To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: http://www.renesas.com

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

Send any inquiries to http://www.renesas.com/inquiry.

Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
2. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
4. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
7. Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.

   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.

   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.

   "Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

RENESAS

SILICON TRANSISTOR
2SC5184

NPN EPITAXIAL SILICON TRANSISTOR IN SUPER MINI-MOLD PACKAGE FOR LOW-NOISE MICROWAVE AMPLIFICATION

FEATURES

- Low Noise
- NF = 1.3 dB TYP. @ V_{CE} = 2 V, I_C = 3 mA, f = 2 GHz
- NF = 1.3 dB TYP. @ V_{CE} = 1 V, I_C = 3 mA, f = 2 GHz
- Super Mini-Mold package
  EIAJ: SC-70

ORDERING INFORMATION

PART NUMBER	QUANTITY	ARRANGEMENT
2SC5184-T1	3 000 units/reel	Embossed tape, 8 mm wide, Pin No. 3 (collector) facing the perforations
2SC5184-T2	3 000 units/reel	Embossed tape, 8 mm wide, Pins No. 1 (emitter) and No. 2 (base) facing the perforations

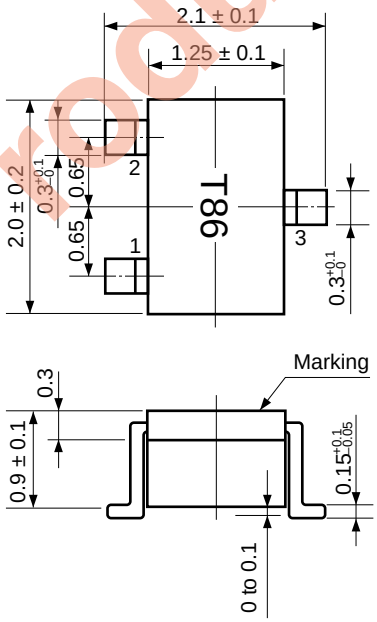
Remark: Contact your NEC sales representative to order samples for evaluation (available in batches of 50).

ABSOLUTE MAXIMUM RATINGS (T_A = 25 ˚C)

Collector to Base Voltage	V_{CBO}	5	V
Collector to Emitter Voltage	V_{CEO}	3	V
Emitter to Base Voltage	V_{EBO}	2	V
Collector Current	I_C	30	mA
Total Power Dissipation	P_T	90	mW
Junction Temperature	T_j	150	˚C
Storage Temperature	T_{stg}	–65 to +150	˚C

PACKAGE DIMENSIONS

(Units: mm)



PIN CONNECTIONS

1. Emitter
2. Base
3. Collector

Caution; This transistor uses high-frequency technology. Be careful not to allow excessive current to flow through the transistor, including static electricity.

Document No. P12108EJ2V0DS00 (2nd edition)
(Previous No. TC-2481)
Date Published November 1996 N
Printed in Japan

ELECTRICAL CHARACTERISTICS (T_A = 25 °C)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Collector Cutoff Current	I_{CBO}			100	nA	V_{CB} = 5 V, I_E = 0
Emitter Cutoff Current	I_{EBO}			100	nA	V_{EB} = 1 V, I_C = 0
DC Current Gain	h_{FE}	70		140		V_{CE} = 2 V, I_C = 20 mA*1
Insertion Power Gain (1)	$\|S_{21e}\|^2$	7	8.5		dB	V_{CE} = 2 V, I_C = 20 mA, f = 2 GHz
Insertion Power Gain (2)	$\|S_{21e}\|^2$	6	7.5		dB	V_{CE} = 1 V, I_C = 10 mA, f = 2 GHz
Noise Figure (1)	NF		1.3	2.0	dB	V_{CE} = 2 V, I_C = 3 mA, f = 2 GHz
Noise Figure (2)	NF		1.3	2.0	dB	V_{CE} = 1 V, I_C = 3 mA, f = 2 GHz
Gain Bandwidth Product (1)	f_T	9	11		GHz	V_{CE} = 2 V, I_C = 20 mA, f = 2 GHz
Gain Bandwidth Product (2)	f_T	7	9		GHz	V_{CE} = 1 V, I_C = 10 mA, f = 2 GHz
Feedback Capacitance	C_{re}		0.4	0.8	pF	V_{CB} = 2 V, I_E = 0 mA, f = 1 MHz*2

***1** Measured with pulses: Pulse width ≤ 350 μs, duty clcye ≤ 2 %, pulsed.

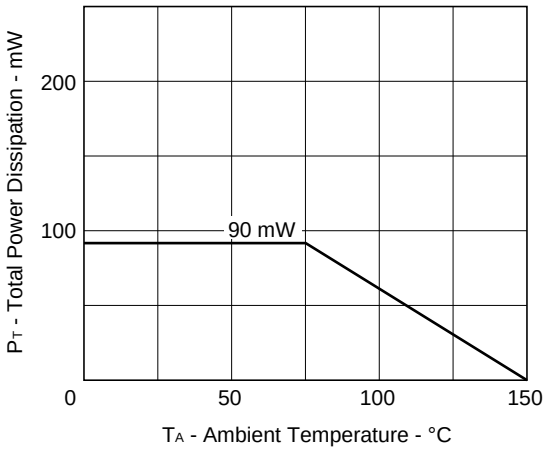
***2** Measured with a three-terminal bridge. The emitter and case terminal are connected to the guard terminal of the bridge.

h_{FE} Class

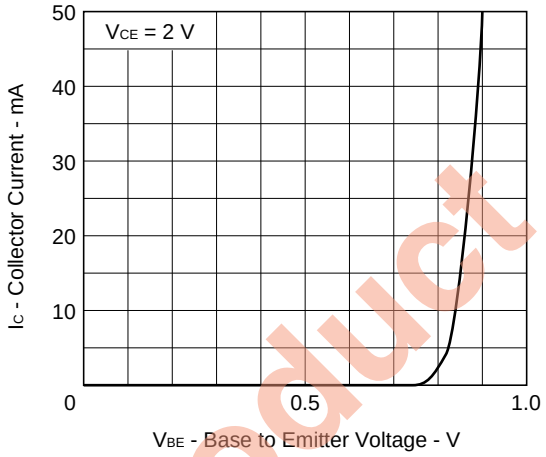
Class	FB
Marking	T86
h_{FE}	70 to 140

CHARACTERISTICS CURVES (T_A = 25 °C)

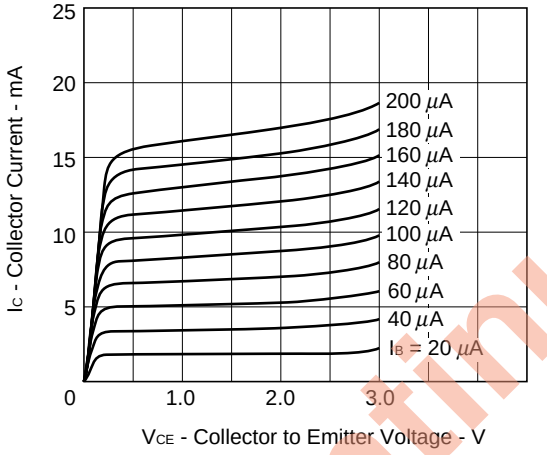
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



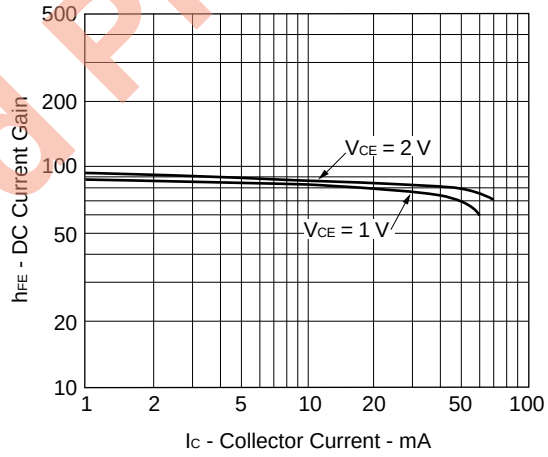
COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



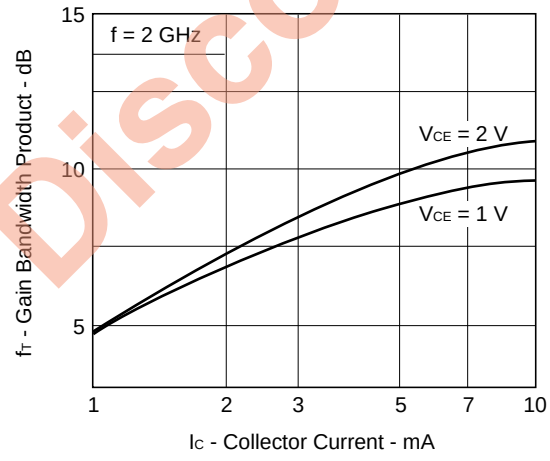
COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE



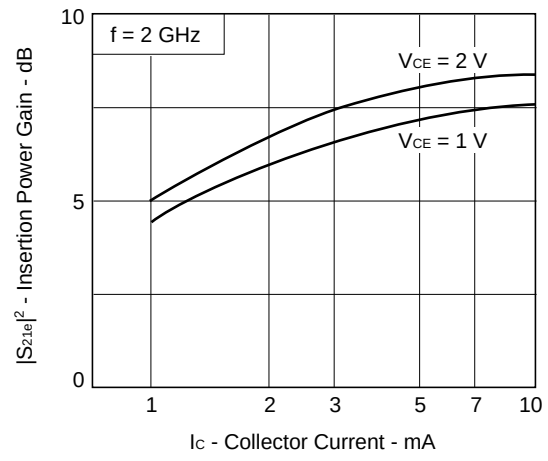
DC CURRENT GAIN vs. COLLECTOR CURRENT



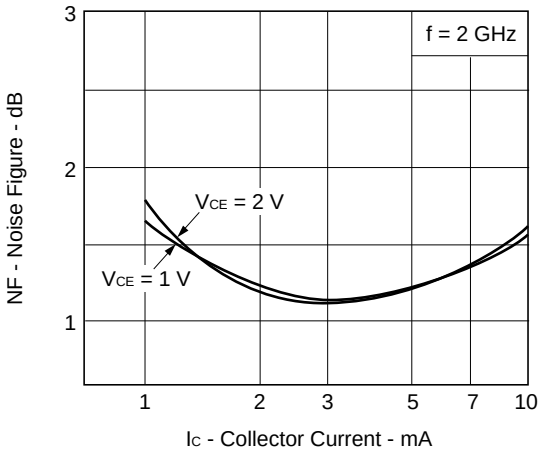
GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



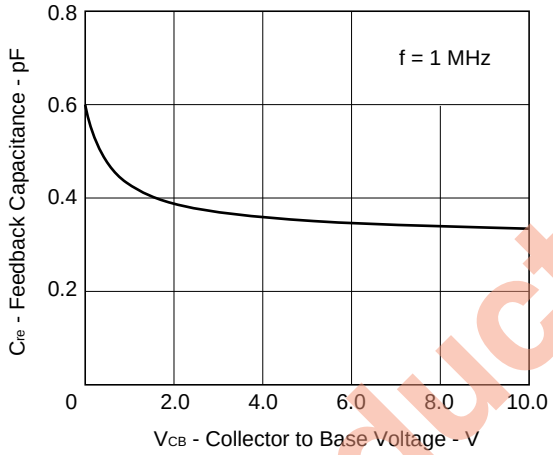
INSERTION POWER GAIN vs. COLLECTOR CURRENT



NOISE FIGURE vs.
COLLECTOR CURRENT



FEED-BACK CAPACITANCE vs.
COLLECTOR TO BASE VOLTAGE



S-PARAMETERS

V_{CE} = 1 V, I_C = 1 mA, Z_O = 50 Ω

FREQUENCY	S11		S21		S12		S22	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0000	0.974	–6.9	2.031	170.7	0.029	84.1	0.993	–5.5
200.0000	0.971	–14.0	1.953	162.5	0.057	78.0	0.982	–10.9
300.0000	0.956	–20.5	1.928	154.8	0.083	72.3	0.960	–15.5
400.0000	0.926	–28.4	2.021	147.6	0.105	67.5	0.925	–20.7
500.0000	0.902	–34.5	1.911	141.1	0.126	62.9	0.902	–24.9
600.0000	0.861	–42.2	1.941	135.2	0.144	58.6	0.861	–28.6
700.0000	0.829	–49.5	1.930	129.2	0.158	54.4	0.826	–32.6
800.0000	0.793	–55.6	1.864	123.6	0.172	51.1	0.791	–35.6
900.0000	0.753	–63.1	1.917	118.6	0.182	48.2	0.758	–38.5
1000.0000	0.723	–68.8	1.839	114.1	0.191	45.7	0.731	–41.3
1100.0000	0.691	–76.3	1.838	109.3	0.200	43.4	0.703	–43.4
1200.0000	0.652	–82.9	1.833	104.4	0.204	41.6	0.675	–45.6
1300.0000	0.628	–88.7	1.742	100.1	0.209	39.4	0.652	–47.9
1400.0000	0.587	–95.8	1.756	95.7	0.213	38.4	0.629	–49.5
1500.0000	0.565	–101.4	1.686	92.0	0.215	37.0	0.610	–51.6
1600.0000	0.535	–107.4	1.654	88.1	0.217	36.0	0.591	–53.0
1700.0000	0.508	–113.5	1.624	84.7	0.218	35.3	0.574	–54.6
1800.0000	0.489	–118.6	1.565	81.2	0.220	35.0	0.559	–56.0
1900.0000	0.471	–124.6	1.530	78.4	0.221	34.5	0.545	–57.4
2000.0000	0.449	–130.5	1.509	75.2	0.222	34.6	0.532	–59.0

V_{CE} = 1 V, I_C = 3 mA, Z_O = 50 Ω

FREQUENCY	S11		S21		S12		S22	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0000	0.917	–11.2	5.682	164.5	0.027	81.0	0.966	–10.7
200.0000	0.879	–22.2	5.447	154.3	0.052	72.7	0.914	–20.4
300.0000	0.830	–31.8	5.165	144.7	0.072	66.6	0.845	–28.1
400.0000	0.755	–44.2	5.205	136.0	0.087	61.7	0.764	–34.6
500.0000	0.703	–52.5	4.838	129.3	0.101	58.1	0.705	–39.7
600.0000	0.625	–63.5	4.684	122.1	0.111	55.8	0.639	–43.1
700.0000	0.560	–73.9	4.522	115.3	0.121	54.2	0.587	–46.8
800.0000	0.506	–81.8	4.219	109.8	0.129	53.3	0.543	–49.0
900.0000	0.456	–90.8	4.031	104.7	0.137	52.9	0.508	–51.3
1000.0000	0.411	–98.6	3.796	100.0	0.143	52.3	0.478	–52.9
1100.0000	0.384	–105.7	3.574	95.9	0.152	51.9	0.451	–54.4
1200.0000	0.346	–113.0	3.377	91.7	0.158	51.7	0.428	–55.6
1300.0000	0.327	–119.7	3.166	88.4	0.165	51.6	0.408	–57.2
1400.0000	0.303	–126.4	3.011	85.2	0.171	51.8	0.390	–58.2
1500.0000	0.289	–132.4	2.850	82.4	0.179	51.9	0.375	–59.6
1600.0000	0.273	–138.2	2.707	79.6	0.185	51.9	0.361	–60.2
1700.0000	0.261	–144.4	2.588	77.1	0.193	51.9	0.348	–61.3
1800.0000	0.252	–150.1	2.468	74.4	0.200	52.1	0.338	–62.4
1900.0000	0.247	–156.0	2.364	72.2	0.207	52.4	0.329	–63.4
2000.0000	0.242	–161.8	2.274	69.8	0.214	52.4	0.319	–64.8

V_{CE} = 1 V, I_C = 7 mA, Z_O = 50 Ω

FREQUENCY	S11		S21		S12		S22	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0000	0.784	–18.0	11.844	157.9	0.026	77.0	0.906	–18.0
200.0000	0.700	–36.7	10.881	143.4	0.045	68.8	0.784	–32.0
300.0000	0.606	–51.4	9.746	131.7	0.060	64.3	0.664	–40.8
400.0000	0.490	–68.6	9.052	121.0	0.070	62.4	0.563	–46.7
500.0000	0.412	–80.3	8.022	113.0	0.081	61.4	0.496	–50.2
600.0000	0.343	–92.6	7.101	106.5	0.091	61.2	0.436	–52.6
700.0000	0.299	–103.1	6.348	101.0	0.100	62.0	0.393	–54.8
800.0000	0.265	–111.9	5.687	96.8	0.110	62.1	0.359	–55.8
900.0000	0.243	–120.0	5.170	93.2	0.119	62.3	0.336	–57.4
1000.0000	0.222	–127.7	4.735	89.7	0.130	62.2	0.317	–58.1
1100.0000	0.213	–135.2	4.360	86.9	0.140	62.3	0.298	–59.3
1200.0000	0.198	–142.5	4.033	83.9	0.150	62.7	0.283	–59.8
1300.0000	0.193	–149.8	3.756	81.5	0.159	62.2	0.268	–61.4
1400.0000	0.184	–156.2	3.508	79.0	0.169	61.9	0.257	–62.2
1500.0000	0.183	–162.3	3.310	76.8	0.179	61.8	0.248	–63.3
1600.0000	0.178	–168.3	3.127	74.6	0.189	61.4	0.239	–63.8
1700.0000	0.177	–173.9	2.963	72.7	0.199	61.0	0.231	–65.1
1800.0000	0.176	–179.6	2.814	70.6	0.208	60.9	0.224	–66.2
1900.0000	0.180	175.3	2.686	68.6	0.217	60.3	0.218	–67.3
2000.0000	0.182	170.6	2.573	66.9	0.228	60.0	0.211	–68.8

V_{CE} = 1 V, I_C = 10 mA, Z_O = 50 Ω

FREQUENCY	S11		S21		S12		S22	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0000	0.689	–24.5	14.893	153.4	0.024	76.0	0.865	–22.1
200.0000	0.583	–47.9	13.678	137.1	0.041	68.5	0.710	–37.1
300.0000	0.476	–65.2	11.837	124.5	0.054	65.2	0.579	–45.5
400.0000	0.372	–82.3	10.296	114.1	0.065	63.8	0.483	–50.8
500.0000	0.306	–94.2	8.800	106.9	0.076	65.2	0.421	–53.5
600.0000	0.259	–106.7	7.604	101.4	0.087	65.2	0.367	–55.4
700.0000	0.232	–117.0	6.695	96.9	0.098	65.5	0.331	–57.2
800.0000	0.211	–126.3	5.965	93.1	0.108	65.5	0.301	–58.0
900.0000	0.198	–134.5	5.386	90.1	0.118	65.6	0.282	–59.2
1000.0000	0.184	–142.3	4.901	87.1	0.128	66.0	0.265	–59.5
1100.0000	0.180	–149.3	4.500	84.5	0.140	65.8	0.251	–60.8
1200.0000	0.172	–156.7	4.155	82.0	0.151	65.5	0.239	–61.5
1300.0000	0.172	–163.4	3.851	79.5	0.161	65.1	0.226	–63.1
1400.0000	0.169	–169.2	3.602	77.3	0.170	64.6	0.218	–63.8
1500.0000	0.169	–175.2	3.400	75.4	0.183	64.2	0.210	–65.4
1600.0000	0.168	179.9	3.189	73.1	0.193	63.8	0.203	–66.0
1700.0000	0.168	174.6	3.032	71.4	0.203	63.2	0.195	–67.1
1800.0000	0.170	169.3	2.880	69.4	0.213	62.6	0.188	–68.3
1900.0000	0.175	165.1	2.748	67.6	0.224	62.0	0.184	–69.4
2000.0000	0.179	161.1	2.629	66.0	0.234	61.4	0.179	–71.4

V_{CE} = 1 V, I_C = 20 mA, Z_O = 50 Ω

FREQUENCY	S11		S21		S12		S22	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0000	0.441	–76.4	18.515	138.3	0.021	73.8	0.753	–30.4
200.0000	0.358	–97.6	15.403	121.3	0.037	69.2	0.556	–46.5
300.0000	0.290	–111.1	12.655	110.9	0.049	69.0	0.429	–53.6
400.0000	0.242	–120.8	10.657	104.2	0.061	69.6	0.349	–58.2
500.0000	0.208	–129.8	9.000	99.0	0.073	70.4	0.301	–59.6
600.0000	0.196	–142.5	7.688	94.9	0.084	70.5	0.259	–61.2
700.0000	0.190	–150.3	6.712	91.3	0.096	70.5	0.234	–62.7
800.0000	0.185	–158.8	5.955	88.1	0.108	70.5	0.212	–63.2
900.0000	0.184	–164.7	5.338	85.6	0.120	69.9	0.200	–64.9
1000.0000	0.182	–171.1	4.863	82.9	0.132	69.7	0.189	–65.0
1100.0000	0.183	–176.2	4.468	80.7	0.144	69.3	0.179	–67.1
1200.0000	0.183	178.4	4.106	78.5	0.156	68.5	0.169	–68.2
1300.0000	0.187	173.6	3.806	76.3	0.168	68.2	0.160	–69.9
1400.0000	0.187	169.5	3.540	74.3	0.179	67.5	0.154	–71.5
1500.0000	0.193	165.5	3.337	72.1	0.190	66.9	0.149	–73.3
1600.0000	0.193	161.7	3.154	70.4	0.202	65.8	0.144	–74.4
1700.0000	0.196	158.0	2.980	68.7	0.214	65.3	0.138	–76.3
1800.0000	0.199	153.9	2.843	67.0	0.224	64.3	0.134	–78.3
1900.0000	0.205	151.4	2.699	65.2	0.235	63.7	0.130	–79.8
2000.0000	0.211	148.9	2.579	63.6	0.247	62.9	0.127	–82.4

V_{CE} = 2 V, I_C = 1 mA, Z_O = 50 Ω

FREQUENCY	S11		S21		S12		S22	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0000	0.978	–6.8	2.018	171.8	0.025	83.3	0.995	–4.9
200.0000	0.975	–13.1	1.958	163.5	0.049	78.9	0.987	–9.7
300.0000	0.964	–19.1	1.937	156.3	0.071	74.1	0.970	–13.9
400.0000	0.932	–26.5	2.026	149.7	0.091	68.8	0.938	–18.4
500.0000	0.915	–32.1	1.917	143.3	0.110	64.8	0.920	–22.1
600.0000	0.876	–39.3	1.959	137.6	0.127	60.6	0.884	–25.5
700.0000	0.846	–46.0	1.945	132.0	0.140	57.0	0.852	–29.1
800.0000	0.812	–51.8	1.888	126.6	0.152	53.7	0.822	–31.8
900.0000	0.776	–58.9	1.940	121.9	0.162	50.9	0.791	–34.6
1000.0000	0.746	–64.1	1.862	117.6	0.170	48.7	0.766	–37.1
1100.0000	0.717	–71.2	1.875	112.8	0.177	46.4	0.740	–39.1
1200.0000	0.676	–77.5	1.874	108.0	0.184	44.3	0.714	–41.1
1300.0000	0.652	–83.0	1.785	103.9	0.189	42.2	0.693	–43.1
1400.0000	0.610	–89.8	1.802	99.6	0.192	41.0	0.669	–44.7
1500.0000	0.586	–95.2	1.731	96.0	0.195	39.6	0.653	–46.7
1600.0000	0.554	–101.0	1.709	92.0	0.197	39.0	0.634	–47.8
1700.0000	0.526	–106.7	1.681	88.6	0.198	38.3	0.616	–49.4
1800.0000	0.503	–111.9	1.624	85.1	0.200	37.8	0.602	–50.7
1900.0000	0.482	–117.8	1.594	82.1	0.201	37.5	0.591	–52.0
2000.0000	0.457	–123.4	1.572	79.0	0.202	37.6	0.575	–53.3

V_{CE} = 2 V, I_C = 3 mA, Z_O = 50 Ω

FREQUENCY	S11		S21		S12		S22	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0000	0.916	–10.2	5.805	166.0	0.023	82.8	0.973	–9.3
200.0000	0.893	–20.0	5.495	155.8	0.045	74.6	0.931	–17.8
300.0000	0.850	–28.6	5.238	146.7	0.062	68.0	0.870	–24.4
400.0000	0.777	–39.7	5.292	138.5	0.077	64.1	0.798	–30.4
500.0000	0.731	–47.1	4.938	131.9	0.090	60.3	0.745	–34.8
600.0000	0.656	–57.0	4.818	125.0	0.101	58.5	0.684	–37.8
700.0000	0.592	–66.2	4.673	118.4	0.109	56.7	0.633	–41.0
800.0000	0.536	–73.3	4.389	113.0	0.117	55.5	0.591	–42.9
900.0000	0.481	–81.4	4.223	107.8	0.123	55.0	0.557	–44.8
1000.0000	0.435	–88.0	3.993	103.3	0.131	54.5	0.528	–46.2
1100.0000	0.400	–95.1	3.781	99.0	0.137	54.5	0.504	–47.6
1200.0000	0.357	–101.3	3.589	94.9	0.144	54.2	0.479	–48.5
1300.0000	0.333	–107.4	3.374	91.5	0.151	54.0	0.459	–49.8
1400.0000	0.302	–113.4	3.210	88.0	0.157	54.1	0.441	–50.5
1500.0000	0.284	–119.4	3.047	85.2	0.164	54.4	0.427	–51.7
1600.0000	0.264	–124.8	2.896	82.3	0.170	54.4	0.414	–52.3
1700.0000	0.247	–130.7	2.766	79.9	0.177	54.7	0.401	–53.2
1800.0000	0.233	–136.2	2.641	77.2	0.183	54.7	0.392	–54.0
1900.0000	0.225	–142.5	2.528	75.0	0.191	55.1	0.383	–54.8
2000.0000	0.215	–148.4	2.436	72.9	0.198	54.9	0.373	–55.8

V_{CE} = 2 V, I_C = 5 mA, Z_O = 50 Ω

FREQUENCY	S11		S21		S12		S22	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0000	0.857	–13.2	9.113	162.6	0.023	78.8	0.948	–12.7
200.0000	0.811	–25.8	8.527	150.3	0.041	72.1	0.870	–23.3
300.0000	0.743	–36.6	7.907	139.9	0.057	66.2	0.781	–30.9
400.0000	0.642	–50.1	7.737	130.5	0.069	63.9	0.690	–36.6
500.0000	0.571	–59.3	7.109	123.0	0.079	61.7	0.627	–40.3
600.0000	0.483	–69.9	6.609	115.5	0.088	61.2	0.564	–42.6
700.0000	0.415	–79.3	6.140	109.1	0.096	60.5	0.517	–44.8
800.0000	0.363	–86.7	5.613	104.2	0.105	60.2	0.479	–45.9
900.0000	0.321	–93.7	5.182	99.9	0.113	60.2	0.451	–47.4
1000.0000	0.284	–100.3	4.803	95.9	0.121	60.5	0.427	–47.9
1100.0000	0.260	–106.6	4.448	92.6	0.130	60.6	0.406	–48.9
1200.0000	0.231	–112.8	4.149	89.2	0.137	60.4	0.388	–49.5
1300.0000	0.215	–119.2	3.875	86.4	0.146	60.7	0.372	–50.4
1400.0000	0.196	–125.0	3.635	83.8	0.155	60.7	0.359	–51.0
1500.0000	0.185	–131.8	3.428	81.3	0.163	60.7	0.348	–52.1
1600.0000	0.172	–137.4	3.244	78.9	0.171	60.7	0.337	–52.3
1700.0000	0.163	–144.2	3.090	76.6	0.180	60.5	0.327	–53.0
1800.0000	0.155	–150.5	2.938	74.6	0.188	60.3	0.319	–53.7
1900.0000	0.152	–157.2	2.810	72.6	0.196	60.3	0.313	–54.5
2000.0000	0.149	–164.1	2.692	70.7	0.205	60.0	0.305	–55.4

V_{CE} = 2 V, I_C = 10 mA, Z_O = 50 Ω

FREQUENCY	S11		S21		S12		S22	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0000	0.805	–16.8	12.051	160.5	0.021	76.4	0.923	–15.4
200.0000	0.733	–31.1	11.136	145.9	0.039	71.1	0.818	–27.3
300.0000	0.645	–43.8	10.084	134.6	0.052	66.7	0.711	–34.9
400.0000	0.531	–58.4	9.504	124.1	0.063	64.9	0.615	–39.8
500.0000	0.445	–68.3	8.484	116.3	0.073	64.6	0.550	–42.8
600.0000	0.366	–78.6	7.598	109.4	0.083	64.2	0.492	–44.5
700.0000	0.311	–87.2	6.839	103.8	0.092	63.5	0.451	–46.1
800.0000	0.269	–94.4	6.153	99.5	0.100	63.8	0.416	–46.7
900.0000	0.240	–101.0	5.628	95.7	0.110	63.6	0.393	–47.7
1000.0000	0.212	–107.4	5.139	92.4	0.119	64.0	0.374	–48.1
1100.0000	0.194	–113.9	4.750	89.4	0.128	63.9	0.355	–48.9
1200.0000	0.174	–120.4	4.399	86.5	0.137	64.1	0.341	–49.3
1300.0000	0.161	–127.7	4.097	84.0	0.146	63.5	0.326	–50.1
1400.0000	0.148	–134.2	3.836	81.6	0.155	64.4	0.316	–50.6
1500.0000	0.141	–141.3	3.613	79.2	0.164	64.2	0.307	–51.6
1600.0000	0.132	–147.6	3.403	77.2	0.174	63.5	0.298	–51.8
1700.0000	0.127	–154.8	3.231	75.1	0.182	63.3	0.290	–52.4
1800.0000	0.122	–161.7	3.069	73.1	0.192	63.0	0.283	–53.1
1900.0000	0.123	–169.0	2.919	71.1	0.201	62.6	0.277	–54.1
2000.0000	0.123	–175.7	2.802	69.5	0.210	62.2	0.271	–55.0

V_{CE} = 2 V, I_C = 20 mA, Z_O = 50 Ω

FREQUENCY	S11		S21		S12		S22	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0000	0.723	–20.3	15.896	156.6	0.021	78.2	0.890	–18.6
200.0000	0.629	–38.3	14.304	140.5	0.036	71.0	0.755	–31.2
300.0000	0.520	–53.2	12.506	128.1	0.048	67.3	0.633	–38.5
400.0000	0.403	–67.5	11.061	117.4	0.059	67.5	0.541	–42.4
500.0000	0.327	–76.9	9.540	110.0	0.069	66.7	0.480	–44.5
600.0000	0.266	–86.7	8.285	104.2	0.079	67.1	0.427	–45.6
700.0000	0.228	–95.0	7.319	99.5	0.088	67.3	0.393	–46.6
800.0000	0.196	–102.2	6.522	95.8	0.098	67.3	0.363	–46.7
900.0000	0.175	–109.0	5.905	92.5	0.107	67.2	0.343	–47.5
1000.0000	0.155	–116.2	5.381	89.5	0.117	67.0	0.329	–47.6
1100.0000	0.143	–123.2	4.958	86.8	0.128	67.2	0.313	–48.2
1200.0000	0.129	–130.1	4.574	84.3	0.137	67.2	0.301	–48.6
1300.0000	0.121	–138.7	4.251	81.9	0.147	66.8	0.289	–49.3
1400.0000	0.114	–145.5	3.961	79.8	0.157	66.7	0.281	–49.7
1500.0000	0.109	–153.5	3.732	77.7	0.166	66.5	0.273	–50.7
1600.0000	0.105	–160.3	3.520	75.7	0.176	65.7	0.266	–51.0
1700.0000	0.102	–168.2	3.341	74.0	0.186	65.3	0.259	–51.7
1800.0000	0.101	–176.1	3.172	72.0	0.196	64.8	0.253	–52.8
1900.0000	0.105	177.1	3.013	70.3	0.205	64.3	0.248	–53.5
2000.0000	0.108	171.3	2.886	68.6	0.215	64.0	0.242	–54.2

V_{CE} = 2 V, I_C = 20 mA, Z_O = 50 Ω

FREQUENCY	S11		S21		S12		S22	
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0000	0.474	–33.9	27.070	147.2	0.018	76.5	0.805	–24.1
200.0000	0.354	–57.5	20.499	127.1	0.031	74.3	0.624	–36.4
300.0000	0.270	–73.3	15.719	115.1	0.043	72.8	0.501	–42.1
400.0000	0.213	–85.2	12.575	107.5	0.054	71.2	0.424	–44.2
500.0000	0.173	–94.8	10.387	101.9	0.064	72.6	0.376	–44.6
600.0000	0.146	–105.1	8.873	97.6	0.074	73.1	0.337	–44.9
700.0000	0.129	–115.0	7.714	93.9	0.084	72.7	0.312	–45.2
800.0000	0.116	–124.7	6.794	91.0	0.095	72.0	0.294	–44.9
900.0000	0.104	–133.8	6.117	88.4	0.106	72.5	0.279	–45.8
1000.0000	0.097	–143.0	5.522	85.2	0.116	72.4	0.266	–44.9
1100.0000	0.093	–151.3	5.083	83.4	0.128	71.7	0.257	–45.7
1200.0000	0.091	–159.0	4.649	81.0	0.137	71.1	0.250	–46.1
1300.0000	0.090	–169.5	4.346	79.0	0.148	70.9	0.241	–46.9
1400.0000	0.089	–176.4	4.044	77.1	0.159	70.5	0.234	–47.2
1500.0000	0.091	177.3	3.797	75.6	0.169	69.5	0.229	–48.7
1600.0000	0.094	170.6	3.565	73.8	0.179	68.9	0.224	–49.5
1700.0000	0.095	165.4	3.378	71.8	0.190	68.2	0.218	–50.2
1800.0000	0.100	160.1	3.222	70.2	0.200	67.6	0.216	–50.7
1900.0000	0.106	156.6	3.080	68.4	0.210	66.9	0.210	–52.1
2000.0000	0.106	150.5	2.922	67.1	0.219	66.3	0.204	–52.9

[MEMO]

M4 96.5