

5 GHz Low Noise Amplifier with Bypass function

■ FEATURES

- Operating frequency $f = 4900$ to 5925 MHz
 - Operating voltage 2.5 to 5.5 V
- [LNA active mode]
- High gain 16 dB typ.
 - Low noise figure 0.95 dB typ.
 - High IIP3 $+9$ dBm typ.
 - Small package size $1.6 \times 1.6 \times 0.397$ mm³ typ.
 - RoHS compliant and Halogen Free, MSL1

■ APPLICATION

- LTE advanced in unlicensed spectrum (LTE-U/LAA)
- WLAN (IEEE 802.11 a/n/ac/ax)
- Small cell, CPE
- Access points, routers, gateways
- Wireless routers
- 5 GHz ISM radios

■ GENERAL DESCRIPTION

The NJG1175KG1 is a low noise amplifier for wireless receiver applications in the 4900 MHz to 5925 MHz. This LNA has a LNA pass-through function to select LNA active mode or bypass mode.

The NJG1175KG1 achieves High linearity, Low distortion, high gain, and low noise figure.

Integrated ESD protection device on each port achieves excellent ESD robustness.

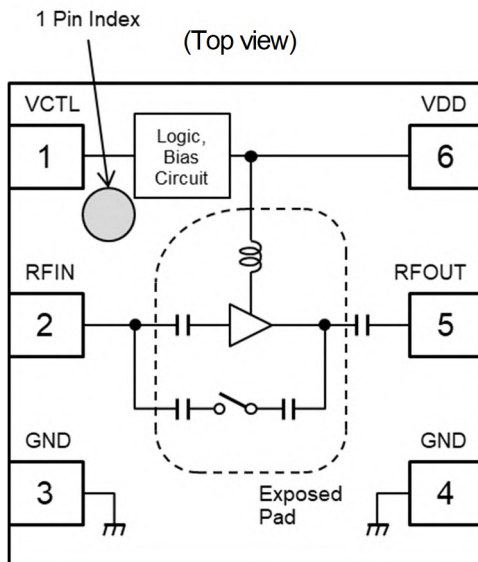
The small and thin ESON6-G1 package is adopted.

■ TRUTH TABLE

“H”= $V_{CTL(H)}$, “L”= $V_{CTL(L)}$

V_{CTL}	Mode
L	Bypass mode
H	LNA Active mode

■ BLOCK DIAGRAM (ESON6-G1)



■ PIN CONFIGURATION

PIN NO.	SYMBOL	DESCRIPTION
1	VCTL	Control signal input terminal
2	RFIN	RF input terminal
3	GND	Ground terminal
4	GND	Ground terminal
5	RFOUT	RF output terminal
6	VDD	Operating voltage supply terminal
Exposed pad	GND	Ground terminal

■ PRODUCT NAME INFORMATION



■ ORDERING INFORMATION

PART NUMBER	PACKAGE OUTLINE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs.)
NJG1175KG1	ESON6-G1	Yes	Yes	Sn-Bi	1175	3.5	3,000

■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNIT
RF Input Power ⁽¹⁾	P_{IN}	+15	dBm
Supply Voltage ⁽²⁾	V_{DD}	6.0	V
Control Voltage ⁽³⁾	V_{CTL}	6.0	V
Power Dissipation ⁽⁴⁾	P_D	1200	mW
Operating Temperature	T_{opr}	-40 to +105	°C
Storage Temperature	T_{stg}	-55 to +150	°C

(1): $V_{DD} = 3.3$ V

(2): VDD port

(3): VCTL port

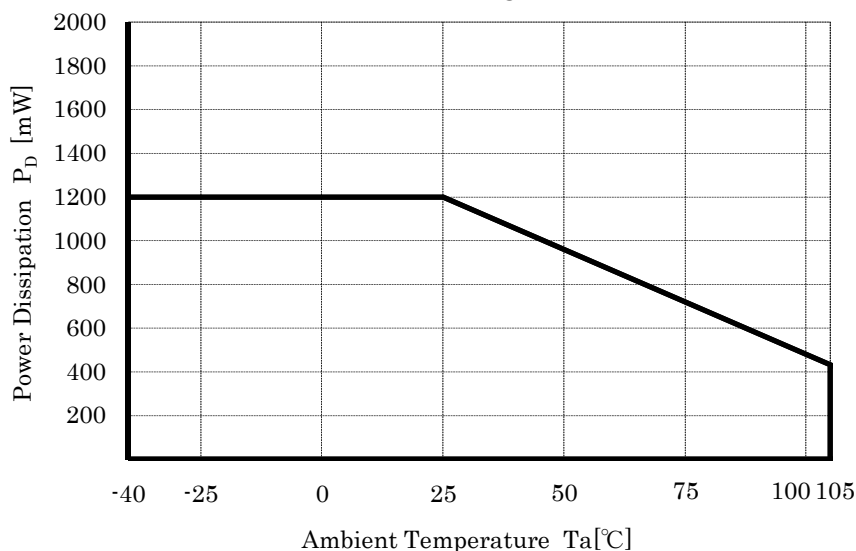
(4): Mounted on four-layer FR4 PCB with through-hole (101.5 × 114.5 mm), $T_j = 150^\circ\text{C}$

■ POWER DISSIPATION VS. AMBIENT TEMPERATURE

Please, refer to the following Power Dissipation and Ambient Temperature.

(Please note the surface mount package has a small maximum rating of Power Dissipation [P_D], a special attention should be paid in designing of thermal radiation.)

Power Dissipation—Ambient Temperature Characteristic
Mounted on PCB



RECOMMENDED OPERATING CONDITIONS

$T_a = 25^\circ\text{C}$

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD}	2.5	3.3	5.5	V
Control Voltage (HIGH)	$V_{CTL(H)}$	1.3	3.3	5.5	V
Control Voltage (LOW)	$V_{CTL(L)}$	0	0	0.3	V

ELECTRICAL CHARACTERISTICS 1 (DC CHARACTERISTICS)

$T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50\ \Omega$, with application circuit

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current 1 (LNA active mode)	I_{DD1}	RF OFF, $V_{DD} = 3.3\ \text{V}$, $V_{CTL} = 3.3\ \text{V}$	-	13	18	mA
Operating Current 2 (Bypass mode)	I_{DD2}	RF OFF, $V_{DD} = 3.3\ \text{V}$, $V_{CTL} = 0\ \text{V}$	-	20	100	μA
Control Current	I_{CTL}	RF OFF, $V_{CTL} = 3.3\ \text{V}$	-	25	50	μA

ELECTRICAL CHARACTERISTICS 2 (RF CHARACTERISTICS: LNA active mode)

$f_{RF} = 4900\ \text{to}\ 5925\ \text{MHz}$, $V_{DD} = 3.3\ \text{V}$, $V_{CTL} = 3.3\ \text{V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50\ \Omega$, with application circuit

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Small signal gain	Gain	Exclude PCB and connector losses *1	12	16	-	dB
Noise figure	NF	Exclude PCB and connector losses *2	-	0.95	1.6	dB
Input power at 1 dB gain compression point 1	P-1dB(IN)1		-14	-5	-	dBm
Input 3 rd order intercept point 1	IIP3_1	$f_1 = f_{RF}$, $f_2 = f_{RF} + 1\ \text{MHz}$, $P_{IN} = -30\ \text{dBm}$	-3	+9	-	dBm
RF IN return loss 1	RLi1		6	13	-	dB
RF OUT return loss 1	RLo1		6	18	-	dB
Gain settling time 1	T_{s1}	Bypass to LNA active mode, To be within 1 dB of the final gain	-	0.5	2	μs
Gain settling time 2	T_{s2}	LNA active to bypass mode, To be within 1 dB of the final insertion loss	-	1	2	μs

*1: PCB and connector losses: 0.60 dB @ 4900 MHz, 0.64 dB @ 5500 MHz, 0.69 dB @ 5925 MHz

*2: PCB and connector losses: 0.27 dB @ 4900 MHz, 0.30 dB @ 5500 MHz, 0.31 dB @ 5925 MHz

ELECTRICAL CHARACTERISTICS 3 (RF CHARACTERISTICS: Bypass mode)

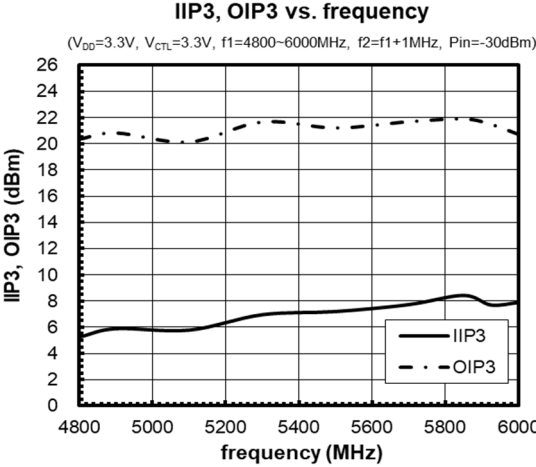
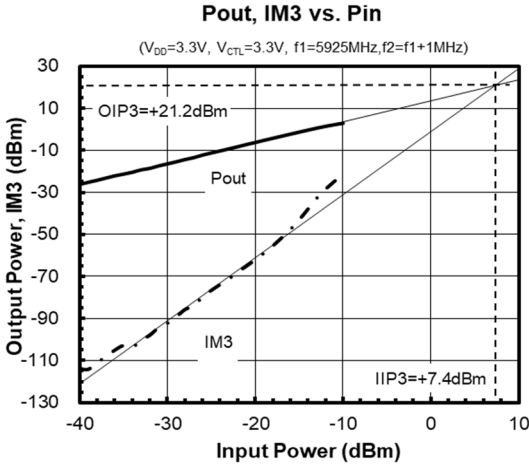
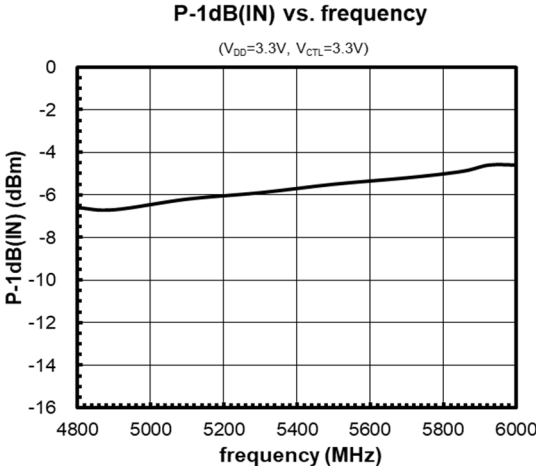
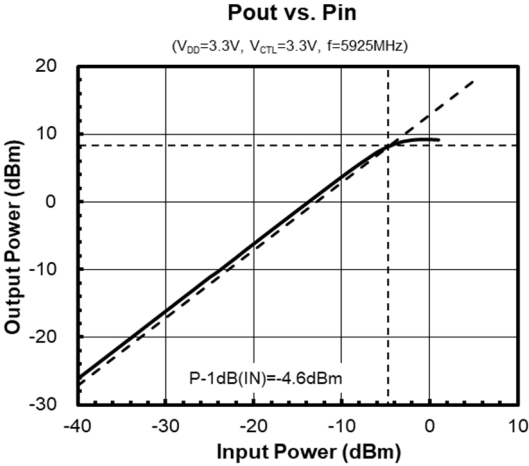
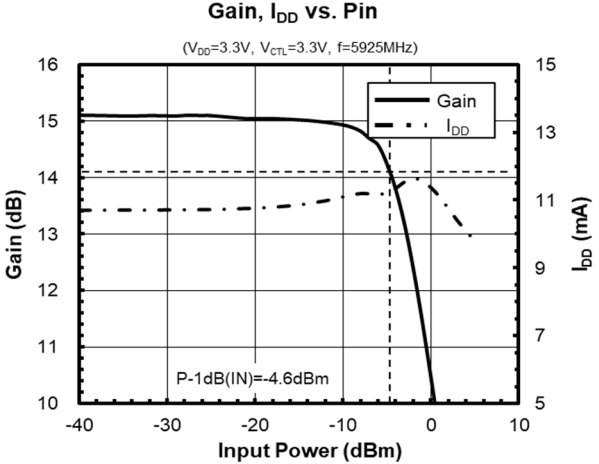
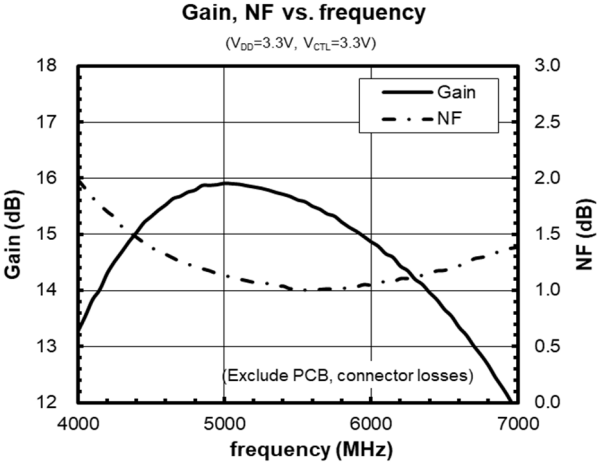
$f_{RF} = 4900\ \text{to}\ 5925\ \text{MHz}$, $V_{DD} = 3.3\ \text{V}$, $V_{CTL} = 0\ \text{V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50\ \Omega$, with application circuit

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Insertion loss	Loss	Exclude PCB and connector losses *1	-	5.5	9	dB
Input power at 1 dB gain compression point 2	P-1dB(IN)2		0	+9	-	dBm
Input 3 rd order intercept point 2	IIP3_2	$f_1 = f_{RF}$, $f_2 = f_{RF} + 1\ \text{MHz}$, $P_{IN} = -15\ \text{dBm}$	0	+14	-	dBm
RF IN return loss 2	RLi2		4	10	-	dB
RF OUT return loss 2	RLo2		4	11	-	dB

*1: PCB and connector losses: 0.60 dB @ 4900 MHz, 0.64 dB @ 5500 MHz, 0.69 dB @ 5925 MHz

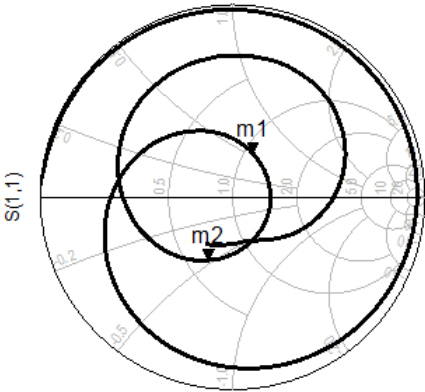
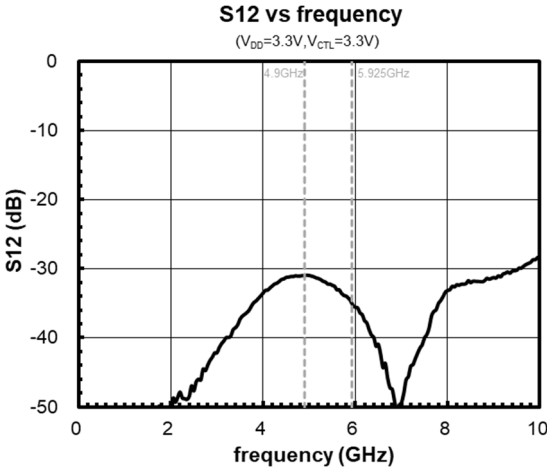
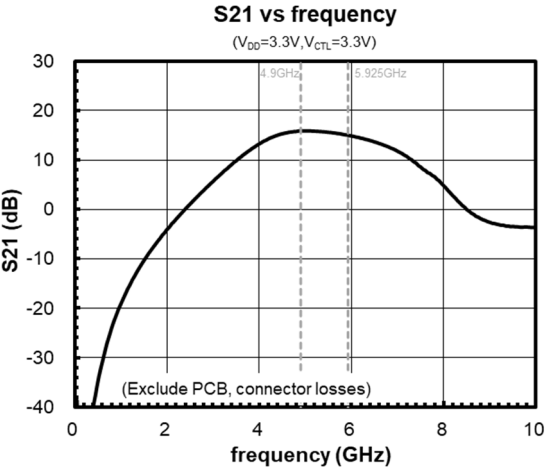
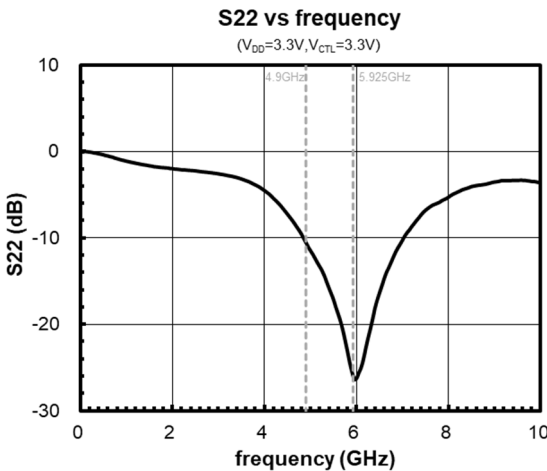
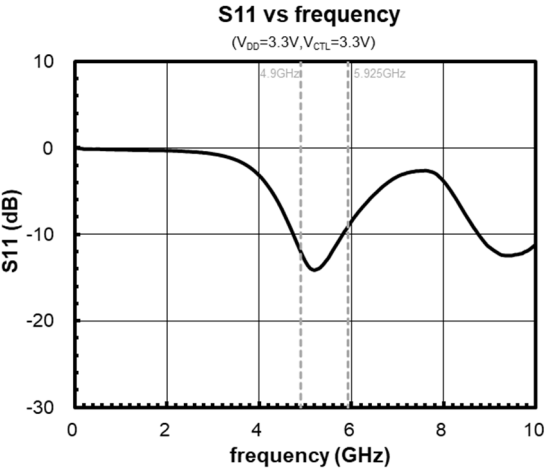
■ ELECTRICAL CHARACTERISTICS (LNA active mode)

$V_{DD} = 3.3\text{ V}$, $V_{CTL} = 3.3\text{ V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50\ \Omega$, with application circuit



■ ELECTRICAL CHARACTERISTICS (LNA active mode)

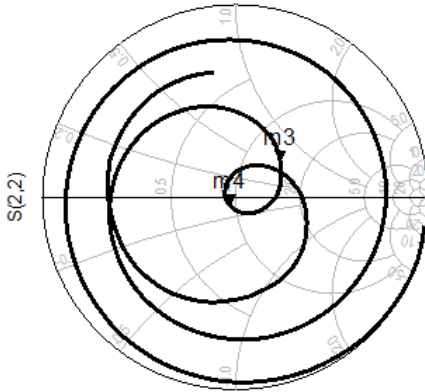
$V_{DD} = 3.3\text{ V}$, $V_{CTL} = 3.3\text{ V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50\ \Omega$, with application circuit



freq (50.00MHz to 10.00GHz)

m1
freq=4.900GHz
$S(1,1)=0.251 / 65.532$
impedance = $Z_0 * (1.096 + j0.533)$
m2
freq=5.925GHz
$S(1,1)=0.351 / -111.177$
impedance = $Z_0 * (0.637 - j0.476)$

Zin



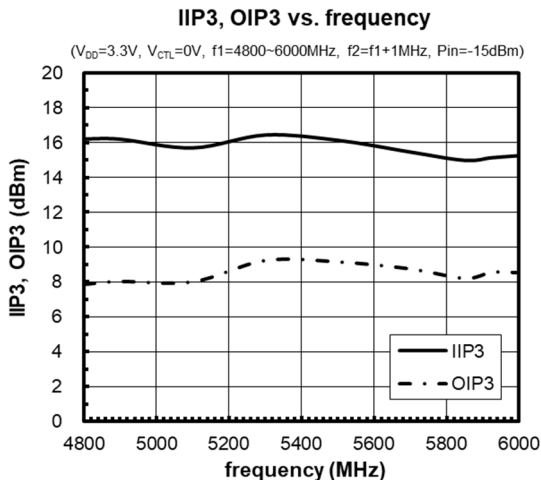
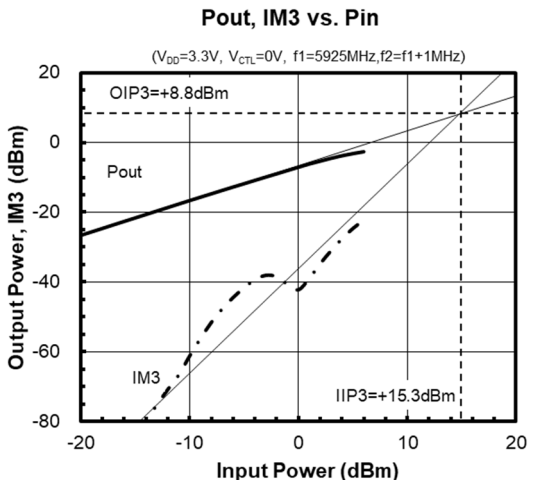
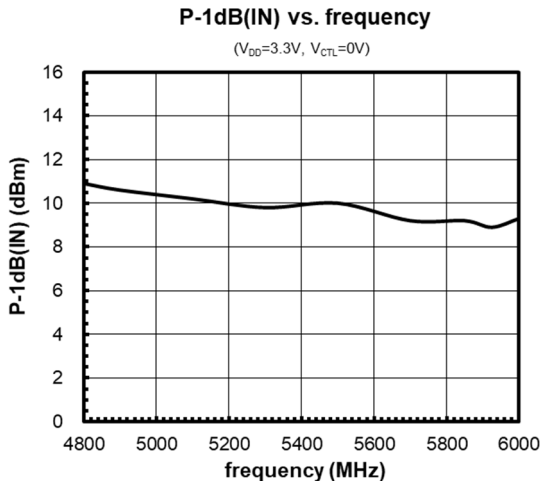
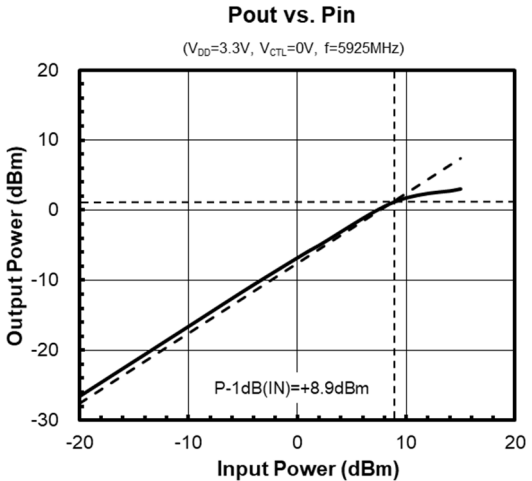
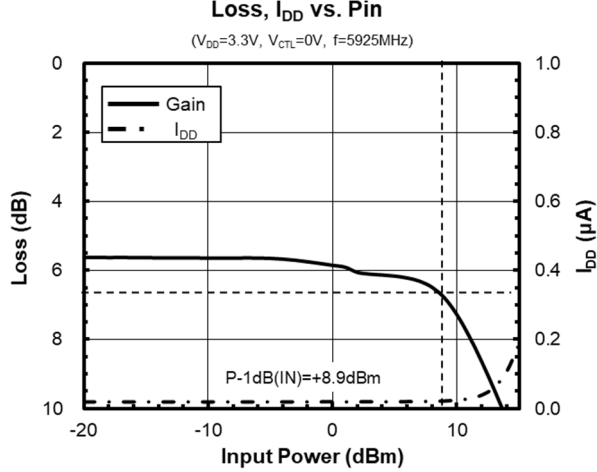
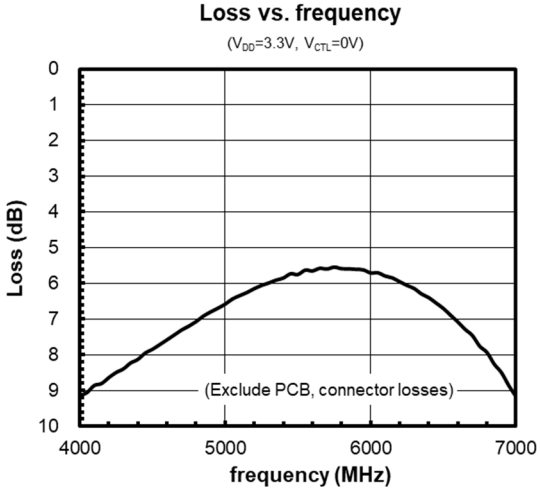
freq (50.00MHz to 10.00GHz)

m3
freq=4.900GHz
$S(2,2)=0.298 / 38.736$
impedance = $Z_0 * (1.460 + j0.597)$
m4
freq=5.925GHz
$S(2,2)=0.051 / -125.265$
impedance = $Z_0 * (0.940 - j0.078)$

Zout

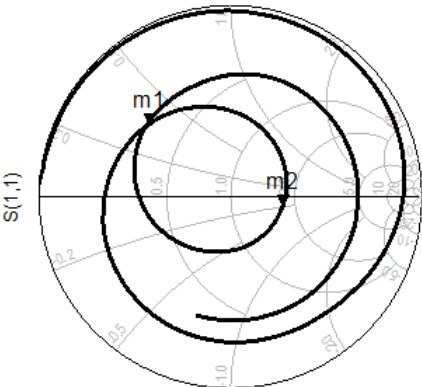
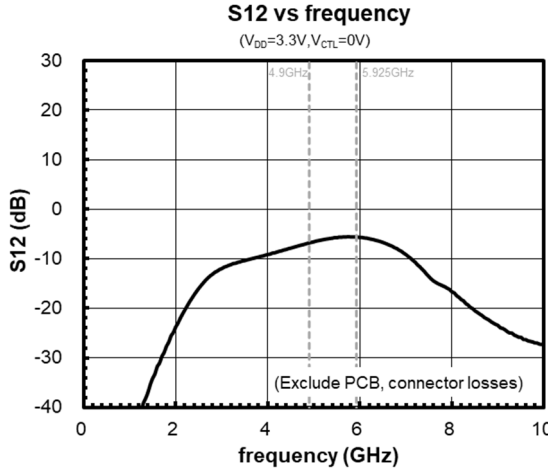
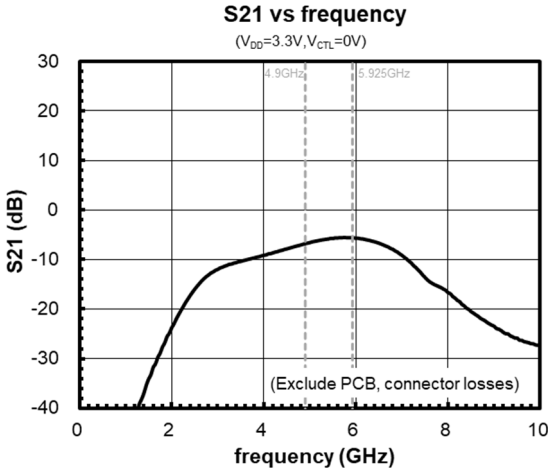
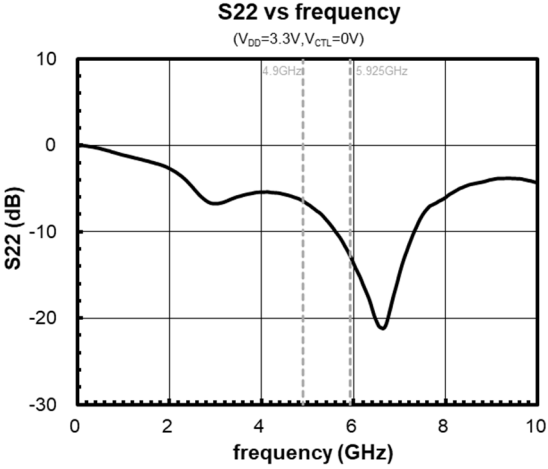
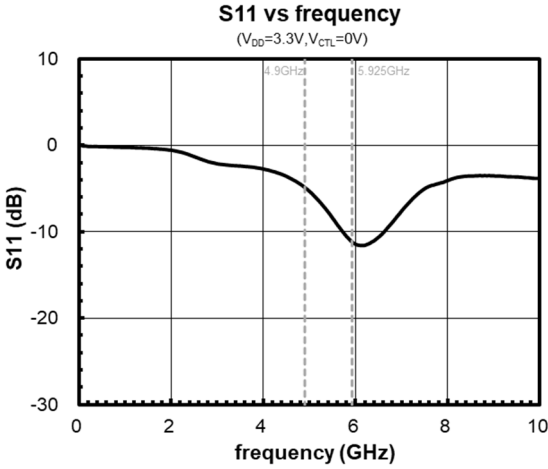
■ **ELECTRICAL CHARACTERISTICS (Bypass mode)**

$V_{DD} = 3.3\text{ V}$, $V_{CTL} = 0\text{ V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50\ \Omega$, with application circuit



■ **ELECTRICAL CHARACTERISTICS (Bypass mode)**

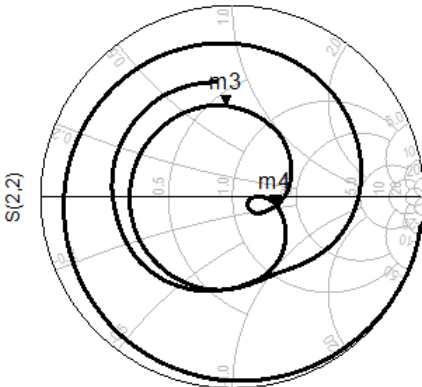
$V_{DD} = 3.3\text{ V}$, $V_{CTL} = 0\text{ V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50\ \Omega$, with application circuit



freq (50.00MHz to 10.00GHz)

m1
freq=4.900GHz
S(1,1)=0.569 / 138.320
impedance = $Z_0 * (0.311 + j0.348)$
m2
freq=5.925GHz
S(1,1)=0.276 / -10.176
impedance = $Z_0 * (1.734 - j0.183)$

Zin



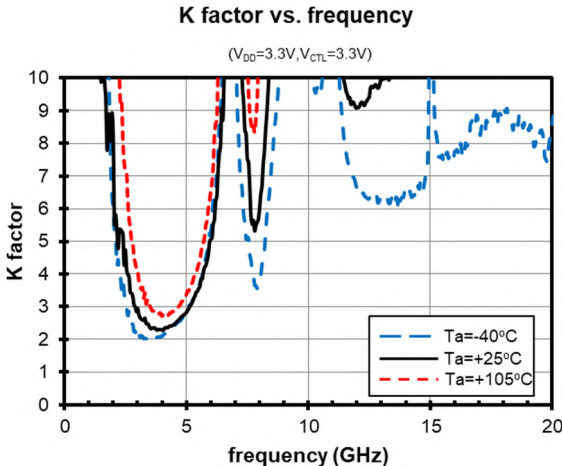
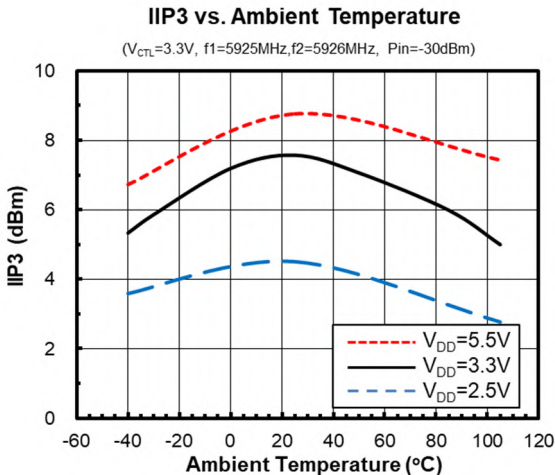
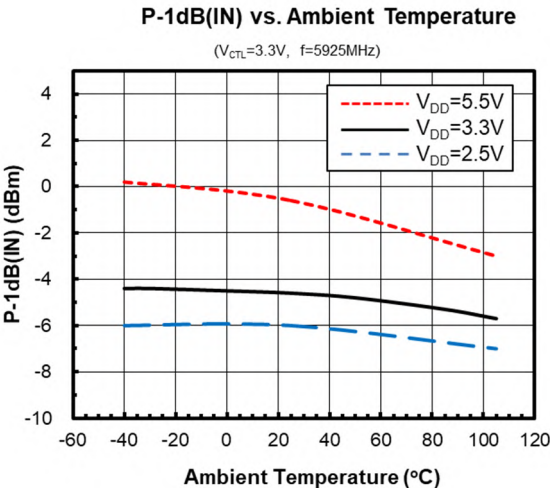
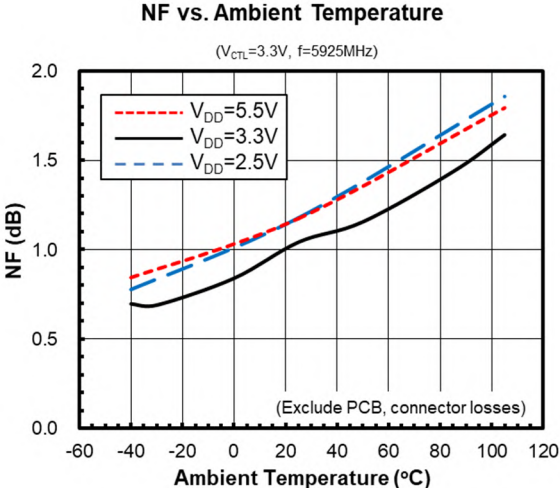
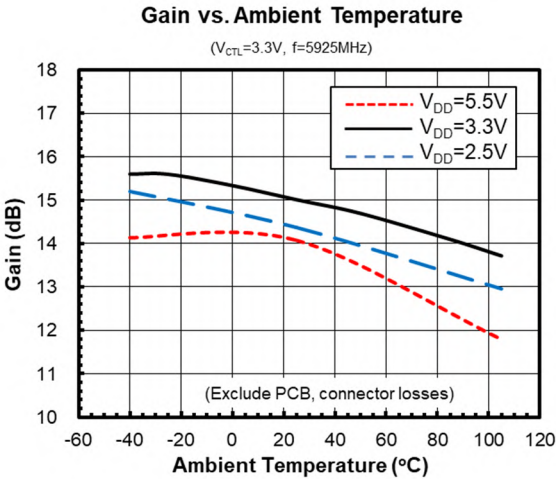
freq (50.00MHz to 10.00GHz)

m3
freq=4.900GHz
S(2,2)=0.477 / 94.048
impedance = $Z_0 * (0.597 + j0.735)$
m4
freq=5.925GHz
S(2,2)=0.229 / -12.445
impedance = $Z_0 * (1.567 - j0.163)$

Zout

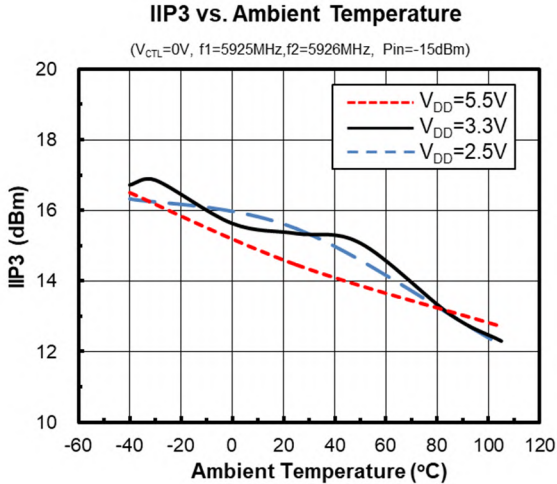
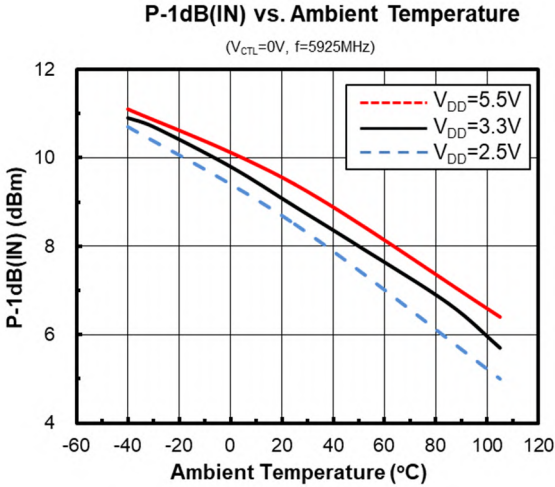
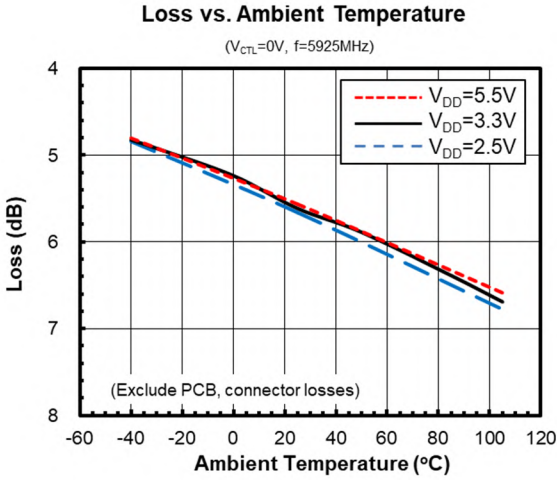
■ ELECTRICAL CHARACTERISTICS (LNA active mode)

$V_{CTL} = 3.3\text{ V}$, $Z_s = Z_l = 50\ \Omega$, with application circuit



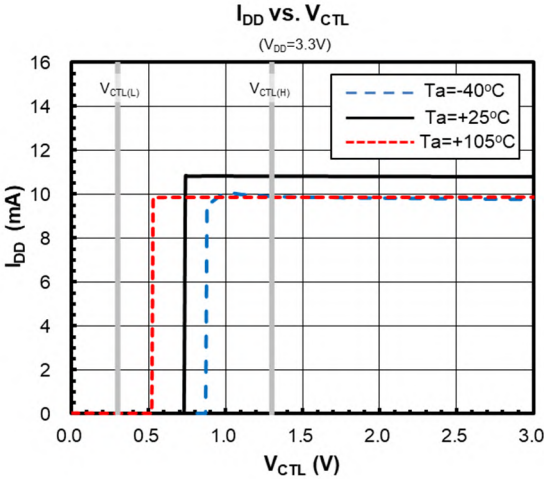
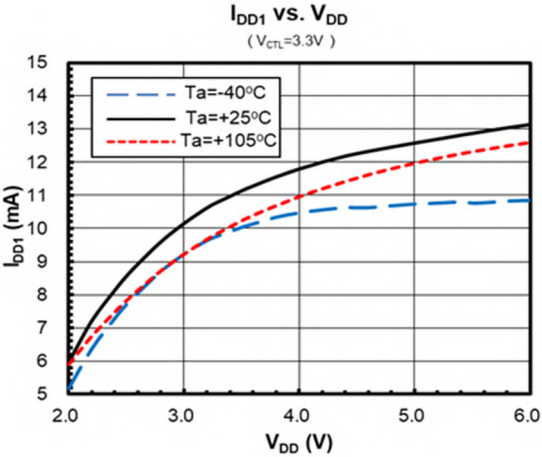
■ **ELECTRICAL CHARACTERISTICS (Bypass mode)**

$V_{CTL} = 0\text{ V}$, $Z_s = Z_l = 50\ \Omega$, with application circuit

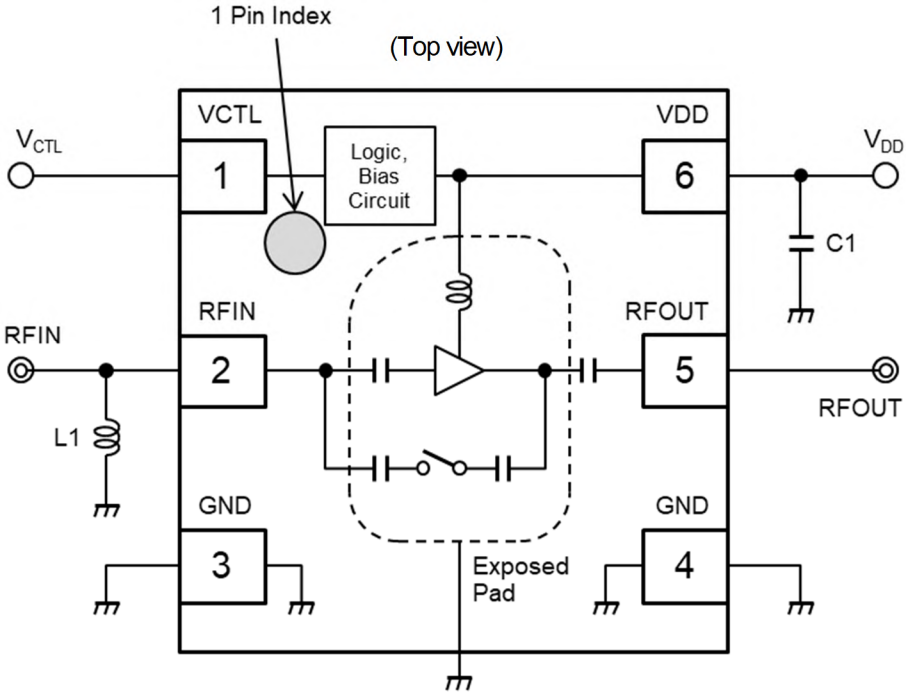


■ **ELECTRICAL CHARACTERISTICS (DC)**

$Z_s = Z_l = 50\ \Omega$, with application circuit



■ APPLICATION CIRCUIT

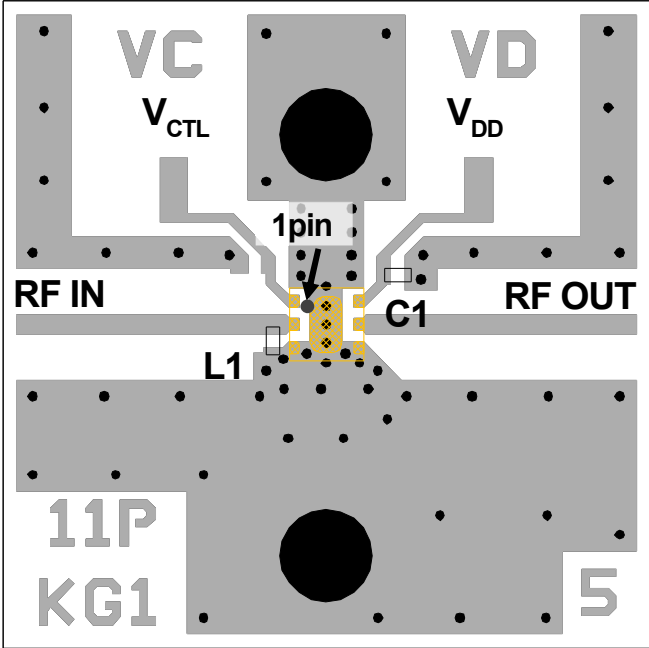


<PARTS LIST>

Part ID	Value	Notes
L1	1.3 nH	LQP03TN_02 Series (MURATA)
C1	1000 pF	GRM03 Series (MURATA)

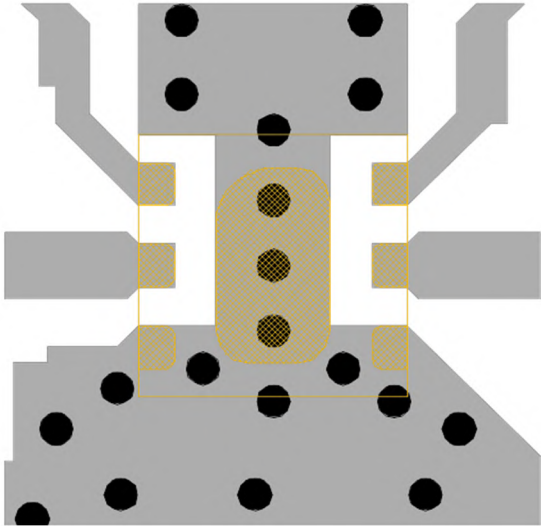
■ EVALUATION BOARD-PCB LAYOUT





(Top view)



PCB Information
 Substrate: FR-4
 Thickness: 0.2mm
 Microstrip line width: 0.4mm ($Z_0=50\Omega$)
 Size: 14.0mm x 14.0mm

<PCB LAYOUT GUIDELINE>



-  PCB
-  PKG Terminal
-  PKG Outline
-  GND Via Hole
Diameter $\phi = 0.2 \text{ mm}$

PRECAUTIONS

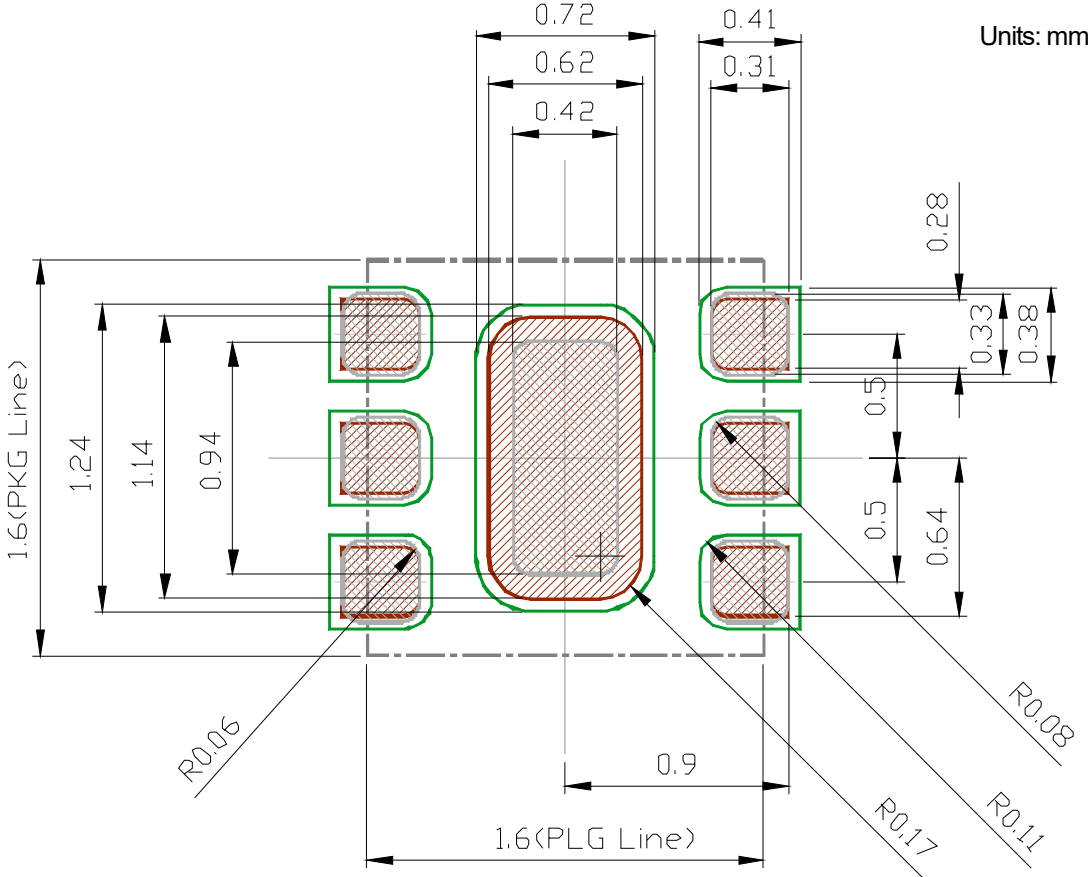
- All external parts should be placed as close as possible to the IC.
- For good RF performance, all GND terminals (include the exposed pad) must be connected to PCB ground plane of substrate, and via-holes for GND should be placed near the IC.

RECOMMENDED FOOTPRINT PATTERN (ESON6-G1)

PKG: 1.6 mm x 1.6 mm

Pin pitch: 0.5 mm

- Land
- Mask (Open area) *Metal mask thickness : 100μm
- Resist (Open area)



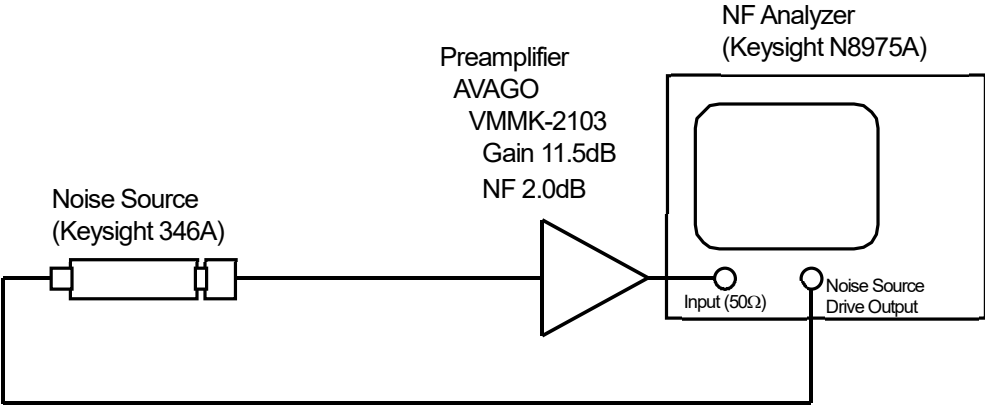
■ NOISE FIGURE MEASUREMENT BLOCK DIAGRAM

Measuring instruments

NF Analyzer : Keysight N8975A
Noise Source : Keysight 346A

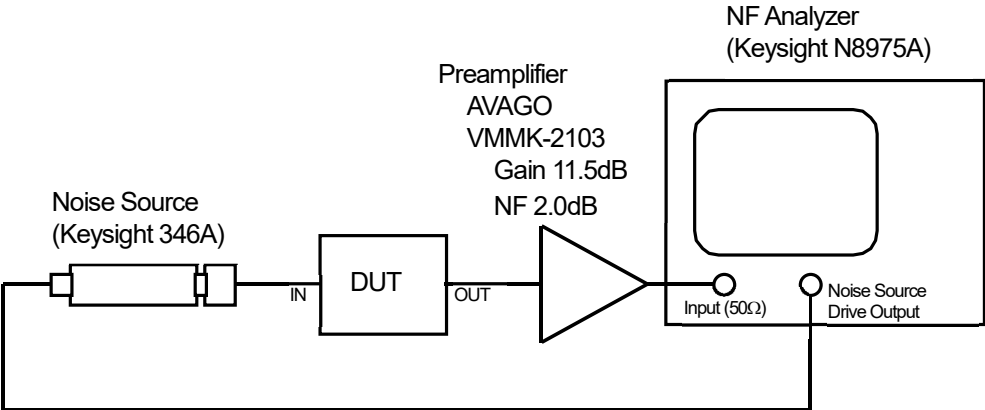
Setting the NF analyzer

Measurement mode form
Device under test : Amplifier
System downconverter : off
Mode setup form
Sideband : LSB
Averages : 8
Average mode : Point
Bandwidth : 4MHz
Loss comp : off
Tcold : setting the temperature of noise source (305.15K)



* Pre-amplifier is used to improve NF measurement accuracy.
* Noise source, pre-amplifier and NF analyzer are connected directly.

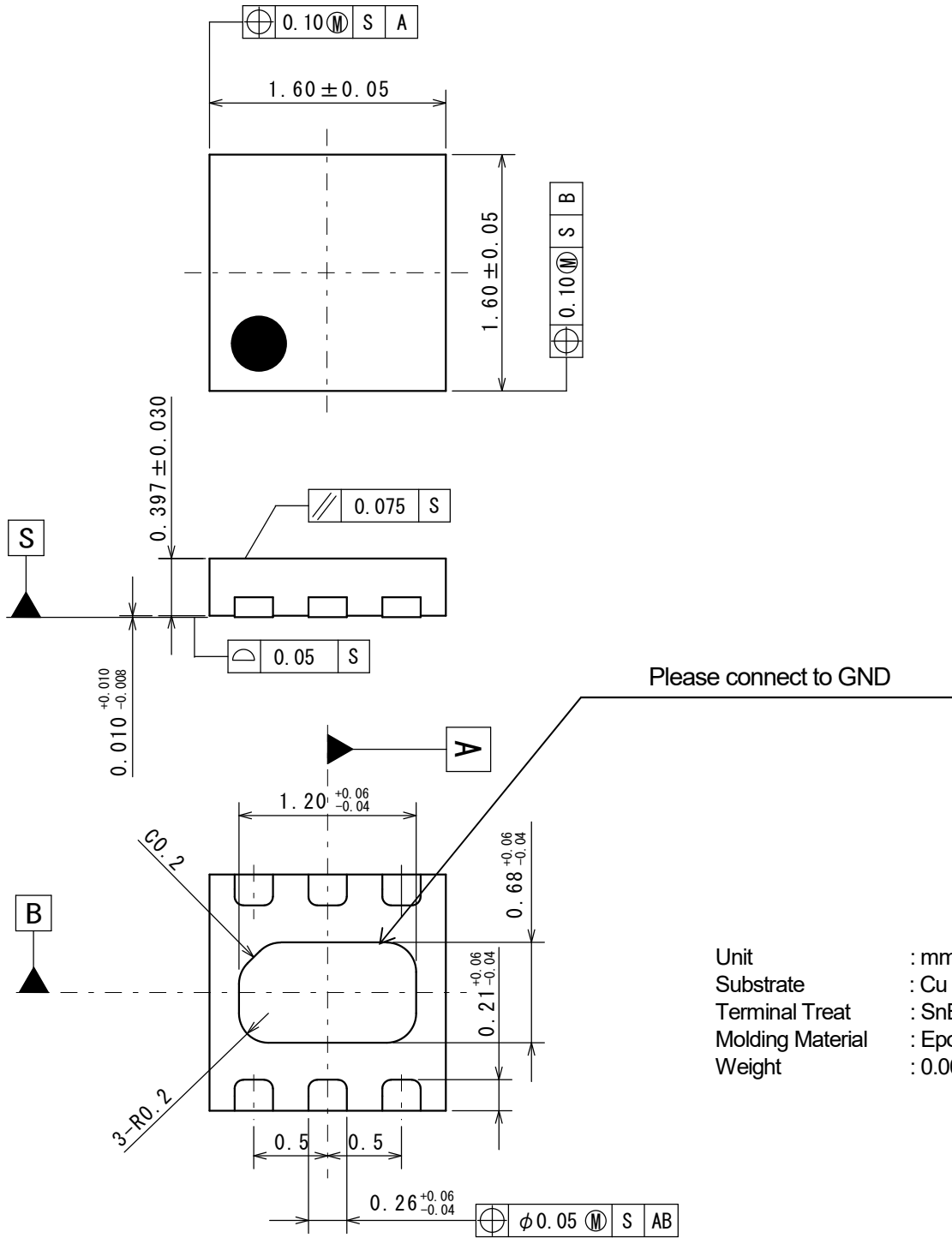
Calibration Setup



* Noise source, DUT, pre-amplifier and NF analyzer are connected directly.

Measurement Setup

■ PACKAGE OUTLINE



Unit : mm
 Substrate : Cu
 Terminal Treat : SnBi
 Molding Material : Epoxy Resin
 Weight : 0.0035 (g)

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 - Aerospace Equipment
 - Equipment Used in the Deep Sea
 - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
 - Life Maintenance Medical Equipment
 - Fire Alarms / Intruder Detectors
 - Vehicle Control Equipment (automotive, airplane, railroad, ship, etc.)
 - Various Safety Devices
 - Traffic control system
 - Combustion equipment

In case your company desires to use this product for any applications other than general electronic equipment mentioned above, make sure to contact our company in advance. Note that the important requirements mentioned in this section are not applicable to cases where operation requirements such as application conditions are confirmed by our company in writing after consultation with your company.

6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. The products have been designed and tested to function within controlled environmental conditions. Do not use products under conditions that deviate from methods or applications specified in this datasheet. Failure to employ the products in the proper applications can lead to deterioration, destruction or failure of the products. We shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of the products.
8. **Quality Warranty**
 - 8-1. **Quality Warranty Period**

In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
 - 8-2. **Quality Warranty Remedies**

When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.

Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
 - 8-3. **Remedies after Quality Warranty Period**

With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
12. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.



Nisshinbo Micro Devices Inc.

Official website

<https://www.nisshinbo-microdevices.co.jp/en/>

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