

DATA SHEET

NEC

NPN SILICON RF TRANSISTOR 2SC5617

NPN SILICON RF TRANSISTOR FOR HIGH-FREQUENCY LOW NOISE 3-PIN LEAD-LESS MINIMOLD

FEATURES

- NF = 1.5 dB TYP. @ $V_{CE} = 3\text{ V}$, $I_C = 3\text{ mA}$, $f = 2\text{ GHz}$
- $|S_{21e}|^2 = 8.5\text{ dB TYP. @ } V_{CE} = 3\text{ V}$, $I_C = 10\text{ mA}$, $f = 2\text{ GHz}$
- 3-pin lead-less minimold package

ORDERING INFORMATION

Part Number	Quantity	Supplying Form
2SC5617	50 pcs (Non reel)	• 8 mm wide embossed taping
2SC5617-T3	10 kpcs/reel	• Pin 2 (Base) face the perforation side of the tape

Remark To order evaluation samples, contact your nearby sales office.
The unit sample quantity is 50 pcs.

ABSOLUTE MAXIMUM RATINGS ($T_A = +25^\circ\text{C}$)

Parameter	Symbol	Ratings	Unit
Collector to Base Voltage	V_{CBO}	9.0	V
Collector to Emitter Voltage	V_{CEO}	6.0	V
Emitter to Base Voltage	V_{EBO}	2.0	V
Collector Current	I_C	30	mA
Total Power Dissipation	P_{tot} Note	140	mW
Junction Temperature	T_J	150	$^\circ\text{C}$
Storage Temperature	T_{stg}	-65 to +150	$^\circ\text{C}$

Note Mounted on $1.08\text{ cm}^2 \times 1.0\text{ mm}$ (t) glass epoxy PCB

Because this product uses high-frequency technology, avoid excessive static electricity, etc.

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.
Not all devices/types available in every country. Please check with local NEC Compound Semiconductor Devices representative for availability and additional information.

ELECTRICAL CHARACTERISTICS ($T_A = +25^\circ\text{C}$)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
DC Characteristics						
Collector Cut-off Current	I_{CBO}	$V_{CB} = 5\text{ V}, I_E = 0\text{ mA}$	—	—	100	nA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = 1\text{ V}, I_C = 0\text{ mA}$	—	—	100	nA
DC Current Gain	h_{FE} ^{Note 1}	$V_{CE} = 3\text{ V}, I_C = 10\text{ mA}$	75	—	140	—
RF Characteristics						
Gain Bandwidth Product	f_T	$V_{CE} = 3\text{ V}, I_C = 10\text{ mA}, f = 2\text{ GHz}$	—	12.0	—	GHz
Insertion Power Gain	$ S_{21e} ^2$	$V_{CE} = 3\text{ V}, I_C = 10\text{ mA}, f = 2\text{ GHz}$	7.0	8.5	—	dB
Noise Figure	NF	$V_{CE} = 3\text{ V}, I_C = 3\text{ mA}, f = 2\text{ GHz}, Z_S = Z_{opt}$	—	1.5	2.5	dB
Reverse Transfer Capacitance	C_{re} ^{Note 2}	$V_{CB} = 3\text{ V}, I_E = 0\text{ mA}, f = 1\text{ MHz}$	—	0.4	0.7	pF

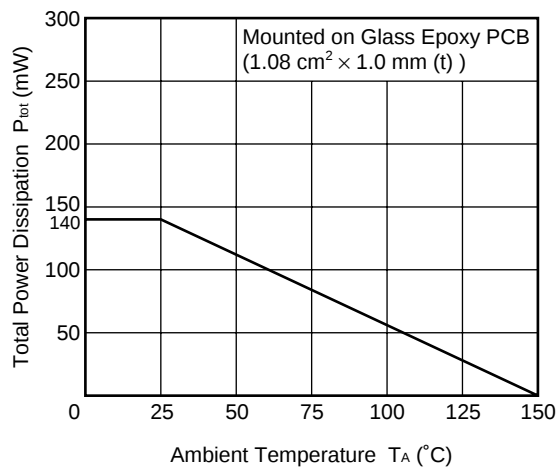
- Notes** **1.** Pulse measurement: $PW \leq 350\text{ }\mu\text{s}$, Duty Cycle $\leq 2\%$
2. Collector to base capacitance when the emitter grounded

h_{FE} CLASSIFICATION

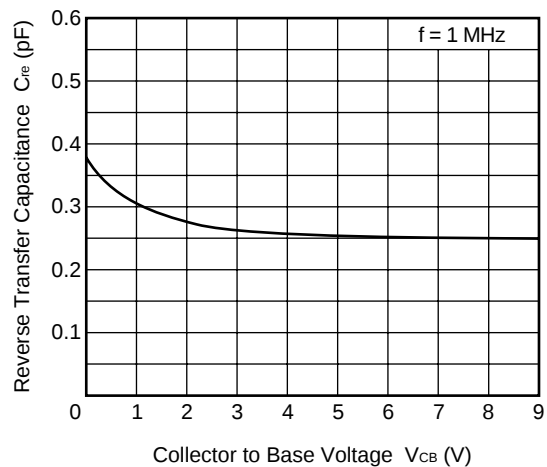
Rank	EB	FB
Marking	Y1	Y2
h_{FE} Value	75 to 110	95 to 140

★ TYPICAL CHARACTERISTICS (Unless otherwise specified, $T_A = +25^\circ\text{C}$)

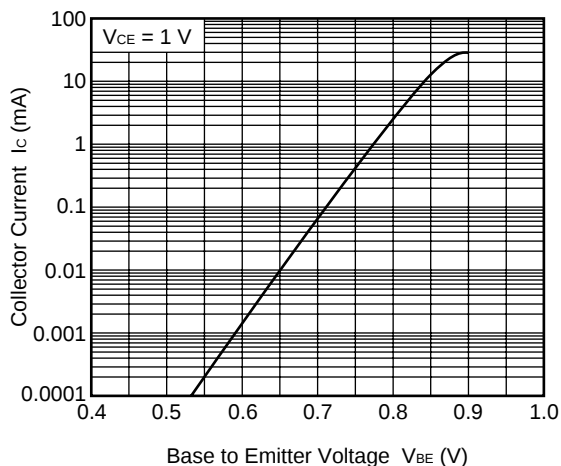
TOTAL POWER DISSIPATION
vs. AMBIENT TEMPERATURE



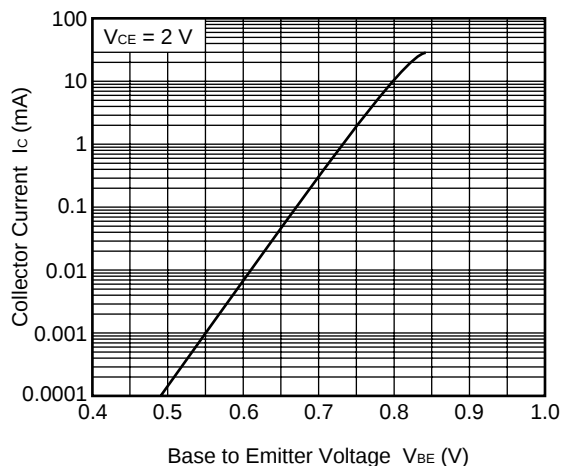
REVERSE TRANSFER CAPACITANCE
vs. COLLECTOR TO BASE VOLTAGE



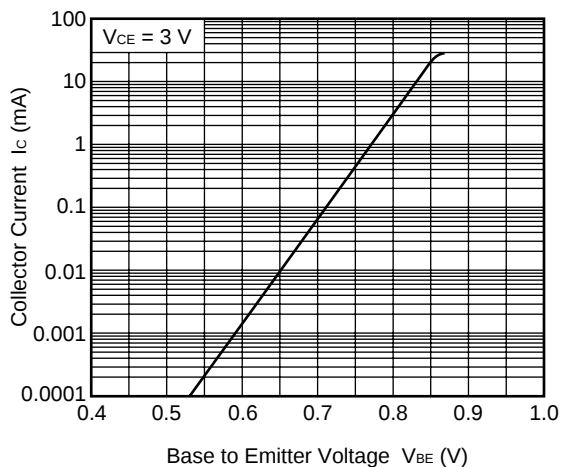
COLLECTOR CURRENT vs.
BASE TO EMITTER VOLTAGE



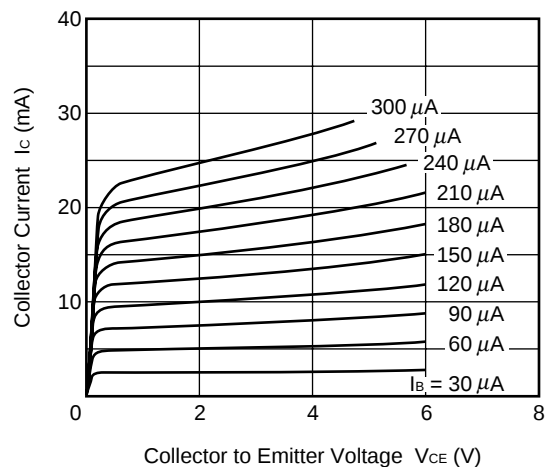
COLLECTOR CURRENT vs.
BASE TO EMITTER VOLTAGE



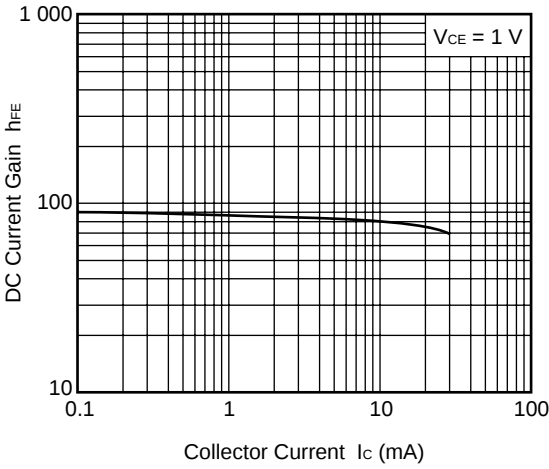
COLLECTOR CURRENT vs.
BASE TO EMITTER VOLTAGE



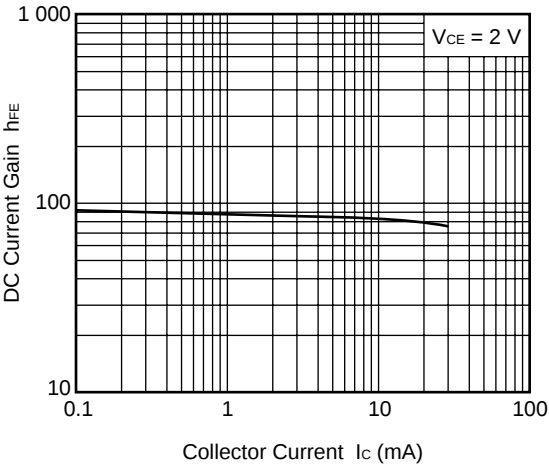
COLLECTOR CURRENT vs.
COLLECTOR TO EMITTER VOLTAGE



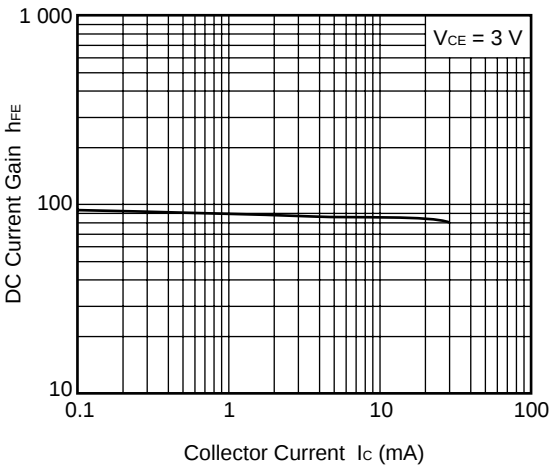
DC CURRENT GAIN vs.
COLLECTOR CURRENT



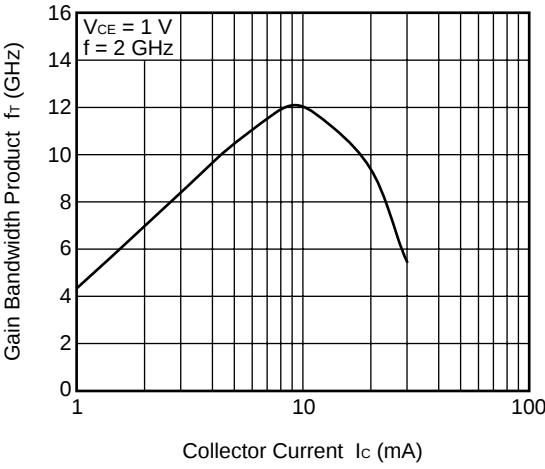
DC CURRENT GAIN vs.
COLLECTOR CURRENT



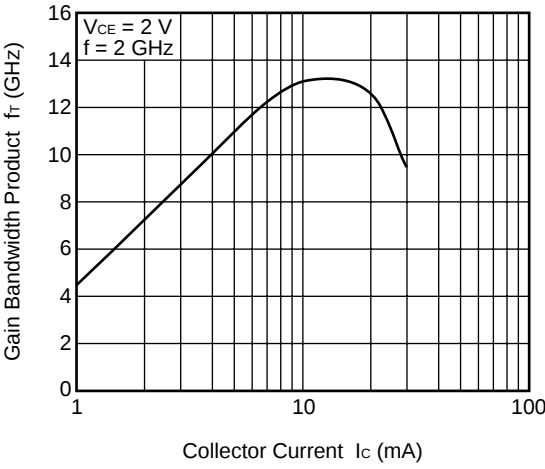
DC CURRENT GAIN vs.
COLLECTOR CURRENT



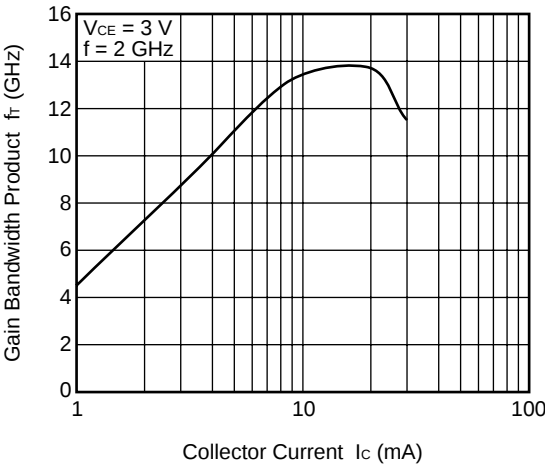
GAIN BANDWIDTH PRODUCT
vs. COLLECTOR CURRENT



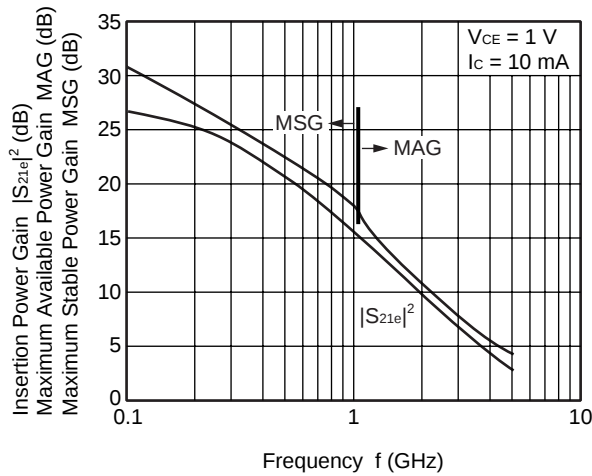
GAIN BANDWIDTH PRODUCT
vs. COLLECTOR CURRENT



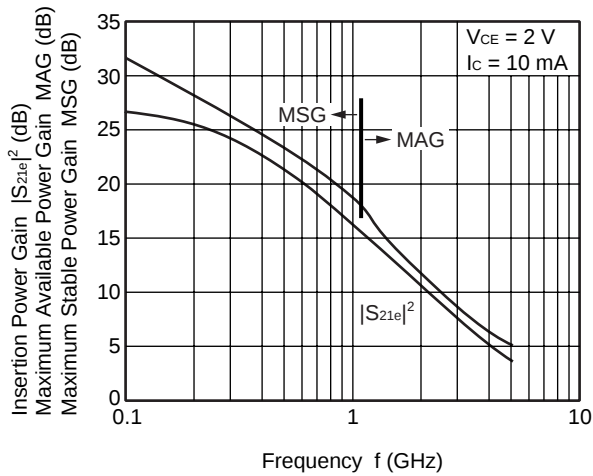
GAIN BANDWIDTH PRODUCT
vs. COLLECTOR CURRENT



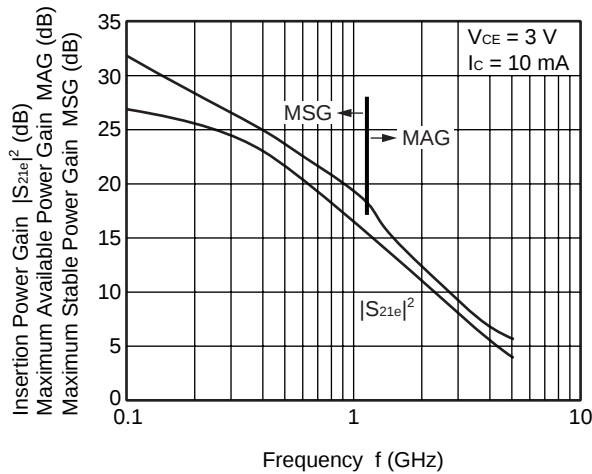
INSERTION POWER GAIN,
MAG, MSG vs. FREQUENCY



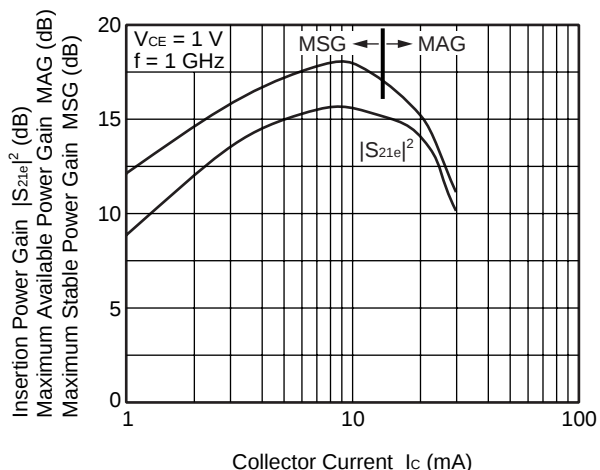
INSERTION POWER GAIN,
MAG, MSG vs. FREQUENCY



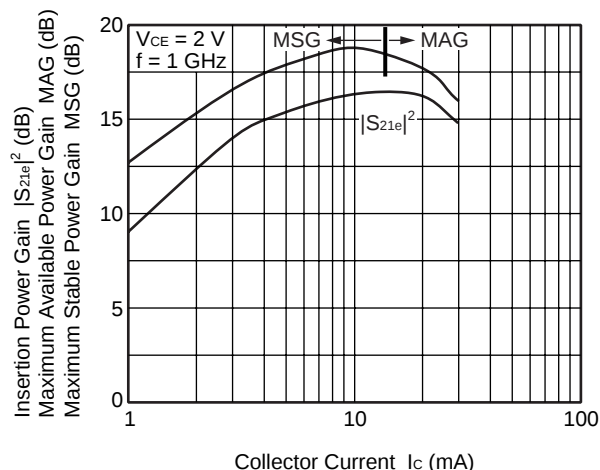
INSERTION POWER GAIN,
MAG, MSG vs. FREQUENCY



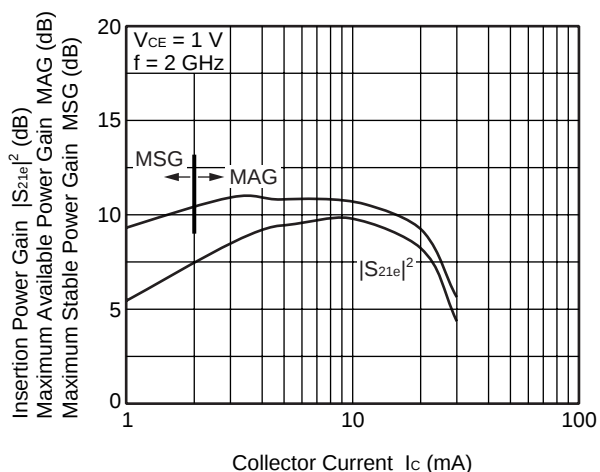
INSERTION POWER GAIN, MAG, MSG
vs. COLLECTOR CURRENT



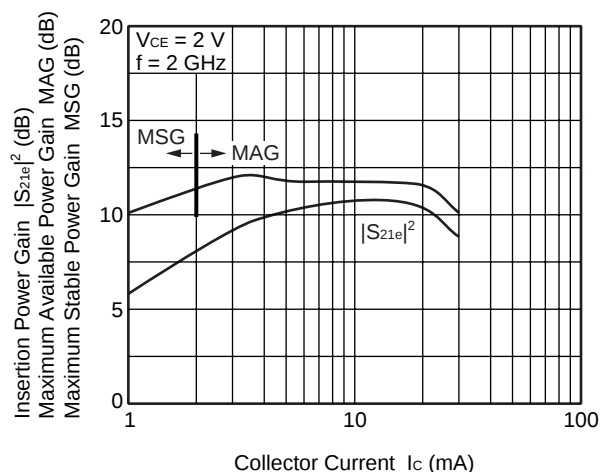
INSERTION POWER GAIN, MAG, MSG
vs. COLLECTOR CURRENT



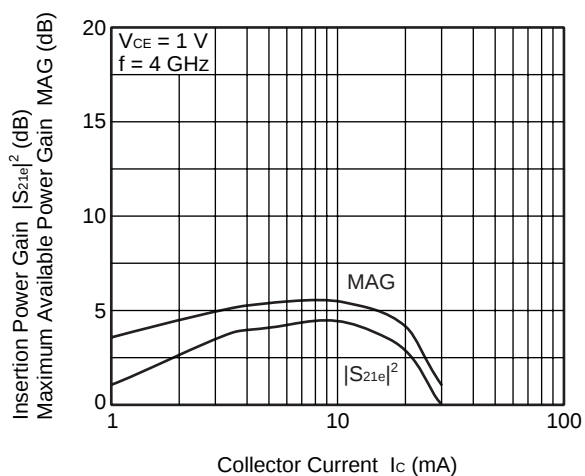
INSERTION POWER GAIN, MAG, MSG
vs. COLLECTOR CURRENT



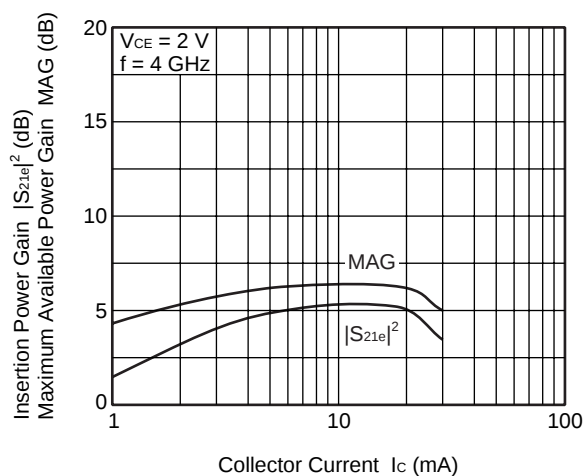
INSERTION POWER GAIN, MAG, MSG
vs. COLLECTOR CURRENT



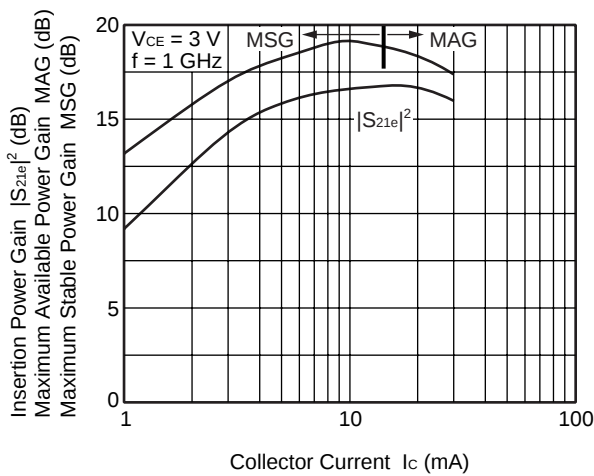
INSERTION POWER GAIN, MAG
vs. COLLECTOR CURRENT



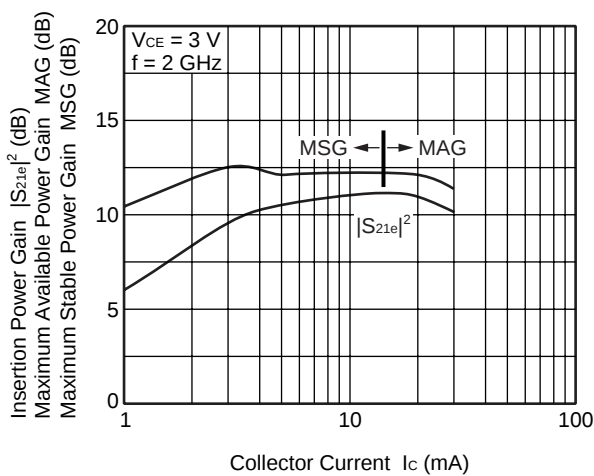
INSERTION POWER GAIN, MAG
vs. COLLECTOR CURRENT



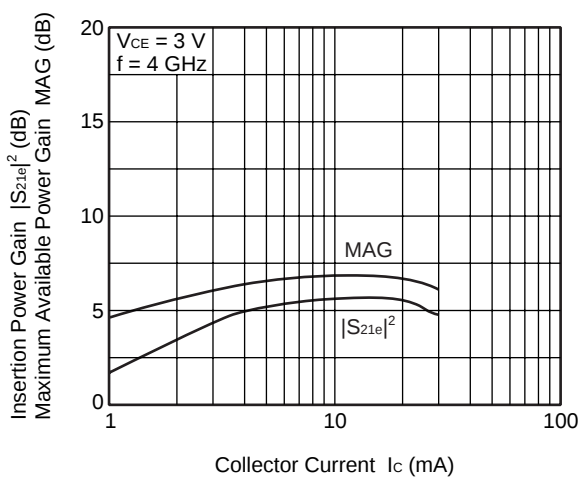
INSERTION POWER GAIN, MAG, MSG
vs. COLLECTOR CURRENT



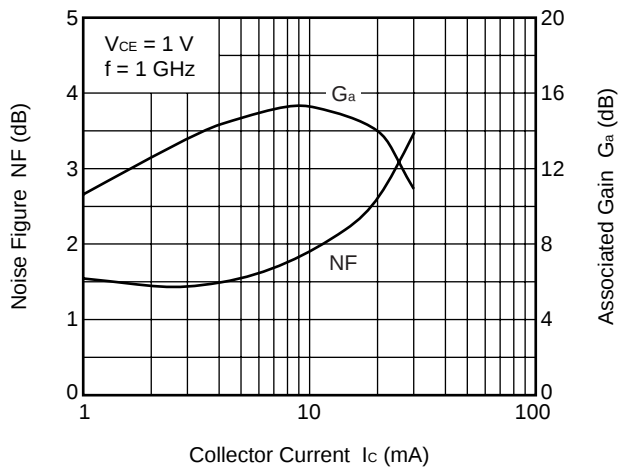
INSERTION POWER GAIN, MAG, MSG
vs. COLLECTOR CURRENT



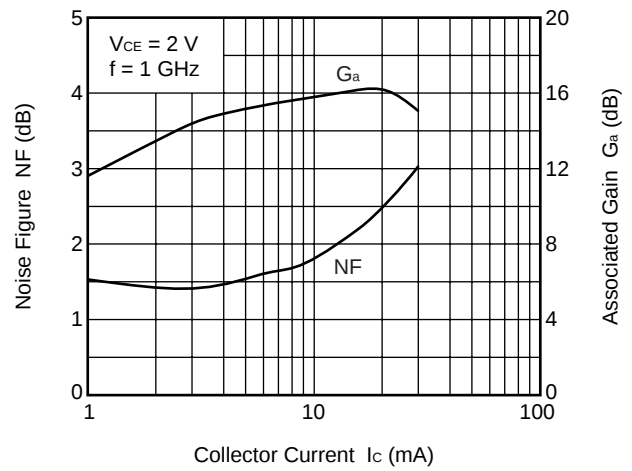
INSERTION POWER GAIN, MAG
vs. COLLECTOR CURRENT



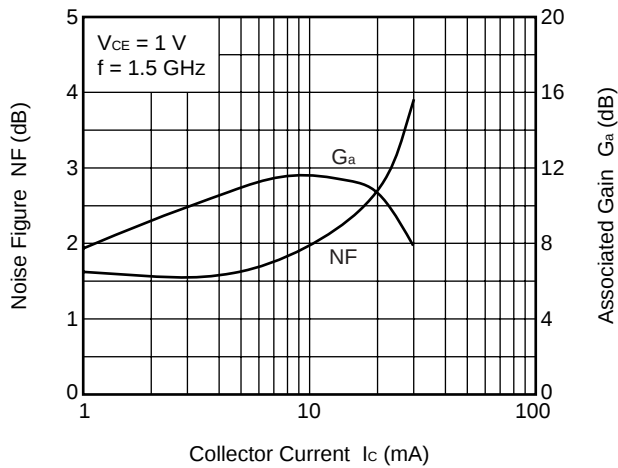
NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT



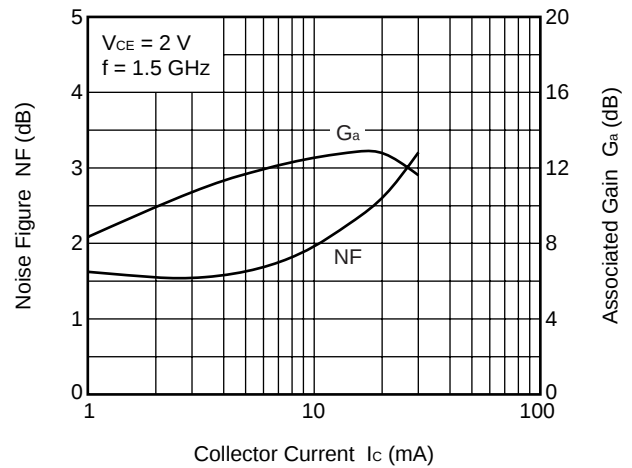
NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT



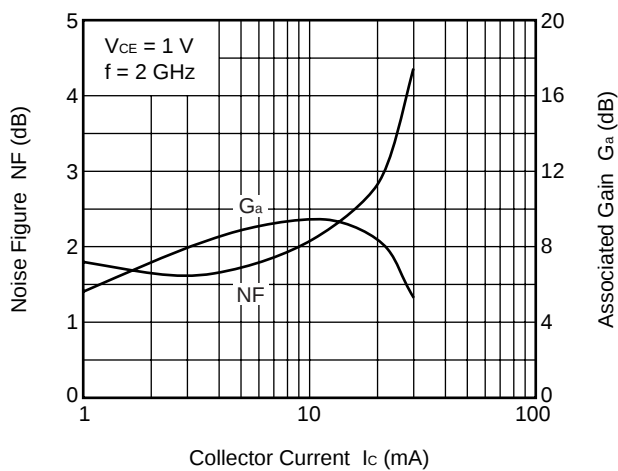
NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT



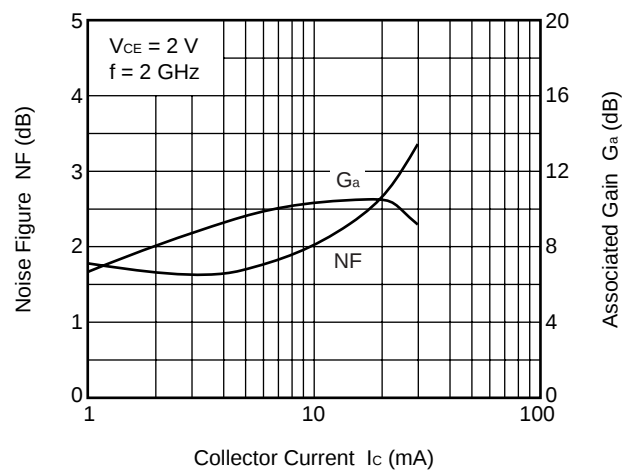
NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT



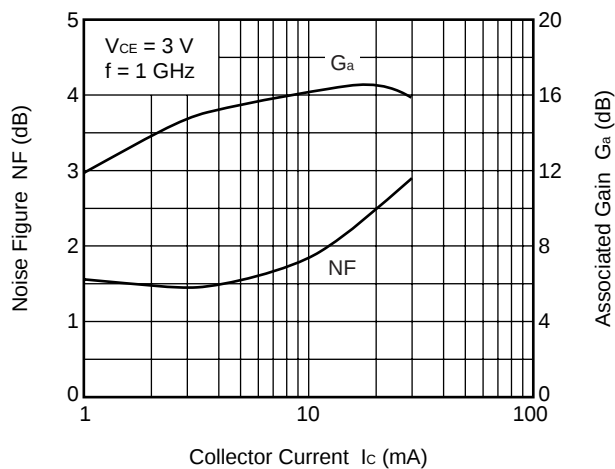
NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT



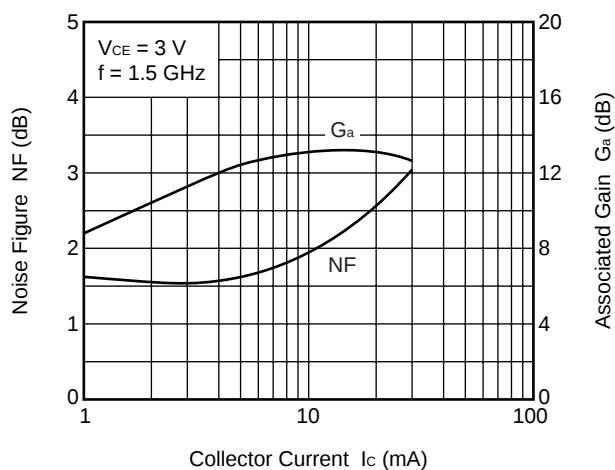
NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT



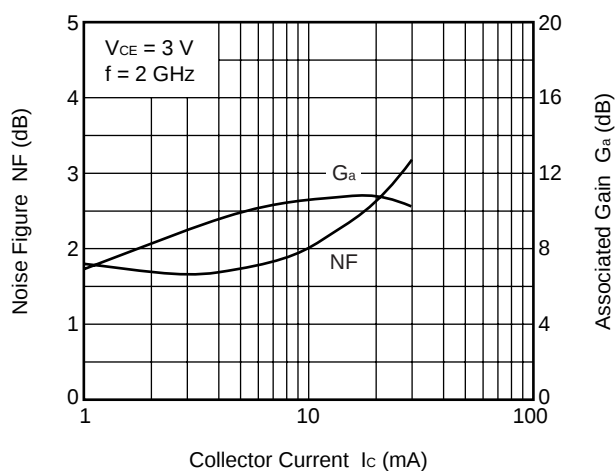
NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT



NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT



NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT



Remark The graphs indicate nominal characteristics.

S-PARAMETERS

$V_{CE} = 1\text{ V}$, $I_C = 1\text{ mA}$, $Z_0 = 50\ \Omega$

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.964	-8.2	3.547	172.1	0.020	85.4	1.001	-3.6
0.2	0.963	-13.8	3.472	166.9	0.044	80.7	0.989	-7.7
0.3	0.927	-21.7	3.383	160.6	0.065	76.5	0.980	-11.3
0.4	0.917	-29.2	3.345	153.5	0.086	71.9	0.957	-15.4
0.5	0.892	-36.1	3.309	147.5	0.105	67.5	0.940	-18.8
0.6	0.850	-42.9	3.189	140.7	0.122	63.1	0.901	-22.7
0.7	0.816	-49.8	3.106	135.3	0.137	59.5	0.877	-26.0
0.8	0.772	-56.2	2.997	129.2	0.150	55.7	0.837	-29.1
0.9	0.730	-62.8	2.874	124.4	0.162	52.4	0.806	-32.3
1.0	0.694	-69.1	2.768	119.4	0.171	49.5	0.767	-35.1
1.1	0.659	-75.6	2.660	114.3	0.180	46.6	0.744	-37.9
1.2	0.626	-81.9	2.567	109.7	0.187	44.4	0.710	-40.3
1.3	0.596	-88.0	2.452	105.3	0.194	41.6	0.692	-42.7
1.4	0.563	-94.2	2.363	100.6	0.199	39.4	0.662	-44.8
1.5	0.535	-100.1	2.262	97.1	0.204	37.6	0.645	-46.9
1.6	0.510	-105.4	2.174	93.1	0.207	35.6	0.618	-48.7
1.7	0.492	-111.3	2.101	89.8	0.210	34.0	0.601	-50.6
1.8	0.464	-117.4	2.017	85.8	0.212	32.6	0.578	-51.8
1.9	0.449	-121.8	1.942	83.1	0.214	31.4	0.562	-53.6
2.0	0.440	-127.9	1.868	79.7	0.215	30.6	0.541	-54.7
2.1	0.432	-133.4	1.812	77.0	0.216	29.8	0.528	-56.6
2.2	0.423	-137.8	1.761	74.5	0.217	29.1	0.512	-57.6
2.3	0.418	-142.5	1.701	71.6	0.218	28.5	0.505	-59.4
2.4	0.411	-147.8	1.658	69.5	0.217	27.9	0.491	-60.6
2.5	0.407	-152.5	1.599	67.1	0.218	27.5	0.485	-62.4
2.6	0.404	-157.0	1.557	64.2	0.218	26.0	0.479	-64.0
2.7	0.402	-160.4	1.522	62.1	0.219	25.8	0.472	-65.5
2.8	0.401	-164.5	1.472	59.5	0.219	25.2	0.466	-66.4
2.9	0.398	-167.8	1.433	57.6	0.221	25.7	0.457	-67.6
3.0	0.394	-171.9	1.397	55.6	0.221	25.7	0.446	-68.5
4.0	0.419	154.7	1.130	36.6	0.233	29.7	0.394	-84.1
5.0	0.505	131.9	0.967	21.4	0.272	32.6	0.336	-104.3

$V_{CE} = 1\text{ V}$, $I_C = 3\text{ mA}$, $Z_0 = 50\ \Omega$

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.888	-13.1	9.320	167.8	0.021	82.3	0.983	-7.9
0.2	0.866	-24.8	8.902	158.1	0.042	75.9	0.944	-15.5
0.3	0.793	-36.8	8.328	148.7	0.059	69.9	0.899	-22.2
0.4	0.748	-48.2	7.822	139.3	0.074	64.6	0.833	-28.5
0.5	0.687	-58.5	7.307	131.4	0.087	59.9	0.776	-33.4
0.6	0.620	-67.3	6.668	124.0	0.097	56.4	0.704	-37.9
0.7	0.562	-76.1	6.174	118.3	0.106	54.0	0.654	-41.2
0.8	0.511	-83.9	5.668	112.4	0.112	51.8	0.599	-44.5
0.9	0.469	-92.0	5.229	108.0	0.119	50.1	0.557	-47.2
1.0	0.433	-99.6	4.845	103.6	0.124	49.1	0.513	-49.6
1.1	0.402	-107.2	4.508	99.5	0.130	48.1	0.485	-51.8
1.2	0.381	-114.2	4.235	95.7	0.135	47.7	0.452	-54.0
1.3	0.361	-121.1	3.952	92.4	0.139	46.7	0.433	-55.8
1.4	0.341	-128.2	3.712	88.9	0.144	46.3	0.407	-57.3
1.5	0.327	-134.5	3.500	86.1	0.149	46.1	0.394	-58.7
1.6	0.315	-141.2	3.303	83.1	0.153	45.8	0.369	-60.0
1.7	0.310	-147.4	3.141	80.8	0.157	45.5	0.358	-61.4
1.8	0.299	-154.1	2.987	77.8	0.161	45.4	0.338	-62.2
1.9	0.293	-157.6	2.856	75.7	0.166	45.4	0.327	-63.8
2.0	0.301	-163.5	2.713	73.2	0.170	45.4	0.311	-64.6
2.1	0.301	-168.4	2.607	71.1	0.175	45.3	0.302	-66.6
2.2	0.305	-171.6	2.518	69.2	0.179	45.4	0.290	-67.4
2.3	0.304	-175.5	2.422	66.8	0.184	45.3	0.284	-69.5
2.4	0.306	-179.7	2.340	65.4	0.188	45.1	0.275	-70.3
2.5	0.311	176.9	2.242	63.6	0.192	45.0	0.270	-72.4
2.6	0.316	172.8	2.172	61.3	0.197	44.4	0.265	-73.4
2.7	0.316	170.3	2.115	59.6	0.201	44.2	0.260	-75.2
2.8	0.320	166.7	2.042	57.6	0.206	43.8	0.255	-75.5
2.9	0.322	165.0	1.983	56.2	0.213	44.1	0.248	-77.3
3.0	0.323	161.5	1.921	54.6	0.217	43.9	0.240	-77.7
4.0	0.375	138.2	1.502	38.4	0.267	42.2	0.201	-98.0
5.0	0.462	122.9	1.271	24.6	0.322	37.0	0.143	-127.5

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

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.814	-17.2	13.888	164.3	0.019	79.7	0.964	-11.3
0.2	0.771	-33.4	12.825	151.4	0.039	72.2	0.895	-21.4
0.3	0.678	-48.5	11.484	140.3	0.053	66.4	0.816	-29.6
0.4	0.613	-61.4	10.318	130.0	0.065	61.7	0.726	-36.2
0.5	0.547	-73.3	9.258	121.9	0.075	58.2	0.651	-40.9
0.6	0.477	-83.0	8.201	115.0	0.083	56.1	0.575	-44.9
0.7	0.426	-92.5	7.406	109.6	0.089	55.1	0.523	-47.7
0.8	0.385	-100.9	6.680	104.5	0.095	54.1	0.469	-50.3
0.9	0.350	-110.0	6.061	100.7	0.101	53.5	0.433	-52.4
1.0	0.329	-117.6	5.557	96.9	0.107	53.3	0.395	-54.5
1.1	0.309	-125.9	5.102	93.4	0.113	53.4	0.372	-56.4
1.2	0.295	-133.7	4.743	90.1	0.118	53.4	0.345	-58.3
1.3	0.286	-140.1	4.409	87.1	0.124	53.0	0.330	-59.8
1.4	0.278	-147.2	4.111	84.2	0.130	53.0	0.308	-61.3
1.5	0.270	-153.8	3.873	81.9	0.136	53.0	0.298	-62.4
1.6	0.266	-160.6	3.639	79.3	0.141	52.9	0.279	-63.6
1.7	0.270	-165.8	3.452	77.2	0.147	52.8	0.270	-65.0
1.8	0.266	-172.2	3.272	74.7	0.152	52.8	0.253	-65.8
1.9	0.263	-175.7	3.122	72.9	0.158	52.7	0.245	-67.5
2.0	0.275	-179.7	2.964	70.6	0.164	52.6	0.231	-68.4
2.1	0.280	176.3	2.839	68.7	0.170	52.4	0.226	-70.8
2.2	0.285	173.2	2.738	67.1	0.176	52.3	0.215	-71.6
2.3	0.285	170.8	2.634	64.9	0.182	52.0	0.211	-74.1
2.4	0.290	166.7	2.541	63.6	0.187	51.7	0.203	-75.0
2.5	0.298	164.2	2.431	62.0	0.193	51.4	0.200	-77.7
2.6	0.304	161.1	2.347	59.9	0.198	50.6	0.195	-78.6
2.7	0.306	159.0	2.286	58.4	0.204	50.4	0.191	-80.7
2.8	0.312	156.5	2.209	56.6	0.210	49.6	0.187	-81.0
2.9	0.314	155.0	2.145	55.2	0.217	49.6	0.183	-83.2
3.0	0.317	151.9	2.072	53.8	0.222	49.3	0.175	-83.6
4.0	0.367	132.6	1.611	38.7	0.280	45.2	0.147	-109.7
5.0	0.457	119.8	1.360	25.4	0.336	38.1	0.106	-153.3

$V_{CE} = 1\text{ V}$, $I_C = 7\text{ mA}$, $Z_0 = 50\ \Omega$

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.745	-21.4	17.422	161.3	0.019	78.1	0.943	-13.9
0.2	0.688	-40.0	15.581	146.1	0.036	70.2	0.848	-25.8
0.3	0.587	-57.3	13.483	134.3	0.049	64.6	0.747	-34.4
0.4	0.519	-71.2	11.713	123.9	0.059	60.9	0.646	-40.8
0.5	0.457	-83.7	10.251	116.0	0.067	58.6	0.569	-44.9
0.6	0.392	-94.5	8.924	109.7	0.074	57.4	0.495	-48.3
0.7	0.353	-104.1	7.948	104.8	0.081	57.4	0.446	-50.6
0.8	0.317	-113.8	7.110	100.0	0.086	57.1	0.397	-52.7
0.9	0.297	-123.2	6.421	96.6	0.093	56.8	0.365	-54.5
1.0	0.282	-131.2	5.848	93.3	0.099	57.0	0.332	-56.3
1.1	0.268	-139.3	5.346	90.0	0.106	57.2	0.312	-58.0
1.2	0.262	-146.9	4.956	87.1	0.112	57.5	0.289	-59.8
1.3	0.260	-153.3	4.577	84.6	0.118	57.2	0.277	-61.1
1.4	0.257	-160.2	4.271	81.7	0.124	57.2	0.258	-62.6
1.5	0.255	-166.1	4.020	79.7	0.131	57.2	0.251	-63.7
1.6	0.254	-172.4	3.771	77.2	0.138	57.1	0.234	-65.0
1.7	0.261	-176.6	3.570	75.4	0.144	56.9	0.227	-66.3
1.8	0.260	177.5	3.385	73.0	0.150	56.8	0.211	-67.3
1.9	0.259	174.3	3.233	71.3	0.156	56.5	0.206	-69.1
2.0	0.271	171.1	3.058	69.2	0.163	56.3	0.193	-70.1
2.1	0.277	168.3	2.930	67.4	0.169	55.9	0.189	-73.0
2.2	0.281	165.6	2.824	65.8	0.176	55.8	0.179	-73.9
2.3	0.285	163.0	2.712	63.7	0.182	55.3	0.176	-76.8
2.4	0.291	159.9	2.619	62.7	0.188	54.9	0.170	-77.6
2.5	0.297	157.5	2.503	61.1	0.194	54.5	0.167	-80.7
2.6	0.304	154.7	2.419	59.0	0.200	53.7	0.163	-81.7
2.7	0.307	153.3	2.353	57.5	0.206	53.2	0.160	-84.2
2.8	0.312	150.4	2.271	56.0	0.213	52.3	0.156	-84.4
2.9	0.314	149.3	2.205	54.6	0.220	52.2	0.152	-87.1
3.0	0.317	146.7	2.132	53.2	0.226	51.6	0.145	-87.6
4.0	0.370	129.5	1.650	38.6	0.285	46.5	0.126	-118.2
5.0	0.458	118.1	1.386	25.7	0.343	38.6	0.100	-169.8

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

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.672	-27.5	21.337	157.6	0.018	76.7	0.912	-17.1
0.2	0.597	-49.5	18.295	140.2	0.033	68.3	0.786	-30.4
0.3	0.486	-68.7	15.148	127.9	0.044	64.0	0.666	-38.9
0.4	0.423	-83.6	12.748	117.8	0.053	61.6	0.560	-44.6
0.5	0.373	-97.0	10.899	110.4	0.060	60.3	0.486	-47.8
0.6	0.322	-108.3	9.366	104.6	0.067	59.9	0.419	-50.4
0.7	0.292	-118.5	8.258	100.5	0.074	60.3	0.376	-51.8
0.8	0.268	-129.1	7.332	96.1	0.080	60.5	0.333	-53.5
0.9	0.258	-138.4	6.599	93.1	0.087	60.7	0.305	-54.9
1.0	0.252	-146.3	5.976	90.0	0.094	60.9	0.278	-56.6
1.1	0.247	-154.0	5.454	87.2	0.101	61.2	0.262	-58.0
1.2	0.245	-160.5	5.049	84.5	0.108	61.4	0.242	-59.7
1.3	0.247	-166.5	4.668	82.2	0.115	61.1	0.234	-61.1
1.4	0.249	-172.4	4.338	79.6	0.121	61.0	0.218	-62.5
1.5	0.252	-177.6	4.078	77.6	0.128	60.8	0.213	-63.7
1.6	0.254	177.3	3.822	75.3	0.135	60.8	0.197	-64.9
1.7	0.263	173.6	3.612	73.5	0.142	60.4	0.193	-66.4
1.8	0.265	167.9	3.425	71.4	0.149	60.1	0.179	-67.5
1.9	0.262	165.7	3.267	69.8	0.155	59.7	0.174	-69.6
2.0	0.276	163.3	3.085	67.7	0.162	59.4	0.162	-70.5
2.1	0.285	160.9	2.957	66.0	0.169	58.9	0.160	-73.9
2.2	0.289	158.6	2.856	64.7	0.176	58.5	0.151	-74.9
2.3	0.291	156.6	2.739	62.5	0.183	58.0	0.149	-78.3
2.4	0.297	154.3	2.643	61.5	0.189	57.4	0.144	-79.3
2.5	0.304	152.1	2.527	60.0	0.196	57.0	0.142	-83.0
2.6	0.311	149.8	2.440	58.0	0.202	56.1	0.138	-84.0
2.7	0.314	148.3	2.375	56.7	0.208	55.5	0.136	-86.8
2.8	0.320	146.1	2.293	55.1	0.215	54.6	0.132	-87.1
2.9	0.321	144.8	2.223	53.9	0.223	54.3	0.129	-90.2
3.0	0.323	142.6	2.152	52.5	0.229	53.7	0.123	-90.8
4.0	0.376	127.4	1.658	38.1	0.290	47.7	0.112	-125.9
5.0	0.463	116.4	1.398	25.6	0.348	39.2	0.101	178.4

$V_{CE} = 1\text{ V}$, $I_C = 20\text{ mA}$, $Z_O = 50\ \Omega$

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.458	-47.7	25.447	148.0	0.017	72.5	0.781	-24.4
0.2	0.404	-79.8	19.296	127.1	0.028	65.3	0.600	-38.1
0.3	0.331	-105.4	14.700	115.4	0.037	63.5	0.476	-43.8
0.4	0.311	-122.2	11.737	106.8	0.044	63.8	0.389	-46.4
0.5	0.297	-135.9	9.706	100.7	0.052	64.1	0.337	-46.8
0.6	0.281	-147.1	8.204	96.0	0.059	64.8	0.290	-47.4
0.7	0.276	-156.5	7.162	92.6	0.066	65.7	0.263	-47.1
0.8	0.275	-164.4	6.307	89.0	0.073	66.1	0.235	-47.6
0.9	0.280	-171.3	5.635	86.5	0.081	66.4	0.219	-48.3
1.0	0.286	-176.6	5.089	83.9	0.088	66.5	0.200	-49.6
1.1	0.288	178.5	4.624	81.4	0.096	66.6	0.193	-51.0
1.2	0.295	174.4	4.267	79.1	0.103	66.6	0.179	-52.7
1.3	0.299	170.8	3.953	77.0	0.111	66.1	0.176	-54.4
1.4	0.306	167.2	3.671	74.6	0.118	65.9	0.165	-55.8
1.5	0.311	164.0	3.442	72.9	0.125	65.7	0.164	-57.2
1.6	0.316	160.1	3.222	70.7	0.133	65.3	0.153	-58.4
1.7	0.326	158.4	3.046	69.2	0.140	64.7	0.152	-60.5
1.8	0.331	154.5	2.886	67.0	0.147	64.3	0.140	-61.5
1.9	0.330	152.6	2.755	65.4	0.154	63.9	0.139	-64.4
2.0	0.341	151.0	2.604	63.5	0.162	63.3	0.129	-65.5
2.1	0.350	149.8	2.493	61.8	0.169	62.6	0.129	-69.9
2.2	0.351	148.3	2.409	60.5	0.176	62.1	0.122	-71.1
2.3	0.353	146.4	2.312	58.4	0.183	61.4	0.121	-75.5
2.4	0.361	144.5	2.232	57.5	0.190	60.8	0.117	-76.7
2.5	0.367	143.1	2.135	56.1	0.197	60.2	0.117	-81.5
2.6	0.376	141.5	2.061	54.2	0.204	59.2	0.115	-82.6
2.7	0.376	140.0	2.008	52.8	0.210	58.4	0.114	-86.4
2.8	0.384	138.3	1.941	51.2	0.217	57.4	0.112	-87.0
2.9	0.384	137.5	1.885	50.1	0.225	57.0	0.110	-91.1
3.0	0.387	135.3	1.822	48.7	0.231	56.3	0.105	-92.1
4.0	0.431	121.9	1.406	34.8	0.295	49.6	0.106	-131.7
5.0	0.511	112.0	1.192	22.6	0.355	40.6	0.112	173.9

$V_{CE} = 2\text{ V}$, $I_C = 1\text{ mA}$, $Z_0 = 50\ \Omega$

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.965	-6.9	3.517	172.7	0.018	87.1	1.004	-3.0
0.2	0.967	-12.6	3.451	167.9	0.037	82.2	0.992	-6.4
0.3	0.932	-19.9	3.375	161.9	0.055	77.5	0.987	-9.4
0.4	0.927	-26.9	3.346	155.4	0.073	73.7	0.967	-13.0
0.5	0.903	-33.0	3.318	149.7	0.090	69.7	0.956	-16.0
0.6	0.866	-39.5	3.211	143.2	0.105	65.4	0.921	-19.3
0.7	0.829	-45.9	3.141	138.2	0.118	62.3	0.901	-22.2
0.8	0.794	-51.8	3.041	132.3	0.130	58.7	0.865	-25.1
0.9	0.750	-57.9	2.924	127.7	0.141	55.5	0.839	-27.7
1.0	0.718	-64.0	2.832	122.8	0.149	52.7	0.803	-30.2
1.1	0.681	-70.2	2.733	117.7	0.158	49.9	0.782	-32.8
1.2	0.648	-76.1	2.655	113.3	0.165	47.8	0.752	-35.0
1.3	0.618	-82.1	2.538	108.9	0.171	45.0	0.736	-37.2
1.4	0.585	-87.7	2.450	104.4	0.176	42.9	0.709	-39.1
1.5	0.552	-93.3	2.356	100.7	0.182	41.2	0.693	-41.0
1.6	0.525	-98.8	2.268	96.7	0.185	39.2	0.667	-42.6
1.7	0.504	-104.5	2.193	93.5	0.188	37.8	0.651	-44.4
1.8	0.475	-109.8	2.110	89.5	0.190	36.4	0.628	-45.6
1.9	0.457	-114.1	2.034	86.8	0.192	35.2	0.613	-47.1
2.0	0.449	-120.6	1.958	83.5	0.193	34.5	0.593	-48.1
2.1	0.438	-125.9	1.901	80.8	0.195	33.7	0.581	-49.6
2.2	0.429	-130.3	1.853	78.1	0.196	33.0	0.566	-50.8
2.3	0.417	-135.1	1.791	75.3	0.197	32.5	0.558	-52.3
2.4	0.408	-140.3	1.742	73.2	0.197	31.9	0.545	-53.4
2.5	0.401	-145.1	1.680	70.7	0.197	31.5	0.538	-55.0
2.6	0.397	-149.7	1.637	67.8	0.198	30.2	0.534	-56.6
2.7	0.394	-153.5	1.601	65.8	0.199	30.0	0.527	-57.9
2.8	0.391	-158.0	1.550	63.3	0.200	29.5	0.522	-58.7
2.9	0.387	-161.3	1.509	61.2	0.202	30.0	0.511	-59.8
3.0	0.380	-165.1	1.470	59.3	0.202	30.2	0.502	-60.6
4.0	0.398	158.8	1.191	40.2	0.217	35.0	0.448	-74.4
5.0	0.481	134.6	1.019	24.6	0.259	38.6	0.389	-91.1

$V_{CE} = 2\text{ V}$, $I_C = 3\text{ mA}$, $Z_0 = 50\ \Omega$

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.888	-12.0	9.332	168.8	0.017	84.2	0.989	-6.5
0.2	0.876	-22.0	8.935	159.7	0.035	77.8	0.956	-12.9
0.3	0.810	-32.9	8.423	150.8	0.050	72.0	0.918	-18.5
0.4	0.769	-43.3	7.967	141.8	0.064	67.3	0.863	-23.9
0.5	0.711	-52.7	7.521	134.3	0.076	62.8	0.814	-28.0
0.6	0.645	-61.0	6.912	127.0	0.085	59.4	0.749	-31.9
0.7	0.590	-69.0	6.446	121.4	0.093	57.2	0.704	-34.8
0.8	0.532	-76.0	5.953	115.5	0.099	54.9	0.649	-37.4
0.9	0.485	-83.5	5.512	111.1	0.106	53.3	0.612	-39.8
1.0	0.450	-90.4	5.133	106.8	0.111	52.2	0.569	-41.6
1.1	0.414	-97.2	4.785	102.5	0.116	51.3	0.543	-43.5
1.2	0.385	-104.0	4.497	98.7	0.121	50.9	0.511	-45.1
1.3	0.363	-110.5	4.214	95.4	0.126	49.9	0.492	-46.7
1.4	0.337	-117.4	3.968	91.8	0.130	49.5	0.467	-47.8
1.5	0.320	-123.7	3.751	89.0	0.135	49.2	0.454	-49.1
1.6	0.302	-130.3	3.542	86.0	0.139	48.9	0.431	-49.9
1.7	0.296	-136.4	3.373	83.6	0.143	48.7	0.420	-51.2
1.8	0.281	-143.1	3.207	80.6	0.147	48.7	0.400	-51.6
1.9	0.271	-146.7	3.065	78.5	0.152	48.5	0.389	-52.9
2.0	0.274	-153.4	2.917	76.0	0.156	48.6	0.373	-53.3
2.1	0.276	-158.4	2.804	73.9	0.160	48.6	0.364	-54.9
2.2	0.276	-162.3	2.705	72.0	0.164	48.5	0.353	-55.4
2.3	0.273	-166.7	2.604	69.7	0.169	48.5	0.347	-57.0
2.4	0.274	-171.6	2.517	68.3	0.173	48.4	0.338	-57.6
2.5	0.276	-175.5	2.414	66.3	0.177	48.4	0.332	-59.4
2.6	0.281	-179.8	2.336	64.0	0.182	47.6	0.328	-60.2
2.7	0.281	177.6	2.277	62.4	0.186	47.6	0.322	-61.6
2.8	0.286	173.6	2.197	60.4	0.191	47.2	0.319	-61.9
2.9	0.286	171.2	2.131	58.9	0.197	47.4	0.311	-63.1
3.0	0.287	167.5	2.065	57.4	0.201	47.4	0.304	-63.4
4.0	0.336	142.0	1.614	41.3	0.250	46.2	0.258	-79.2
5.0	0.426	125.5	1.369	27.4	0.305	41.6	0.188	-96.7

$V_{CE} = 2 \text{ V}$, $I_C = 5 \text{ mA}$, $Z_o = 50 \Omega$

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.836	-15.2	13.930	165.3	0.015	80.7	0.974	-9.2
0.2	0.788	-29.2	12.973	153.4	0.033	74.3	0.916	-17.7
0.3	0.702	-42.7	11.773	142.8	0.046	69.1	0.850	-24.5
0.4	0.639	-54.5	10.712	132.8	0.057	64.7	0.769	-30.1
0.5	0.571	-65.4	9.705	124.8	0.066	61.1	0.703	-34.0
0.6	0.498	-73.7	8.665	117.9	0.073	59.1	0.631	-37.4
0.7	0.445	-82.6	7.862	112.7	0.080	58.0	0.582	-39.5
0.8	0.394	-90.1	7.132	107.3	0.085	57.0	0.531	-41.4
0.9	0.357	-98.1	6.497	103.4	0.091	56.4	0.495	-43.2
1.0	0.329	-105.5	5.969	99.7	0.097	56.1	0.457	-44.5
1.1	0.302	-113.1	5.499	96.2	0.102	56.2	0.434	-45.8
1.2	0.285	-120.6	5.126	92.7	0.107	56.2	0.409	-47.0
1.3	0.269	-127.4	4.757	90.0	0.113	55.7	0.394	-48.2
1.4	0.255	-135.0	4.450	86.7	0.118	55.7	0.373	-49.0
1.5	0.246	-141.6	4.195	84.5	0.124	55.9	0.364	-50.0
1.6	0.237	-148.9	3.947	81.8	0.129	55.7	0.344	-50.7
1.7	0.239	-154.5	3.743	79.8	0.134	55.6	0.336	-51.7
1.8	0.230	-161.8	3.552	77.2	0.140	55.5	0.319	-52.0
1.9	0.225	-165.6	3.393	75.4	0.145	55.4	0.311	-53.2
2.0	0.236	-171.3	3.215	73.2	0.151	55.4	0.298	-53.5
2.1	0.240	-174.5	3.085	71.2	0.156	55.2	0.291	-55.4
2.2	0.243	-178.8	2.977	69.7	0.162	55.2	0.281	-55.6
2.3	0.244	178.4	2.857	67.5	0.167	54.9	0.276	-57.5
2.4	0.247	174.1	2.758	66.3	0.172	54.7	0.269	-58.0
2.5	0.253	170.3	2.642	64.6	0.178	54.5	0.264	-60.0
2.6	0.259	166.9	2.549	62.5	0.183	53.6	0.261	-60.7
2.7	0.261	164.7	2.483	61.0	0.189	53.4	0.256	-62.2
2.8	0.267	161.4	2.395	59.3	0.194	52.7	0.253	-62.3
2.9	0.268	159.8	2.324	57.9	0.201	52.7	0.247	-63.7
3.0	0.269	156.3	2.247	56.4	0.206	52.5	0.240	-63.9
4.0	0.325	135.4	1.745	41.6	0.262	49.0	0.200	-82.4
5.0	0.416	122.5	1.474	28.4	0.319	42.6	0.128	-104.0

$V_{CE} = 2 \text{ V}$, $I_C = 7 \text{ mA}$, $Z_0 = 50 \Omega$

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.767	-19.5	17.533	162.8	0.016	78.0	0.958	-11.3
0.2	0.722	-34.9	15.888	148.6	0.031	72.4	0.878	-21.2
0.3	0.618	-50.2	13.968	137.2	0.042	67.8	0.792	-28.3
0.4	0.543	-62.8	12.299	127.0	0.052	64.2	0.699	-33.7
0.5	0.479	-74.0	10.887	119.1	0.060	61.5	0.628	-37.0
0.6	0.409	-83.2	9.542	112.6	0.066	60.0	0.557	-39.6
0.7	0.361	-92.1	8.545	107.7	0.073	60.1	0.511	-41.1
0.8	0.320	-99.9	7.672	102.8	0.078	59.7	0.463	-42.5
0.9	0.289	-108.6	6.931	99.4	0.084	59.4	0.432	-43.8
1.0	0.267	-116.7	6.341	95.9	0.090	59.6	0.399	-44.8
1.1	0.249	-124.6	5.818	92.7	0.096	59.7	0.380	-45.9
1.2	0.237	-132.6	5.394	89.8	0.102	60.0	0.356	-46.8
1.3	0.228	-139.3	5.007	87.2	0.108	59.7	0.345	-47.9
1.4	0.220	-147.5	4.668	84.4	0.113	59.7	0.327	-48.6
1.5	0.215	-153.4	4.389	82.2	0.120	59.7	0.320	-49.5
1.6	0.214	-160.8	4.125	79.7	0.126	59.6	0.303	-50.0
1.7	0.216	-166.1	3.905	77.9	0.132	59.3	0.296	-51.1
1.8	0.213	-173.8	3.704	75.5	0.138	59.2	0.281	-51.2
1.9	0.210	-177.3	3.537	73.8	0.144	59.1	0.274	-52.6
2.0	0.223	178.4	3.345	71.7	0.150	58.9	0.262	-52.8
2.1	0.228	175.1	3.206	69.9	0.156	58.6	0.256	-54.8
2.2	0.233	172.6	3.088	68.5	0.162	58.3	0.247	-55.1
2.3	0.235	169.9	2.968	66.3	0.168	58.1	0.243	-57.2
2.4	0.241	165.7	2.861	65.2	0.173	57.7	0.237	-57.5
2.5	0.247	163.1	2.740	63.7	0.179	57.3	0.233	-59.8
2.6	0.256	159.9	2.649	61.6	0.185	56.4	0.230	-60.4
2.7	0.256	157.6	2.579	60.3	0.191	56.1	0.225	-62.0
2.8	0.263	155.3	2.484	58.6	0.197	55.2	0.222	-62.1
2.9	0.264	153.6	2.410	57.3	0.204	55.2	0.217	-63.7
3.0	0.265	150.5	2.333	55.9	0.209	54.7	0.211	-63.8
4.0	0.321	132.6	1.799	41.5	0.267	50.3	0.173	-84.4
5.0	0.412	120.7	1.518	28.7	0.325	43.0	0.102	-110.3

$V_{CE} = 2\text{ V}$, $I_C = 10\text{ mA}$, $Z_O = 50\ \Omega$

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.698	-22.1	21.714	159.4	0.015	78.9	0.936	-13.9
0.2	0.628	-41.9	18.942	143.2	0.029	70.5	0.828	-24.8
0.3	0.517	-58.8	16.006	131.2	0.039	66.4	0.722	-31.8
0.4	0.447	-71.8	13.661	121.0	0.047	64.2	0.623	-36.5
0.5	0.384	-83.9	11.809	113.6	0.054	62.8	0.554	-38.9
0.6	0.325	-93.5	10.206	107.6	0.060	62.3	0.488	-40.7
0.7	0.288	-103.4	9.052	103.2	0.067	62.9	0.446	-41.4
0.8	0.255	-112.4	8.059	98.8	0.073	62.9	0.404	-42.3
0.9	0.235	-121.7	7.252	95.7	0.079	63.0	0.377	-43.0
1.0	0.221	-130.0	6.589	92.7	0.085	63.1	0.349	-43.7
1.1	0.209	-138.4	6.034	89.7	0.092	63.5	0.334	-44.6
1.2	0.205	-146.4	5.576	86.9	0.098	63.6	0.314	-45.5
1.3	0.199	-153.2	5.163	84.8	0.104	63.5	0.306	-46.4
1.4	0.200	-160.3	4.808	82.0	0.111	63.4	0.289	-47.0
1.5	0.200	-166.9	4.516	80.1	0.118	63.2	0.285	-47.9
1.6	0.201	-173.3	4.229	77.8	0.124	63.1	0.270	-48.3
1.7	0.207	-177.8	4.008	76.2	0.130	62.7	0.265	-49.4
1.8	0.210	175.4	3.800	73.9	0.136	62.3	0.251	-49.6
1.9	0.205	172.4	3.625	72.3	0.143	62.2	0.246	-51.0
2.0	0.219	169.3	3.432	70.3	0.149	61.9	0.234	-51.1
2.1	0.229	166.7	3.285	68.7	0.155	61.4	0.229	-53.4
2.2	0.231	163.7	3.164	67.3	0.162	61.2	0.221	-53.6
2.3	0.232	161.7	3.039	65.2	0.168	60.7	0.218	-56.0
2.4	0.241	158.2	2.931	64.3	0.174	60.1	0.213	-56.4
2.5	0.247	156.5	2.807	62.8	0.180	59.7	0.209	-58.9
2.6	0.257	153.9	2.705	60.9	0.186	58.7	0.206	-59.4
2.7	0.256	152.4	2.632	59.5	0.193	58.2	0.202	-61.2
2.8	0.262	149.6	2.539	57.9	0.199	57.5	0.200	-61.3
2.9	0.265	148.3	2.463	56.7	0.206	57.2	0.194	-63.1
3.0	0.268	145.7	2.385	55.3	0.212	56.6	0.189	-63.1
4.0	0.323	129.9	1.836	41.4	0.272	51.4	0.154	-85.9
5.0	0.413	119.5	1.549	28.7	0.330	43.6	0.085	-116.8

$V_{CE} = 2 \text{ V}$, $I_C = 20 \text{ mA}$, $Z_O = 50 \Omega$

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.523	-33.8	28.767	152.2	0.014	75.2	0.871	-18.6
0.2	0.443	-59.0	22.932	132.7	0.025	70.5	0.713	-30.2
0.3	0.342	-79.9	18.030	120.8	0.032	66.8	0.592	-35.2
0.4	0.292	-96.0	14.632	111.5	0.039	67.4	0.500	-37.4
0.5	0.261	-109.0	12.228	105.2	0.046	67.3	0.444	-37.6
0.6	0.225	-121.7	10.407	100.2	0.053	67.6	0.393	-37.7
0.7	0.208	-132.4	9.113	96.7	0.060	68.7	0.365	-37.3
0.8	0.195	-142.9	8.038	92.9	0.066	68.7	0.334	-37.2
0.9	0.193	-152.5	7.192	90.3	0.073	68.9	0.316	-37.5
1.0	0.192	-159.8	6.505	87.7	0.080	68.9	0.295	-37.8
1.1	0.195	-167.2	5.924	85.3	0.087	69.1	0.286	-38.7
1.2	0.199	-172.6	5.475	82.9	0.094	69.1	0.271	-39.3
1.3	0.202	-177.5	5.051	80.9	0.101	68.6	0.267	-40.4
1.4	0.208	176.9	4.707	78.5	0.107	68.4	0.255	-40.9
1.5	0.210	172.6	4.410	76.8	0.115	68.1	0.253	-42.0
1.6	0.219	167.4	4.136	74.7	0.121	67.6	0.241	-42.4
1.7	0.228	165.8	3.912	73.2	0.128	67.1	0.238	-43.8
1.8	0.232	159.9	3.705	71.1	0.135	66.7	0.227	-43.8
1.9	0.230	158.3	3.532	69.6	0.141	66.3	0.223	-45.6
2.0	0.243	156.2	3.337	67.7	0.148	65.8	0.213	-45.6
2.1	0.252	154.5	3.198	66.2	0.155	65.2	0.210	-48.3
2.2	0.256	153.0	3.079	64.9	0.161	64.7	0.203	-48.6
2.3	0.257	151.0	2.961	63.0	0.168	64.2	0.200	-51.1
2.4	0.265	148.4	2.851	62.0	0.174	63.5	0.196	-51.7
2.5	0.272	147.5	2.731	60.7	0.181	62.9	0.192	-54.5
2.6	0.280	145.1	2.632	58.7	0.187	61.9	0.190	-55.1
2.7	0.281	144.3	2.563	57.5	0.193	61.2	0.187	-57.3
2.8	0.290	142.2	2.468	56.0	0.200	60.3	0.185	-57.4
2.9	0.290	141.5	2.399	54.8	0.207	60.0	0.180	-59.4
3.0	0.294	139.2	2.318	53.5	0.213	59.3	0.176	-59.6
4.0	0.349	125.6	1.781	39.9	0.275	53.2	0.144	-84.7
5.0	0.432	116.5	1.499	27.5	0.334	44.9	0.078	-119.3

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M8E 00.4-0110

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