Low Noise Amplifier with Bypass for 5 GHz band

■ FEATURES

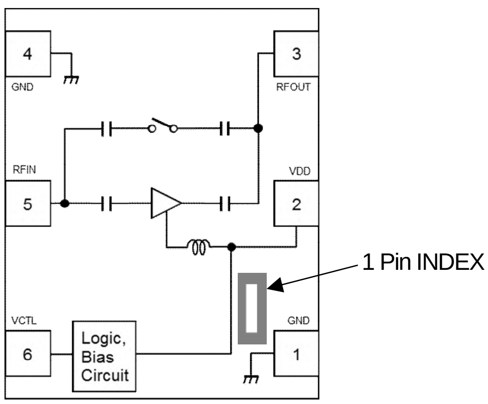
- Wide frequency range 4900MHz to 5950MHz
- Low operating voltage 1.5V to 3.3 V
- Low current 5.0/3.5mA typ. @ V_{DD}=2.8/1.8V
- High gain
  15.0dB typ. @ V_{DD}=2.8V, f_{RF}=5500 MHz
- Low noise figure
  1.1dB typ. @ V_{DD}=2.8V, f_{RF}=5500MHz
- High IIP3
  +2.0dBm typ.@V_{DD}=2.8V,f_{RF}=5500MHz+5501MHz
- Low insertion loss (bypass mode)
  3.5dB typ.@ V_{DD}=2.8V, f_{RF}=5500MHz
- Ultra-small package size 1.1 x 0.7 x 0.37mm typ.
- RoHS compliant and Halogen Free, MSL1

■ APPLICATION

- LTE-U/LAA receive application
- WiMAX 5GHz receive application
- WLAN 5GHz receive application
- RF front-end modules, data cards, and other mobile applications

■ BLOCK DIAGRAM (EPFFP6-X2)

(Top view)



■ GENERAL DESCRIPTION

NJG1182UX2 is low noise amplifier with bypass switch for 5GHz application such as LTE-U/LAA, which covers frequency from 4900MHz to 5950MHz.

NJG1182UX2 is able to select LNA active mode or bypass mode by low control voltage. This LNA achieves low noise figure and high linearity.

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

A very small and ultra-thin package EPFFP6-X2 is adopted.

■ TRUTH TABLE

"H"=$V_{CTL(H)}$, "L"=$V_{CTL(L)}$

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

■ PIN CONFIGURATION

PIN NO.	SYMBOL	DESCRIPTION
1	GND	Ground
2	VDD	Power supply
3	RFOUT	RF output
4	GND	Ground
5	RFIN	RF input
6	VCTL	Control voltage

■ PRODUCT NAME INFORMATION

NJG1182 UX2 (TE1)

| | |

Part number Package Taping form

■ ORDERING INFORMATION

PART NUMBER	PACKAGE OUTLINE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs.)
NJG1182UX2	EPFFP6-X2	Yes	Yes	Ni/Pd/Au	5	0.7	5,000

■ ABSOLUTE MAXIMUM RATINGS

T_a = 25°C, Z_s = Z_l = 50 Ω

PARAMETER	SYMBOL	RATINGS	UNIT
Operating voltage	V_{DD}	5.0	V
Control voltage	V_{CTL}	5.0	V
Input power	P_{IN}	+15 (1)	dBm
Power dissipation	P_D	430 (2)	mW
Operating temperature	T_{opr}	-40 to +105	°C
Storage temperature	T_{stg}	-55 to +150	°C

(1): V_{DD}=2.8V

(2): 4-layer FR4 PCB with through-hole (101.5x114.5mm), T_j=150°C

■ ELECTRICAL CHARACTERISTICS 1 (DC)

General condition: T_a=+25°C, with application circuit

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating voltage	V_{DD}		1.5	-	3.3	V
Control voltage (High)	$V_{CTL(H)}$		1.3	1.8	3.3	V
Control voltage (Low)	$V_{CTL(L)}$		0	0	0.3	V
Operating current 1	$I_{DD}1$	RF OFF, V_{DD}=2.8V, V_{CTL}=1.8V	-	5.0	8.0	mA
Operating current 2	$I_{DD}2$	RF OFF, V_{DD}=1.8V, V_{CTL}=1.8V	-	3.5	8.0	mA
Operating current 3	$I_{DD}3$	RF OFF, V_{DD}=2.8V, V_{CTL}=0V	-	20	60	µA
Operating current 4	$I_{DD}4$	RF OFF, V_{DD}=1.8V, V_{CTL}=0V	-	10	60	µA
Control current	I_{CTL}	RF OFF, V_{CTL}=1.8V	-	7	20	µA

■ELECTRICAL CHARACTERISTICS 2 (LNA active mode)

General condition: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=5500MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Small signal gain1	Gain1	Exclude PCB & connector losses *1	12.0	15.0	17.5	dB
Noise figure1	NF1	Exclude PCB & connector losses *2	-	1.1	1.7	dB
Input power at 1dB gain compression point1(1)	P-1dB(IN) 1(1)		-16.0	-11.0	-	dBm
Input 3rd order intercept point1(1)	IIP3_1(1)	f1=f_{RF}, f2= f_{RF}+1MHz, P_{IN}=-30dBm	-5.0	+2.0	-	dBm
RF IN return loss1(1)	RLi1(1)		8.0	16.0	-	dB
RF OUT return loss1(1)	RLo1(1)		5.0	8.0	-	dB
Gain settling time1(1)	Ts1(1)	Bypass to LNA active mode to be within 1 dB of the final gain	-	1.0	2.5	μs
Gain settling time1(2)	Ts1(2)	LNA active to Bypass mode to be within 1 dB of the final insertion loss	-	0.8	2.5	μs

*1: PCB and connector losses: 0.64 dB

*2: PCB and connector losses: 0.30 dB

■ ELECTRICAL CHARACTERISTICS 3 (Bypass mode)

General condition: V_{DD}=2.8V, V_{CTL}=0V, f_{RF}=5500MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Insertion Loss1	Loss1	Exclude PCB & connector losses *1	-	3.5	5.0	dB
Input power at 1dB compression point1(2)	P-1dB(IN) 1(2)		+2.0	+7.5	-	dBm
Input 3rd order intercept point1(2)	IIP3_1(2)	f1=f_{RF}, f2=f_{RF}+1MHz, P_{IN}=-10dBm	+10.0	+18.0	-	dBm
RF IN return loss1(2)	RLi1(2)		6.0	13.0	-	dB
RF OUT return loss1(2)	RLo1(2)		4.0	6.0	-	dB

*1: PCB and connector losses: 0.64 dB

■ ELECTRICAL CHARACTERISTICS 4 (LNA active mode)

General condition: V_{DD}=1.8V, V_{CTL}=1.8V, f_{RF}=5500MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Small signal gain2	Gain2	Exclude PCB & connector losses *1	-	14.5	-	dB
Noise figure2	NF2	Exclude PCB & connector losses *2	-	1.4	-	dB
Input power at 1dB gain compression point2(1)	P-1dB(IN) 2(1)			-13.0		dBm
Input 3rd order intercept point2(1)	IIP3_2(1)	$f1=f_{RF}$, $f2= f_{RF}+1MHz$, P_{IN}=-30dBm	-	-1.0	-	dBm
RF IN return loss2(1)	RLi2(1)		-	11.0	-	dB
RF OUT return loss2(1)	RLo2(1)		-	8.0	-	dB
Gain settling time2(1)	Ts2(1)	Bypass to LNA active mode To be within 1 dB of the final gain	-	2.0	-	µs
Gain settling time2(2)	Ts2(2)	LNA active to Bypass mode To be within 1 dB of the final insertion loss	-	0.8	-	µs

*1: PCB and connector losses: 0.64 dB

*2: PCB and connector losses: 0.30 dB

■ ELECTRICAL CHARACTERISTICS 5 (Bypass mode)

General condition: V_{DD}=1.8V, V_{CTL}=0V, f_{RF}=5500MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Insertion Loss2	Loss2	Exclude PCB & connector losses *1	-	3.5	-	dB
Input power at 1dB compression point2(2)	P-1dB(IN) 2(2)		-	+7.0	-	dBm
Input 3rd order intercept point2(2)	IIP3_2(2)	$f1=f_{RF}$, $f2=f_{RF}+1MHz$, P_{IN}=-10dBm	-	+18.0	-	dBm
RF IN return loss2(2)	RLi2(2)		-	13.0	-	dB
RF OUT return loss2(2)	RLo2(2)		-	7.0	-	dB

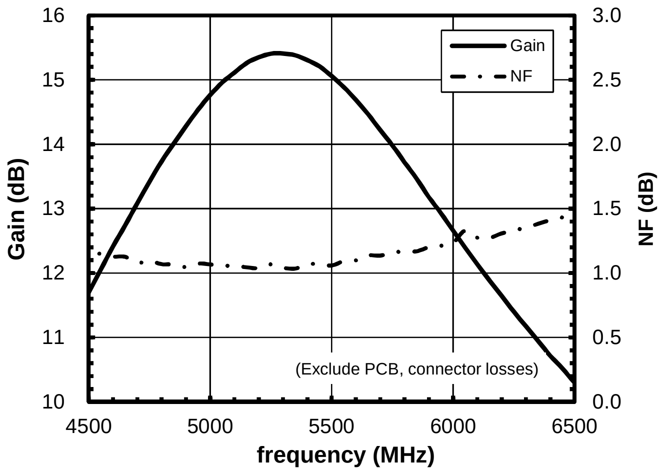
*1: PCB and connector losses: 0.64 dB

■ **ELECTRICAL CHARACTERISTICS** (LNA active mode)

Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=5500MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

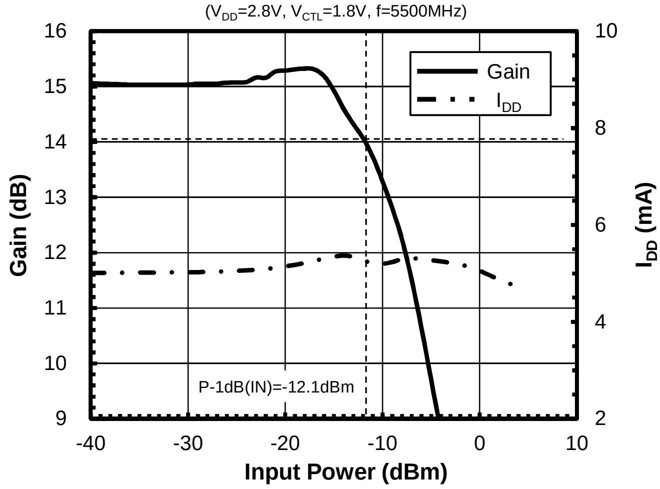
Gain, NF vs. frequency

(V_{DD}=2.8V, V_{CTL}=1.8V)



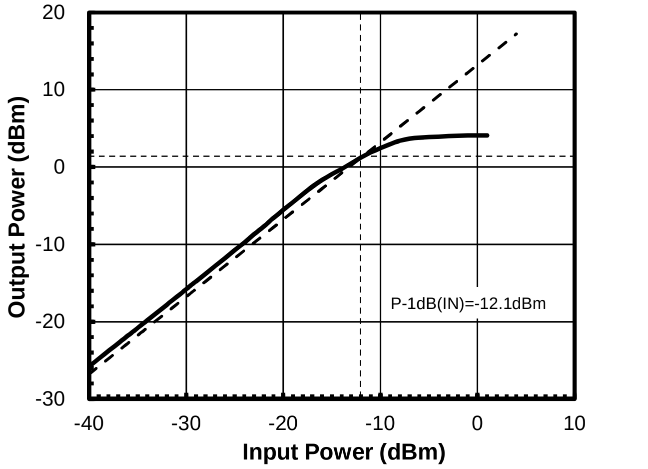
Gain, I_{DD} vs. Pin

(V_{DD}=2.8V, V_{CTL}=1.8V, f=5500MHz)



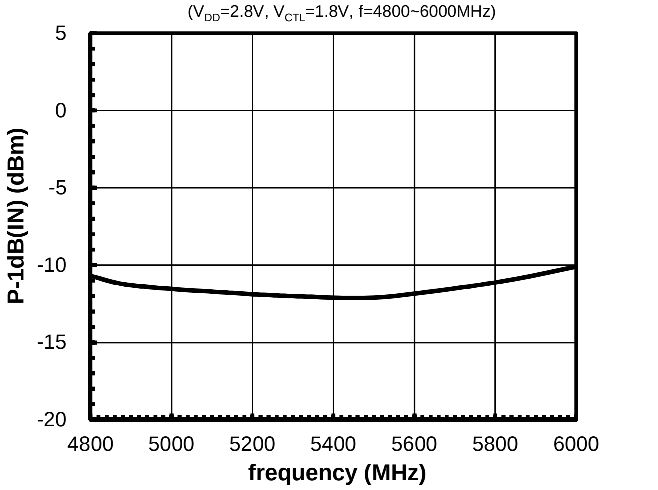
Pout vs. Pin

(V_{DD}=2.8V, V_{CTL}=1.8V, f=5500MHz)



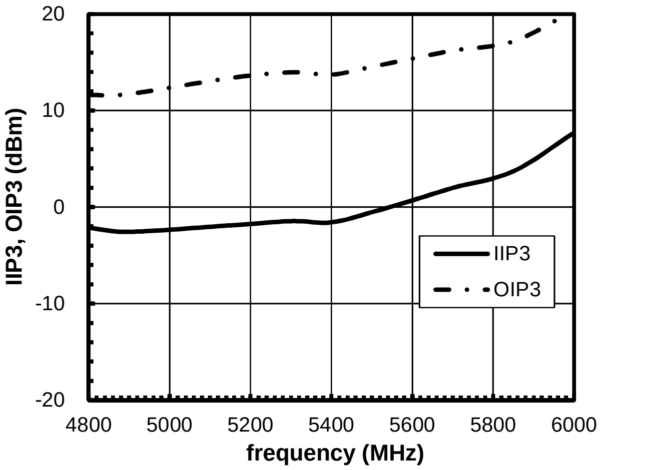
P-1dB(IN) vs. frequency

(V_{DD}=2.8V, V_{CTL}=1.8V, f=4800~6000MHz)



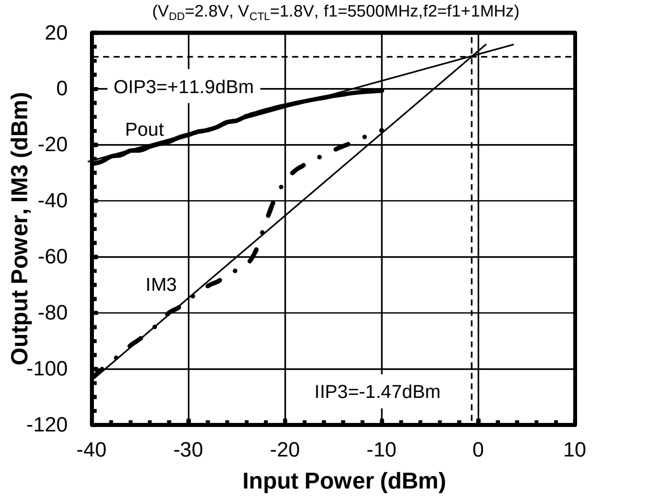
IIP3, OIP3 vs. frequency

(V_{DD}=2.8V, V_{CTL}=1.8V, f1=4800~6000MHz, f2=f1+1MHz, Pin=-30dBm)



Pout, IM3 vs. Pin

(V_{DD}=2.8V, V_{CTL}=1.8V, f1=5500MHz,f2=f1+1MHz)

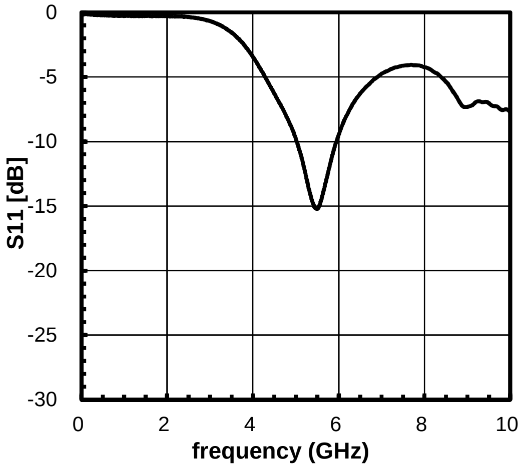


■ **ELECTRICAL CHARACTERISTICS** (LNA active mode)

Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=50MHz to 10000MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

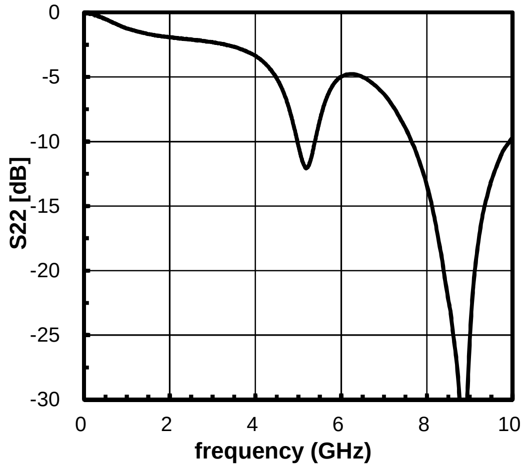
S11 vs. frequency

(V_{DD} = 2.8V, V_{CTL}=1.8V)



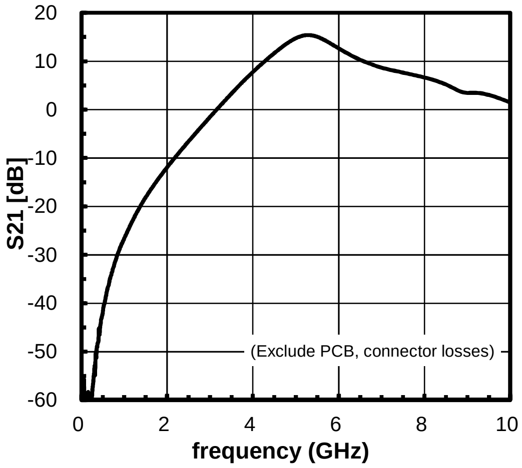
S22 vs. frequency

(V_{DD} = 2.8V, V_{CTL}=1.8V)



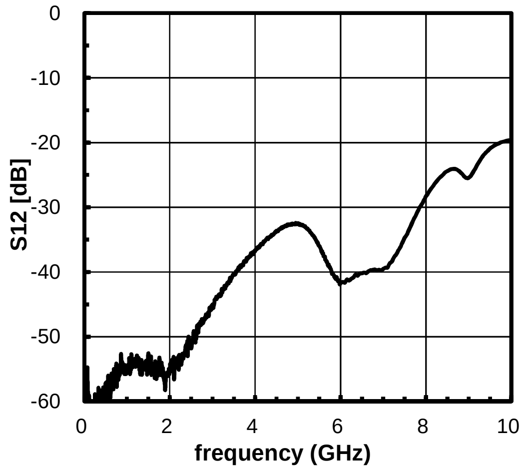
S21 vs. frequency

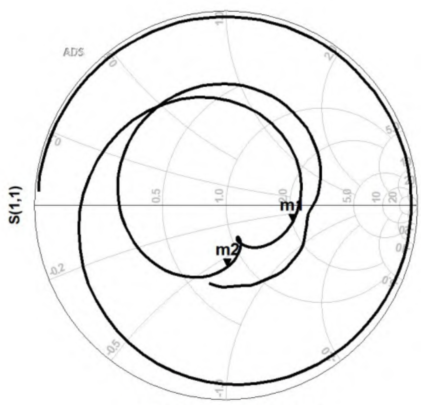
(V_{DD} = 2.8V, V_{CTL}=1.8V)



S12 vs. frequency

(V_{DD} = 2.8V, V_{CTL}=1.8V)

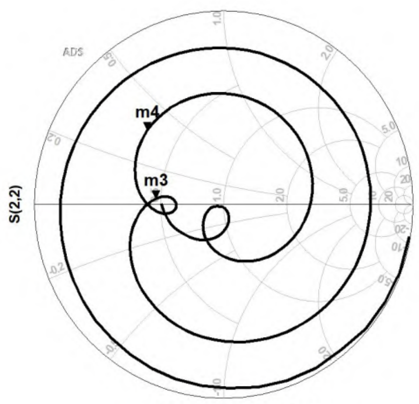




freq (50.00MHz to 10.00GHz)

m1
freq=4.900GHz
S(1,1)=0.358 / -14.219
impedance = Z0 * (2.010 - j0.406)

m2
freq=5.950GHz
S(1,1)=0.317 / -88.662
impedance = Z0 * (0.828 - j0.585)



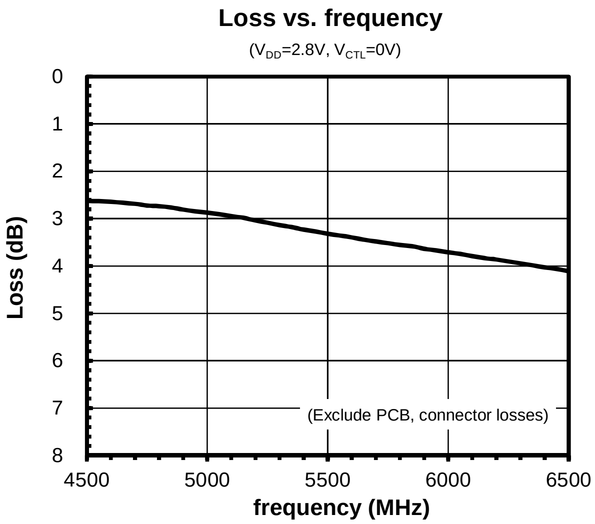
freq (50.00MHz to 10.00GHz)

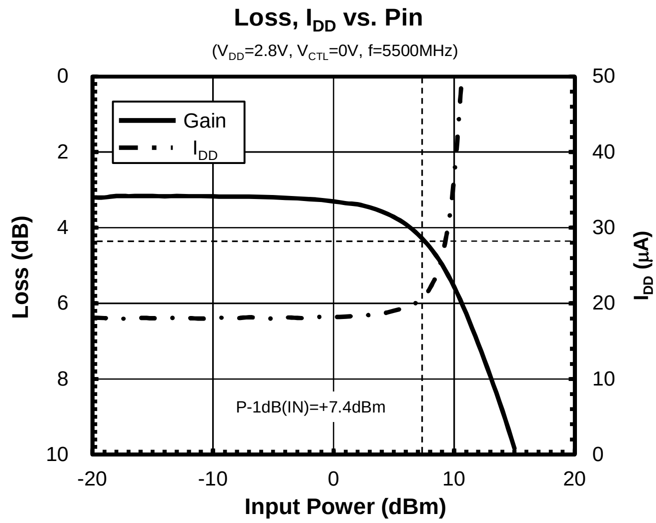
m3
freq=4.900GHz
S(2,2)=0.360 / 175.137
impedance = Z0 * (0.472 + j0.033)

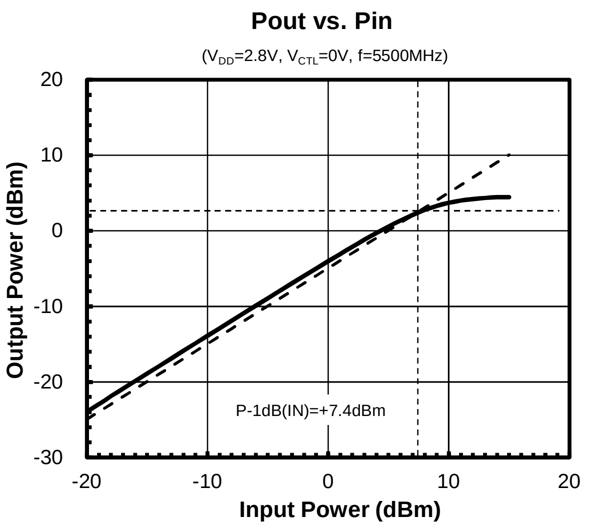
m4
freq=5.950GHz
S(2,2)=0.558 / 136.434
impedance = Z0 * (0.325 + j0.363)

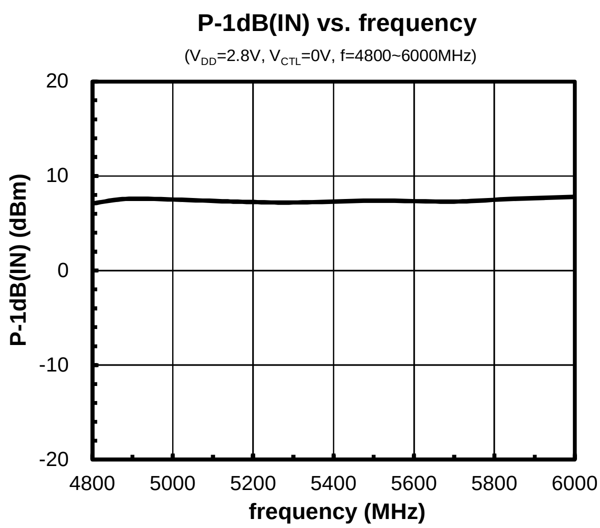
■ ELECTRICAL CHARACTERISTICS (Bypass mode)

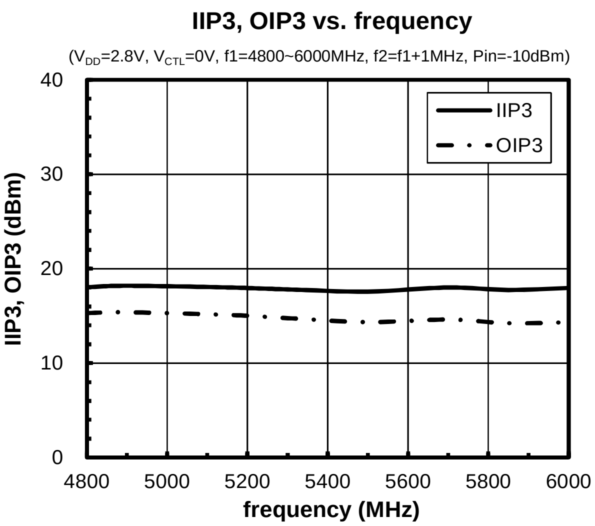
Conditions: V_{DD}=2.8V, V_{CTL}=0V, f_{RF}=5500MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

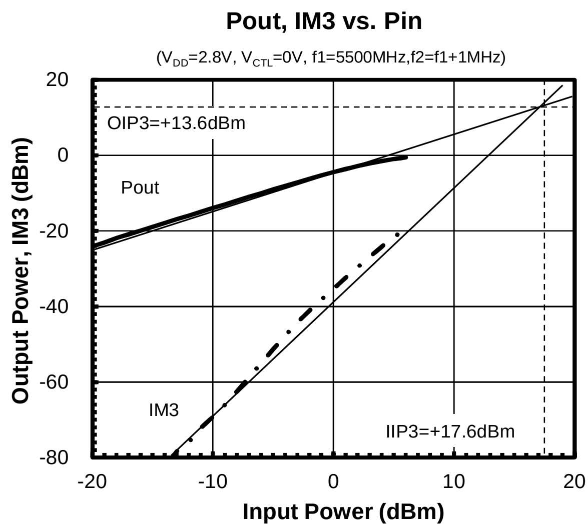






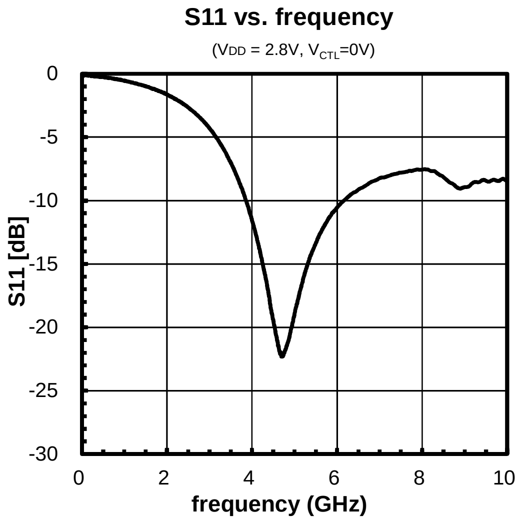


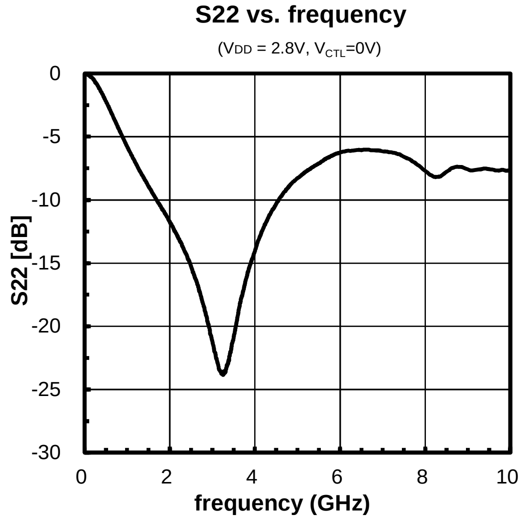


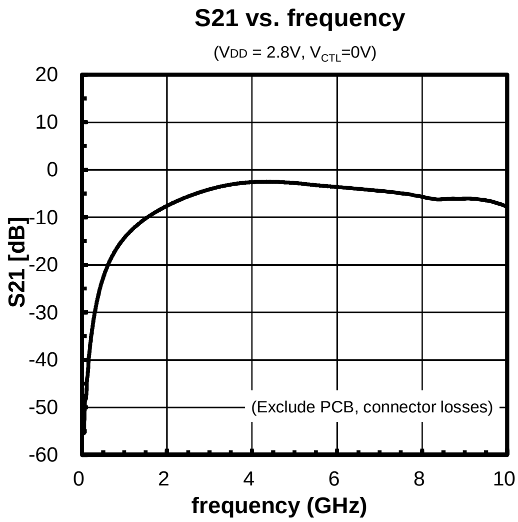


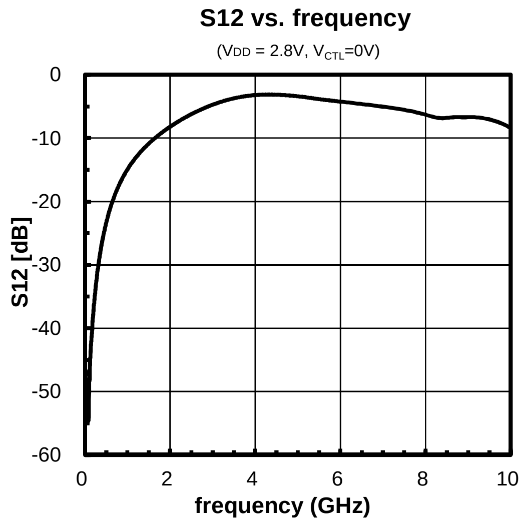
■ **ELECTRICAL CHARACTERISTICS** (Bypass mode)

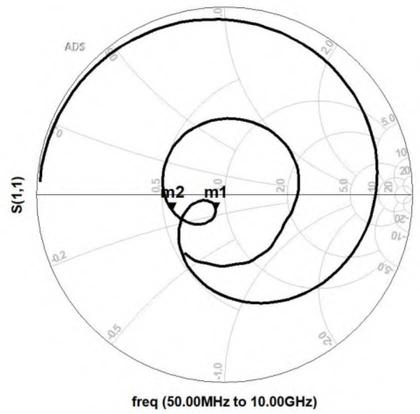
Conditions: V_{DD}=2.8V, V_{CTL}=0V, f_{RF}=50MHz to 10000MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit





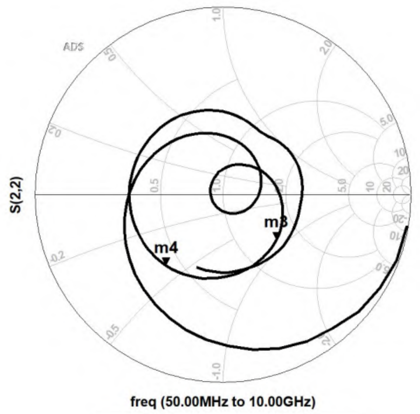






m1
freq=4.900GHz
S(1,1)=0.095 / -119.355
impedance = Z0 * (0.899 - j0.151)

m2
freq=5.950GHz
S(1,1)=0.290 / -163.234
impedance = Z0 * (0.559 - j0.102)

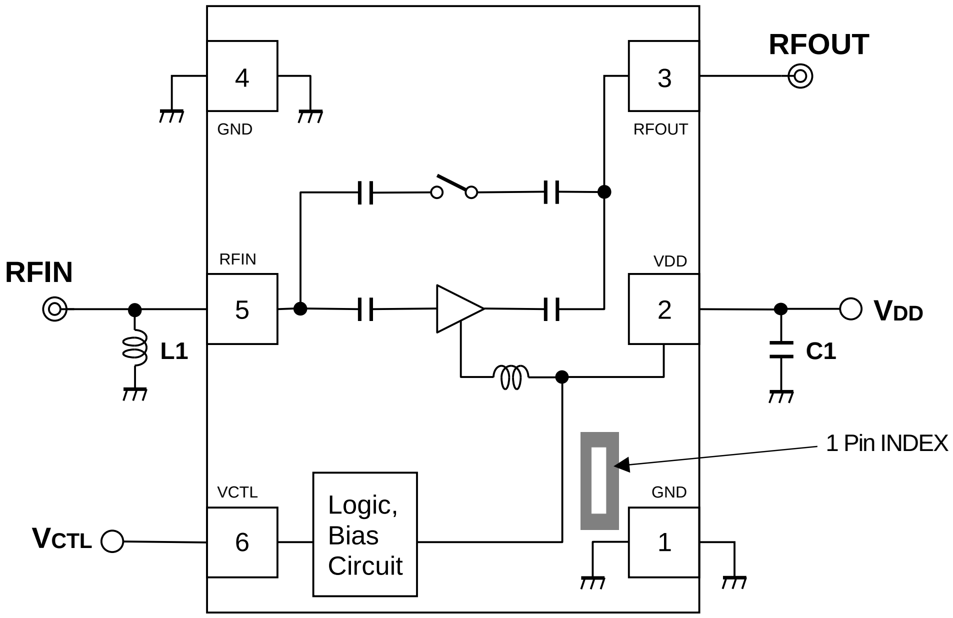


m3
freq=4.900GHz
S(2,2)=0.373 / -40.290
impedance = Z0 * (1.510 - j0.846)

m4
freq=5.950GHz
S(2,2)=0.485 / -128.876
impedance = Z0 * (0.415 - j0.409)

■ APPLICATION CIRCUIT

(Top view)



Parts list

Part ID	Value	Notes
L1	1.6nH	LQP03TN_02 series (MURATA)
C1	4700pF	GRM03 series (MURATA)

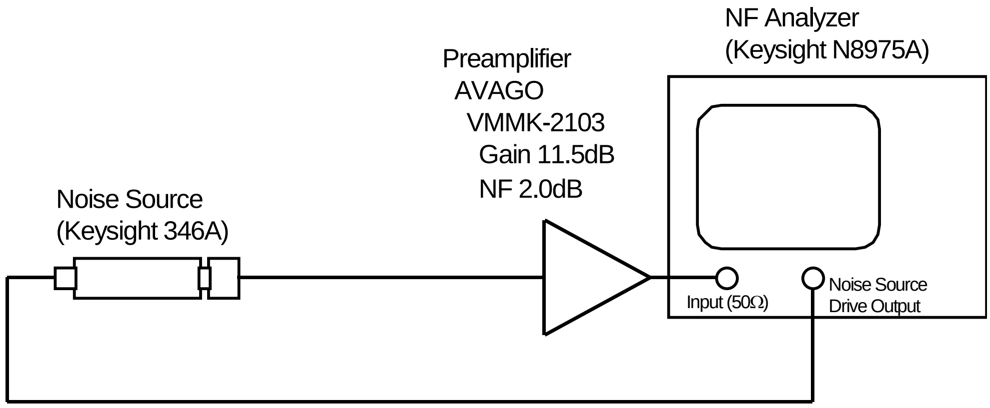
■ NF MEASUREMENT BLOCK DIAGRAM

Measuring instruments

NF Analyzer	: Keysight N8975A
Noise Source	: Keysight 346A

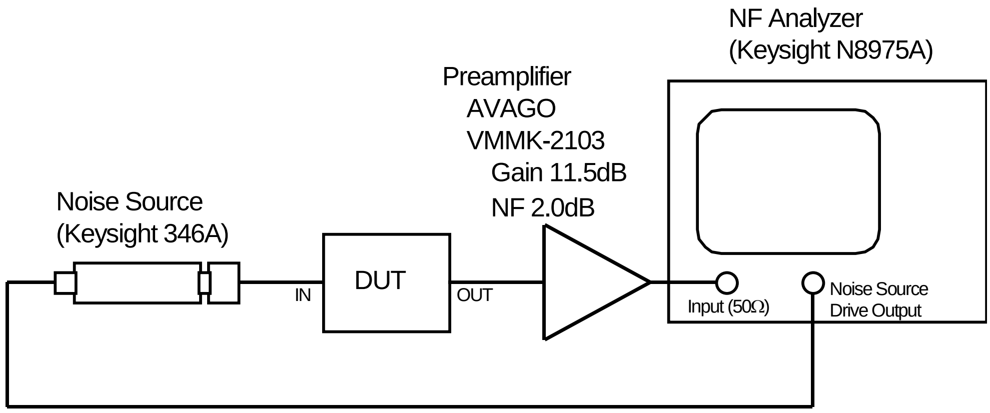
Setting the NF analyzer

Measurement mode form	
Device under test	: Amplifier
System downconverter	: off
Mode setup form	
Sideband	: LSB
Averages	: 16
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

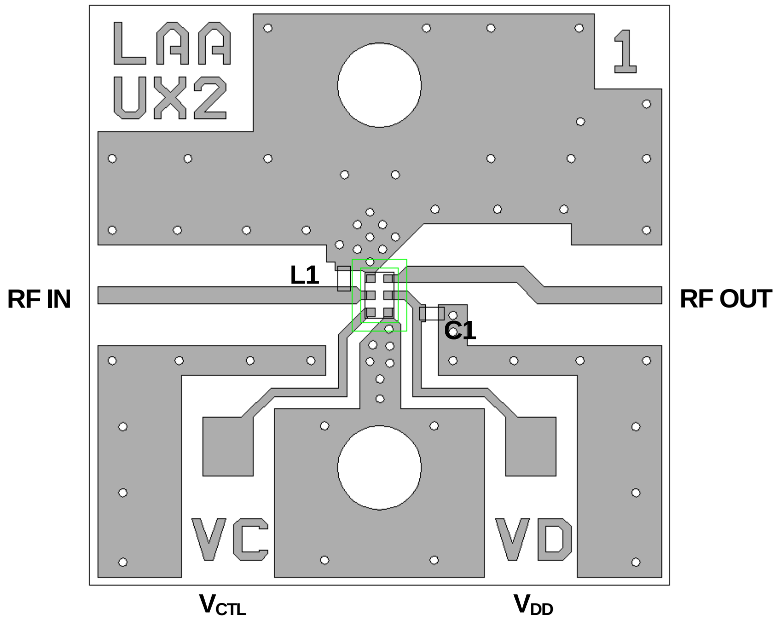


* Noise source, DUT, preamplifier and NF analyzer are connected directly.

Measurement Setup

■ EVALUATION BOARD

(Top View)



PCB Information

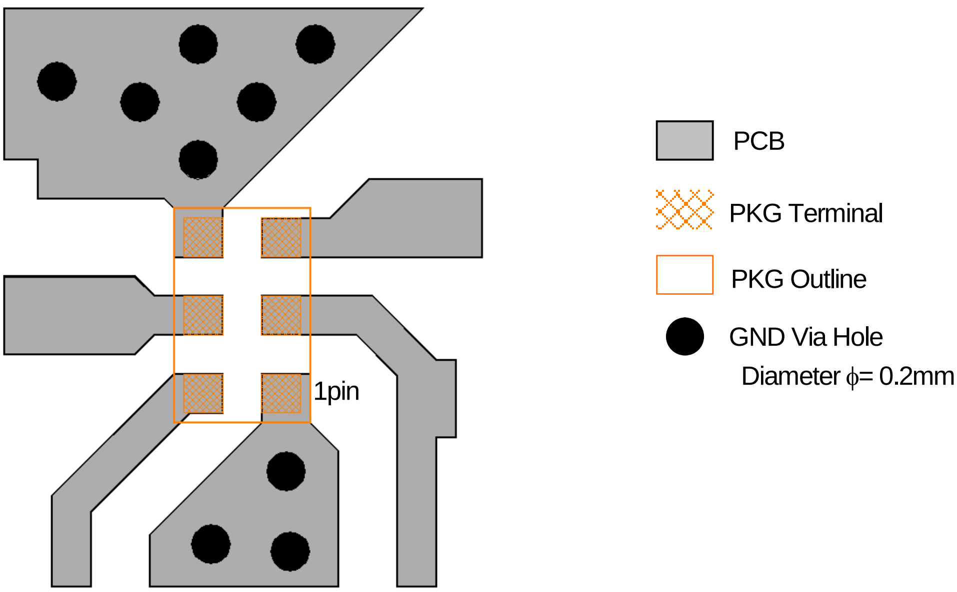
Substrate: FR-4

Thickness: 0.2mm

Microstrip line width: 0.4mm (Z_0=50Ω)

Size: 14.0mm x 14.0mm

< PCB LAYOUT GUIDELINE>



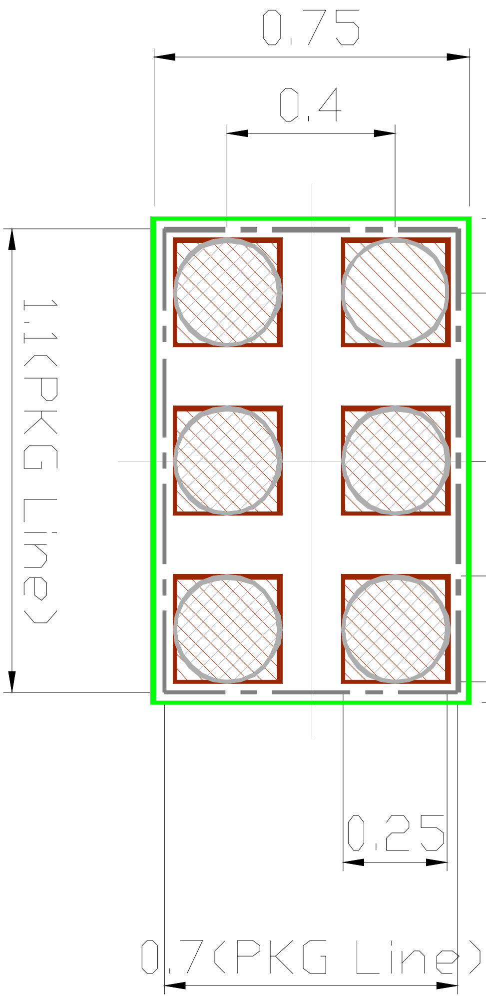
PRECAUTIONS

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

■ **RECOMMENDED FOOTPRINT PATTERN** (EPFFP6-X2)

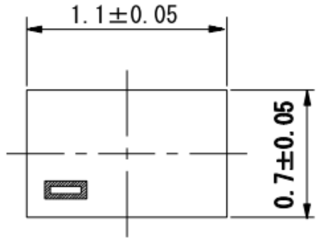
: Land
: Mask (Open area) *Metal mask thickness: 100 μm
: Resist (Open area)

Unit: mm

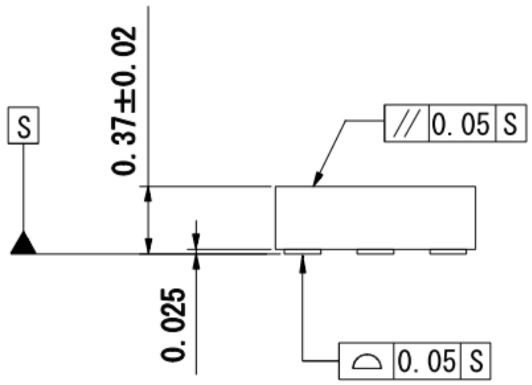


■ PACKAGE OUTLINE (EPFFP6-X2)

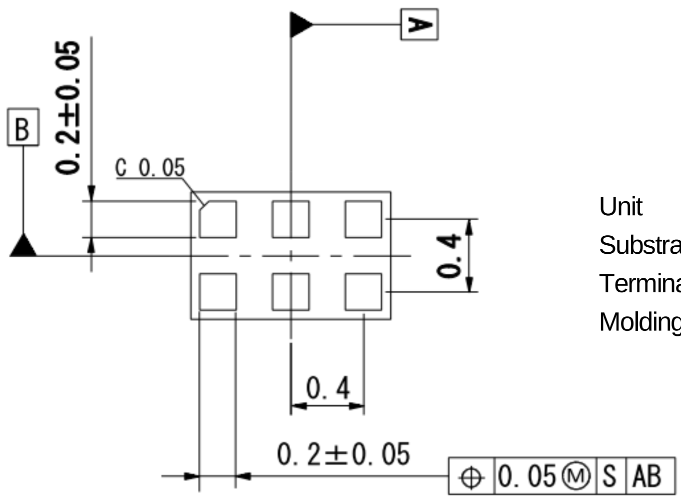
TOP VIEW



SIDE VIEW



BOTTOM VIEW

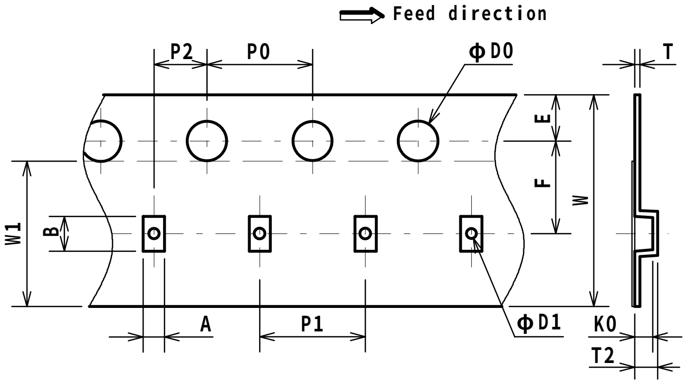


Unit	: mm
Substrate	: FR4
Terminal treat	: Ni/Pd/Au
Molding material	: Epoxy resin

■ PACKING SPECIFICATION (EPFFP6-X2)

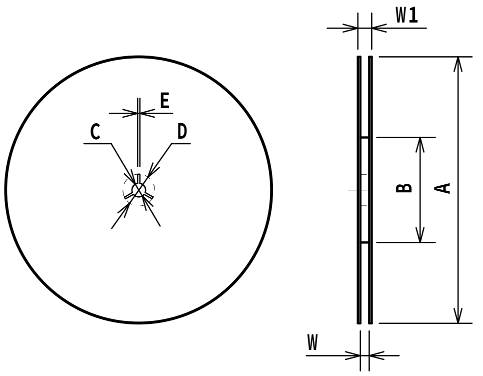
Unit: mm

TAPING DIMENSIONS



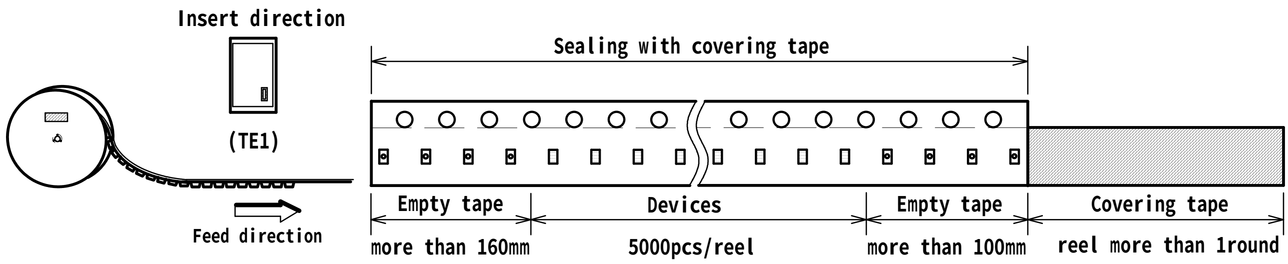
SYMBOL	DIMENSION	REMARKS
A	0.85±0.03	BOTTOM DIMENSION
B	1.25±0.03	BOTTOM DIMENSION
D0	1.5 $^{+0.1}_{0}$	
D1	0.35±0.05	
E	1.75±0.1	
F	3.5±0.05	
P0	4.0±0.1	
P1	4.0±0.1	
P2	2.0±0.05	
T	0.2±0.05	
T2	0.75	
K0	0.45±0.05	
W	8.0 $^{+0.3}_{-0.1}$	
W1	5.5	THICKNESS 0.1max

REEL DIMENSIONS

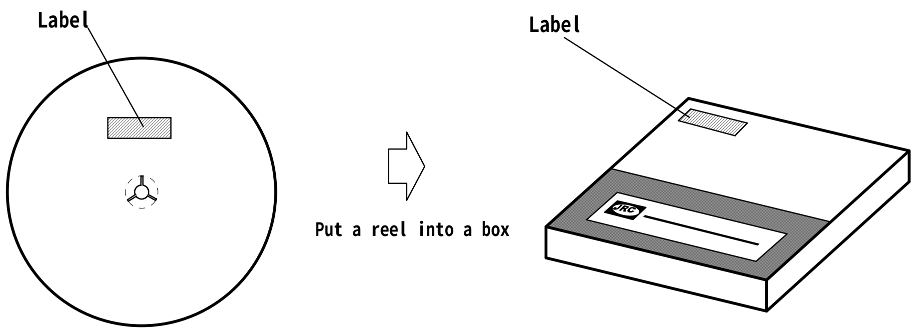


SYMBOL	DIMENSION
A	φ180 $^{0}_{-1.5}$
B	φ 60 $^{+1}_{0}$
C	φ 13±0.2
D	φ 21±0.8
E	2±0.5
W	9 $^{+0.3}_{0}$
W1	11.4±0.1

TAPING STATE



PACKING STATE



[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.