286	24.3	.479	–79.5
2900.00	.326	–114.6	1.761	55.8	.290	23.2	.458	–81.8
3000.00	.305	–119.8	1.732	52.8	.295	21.6	.440	–84.3

[MEMO]