

DATA SHEET

NEC

NPN SILICON RF TRANSISTOR 2SC5509

NPN SILICON RF TRANSISTOR FOR MEDIUM OUTPUT POWER · LOW NOISE · HIGH-GAIN AMPLIFICATION FLAT-LEAD 4-PIN THIN-TYPE SUPER MINIMOLD

FEATURES

- Ideal for medium output power amplification
- $NF = 1.2 \text{ dB TYP.}$, $G_a = 12 \text{ dB TYP.}$ @ $V_{CE} = 2 \text{ V}$, $I_c = 10 \text{ mA}$, $f = 2 \text{ GHz}$
- Maximum available power gain: $MAG = 14 \text{ dB TYP.}$ @ $V_{CE} = 2 \text{ V}$, $I_c = 50 \text{ mA}$, $f = 2 \text{ GHz}$
- $f_T = 25 \text{ GHz}$ technology adopted
- Flat-lead 4-pin thin-type super minimold package

ORDERING INFORMATION

Part Number	Quantity	Supplying Form
2SC5509	50 pcs (Non reel)	• 8 mm wide embossed taping • Pin 1 (Emitter), Pin 2 (Collector) face the perforation side of the tape
2SC5509-T2	3 kpcs/reel	

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}	15	V
Collector to Emitter Voltage	V_{CEO}	3.3	V
Emitter to Base Voltage	V_{EBO}	1.5	V
Collector Current	I_c	100	mA
Total Power Dissipation	P_{tot}^{Note}	190	mW
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature	T_{stg}	-65 to +150	$^\circ\text{C}$

Note Free Air

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.

THERMAL RESISTANCE

Parameter	Symbol	Ratings	Unit
Junction to Case Resistance	R _{th j-c}	95	°C/W
Junction to Ambient Resistance	R _{th j-a}	650	°C/W

ELECTRICAL CHARACTERISTICS (T_A = +25°C)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
DC Characteristics						
Collector Cut-off Current	I _{CB0}	V _{CB} = 5 V, I _E = 0 mA	–	–	600	nA
Emitter Cut-off Current	I _{EB0}	V _{BE} = 1 V, I _C = 0 mA	–	–	600	nA
DC Current Gain	h _{FE} ^{Note 1}	V _{CE} = 2 V, I _C = 10 mA	50	70	100	–
RF Characteristics						
Gain Bandwidth Product	f _T	V _{CE} = 3 V, I _C = 90 mA, f = 2 GHz	13	15	–	GHz
Insertion Power Gain	S _{21e} ²	V _{CE} = 2 V, I _C = 50 mA, f = 2 GHz	8	11	–	dB
Noise Figure	NF	V _{CE} = 2 V, I _C = 10 mA, f = 2 Hz, Z _S = Z _{opt}	–	1.2	1.7	dB
Reverse Transfer Capacitance	C _{re} ^{Note 2}	V _{CB} = 2 V, I _E = 0 mA, f = 1 MHz	–	0.5	0.75	pF
Maximum Available Power Gain	MAG ^{Note 3}	V _{CE} = 2 V, I _C = 50 mA, f = 2 GHz	–	14	–	dB
Maximum Stable Power Gain	MSG ^{Note 4}	V _{CE} = 2 V, I _C = 50 mA, f = 2 GHz	–	15	–	dB
Gain 1 dB Compression Output Power	P _{O(1 dB)}	V _{CE} = 2 V, I _C = 70 mA ^{Note 5} , f = 2 GHz	–	17	–	dBm
3rd Order Intermodulation Distortion Output Intercept Point	OIP ₃	V _{CE} = 2 V, I _C = 70 mA ^{Note 5} , f = 2 GHz	–	27	–	dBm

- Notes**
1. Pulse measurement: PW ≤ 350 μs, Duty Cycle ≤ 2%
 2. Collector to base capacitance when the emitter grounded

$$3. \text{ MAG} = \left| \frac{S_{21}}{S_{12}} \right| (K - \sqrt{K^2 - 1})$$

$$4. \text{ MSG} = \left| \frac{S_{21}}{S_{12}} \right|$$

5. Collector current when P_{O(1 dB)} is output

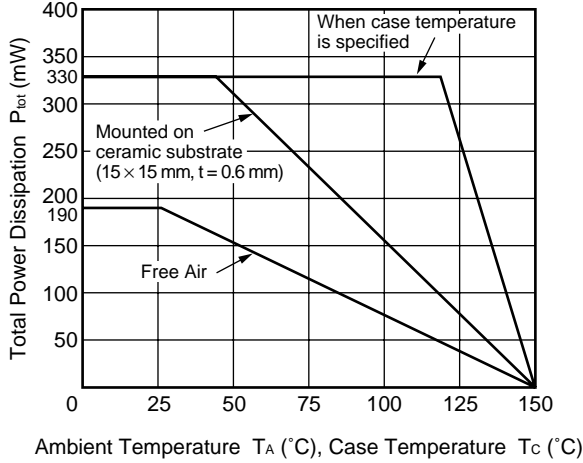
h_{FE} CLASSIFICATION

Rank	FB
Marking	T80
h _{FE} Value	50 to 100

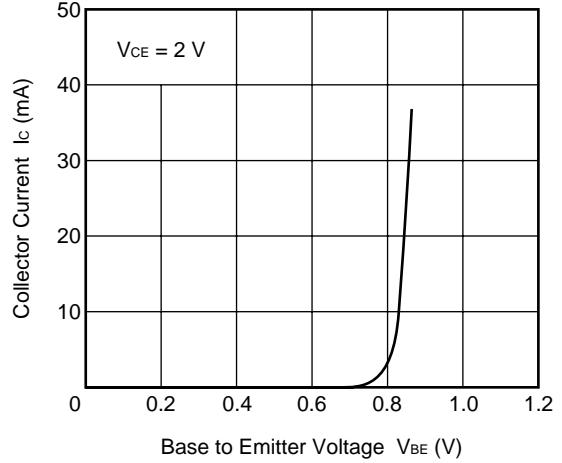
TYPICAL CHARACTERISTICS (Unless otherwise specified, $T_A = +25^\circ\text{C}$)

Thermal/DC Characteristics

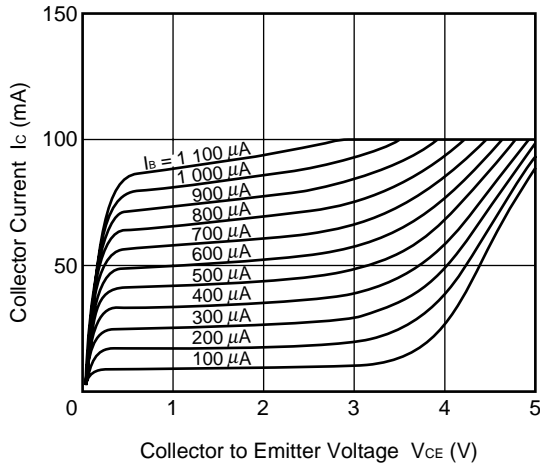
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE, CASE TEMPERATURE



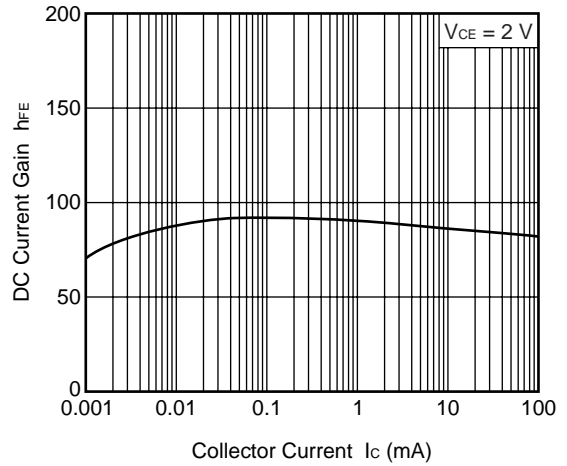
COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE

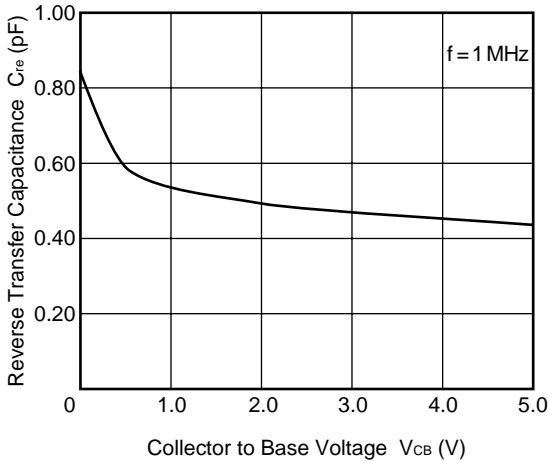


DC CURRENT GAIN vs. COLLECTOR CURRENT

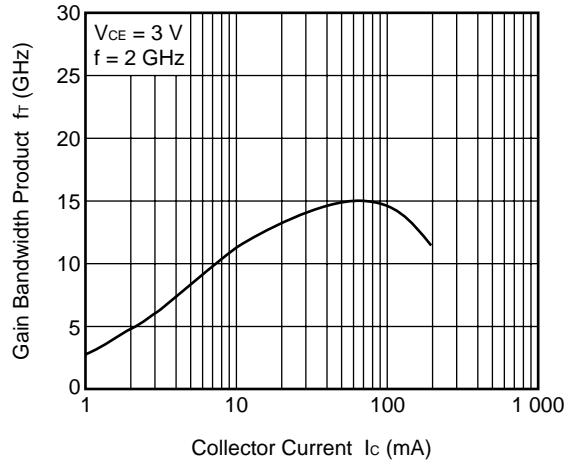


Capacitance/ft Characteristics

REVERSE TRANSFER CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE

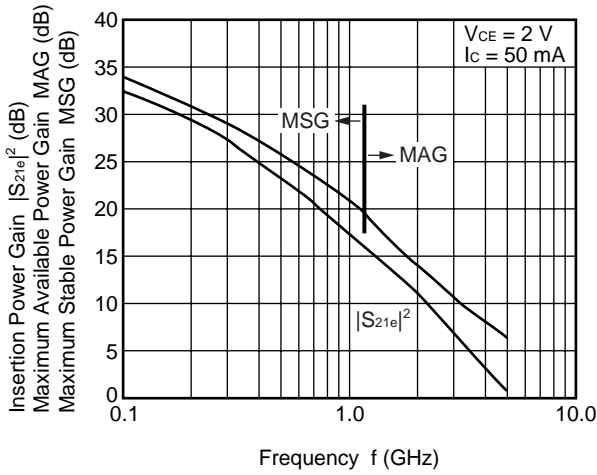


GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT

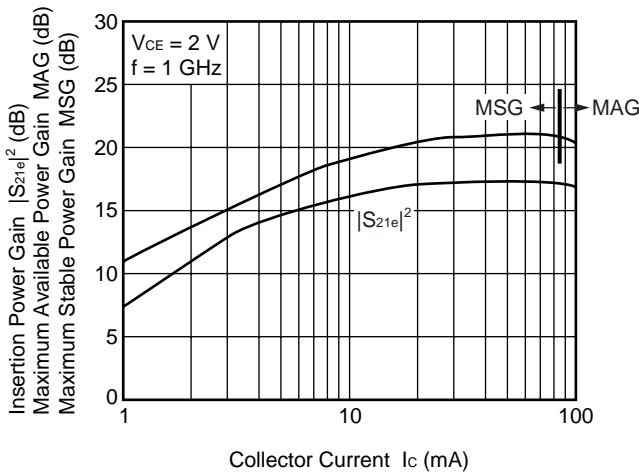


Gain Characteristics

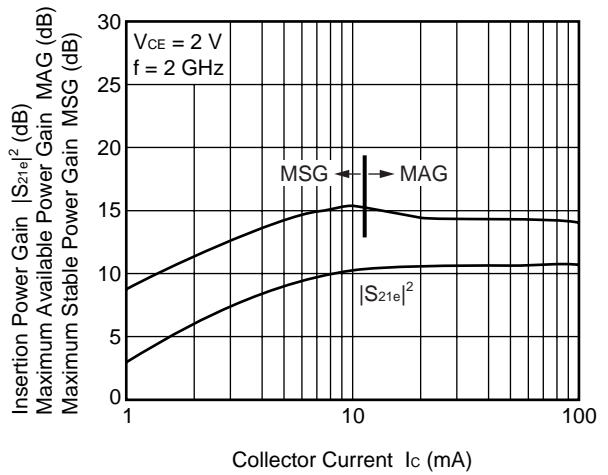
INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY



INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

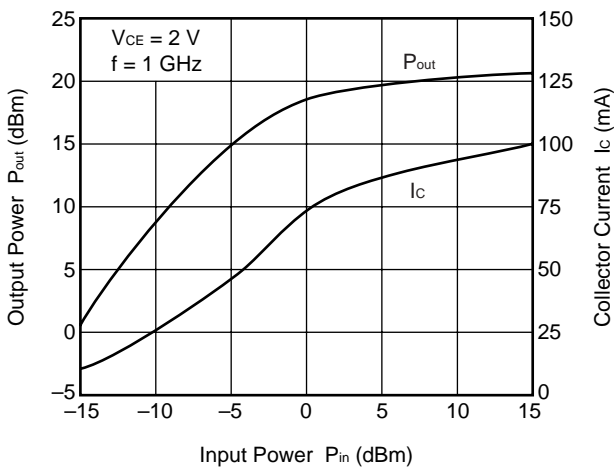


INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

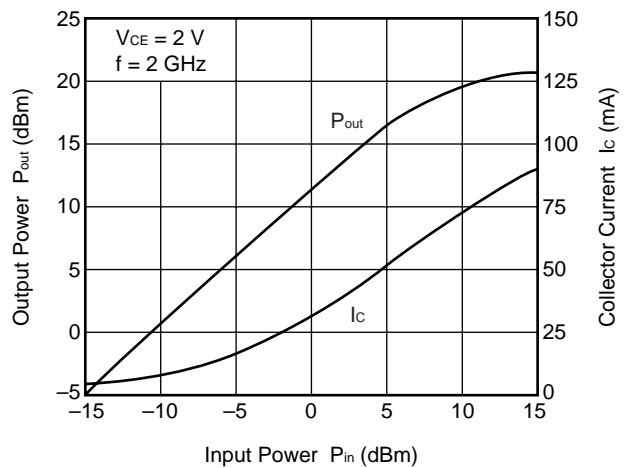


Output Characteristics

OUTPUT POWER, COLLECTOR CURRENT vs. INPUT POWER

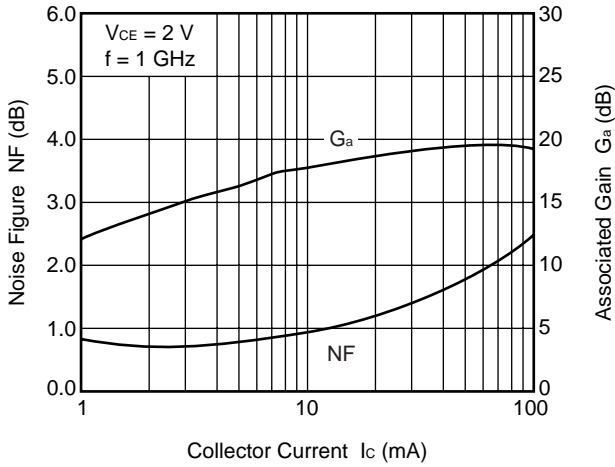


OUTPUT POWER, COLLECTOR CURRENT vs. INPUT POWER

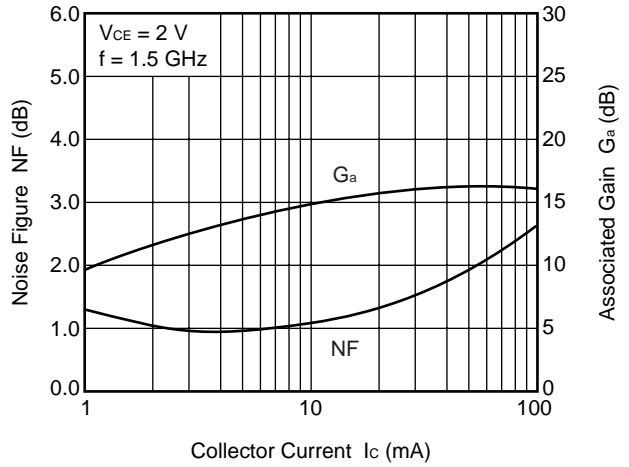


Noise Characteristics

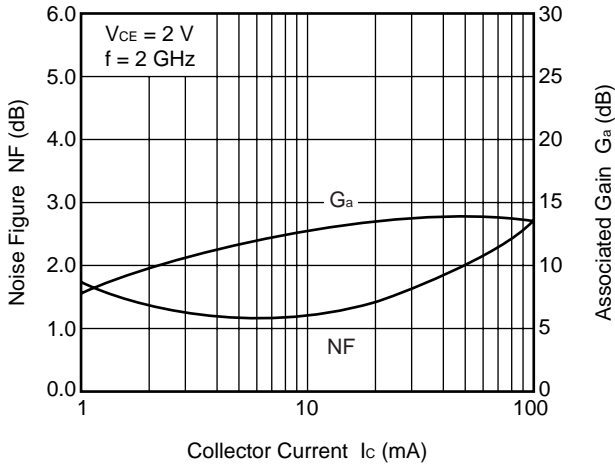
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



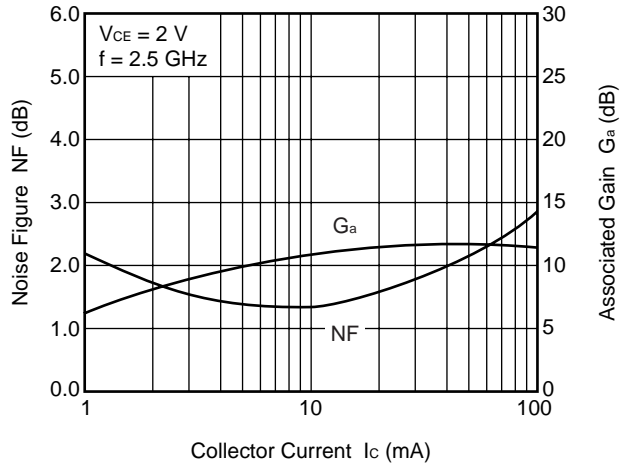
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



Remark The graphs indicate nominal characteristics.

S-PARAMETERS

V_{CE} = 2 V, I_c = 5 mA

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.79	-28.2	14.75	161.9	0.03	72.3	0.93	-19.5
0.2	0.75	-53.3	13.32	147.0	0.05	60.2	0.84	-35.9
0.3	0.73	-74.8	11.81	134.8	0.07	50.9	0.74	-49.6
0.4	0.71	-92.9	10.40	124.5	0.08	42.8	0.65	-61.4
0.5	0.69	-108.1	9.18	116.0	0.09	36.7	0.58	-71.5
0.6	0.68	-121.0	8.15	108.6	0.09	31.7	0.51	-80.4
0.7	0.67	-132.0	7.28	102.3	0.10	27.8	0.46	-88.6
0.8	0.67	-141.6	6.55	96.6	0.10	24.7	0.42	-96.2
0.9	0.67	-149.9	5.94	91.5	0.10	21.8	0.38	-103.3
1.0	0.67	-157.3	5.42	86.9	0.10	19.7	0.35	-110.1
1.1	0.67	-164.0	4.97	82.6	0.11	17.7	0.33	-116.6
1.2	0.67	-170.0	4.59	78.6	0.11	16.0	0.31	-123.0
1.3	0.67	-175.5	4.25	74.9	0.11	14.6	0.30	-129.1
1.4	0.67	179.5	3.96	71.3	0.11	13.4	0.29	-134.9
1.5	0.68	174.7	3.70	67.9	0.11	12.3	0.28	-140.6
1.6	0.68	170.4	3.47	64.6	0.11	11.3	0.27	-146.1
1.7	0.69	166.2	3.26	61.4	0.11	10.4	0.27	-151.4
1.8	0.69	162.4	3.07	58.4	0.11	9.6	0.27	-156.5
1.9	0.69	158.8	2.90	55.5	0.11	8.9	0.27	-161.2
2.0	0.70	155.2	2.74	52.6	0.11	8.4	0.27	-165.8
2.1	0.71	152.2	2.60	49.8	0.11	7.7	0.27	-170.2
2.2	0.71	148.9	2.47	47.1	0.11	7.0	0.27	-174.2
2.3	0.72	146.0	2.35	44.4	0.11	6.5	0.28	-178.1
2.4	0.72	143.3	2.24	41.8	0.11	6.0	0.28	178.2
2.5	0.72	140.4	2.14	39.2	0.11	5.5	0.29	174.6
2.6	0.73	137.9	2.03	36.7	0.11	4.8	0.29	170.4
2.7	0.72	135.3	1.93	34.4	0.11	4.9	0.30	165.9
2.8	0.73	133.7	1.84	33.0	0.11	7.1	0.29	162.7
2.9	0.73	132.1	1.79	31.3	0.11	8.4	0.28	162.4
3.0	0.74	130.0	1.73	29.1	0.11	8.0	0.29	161.5
4.0	0.80	121.2	1.27	16.5	0.12	9.0	0.38	149.8

V_{CE} = 2 V, I_c = 10 mA

Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.65	-42.0	23.47	156.3	0.03	67.9	0.88	-29.3
0.2	0.63	-75.4	19.87	138.3	0.04	53.8	0.75	-52.4
0.3	0.63	-100.3	16.55	125.1	0.05	45.8	0.63	-70.5
0.4	0.62	-118.7	13.88	115.1	0.06	39.3	0.54	-85.4
0.5	0.62	-132.8	11.82	107.2	0.07	35.3	0.48	-97.8
0.6	0.63	-144.0	10.22	100.7	0.07	32.5	0.43	-108.7
0.7	0.63	-153.1	8.97	95.1	0.07	30.7	0.40	-118.3
0.8	0.63	-160.9	7.96	90.3	0.07	29.3	0.37	-127.1
0.9	0.64	-167.5	7.15	86.0	0.08	28.2	0.36	-135.0
1.0	0.64	-173.5	6.47	82.0	0.08	27.5	0.34	-142.2
1.1	0.65	-178.7	5.89	78.4	0.08	26.8	0.34	-148.8
1.2	0.65	176.5	5.41	75.0	0.08	26.5	0.33	-154.9
1.3	0.65	172.1	4.99	71.7	0.08	25.9	0.33	-160.6
1.4	0.66	168.0	4.63	68.6	0.09	25.6	0.33	-165.8
1.5	0.67	164.2	4.32	65.6	0.09	25.3	0.33	-170.6
1.6	0.67	160.7	4.04	62.8	0.09	24.8	0.33	-175.0
1.7	0.68	157.2	3.79	60.0	0.09	24.3	0.33	-179.2
1.8	0.68	154.0	3.56	57.3	0.09	23.9	0.34	176.9
1.9	0.69	151.0	3.36	54.7	0.10	23.4	0.34	173.3
2.0	0.69	148.0	3.17	52.1	0.10	23.1	0.35	169.8
2.1	0.70	145.4	3.01	49.7	0.10	22.7	0.35	166.7
2.2	0.70	142.6	2.86	47.3	0.10	21.9	0.36	163.7
2.3	0.71	140.1	2.71	44.9	0.10	21.4	0.37	160.8
2.4	0.71	137.7	2.58	42.5	0.10	20.9	0.37	158.0
2.5	0.72	135.1	2.46	40.2	0.11	20.2	0.38	155.2
2.6	0.72	132.9	2.34	37.9	0.11	19.6	0.39	152.2
2.7	0.72	130.5	2.22	35.8	0.11	19.7	0.39	148.9
2.8	0.72	129.0	2.11	34.6	0.11	21.2	0.39	145.9
2.9	0.73	127.8	2.05	33.1	0.11	21.6	0.38	145.0
3.0	0.74	126.0	1.99	31.1	0.12	20.6	0.39	144.3
4.0	0.80	118.7	1.45	19.9	0.13	17.6	0.47	136.2
5.0	0.83	107.5	1.09	5.8	0.14	13.1	0.53	125.3

$V_{CE} = 2\text{ V}$, $I_c = 20\text{ mA}$

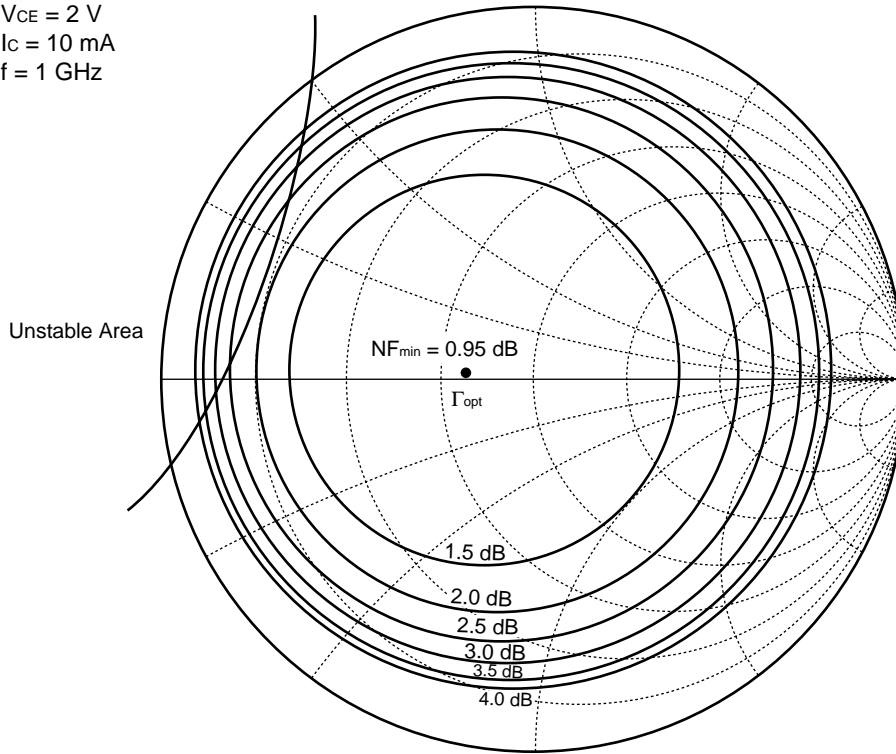
Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.50	-63.8	33.35	149.5	0.02	64.8	0.81	-41.4
0.2	0.54	-103.8	25.91	129.5	0.03	50.4	0.65	-71.4
0.3	0.57	-127.4	20.30	116.5	0.04	44.2	0.55	-93.1
0.4	0.59	-142.7	16.37	107.3	0.04	41.0	0.48	-109.7
0.5	0.60	-153.8	13.60	100.5	0.05	39.5	0.44	-122.8
0.6	0.61	-162.3	11.58	94.9	0.05	39.0	0.42	-133.6
0.7	0.61	-169.2	10.05	90.1	0.05	38.8	0.40	-142.6
0.8	0.62	-175.1	8.86	86.0	0.06	38.9	0.39	-150.4
0.9	0.63	179.8	7.91	82.2	0.06	38.8	0.39	-157.1
1.0	0.63	175.2	7.12	78.8	0.06	38.8	0.38	-163.0
1.1	0.64	171.1	6.47	75.6	0.07	38.7	0.38	-168.3
1.2	0.64	167.2	5.93	72.5	0.07	38.6	0.38	-173.1
1.3	0.65	163.7	5.46	69.6	0.07	38.3	0.39	-177.5
1.4	0.66	160.3	5.06	66.9	0.08	38.0	0.39	178.5
1.5	0.66	157.1	4.70	64.1	0.08	37.5	0.40	174.8
1.6	0.67	154.1	4.40	61.6	0.08	37.0	0.40	171.4
1.7	0.67	151.2	4.12	59.0	0.09	36.3	0.41	168.2
1.8	0.68	148.5	3.87	56.5	0.09	35.7	0.41	165.1
1.9	0.68	145.8	3.65	54.2	0.09	35.0	0.42	162.2
2.0	0.69	143.2	3.44	51.8	0.10	34.3	0.42	159.5
2.1	0.70	140.9	3.26	49.5	0.10	33.5	0.43	156.9
2.2	0.70	138.4	3.10	47.3	0.10	32.5	0.44	154.4
2.3	0.71	136.2	2.94	45.1	0.10	31.7	0.45	152.0
2.4	0.71	134.0	2.80	42.9	0.11	30.8	0.45	149.6
2.5	0.72	131.6	2.66	40.7	0.11	29.8	0.46	147.3
2.6	0.72	129.6	2.53	38.6	0.11	28.9	0.47	144.8
2.7	0.72	127.3	2.41	36.6	0.11	28.6	0.48	142.0
2.8	0.72	125.8	2.28	35.5	0.11	29.6	0.47	139.1
2.9	0.72	124.9	2.22	34.4	0.12	29.9	0.46	138.1
3.0	0.74	123.4	2.16	32.4	0.12	28.1	0.47	137.6
4.0	0.80	116.8	1.54	22.1	0.13	23.2	0.55	130.3
5.0	0.83	106.4	1.16	8.9	0.14	15.7	0.60	119.8

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

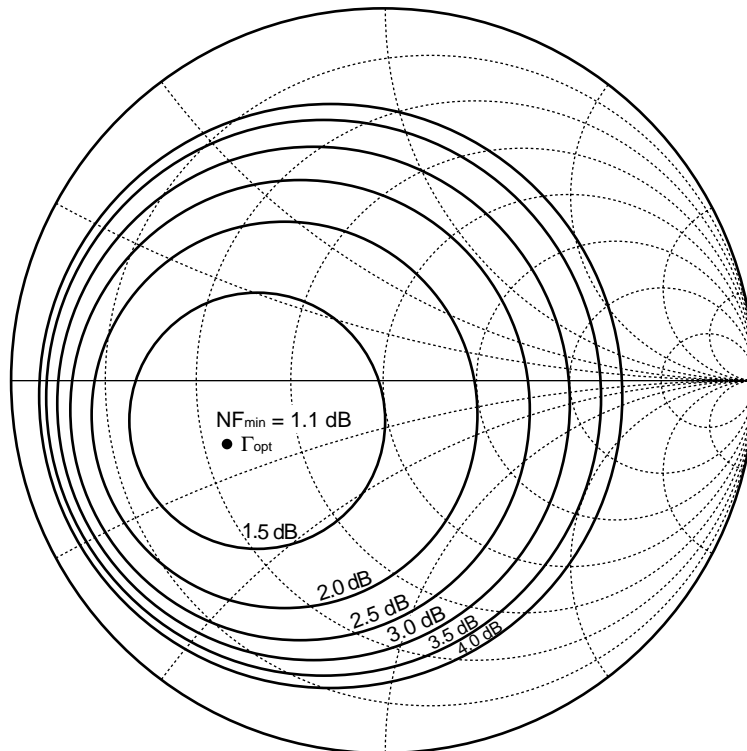
Frequency (GHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
0.1	0.39	-99.2	41.74	143.0	0.02	59.2	0.71	-55.1
0.2	0.51	-133.4	29.88	122.2	0.03	50.6	0.57	-90.5
0.3	0.56	-150.6	22.35	110.1	0.03	48.2	0.50	-113.6
0.4	0.58	-161.3	17.59	102.0	0.03	47.8	0.46	-129.7
0.5	0.60	-169.1	14.41	96.0	0.04	48.3	0.44	-141.6
0.6	0.61	-175.2	12.16	91.0	0.04	48.7	0.43	-150.8
0.7	0.62	179.7	10.50	86.9	0.05	49.1	0.43	-158.3
0.8	0.62	175.2	9.22	83.2	0.05	49.6	0.43	-164.6
0.9	0.63	171.3	8.20	79.8	0.05	49.7	0.43	-169.9
1.0	0.64	167.6	7.38	76.7	0.06	49.5	0.43	-174.7
1.1	0.64	164.2	6.70	73.7	0.06	49.0	0.43	-178.9
1.2	0.65	161.0	6.12	70.9	0.07	48.7	0.44	177.3
1.3	0.65	158.0	5.63	68.2	0.07	48.0	0.44	173.8
1.4	0.66	155.2	5.21	65.6	0.07	47.2	0.45	170.5
1.5	0.67	152.4	4.84	63.1	0.08	46.5	0.45	167.4
1.6	0.67	149.8	4.52	60.7	0.08	45.5	0.46	164.5
1.7	0.68	147.1	4.23	58.3	0.09	44.4	0.46	161.8
1.8	0.68	144.8	3.98	55.9	0.09	43.5	0.47	159.1
1.9	0.69	142.4	3.75	53.7	0.09	42.3	0.48	156.7
2.0	0.70	140.0	3.54	51.5	0.10	41.3	0.48	154.2
2.1	0.70	137.9	3.35	49.3	0.10	40.1	0.49	152.0
2.2	0.71	135.6	3.18	47.2	0.10	38.9	0.50	149.8
2.3	0.71	133.5	3.02	45.1	0.11	37.8	0.51	147.6
2.4	0.72	131.5	2.87	43.0	0.11	36.6	0.51	145.5
2.5	0.72	129.3	2.73	40.9	0.11	35.4	0.52	143.4
2.6	0.73	127.4	2.60	38.9	0.11	34.4	0.53	141.1
2.7	0.73	125.1	2.47	36.9	0.11	33.6	0.53	138.6
2.8	0.72	123.4	2.33	35.8	0.11	34.3	0.53	135.7
2.9	0.72	122.9	2.26	35.1	0.12	34.4	0.52	134.7
3.0	0.74	121.6	2.21	33.2	0.13	32.2	0.53	134.4
4.0	0.81	115.4	1.52	23.2	0.14	25.7	0.62	126.9
5.0	0.84	105.2	1.14	10.8	0.15	17.6	0.66	126.5

EQUAL NF CIRCLE

$V_{CE} = 2\text{ V}$
 $I_C = 10\text{ mA}$
 $f = 1\text{ GHz}$



$V_{CE} = 2\text{ V}$
 $I_C = 10\text{ mA}$
 $f = 2\text{ GHz}$



NOISE PARAMETERS

$V_{CE} = 2\text{ V}$, $I_c = 5\text{ mA}$

f (GHz)	NF _{min} (dB)	G _a (dB)	Γ _{opt}		Rn/50
			MAG.	ANG.	
0.8	0.70	18.0	0.17	93.0	0.11
0.9	0.74	17.0	0.18	103.0	0.11
1.0	0.78	16.2	0.20	112.7	0.11
1.5	0.98	13.6	0.32	155.4	0.09
1.8	1.10	12.5	0.40	176.2	0.07
1.9	1.14	12.2	0.43	-177.8	0.06
2.0	1.18	11.8	0.46	-172.2	0.06
2.5	1.39	9.9	0.56	-151.8	0.08

$V_{CE} = 2\text{ V}$, $I_c = 20\text{ mA}$

f (GHz)	NF _{min} (dB)	G _a (dB)	Γ _{opt}		Rn/50
			MAG.	ANG.	
0.8	1.12	20.7	0.30	-164.8	0.08
0.9	1.15	19.7	0.31	-162.7	0.09
1.0	1.18	18.8	0.32	-160.7	0.09
1.5	1.31	15.7	0.39	-151.5	0.10
1.8	1.38	14.4	0.45	-146.3	0.10
1.9	1.41	14.0	0.47	-144.6	0.10
2.0	1.43	13.6	0.49	-142.9	0.11
2.5	1.56	11.5	0.56	-133.5	0.14

$V_{CE} = 2\text{ V}$, $I_c = 10\text{ mA}$

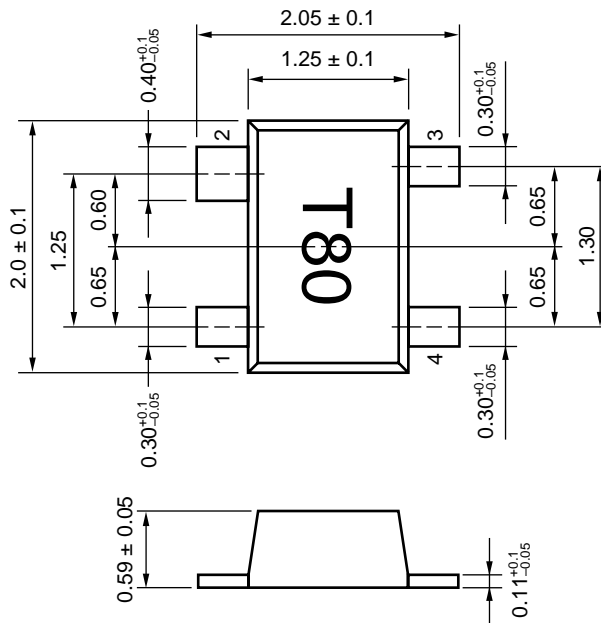
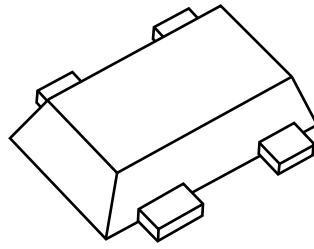
f (GHz)	NF _{min} (dB)	G _a (dB)	Γ _{opt}		Rn/50
			MAG.	ANG.	
0.8	0.87	19.6	0.13	170.3	0.09
0.9	0.90	18.6	0.15	171.5	0.09
1.0	0.93	17.8	0.17	173.0	0.09
1.5	1.07	14.8	0.30	-174.1	0.08
1.8	1.15	13.6	0.39	-164.1	0.07
1.9	1.18	13.2	0.41	-160.6	0.07
2.0	1.20	12.8	0.44	-157.2	0.07
2.5	1.35	10.9	0.53	-142.3	0.10

$V_{CE} = 2\text{ V}$, $I_c = 50\text{ mA}$

f (GHz)	NF _{min} (dB)	G _a (dB)	Γ _{opt}		Rn/50
			MAG.	ANG.	
0.8	1.75	21.3	0.49	-159.4	0.10
0.9	1.78	20.3	0.49	-157.2	0.10
1.0	1.80	19.4	0.50	-154.9	0.11
1.5	1.92	16.2	0.55	-144.7	0.14
1.8	2.00	14.8	0.59	-139.1	0.17
1.9	2.02	14.4	0.60	-137.3	0.19
2.0	2.04	13.9	0.61	-135.5	0.20
2.5	2.17	11.8	0.65	-126.4	0.28

PACKAGE DIMENSIONS

FLAT-LEAD 4-PIN THIN-TYPE SUPER MINIMOLD (UNIT: mm)



PIN CONNECTIONS

- 1. Emitter
- 2. Collector
- 3. Emitter
- 4. Base

RECOMMENDED SOLDERING CONDITIONS

This product should be soldered and mounted under the following recommended conditions. For soldering methods and conditions other than those recommended below, contact your nearby sales office.

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared Reflow	Package peak temperature: 235°C or below, Time: 30 seconds or less (at 210°C or higher), Count: 2 times or less, Exposure limit: None ^{Note}	IR30-00-2
VPS	Package peak temperature: 215°C or below, Time: 40 seconds or less (at 200°C or higher), Count: 2 times or less, Exposure limit: None ^{Note}	VP15-00-2
Wave Soldering	Soldering bath temperature: 260°C or below, Time: 10 seconds or less, Count: 1 time, Exposure limit: None ^{Note}	WS60-00-1

Note After opening the dry pack, store it at 25°C or less and 65% RH or less for the allowable storage period.

Caution Do not use different soldering methods together (except for partial heating).

For the details the recommended soldering conditions, refer to the document **SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL (C10535E: published by NEC Corporation)**.

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► **Business issue**

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► **Technical issue**

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