

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"> • 8 mm wide embossed taping • Pin 1 (Emitter), Pin 2 (Collector) face the perforation side of the tape |
| 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} <small>Note</small> | 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_A = +25 °C)

| Parameter | Symbol | Conditions | MIN. | TYP. | MAX. | Unit |
|---|-----------------------------------|--|------|------|------|------|
| DC Characteristics | | | | | | |
| Collector Cut-off Current | I _{CBO} | V _{CB} = 5 V, I _E = 0 | – | – | 600 | nA |
| Emitter Cut-off Current | I _{EBO} | V _{EB} = 1 V, I _C = 0 | – | – | 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 GHz, Z _S = Z _{opt} | – | 1.2 | 1.7 | dB |
| Reverse Transfer Capacitance | C _{re} ^{Note 2} | V _{CB} = 2 V, I _E = 0, 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

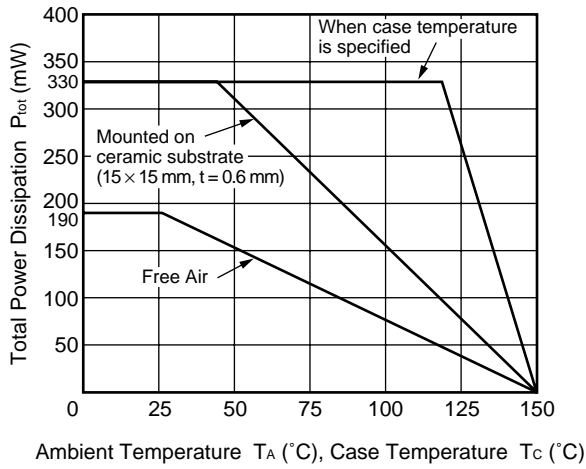
h_{FE} CLASSIFICATION

| Rank | FB/YFB |
|-----------------------|-----------|
| Marking | T80 |
| h _{FE} Value | 50 to 100 |

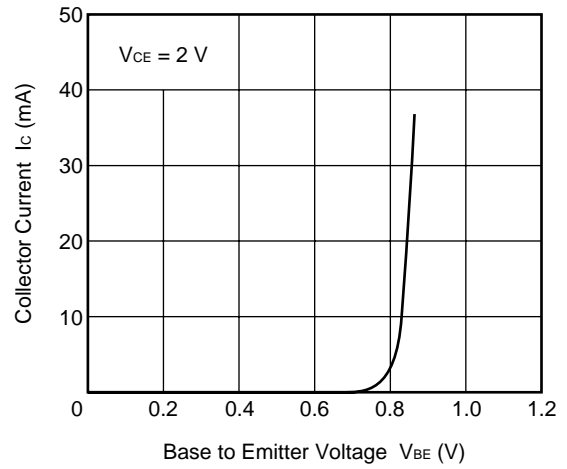
TYPICAL CHARACTERISTICS (T_A = +25°C, unless otherwise specified)

Thermal/DC Characteristics

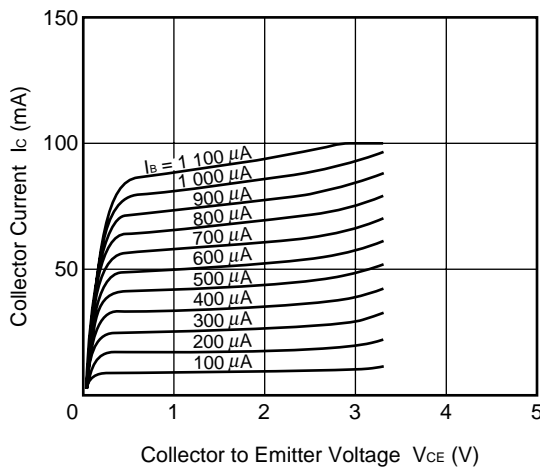
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE, CASE TEMPERATURE



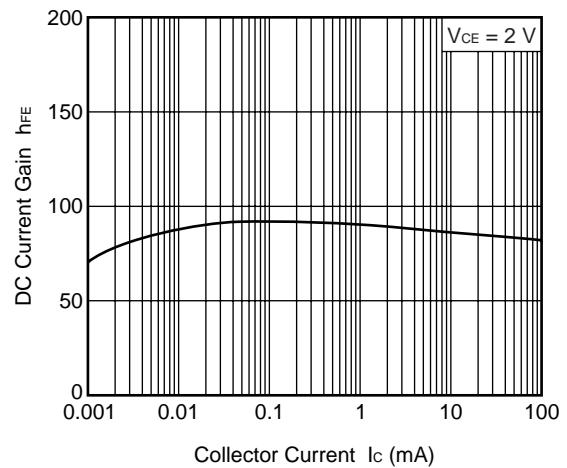
COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE

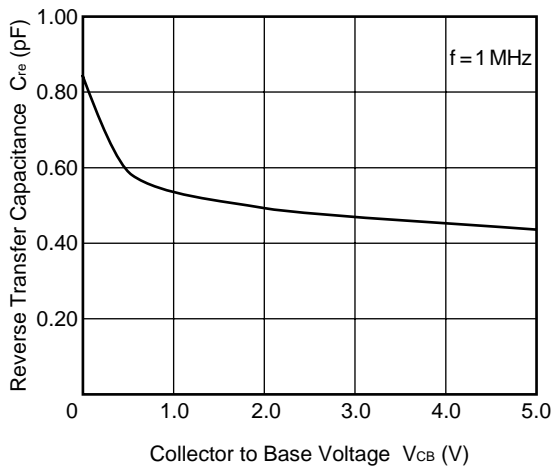


DC CURRENT GAIN vs. COLLECTOR CURRENT

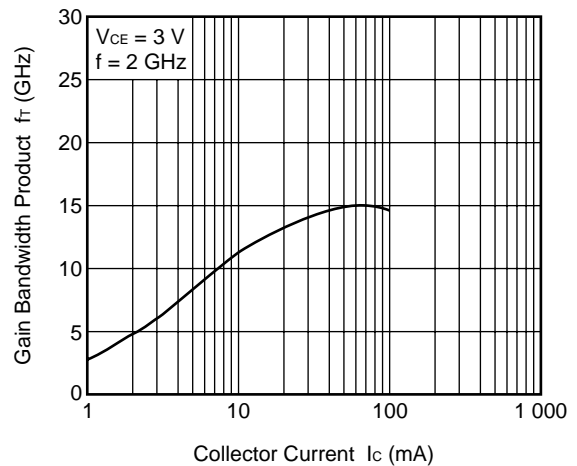


Capacitance/f_T Characteristics

REVERSE TRANSFER CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



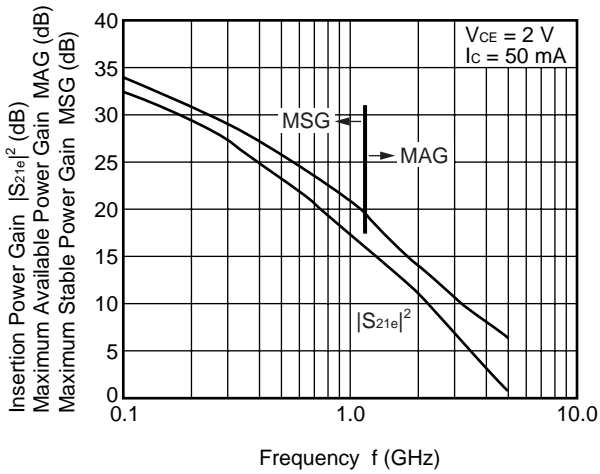
GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



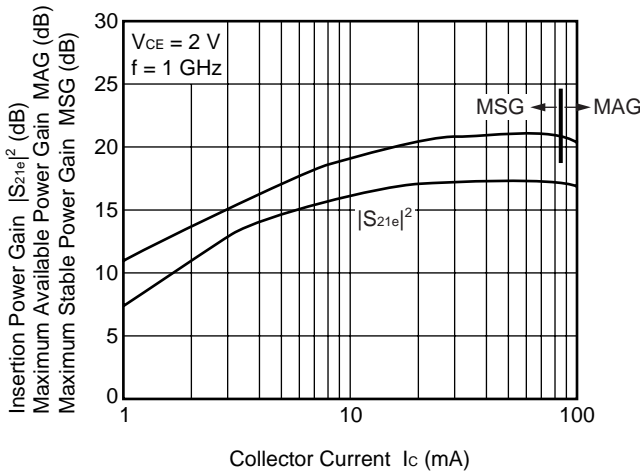
Remark The graphs indicate nominal characteristics.

Gain Characteristics

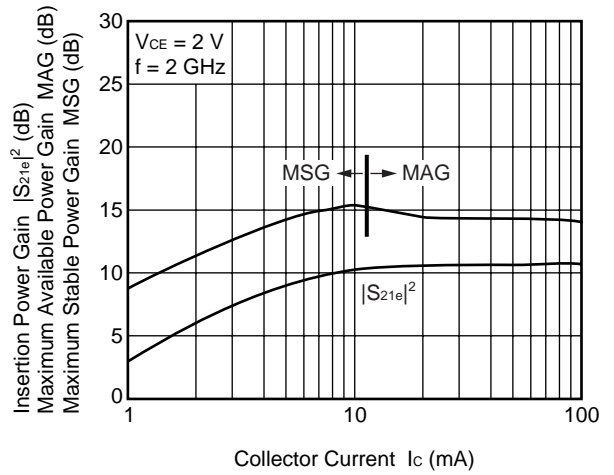
INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY



INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

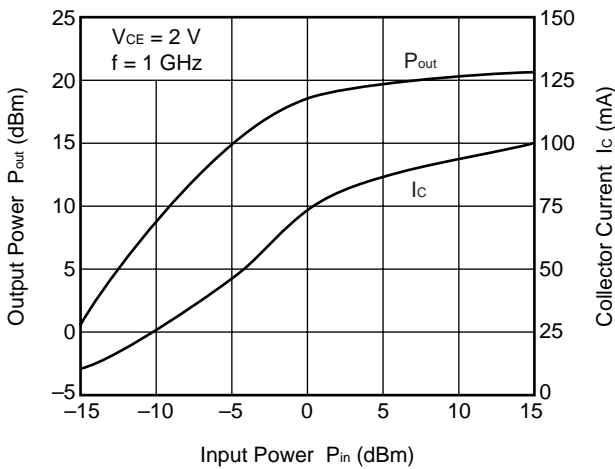


INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

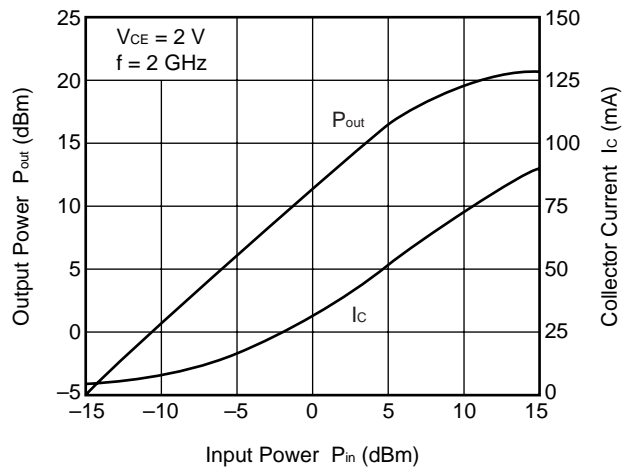


Output Characteristics

OUTPUT POWER, COLLECTOR CURRENT vs. INPUT POWER



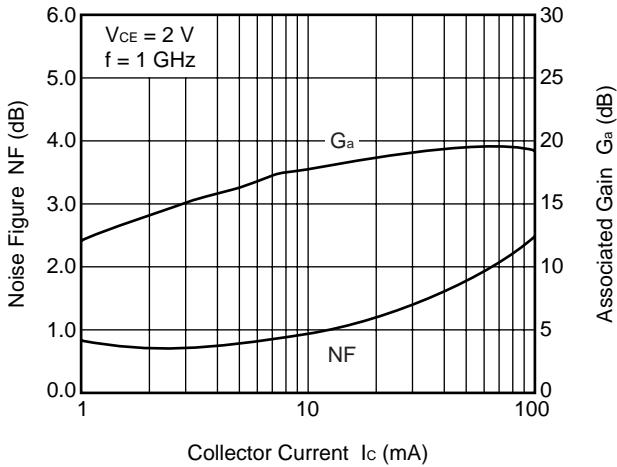
OUTPUT POWER, COLLECTOR CURRENT vs. INPUT POWER



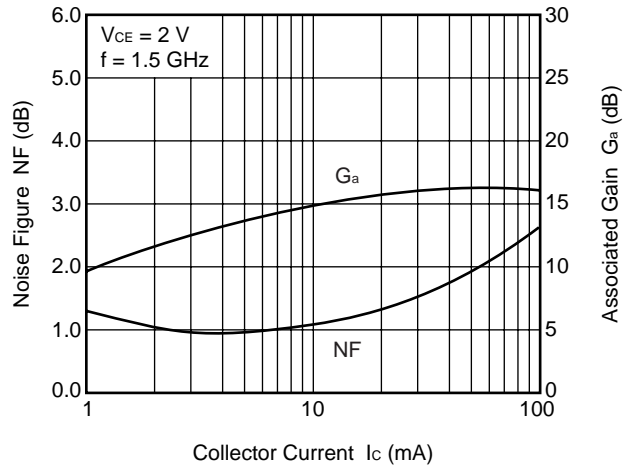
Remark The graphs indicate nominal characteristics.

Noise Characteristics

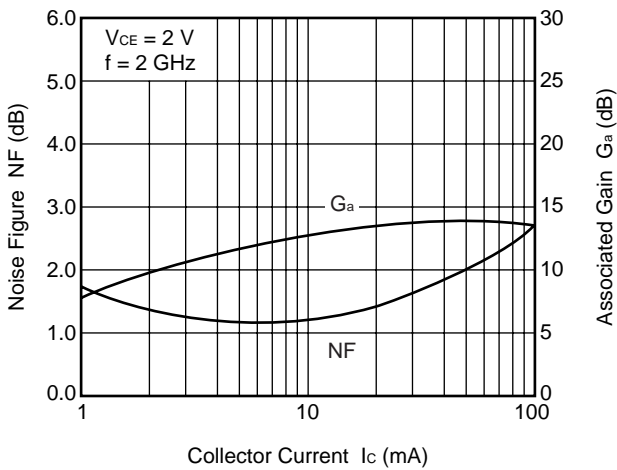
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



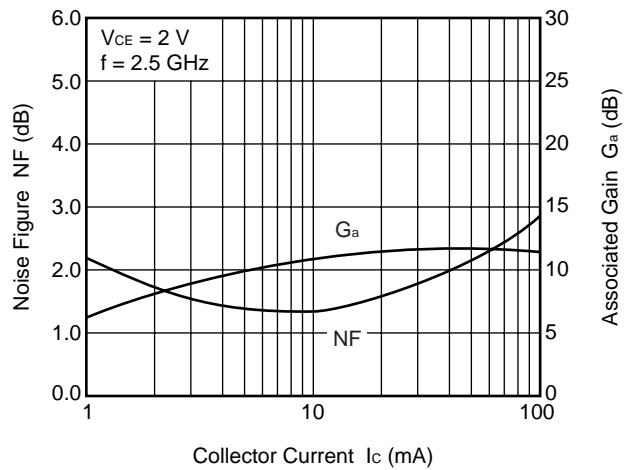
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



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.

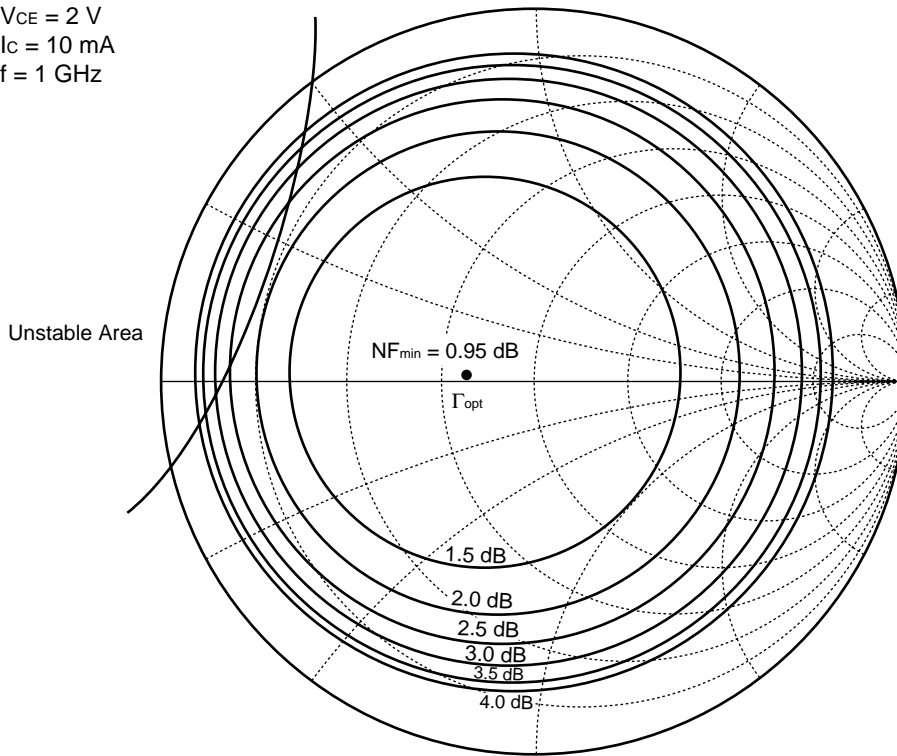
Click here to download S-parameters.

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

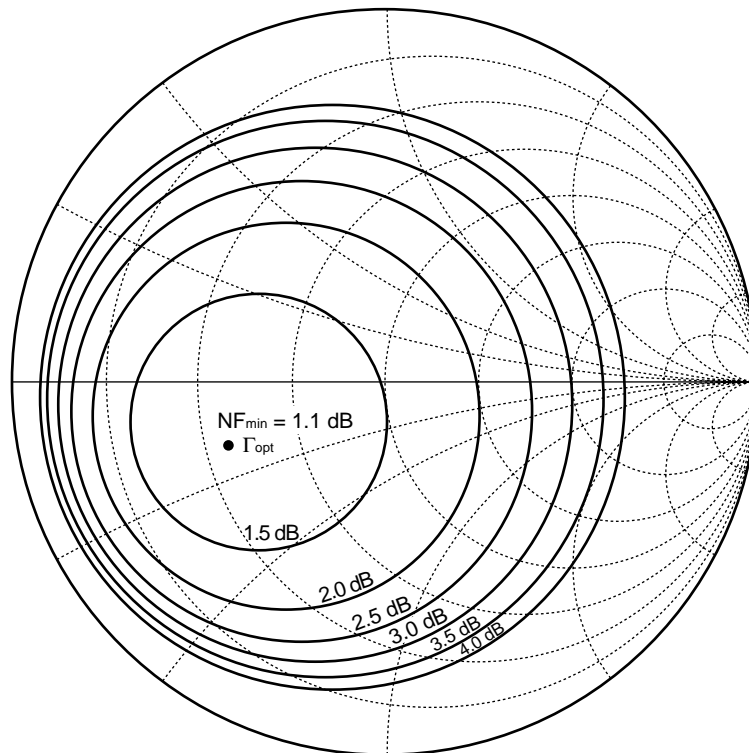
URL <http://www.renesas.com/products/microwave/>

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 _{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 |

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

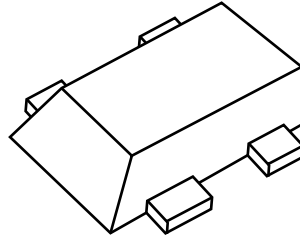
| f (GHz) | NF _{min} (dB) | G _a (dB) | Γ _{opt} | | Rn/50 |
|------------|---------------------------|------------------------|------------------|--------|-------|
| | | | MAG. | ANG. | |
| 0.8 | 0.87 | 19.6 | 0.13 | 170.3 | 0.09 |
| 0.9 | 0.90 | 18.6 | 0.15 | 171.5 | 0.09 |
| 1.0 | 0.93 | 17.8 | 0.17 | 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 |

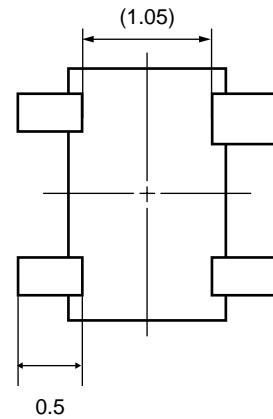
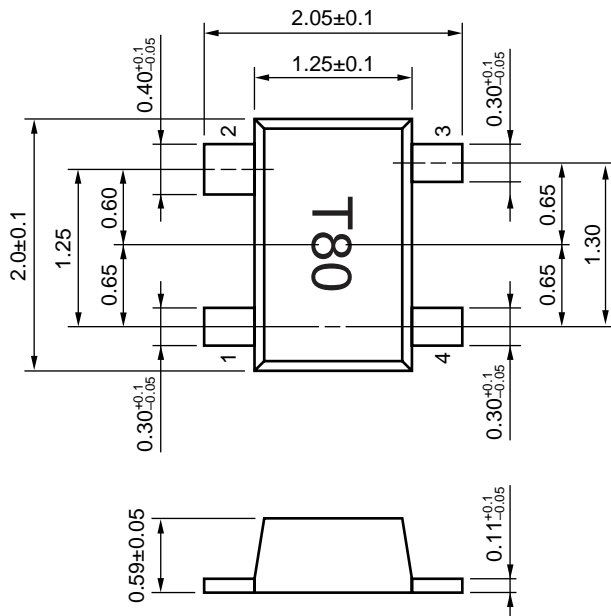
<R> PACKAGE DIMENSIONS

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

| | |
|-------------------------|--------------------------------------|
| Revision History | NE663M04 / 2SC5509 Data Sheet |
|-------------------------|--------------------------------------|

| 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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