

**NPN SILICON EPITAXIAL TRANSISTOR (WITH 2 DIFFERENT ELEMENTS)  
IN A 6-PIN THIN-TYPE SMALL MINI MOLD PACKAGE**

**DESCRIPTION**

The  $\mu$ PA833TF has two different built-in transistors (Q1 and Q2) for low noise amplification in the VHF band to UHF band.

**FEATURES**

- Low noise  
Q1 : NF = 1.7 dB TYP. @ f = 2 GHz,  $V_{CE} = 1$  V,  $I_C = 3$  mA  
Q2 : NF = 1.5 dB TYP. @ f = 2 GHz,  $V_{CE} = 3$  V,  $I_C = 3$  mA
- High gain  
Q1 :  $|S_{21e}|^2 = 3.5$  dB TYP. @ f = 2 GHz,  $V_{CE} = 1$  V,  $I_C = 3$  mA  
Q2 :  $|S_{21e}|^2 = 8.5$  dB TYP. @ f = 2 GHz,  $V_{CE} = 3$  V,  $I_C = 10$  mA
- 6-pin thin-type small mini mold package
- 2 different transistors on-chip (2SC5193, 2SC4959)

**ON-CHIP TRANSISTORS**

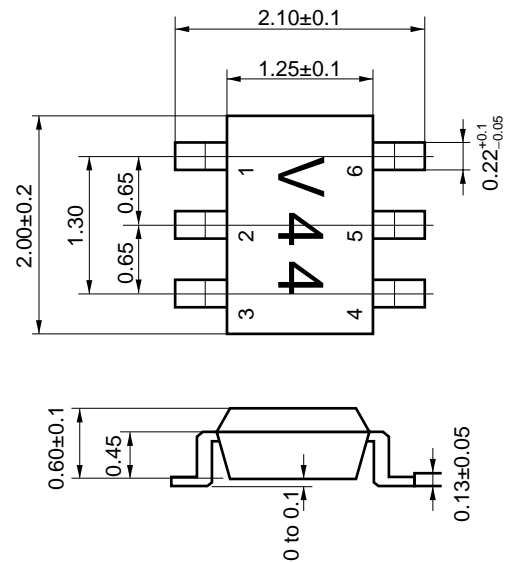
	Q1	Q2
3-pin small mini mold part No.	2SC5193	2SC4959

The  $\mu$ PA836TF features the Q1 and Q2 in inverted positions.

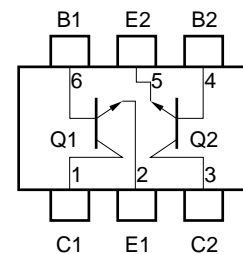
**ORDERING INFORMATION**

PART NUMBER	QUANTITY	PACKING STYLE
$\mu$ PA833TF	Loose products (50 pcs)	8-mm wide embossed tape. Pin 6 (Q1 Base), pin 5 (Q2 Emitter), and pin 4 (Q2 Base) face perforated side of tape.
$\mu$ PA833TF-T1	Taping products (3 kpcs/reel)	

**PACKAGE DRAWINGS (Unit:mm)**



**PIN CONFIGURATION (Top View)**



**PIN CONNECTIONS**

- |                   |                 |
|-------------------|-----------------|
| 1. Collector (Q1) | 4. Base (Q2)    |
| 2. Emitter (Q1)   | 5. Emitter (Q2) |
| 3. Collector (Q2) | 6. Base (Q1)    |

**Caution is required concerning excess input, such as from static electricity, because the high-frequency process is used for this device.**

The information in this document is subject to change without notice.

**ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C)**

PARAMETER	SYMBOL	RATING		UNIT
		Q1	Q2	
Collector to base voltage	V <sub>CBO</sub>	9	9	V
Collector to emitter voltage	V <sub>CEO</sub>	6	6	V
Emitter to base voltage	V <sub>EBO</sub>	2	2	V
Collector current	I <sub>C</sub>	100	30	mA
Total power dissipation	P <sub>T</sub>	150 in 1 element	150 in 1 element	mW
		200 in 2 elements <sup>Note</sup>		
Junction temperature	T <sub>J</sub>	150	150	°C
Storage temperature	T <sub>stg</sub>	-65 to +150		°C

**Note** 110 mW must not be exceeded for 1 element.

(1) Q1

**ELECTRICAL CHARACTERISTICS**

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Collector cutoff current	I <sub>CBO</sub>	V <sub>CB</sub> = 5 V, I <sub>E</sub> = 0			0.1	μA
Emitter cutoff current	I <sub>EBO</sub>	V <sub>EB</sub> = 1 V, I <sub>C</sub> = 0			0.1	μA
DC current gain	h <sub>FE</sub>	V <sub>CE</sub> = 1 V, I <sub>C</sub> = 3 mA <sup>Note 1</sup>	100		145	
Gain bandwidth product (1)	f <sub>T</sub>	V <sub>CE</sub> = 1 V, I <sub>C</sub> = 3 mA, f = 2 GHz	4.0	4.5		GHz
Gain bandwidth product (2)	f <sub>T</sub>	V <sub>CE</sub> = 3 V, I <sub>C</sub> = 20 mA, f = 2 GHz		9.0		GHz
Feedback capacitance	C <sub>re</sub>	V <sub>CB</sub> = 1 V, I <sub>E</sub> = 0, f = 1 MHz <sup>Note 2</sup>		0.75	0.85	pF
Insertion power gain (1)	S <sub>21e</sub>   <sup>2</sup>	V <sub>CE</sub> = 1 V, I <sub>C</sub> = 3 mA, f = 2 GHz	2.5	3.5		dB
Insertion power gain (2)	S <sub>21e</sub>   <sup>2</sup>	V <sub>CE</sub> = 3 V, I <sub>C</sub> = 20 mA, f = 2 GHz		6.5		dB
Noise figure (1)	NF	V <sub>CE</sub> = 1 V, I <sub>C</sub> = 3 mA, f = 2 GHz		1.7	2.5	dB
Noise figure (2)	NF	V <sub>CE</sub> = 3 V, I <sub>C</sub> = 7 mA, f = 2 GHz		1.5		dB

**Notes** 1. Pulse measurement: PW ≤ 350 μs, Duty cycle ≤ 2%

2. Collector to base capacitance when measured with capacitance meter (automatic balanced bridge method), with emitter connected to guard pin of capacitance meter.

(2) Q2

**ELECTRICAL CHARACTERISTICS**

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Collector cutoff current	I <sub>CBO</sub>	V <sub>CB</sub> = 5 V, I <sub>E</sub> = 0			0.1	μA
Emitter cutoff current	I <sub>EBO</sub>	V <sub>EB</sub> = 1 V, I <sub>C</sub> = 0			0.1	μA
DC current gain	h <sub>FE</sub>	V <sub>CE</sub> = 3 V, I <sub>C</sub> = 10 mA <sup>Note 1</sup>	75		150	
Gain bandwidth product	f <sub>T</sub>	V <sub>CE</sub> = 3 V, I <sub>C</sub> = 10 mA, f = 2 GHz		12		GHz
Feedback capacitance	C <sub>re</sub>	V <sub>CB</sub> = 3 V, I <sub>E</sub> = 0, f = 1 MHz <sup>Note 2</sup>		0.4	0.7	pF
Insertion power gain	S <sub>21e</sub>   <sup>2</sup>	V <sub>CE</sub> = 3 V, I <sub>C</sub> = 10 mA, f = 2 GHz	7	8.5		dB
Noise figure	NF	V <sub>CE</sub> = 3 V, I <sub>C</sub> = 3 mA, f = 2 GHz		1.5	2.5	dB

**Notes** 1. Pulse measurement: PW ≤ 350 μs, Duty cycle ≤ 2%

2. Collector to base capacitance when measured with capacitance meter (automatic balanced bridge method), with emitter connected to guard pin of capacitance meter.

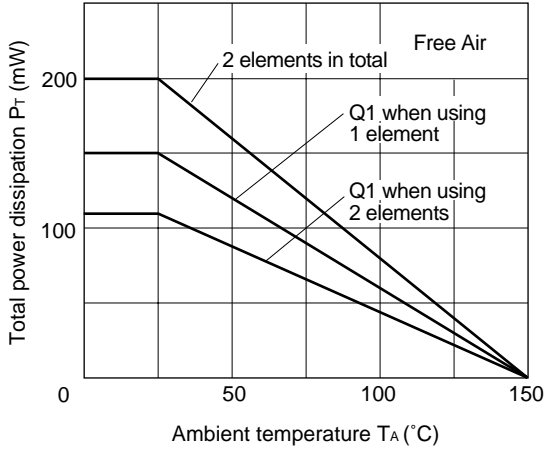
**h<sub>FE</sub> CLASSIFICATION**

Rank	FB
Marking	V44
h <sub>FE</sub> value of Q1	100 to 145
h <sub>FE</sub> value of Q2	75 to 150

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

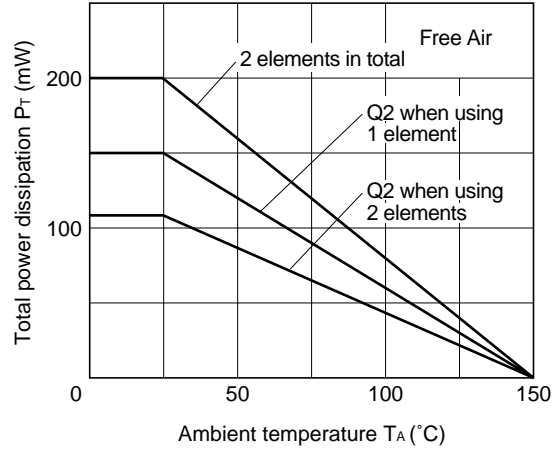
Q1

Total Power Dissipation vs. Ambient Temperature

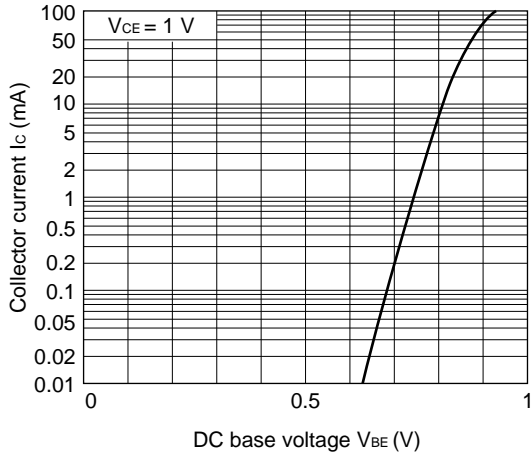


Q2

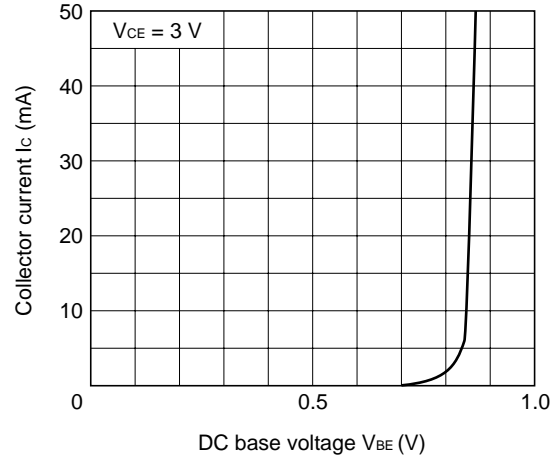
Total Power Dissipation vs. Ambient Temperature



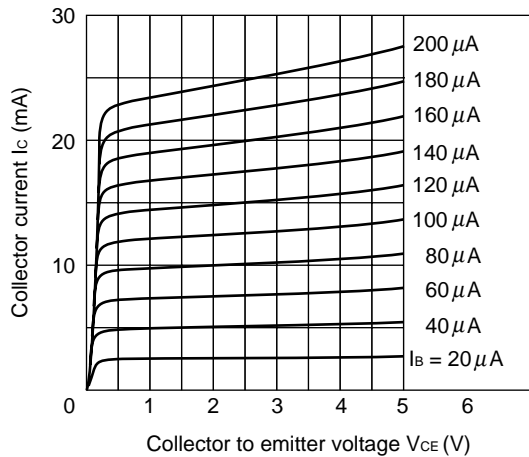
Collector Current vs. DC Base Voltage



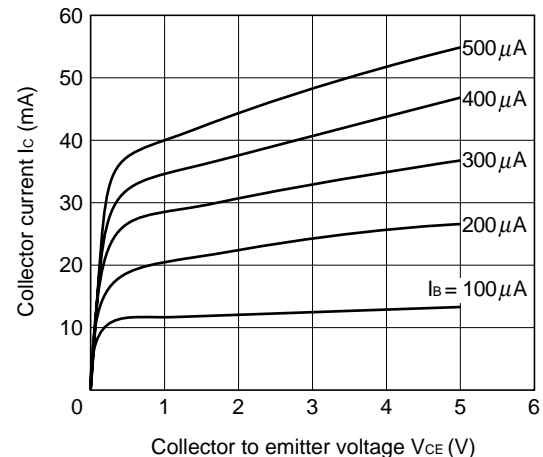
Collector Current vs. DC Base Voltage



Collector Current vs. Collector to Emitter Voltage

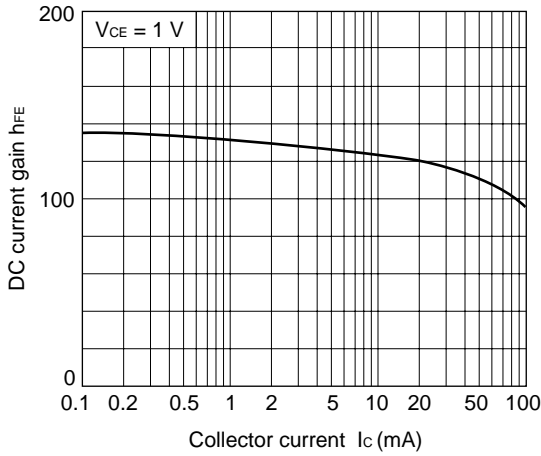


Collector Current vs. Collector to Emitter Voltage



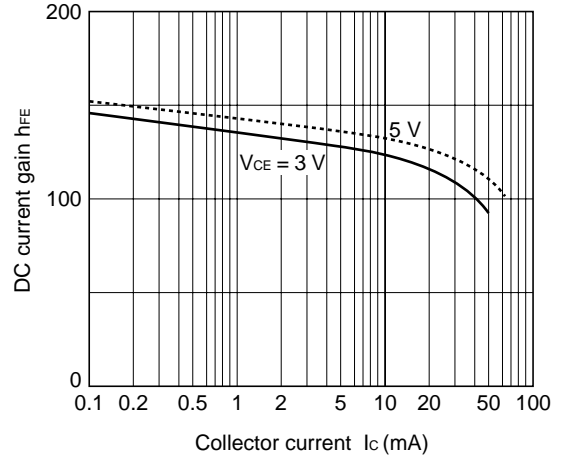
Q1

DC Current Gain vs. Collector Current

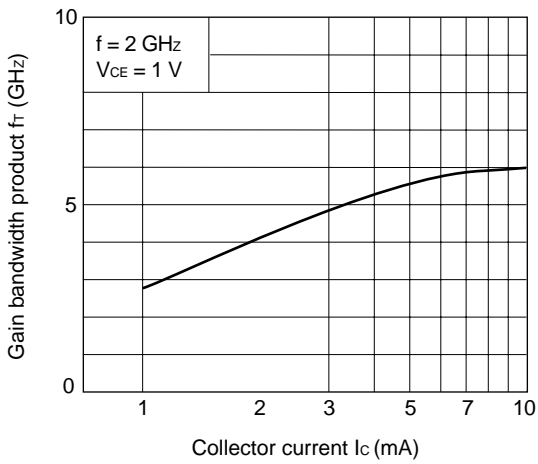


Q2

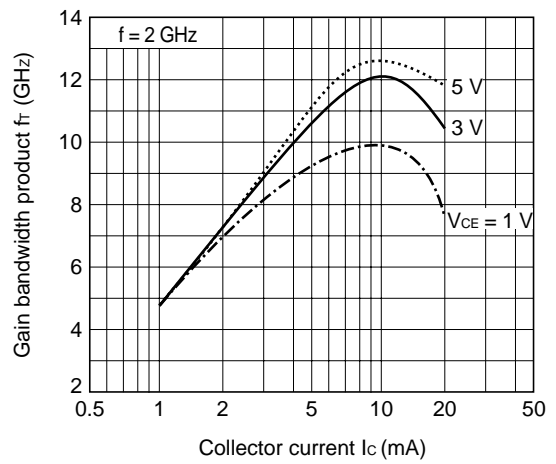
DC Current Gain vs. Collector Current



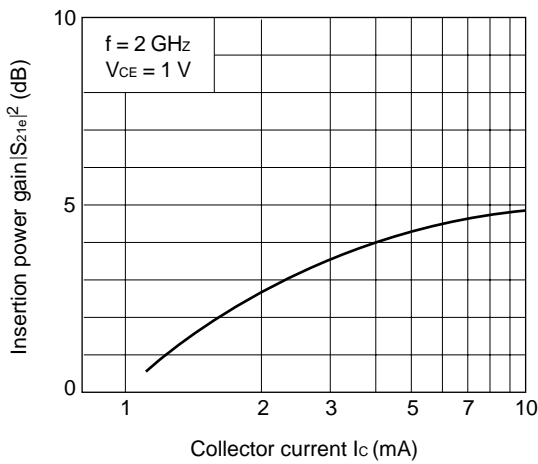
Gain Bandwidth Product vs. Collector Current



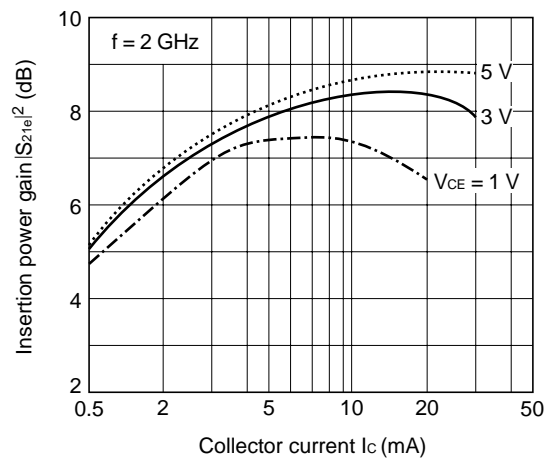
Gain Bandwidth Product vs. Collector Current



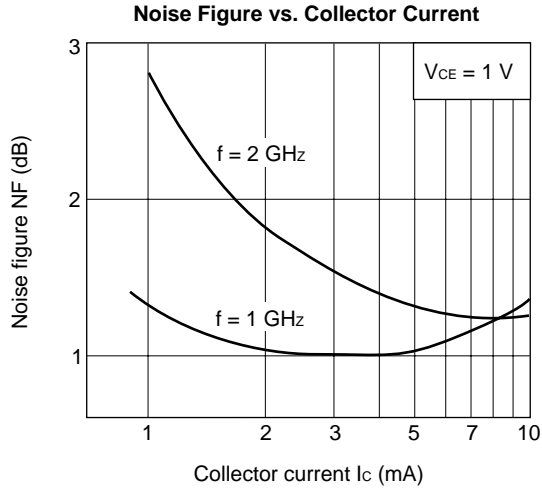
Insertion Power Gain vs. Collector Current



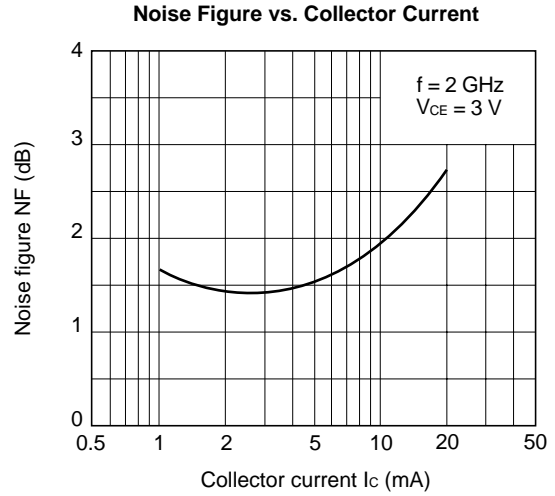
Insertion Power Gain vs. Collector Current



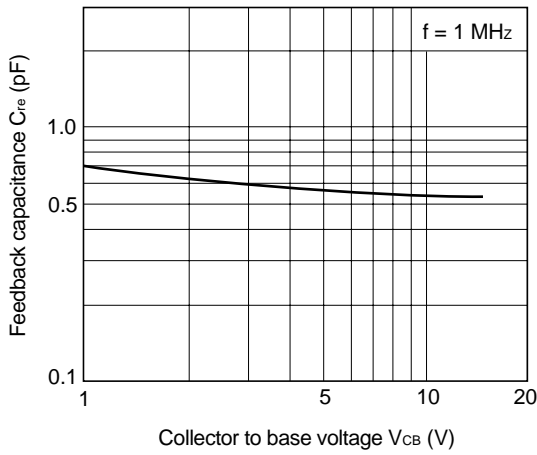
Q1



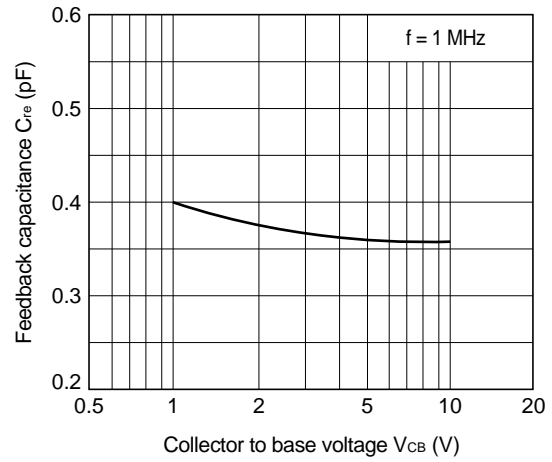
Q2



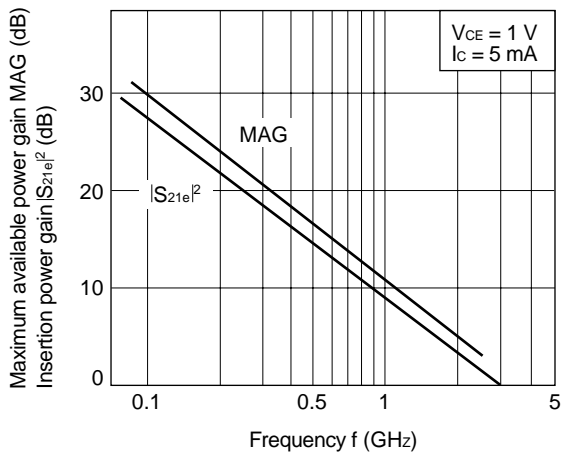
**Feedback Capacitance vs. Collector to Base Voltage**



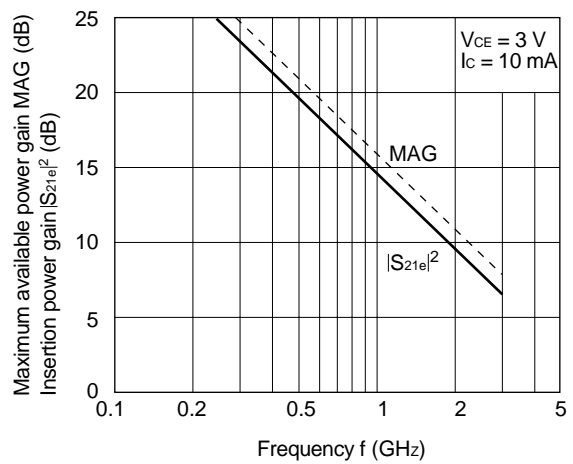
**Feedback Capacitance vs. Collector to Base Voltage**

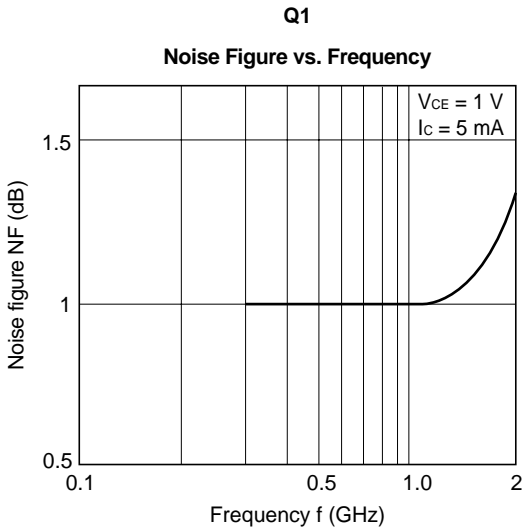


**Maximum Available Gain, Insertion Power Gain vs. Frequency**



**Maximum Available Gain, Insertion Power Gain vs. Frequency**





**S-PARAMETERS Q1**

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 1 mA, Z<sub>0</sub> = 50 Ω

FREQUENCY	S11		S21		S12		S22	
	GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG
.10	.97	-14.33	2.43	166.54	.04	80.24	.99	-7.18
.20	.95	-28.67	2.38	154.71	.07	70.60	.97	-13.99
.30	.91	-42.88	2.36	144.04	.10	62.11	.92	-19.89
.40	.87	-56.75	2.27	134.07	.13	54.03	.88	-25.53
.50	.83	-70.72	2.23	125.01	.15	47.25	.83	-29.96
.60	.79	-84.33	2.16	116.71	.16	40.79	.78	-34.25
.70	.75	-97.41	2.08	108.43	.17	35.62	.75	-37.36
.80	.71	-109.76	1.99	101.04	.17	31.08	.70	-40.60
.90	.68	-122.09	1.92	93.80	.18	26.89	.67	-43.12
1.00	.66	-133.22	1.82	87.30	.18	23.81	.64	-45.41
1.10	.64	-144.02	1.74	81.47	.18	21.08	.62	-47.82
1.20	.62	-154.11	1.66	75.63	.18	19.11	.60	-49.75
1.30	.61	-163.41	1.57	70.50	.17	17.32	.58	-51.90
1.40	.61	-172.15	1.50	65.55	.17	16.33	.57	-54.11
1.50	.61	179.69	1.43	60.93	.17	15.48	.56	-56.32
1.60	.61	172.31	1.36	56.58	.16	15.52	.54	-58.59
1.70	.61	165.55	1.29	52.57	.16	15.97	.54	-61.07
1.80	.62	159.12	1.24	48.65	.15	16.87	.53	-63.68
1.90	.63	153.12	1.18	44.96	.15	18.29	.52	-66.32
2.00	.63	147.73	1.12	41.71	.15	20.29	.52	-69.09
2.10	.64	142.54	1.08	38.29	.15	22.73	.51	-71.98
2.20	.65	137.65	1.03	35.21	.15	25.25	.51	-75.26
2.30	.66	133.23	.99	32.01	.15	27.87	.51	-78.60
2.40	.67	129.32	.95	29.64	.15	30.83	.50	-82.11
2.50	.67	125.32	.92	27.04	.15	33.50	.50	-85.80
2.60	.68	121.78	.88	24.60	.16	36.03	.50	-89.61
2.70	.69	118.50	.85	22.41	.17	38.41	.50	-93.50
2.80	.70	115.24	.82	20.14	.17	40.23	.50	-97.66
2.90	.71	112.33	.79	18.25	.18	41.83	.50	-101.66
3.00	.72	109.50	.76	16.28	.19	42.71	.50	-105.83

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 3 mA, Z<sub>0</sub> = 50 Ω

FREQUENCY	S11		S21		S12		S22	
	GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG
.10	.91	-20.87	6.85	160.51	.04	76.06	.95	-14.18
.20	.84	-40.75	6.38	145.81	.06	64.42	.87	-26.10
.30	.77	-60.61	6.07	133.27	.08	55.69	.77	-34.95
.40	.69	-79.21	5.65	122.38	.10	49.28	.68	-41.90
.50	.62	-96.87	5.20	112.63	.11	45.15	.61	-46.55
.60	.57	-112.43	4.72	104.66	.12	41.99	.54	-50.59
.70	.52	-126.51	4.31	97.30	.12	40.07	.50	-53.40
.80	.49	-139.31	3.94	91.09	.13	38.98	.46	-55.90
.90	.47	-150.57	3.59	85.51	.13	38.14	.42	-58.00
1.00	.46	-160.97	3.31	80.44	.14	38.00	.40	-60.02
1.10	.46	-170.30	3.05	75.95	.14	37.60	.38	-62.10
1.20	.46	-178.72	2.83	71.60	.14	37.86	.36	-63.86
1.30	.46	173.69	2.64	67.73	.15	37.91	.34	-66.00
1.40	.47	166.63	2.47	63.86	.15	38.15	.33	-68.28
1.50	.47	160.24	2.32	60.26	.16	38.28	.32	-70.83
1.60	.48	154.42	2.19	56.86	.16	38.60	.31	-73.24
1.70	.49	149.16	2.07	53.60	.17	38.76	.30	-76.06
1.80	.50	144.23	1.96	50.43	.17	39.12	.29	-78.94
1.90	.51	139.58	1.86	47.34	.18	38.98	.28	-81.98
2.00	.52	135.44	1.77	44.29	.18	39.31	.28	-85.18
2.10	.53	131.39	1.70	41.48	.19	39.23	.27	-88.50
2.20	.54	127.65	1.62	38.94	.20	39.28	.26	-92.55
2.30	.55	124.36	1.55	36.05	.20	39.08	.26	-96.16
2.40	.57	121.18	1.49	33.64	.21	39.04	.26	-100.32
2.50	.58	118.19	1.43	31.34	.22	39.03	.26	-104.63
2.60	.59	115.58	1.38	28.95	.22	38.56	.26	-109.15
2.70	.60	112.99	1.33	26.70	.23	38.53	.26	-113.50
2.80	.61	110.43	1.29	24.45	.24	38.23	.26	-118.22
2.90	.62	108.13	1.24	22.28	.24	37.87	.26	-122.53
3.00	.63	105.91	1.20	20.22	.25	37.38	.26	-126.83



**S-PARAMETERS Q1**

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 5 mA, Z<sub>0</sub> = 50 Ω

FREQUENCY		S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG	
.10	.85	-26.44	10.69	155.98	.03	73.46	.92	-19.86	
.20	.75	-51.20	9.61	139.24	.06	61.17	.79	-34.91	
.30	.64	-75.20	8.75	125.25	.07	54.17	.65	-44.33	
.40	.56	-96.72	7.76	113.92	.08	50.16	.55	-51.20	
.50	.49	-115.03	6.80	104.72	.09	48.17	.48	-55.56	
.60	.45	-130.31	5.95	97.69	.10	47.13	.42	-59.25	
.70	.42	-143.59	5.26	91.52	.11	46.84	.38	-61.89	
.80	.41	-155.39	4.72	86.26	.11	46.85	.35	-64.36	
.90	.40	-165.50	4.25	81.56	.12	46.62	.32	-66.67	
1.00	.40	-174.72	3.87	77.29	.13	46.83	.30	-68.91	
1.10	.40	177.10	3.55	73.37	.13	46.91	.28	-71.34	
1.20	.41	169.76	3.28	69.66	.14	46.94	.27	-73.69	
1.30	.41	163.14	3.04	66.19	.15	46.69	.25	-76.39	
1.40	.42	157.10	2.83	62.87	.16	46.57	.24	-79.41	
1.50	.43	151.58	2.66	59.70	.16	46.31	.23	-82.66	
1.60	.44	146.60	2.50	56.66	.17	45.94	.22	-86.03	
1.70	.45	142.01	2.36	53.73	.18	45.59	.22	-89.61	
1.80	.46	137.81	2.23	50.83	.19	45.07	.21	-93.69	
1.90	.48	133.84	2.12	48.10	.19	44.55	.21	-97.41	
2.00	.49	130.04	2.01	45.17	.20	44.01	.20	-101.67	
2.10	.50	126.68	1.93	42.52	.21	43.30	.20	-105.84	
2.20	.51	123.26	1.83	40.17	.22	42.61	.20	-111.09	
2.30	.52	120.32	1.76	37.50	.22	41.82	.19	-115.75	
2.40	.53	117.64	1.69	35.27	.23	41.27	.20	-120.90	
2.50	.54	114.93	1.62	32.99	.24	40.36	.20	-125.90	
2.60	.56	112.60	1.56	30.62	.25	39.55	.20	-131.14	
2.70	.57	110.25	1.50	28.52	.25	38.85	.20	-136.28	
2.80	.58	108.05	1.46	26.39	.26	38.08	.21	-141.19	
2.90	.59	105.95	1.41	24.29	.27	37.27	.21	-145.61	
3.00	.60	103.96	1.36	22.18	.27	36.49	.21	-149.97	

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 7 mA, Z<sub>0</sub> = 50 Ω

FREQUENCY		S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG	
.10	.79	-31.67	14.14	152.27	.03	71.15	.88	-24.58	
.20	.67	-60.82	12.28	133.87	.05	59.89	.72	-41.34	
.30	.55	-87.90	10.67	119.07	.06	54.65	.57	-50.83	
.40	.47	-110.16	9.04	108.13	.07	52.59	.47	-57.33	
.50	.42	-127.95	7.66	99.95	.08	51.97	.40	-61.50	
.60	.39	-142.37	6.59	93.83	.09	51.63	.35	-65.05	
.70	.38	-154.76	5.76	88.35	.10	52.13	.32	-67.82	
.80	.37	-165.47	5.12	83.75	.11	52.11	.29	-70.62	
.90	.37	-174.83	4.59	79.53	.12	52.18	.27	-73.11	
1.00	.37	176.89	4.16	75.64	.13	52.20	.25	-75.82	
1.10	.38	169.63	3.81	72.18	.13	51.99	.23	-78.72	
1.20	.38	162.95	3.50	68.56	.14	51.72	.22	-81.78	
1.30	.39	156.98	3.25	65.42	.15	51.33	.21	-85.11	
1.40	.40	151.53	3.03	62.34	.16	50.81	.20	-88.95	
1.50	.41	146.63	2.83	59.33	.17	50.15	.19	-92.87	
1.60	.42	141.98	2.66	56.50	.18	49.40	.19	-97.18	
1.70	.44	137.93	2.51	53.72	.19	48.77	.18	-101.69	
1.80	.45	133.89	2.38	50.97	.20	48.00	.18	-106.30	
1.90	.46	130.36	2.26	48.32	.20	47.04	.18	-110.96	
2.00	.47	126.94	2.14	45.65	.21	46.10	.17	-116.39	
2.10	.48	123.80	2.05	43.03	.22	45.20	.17	-120.97	
2.20	.49	120.71	1.95	40.91	.23	44.15	.17	-126.84	
2.30	.50	118.00	1.87	38.45	.24	43.05	.18	-132.13	
2.40	.52	115.48	1.80	36.15	.24	42.04	.18	-137.40	
2.50	.53	113.00	1.73	33.97	.25	41.08	.18	-142.69	
2.60	.54	110.80	1.66	31.82	.26	39.96	.19	-148.07	
2.70	.55	108.67	1.60	29.74	.26	39.23	.19	-152.96	
2.80	.56	106.60	1.55	27.34	.27	38.14	.20	-157.19	
2.90	.58	104.57	1.50	25.66	.28	37.25	.21	-161.69	
3.00	.59	102.82	1.45	23.37	.29	36.23	.21	-165.54	

**S-PARAMETERS Q1**

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 10 mA, Z<sub>0</sub> = 50 Ω

FREQUENCY	S11		S21		S12		S22	
	GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG
.10	.71	-39.03	18.58	147.71	.03	68.69	.83	-30.16
.20	.57	-73.63	15.31	127.39	.05	59.38	.63	-48.07
.30	.45	-102.58	12.43	112.73	.06	56.68	.49	-57.41
.40	.39	-124.33	10.08	102.91	.07	56.27	.40	-63.51
.50	.36	-141.02	8.36	95.89	.08	56.57	.34	-67.57
.60	.35	-154.37	7.10	90.47	.09	56.86	.29	-71.19
.70	.34	-165.44	6.16	85.73	.10	57.18	.26	-74.31
.80	.34	-175.03	5.44	81.62	.11	57.18	.24	-77.41
.90	.34	176.63	4.87	77.75	.12	57.09	.22	-80.56
1.00	.35	169.25	4.40	74.22	.13	56.69	.21	-83.81
1.10	.36	162.75	4.02	71.00	.14	56.34	.20	-87.55
1.20	.37	156.83	3.70	67.77	.15	55.55	.19	-91.34
1.30	.38	151.50	3.42	64.82	.16	54.83	.18	-95.70
1.40	.39	146.60	3.19	61.79	.17	53.99	.17	-100.40
1.50	.40	142.12	2.98	59.04	.17	53.03	.17	-104.99
1.60	.41	138.03	2.80	56.45	.18	52.03	.16	-110.36
1.70	.42	134.21	2.63	53.75	.19	51.04	.16	-115.48
1.80	.43	130.67	2.50	51.05	.20	49.91	.16	-120.86
1.90	.45	127.37	2.37	48.74	.21	48.75	.16	-126.15
2.00	.46	124.22	2.25	46.04	.22	47.77	.16	-131.74
2.10	.47	121.31	2.15	43.60	.23	46.48	.16	-136.39
2.20	.48	118.37	2.05	41.36	.24	45.20	.17	-142.70
2.30	.49	115.87	1.96	38.90	.25	43.97	.17	-147.46
2.40	.50	113.55	1.89	36.95	.25	42.65	.18	-152.75
2.50	.52	111.30	1.81	34.71	.26	41.70	.19	-157.66
2.60	.53	109.28	1.74	32.62	.27	40.45	.19	-162.35
2.70	.54	107.16	1.67	30.43	.28	39.28	.20	-166.91
2.80	.55	105.27	1.62	28.76	.28	38.16	.21	-170.83
2.90	.57	103.43	1.57	26.44	.29	37.04	.22	-174.49
3.00	.58	101.61	1.51	24.93	.30	36.10	.23	-177.86

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 20 mA, Z<sub>0</sub> = 50 Ω

FREQUENCY	S11		S21		S12		S22	
	GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG
.10	.52	-60.10	28.62	137.10	.02	67.35	.71	-41.30
.20	.39	-103.44	19.94	115.16	.04	63.08	.48	-59.79
.30	.33	-130.53	14.51	103.51	.05	63.34	.35	-68.39
.40	.31	-148.95	11.26	96.02	.06	64.33	.28	-74.25
.50	.30	-162.62	9.15	90.56	.07	65.01	.24	-78.55
.60	.30	-172.99	7.69	86.27	.08	65.06	.21	-82.95
.70	.31	178.35	6.63	82.36	.09	64.97	.19	-87.11
.80	.31	170.80	5.84	78.82	.11	64.40	.18	-91.38
.90	.32	164.26	5.21	75.55	.12	63.46	.16	-96.07
1.00	.33	158.34	4.70	72.35	.13	62.64	.16	-100.35
1.10	.34	153.02	4.28	69.45	.14	61.47	.15	-105.51
1.20	.35	148.21	3.94	66.66	.15	60.45	.15	-110.63
1.30	.36	143.86	3.63	63.96	.16	59.09	.15	-116.00
1.40	.37	139.65	3.38	61.26	.17	58.05	.15	-121.72
1.50	.38	135.96	3.16	58.61	.18	56.50	.15	-127.25
1.60	.40	132.38	2.97	56.19	.19	55.17	.15	-133.07
1.70	.41	129.06	2.79	53.72	.20	53.77	.15	-138.41
1.80	.42	126.14	2.64	51.32	.21	52.54	.16	-143.83
1.90	.43	123.11	2.50	48.96	.22	51.02	.16	-148.58
2.00	.44	120.40	2.38	46.54	.23	49.64	.17	-153.87
2.10	.46	117.80	2.27	44.17	.24	48.25	.18	-157.74
2.20	.47	115.23	2.16	42.21	.25	46.65	.18	-162.91
2.30	.48	112.96	2.07	39.64	.26	45.13	.19	-167.09
2.40	.49	110.86	1.99	37.96	.27	43.59	.20	-171.04
2.50	.50	108.77	1.90	35.67	.27	42.37	.21	-174.96
2.60	.51	106.98	1.84	33.82	.28	40.93	.22	-178.81
2.70	.53	105.14	1.77	31.79	.29	39.70	.23	177.40
2.80	.54	103.40	1.72	29.93	.30	38.37	.24	174.62
2.90	.55	101.60	1.65	28.01	.30	37.05	.25	171.56
3.00	.56	100.10	1.61	26.09	.31	35.76	.26	168.73

**S-PARAMETERS Q2**

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 1 mA, Z<sub>0</sub> = 50 Ω

FREQUENCY		S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG	
.10	.98	-5.93	2.43	171.79	.02	85.64	.99	-3.75	
.20	.97	-11.82	2.41	164.40	.04	80.86	.99	-7.53	
.30	.95	-17.85	2.42	157.59	.05	76.45	.97	-11.10	
.40	.93	-23.59	2.39	151.04	.07	72.26	.95	-14.56	
.50	.90	-29.61	2.38	144.91	.09	68.73	.93	-17.91	
.60	.87	-35.62	2.37	139.49	.10	64.78	.90	-21.19	
.70	.84	-41.49	2.34	133.87	.11	61.52	.87	-23.71	
.80	.81	-47.40	2.32	128.66	.12	58.06	.85	-26.91	
.90	.77	-53.49	2.32	123.12	.13	55.30	.82	-29.05	
1.00	.73	-59.00	2.26	118.06	.14	52.86	.78	-31.52	
1.10	.69	-65.20	2.25	113.30	.15	50.42	.76	-33.73	
1.20	.65	-71.05	2.21	108.31	.16	48.61	.73	-35.51	
1.30	.62	-77.22	2.17	103.81	.16	46.62	.70	-37.59	
1.40	.58	-83.22	2.15	99.18	.17	45.21	.68	-39.34	
1.50	.54	-89.53	2.13	94.49	.17	43.82	.66	-41.12	
1.60	.51	-95.27	2.07	90.14	.18	42.57	.63	-42.89	
1.70	.47	-101.29	2.02	86.01	.18	41.68	.61	-44.56	
1.80	.45	-107.59	1.99	82.00	.18	40.66	.59	-46.38	
1.90	.42	-114.02	1.95	78.38	.19	40.08	.57	-47.99	
2.00	.40	-120.45	1.90	74.87	.19	39.57	.55	-49.87	
2.10	.38	-127.04	1.87	70.82	.19	39.19	.53	-51.49	
2.20	.36	-133.41	1.83	67.34	.20	38.84	.51	-53.44	
2.30	.35	-139.83	1.78	63.84	.20	38.49	.50	-55.39	
2.40	.34	-146.46	1.74	60.75	.20	38.49	.48	-57.67	
2.50	.33	-153.17	1.71	57.60	.21	38.43	.46	-59.91	
2.60	.32	-159.96	1.68	54.38	.21	38.28	.45	-62.31	
2.70	.32	-166.01	1.64	51.35	.22	38.20	.43	-64.97	
2.80	.32	-172.06	1.61	48.28	.22	38.44	.41	-67.87	
2.90	.32	-177.98	1.58	45.54	.23	38.28	.40	-70.94	
3.00	.33	177.01	1.54	42.57	.23	38.11	.38	-74.21	

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 3 mA, Z<sub>0</sub> = 50 Ω

FREQUENCY		S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG	
.10	.93	-9.39	6.76	166.53	.02	82.60	.98	-7.24	
.20	.90	-18.39	6.46	155.80	.03	76.86	.94	-13.64	
.30	.84	-27.39	6.32	146.52	.05	71.65	.89	-18.91	
.40	.79	-35.83	6.06	138.21	.06	67.47	.83	-23.49	
.50	.72	-44.06	5.82	130.60	.07	64.58	.77	-26.46	
.60	.66	-51.67	5.54	123.94	.08	61.95	.72	-29.65	
.70	.59	-58.86	5.28	117.07	.09	60.46	.68	-31.43	
.80	.53	-65.57	5.01	111.07	.10	59.12	.64	-33.17	
.90	.48	-71.57	4.72	105.46	.10	57.98	.60	-34.36	
1.00	.43	-77.20	4.45	100.46	.11	57.39	.57	-35.31	
1.10	.38	-82.70	4.20	95.95	.12	56.96	.55	-36.47	
1.20	.34	-87.82	3.95	91.74	.13	56.54	.52	-37.08	
1.30	.31	-93.49	3.74	87.96	.13	56.14	.50	-37.96	
1.40	.28	-98.65	3.55	84.35	.14	55.72	.48	-38.83	
1.50	.26	-104.50	3.37	80.85	.15	55.21	.46	-39.70	
1.60	.24	-110.31	3.21	77.72	.15	54.91	.44	-40.63	
1.70	.22	-116.75	3.06	74.57	.16	54.46	.43	-41.65	
1.80	.21	-123.46	2.94	71.63	.17	53.91	.41	-42.70	
1.90	.20	-130.51	2.81	68.84	.18	53.57	.39	-43.76	
2.00	.19	-137.84	2.71	66.02	.18	53.01	.38	-44.95	
2.10	.18	-145.47	2.61	63.33	.19	52.38	.36	-46.23	
2.20	.18	-152.73	2.52	60.80	.20	51.91	.35	-47.64	
2.30	.18	-160.13	2.44	58.00	.21	51.17	.33	-49.19	
2.40	.18	-167.47	2.36	55.57	.22	50.80	.32	-50.82	
2.50	.19	-174.18	2.29	53.07	.22	49.89	.30	-52.82	
2.60	.20	179.79	2.23	50.72	.23	49.17	.28	-54.67	
2.70	.20	173.96	2.16	48.10	.24	48.35	.27	-56.94	
2.80	.21	168.73	2.10	45.81	.25	47.49	.25	-59.46	
2.90	.22	163.65	2.05	43.41	.26	46.43	.24	-62.59	
3.00	.24	159.82	1.99	41.14	.26	45.56	.22	-65.40	

**S-PARAMETERS Q2**

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 5 mA, Z<sub>0</sub> = 50 Ω

FREQUENCY GHz	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.89	-12.31	10.46	162.72	.02	81.62	.96	-9.77
.20	.83	-23.63	9.75	149.86	.03	74.55	.90	-17.75
.30	.75	-34.70	9.25	138.82	.04	69.69	.81	-23.24
.40	.66	-44.55	8.62	129.30	.06	66.77	.74	-27.15
.50	.57	-53.23	7.96	120.72	.06	64.98	.68	-29.45
.60	.50	-60.42	7.27	113.73	.07	63.78	.62	-31.18
.70	.43	-66.51	6.64	107.23	.08	63.28	.58	-32.03
.80	.37	-71.94	6.08	101.84	.09	62.73	.55	-32.89
.90	.33	-76.60	5.57	97.19	.10	62.37	.52	-33.36
1.00	.29	-81.19	5.15	92.96	.10	62.23	.49	-33.76
1.10	.26	-85.79	4.77	89.24	.11	61.85	.47	-34.33
1.20	.23	-90.41	4.45	85.71	.12	61.60	.45	-34.67
1.30	.21	-95.79	4.17	82.52	.13	61.06	.43	-35.08
1.40	.19	-100.84	3.91	79.44	.14	60.78	.42	-35.79
1.50	.17	-106.89	3.70	76.63	.14	60.08	.40	-36.32
1.60	.16	-113.52	3.50	73.79	.15	59.69	.39	-37.17
1.70	.15	-120.69	3.33	71.22	.16	58.93	.37	-38.02
1.80	.14	-128.54	3.18	68.57	.17	58.47	.36	-38.84
1.90	.13	-136.73	3.04	66.08	.18	57.63	.34	-40.00
2.00	.13	-145.48	2.92	63.46	.19	57.05	.33	-40.74
2.10	.13	-153.95	2.81	61.14	.20	56.13	.32	-42.01
2.20	.13	-161.96	2.71	58.79	.20	55.20	.30	-43.19
2.30	.14	-169.65	2.61	56.38	.21	54.17	.29	-44.77
2.40	.15	-177.12	2.53	53.98	.22	53.43	.27	-46.33
2.50	.15	176.33	2.45	51.77	.23	52.54	.26	-48.08
2.60	.17	170.73	2.37	49.49	.24	51.49	.24	-49.77
2.70	.18	165.64	2.31	47.17	.25	50.53	.22	-51.64
2.80	.19	160.85	2.24	45.04	.26	49.38	.21	-54.34
2.90	.20	156.69	2.18	42.82	.27	48.22	.19	-56.82
3.00	.22	153.43	2.12	40.65	.27	47.15	.17	-59.19

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 10 mA, Z<sub>0</sub> = 50 Ω

FREQUENCY GHz	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.79	-18.18	17.81	156.05	.02	79.00	.92	-14.07
.20	.67	-33.75	15.65	139.27	.03	72.98	.80	-22.91
.30	.55	-46.32	13.67	125.80	.04	69.74	.69	-27.06
.40	.44	-55.16	11.71	115.64	.05	69.07	.61	-28.96
.50	.37	-61.11	10.03	108.02	.06	68.93	.56	-29.47
.60	.31	-65.90	8.70	102.30	.07	68.67	.52	-29.62
.70	.26	-69.64	7.66	97.45	.07	68.49	.49	-29.55
.80	.23	-73.22	6.84	93.31	.08	68.26	.46	-29.57
.90	.20	-76.64	6.18	89.63	.09	68.18	.44	-29.61
1.00	.18	-80.09	5.63	86.38	.10	67.74	.43	-29.60
1.10	.15	-84.01	5.17	83.43	.11	67.32	.41	-29.87
1.20	.14	-88.42	4.80	80.51	.12	66.68	.40	-29.99
1.30	.12	-94.33	4.47	77.83	.13	65.96	.38	-30.36
1.40	.11	-100.18	4.18	75.30	.14	65.40	.37	-30.99
1.50	.10	-107.91	3.94	72.79	.15	64.56	.36	-31.58
1.60	.09	-116.38	3.72	70.38	.15	63.80	.34	-32.25
1.70	.08	-126.27	3.53	68.12	.16	62.66	.33	-33.11
1.80	.08	-137.48	3.36	65.70	.17	62.05	.32	-33.82
1.90	.08	-148.12	3.21	63.57	.18	60.90	.31	-34.82
2.00	.09	-158.61	3.08	61.31	.19	59.98	.29	-35.72
2.10	.09	-168.26	2.96	59.03	.20	58.90	.28	-36.80
2.20	.10	-176.89	2.85	56.80	.21	57.81	.26	-37.90
2.30	.11	176.30	2.74	54.71	.22	56.71	.25	-39.12
2.40	.12	170.07	2.66	52.56	.23	55.52	.24	-40.48
2.50	.13	164.55	2.57	50.55	.24	54.48	.22	-42.08
2.60	.14	160.22	2.49	48.36	.25	53.37	.21	-43.45
2.70	.16	156.24	2.41	46.36	.26	52.12	.19	-44.76
2.80	.17	152.57	2.34	44.39	.27	50.92	.17	-46.97
2.90	.19	149.35	2.29	42.02	.27	49.67	.16	-49.05
3.00	.20	146.66	2.21	40.11	.28	48.32	.14	-51.14

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