

# NE663M04 / 2SC5509 JEITA Part No.

## Data Sheet

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
- $NF = 1.2 \text{ dB TYP.}$ ,  $G_a = 12 \text{ dB TYP.}$  @  $V_{CE} = 2 \text{ V}$ ,  $I_C = 10 \text{ mA}$ ,  $f = 2 \text{ GHz}$
- 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 (M04) package

### <R> ORDERING INFORMATION

Part Number	Order Number	Quantity	Package	Supplying Form
NE663M04 2SC5509	NE663M04-A 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>
NE663M04-T2 2SC5509-T2	NE663M04-T2-A 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	$P_{tot}^{\text{Note}}$	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

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

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

**5.** Collector current when P<sub>O (1 dB)</sub> is output

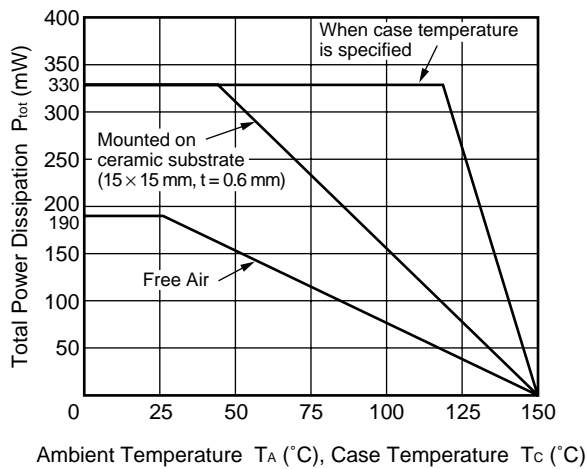
**h<sub>FE</sub> CLASSIFICATION**

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

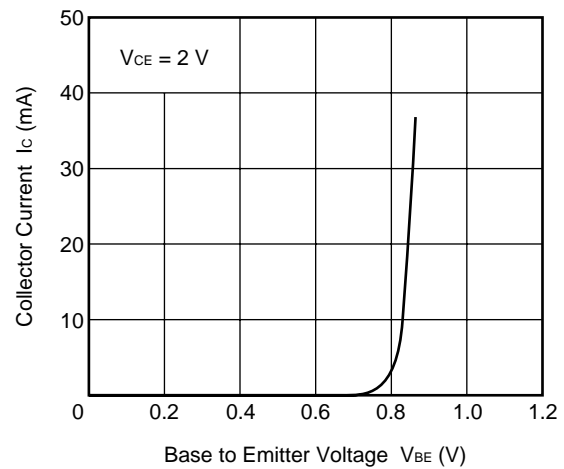
## TYPICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ , unless otherwise specified)

### Thermal/DC Characteristics

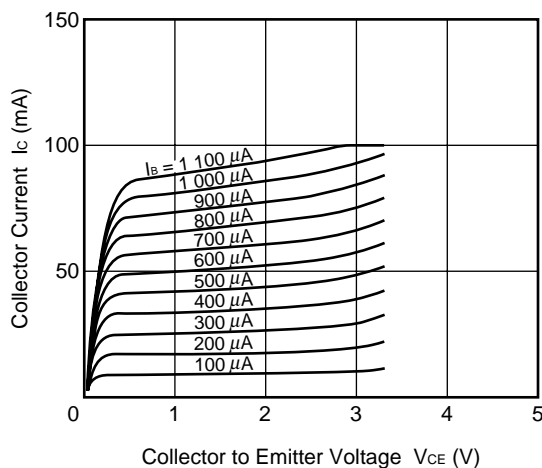
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE, CASE TEMPERATURE



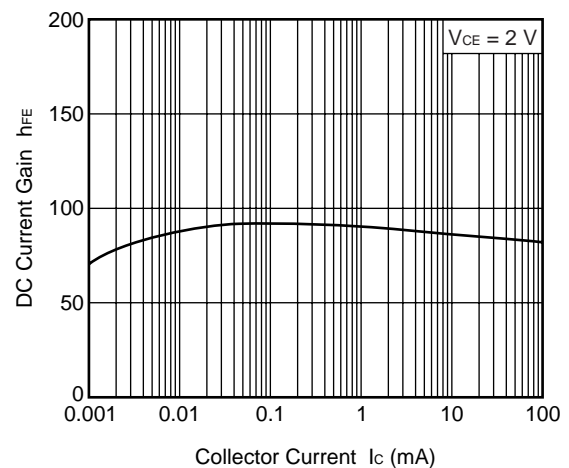
COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE

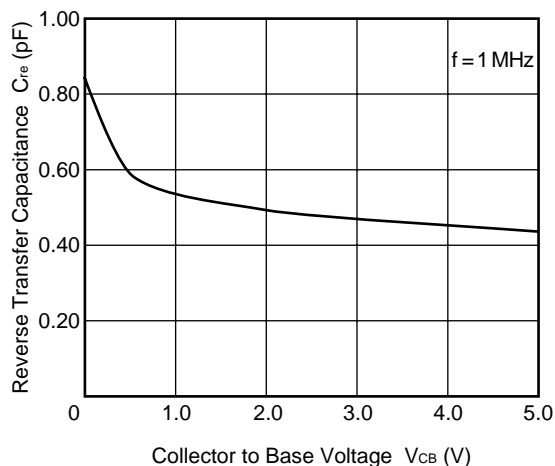


DC CURRENT GAIN vs. COLLECTOR CURRENT

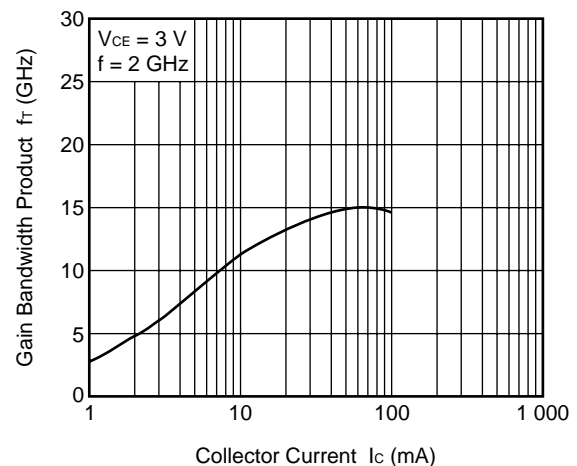


### Capacitance/ $f_T$ Characteristics

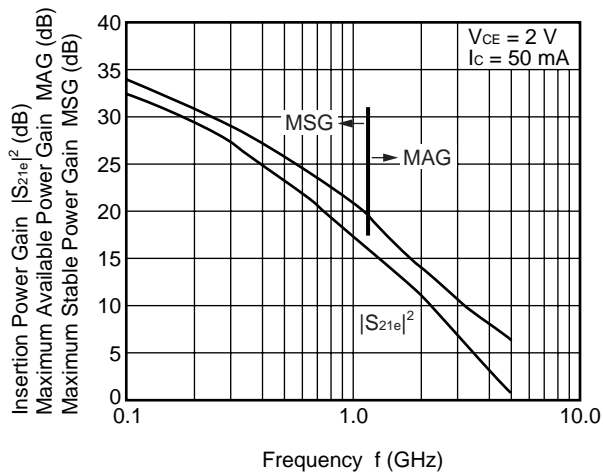
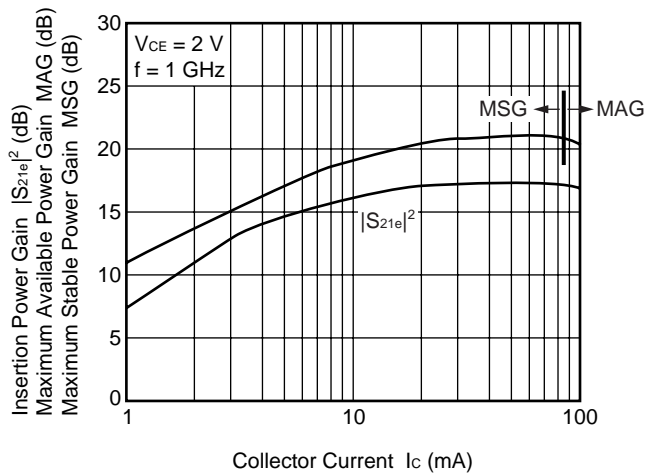
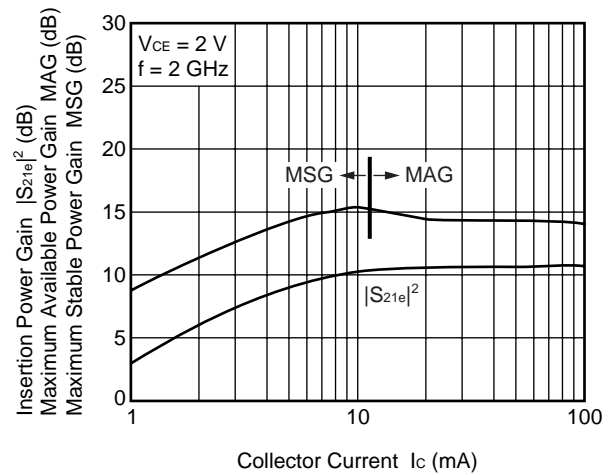
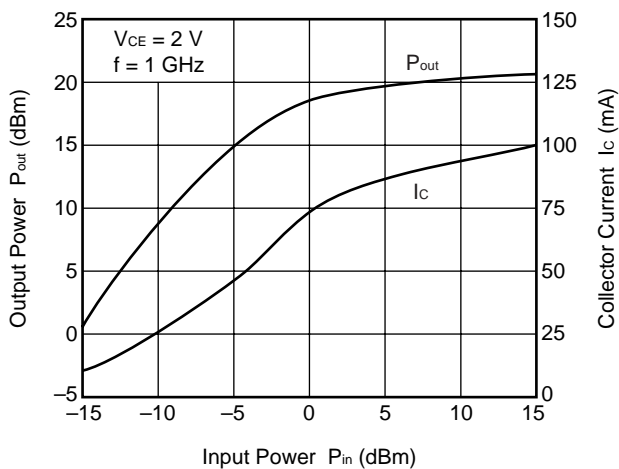
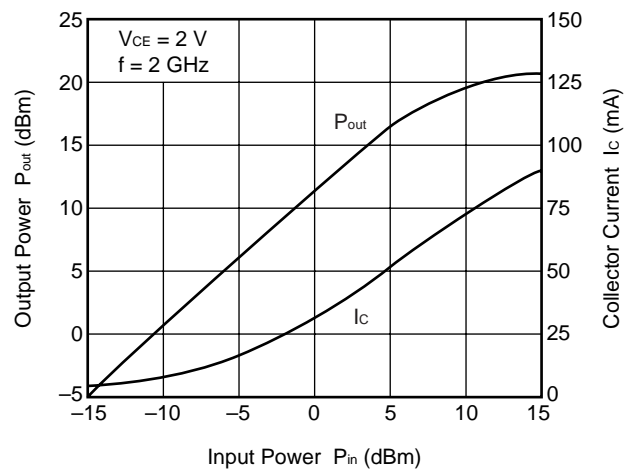
REVERSE TRANSFER CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



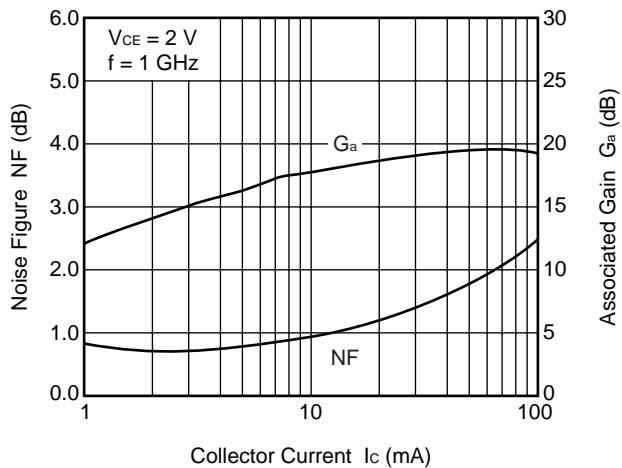
**Remark** The graphs indicate nominal characteristics.

**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**

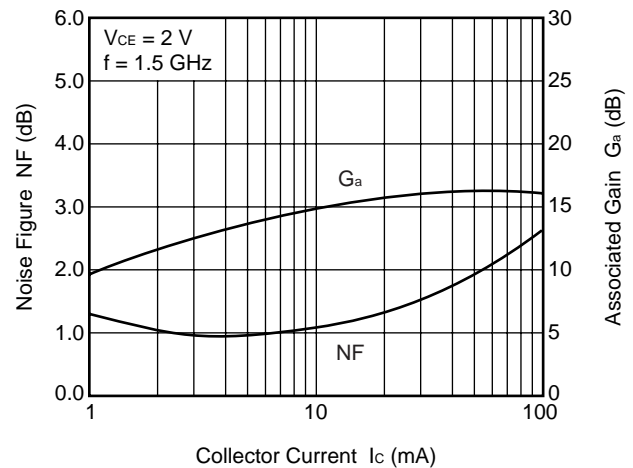
**Remark** The graphs indicate nominal characteristics.

## Noise Characteristics

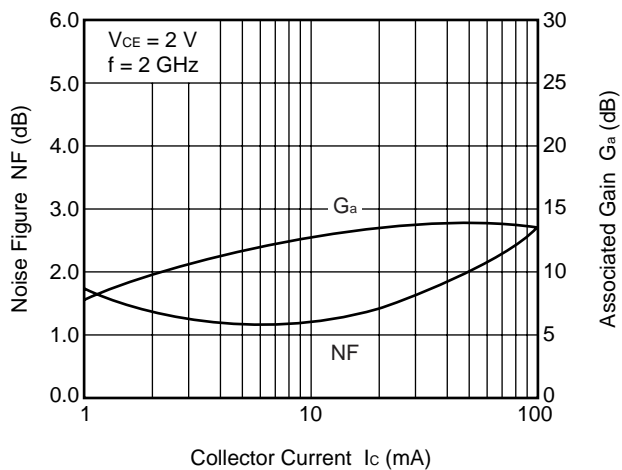
NOISE FIGURE, ASSOCIATED GAIN  
vs. COLLECTOR CURRENT



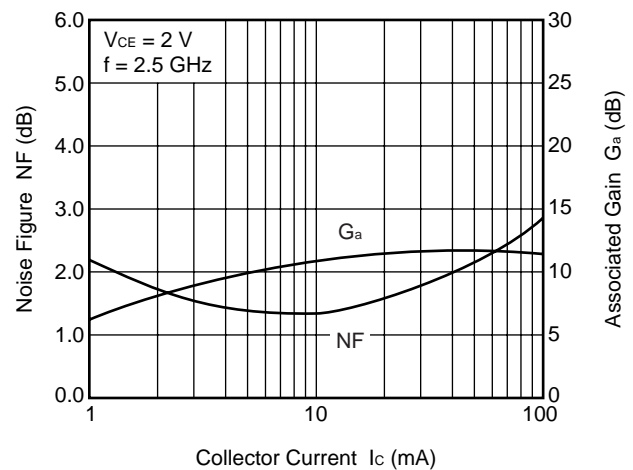
NOISE FIGURE, ASSOCIATED GAIN  
vs. COLLECTOR CURRENT



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.

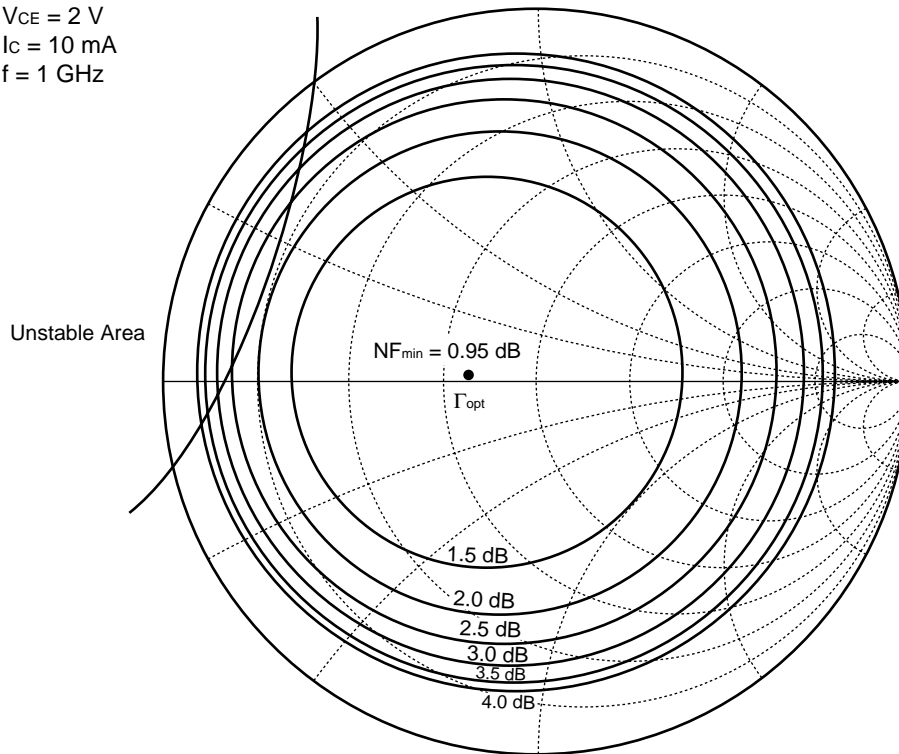
Click here to download S-parameters.

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

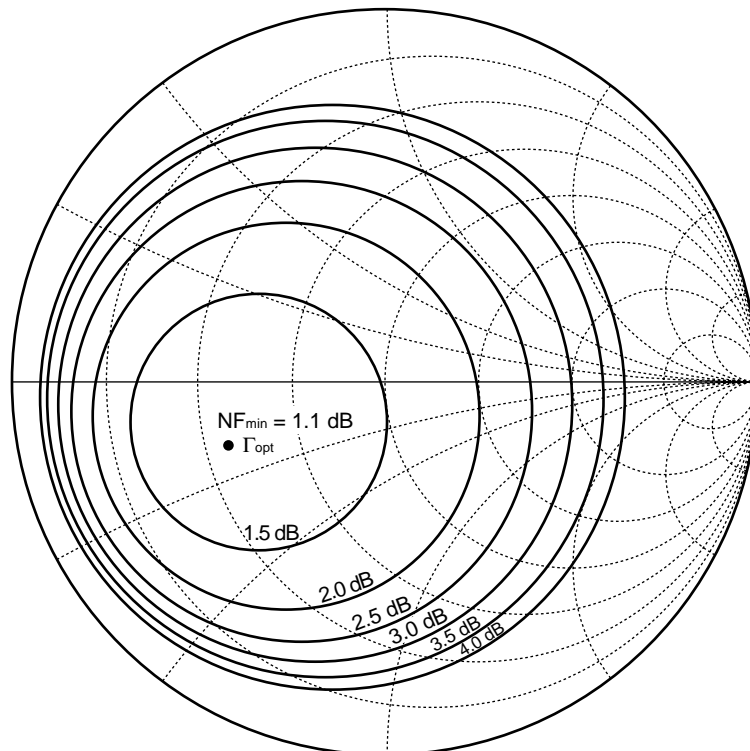
URL <http://www.renesas.com/products/microwave/>

## 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

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

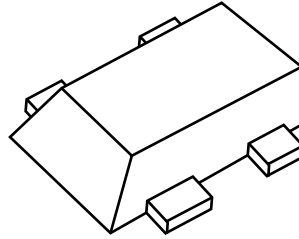
f (GHz)	NF <sub>min</sub> (dB)	G <sub>a</sub> (dB)	Γ <sub>opt</sub>		Rn/50
			MAG.	ANG.	
0.8	1.12	20.7	0.30	-164.8	0.08
0.9	1.15	19.7	0.31	-162.7	0.09
1.0	1.18	18.8	0.32	-160.7	0.09
1.5	1.31	15.7	0.39	-151.5	0.10
1.8	1.38	14.4	0.45	-146.3	0.10
1.9	1.41	14.0	0.47	-144.6	0.10
2.0	1.43	13.6	0.49	-142.9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

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

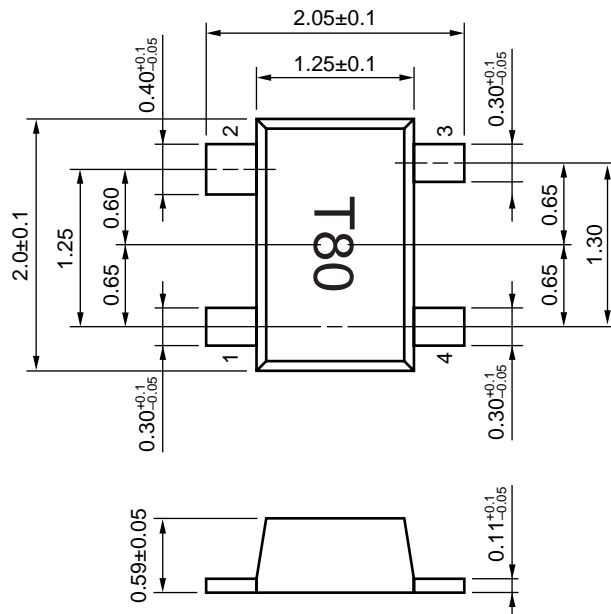
f (GHz)	NF <sub>min</sub> (dB)	G <sub>a</sub> (dB)	Γ <sub>opt</sub>		Rn/50
			MAG.	ANG.	
0.8	0.87	19.6	0.13	170.3	0.09
0.9	0.90	18.6	0.15	171.5	0.09
1.0	0.93	17.8	0.17	173.0	0.09
1.5	1.07	14.8	0.30	-174.1	0.08
1.8	1.15	13.6	0.39	-164.1	0.07
1.9	1.18	13.2	0.41	-160.6	0.07
2.0	1.20	12.8	0.44	-157.2	0.07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

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

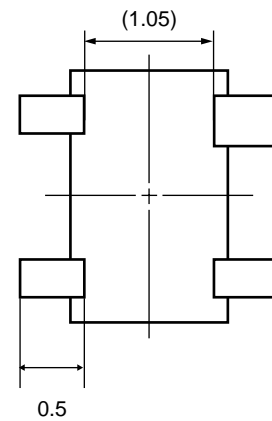
f (GHz)	NF <sub>min</sub> (dB)	G <sub>a</sub> (dB)	Γ <sub>opt</sub>		Rn/50
			MAG.	ANG.	
0.8	1.75	21.3	0.49	-159.4	0.10
0.9	1.78	20.3	0.49	-157.2	0.10
1.0	1.80	19.4	0.50	-154.9	0.11
1.5	1.92	16.2	0.55	-144.7	0.14
1.8	2.00	14.8	0.59	-139.1	0.17
1.9	2.02	14.4	0.60	-137.3	0.19
2.0	2.04	13.9	0.61	-135.5	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>NE663M04 / 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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