# 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 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 |
|---|---|---|---|---|
| NE663M04<br>2SC5509 | NE663M04-A<br>2SC5509-A | 50 pcs (Non reel) | Flat-lead 4-pin thin-type super minimold (M04) (Pb-Free) | • 8 mm wide embossed taping<br>• Pin 1 (Emitter), Pin 2 (Collector) face the perforation side of the tape |
| NE663M04-T2<br>2SC5509-T2 | NE663M04-T2-A<br>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°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 | °C |
| Storage Temperature | $T_{stg}$ | –65 to +150 | °C |

**Note** Free air.

## THERMAL RESISTANCE

| Parameter | Symbol | Ratings | Unit |
|---|---|---|---|
| Junction to Case Resistance | $R_{th\ j\text{-}c}$ | 95 | °C /W |
| Junction to Ambient Resistance | $R_{th\ j\text{-}a}$ | 650 | °C /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.** $MAG = \left|\frac{S_{21}}{S_{12}}\right| (K - \sqrt{(K^2 - 1)})$

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

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

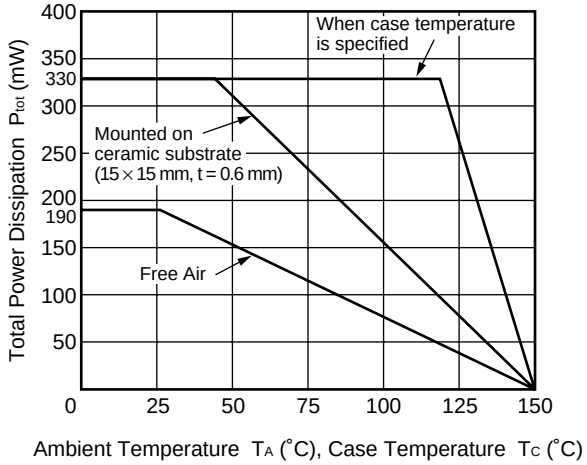
## $h_{FE}$ CLASSIFICATION

| Rank | FB/YFB |
|---|---|
| Marking | T80 |
| $h_{FE}$ Value | 50 to 100 |

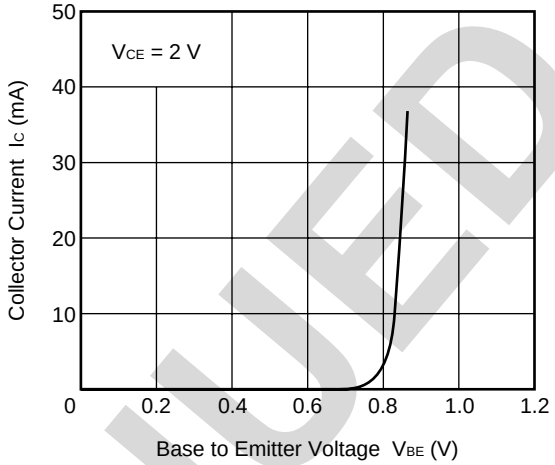
## TYPICAL CHARACTERISTICS ($T_A$ = +25°C, unless otherwise specified)

### Thermal/DC Characteristics

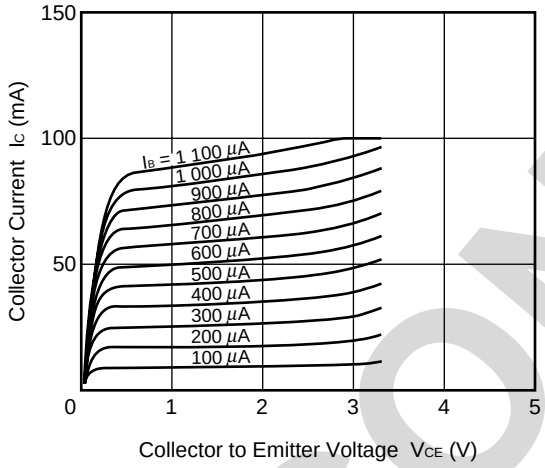
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE, CASE TEMPERATURE



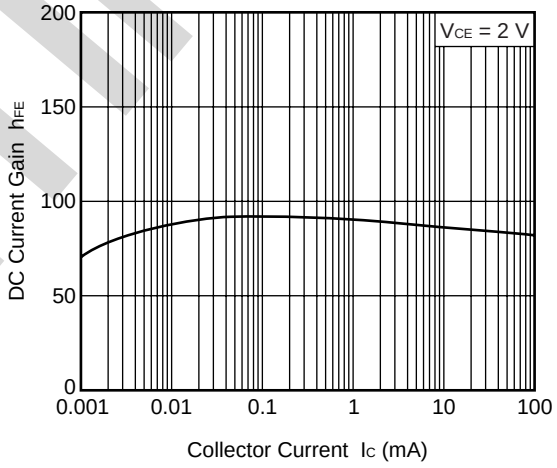

COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE




COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE

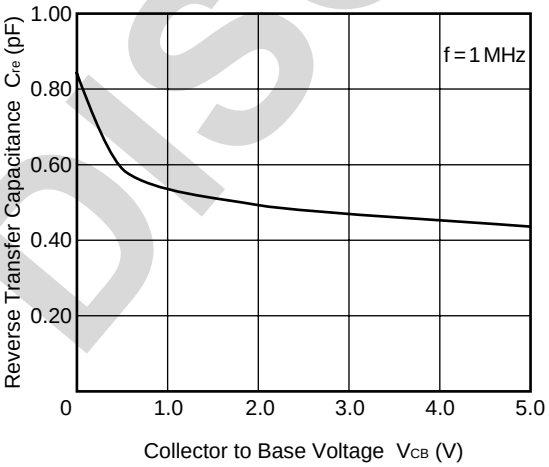



DC CURRENT GAIN vs. COLLECTOR CURRENT

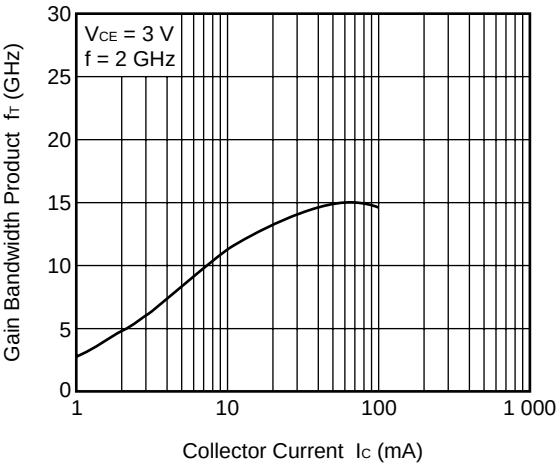



### Capacitance/$f_T$ Characteristics

REVERSE TRANSFER CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



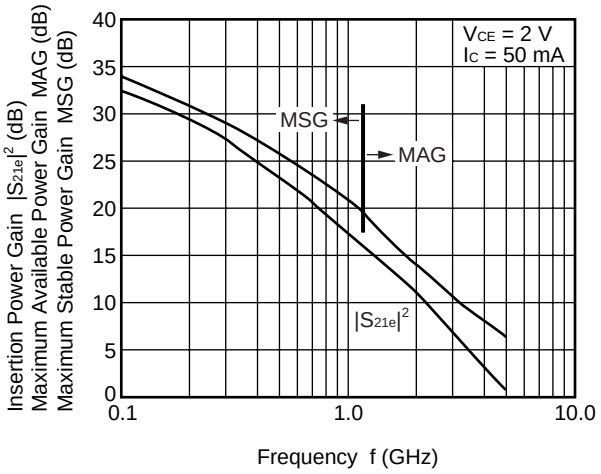

GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



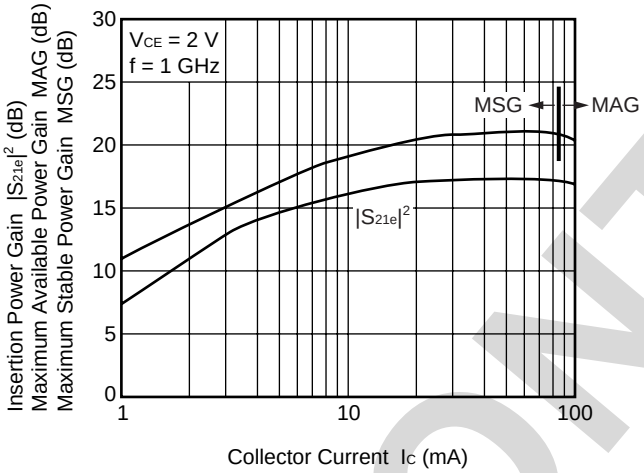

**Remark** The graphs indicate nominal characteristics.

## Gain Characteristics

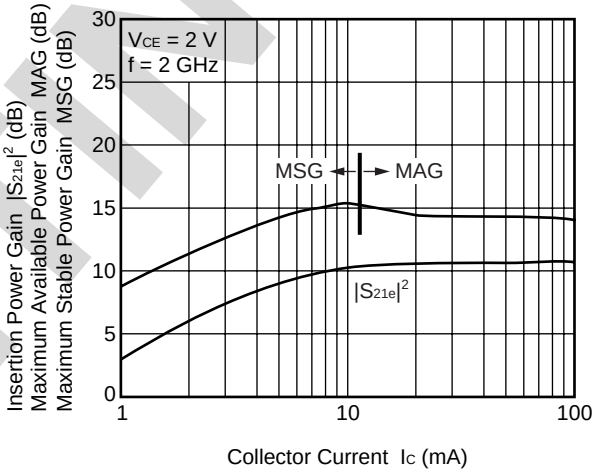
INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY




INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

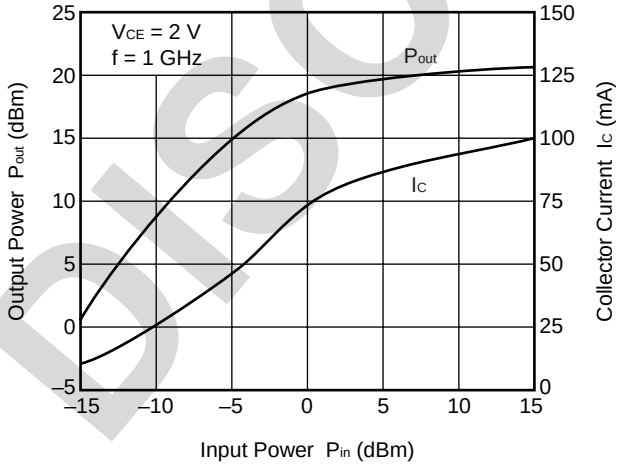



INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

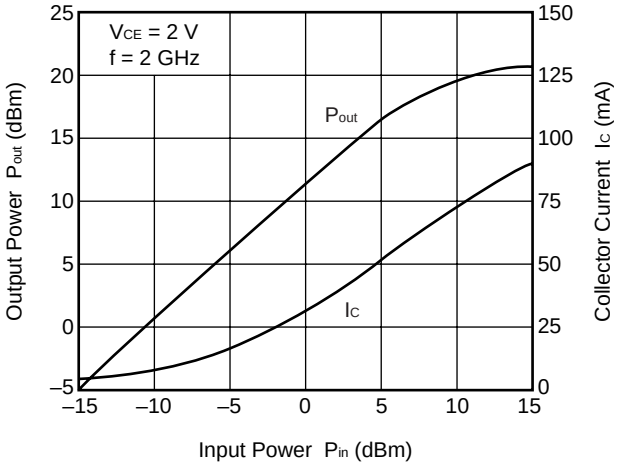



## Output Characteristics

OUTPUT POWER, COLLECTOR CURRENT vs. INPUT POWER



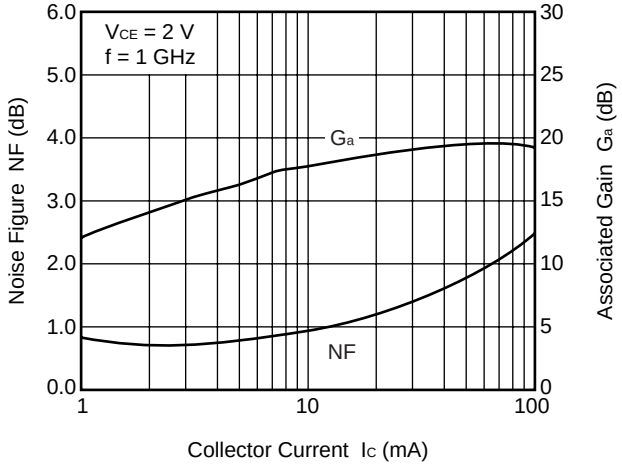

OUTPUT POWER, COLLECTOR CURRENT vs. INPUT POWER



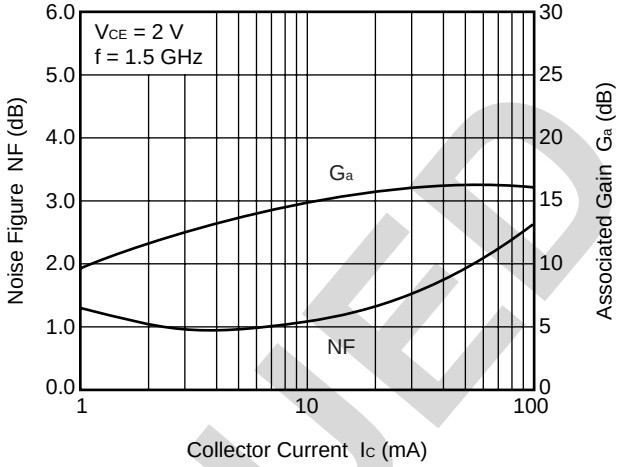

**Remark** The graphs indicate nominal characteristics.

**Noise Characteristics**

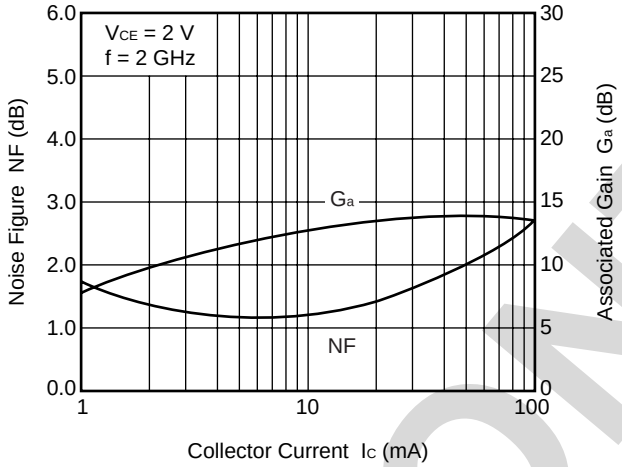
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



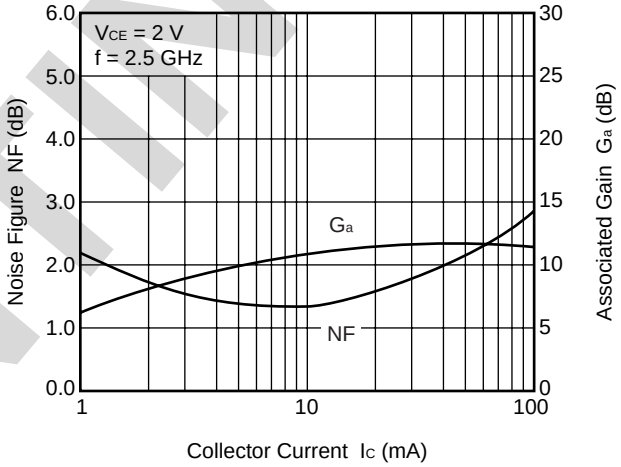

NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT




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.

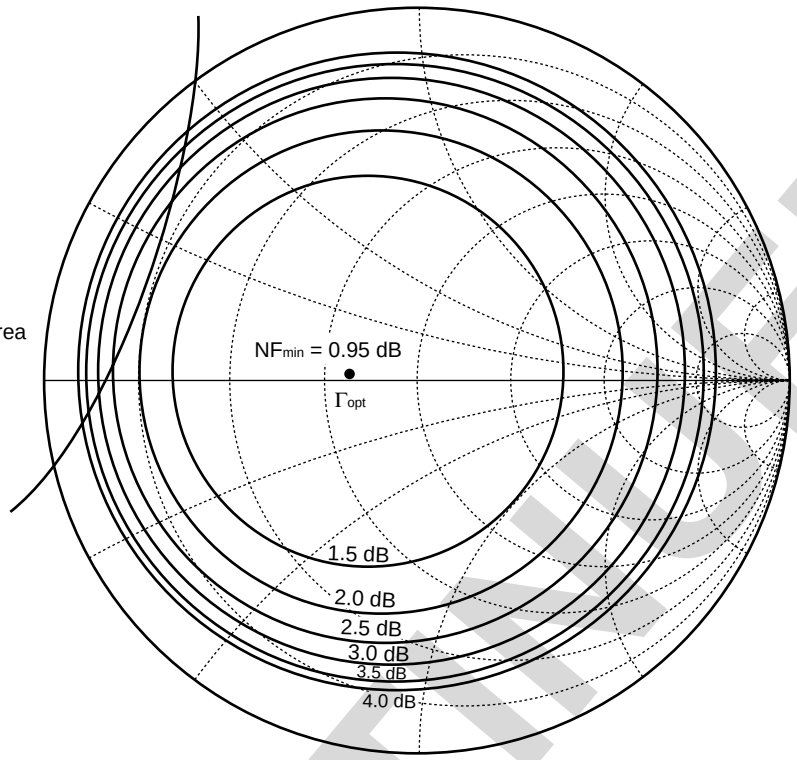
Click here to download S-parameters.

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

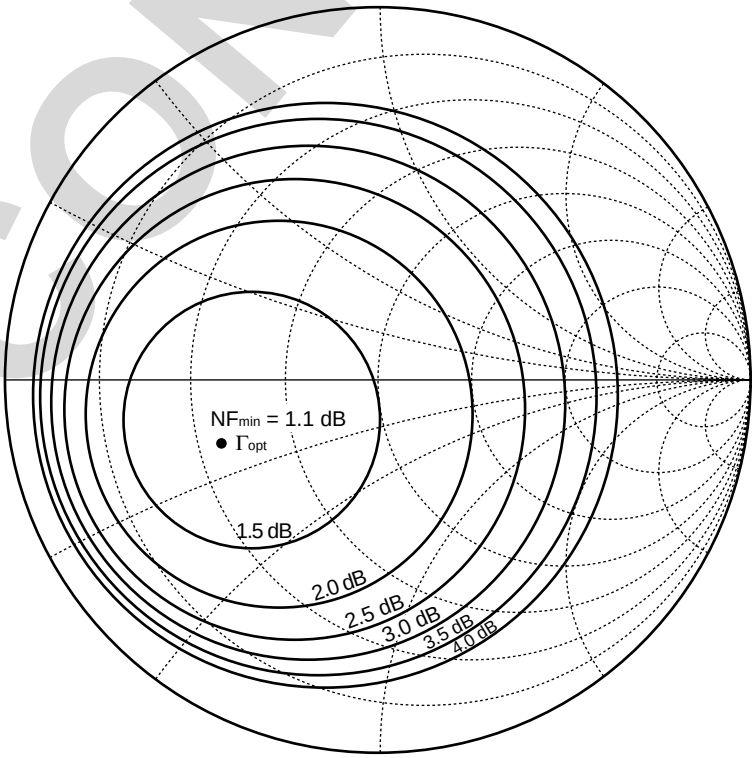
URL http://www.renesas.com/products/microwave/

## EQUAL NF CIRCLE

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




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



## NOISE PARAMETERS

$V_{CE}$ = 2 V, $I_C$ = 5 mA

| f (GHz) | $NF_{min}$ (dB) | $G_a$ (dB) | $\Gamma_{opt}$ MAG. | $\Gamma_{opt}$ ANG. | Rn/50 |
|---|---|---|---|---|---|
| 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 V, $I_C$ = 10 mA

| f (GHz) | $NF_{min}$ (dB) | $G_a$ (dB) | $\Gamma_{opt}$ MAG. | $\Gamma_{opt}$ ANG. | Rn/50 |
|---|---|---|---|---|---|
| 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 V, $I_C$ = 20 mA

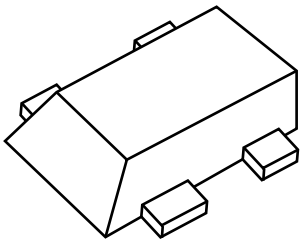
| f (GHz) | $NF_{min}$ (dB) | $G_a$ (dB) | $\Gamma_{opt}$ MAG. | $\Gamma_{opt}$ ANG. | Rn/50 |
|---|---|---|---|---|---|
| 0.8 | 1.12 | 20.7 | 0.30 | –164.8 | 0.08 |
| 0.9 | 1.15 | 19.7 | 0.31 | –162.7 | 0.09 |
| 1.0 | 1.18 | 18.8 | 0.32 | –160.7 | 0.09 |
| 1.5 | 1.31 | 15.7 | 0.39 | –151.5 | 0.10 |
| 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 V, $I_C$ = 50 mA

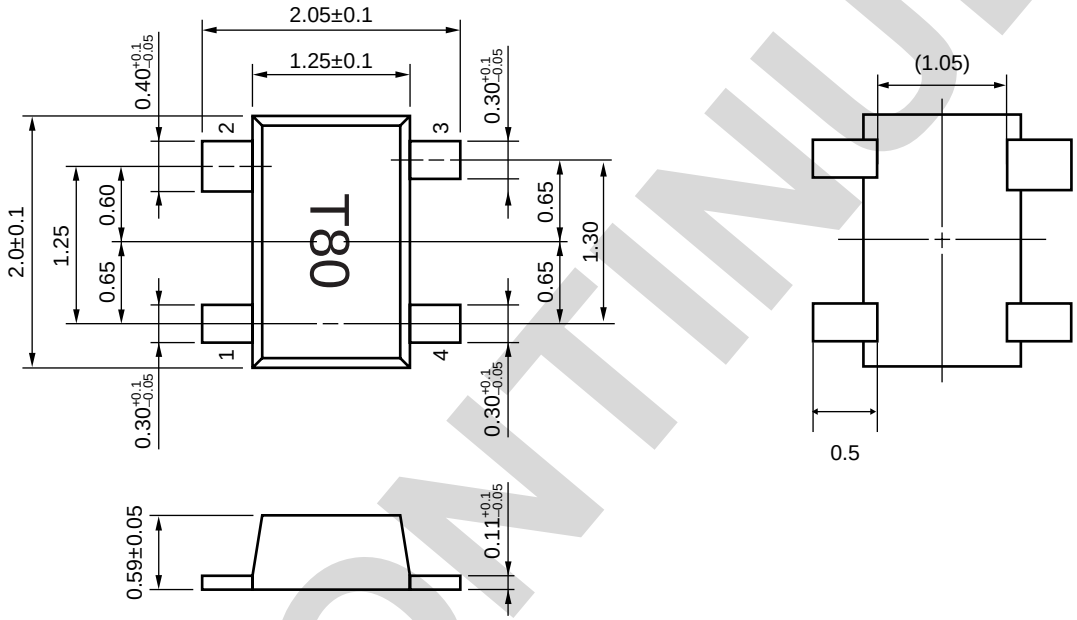
| f (GHz) | $NF_{min}$ (dB) | $G_a$ (dB) | $\Gamma_{opt}$ MAG. | $\Gamma_{opt}$ ANG. | Rn/50 |
|---|---|---|---|---|---|
| 0.8 | 1.75 | 21.3 | 0.49 | –159.4 | 0.10 |
| 0.9 | 1.78 | 20.3 | 0.49 | –157.2 | 0.10 |
| 1.0 | 1.80 | 19.4 | 0.50 | –154.9 | 0.11 |
| 1.5 | 1.92 | 16.2 | 0.55 | –144.7 | 0.14 |
| 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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