

# 2SC5509

NPN SILICON RF TRANSISTOR

FOR MEDIUM OUTPUT POWER, LOW-NOISE, HIGH-GAIN AMPLIFICATION

FLAT-LEAD 4-PIN THIN-TYPE SUPER MINIMOLD (M04)

R09DS0056EJ0300

Rev.3.00

Mar 5, 2013

## FEATURES

- Ideal for medium output power amplification
- $NF = 1.2$  dB TYP.,  $G_a = 12$  dB TYP. @  $V_{CE} = 2$  V,  $I_C = 10$  mA,  $f = 2$  GHz
- Maximum available power gain:  $MAG = 14$  dB TYP. @  $V_{CE} = 2$  V,  $I_C = 50$  mA,  $f = 2$  GHz
- $f_T = 25$  GHz technology adopted
- Flat-lead 4-pin thin-type super minimold (M04) package

## <R> ORDERING INFORMATION

Part Number	Order Number	Quantity	Package	Supplying Form
2SC5509	2SC5509-A	50 pcs (Non reel)	Flat-lead 4-pin thin-type super minimold (M04) (Pb-Free)	<ul style="list-style-type: none"> <li>• 8 mm wide embossed taping</li> <li>• Pin 1 (Emitter), Pin 2 (Collector) face the perforation side of the tape</li> </ul>
2SC5509-T2	2SC5509-T2-A	3 kpcs/reel		

**Remark** To order evaluation samples, please contact your nearby sales office.

The unit sample quantity is 50 pcs.

## ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ )

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	$P_{tot}$ <sup>Note</sup>	190	mW
Junction Temperature	$T_j$	150	$^\circ\text{C}$
Storage Temperature	$T_{stg}$	-65 to +150	$^\circ\text{C}$

**Note** Free air.

## THERMAL RESISTANCE

Parameter	Symbol	Ratings	Unit
Junction to Case Resistance	$R_{th\ j-c}$	95	$^\circ\text{C} / \text{W}$
Junction to Ambient Resistance	$R_{th\ j-a}$	650	$^\circ\text{C} / \text{W}$

### CAUTION

Observe precautions when handling because these devices are sensitive to electrostatic discharge.

The mark <R> shows major revised points.

The revised points can be easily searched by copying an "<R>" in the PDF file and specifying it in the "Find what:" field.

**ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = +25 °C)**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
DC Characteristics						
Collector Cut-off Current	I <sub>CBO</sub>	V <sub>CB</sub> = 5 V, I <sub>E</sub> = 0	–	–	600	nA
Emitter Cut-off Current	I <sub>EBO</sub>	V <sub>EB</sub> = 1 V, I <sub>C</sub> = 0	–	–	600	nA
DC Current Gain	h <sub>FE</sub> <sup>Note 1</sup>	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 10 mA	50	70	100	–
RF Characteristics						
Gain Bandwidth Product	f <sub>T</sub>	V <sub>CE</sub> = 3 V, I <sub>C</sub> = 90 mA, f = 2 GHz	13	15	–	GHz
Insertion Power Gain	S <sub>21e</sub>   <sup>2</sup>	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 50 mA, f = 2 GHz	8	11	–	dB
Noise Figure	NF	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 10 mA, f = 2 GHz, Z <sub>S</sub> = Z <sub>opt</sub>	–	1.2	1.7	dB
Reverse Transfer Capacitance	C <sub>re</sub> <sup>Note 2</sup>	V <sub>CB</sub> = 2 V, I <sub>E</sub> = 0, f = 1 MHz	–	0.5	0.75	pF
Maximum Available Power Gain	MAG <sup>Note 3</sup>	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 50 mA, f = 2 GHz	–	14	–	dB
Maximum Stable Power Gain	MSG <sup>Note 4</sup>	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 50 mA, f = 2 GHz	–	15	–	dB
Gain 1 dB Compression Output Power	P <sub>O(1 dB)</sub>	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 70 mA <sup>Note 5</sup> , f = 2 GHz	–	17	–	dBm
3rd Order Intermodulation Distortion Output Intercept Point	OIP <sub>3</sub>	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 70 mA <sup>Note 5</sup> , 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.**  $MAG = \left| \frac{S_{21}}{S_{12}} \right| (K - \sqrt{K^2 - 1})$
- 4.**  $MSG = \left| \frac{S_{21}}{S_{12}} \right|$
- 5.** Collector current when P<sub>O(1 dB)</sub> is output

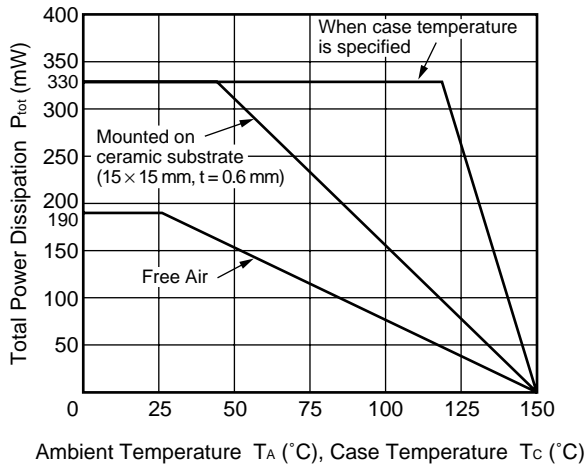
**h<sub>FE</sub> CLASSIFICATION**

Rank	FB/YFB
Marking	T80
h <sub>FE</sub> Value	50 to 100

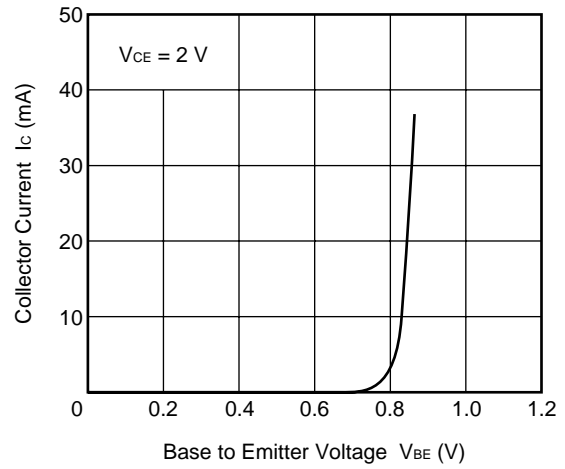
**TYPICAL CHARACTERISTICS (T<sub>A</sub> = +25°C, unless otherwise specified)**

**Thermal/DC Characteristics**

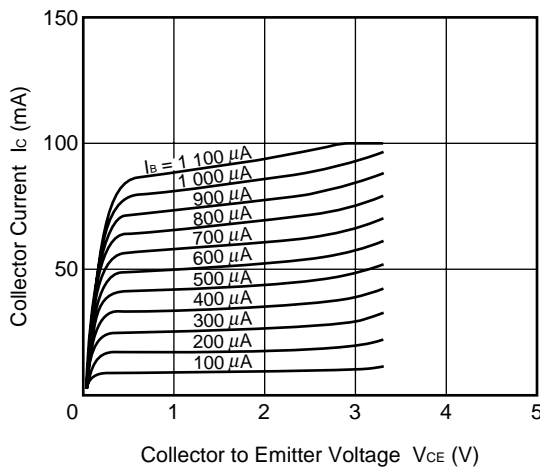
**TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE, CASE TEMPERATURE**



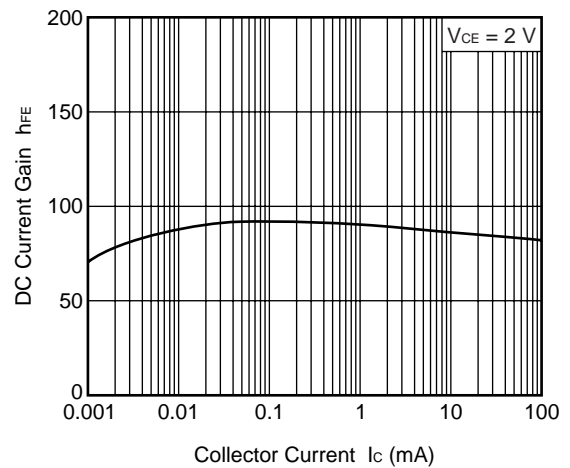
**COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE**



**COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE**

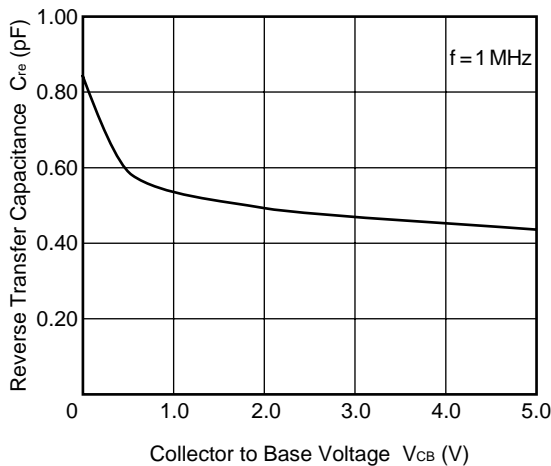


**DC CURRENT GAIN vs. COLLECTOR CURRENT**

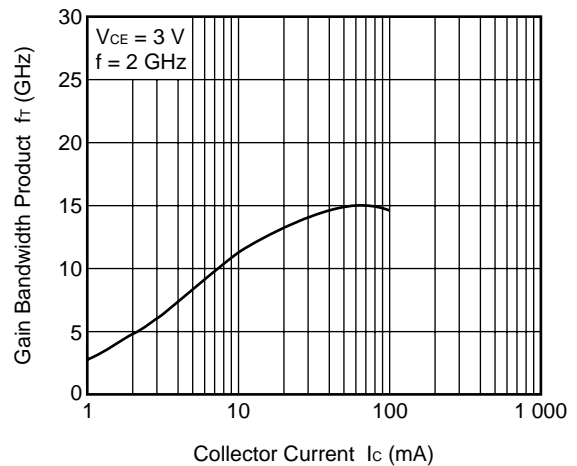


**Capacitance/f<sub>T</sub> Characteristics**

**REVERSE TRANSFER CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE**



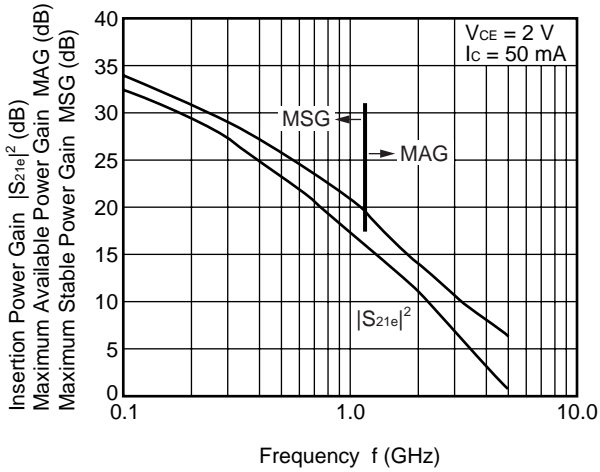
**GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT**



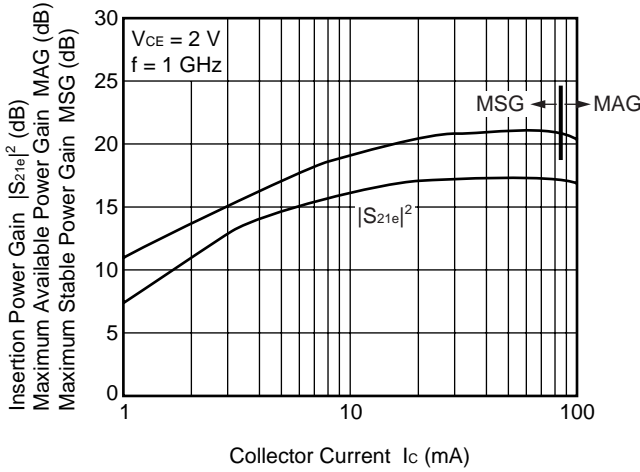
**Remark** The graphs indicate nominal characteristics.

Gain Characteristics

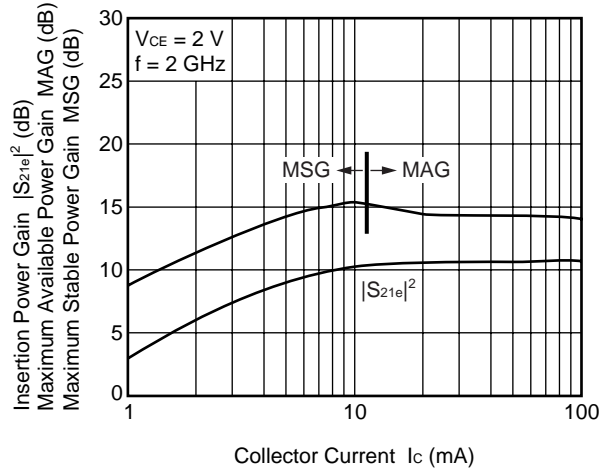
INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY



INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

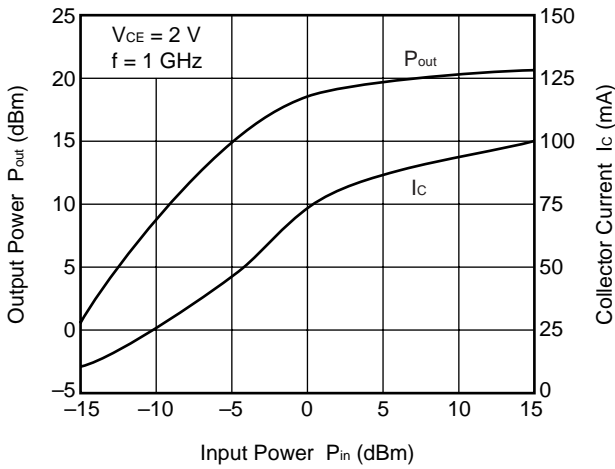


INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

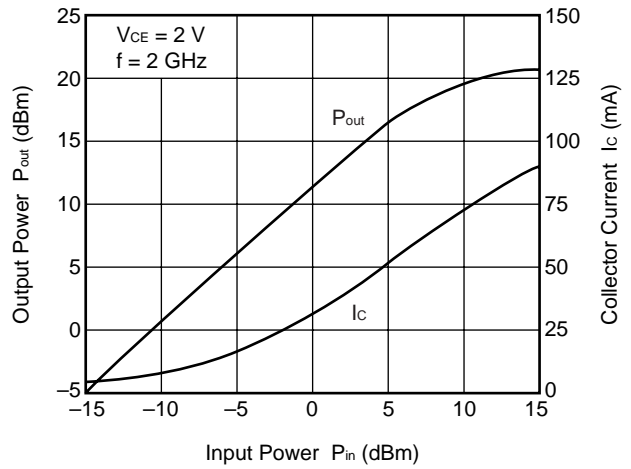


Output Characteristics

OUTPUT POWER, COLLECTOR CURRENT vs. INPUT POWER



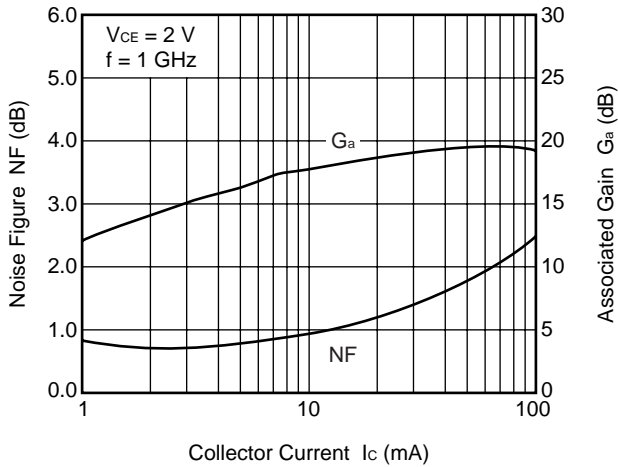
OUTPUT POWER, COLLECTOR CURRENT vs. INPUT POWER



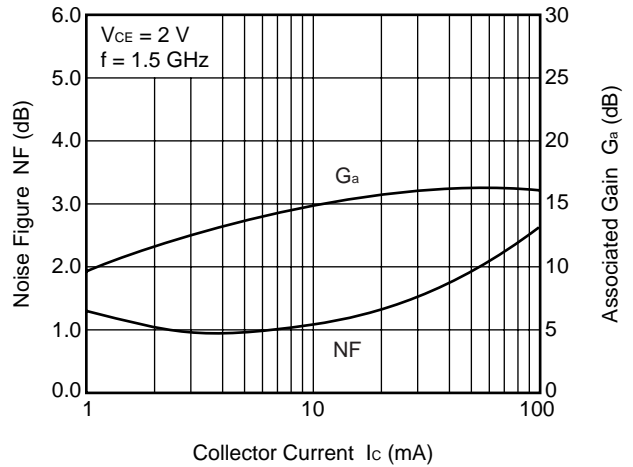
Remark The graphs indicate nominal characteristics.

Noise Characteristics

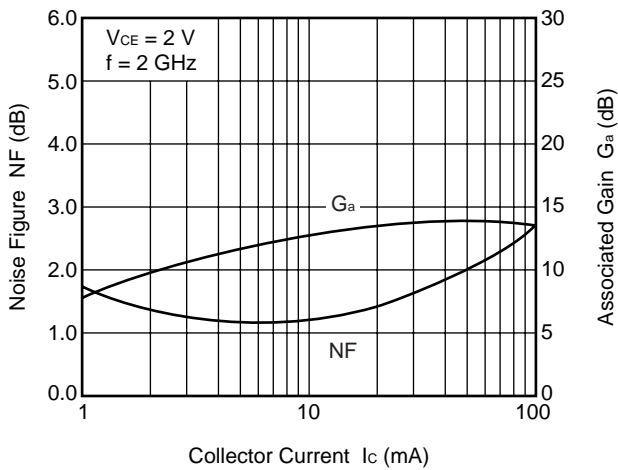
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



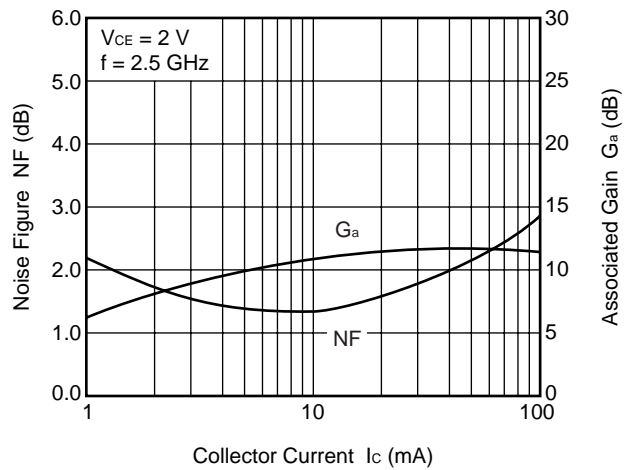
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



**Remark** The graphs indicate nominal characteristics.

<R> **S-PARAMETERS**

S-parameters and noise parameters are provided on our web site in a form (S2P) that enables direct import of the parameters to microwave circuit simulators without the need for keyboard inputs.

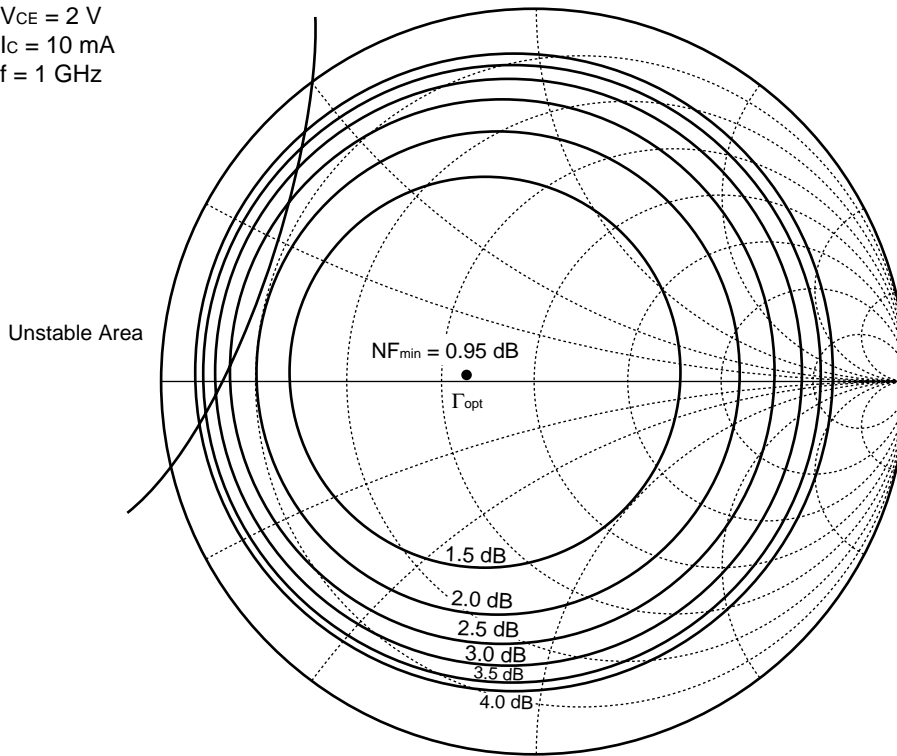
Click here to download S-parameters.

[Products] → [RF Devices] → [Device Parameters]

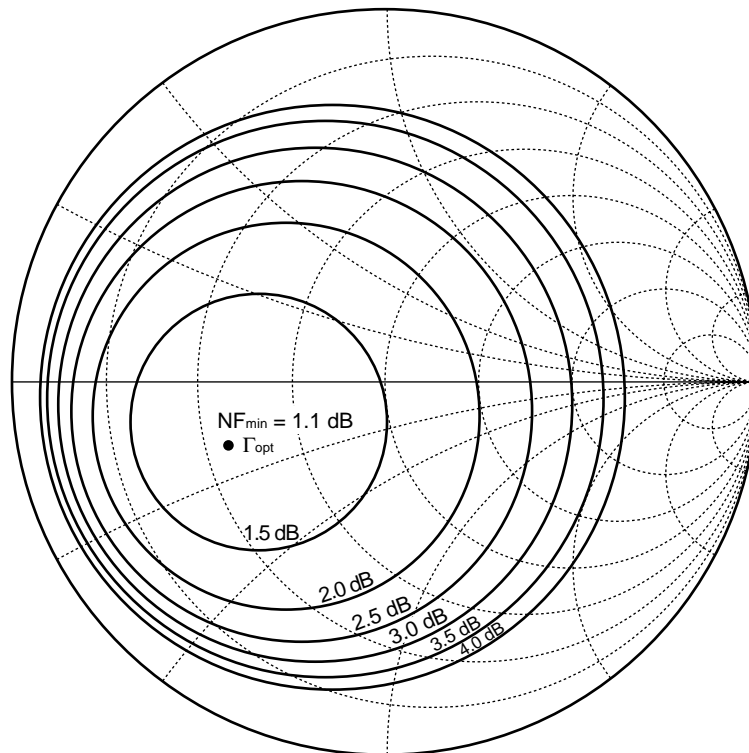
URL <http://www.renesas.com/products/microwave/>

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 <sub>min</sub> (dB)	G <sub>a</sub> (dB)	Γ <sub>opt</sub>		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 <sub>min</sub> (dB)	G <sub>a</sub> (dB)	Γ <sub>opt</sub>		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

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

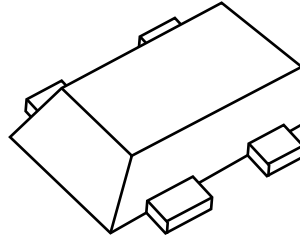
f (GHz)	NF <sub>min</sub> (dB)	G <sub>a</sub> (dB)	Γ <sub>opt</sub>		Rn/50
			MAG.	ANG.	
0.8	0.87	19.6	0.13	170.3	0.09
0.9	0.90	18.6	0.15	171.5	0.09
1.0	0.93	17.8	0.17	173.0	0.09
1.5	1.07	14.8	0.30	-174.1	0.08
1.8	1.15	13.6	0.39	-164.1	0.07
1.9	1.18	13.2	0.41	-160.6	0.07
2.0	1.20	12.8	0.44	-157.2	0.07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

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

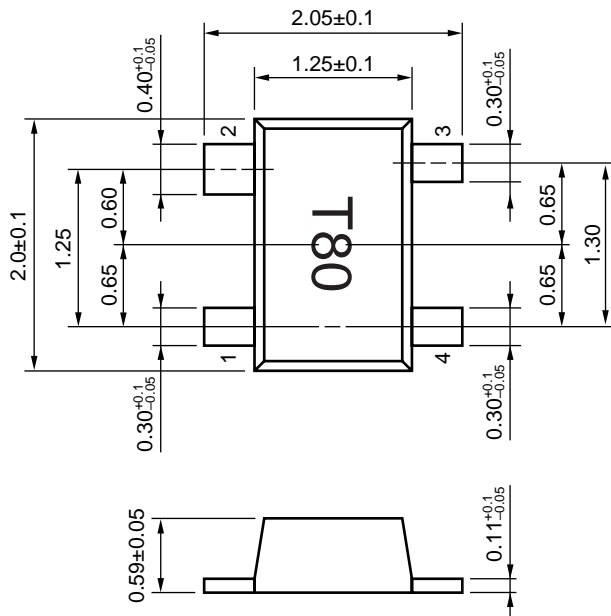
f (GHz)	NF <sub>min</sub> (dB)	G <sub>a</sub> (dB)	Γ <sub>opt</sub>		Rn/50
			MAG.	ANG.	
0.8	1.75	21.3	0.49	-159.4	0.10
0.9	1.78	20.3	0.49	-157.2	0.10
1.0	1.80	19.4	0.50	-154.9	0.11
1.5	1.92	16.2	0.55	-144.7	0.14
1.8	2.00	14.8	0.59	-139.1	0.17
1.9	2.02	14.4	0.60	-137.3	0.19
2.0	2.04	13.9	0.61	-135.5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

<R> PACKAGE DIMENSIONS

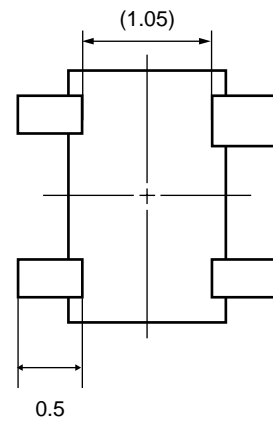
FLAT-LEAD 4-PIN THIN-TYPE SUPER MINIMOLD (M04) PACKAGE (UNIT: mm)



(Top View)



(Bottom View)



**PIN CONNECTIONS**

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



<b>Revision History</b>	<b>2SC5509 Data Sheet</b>
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Rev.	Date	Description	
		Page	Summary
1.00	Sep 9, 2004	–	First edition issued
3.00	Mar 5, 2013	Throughout	Renesas format is applied to this data sheet.
		p.1	ORDERING INFORMATION is modified.
		p.5	Up to date S-PARAMETERS.
		p.8	Added a drawing backside to PACKAGE DIMENSIONS.

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