



# SANYO Semiconductors DATA SHEET

## 2SC5646A — NPN Epitaxial Planar Silicon Transistor UHF to S-Band Low-Noise Amplifier, OSC Applications

### Features

- Low-noise : NF=1.5dB typ (f=2GHz).
- High cut-off frequency :  $f_T=10\text{GHz}$  typ ( $V_{CE}=1\text{V}$ ).
- High cut-off frequency :  $f_T=12.5\text{GHz}$  typ ( $V_{CE}=3\text{V}$ ).
- Low-voltage operation.
- High gain :  $|S_{21e}|^2=9.5\text{dB}$  typ (f=2GHz).
- Ultrasmall, slim flat-lead package (1.4mm×0.8mm×0.6mm).
- Halogen free compliance.

### Specifications

**Absolute Maximum Ratings** at  $T_a=25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Collector-to-Base Voltage	$V_{CBO}$		9	V
Collector-to-Emitter Voltage	$V_{CEO}$		4	V
Emitter-to-Base Voltage	$V_{EBO}$		2	V
Collector Current	$I_C$		30	mA
Collector Dissipation	$P_C$		100	mW
Junction Temperature	$T_j$		150	$^\circ\text{C}$
Storage Temperature	$T_{stg}$		-55 to +150	$^\circ\text{C}$

**Electrical Characteristics** at  $T_a=25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Collector Cutoff Current	$I_{CBO}$	$V_{CB}=5\text{V}, I_E=0\text{A}$			1.0	$\mu\text{A}$
Emitter Cutoff Current	$I_{EBO}$	$V_{EB}=1\text{V}, I_C=0\text{A}$			10	$\mu\text{A}$
DC Current Gain	$h_{FE}$	$V_{CE}=1\text{V}, I_C=5\text{mA}$	100		160	

Marking : NF

Continued on next page.

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# 2SC5646A

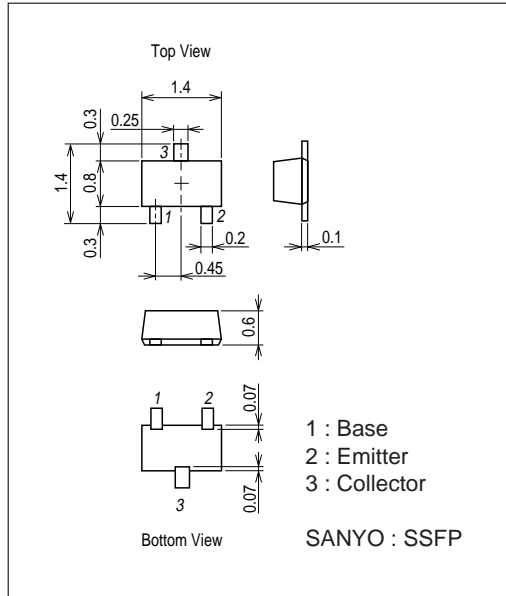
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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Gain-Bandwidth Product	$f_T1$	$V_{CE}=1V, I_C=5mA$	8	10		GHz
	$f_T2$	$V_{CE}=3V, I_C=15mA$		12.5		GHz
Output Capacitance	$C_{ob}$	$V_{CB}=1V, f=1MHz$		0.55	0.7	pF
Reverse Transfer Capacitance	$C_{re}$	$V_{CB}=1V, f=1MHz$		0.4		pF
Forward Transfer Gain	$ S_{21e} ^2_1$	$V_{CE}=1V, I_C=5mA, f=2GHz$	8	9.5		dB
	$ S_{21e} ^2_2$	$V_{CE}=3V, I_C=15mA, f=2GHz$		10.5		dB
Noise Figure	NF	$V_{CE}=1V, I_C=3mA, f=2GHz$		1.5	2.3	dB

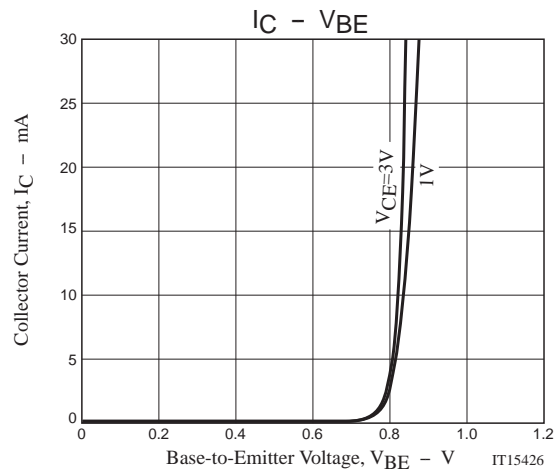
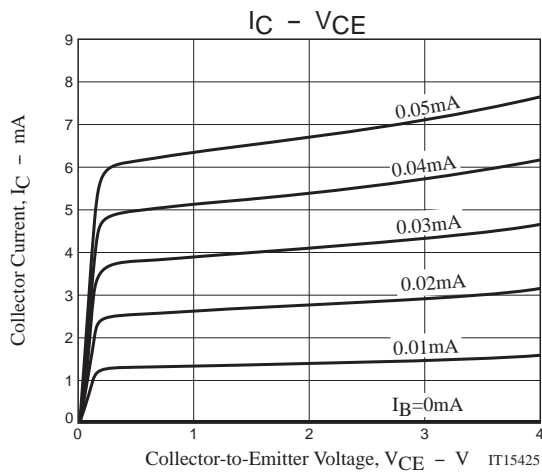
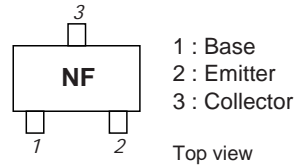
## Package Dimensions

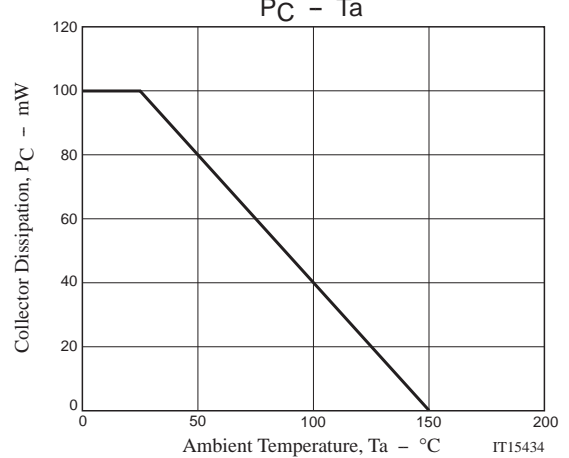
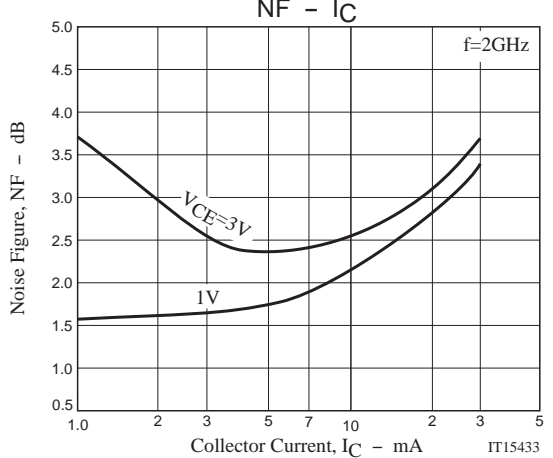
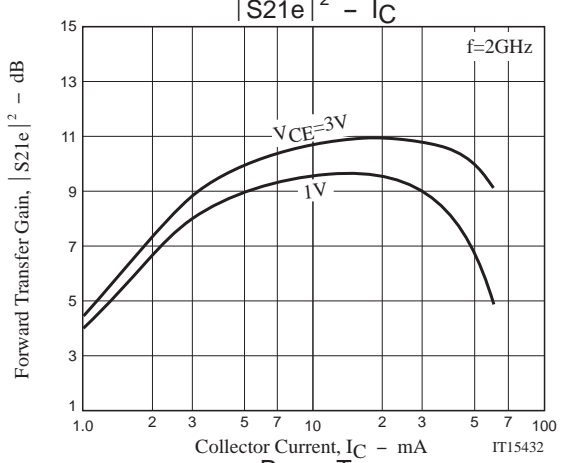
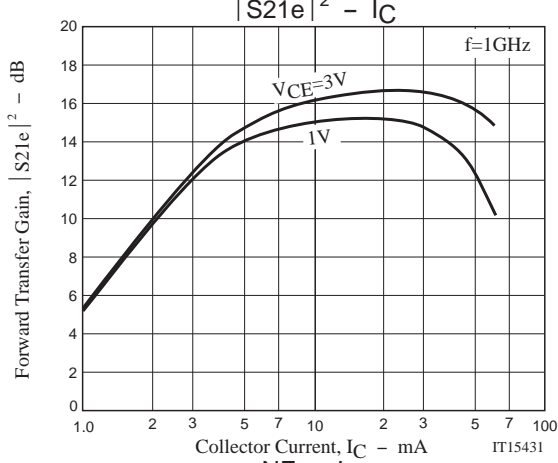
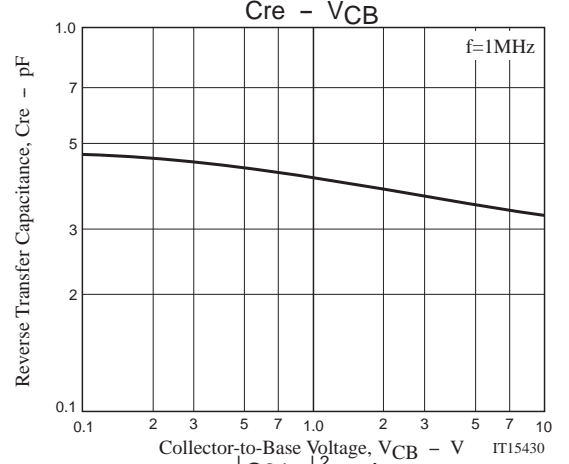
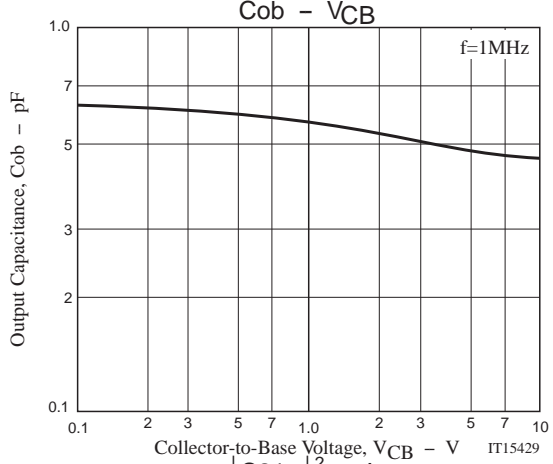
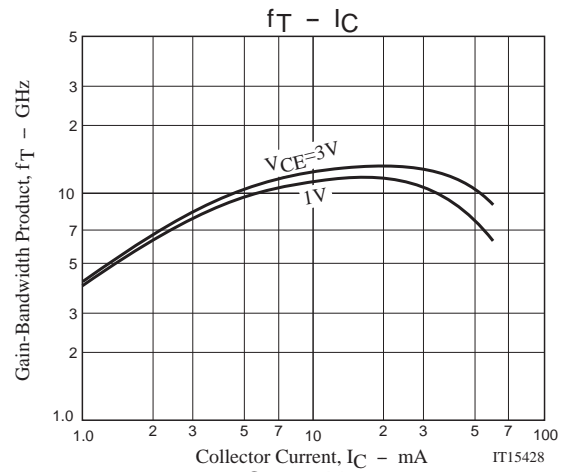
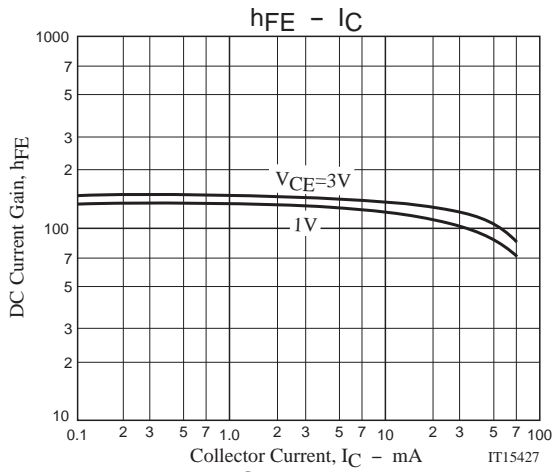
unit : mm (typ)

7029-002



## Marking





## 2SC5646A

### S Parameters (Common emitter)

$V_{CE}=1V, I_C=1mA, Z_O=50\Omega$

Freq(MHz)	$ S_{11} $	$\angle S_{11}$	$ S_{21} $	$\angle S_{21}$	$ S_{12} $	$\angle S_{12}$	$ S_{22} $	$\angle S_{22}$
200	0.967	-13.5	2.360	164.5	0.050	74.0	0.982	-11.4
400	0.929	-26.2	2.289	150.8	0.093	67.5	0.933	-21.8
600	0.888	-36.3	1.944	138.2	0.128	58.3	0.878	-31.2
800	0.821	-51.9	2.239	128.0	0.156	50.6	0.819	-38.6
1000	0.773	-61.9	2.046	119.0	0.172	44.5	0.763	-45.2
1200	0.724	-72.5	1.952	110.3	0.190	39.5	0.717	-50.9
1400	0.662	-84.6	1.956	101.8	0.198	35.4	0.675	-56.1
1600	0.629	-91.8	1.777	95.0	0.204	31.7	0.642	-60.9
1800	0.589	-101.5	1.720	88.5	0.206	29.3	0.612	-65.0
2000	0.554	-110.4	1.649	82.4	0.208	27.2	0.589	-69.1
2200	0.537	-116.0	1.521	76.7	0.207	25.9	0.569	-73.0
2400	0.510	-124.3	1.473	71.7	0.207	24.8	0.555	-76.4
2600	0.496	-130.1	1.393	67.1	0.203	24.4	0.543	-80.2
2800	0.481	-136.1	1.328	62.6	0.201	24.2	0.533	-83.4
3000	0.468	-142.2	1.280	58.5	0.199	25.1	0.527	-86.8

$V_{CE}=1V, I_C=5mA, Z_O=50\Omega$

Freq(MHz)	$ S_{11} $	$\angle S_{11}$	$ S_{21} $	$\angle S_{21}$	$ S_{12} $	$\angle S_{12}$	$ S_{22} $	$\angle S_{22}$
200	0.826	-30.9	9.413	151.9	0.039	70.9	0.866	-27.2
400	0.679	-61.6	8.593	130.9	0.068	56.4	0.681	-44.5
600	0.576	-83.1	7.017	117.1	0.082	49.2	0.547	-55.2
800	0.485	-105.2	6.080	105.2	0.091	47.6	0.457	-61.3
1000	0.436	-120.0	5.151	97.1	0.098	48.0	0.398	-66.0
1200	0.408	-131.3	4.423	90.8	0.109	48.1	0.362	-69.5
1400	0.388	-140.8	3.896	85.3	0.115	49.4	0.331	-72.8
1600	0.376	-148.8	3.465	80.6	0.125	50.8	0.311	-76.1
1800	0.368	-155.4	3.122	76.4	0.132	51.6	0.297	-78.6
2000	0.363	-161.1	2.846	72.6	0.141	52.5	0.289	-81.8
2200	0.361	-166.5	2.621	68.8	0.150	53.6	0.280	-84.6
2400	0.358	-171.3	2.426	65.4	0.160	54.1	0.276	-87.5
2600	0.358	-175.7	2.262	62.1	0.171	54.7	0.273	-90.5
2800	0.357	-179.9	2.125	58.9	0.181	54.9	0.271	-93.3
3000	0.356	176.4	2.003	56.1	0.190	55.7	0.271	-96.4

$V_{CE}=1V, I_C=10mA, Z_O=50\Omega$

Freq(MHz)	$ S_{11} $	$\angle S_{11}$	$ S_{21} $	$\angle S_{21}$	$ S_{12} $	$\angle S_{12}$	$ S_{22} $	$\angle S_{22}$
200	0.680	-49.0	14.963	141.8	0.037	61.7	0.745	-37.5
400	0.504	-91.9	11.934	117.7	0.051	54.2	0.514	-55.1
600	0.426	-116.8	8.944	104.8	0.064	52.9	0.393	-63.2
800	0.389	-133.6	7.032	96.3	0.073	55.8	0.324	-68.3
1000	0.371	-145.4	5.768	90.2	0.083	57.7	0.282	-71.5
1200	0.362	-154.0	4.888	85.2	0.094	59.1	0.255	-74.0
1400	0.356	-161.3	4.240	80.8	0.105	60.4	0.239	-77.0
1600	0.352	-166.8	3.750	76.8	0.116	60.2	0.226	-79.4
1800	0.354	-172.1	3.363	73.2	0.128	61.2	0.221	-82.9
2000	0.353	-176.4	3.059	69.8	0.139	62.3	0.215	-86.1
2200	0.353	179.5	2.804	66.5	0.151	61.9	0.211	-88.9
2400	0.354	175.8	2.592	63.4	0.163	62.0	0.210	-91.8
2600	0.357	172.4	2.417	60.5	0.176	62.0	0.210	-95.3
2800	0.357	169.1	2.263	57.5	0.187	62.0	0.212	-98.4
3000	0.357	166.1	2.133	54.8	0.200	61.4	0.215	-101.4

## 2SC5646A

### S Parameters (Common emitter)

V<sub>CE</sub>=1V, I<sub>C</sub>=20mA, Z<sub>O</sub>=50Ω

Freq(MHz)	S <sub>11</sub>	∠S <sub>11</sub>	S <sub>21</sub>	∠S <sub>21</sub>	S <sub>12</sub>	∠S <sub>12</sub>	S <sub>22</sub>	∠S <sub>22</sub>
200	0.492	-82.8	19.544	128.7	0.030	59.2	0.601	-47.3
400	0.399	-124.0	13.186	107.6	0.042	57.9	0.381	-61.9
600	0.377	-143.8	9.339	97.6	0.052	61.4	0.284	-68.1
800	0.367	-155.4	7.181	91.0	0.065	64.4	0.235	-71.6
1000	0.364	-163.4	5.837	85.9	0.077	66.8	0.209	-74.0
1200	0.363	-169.7	4.913	81.5	0.089	66.5	0.192	-76.9
1400	0.363	-174.8	4.250	77.7	0.102	67.0	0.182	-79.9
1600	0.364	-178.8	3.751	74.1	0.114	67.7	0.178	-82.7
1800	0.365	177.3	3.361	70.8	0.128	67.4	0.174	-85.9
2000	0.367	173.9	3.049	67.6	0.142	67.5	0.173	-89.1
2200	0.369	170.8	2.798	64.5	0.154	67.0	0.174	-93.0
2400	0.372	167.9	2.584	61.5	0.166	66.4	0.175	-95.8
2600	0.373	165.1	2.403	58.6	0.178	66.0	0.178	-98.7
2800	0.375	162.3	2.254	55.9	0.194	65.3	0.180	-102.0
3000	0.378	159.8	2.119	53.2	0.207	64.8	0.185	-104.8

V<sub>CE</sub>=3V, I<sub>C</sub>=1mA, Z<sub>O</sub>=50Ω

Freq(MHz)	S <sub>11</sub>	∠S <sub>11</sub>	S <sub>21</sub>	∠S <sub>21</sub>	S <sub>12</sub>	∠S <sub>12</sub>	S <sub>22</sub>	∠S <sub>22</sub>
200	0.969	-12.0	2.363	165.7	0.043	77.2	0.981	-9.8
400	0.942	-23.4	2.289	153.2	0.076	71.1	0.950	-18.6
600	0.906	-32.6	1.955	141.5	0.107	62.0	0.903	-27.0
800	0.847	-46.8	2.285	131.9	0.131	54.9	0.853	-33.7
1000	0.804	-55.8	2.076	123.6	0.149	48.8	0.803	-39.9
1200	0.755	-65.9	2.018	115.0	0.163	44.0	0.761	-45.1
1400	0.694	-77.3	2.042	106.9	0.173	40.0	0.721	-49.8
1600	0.662	-84.0	1.857	100.1	0.179	35.6	0.691	-54.3
1800	0.618	-93.6	1.822	93.6	0.182	33.6	0.660	-58.2
2000	0.579	-102.1	1.755	87.5	0.183	31.4	0.637	-62.0
2200	0.560	-107.6	1.616	81.9	0.183	30.1	0.616	-65.6
2400	0.529	-116.0	1.582	76.7	0.182	29.1	0.600	-68.9
2600	0.510	-121.7	1.492	72.0	0.181	28.7	0.588	-72.4
2800	0.493	-127.9	1.428	67.5	0.180	29.6	0.577	-75.5
3000	0.475	-134.3	1.381	63.3	0.177	29.8	0.569	-78.8

V<sub>CE</sub>=3V, I<sub>C</sub>=5mA, Z<sub>O</sub>=50Ω

Freq(MHz)	S <sub>11</sub>	∠S <sub>11</sub>	S <sub>21</sub>	∠S <sub>21</sub>	S <sub>12</sub>	∠S <sub>12</sub>	S <sub>22</sub>	∠S <sub>22</sub>
200	0.849	-26.5	9.604	154.4	0.034	68.7	0.895	-22.2
400	0.716	-52.4	8.894	134.9	0.056	59.5	0.736	-37.2
600	0.615	-71.2	7.356	121.6	0.072	52.4	0.605	-46.2
800	0.503	-92.9	6.628	109.2	0.081	50.8	0.519	-51.4
1000	0.441	-107.5	5.685	100.8	0.088	50.2	0.460	-54.9
1200	0.402	-118.7	4.918	94.3	0.098	51.3	0.419	-57.5
1400	0.373	-129.0	4.350	88.6	0.104	52.5	0.390	-60.0
1600	0.355	-137.2	3.872	83.8	0.112	53.4	0.369	-62.3
1800	0.343	-144.4	3.502	79.5	0.120	54.1	0.352	-64.6
2000	0.332	-151.2	3.197	75.5	0.129	55.6	0.340	-67.1
2200	0.327	-156.8	2.940	71.8	0.136	56.2	0.332	-69.5
2400	0.322	-162.0	2.724	68.4	0.146	57.1	0.326	-72.0
2600	0.320	-167.1	2.541	65.0	0.156	58.0	0.322	-74.8
2800	0.319	-171.4	2.384	61.9	0.165	58.4	0.319	-77.2
3000	0.317	-175.6	2.247	58.9	0.175	58.8	0.316	-80.1

## 2SC5646A

### S Parameters (Common emitter)

$V_{CE}=3V$ ,  $I_C=10mA$ ,  $Z_O=50\Omega$

Freq(MHz)	$ S_{11} $	$\angle S_{11}$	$ S_{21} $	$\angle S_{21}$	$ S_{12} $	$\angle S_{12}$	$ S_{22} $	$\angle S_{22}$
200	0.721	-40.7	15.749	145.6	0.028	64.8	0.794	-30.5
400	0.531	-78.2	13.000	122.1	0.046	57.2	0.583	-44.9
600	0.428	-102.2	9.969	108.6	0.056	58.2	0.458	-51.3
800	0.372	-120.2	7.950	99.6	0.066	56.8	0.387	-54.3
1000	0.342	-133.0	6.549	93.0	0.077	59.1	0.344	-56.1
1200	0.325	-142.5	5.564	87.9	0.084	60.8	0.314	-57.6
1400	0.316	-150.8	4.833	83.4	0.095	61.6	0.296	-59.3
1600	0.309	-157.5	4.276	79.4	0.106	63.2	0.284	-61.2
1800	0.306	-162.9	3.835	75.8	0.117	63.7	0.275	-63.4
2000	0.304	-168.1	3.486	72.4	0.128	64.3	0.268	-65.7
2200	0.304	-172.5	3.197	69.2	0.138	64.2	0.263	-67.8
2400	0.304	-176.5	2.955	66.1	0.149	64.3	0.261	-70.8
2600	0.305	179.5	2.753	63.1	0.161	64.6	0.260	-73.5
2800	0.308	176.0	2.576	60.2	0.172	64.3	0.258	-76.4
3000	0.308	172.8	2.423	57.5	0.184	64.2	0.259	-78.9

$V_{CE}=3V$ ,  $I_C=20mA$ ,  $Z_O=50\Omega$

Freq(MHz)	$ S_{11} $	$\angle S_{11}$	$ S_{21} $	$\angle S_{21}$	$ S_{12} $	$\angle S_{12}$	$ S_{22} $	$\angle S_{22}$
200	0.537	-63.4	22.589	134.4	0.024	61.2	0.673	-37.7
400	0.387	-106.2	15.289	111.6	0.038	58.4	0.458	-48.4
600	0.336	-128.8	10.917	100.7	0.047	62.9	0.356	-51.5
800	0.318	-143.0	8.424	93.7	0.059	65.4	0.304	-52.6
1000	0.309	-152.8	6.849	88.4	0.069	69.0	0.275	-53.4
1200	0.306	-160.1	5.773	84.0	0.081	68.8	0.258	-54.5
1400	0.305	-166.3	4.995	80.1	0.092	69.1	0.247	-56.1
1600	0.303	-171.2	4.410	76.6	0.103	70.3	0.240	-58.2
1800	0.304	-175.4	3.947	73.3	0.116	69.6	0.234	-60.1
2000	0.304	-179.2	3.576	70.1	0.128	69.2	0.233	-62.6
2200	0.308	177.4	3.275	67.1	0.139	69.2	0.230	-65.6
2400	0.310	174.1	3.027	64.3	0.152	69.3	0.229	-68.1
2600	0.310	170.9	2.815	61.5	0.164	68.3	0.229	-71.1
2800	0.314	168.1	2.639	58.7	0.176	68.2	0.231	-74.1
3000	0.315	165.2	2.479	56.2	0.187	67.8	0.232	-76.9

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