

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.

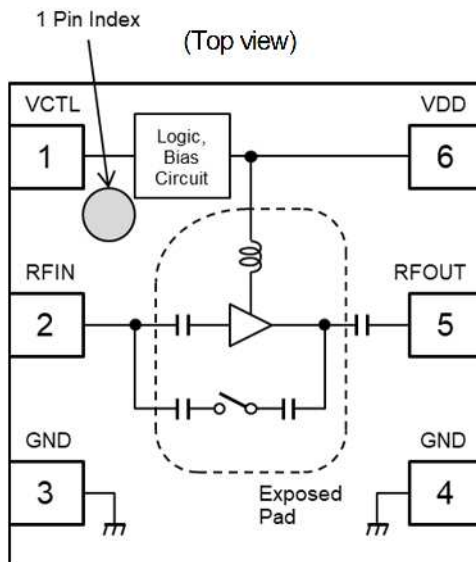
The small and thin ESON6-G1 package is adopted.

■ 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

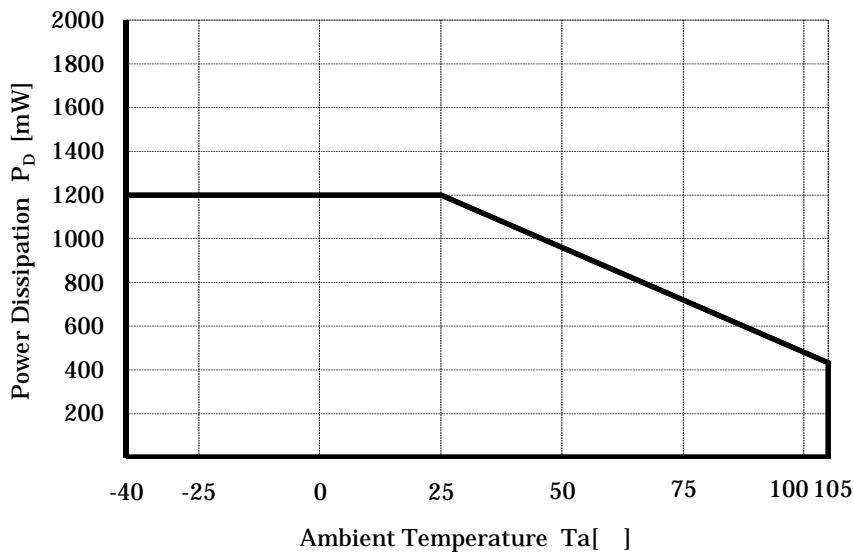
(4): Mounted on four-layer FR4 PCB with through-hole (101.5 × 114.5 mm), $T_j = 150^\circ\text{C}$

■ 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, T_o be within 1 dB of the final gain	-	0.5	2	μs
Gain settling time 2	T_{s2}	LNA active to bypass mode, T_o 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)

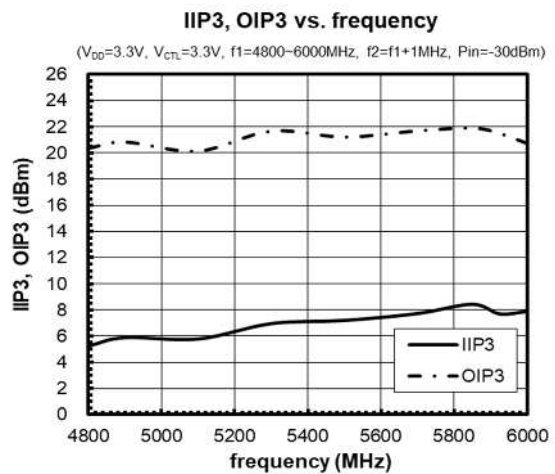
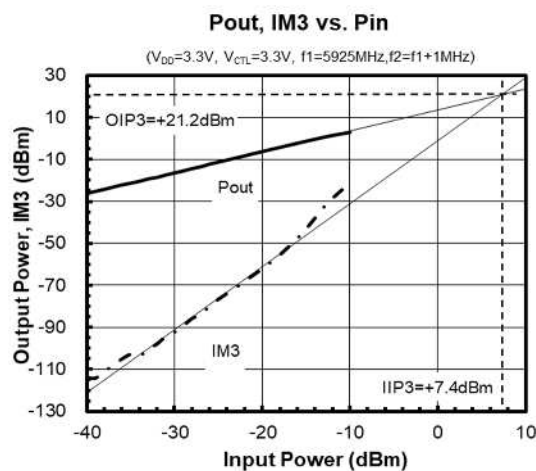
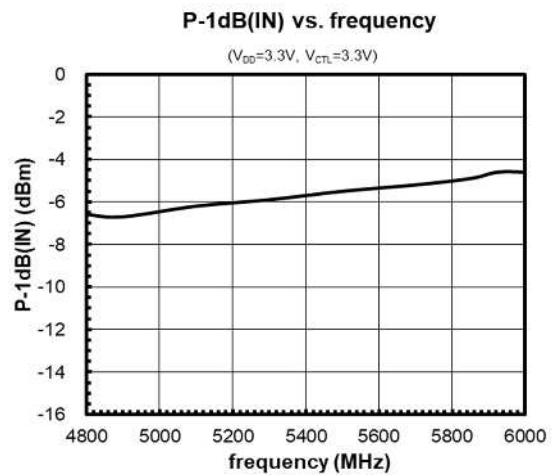
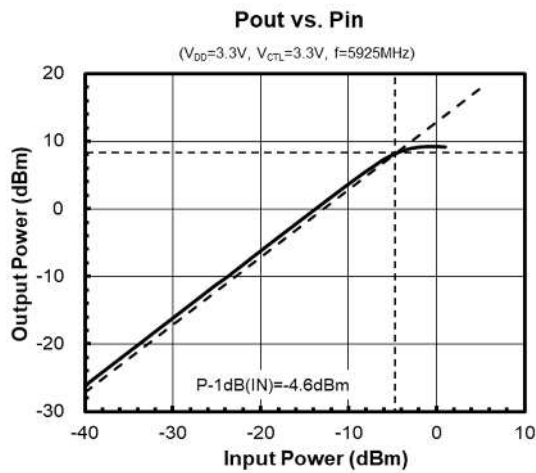
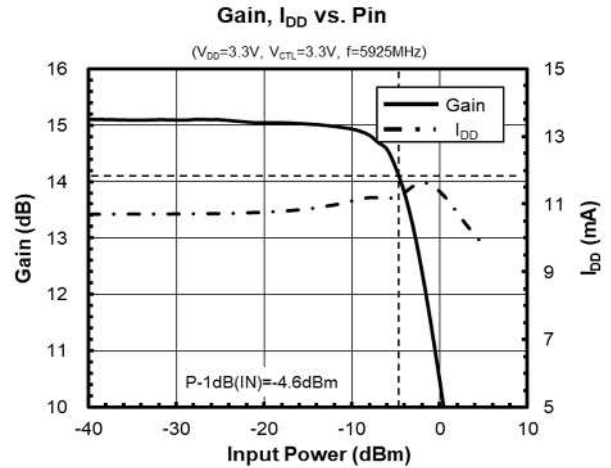
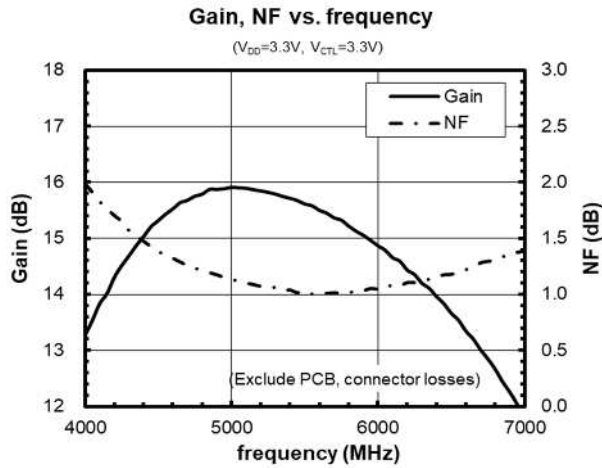
$f_{RF} = 4900 \text{ to } 5925 \text{ MHz}$, $V_{DD} = 3.3 \text{ V}$, $V_{CTL} = 0 \text{ V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50 \Omega$, with application circuit

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

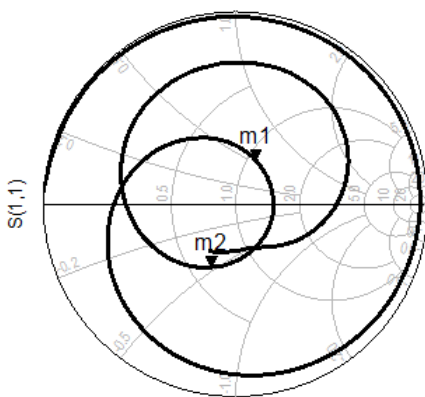
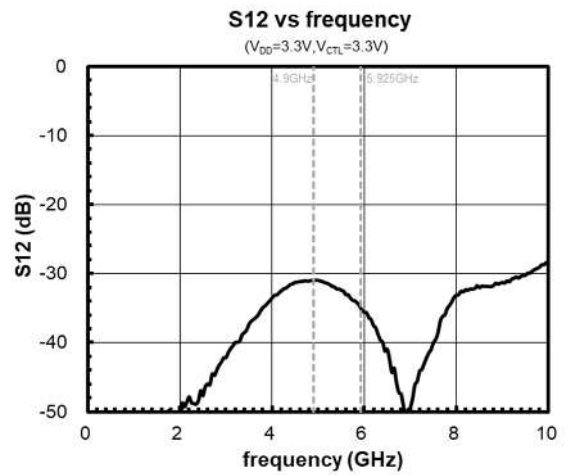
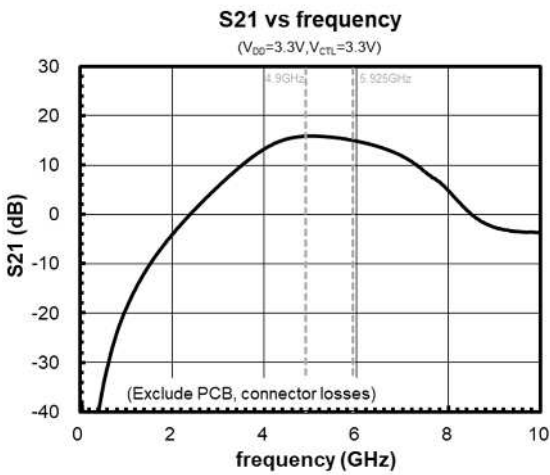
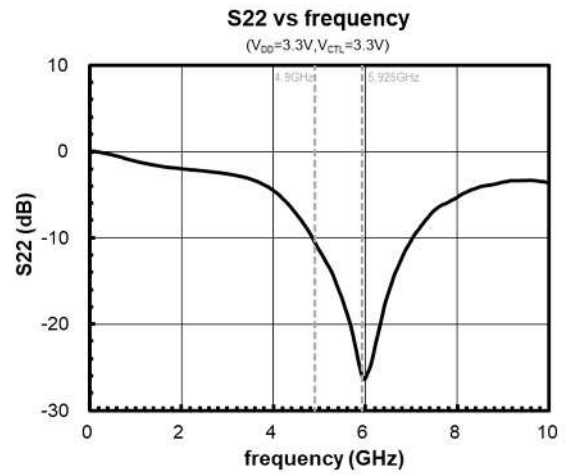
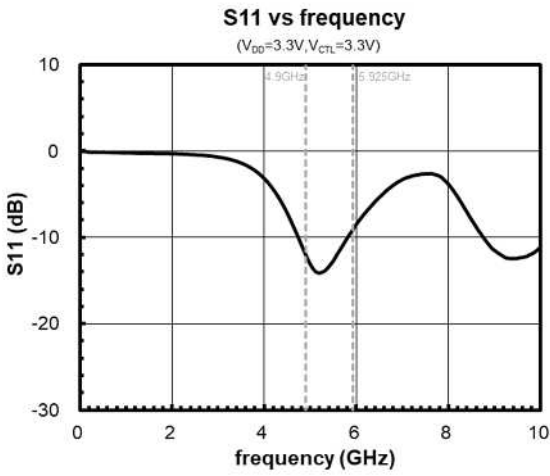
■ ELECTRICAL CHARACTERISTICS (LNA active mode)

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

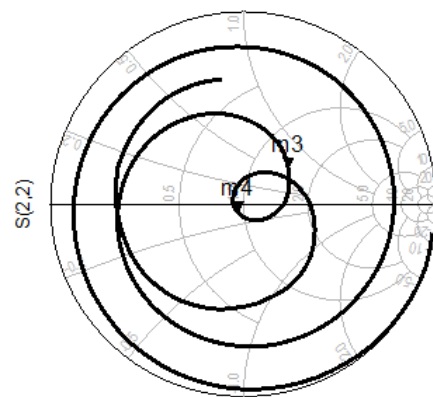


freq (50.00MHz to 10.00GHz)

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)

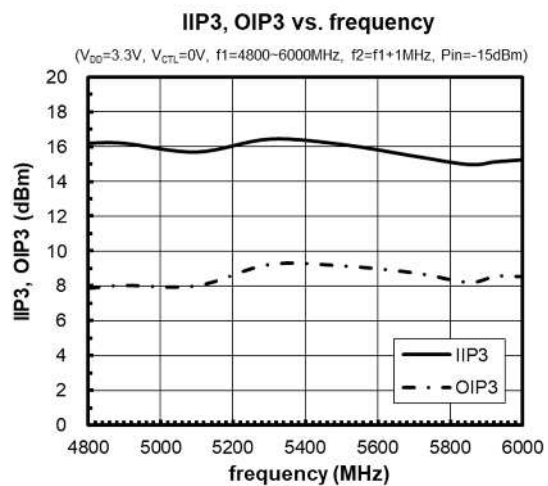
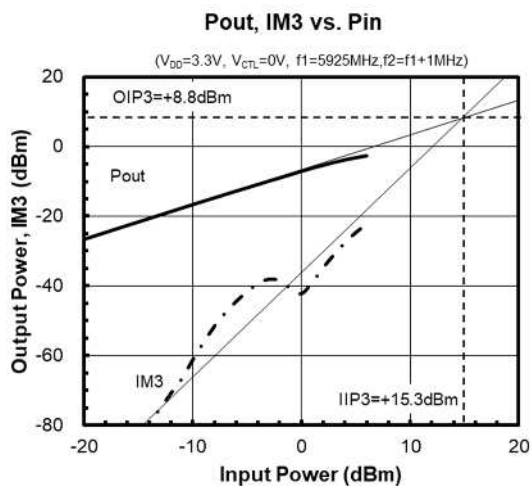
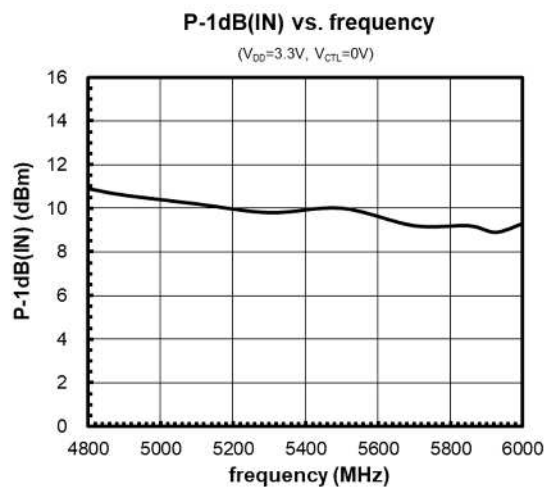
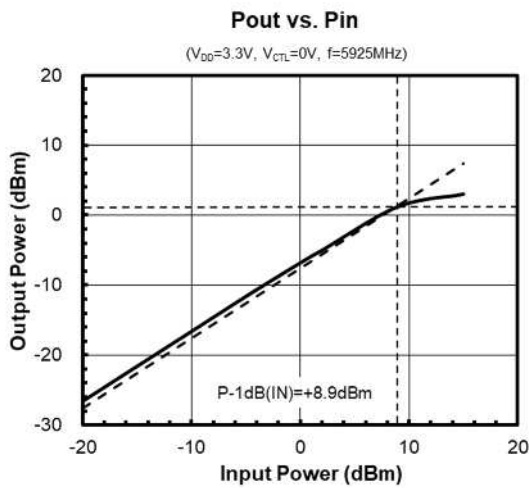
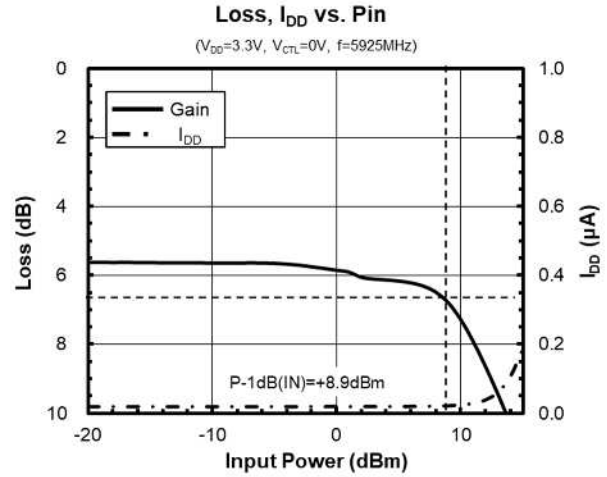
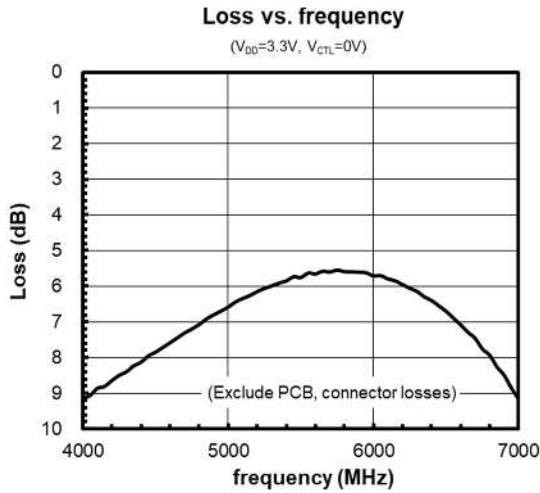
m3
freq=4.900GHz
S(2,2)=0.298 / 38.736
impedance = $Z_0 * (1.460 + j0.597)$

m4
freq=5.925GHz
S(2,2)=0.051 / -125.265
impedance = $Z_0 * (0.940 - j0.078)$

Zout

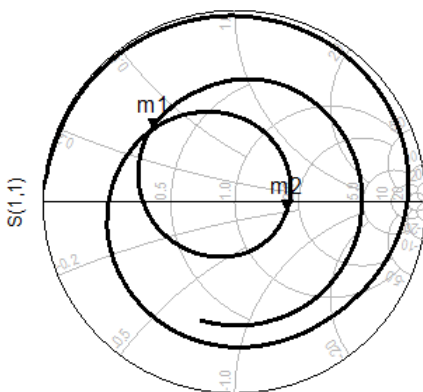
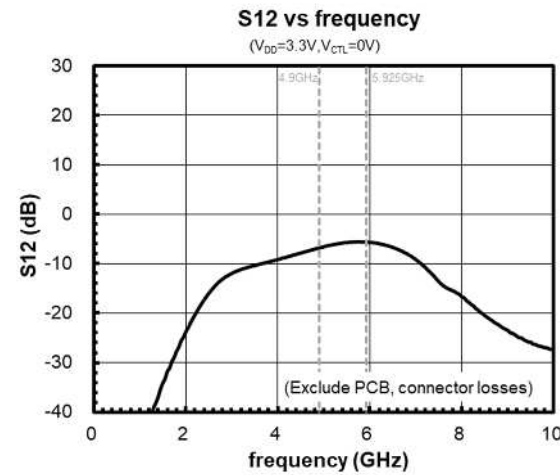
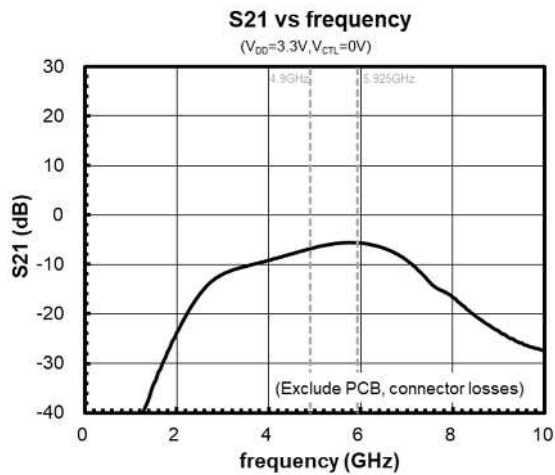
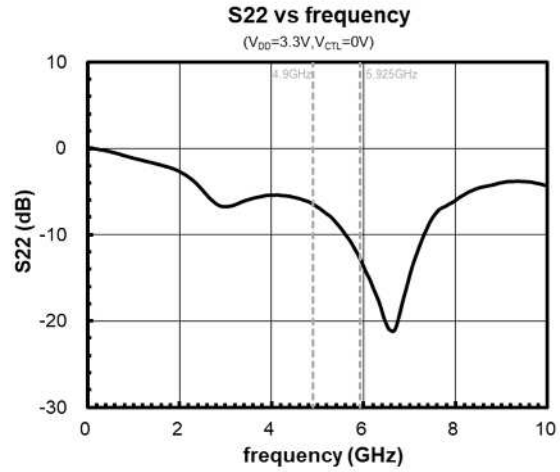
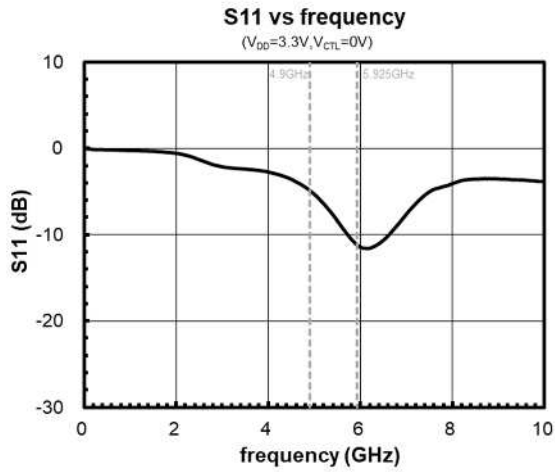
■ ELECTRICAL CHARACTERISTICS (Bypass mode)

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

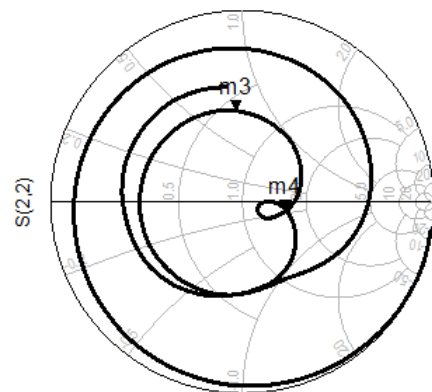


freq (50.00MHz to 10.00GHz)

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)

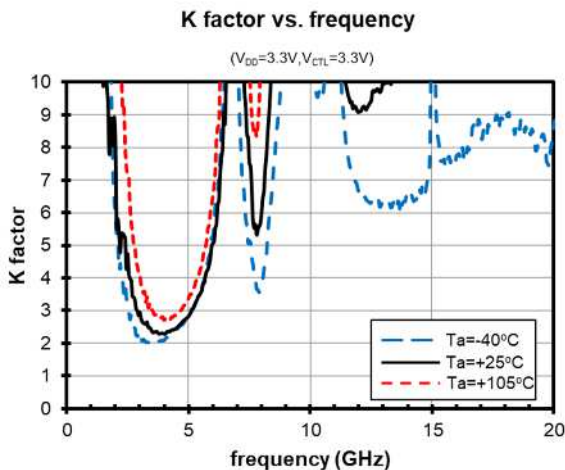
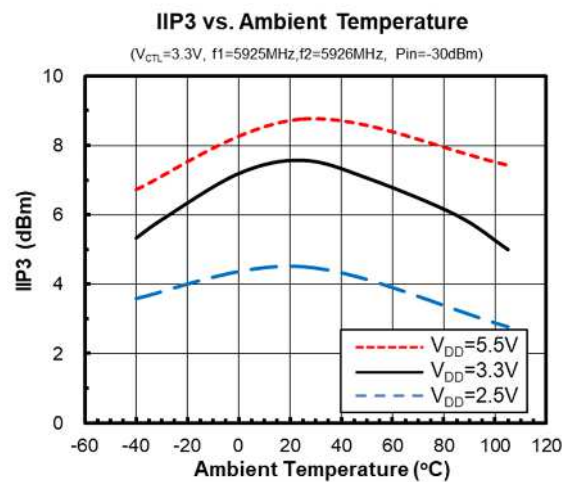
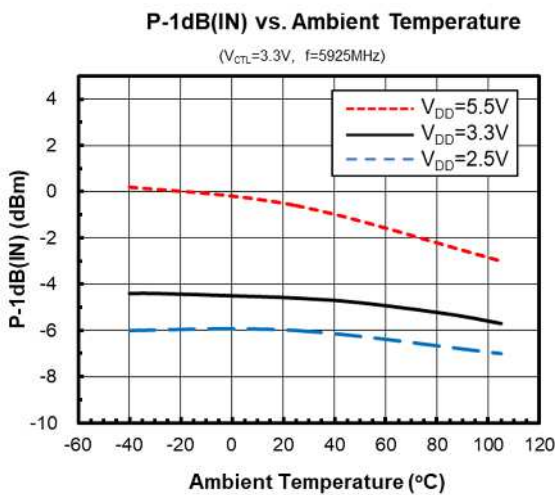
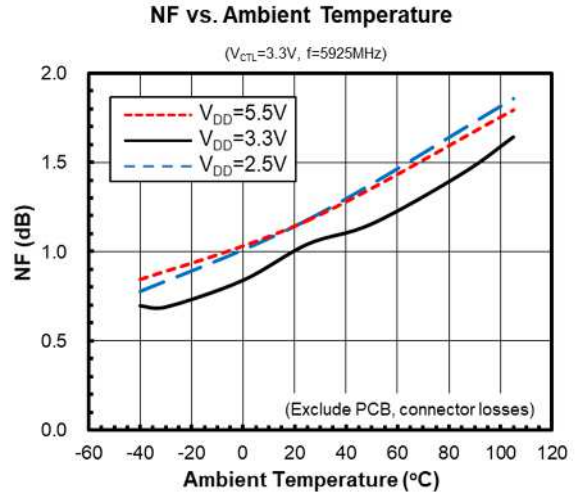
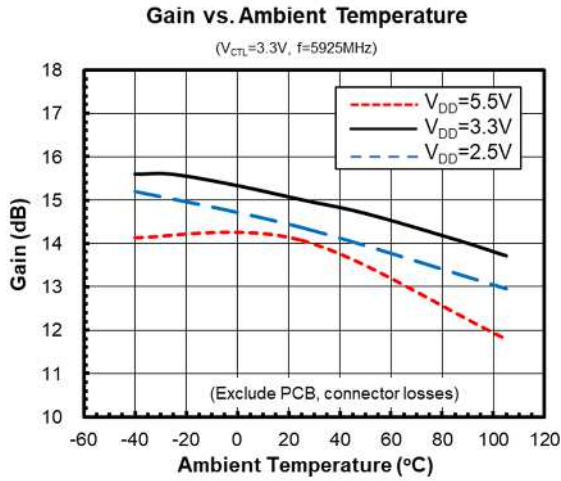
m3
freq=4.900GHz
 $S(2,2)=0.477 / 94.048$
impedance = $Z_0 * (0.597 + j0.735)$

m4
freq=5.925GHz
 $S(2,2)=0.229 / -12.445$
impedance = $Z_0 * (1.567 - j0.163)$

Zout

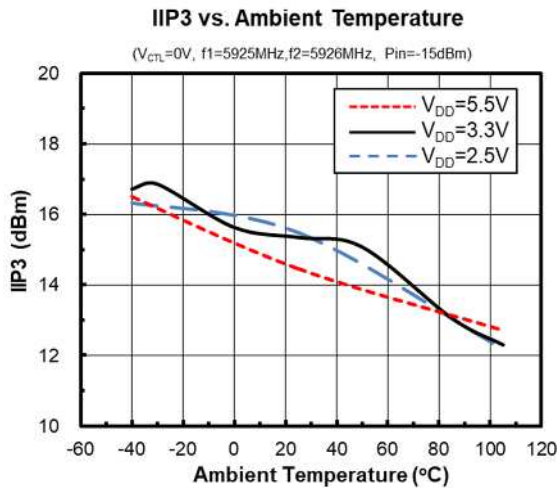
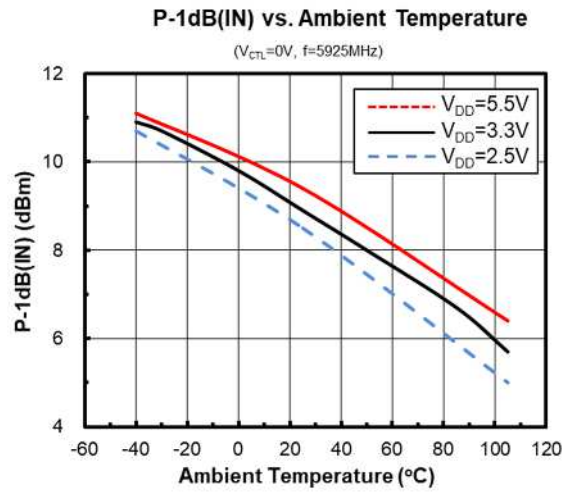
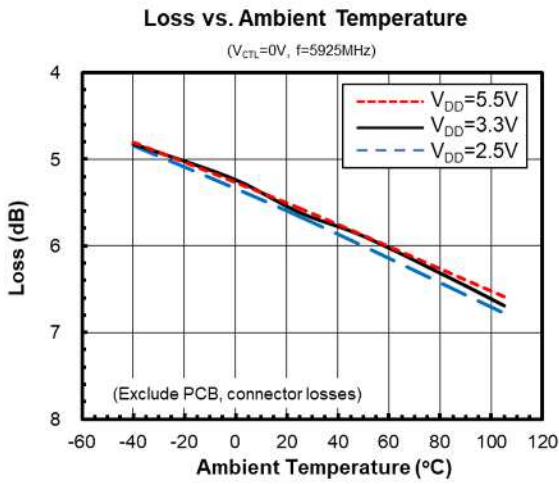
■ ELECTRICAL CHARACTERISTICS (LNA active mode)

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



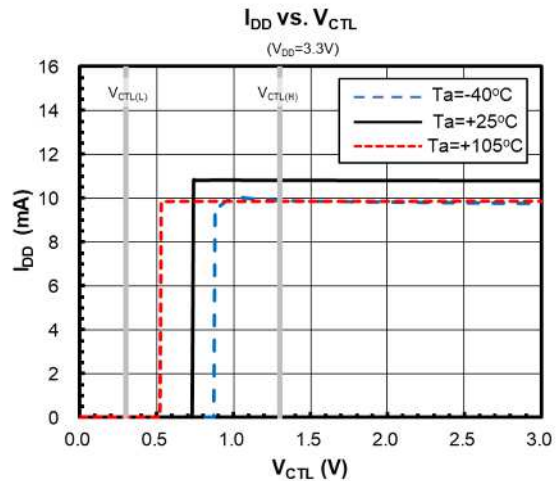
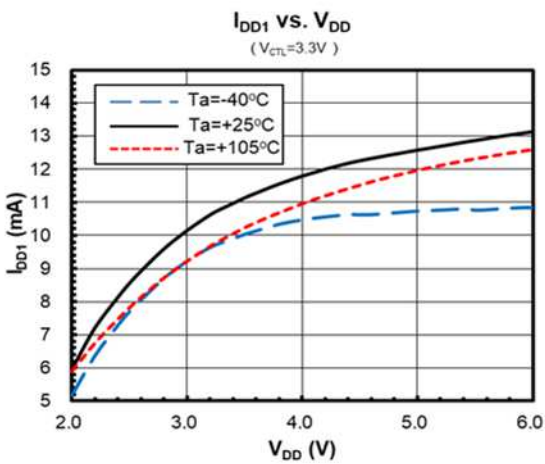
■ ELECTRICAL CHARACTERISTICS (Bypass mode)

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

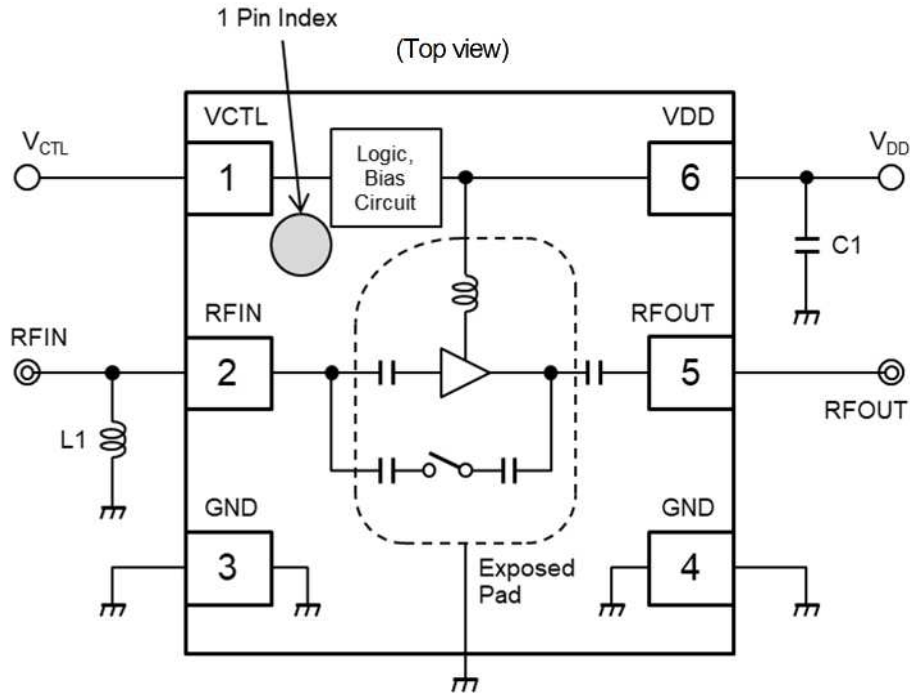


■ ELECTRICAL CHARACTERISTICS (DC)

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



■ APPLICATION CIRCUIT

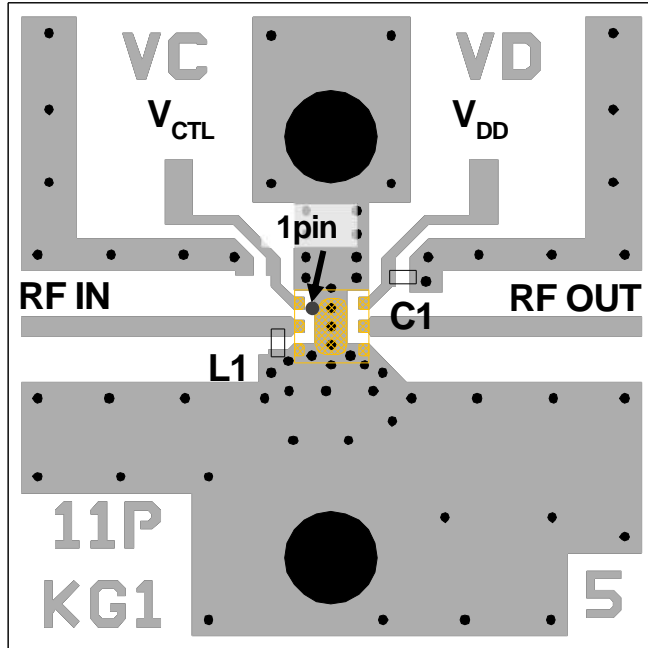


<PARTS LIST>

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

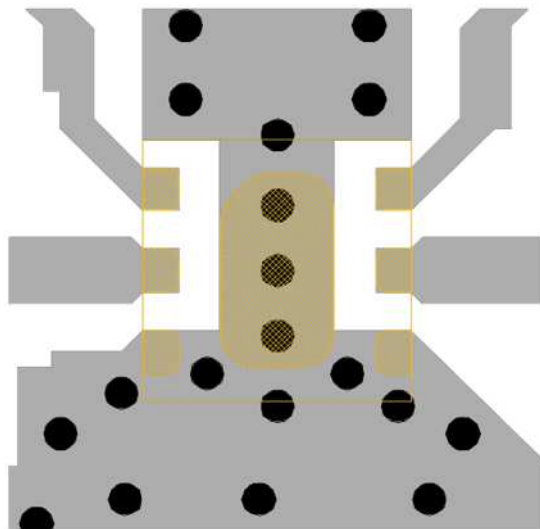
Substrate: FR-4





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 $\phi = 0.2$ 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)

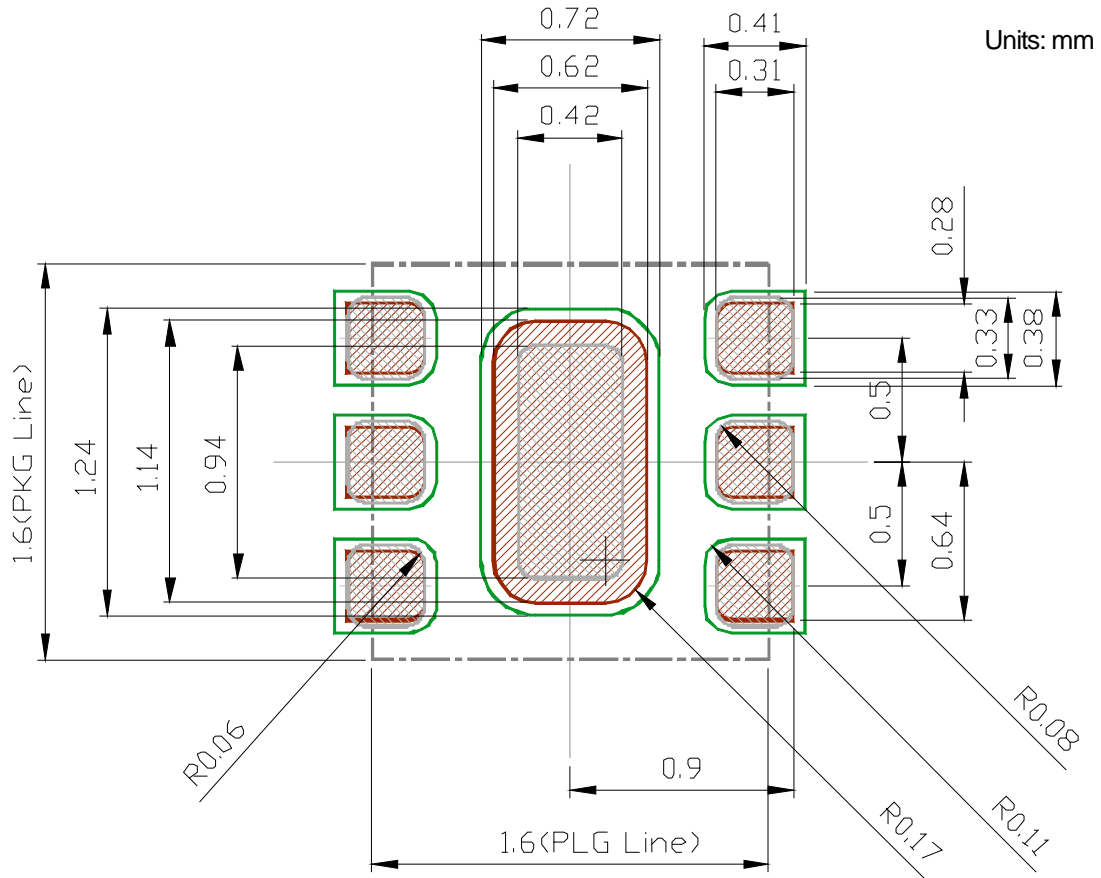
PKG: 1.6 mm x 1.6 mm

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

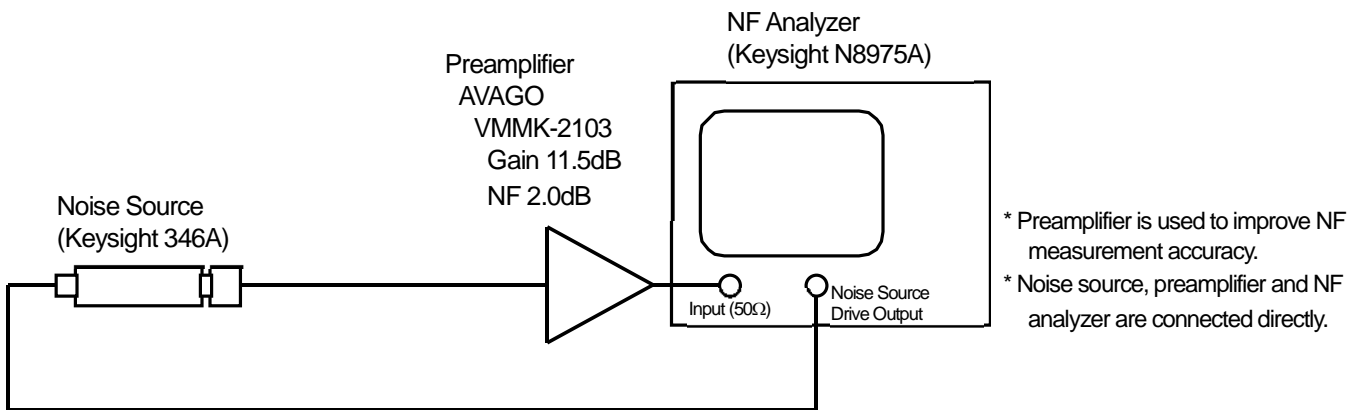
Setting the NF analyzer

Measurement mode form

Device under test : Amplifier
 System downconverter : off

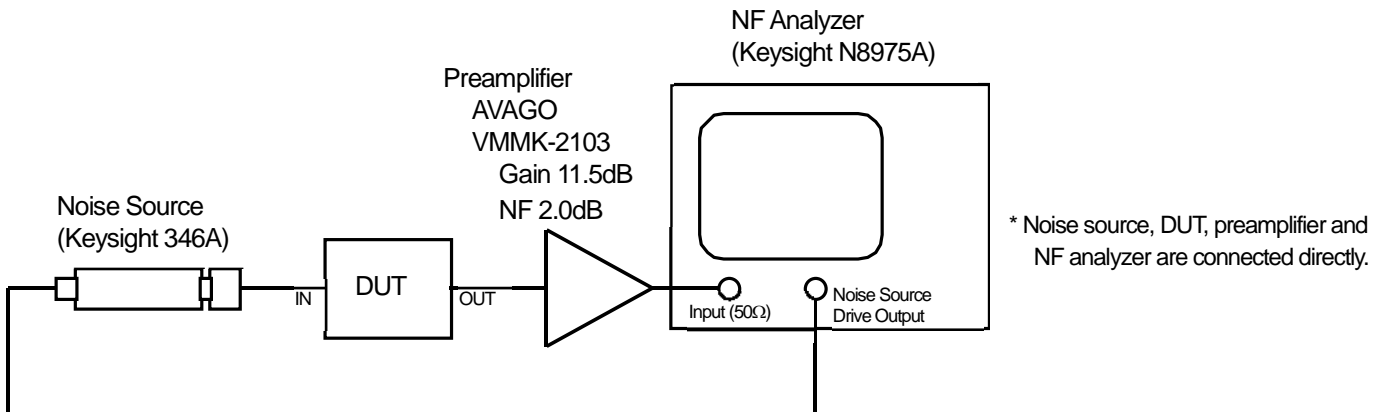
Mode setup form

Sideband : LSB
 Averages : 8
 Average mode : Point
 Bandwidth : 4MHz
 Loss comp : off
 Tcold : setting the temperature of noise source (305.15K)



* Preamplifier is used to improve NF measurement accuracy.
 * Noise source, preamplifier and NF analyzer are connected directly.

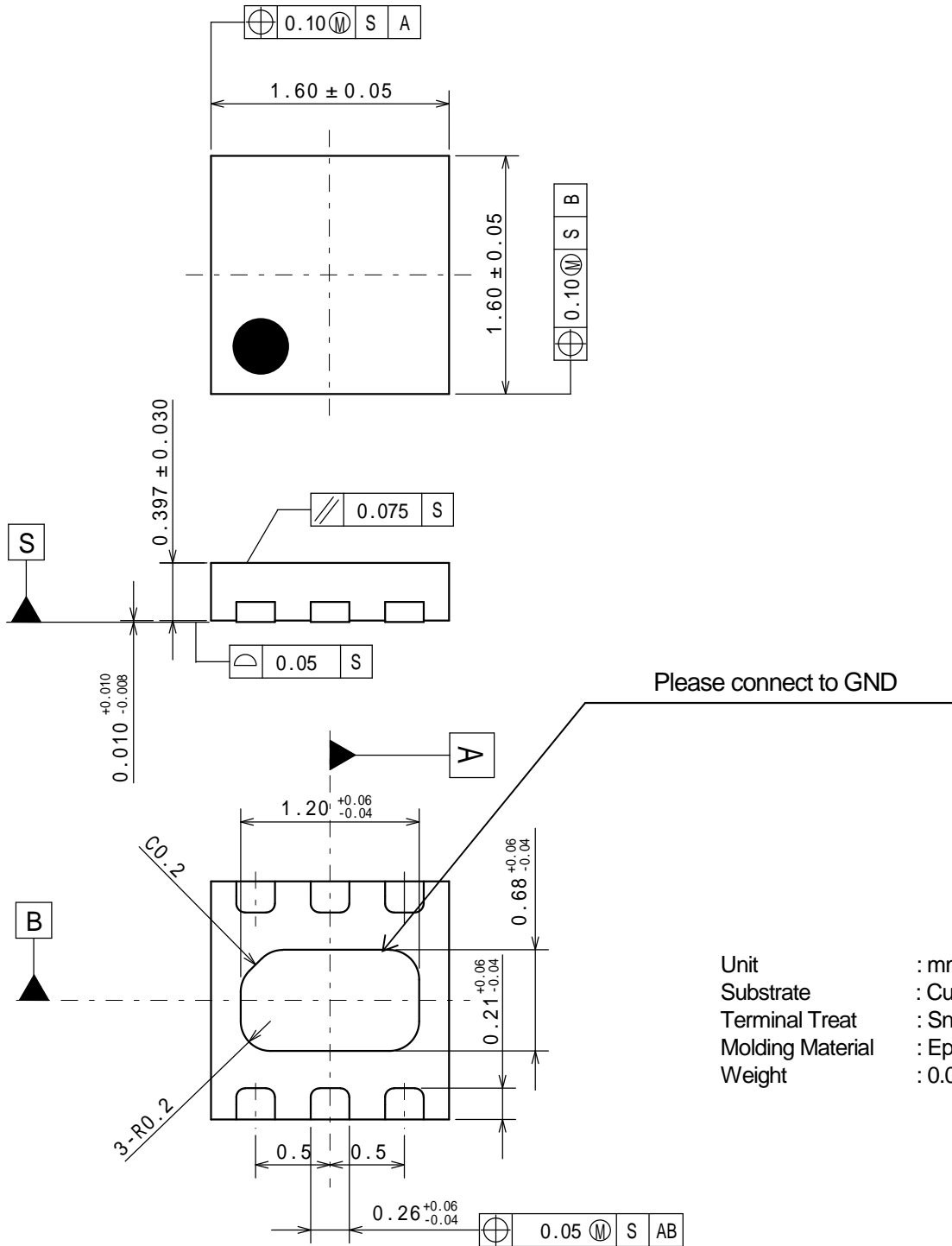
Calibration Setup



* Noise source, DUT, preamplifier 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)

[CAUTION]

1. NJR strives to produce reliable and high quality semiconductors. NJR's semiconductors are intended for specific applications and require proper maintenance and handling. To enhance the performance and service of NJR's semiconductors, the devices, machinery or equipment into which they are integrated should undergo preventative maintenance and inspection at regularly scheduled intervals. Failure to properly maintain equipment and machinery incorporating these products can result in catastrophic system failures
2. The specifications on this datasheet are only given for information without any guarantee as regards either mistakes or omissions. The application circuits in this datasheet are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial property rights.
All other trademarks mentioned herein are the property of their respective companies.
3. To ensure the highest levels of reliability, NJR products must always be properly handled.
The introduction of external contaminants (e.g. dust, oil or cosmetics) can result in failures of semiconductor products.
4. NJR offers a variety of semiconductor products intended for particular applications. It is important that you select the proper component for your intended application. You may contact NJR's Sale's Office if you are uncertain about the products listed in this datasheet.
5. Special care is required in designing devices, machinery or equipment which demand high levels of reliability. This is particularly important when designing critical components or systems whose failure can foreseeably result in situations that could adversely affect health or safety. In designing such critical devices, equipment or machinery, careful consideration should be given to amongst other things, their safety design, fail-safe design, back-up and redundancy systems, and diffusion design.
6. The products listed in this datasheet may not be appropriate for use in certain equipment where reliability is critical or where the products may be subjected to extreme conditions. You should consult our sales office before using the products in any of the following types of equipment.
 - 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 (Automobile, airplane, railroad, ship, etc.)
 - Various Safety Devices
7. NJR's 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. NJR 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. The products are sold without warranty of any kind, either express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose.
8. 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.
9. The product specifications and descriptions listed in this datasheet are subject to change at any time, without notice.

