

# NPN SILICON GERMANIUM RF TRANSISTOR

# NESG3033M14

### NPN SiGe RF TRANSISTOR FOR LOW NOISE, HIGH-GAIN AMPLIFICATION 4-PIN LEAD-LESS MINIMOLD (M14, 1208 PKG)

#### FEATURES

- The device is an ideal choice for low noise, high-gain amplification  
NF = 0.6 dB TYP. @  $V_{CE} = 2\text{ V}$ ,  $I_C = 6\text{ mA}$ ,  $f = 2.0\text{ GHz}$
- Maximum stable power gain: MSG = 20.5 dB TYP. @  $V_{CE} = 2\text{ V}$ ,  $I_C = 15\text{ mA}$ ,  $f = 2.0\text{ GHz}$
- SiGe HBT technology (UHS3) adopted:  $f_{max} = 110\text{ GHz}$
- This product is improvement of ESD of NESG3032M14.
- 4-pin lead-less minimold (M14, 1208 PKG)

#### ORDERING INFORMATION

Part Number	Order Number	Package	Quantity	Supplying Form
NESG3033M14	NESG3033M14-A	4-pin lead-less minimold (M14, 1208 PKG) (Pb-Free) <sup>Note</sup>	50 pcs (Non reel)	<ul style="list-style-type: none"> <li>8 mm wide embossed taping</li> <li>Pin 1 (Collector), Pin 4 (Emitter) face the perforation side of the tape</li> </ul>
NESG3033M14-T3	NESG3033M14-T3-A		10 kpcs/reel	

**Note** With regards to terminal solder (the solder contains lead) plated products (conventionally plated), contact your nearby sales office.

**Remark** To order evaluation samples, contact your nearby sales office.  
Unit sample quantity is 50 pcs.

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

Parameter	Symbol	Ratings	Unit
Collector to Base Voltage	$V_{CBO}$ <sup>Note 1</sup>	5.0	V
Collector to Emitter Voltage	$V_{CEO}$	4.3	V
Base Current	$I_B$ <sup>Note 1</sup>	12	mA
Collector Current	$I_C$	35	mA
Total Power Dissipation	$P_{tot}$ <sup>Note 2</sup>	150	mW
Junction Temperature	$T_j$	150	$^\circ\text{C}$
Storage Temperature	$T_{stg}$	-65 to +150	$^\circ\text{C}$

**Notes 1.**  $V_{CBO}$  and  $I_B$  are limited by the permissible current of the protection element.

**2.** Mounted on  $1.08\text{ cm}^2 \times 1.0\text{ mm}$  (t) glass epoxy PWB

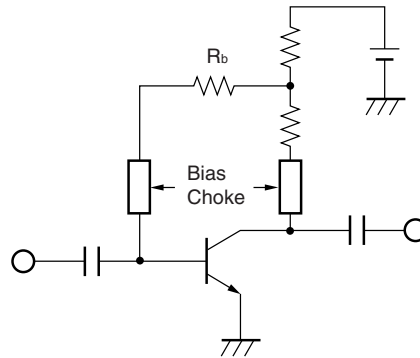
**Caution** Observe precautions when handling because these devices are sensitive to electrostatic discharge.

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 products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.

**RECOMMENDED OPERATING RANGE (T<sub>A</sub> = +25°C)**

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Input Power	P <sub>in</sub>	-	-	0	dBm
Base Feedback Resister	R <sub>b</sub>	-	-	100	kΩ

**Remark** When the voltage return bias circuit like the figure below is used, a current increase is seen because the ESD protection element is turned on when recommended range of motion in the above table is exceeded. However, there is no influence of reliability, including deterioration.



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

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
<b>DC Characteristics</b>						
Collector Cut-off Current	I <sub>CB0</sub>	V <sub>CB</sub> = 5 V, I <sub>E</sub> = 0 mA	–	–	100	nA
Emitter Cut-off Current	I <sub>EB0</sub>	V <sub>EB</sub> = 1 V, I <sub>C</sub> = 0 mA	–	–	100	nA
DC Current Gain	h <sub>FE</sub> <sup>Note 1</sup>	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 6 mA	220	300	380	–
<b>RF Characteristics</b>						
Insertion Power Gain	S <sub>21e</sub>   <sup>2</sup>	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 15 mA, f = 2.0 GHz	15.0	17.5	–	dB
Noise Figure	NF	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 6 mA, f = 2.0 GHz, Z <sub>S</sub> = Z <sub>Sopt</sub> , Z <sub>L</sub> = Z <sub>Lopt</sub>	–	0.60	0.85	dB
Associated Gain	G <sub>a</sub>	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 6 mA, f = 2.0 GHz, Z <sub>S</sub> = Z <sub>Sopt</sub> , Z <sub>L</sub> = Z <sub>Lopt</sub>	–	17.5	–	dB
Reverse Transfer Capacitance	C <sub>re</sub> <sup>Note 2</sup>	V <sub>CB</sub> = 2 V, I <sub>E</sub> = 0 mA, f = 1 MHz	–	0.15	0.25	pF
Maximum Stable Power Gain	MSG <sup>Note 3</sup>	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 15 mA, f = 2.0 GHz	17.5	20.5	–	dB
Gain 1 dB Compression Output Power	P <sub>O(1 dB)</sub>	V <sub>CE</sub> = 3 V, I <sub>C(set)</sub> = 20 mA, f = 2.0 GHz, Z <sub>S</sub> = Z <sub>Sopt</sub> , Z <sub>L</sub> = Z <sub>Lopt</sub>	–	12.5	–	dBm
3rd Order Intermodulation Distortion Output Intercept Point	OIP <sub>3</sub>	V <sub>CE</sub> = 3 V, I <sub>C(set)</sub> = 20 mA, f = 2.0 GHz, Z <sub>S</sub> = Z <sub>Sopt</sub> , Z <sub>L</sub> = Z <sub>Lopt</sub>	–	24.0	–	dBm

**Notes 1.** Pulse measurement: PW ≤ 350 μs, Duty Cycle ≤ 2%

**2.** Collector to base capacitance when the emitter grounded

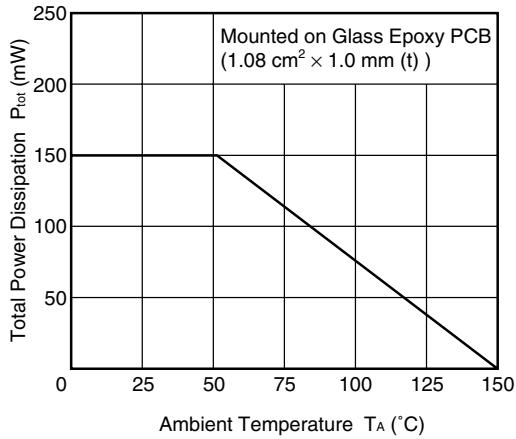
**3.**  $MSG = \left| \frac{S_{21}}{S_{12}} \right|$

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

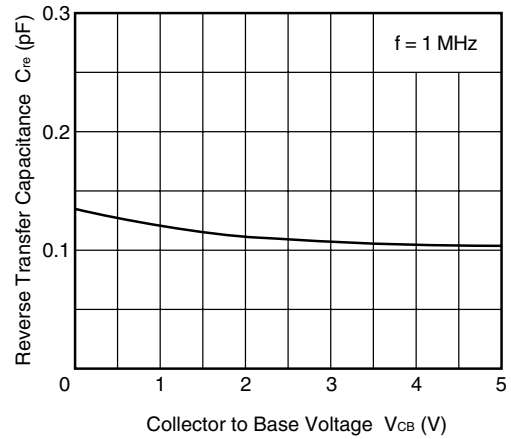
Rank	FB
Marking	zL
h <sub>FE</sub> Value	220 to 380

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

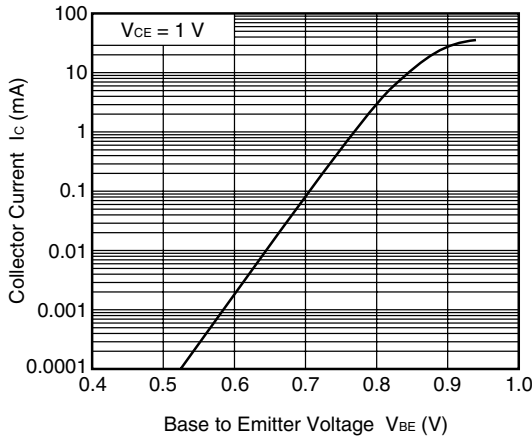
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



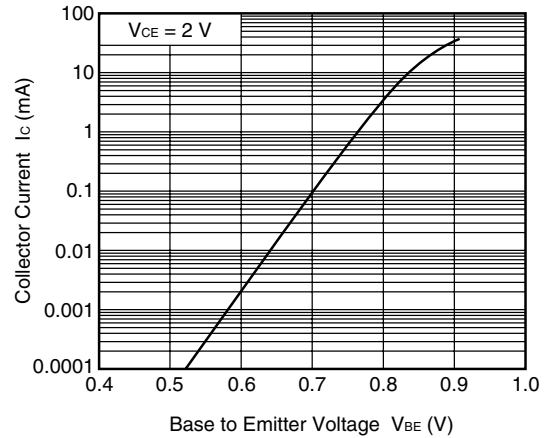
REVERSE TRANSFER CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



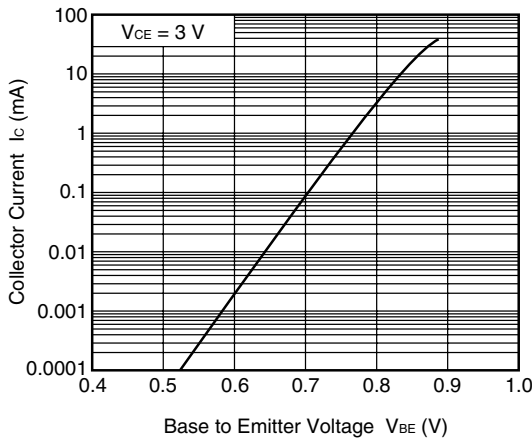
COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



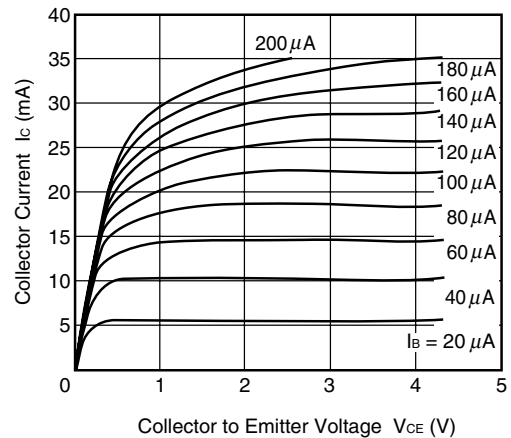
COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE

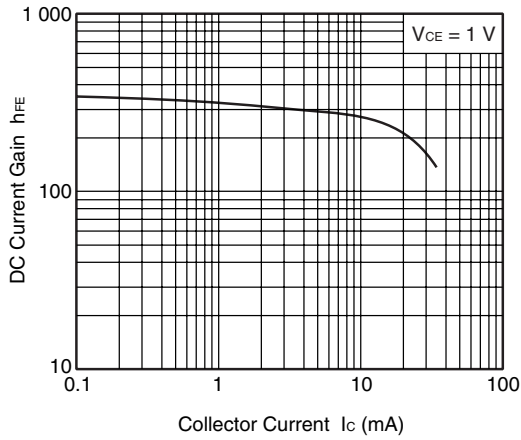


COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE

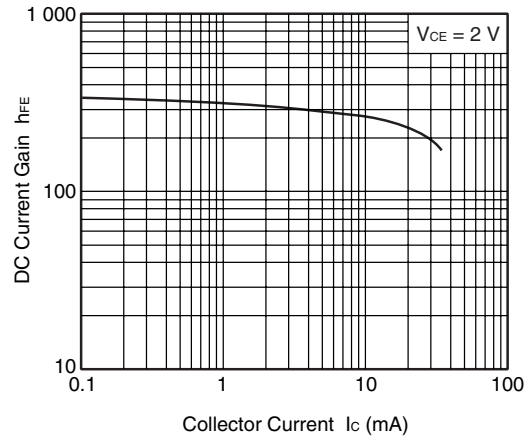


**Remark** The graphs indicate nominal characteristics.

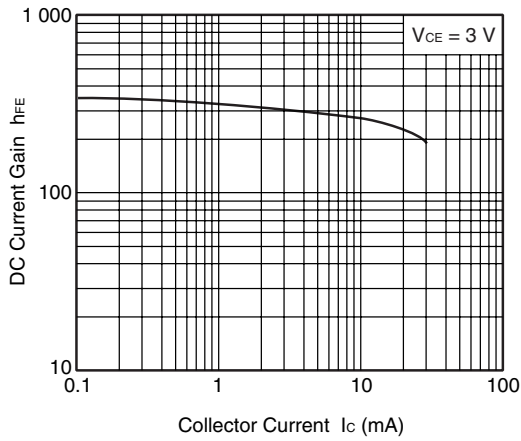
DC CURRENT GAIN vs.  
COLLECTOR CURRENT



DC CURRENT GAIN vs.  
COLLECTOR CURRENT

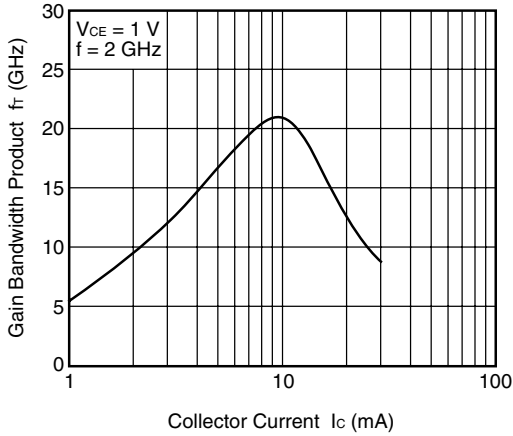


DC CURRENT GAIN vs.  
COLLECTOR CURRENT

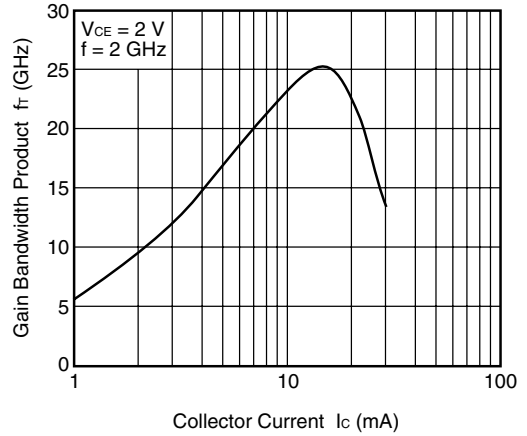


**Remark** The graphs indicate nominal characteristics.

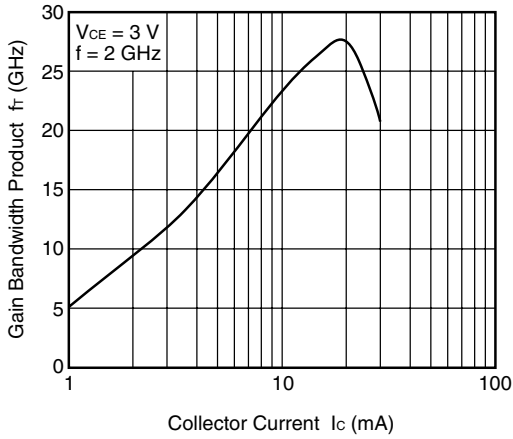
GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



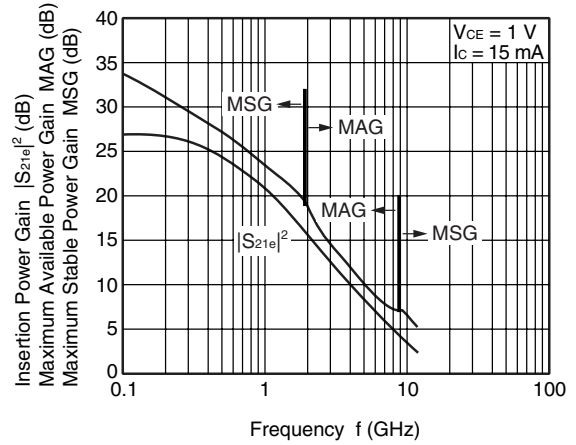
GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



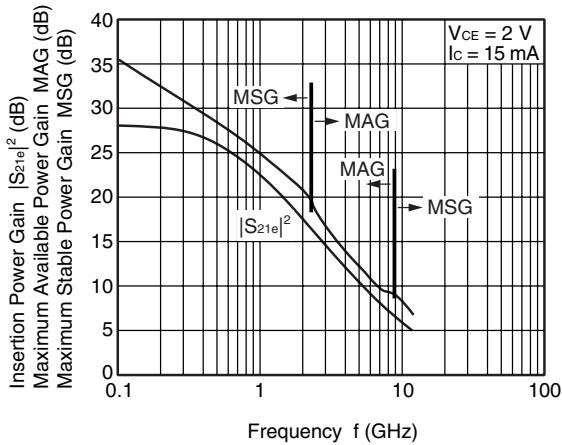
GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



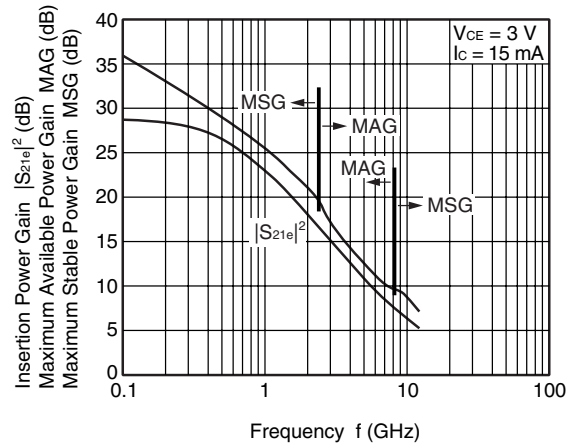
INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY



INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY

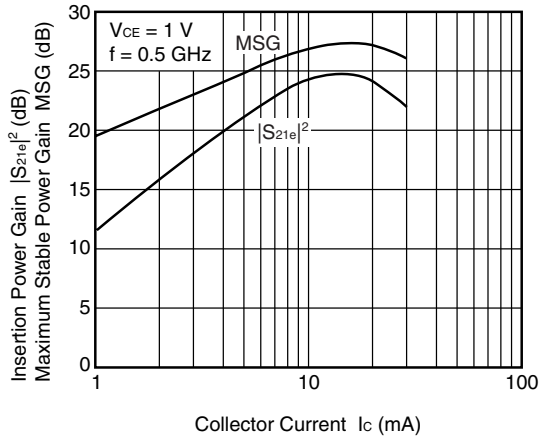


INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY

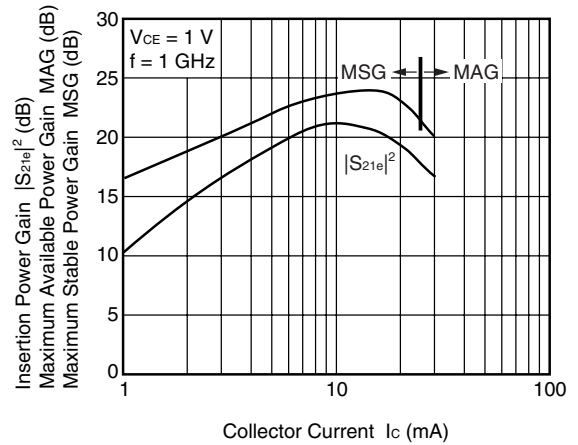


**Remark** The graphs indicate nominal characteristics.

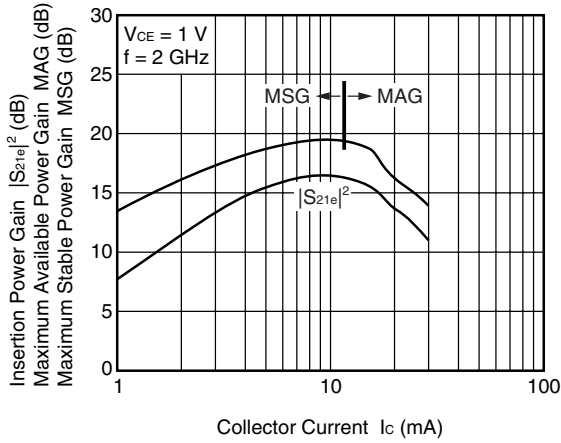
INSERTION POWER GAIN, MSG  
vs. COLLECTOR CURRENT



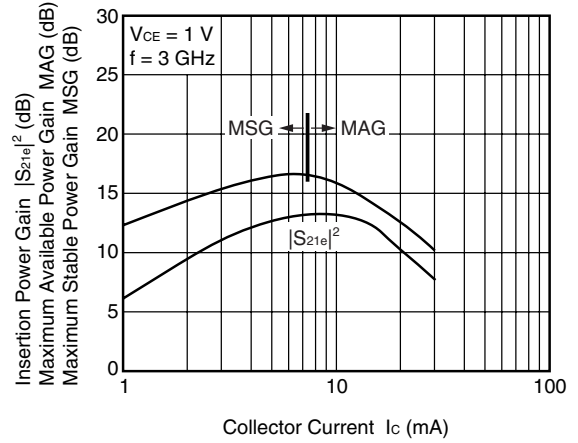
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



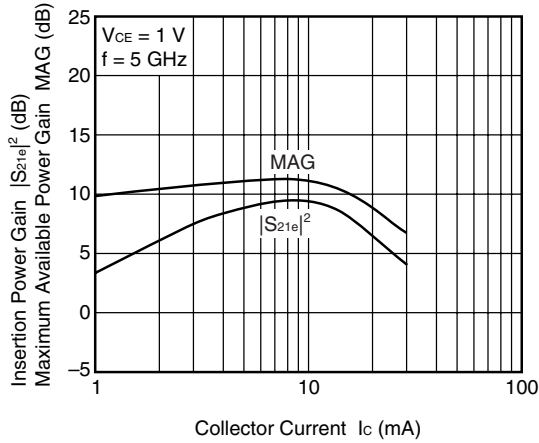
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



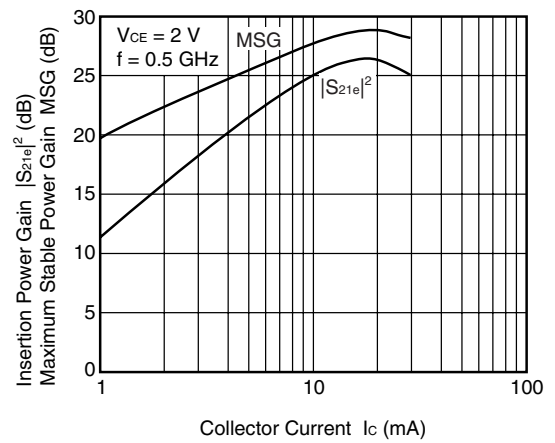
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



INSERTION POWER GAIN, MAG  
vs. COLLECTOR CURRENT

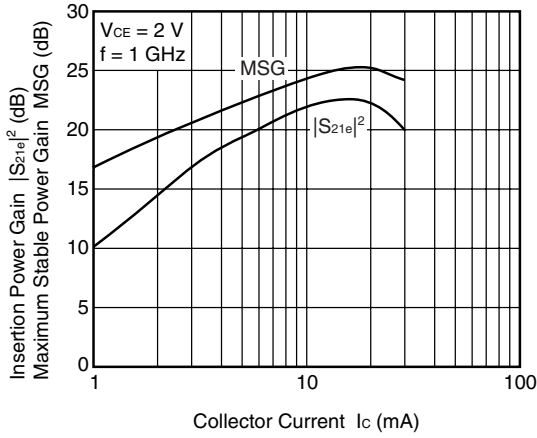


INSERTION POWER GAIN, MSG  
vs. COLLECTOR CURRENT

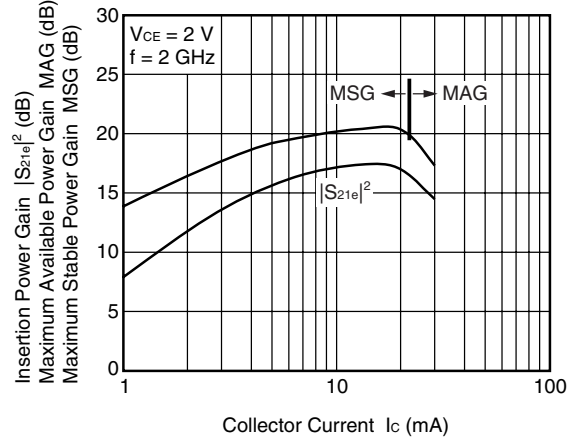


**Remark** The graphs indicate nominal characteristics.

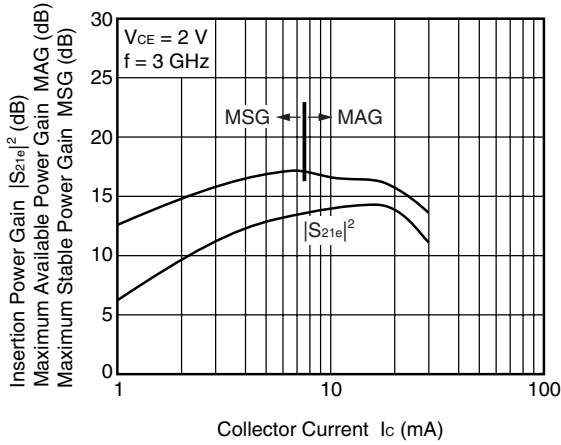
INSERTION POWER GAIN, MSG  
vs. COLLECTOR CURRENT



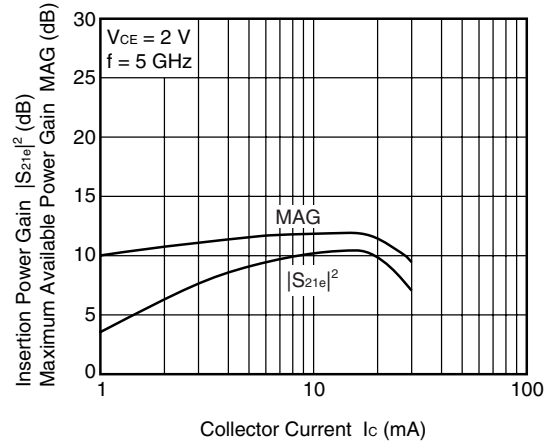
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



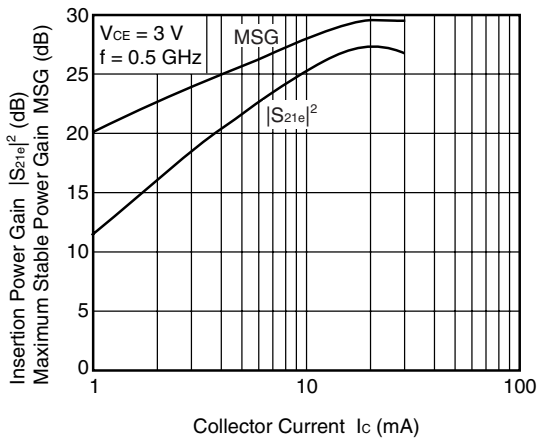
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



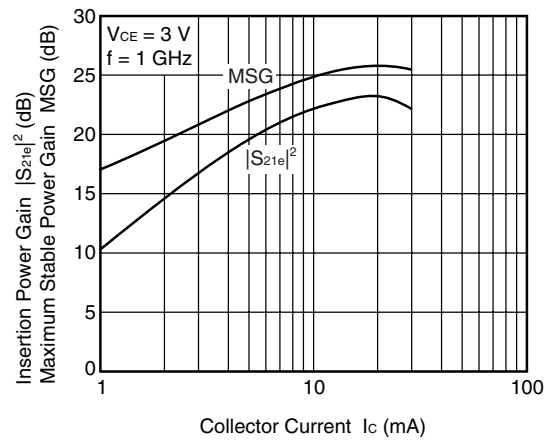
INSERTION POWER GAIN, MAG  
vs. COLLECTOR CURRENT



INSERTION POWER GAIN, MSG  
vs. COLLECTOR CURRENT



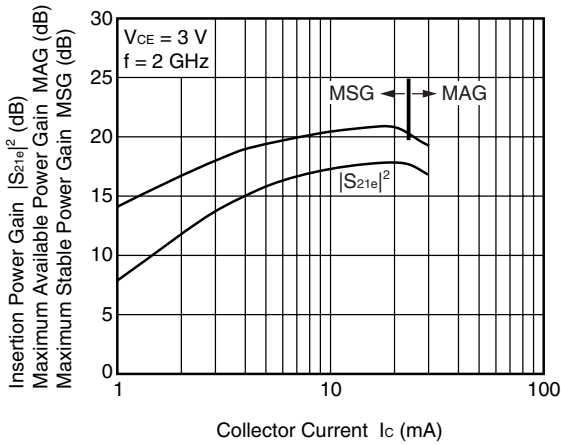
INSERTION POWER GAIN, MSG  
vs. COLLECTOR CURRENT



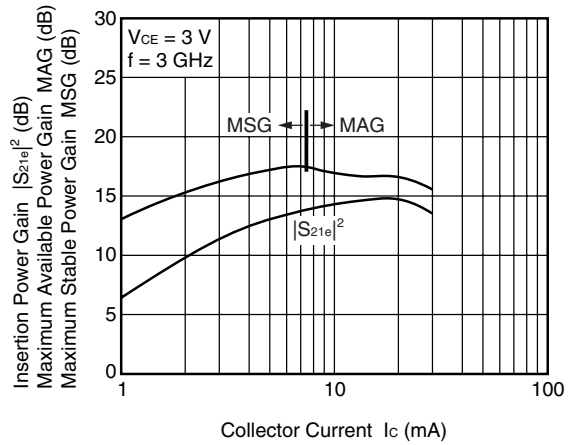
**Remark** The graphs indicate nominal characteristics.



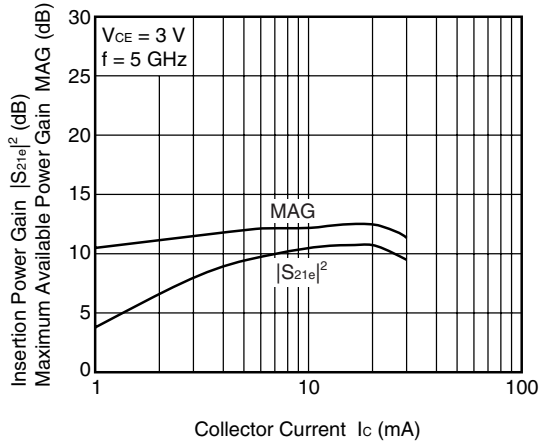
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



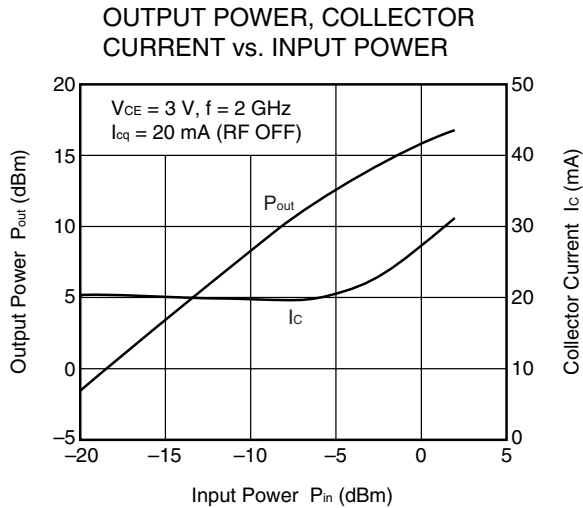
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



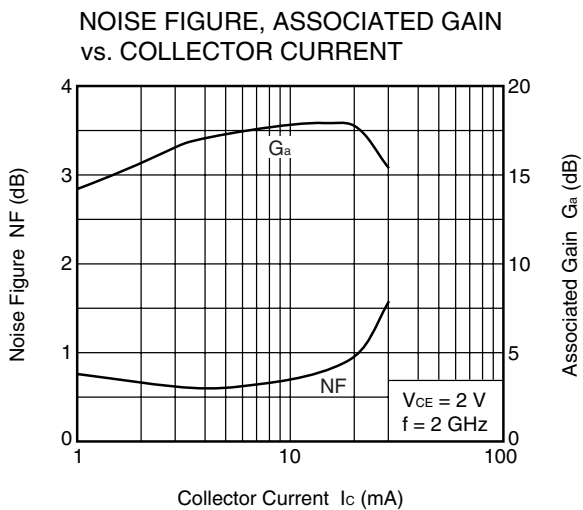
INSERTION POWER GAIN, MAG  
vs. COLLECTOR CURRENT



**Remark** The graphs indicate nominal characteristics.



Measuring method : Measured at power matched with external sleeve tuner. (The load resistance is not inserted between the base DC power supply and Bias Tee.)



**Remark** The graphs indicate nominal characteristics.

<R> **S-PARAMETERS**

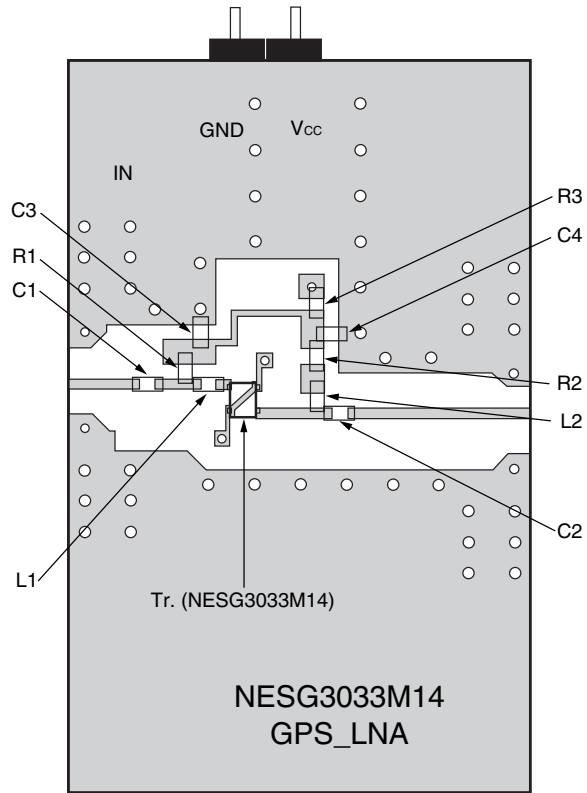
S-parameters/Noise parameters are provided on our web site in a form (S2P) that enables direct import to a microwave circuit simulator without keyboard input.

Click here to download S-parameters.

[RF and Microwave] → [Device Parameters]

URL <http://www.ncsd.necel.com/microwave/index.html>

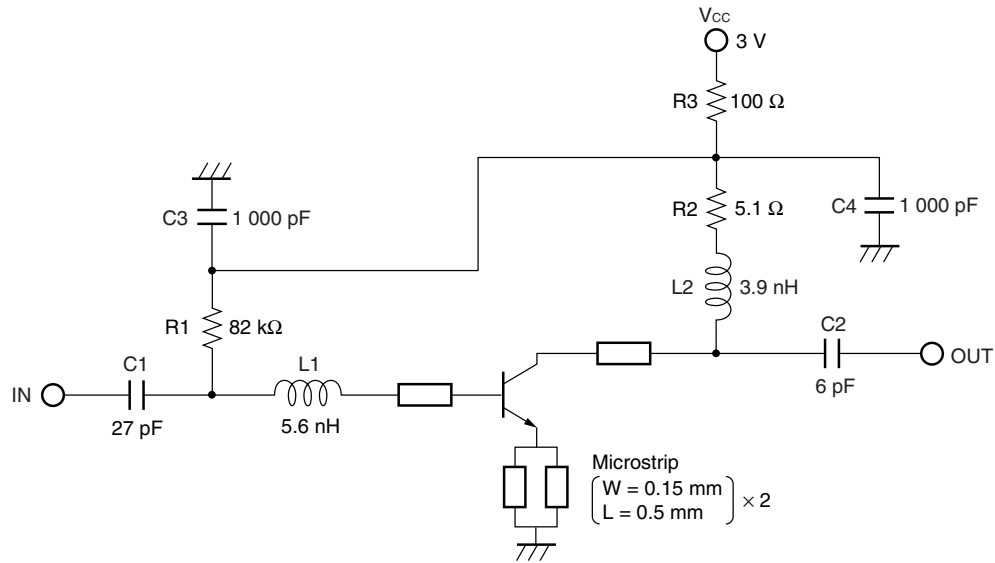
<R> EVALUATION CIRCUIT EXAMPLE (f = 1.575 GHz LNA)



**Notes**

1. 15 × 24 mm, t = 0.2 mm double sided copper clad glass epoxy PWB.
2. Au plated on pattern
3. ○ : Through holes

<R> EVALUATION CIRCUIT (f = 1.575 GHz LNA)



The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.

<R> COMPONENT LIST

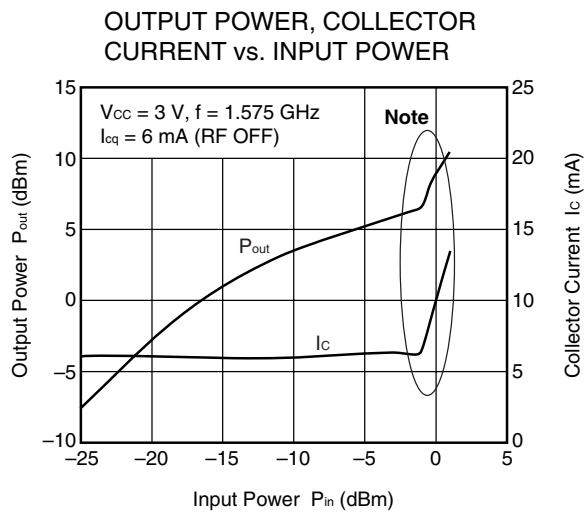
Symbol	Parts	Part Number	Maker	Value
C1	Chip Capacitor	GRM1552C1H270JZ01	Murata	27 pF
C2	Chip Capacitor	GRM1552C1H6R0JZ01	Murata	6 pF
C3, C4	Chip Capacitor	GRM155B11H102KA01	Murata	1 000 pF
L1	Chip Inductor	AML1005H5N6STS	FDK	5.6 nH
L2	Chip Inductor	AML1005H3N9STS	FDK	3.9 nH
R1	Chip Resistor	MCR01MZPJ823	ROHM	82 kΩ
R2	Chip Resistor	MCR01MZPJ5R1	ROHM	5.1 Ω
R3	Chip Resistor	MCR01MZPJ101	ROHM	100 Ω

<R> EXAMPLE OF CHARACTERISTICS FOR 1.575 GHz LNA EVALUATION BOARD

ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = +25°C, V<sub>CC</sub> = 3 V, I<sub>c</sub> = 6.1 mA, f = 1.575 GHz)

Parameter	Symbol	Value	Unit
Noise Figure	NF	0.65	dB
Gain	G <sub>a</sub>	17.4	dB
Input Return Loss	RL <sub>in</sub>	10.1	dB
Output Return Loss	RL <sub>out</sub>	14.4	dB
Gain 1 dB Compression Output Power	P <sub>O (1 dB)</sub>	0.7	dBm

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

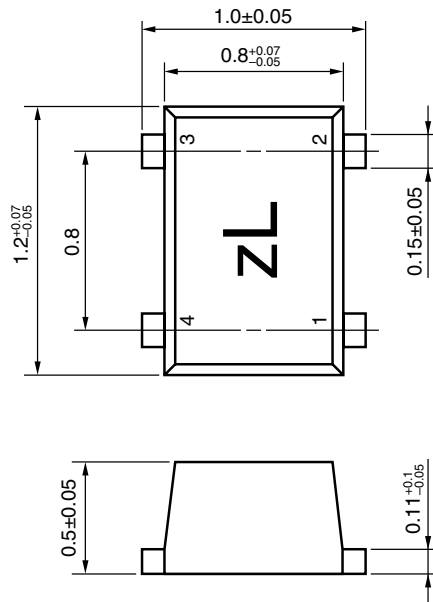


**Note** A current increase is seen because the ESD protection element is turned on. However, there is no influence of deterioration etc. on reliability.

**Remark** The graph indicates nominal characteristics.

PACKAGE DIMENSIONS

4-PIN LEAD-LESS MINIMOLD (M14, 1208 PKG) (UNIT: mm)



PIN CONNECTIONS

- 1. Collector
- 2. Emitter
- 3. Base
- 4. NC (Connected with Pin 2) <sup>Note</sup>

<R> **Note** A NC pin is Non-connection in the mold package (When NC-pin is open state, It will get an influences of floating capacitance. Therefore, we recommend connect to NC pin and Emitter pin).

• **The information in this document is current as of May, 2007. The information is subject to change without notice. For actual design-in, refer to the latest publications of NEC Electronics data sheets or data books, etc., for the most up-to-date specifications of NEC Electronics products. Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.**

• No part of this document may be copied or reproduced in any form or by any means without the prior written consent of NEC Electronics. NEC Electronics assumes no responsibility for any errors that may appear in this document.

• NEC Electronics does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from the use of NEC Electronics products listed in this document or any other liability arising from the use of such products. No license, express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC Electronics or others.

• Descriptions of circuits, software and other related information in this document are provided for illustrative purposes in semiconductor product operation and application examples. The incorporation of these circuits, software and information in the design of a customer's equipment shall be done under the full responsibility of the customer. NEC Electronics assumes no responsibility for any losses incurred by customers or third parties arising from the use of these circuits, software and information.

• While NEC Electronics endeavors to enhance the quality, reliability and safety of NEC Electronics products, customers agree and acknowledge that the possibility of defects thereof cannot be eliminated entirely. To minimize risks of damage to property or injury (including death) to persons arising from defects in NEC Electronics products, customers must incorporate sufficient safety measures in their design, such as redundancy, fire-containment and anti-failure features.

• NEC Electronics products are classified into the following three quality grades: "Standard", "Special" and "Specific".

The "Specific" quality grade applies only to NEC Electronics products developed based on a customer-designated "quality assurance program" for a specific application. The recommended applications of an NEC Electronics product depend on its quality grade, as indicated below. Customers must check the quality grade of each NEC Electronics product before using it in a particular application.

"Standard": Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots.

"Special": Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support).

"Specific": Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc.

The quality grade of NEC Electronics products is "Standard" unless otherwise expressly specified in NEC Electronics data sheets or data books, etc. If customers wish to use NEC Electronics products in applications not intended by NEC Electronics, they must contact an NEC Electronics sales representative in advance to determine NEC Electronics' willingness to support a given application.

(Note)

(1) "NEC Electronics" as used in this statement means NEC Electronics Corporation and also includes its majority-owned subsidiaries.

(2) "NEC Electronics products" means any product developed or manufactured by or for NEC Electronics (as defined above).