

## GNSS High Gain Low Noise Amplifier

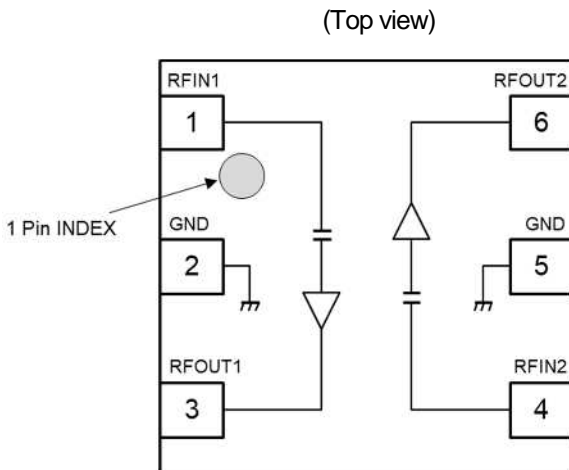
### ■ FEATURES

- Supply voltage 1.5 to 3.7 V
- Low current consumption 8 mA typ. @  $V_{DD} = 3.3$  V
- High gain
  - 34 dB typ. @ L1 band,  $V_{DD} = 3.3$  V
  - 37 dB typ. @ L2/5 band,  $V_{DD} = 3.3$  V
  - 36 dB typ. @ L6 band,  $V_{DD} = 3.3$  V
- Low noise figure
  - 0.60 dB typ. @ L1 band,  $V_{DD} = 3.3$  V
  - 0.65 dB typ. @ L2/5/6 band,  $V_{DD} = 3.3$  V
- Small package size
  - 1.6 mm x 1.6 mm x 0.397 mm typ.
- RoHS compliant and Halogen Free, MSL1

### ■ APPLICATION

- GNSS receive application
- Active antenna, dashboard camera, and navigation
- GNSS module

### ■ BLOCK DIAGRAM (ESON6-G1)



### ■ GENERAL DESCRIPTION

The NJG1187KG1 is a high gain low noise amplifier (LNA) designed for GNSS applications.

The NJG1187KG1 is available to be tuning for L1 (1.5 GHz) or L2/5/6 (1.1 to 1.2 GHz) band by changing only value of external parts. This LNA is also available to place a filter between the two amplifier stages in order to realize high attenuation without degradation of noise figure.

This LNA operates in wide temperature range from -40 to +105°C. Integrated ESD protection device on each port achieves excellent ESD robustness.

The small and thin ESON6-G1 package is adopted.

### ■ PIN CONFIGURATION

PIN NO.	SYMBOL	DESCRIPTION
1	RFIN1	RF input terminal to 1st amp.
2	GND	Ground terminal
3	RFOUT1	RF output from 1st amp. and voltage supply terminal
4	RFIN2	RF input terminal to 2nd amp.
5	GND	Ground terminal
6	RFOUT2	RF output from 2nd amp. and voltage supply terminal
Exposed pad	-	Ground terminal

## ■ PRODUCT NAME INFORMATION

<u>NJG1187</u>	<u>KG1</u>	<u>(TE3)</u>
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Part number	Package	Taping form

## ■ ORDERING INFORMATION

PART NUMBER	PACKAGE OUTLINE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs.)
NJG1187KG1	ESON6-G1	Yes	Yes	Sn-Bi	1187	3.5	3,000

## ■ ABSOLUTE MAXIMUM RATINGS

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

PARAMETER	SYMBOL	RATINGS	UNIT
Supply voltage	$V_{DD}$	5.0	V
Input power	$P_{IN}^{(1)}$	+15	dBm
Power dissipation	$P_D^{(2)}$	1200	mW
Operating temperature	$T_{opr}$	-40 to +105	°C
Storage temperature	$T_{stg}$	-40 to +150	°C

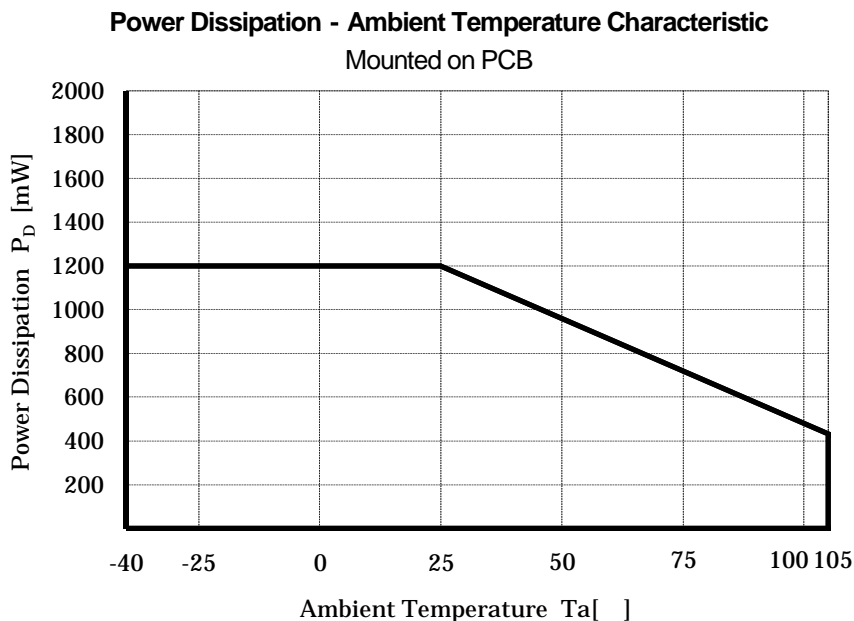
(1):  $V_{DD} = 3.3\ \text{V}$

(2): 4-layer FR4 PCB with through-hole (101.5 x 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.)



## ■ ELECTRICAL CHARACTERISTICS 1 (DC)

General conditions:  $T_a = +25^\circ\text{C}$ , with application circuit

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply voltage	$V_{DD}$		1.5	3.3	3.7	V
Operating current	$I_{DD}$	RF OFF, $V_{DD} = 3.3\text{ V}$	-	8.0	13.0	mA

## ■ ELECTRICAL CHARACTERISTICS 2 (RF)

General conditions:  $V_{DD} = 3.3\text{ V}$ ,  $f_{RF} = 1559\text{ to }1610\text{ MHz}$ ,  $T_a = +25^\circ\text{C}$ ,  $Z_s = Z_l = 50\ \Omega$ , with application circuit

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Small signal gain	Gain	$f = 1575\text{ MHz}$ (L1 band) Exclude PCB, Connector Losses (0.15 dB)	30.0	34.0	38.0	dB
Noise figure	NF	$f = 1575\text{ MHz}$ (L1 band) Exclude PCB, Connector Losses (0.08 dB)	-	0.60	0.95	dB
Isolation	ISL	$f = 1575\text{ MHz}$ (L1 band)	50	57	-	dB
Output power at 1 dB gain compression point	P-1dB(OUT)	$f = 1575\text{ MHz}$ (L1 band)	+7	+13	-	dBm
Output 3rd order intercept point	OIP3	$f_1 = 1575\text{ MHz}$ , $f_2 = f_1 + 1\text{ MHz}$ , $P_{IN} = -42\text{ dBm}$	+12	+17	-	dBm
RF IN return loss	RLi	$f = 1575\text{ MHz}$ (L1 band)	7	11	-	dB
RF OUT return loss	RLo	$f = 1575\text{ MHz}$ (L1 band)	7	13	-	dB
k factor	k	$f = 50\text{ MHz to }10\text{ GHz}$	1.0	-	-	-

## ■ ELECTRICAL CHARACTERISTICS 3 (RF)

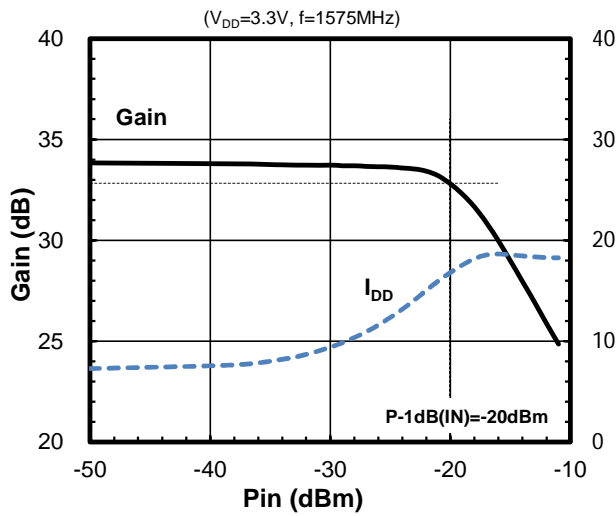
General conditions:  $V_{DD} = 3.3\text{ V}$ ,  $f_{RF} = 1164\text{ to }1300\text{ MHz}$ ,  $T_a = +25^\circ\text{C}$ ,  $Z_s = Z_l = 50\ \Omega$ , with application circuit

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Small signal gain	Gain	f = 1176 MHz (L5 band) Exclude PCB, Connector Losses (0.10 dB)	33.0	37.0	42.0	dB
		f = 1227 MHz (L2 band) Exclude PCB, Connector Losses (0.10 dB)	33.0	37.0	42.0	
		f = 1278 MHz (L6 band) Exclude PCB, Connector Losses (0.11 dB)	31.0	36.0	40.0	
Noise figure	NF	f = 1176 MHz (L5 band) Exclude PCB, Connector Losses (0.05 dB)	-	0.65	0.95	dB
		f = 1227 MHz (L2 band) Exclude PCB, Connector Losses (0.06 dB)	-	0.65	0.95	
		f = 1278 MHz (L6 band) Exclude PCB, Connector Losses (0.06 dB)	-	0.65	0.95	
Isolation	ISL	f = 1176 MHz (L5 band)	45	55	-	dB
		f = 1227 MHz (L2 band)	45	55	-	
		f = 1278 MHz (L6 band)	45	55	-	
Output power at 1 dB gain compression point	P-1dB(OUT)	f = 1176 MHz (L5 band)	+7	+12	-	dBm
		f = 1227 MHz (L2 band)	+7	+12	-	
		f = 1278 MHz (L6 band)	+7	+12	-	
Output 3rd order intercept point	OIP3	f1= 1176 MHz, f2 = f1 + 1 MHz, $P_{IN} = -42\text{ dBm}$	+13	+19	-	dBm
		f1= 1227 MHz, f2 = f1 + 1 MHz, $P_{IN} = -42\text{ dBm}$	+15	+20	-	
		f1= 1278 MHz, f2 = f1 + 1 MHz, $P_{IN} = -42\text{ dBm}$	+15	+20	-	
RF IN return loss	RLi	f = 1176 MHz (L5 band)	7	15	-	dB
		f = 1227 MHz (L2 band)	7	15	-	
		f = 1278 MHz (L6 band)	7	14	-	
RF OUT return loss	RLo	f = 1176 MHz (L5 band)	7	15	-	dB
		f = 1227 MHz (L2 band)	7	15	-	
		f = 1278 MHz (L6 band)	7	15	-	
k factor	k	f = 50 MHz to 10 GHz	1.0	-	-	-

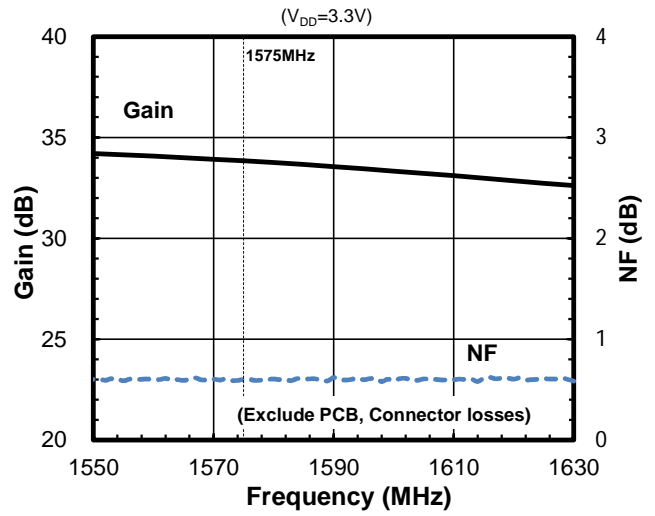
## ■ ELECTRICAL CHARACTERISTICS (L1 band application)

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

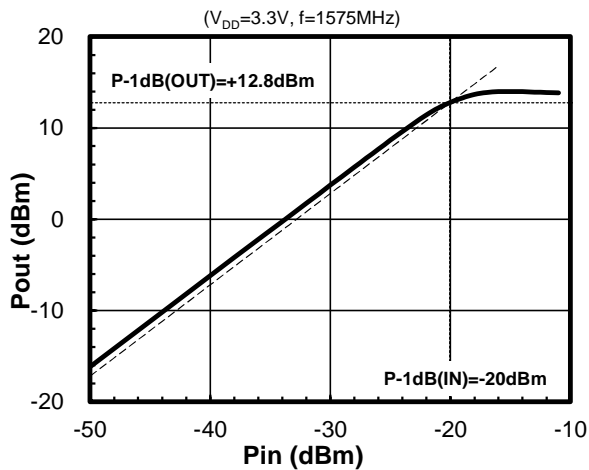
### Gain, $I_{DD}$ vs. Pin



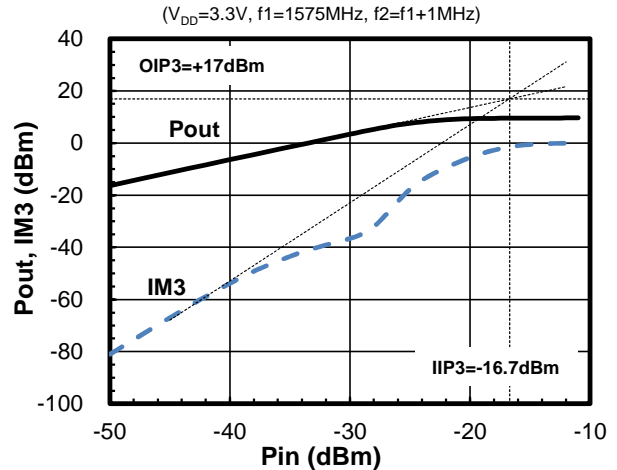
### Gain, NF vs. Frequency



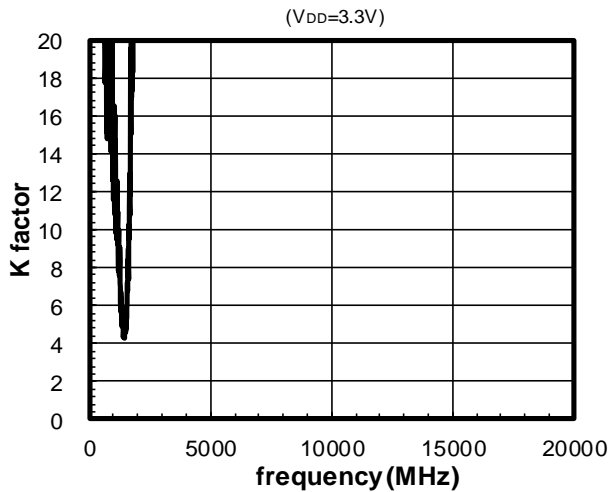
### Pout vs. Pin



### Pout, IM3 vs. Pin

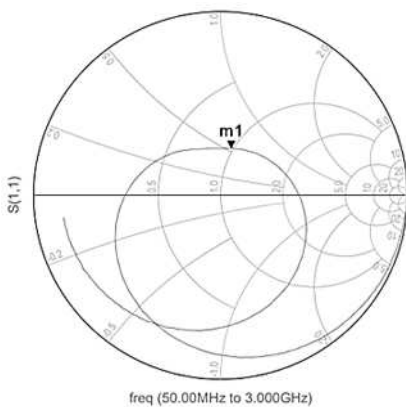
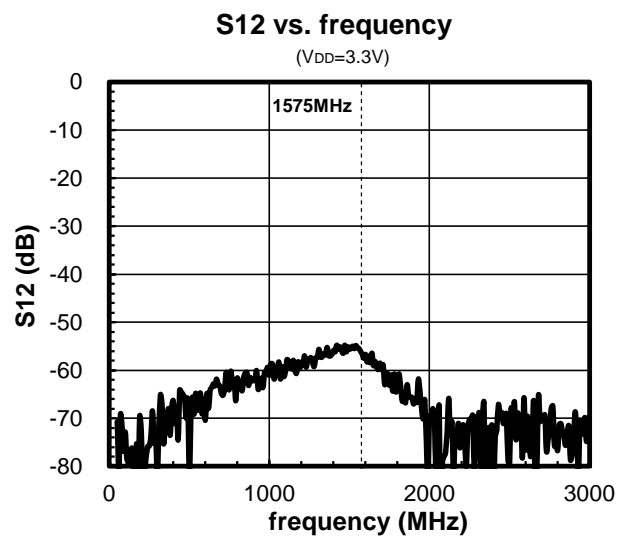
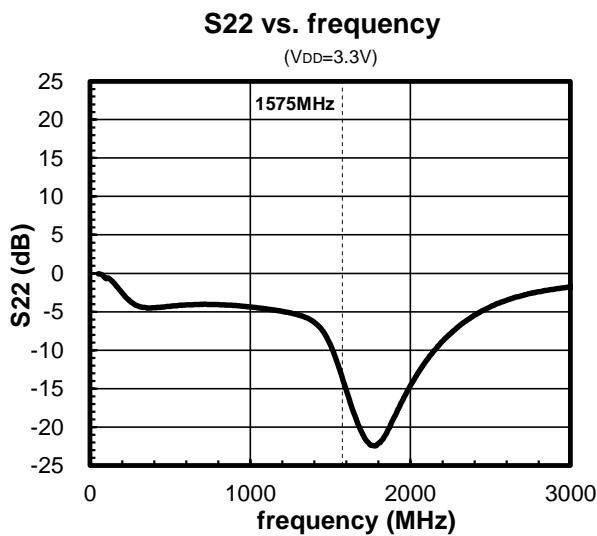
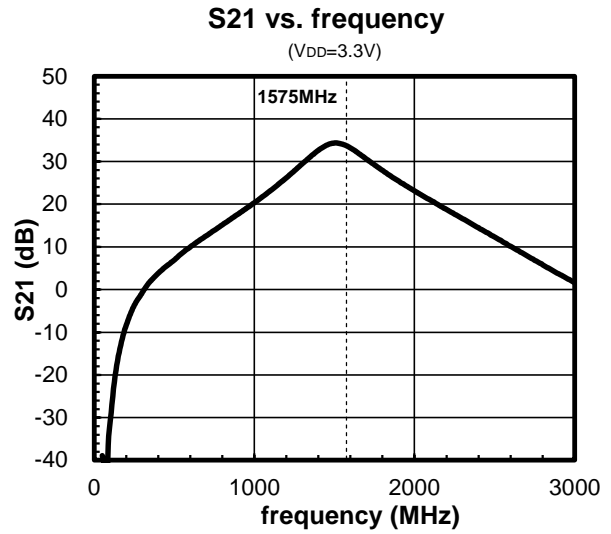
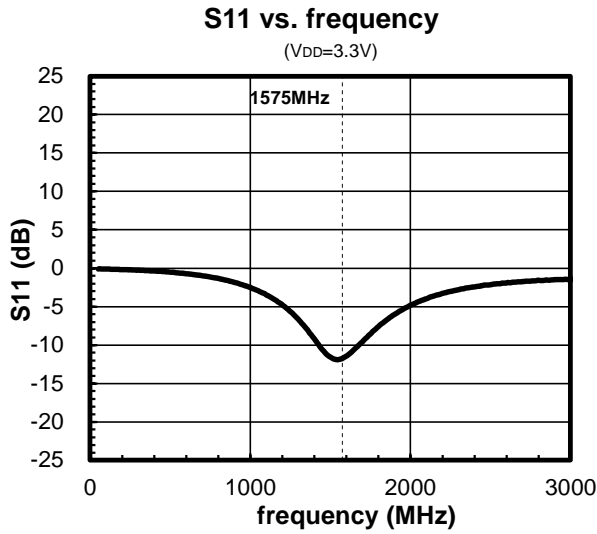


### K factor vs. frequency

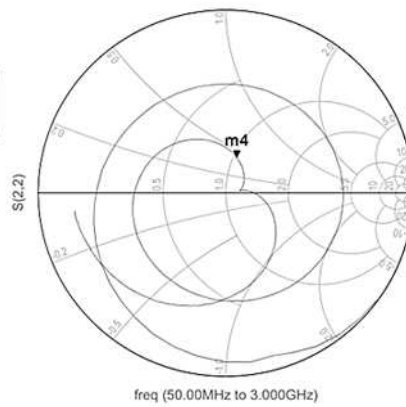


## ■ ELECTRICAL CHARACTERISTICS (L1 band application)

Conditions:  $V_{DD} = 3.3\text{ V}$ ,  $f_{RF} = 50\text{ MHz to }3\text{ GHz}$ ,  $T_a = +25^\circ\text{C}$ ,  $Z_s = Z_l = 50\ \Omega$ , with application circuit



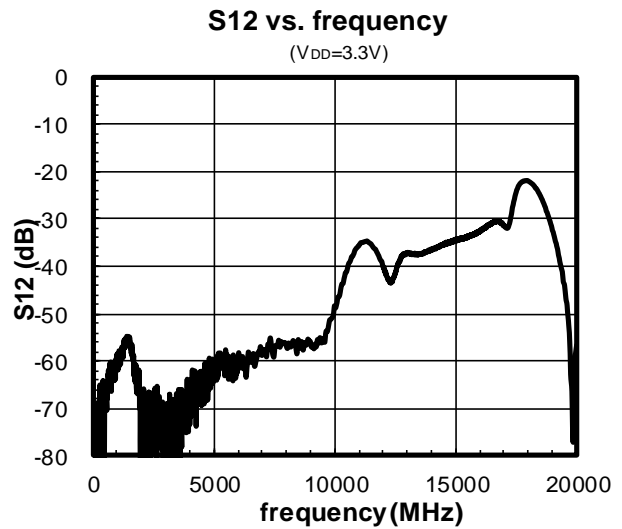
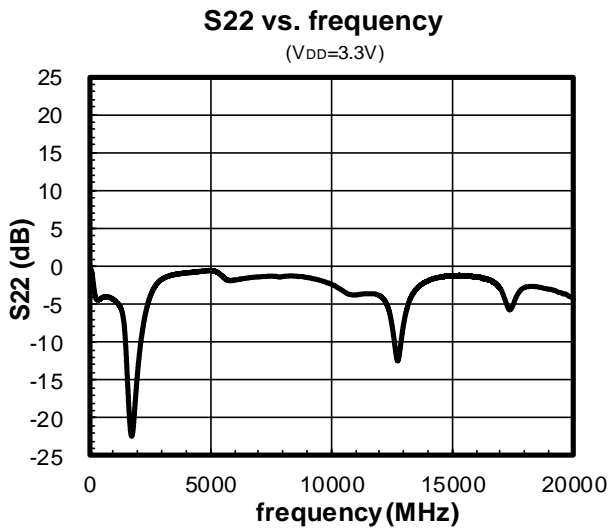
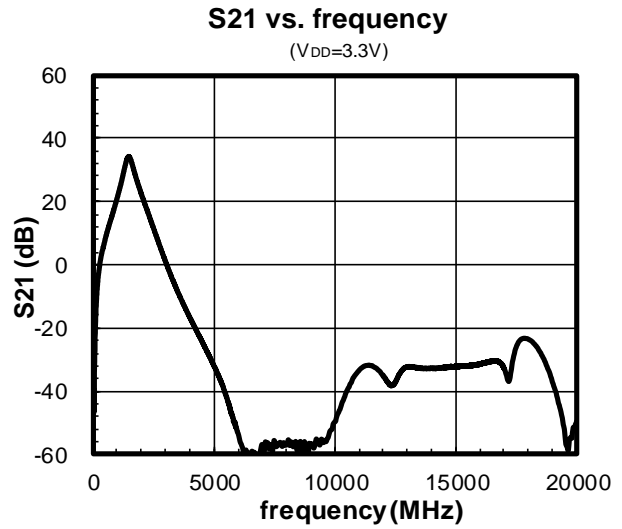
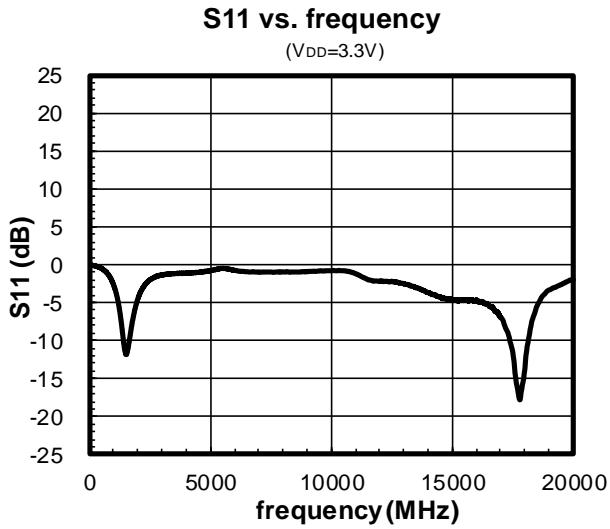
m1  
freq=1.580GHz  
S(1,1)=0.260 / 77.416  
impedance =  $Z_0 \cdot (0.977 + j0.532)$



m4  
freq=1.580GHz  
S(2,2)=0.200 / 72.970  
impedance =  $Z_0 \cdot (1.040 + j0.415)$

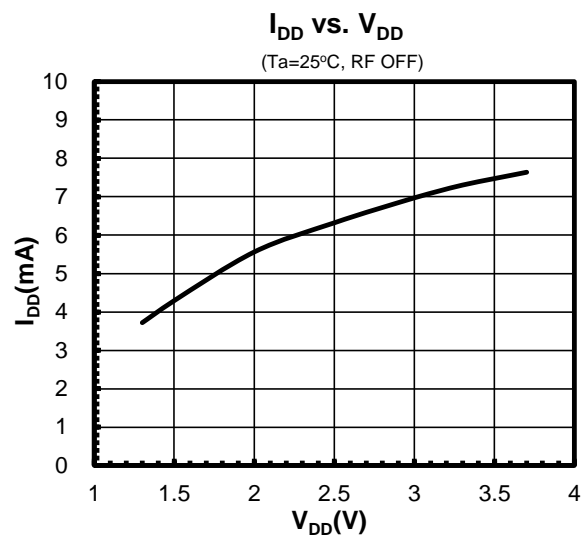
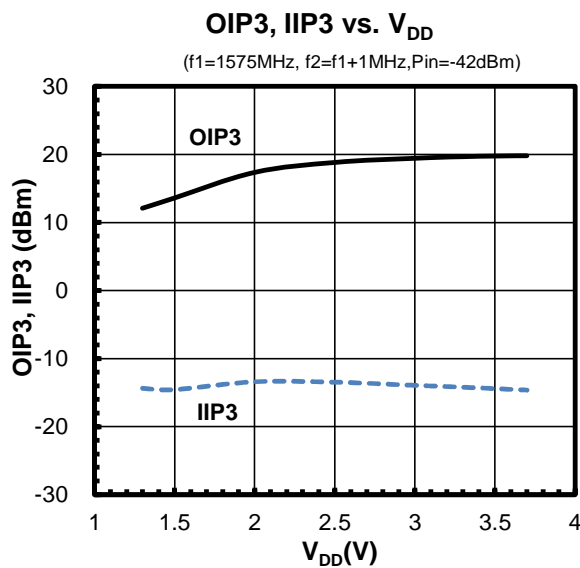
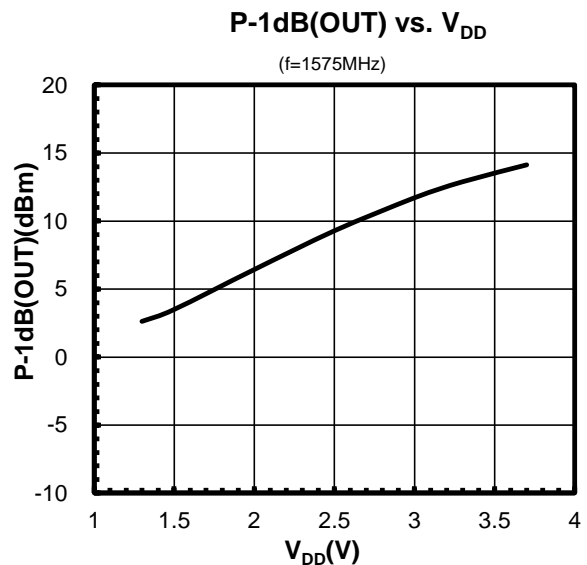
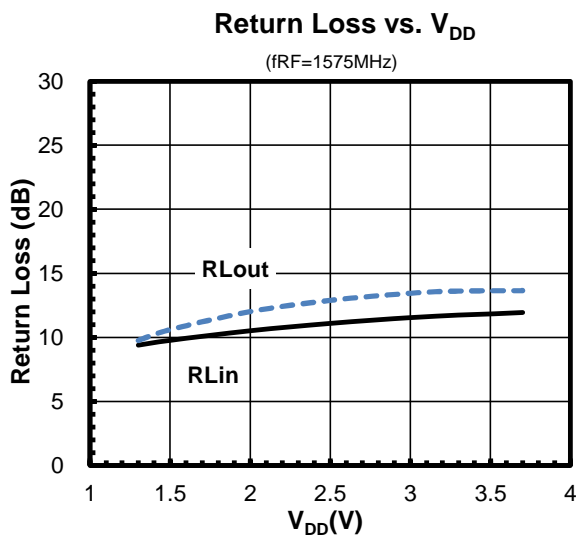
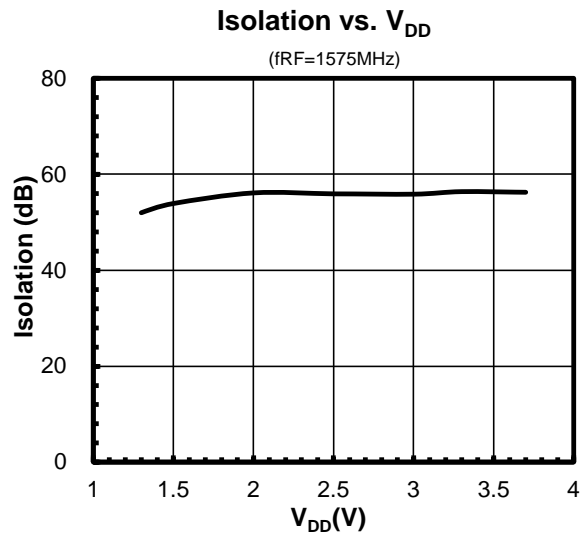
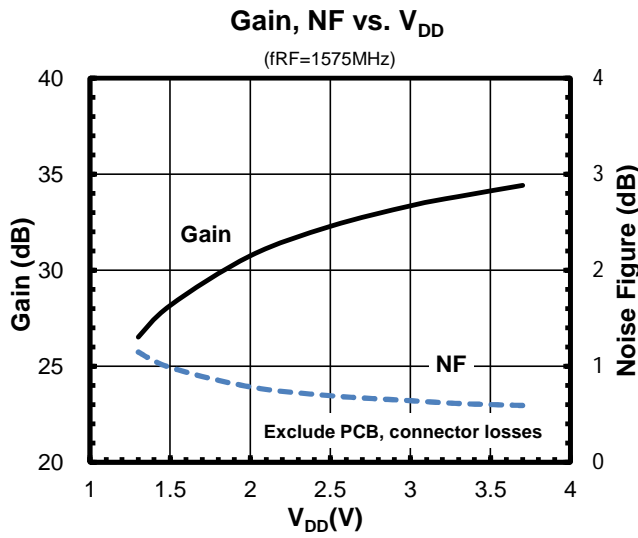
■ ELECTRICAL CHARACTERISTICS (L1 band application)

Conditions:  $V_{DD} = 3.3\text{ V}$ ,  $f_{RF} = 50\text{ MHz to } 20\text{ GHz}$ ,  $T_a = +25^\circ\text{C}$ ,  $Z_s = Z_l = 50\ \Omega$ , with application circuit



## ■ ELECTRICAL CHARACTERISTICS (L1 band application)

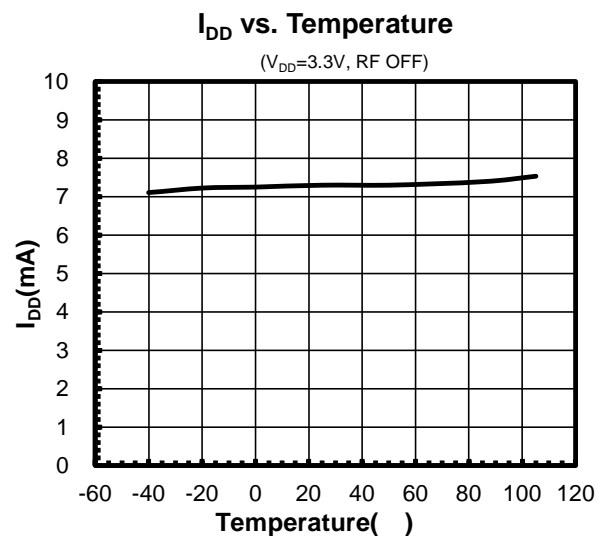
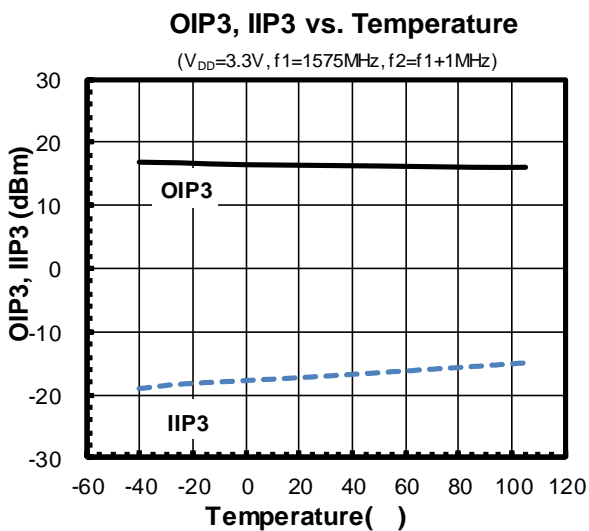
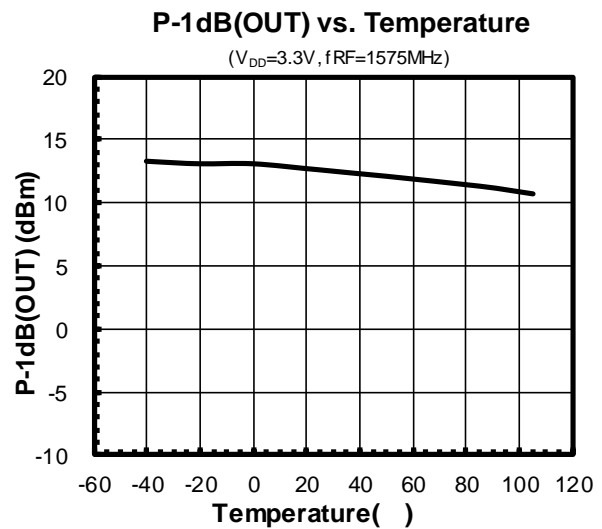
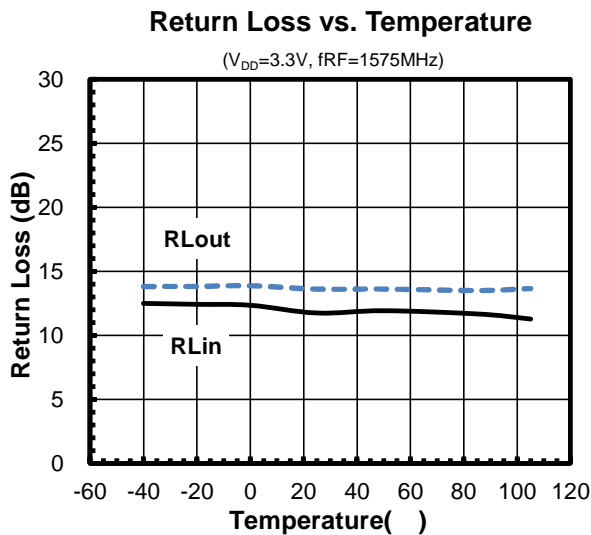
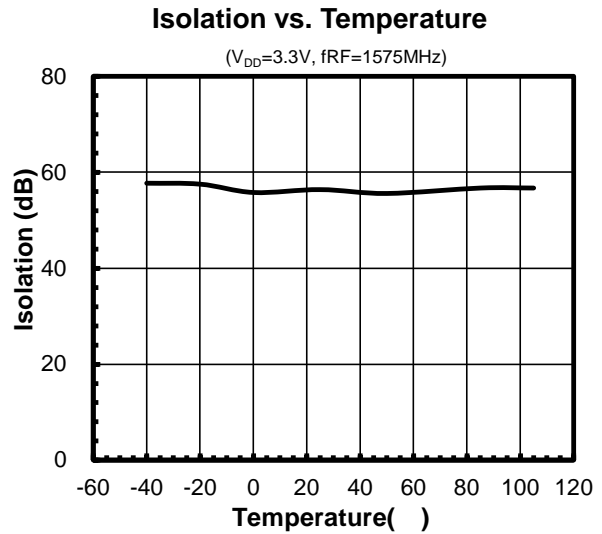
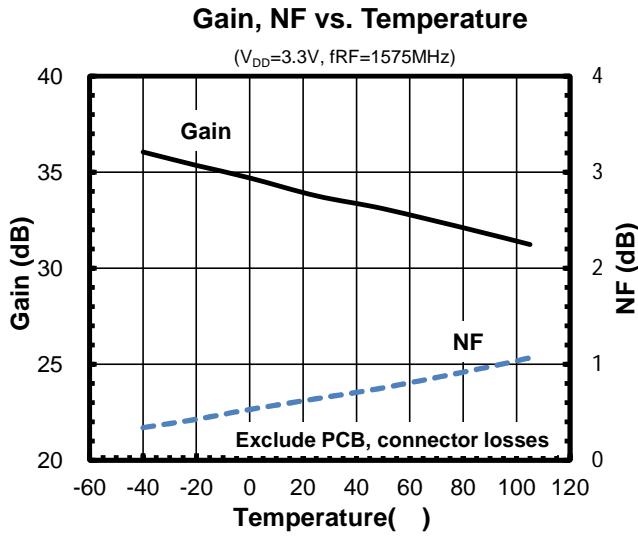
Conditions:  $T_a = +25^\circ\text{C}$ ,  $Z_s = Z_l = 50 \Omega$ , with application circuit





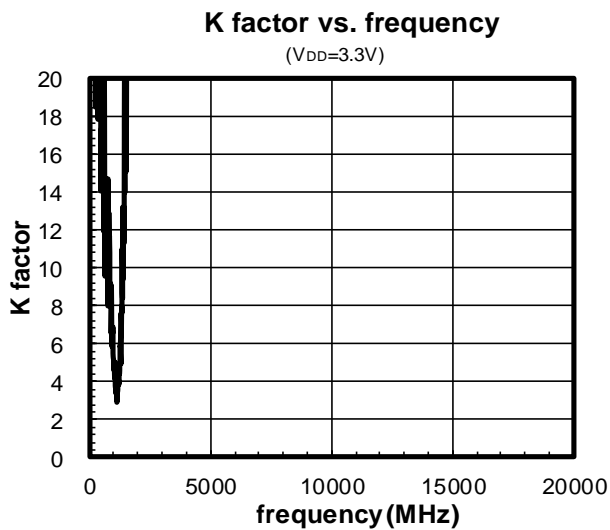
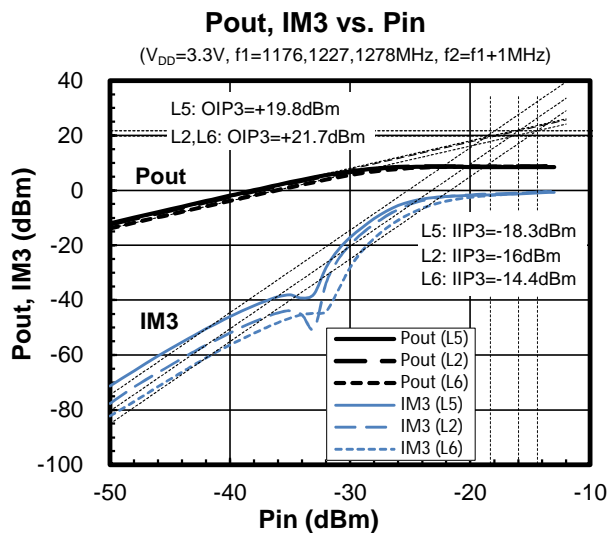
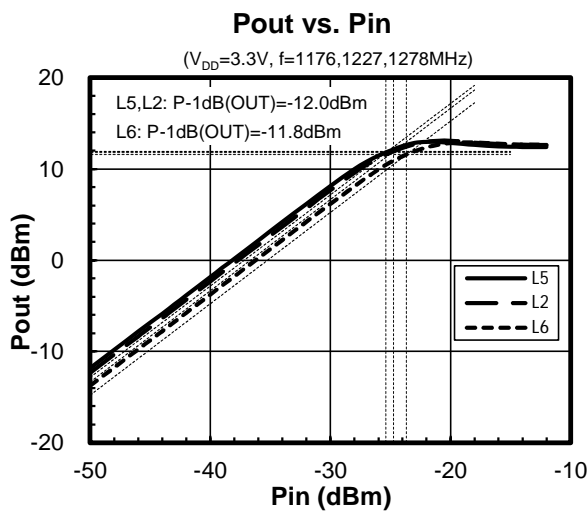
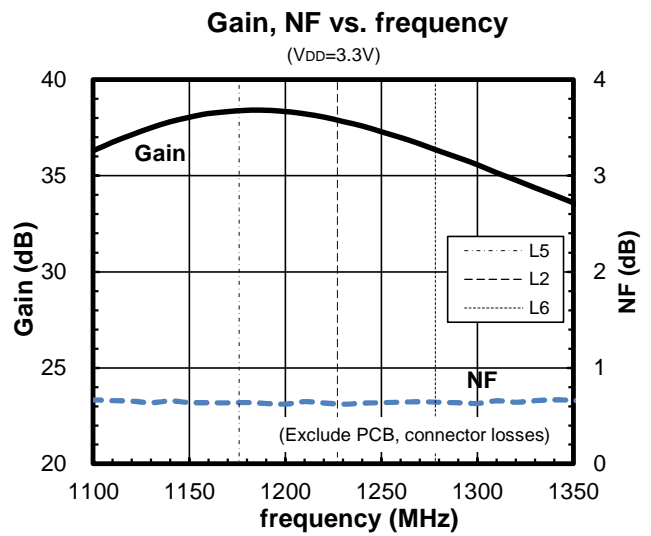
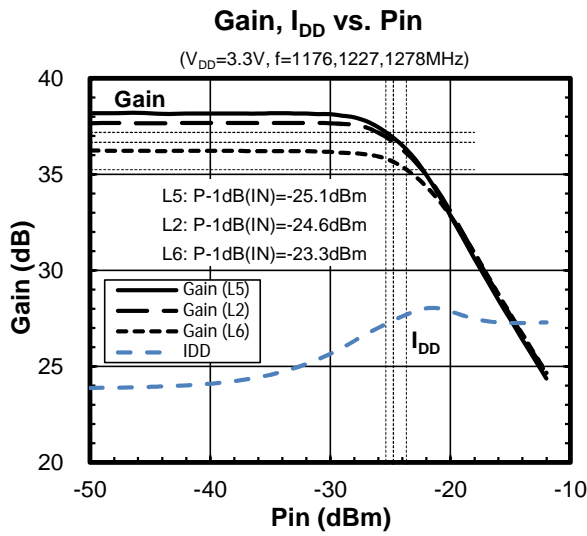
## ELECTRICAL CHARACTERISTICS (L1 band application)

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



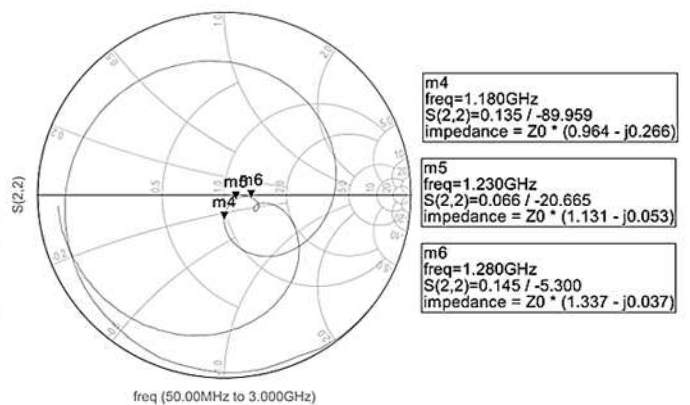
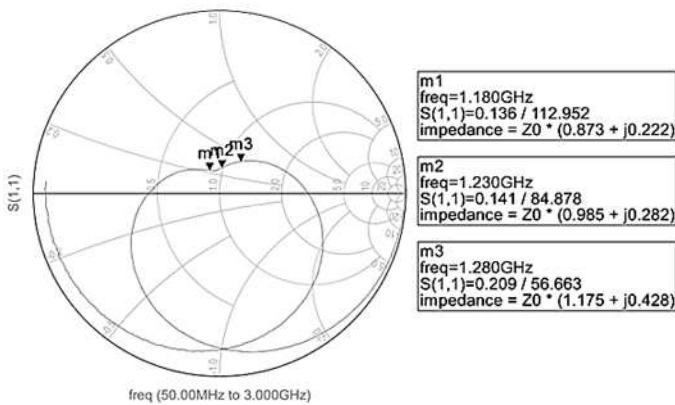
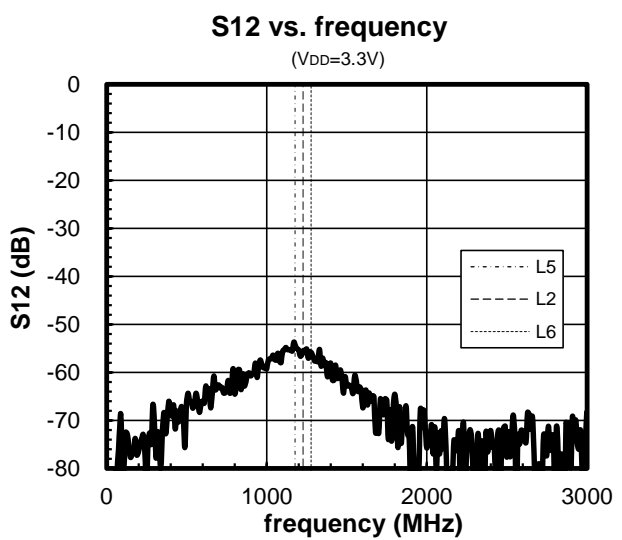
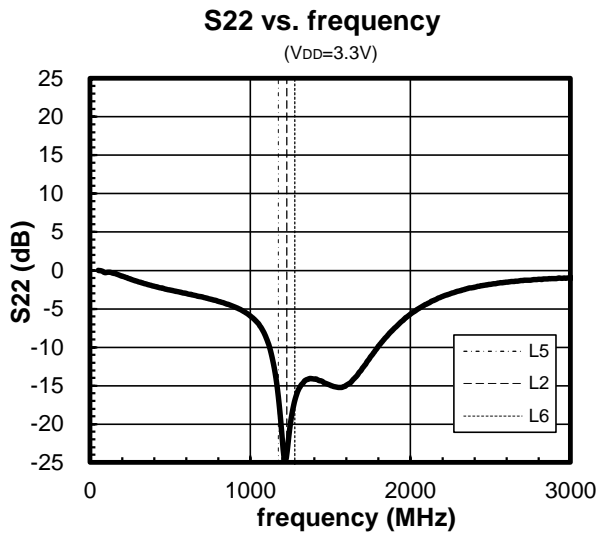
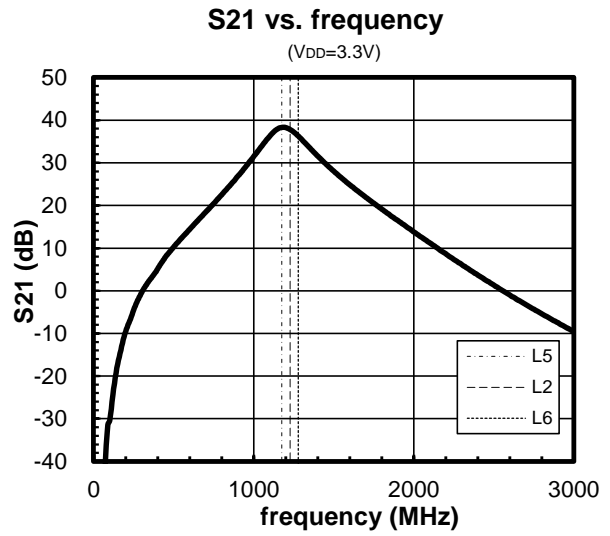
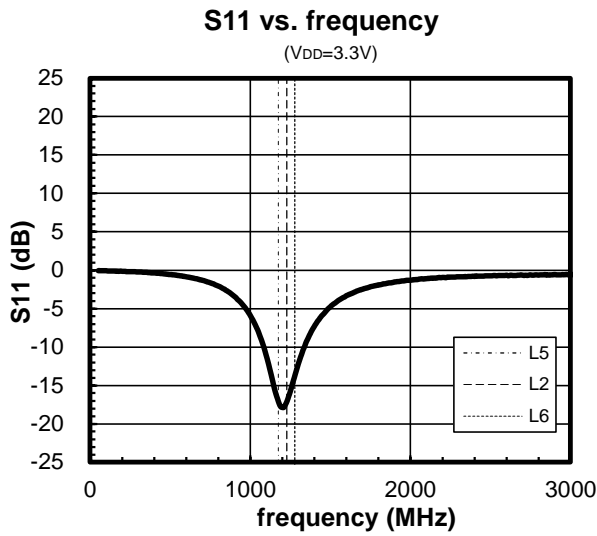
## ■ ELECTRICAL CHARACTERISTICS (L2/5/6 band application)

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



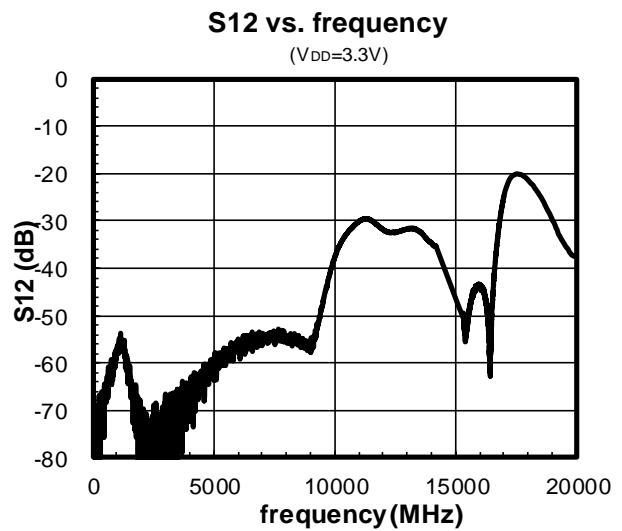
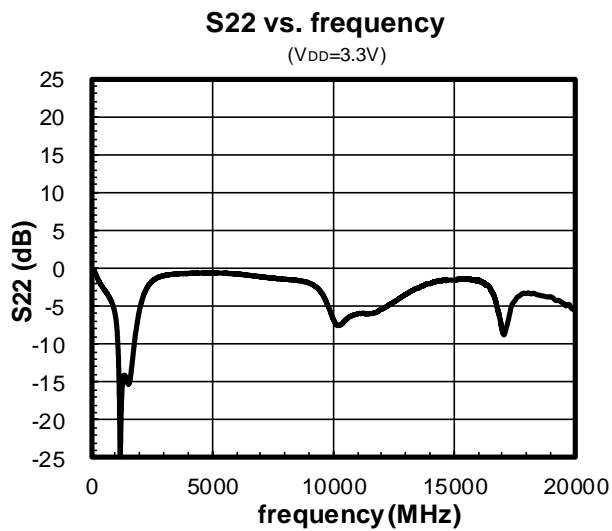
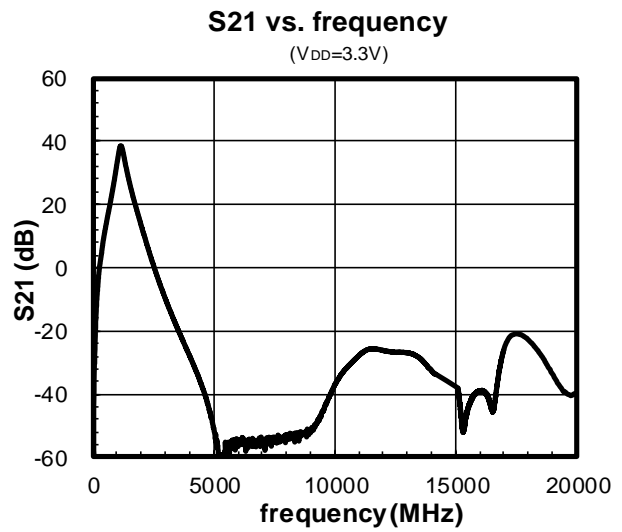
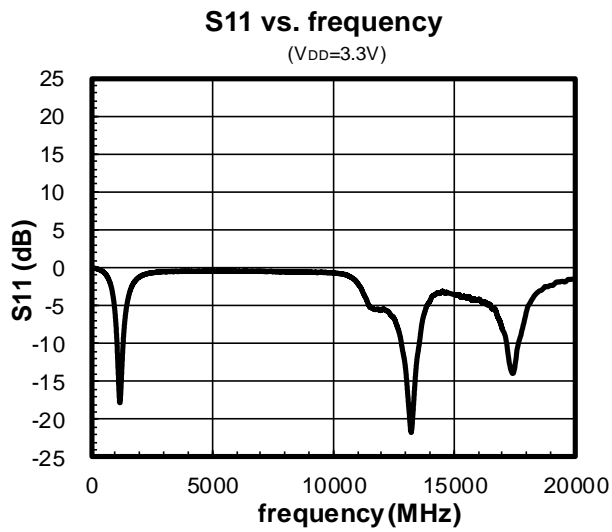
## ■ ELECTRICAL CHARACTERISTICS (L2/5/6 band application)

Conditions:  $V_{DD} = 3.3\text{ V}$ ,  $f_{RF} = 50\text{ MHz to }3\text{ GHz}$ ,  $T_a = +25^\circ\text{C}$ ,  $Z_s = Z_l = 50\ \Omega$ , with application circuit



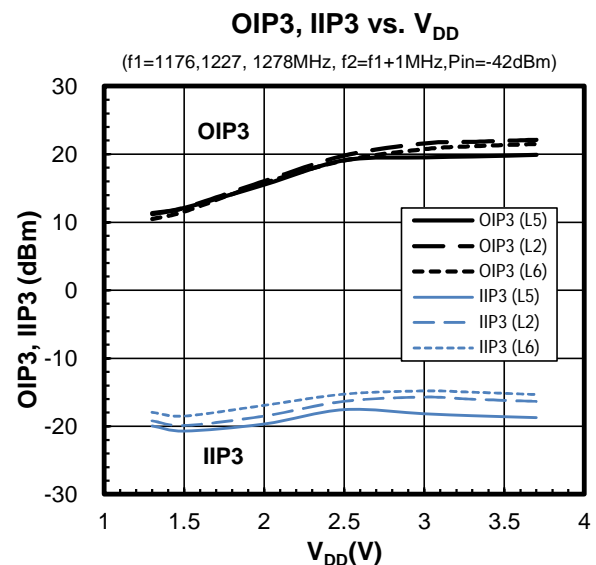
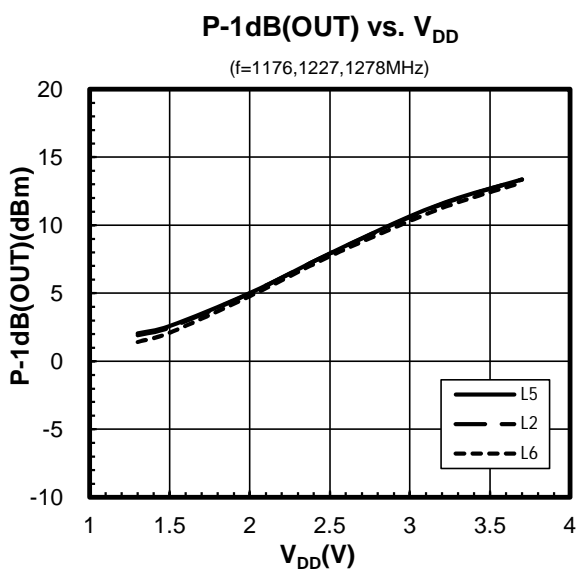
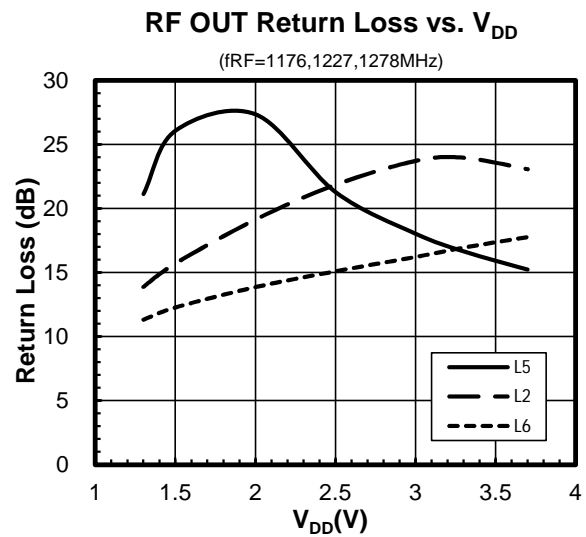
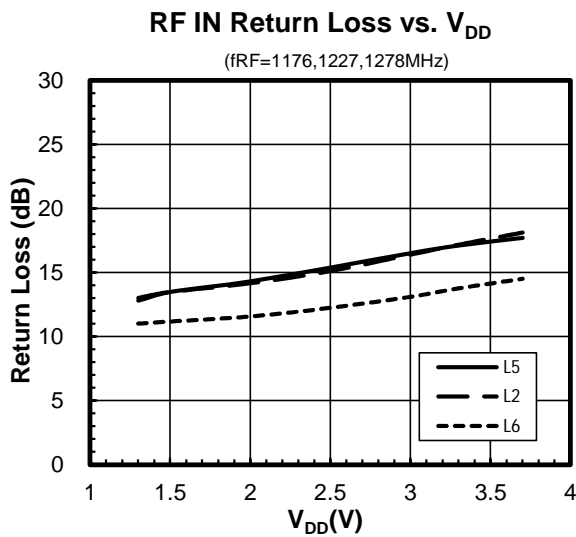
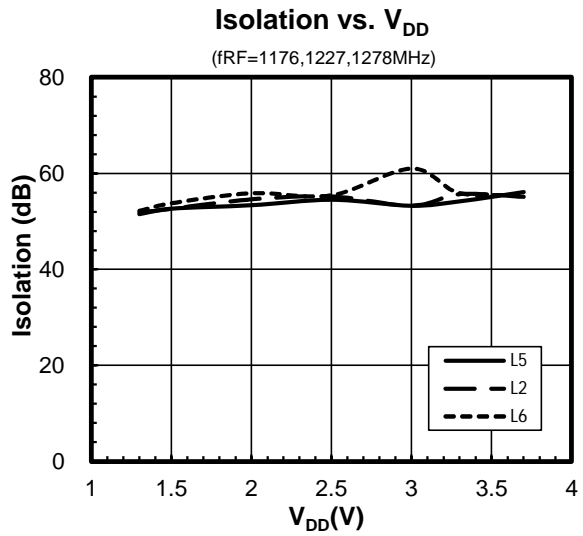
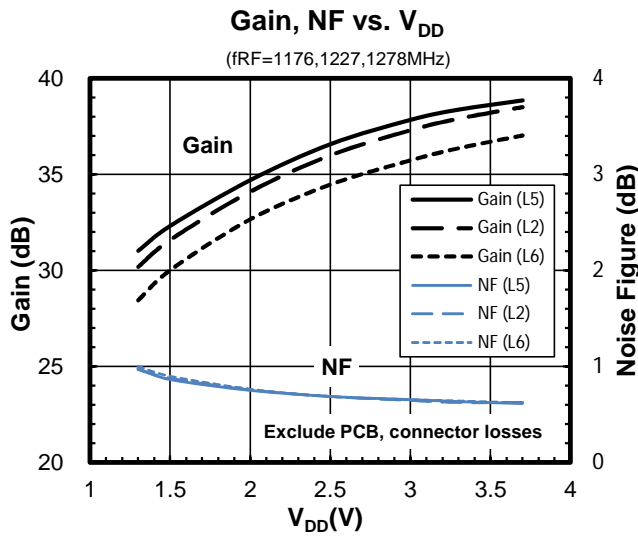
■ **ELECTRICAL CHARACTERISTICS** (L2/5/6 band application)

Conditions:  $V_{DD} = 3.3\text{ V}$ ,  $f_{RF} = 50\text{ MHz to } 20\text{ GHz}$ ,  $T_a = +25^\circ\text{C}$ ,  $Z_s = Z_l = 50\ \Omega$ , with application circuit



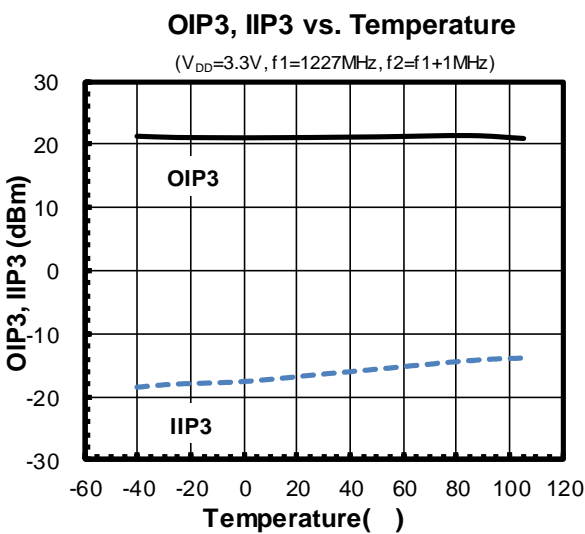
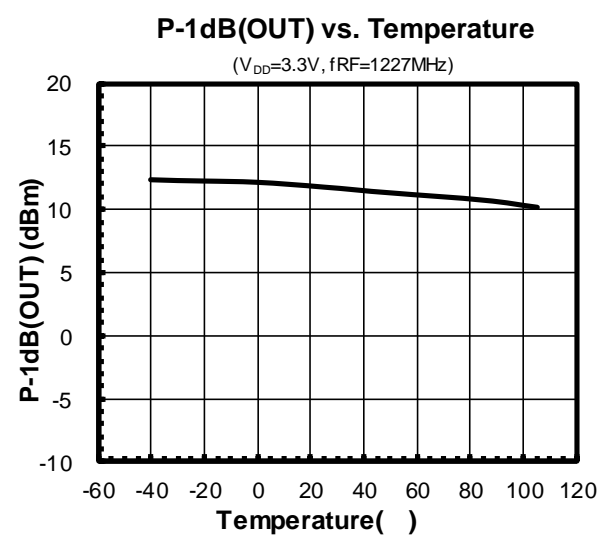
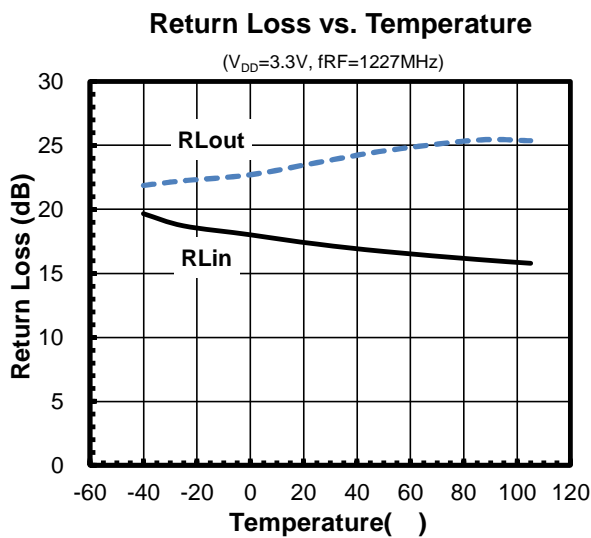
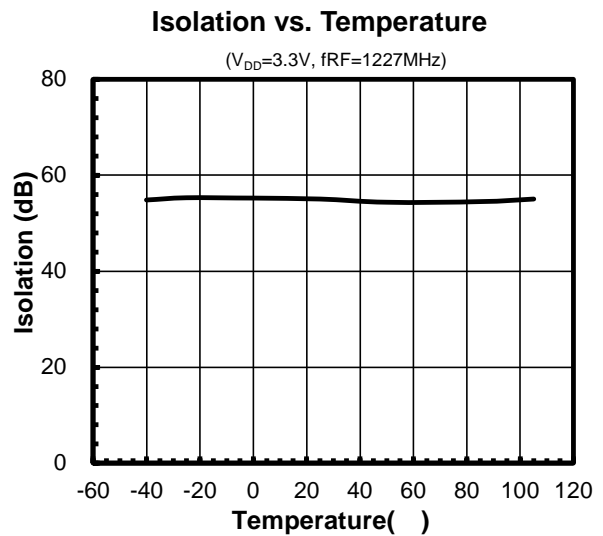
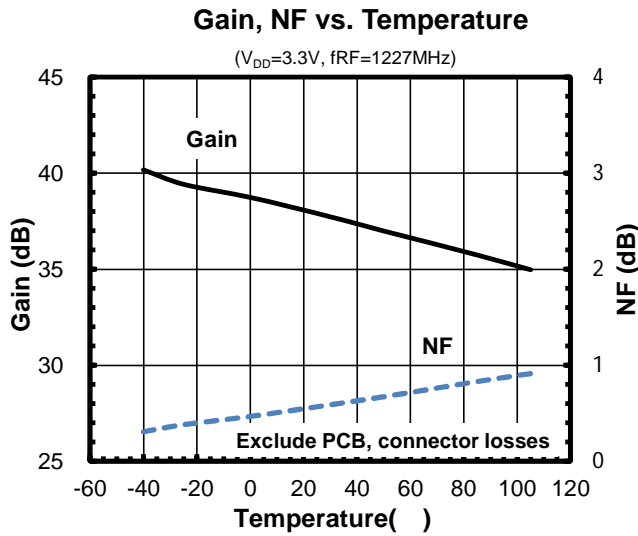
## ■ ELECTRICAL CHARACTERISTICS (L2/5/6 band application)

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

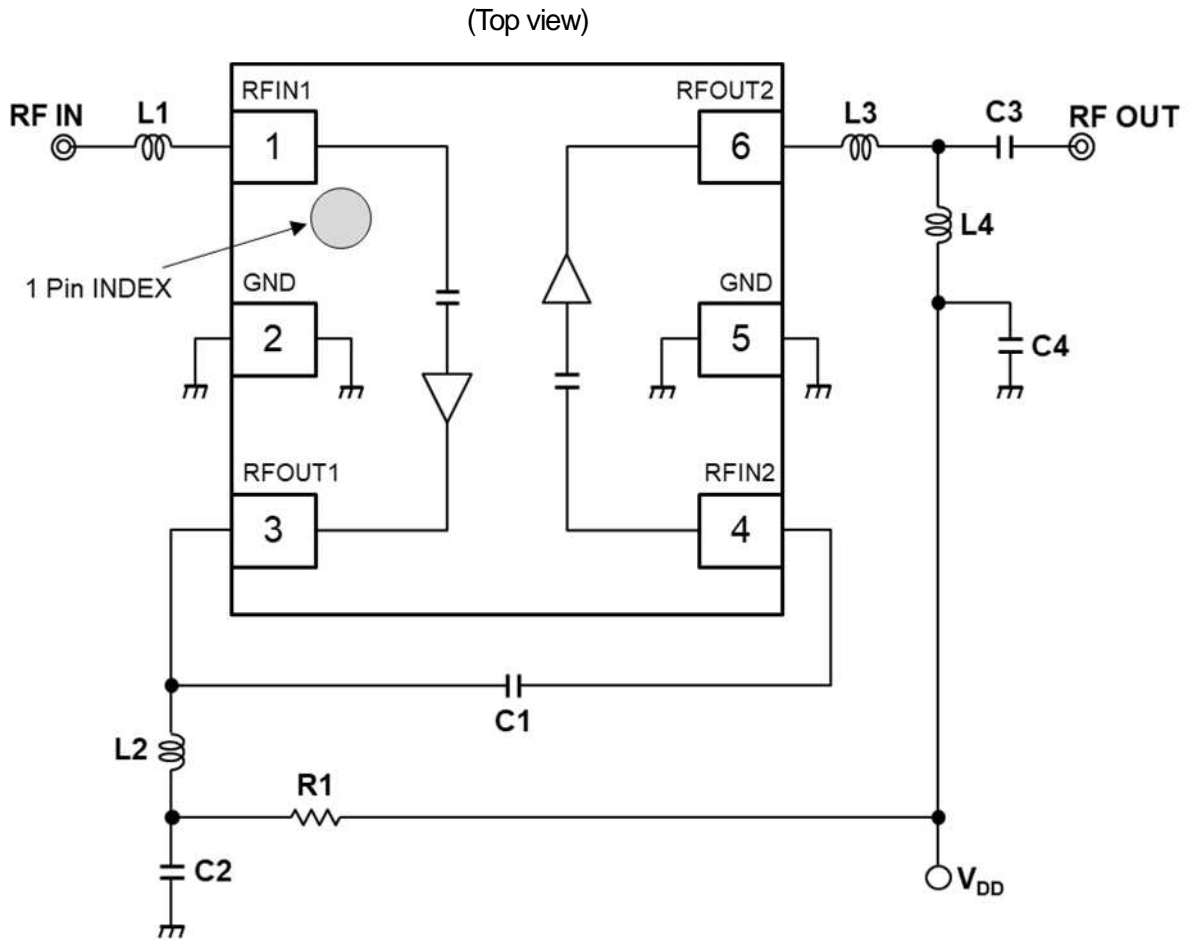


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Conditions:  $V_{DD} = 3.3\text{ V}$ ,  $Z_s = Z_l = 50\ \Omega$ , with application circuit



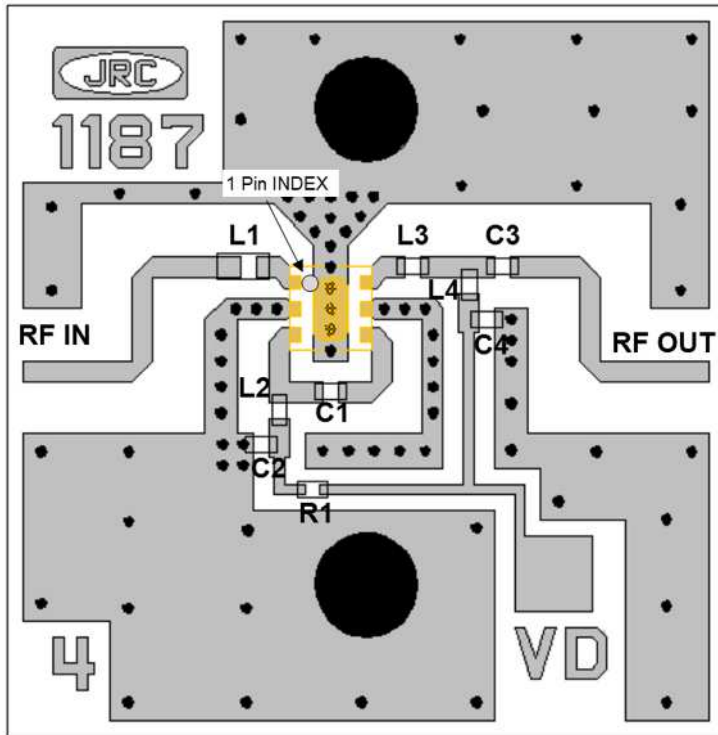
## APPLICATION CIRCUIT



### <PARTS LIST>

Part ID	Value		Notes
	1559 to 1610 MHz (L1 band)	1164 to 1300 MHz (L2/5/6 band)	
L1	10 nH	16 nH	LQW15AN_00 Series (Murata)
L2	4.7 nH	8.2 nH	LQP03TN_02 Series (Murata)
L3	6.8 nH	9.1 nH	
L4	27 nH	12 nH	
C1	3.3 pF	2.2 pF	GRM03 Series (Murata)
C2	1000 pF	1000 pF	
C3	18 pF	18 pF	
C4	1000 pF	1000 pF	
R1	180 Ω	180 Ω	0603 size

## ■ EVALUATION BOARD



### PCB

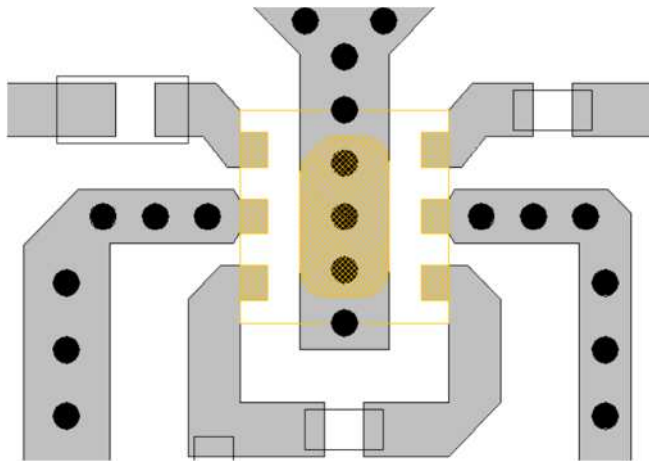
Substrate: FR-4

Thickness: 0.2 mm

Microstrip line width: 0.4 mm ( $Z_0 = 50 \Omega$ )

Size: 14.0 mm x 14.0 mm

### <PCB LAYOUT GUIDELINE>



PCB

PKG Terminal

PKG Outline

GND Via Hole  
Diameter  $\phi = 0.2$  mm

### PRECAUTIONS

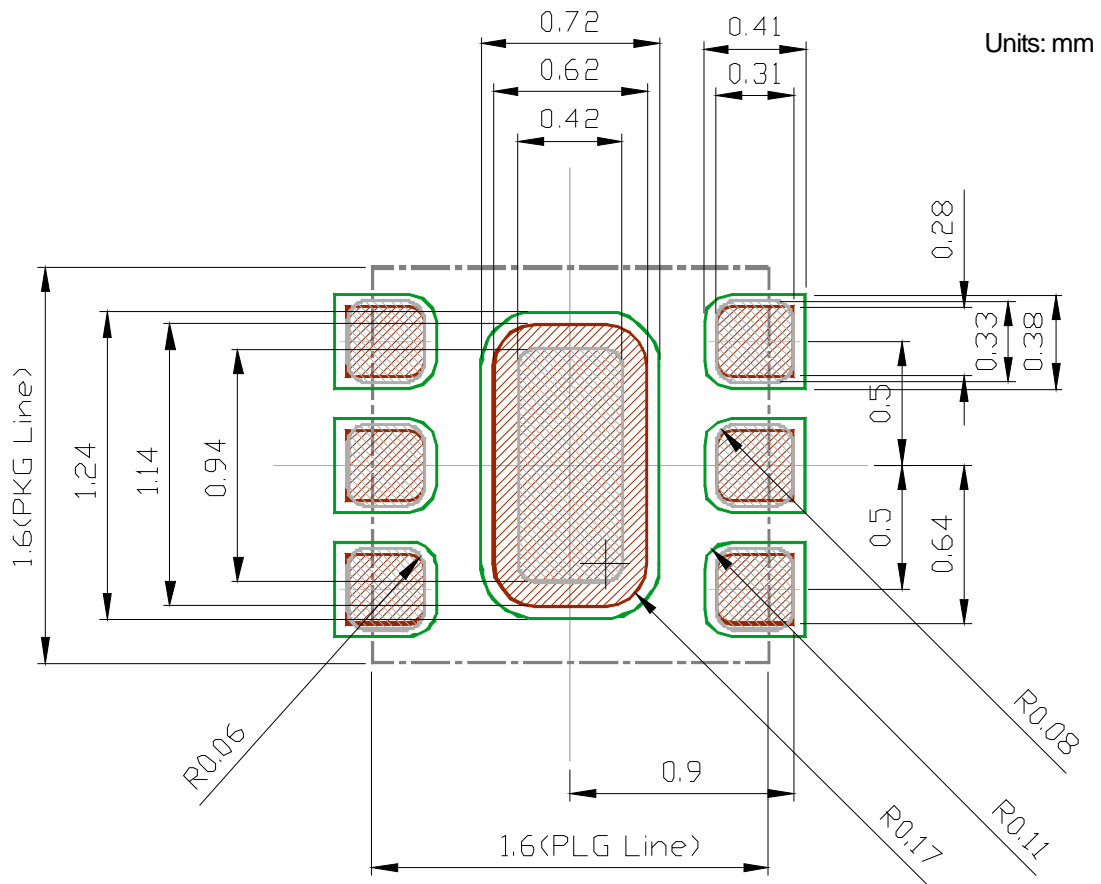
- All external parts should be placed as close as possible to the IC.
- For good RF performance, all GND terminals must be connected to PCB ground plane of substrate, and via-holes for GND should be placed near the IC.



## 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

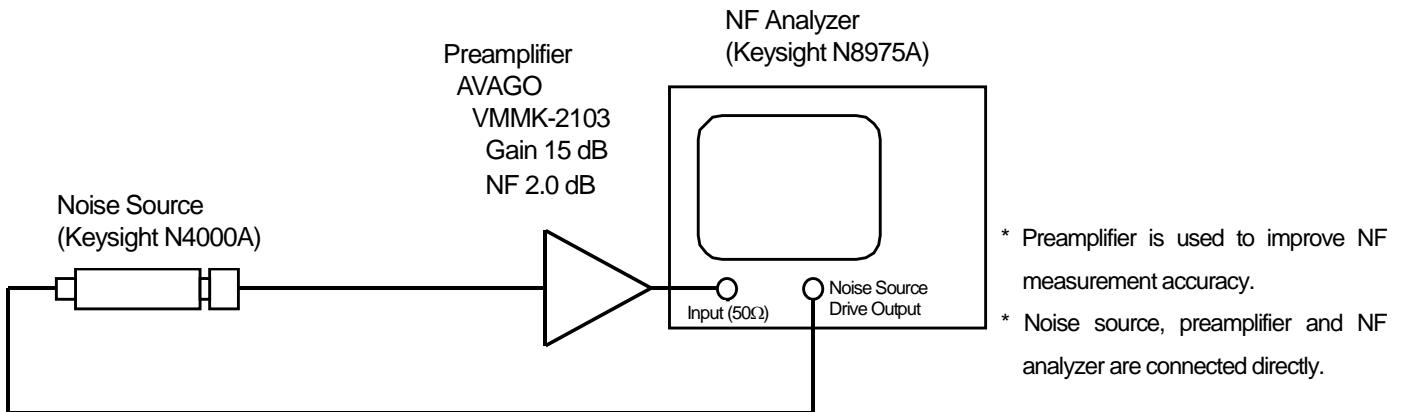
### Measuring instruments

NF Analyzer : Keysight N8975A  
 Noise Source : Keysight N4000A

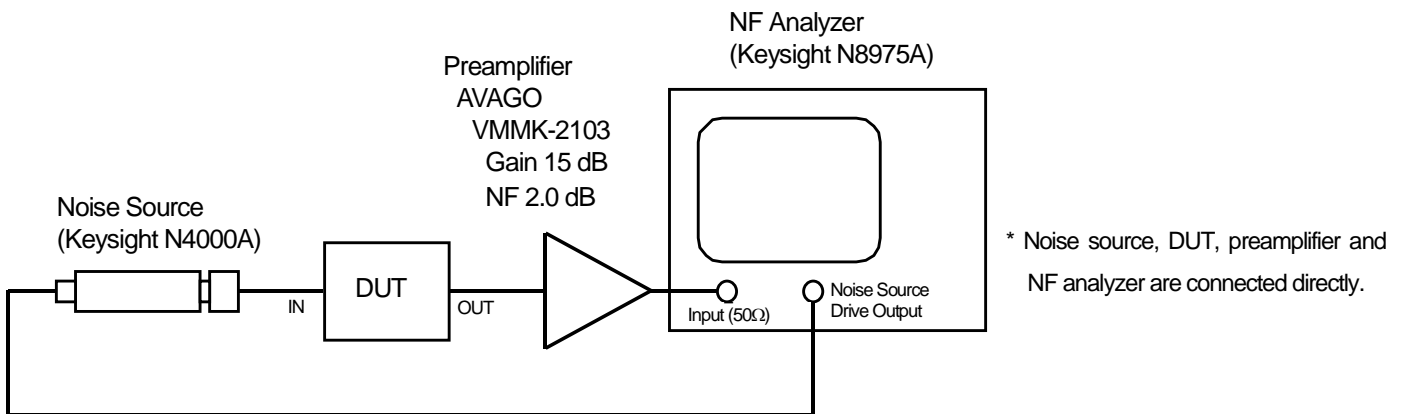
### Setting the NF analyzer

Measurement mode form  
 Device under test : Amplifier  
 System downconverter : off

Mode setup form  
 Sideband : LSB  
 Averages : 8  
 Average mode : Point  
 Bandwidth : 4 MHz  
 Loss comp : off  
 Tcold : Auto

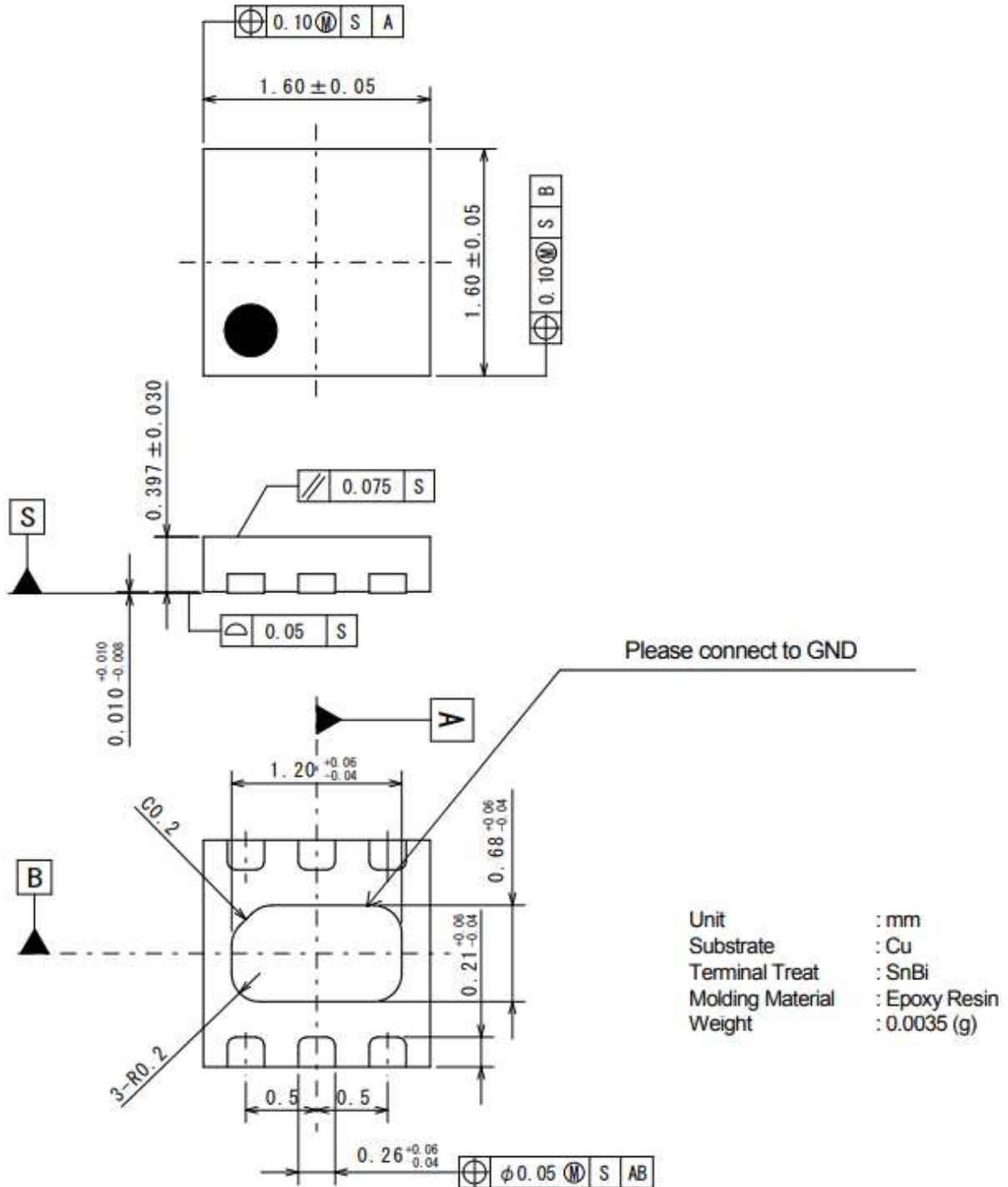


**Calibration setup**



**Measurement Setup**

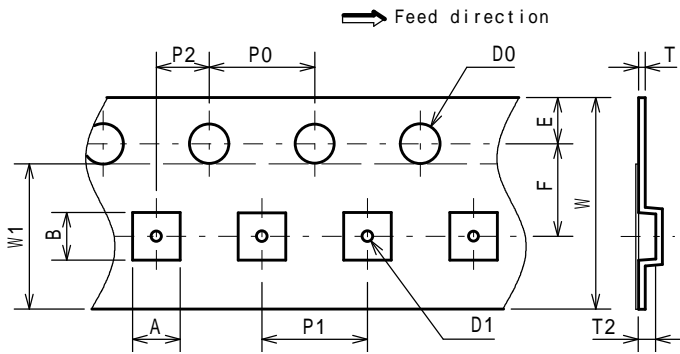
## ■ PACKAGE OUTLINE (ESON6-G1)



## PACKING SPEC

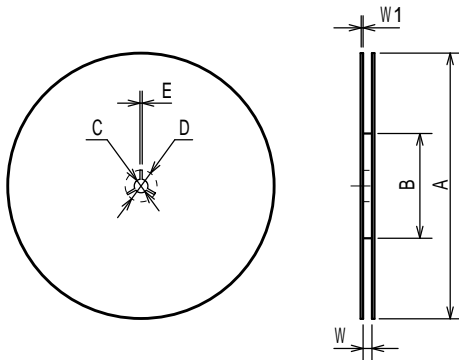
Unit: mm

### TAPING DIMENSIONS



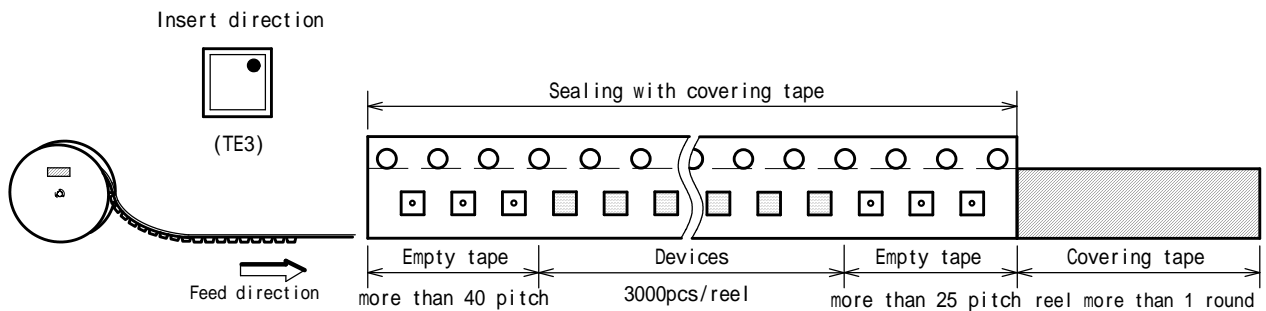
SYMBOL	DIMENSION	REMARKS
A	1.85 ± 0.05	BOTTOM DIMENSION
B	1.85 ± 0.05	BOTTOM DIMENSION
D0	1.5 <sup>+0.1</sup> <sub>0</sub>	
D1	0.5 ± 0.1	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	0.65 ± 0.05	
W	8.0 ± 0.2	
W1	5.5	THICKNESS 0.1max

### REEL DIMENSIONS

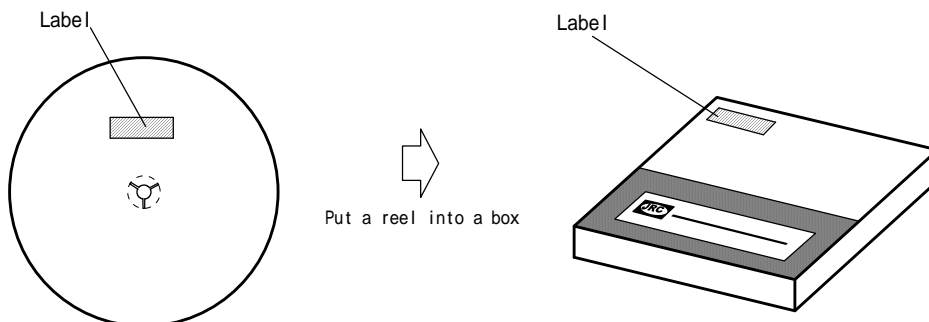


SYMBOL	DIMENSION
A	180 <sup>0</sup> <sub>-1.5</sub>
B	60 <sup>+1</sup> <sub>0</sub>
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	9 <sup>+0.3</sup> <sub>0</sub>
W1	1.2

### TAPING STATE



### PACKING STATE



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