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

■ 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.

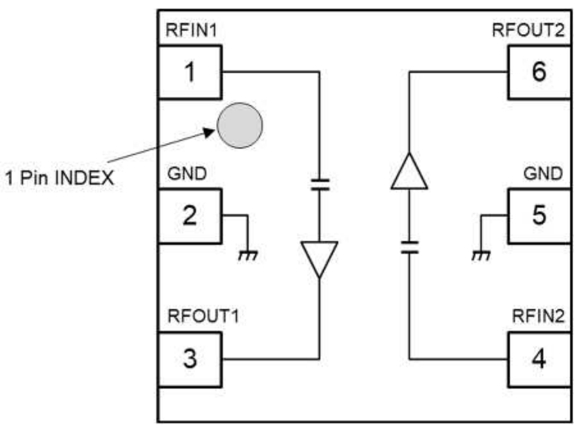
The small and thin ESON6-G1 package is adopted.

■ APPLICATION

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

■ BLOCK DIAGRAM (ESON6-G1)

(Top view)



■ 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

NJG1187 KG1 (TE3)

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°C, Z_s = Z_l = 50 Ω

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 V

(2): 4-layer FR4 PCB with through-hole (101.5 x 114.5 mm), T_j = 150°C

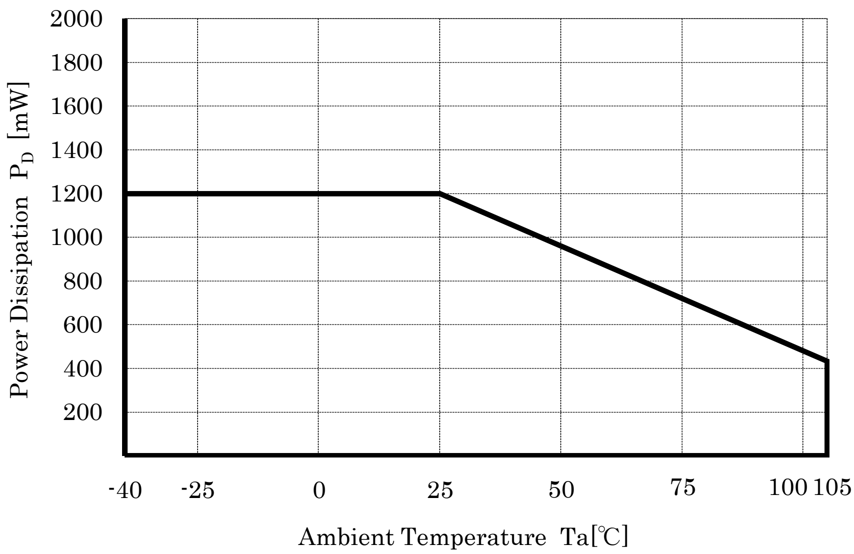
■ POWER DISSIPATION VS. AMBIENT TEMPERATURE

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



■ ELECTRICAL CHARACTERISTICS 1 (DC)

General conditions: T_a = +25°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 V	-	8.0	13.0	mA

■ ELECTRICAL CHARACTERISTICS 2 (RF)

General conditions: V_{DD} = 3.3 V, f_{RF} = 1559 to 1610 MHz, T_a = +25°C, Z_s = Z_l = 50 Ω, with application circuit

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Small signal gain	Gain	f = 1575 MHz (L1 band) Exclude PCB, Connector Losses (0.15 dB)	30.0	34.0	38.0	dB
Noise figure	NF	f = 1575 MHz (L1 band) Exclude PCB, Connector Losses (0.08 dB)	-	0.60	0.95	dB
Isolation	ISL	f = 1575 MHz (L1 band)	50	57	-	dB
Output power at 1 dB gain compression point	P-1dB(OUT)	f = 1575 MHz (L1 band)	+7	+13	-	dBm
Output 3rd order intercept point	OIP3	f1= 1575 MHz, f2 = f1 + 1 MHz, P_{IN} = -42 dBm	+12	+17	-	dBm
RF IN return loss	RLi	f = 1575 MHz (L1 band)	7	11	-	dB
RF OUT return loss	RLo	f = 1575 MHz (L1 band)	7	13	-	dB
k factor	k	f = 50 MHz to 10 GHz	1.0	-	-	-

■ **ELECTRICAL CHARACTERISTICS 3 (RF)**

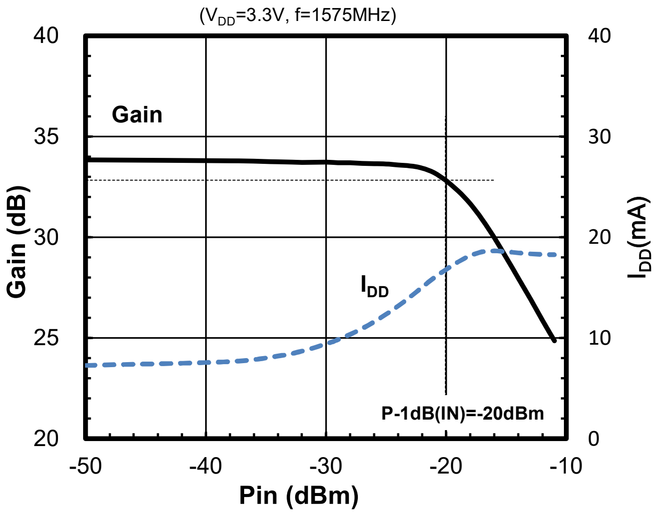
General conditions: V_{DD} = 3.3 V, f_{RF} = 1164 to 1300 MHz, T_a = +25°C, Z_s = Z_l = 50 Ω, with application circuit

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 dBm	+13	+19	-	dBm
		f1= 1227 MHz, f2 = f1 + 1 MHz, P_{IN} = -42 dBm	+15	+20	-	
		f1= 1278 MHz, f2 = f1 + 1 MHz, P_{IN} = -42 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	-	-	-

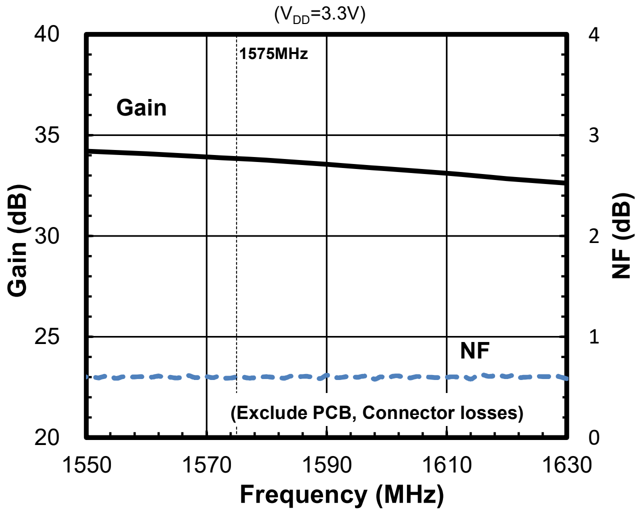
■ **ELECTRICAL CHARACTERISTICS** (L1 band application)

Conditions: V_{DD} = 3.3 V, T_a = +25°C, Z_s = Z_l = 50 Ω, with application circuit

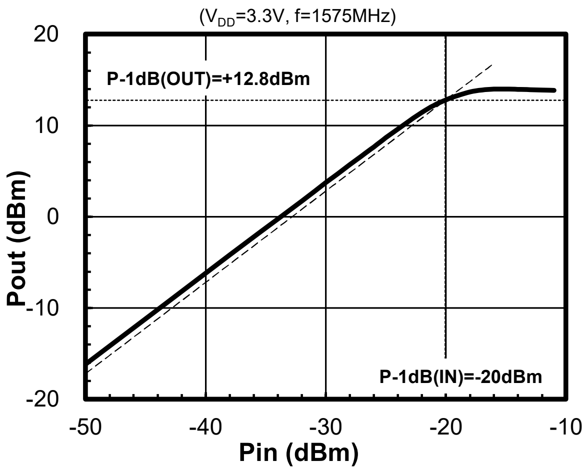
Gain,I_{DD} vs. Pin



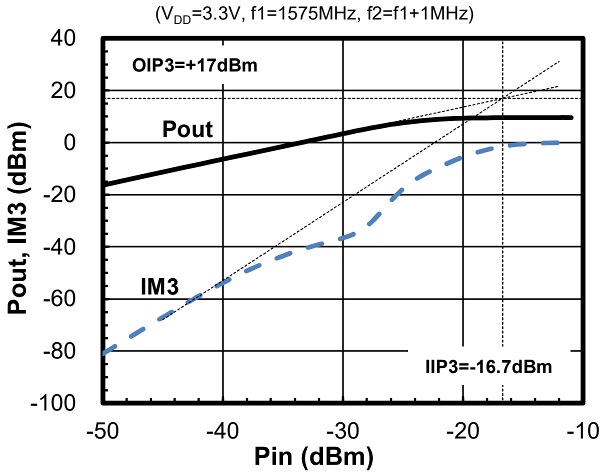
Gain, NF vs. Frequency



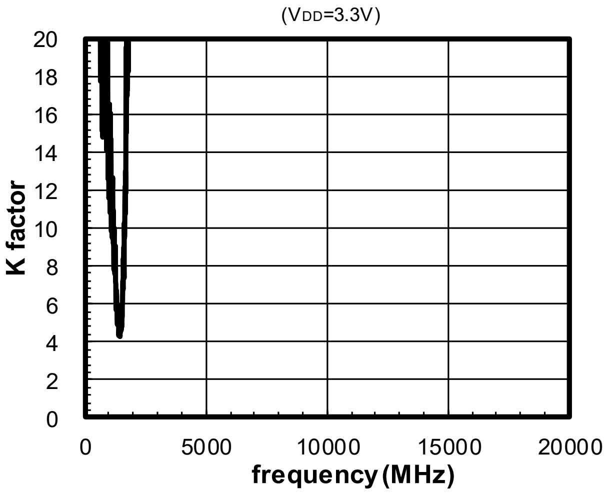
Pout vs. Pin



Pout, IM3 vs. Pin



K factor vs. frequency

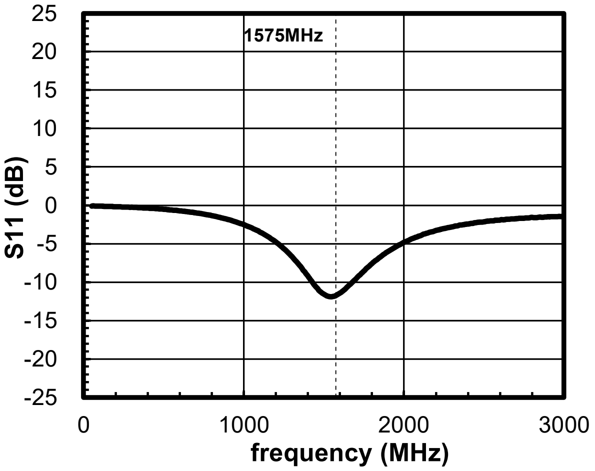


■ **ELECTRICAL CHARACTERISTICS** (L1 band application)

Conditions: V_{DD} = 3.3 V, f_{RF} = 50 MHz to 3 GHz, T_a = +25°C, Z_s = Z_l = 50 Ω, with application circuit

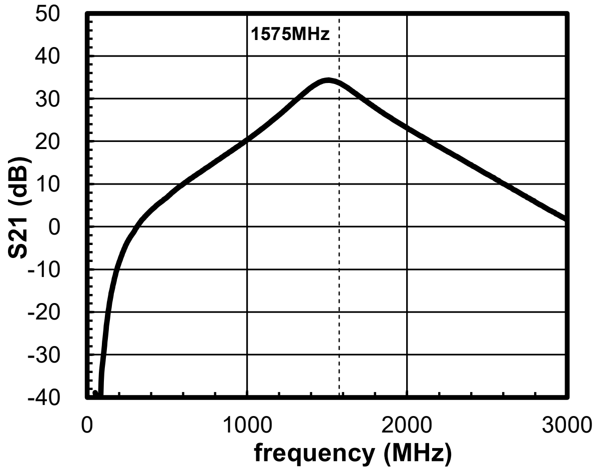
S11 vs. frequency

(V_{DD}=3.3V)



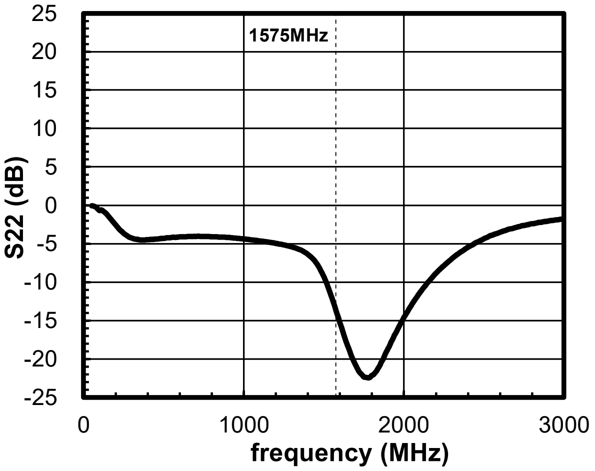
S21 vs. frequency

(V_{DD}=3.3V)



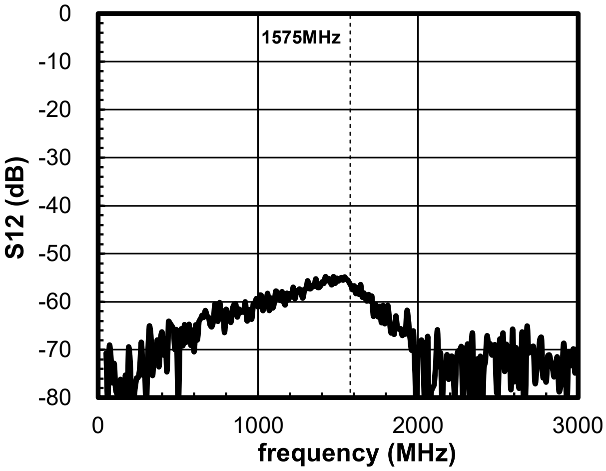
S22 vs. frequency

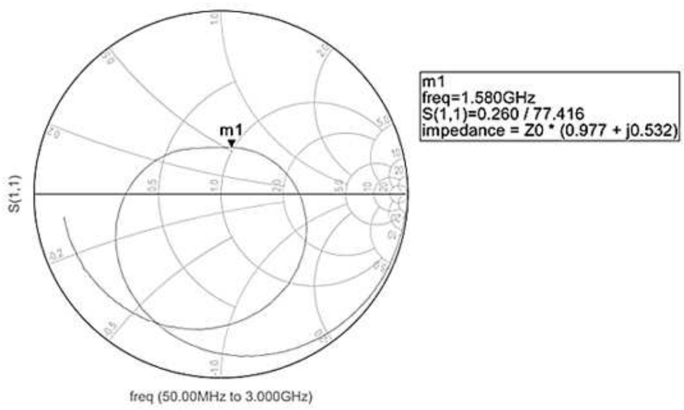
(V_{DD}=3.3V)

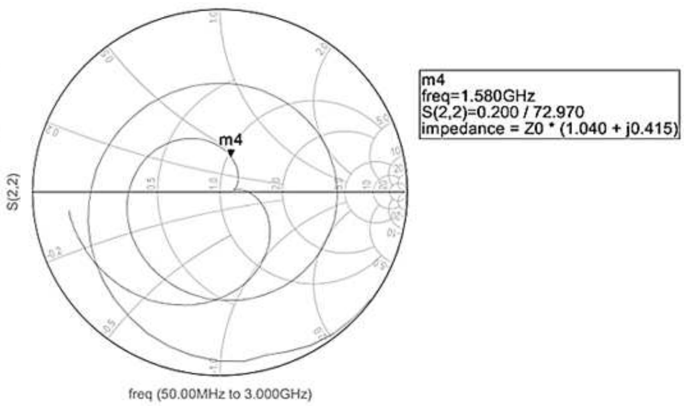


S12 vs. frequency

(V_{DD}=3.3V)

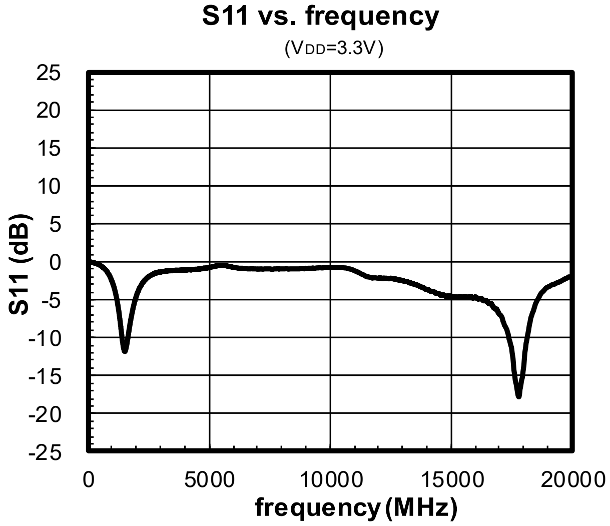


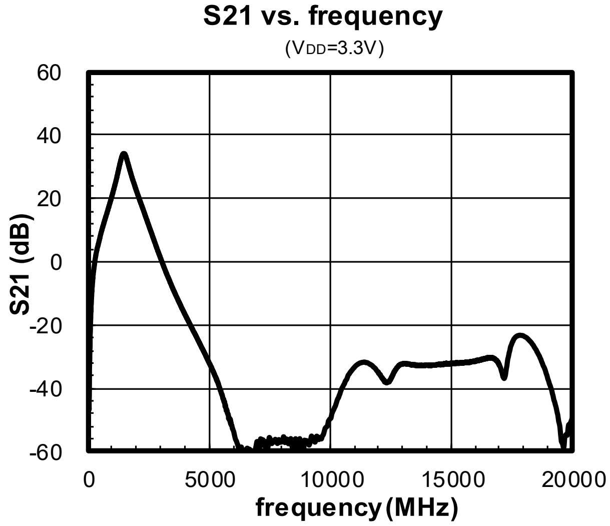


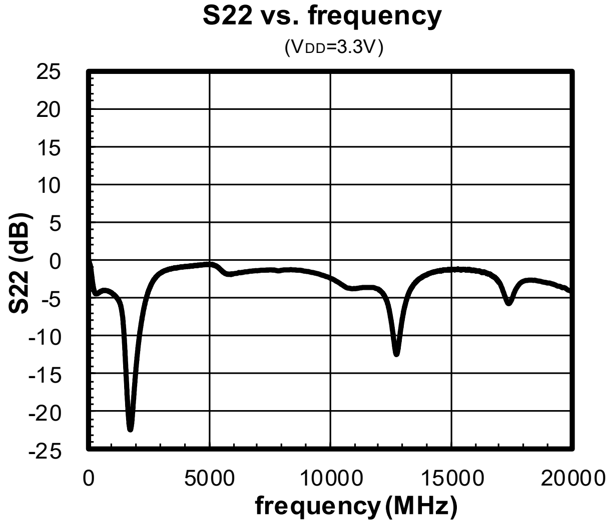


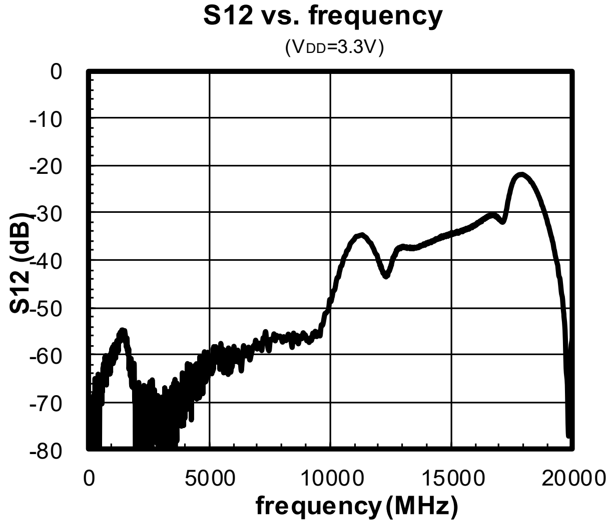
■ **ELECTRICAL CHARACTERISTICS** (L1 band application)

Conditions: V_{DD} = 3.3 V, f_{RF} = 50 MHz to 20 GHz, T_a = +25°C, Z_s = Z_l = 50 Ω, with application circuit



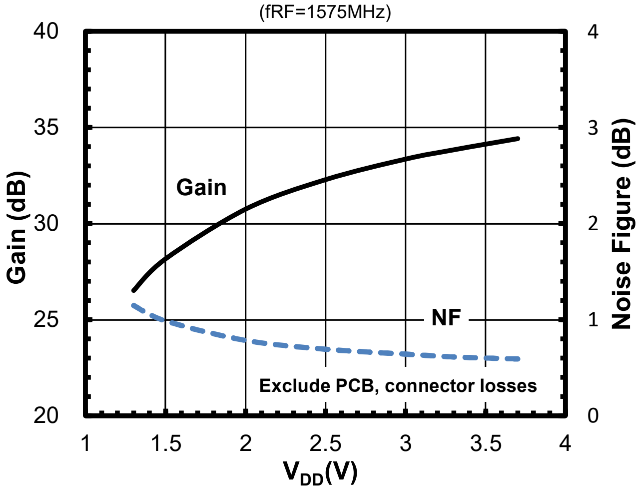




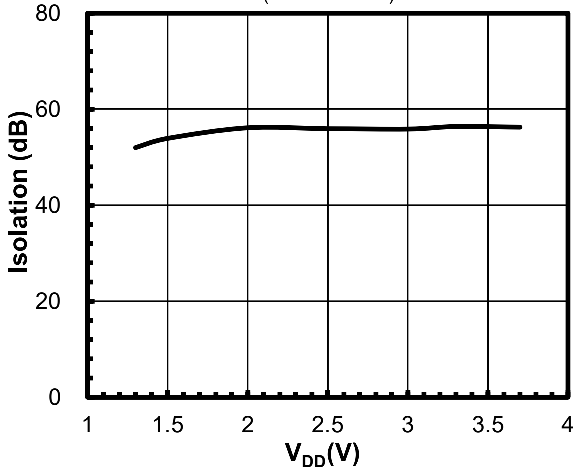


■ **ELECTRICAL CHARACTERISTICS** (L1 band application)
Conditions: T_a = +25°C, Z_s = Z_l = 50 Ω, with application circuit

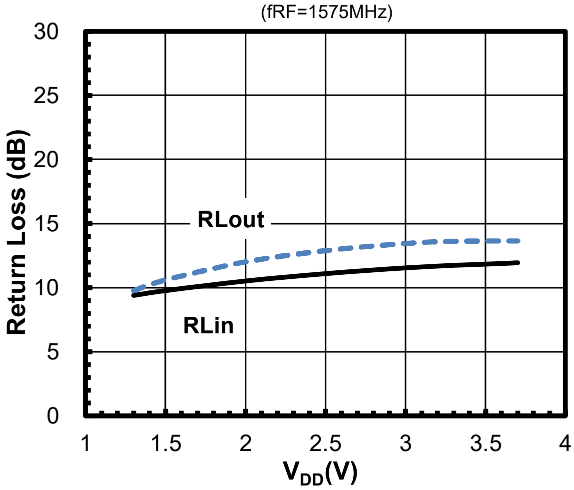
Gain, NF vs. V_{DD}
(fRF=1575MHz)



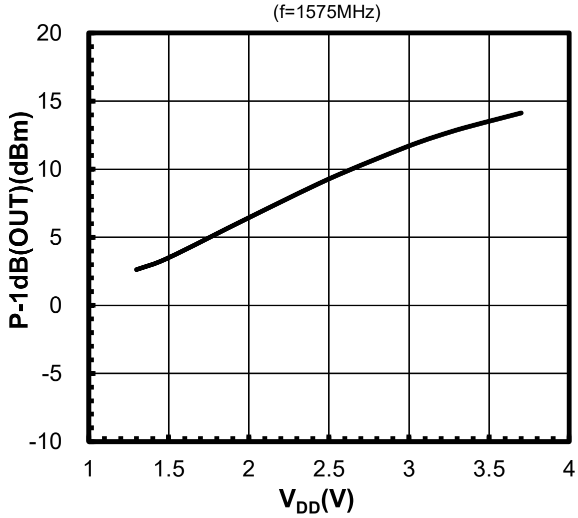
Isolation vs. V_{DD}
(fRF=1575MHz)



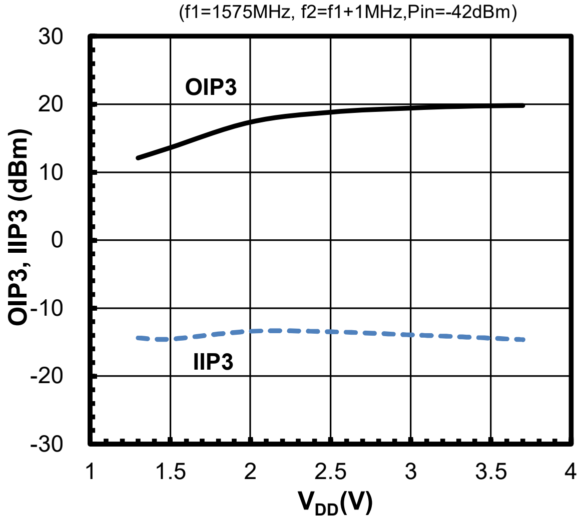
Return Loss vs. V_{DD}
(fRF=1575MHz)



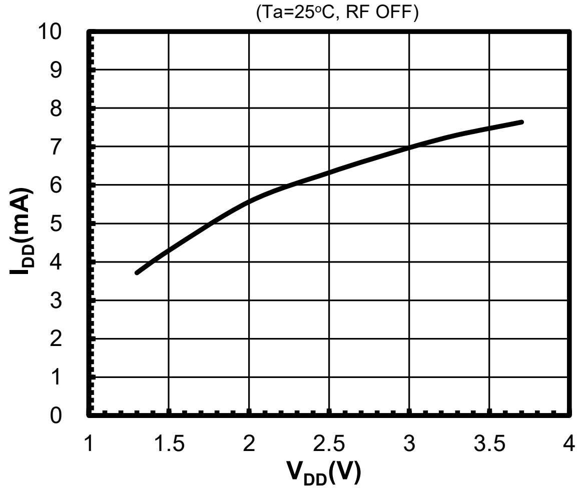
P-1dB(OUT) vs. V_{DD}
(f=1575MHz)



OIP3, IIP3 vs. V_{DD}
(f1=1575MHz, f2=f1+1MHz,Pin=-42dBm)

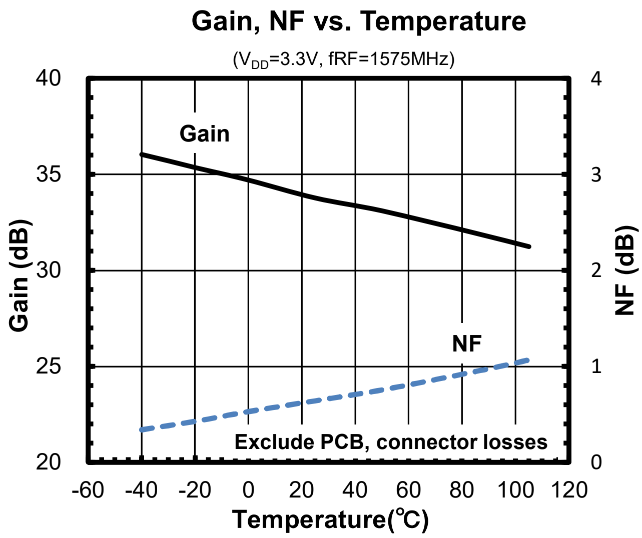


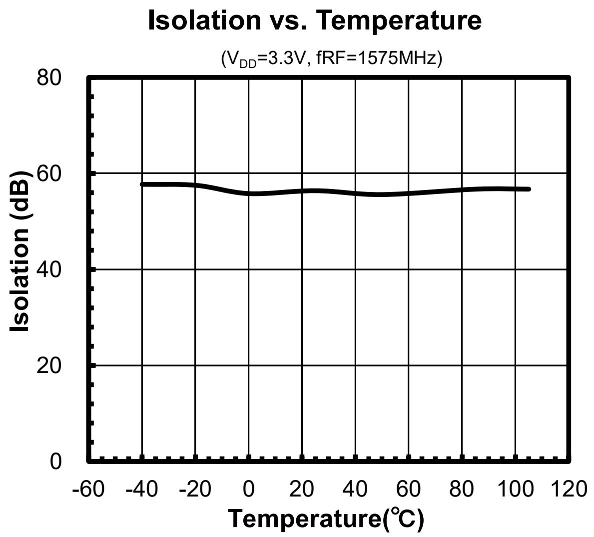
I_{DD} vs. V_{DD}
(Ta=25°C, RF OFF)

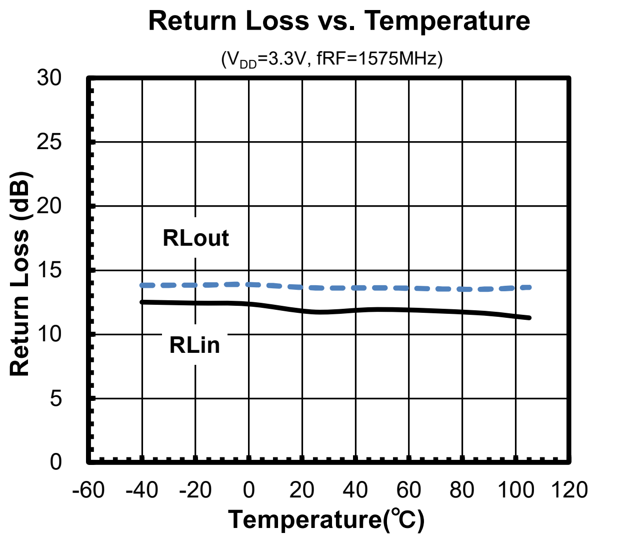


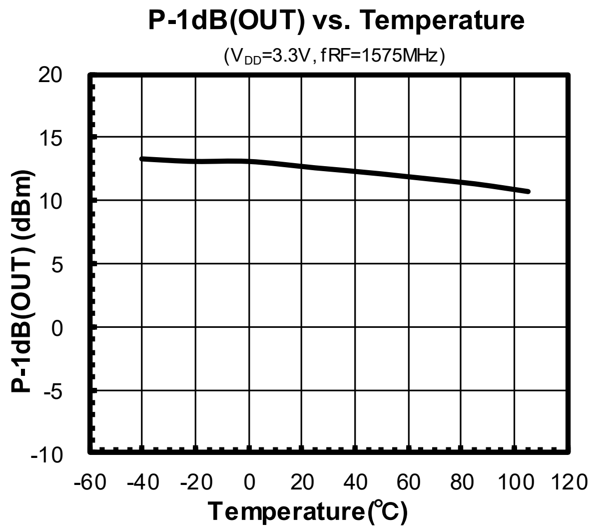
■ **ELECTRICAL CHARACTERISTICS** (L1 band application)

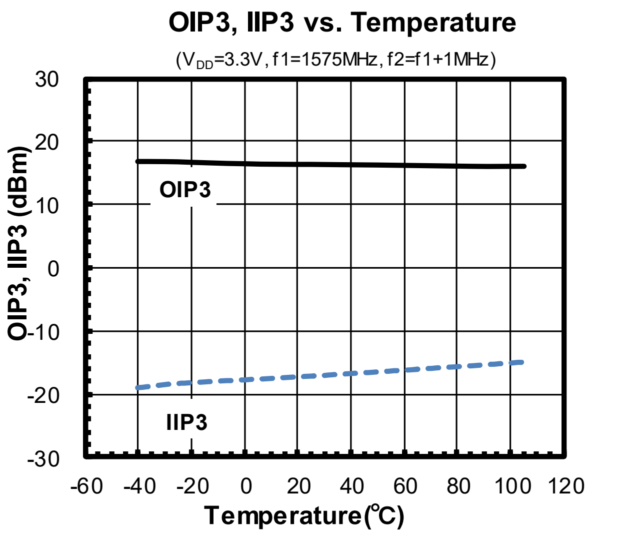
Conditions: V_{DD} = 3.3 V, Z_s = Z_l = 50 Ω, with application circuit

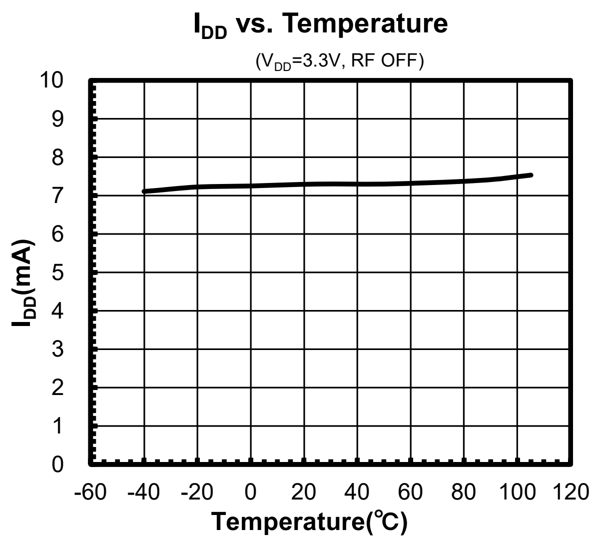










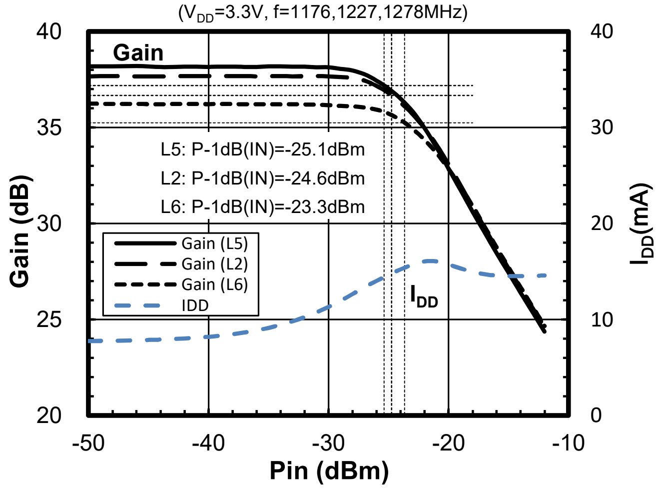


■ **ELECTRICAL CHARACTERISTICS** (L2/5/6 band application)

Conditions: V_{DD} = 3.3 V, T_a = +25°C, Z_s = Z_l = 50 Ω, with application circuit

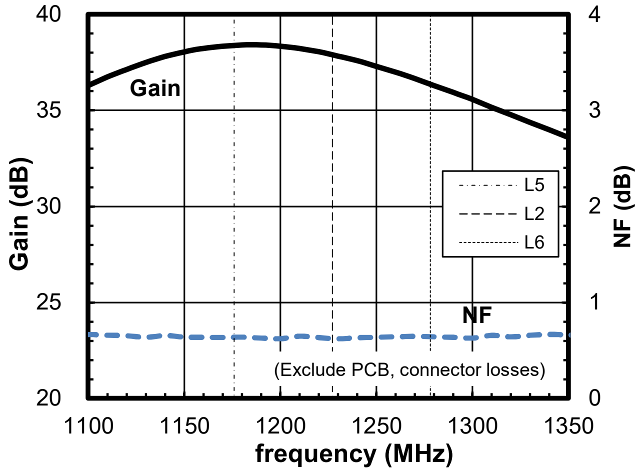
Gain, I_{DD} vs. Pin

(V_{DD}=3.3V, f=1176,1227,1278MHz)



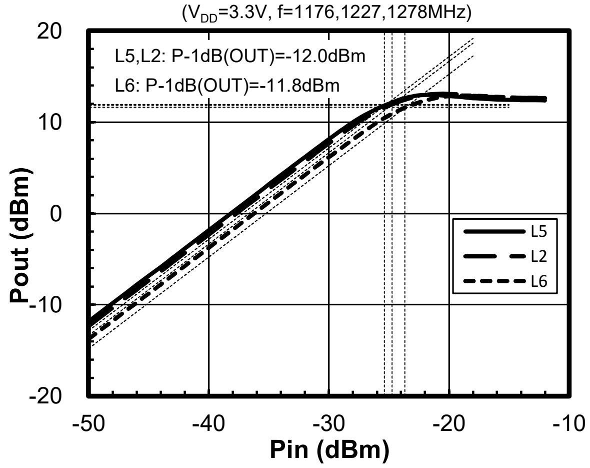
Gain, NF vs. frequency

(VDD=3.3V)



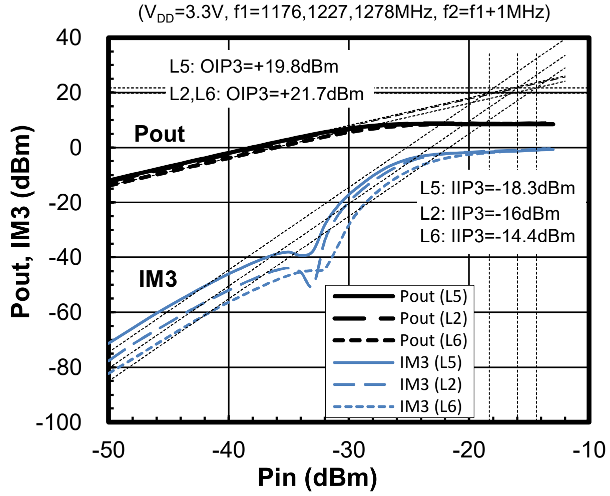
Pout vs. Pin

(V_{DD}=3.3V, f=1176,1227,1278MHz)



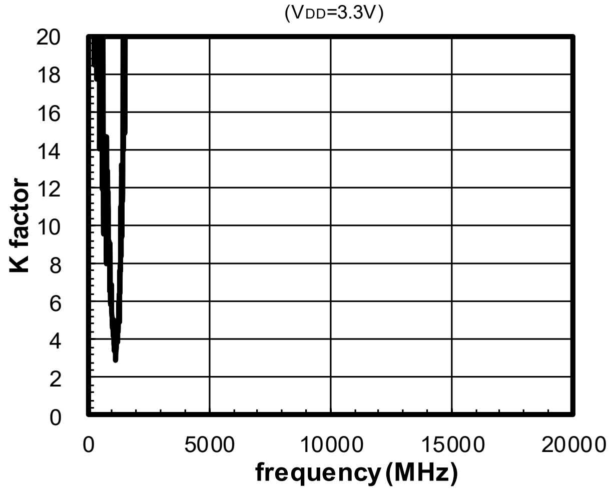
Pout, IM3 vs. Pin

(V_{DD}=3.3V, f1=1176,1227,1278MHz, f2=f1+1MHz)



K factor vs. frequency

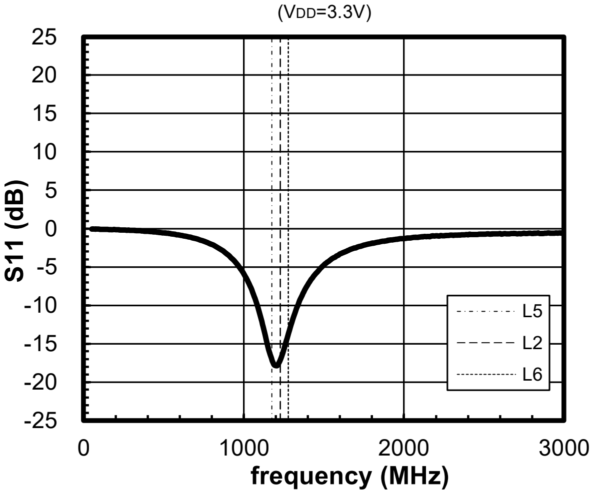
(VDD=3.3V)



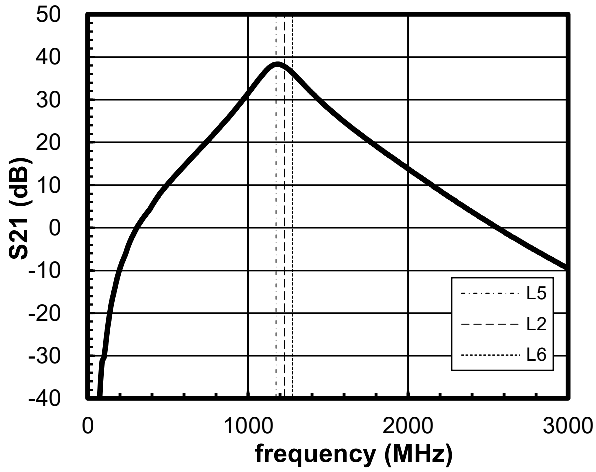
■ **ELECTRICAL CHARACTERISTICS** (L2/5/6 band application)

Conditions: V_{DD} = 3.3 V, f_{RF} = 50 MHz to 3 GHz, T_a = +25°C, Z_s = Z_l = 50 Ω, with application circuit

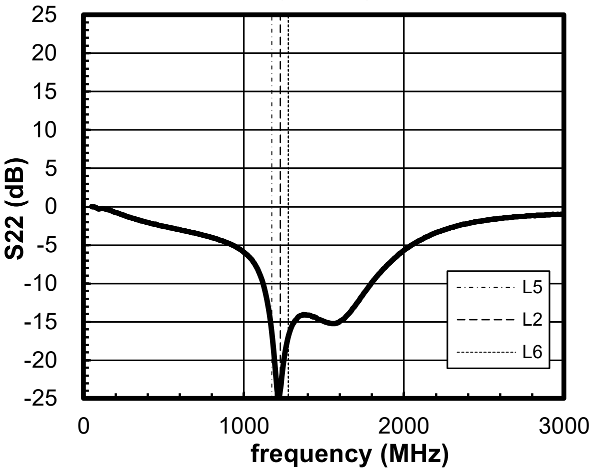
S11 vs. frequency
(V_{DD}=3.3V)



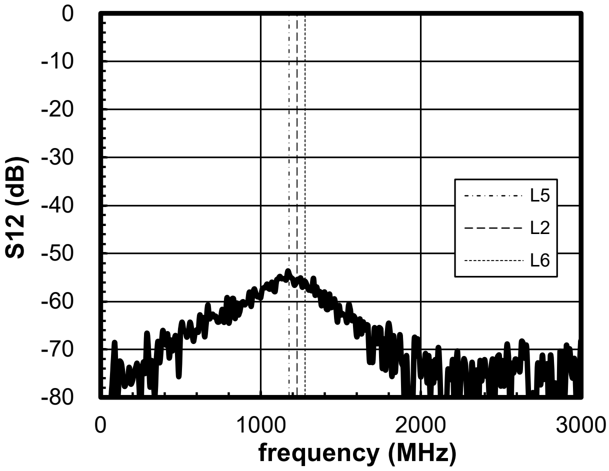
S21 vs. frequency
(V_{DD}=3.3V)

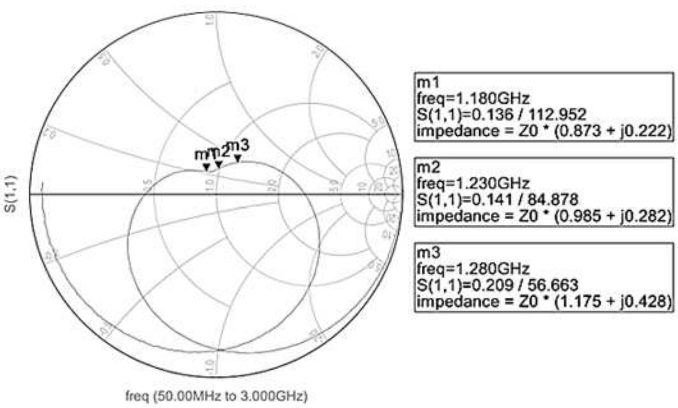


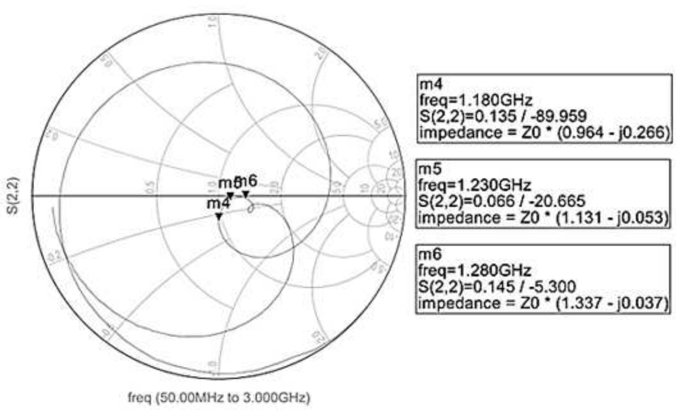
S22 vs. frequency
(V_{DD}=3.3V)



S12 vs. frequency
(V_{DD}=3.3V)

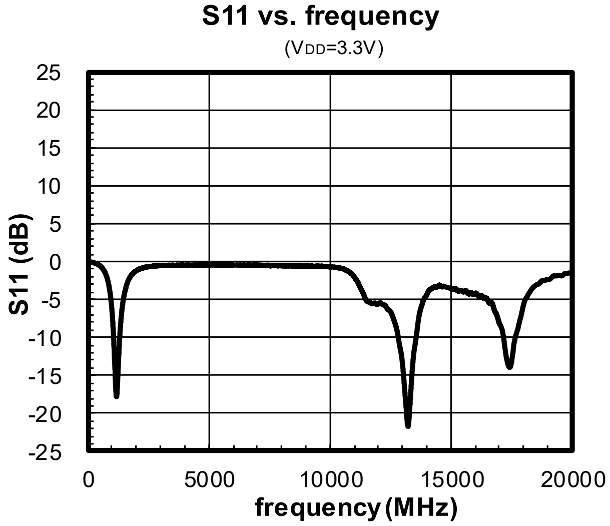


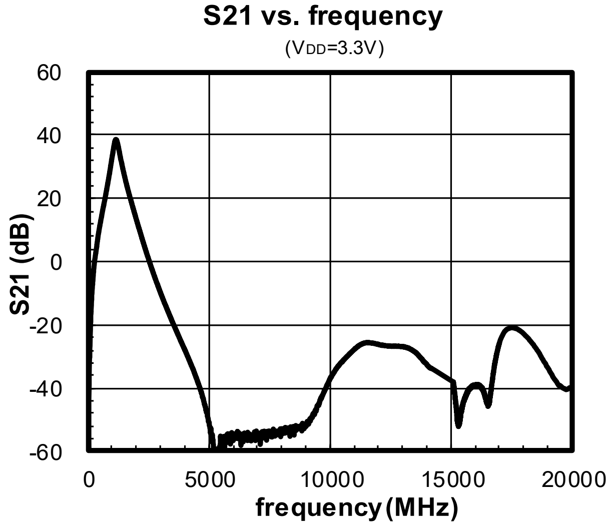


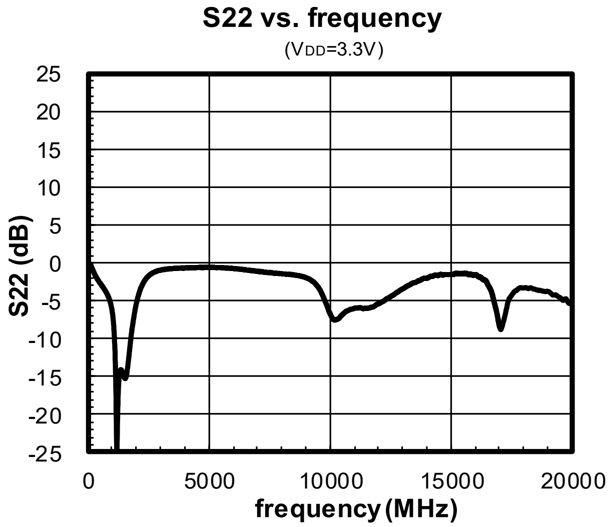


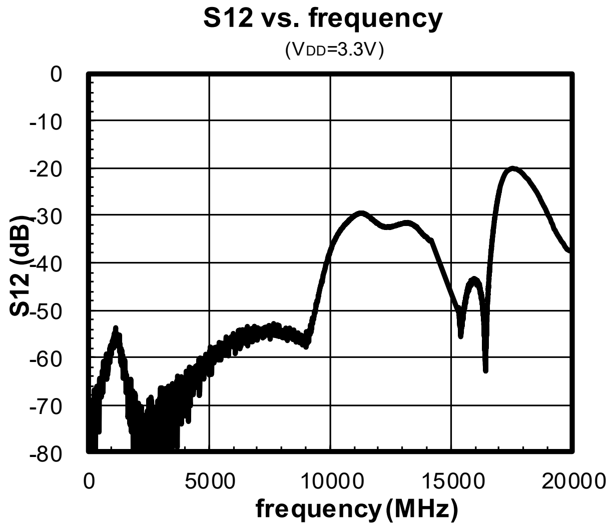
■ **ELECTRICAL CHARACTERISTICS** (L2/5/6 band application)

Conditions: V_{DD} = 3.3 V, f_{RF} = 50 MHz to 20 GHz, T_a = +25°C, Z_s = Z_l = 50 Ω, with application circuit







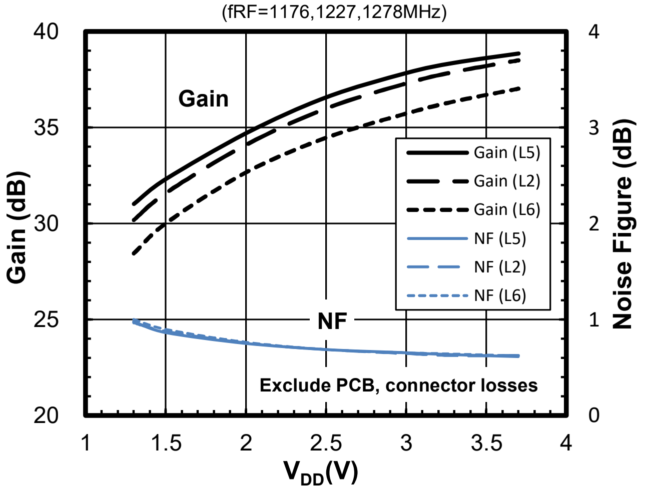


■ **ELECTRICAL CHARACTERISTICS** (L2/5/6 band application)

Conditions: T_a = +25°C, Z_s = Z_l = 50 Ω, with application circuit

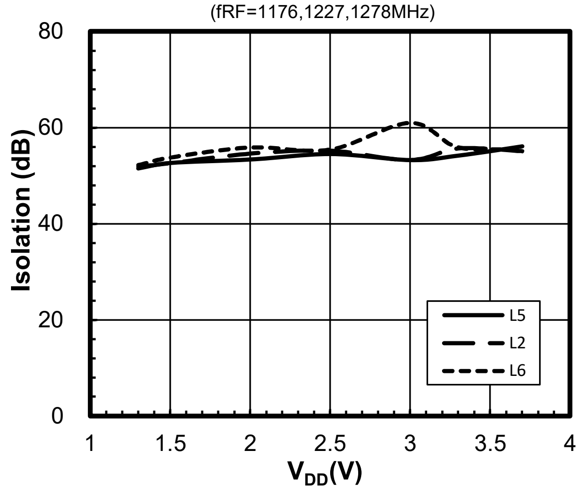
Gain, NF vs. V_{DD}

(fRF=1176,1227,1278MHz)



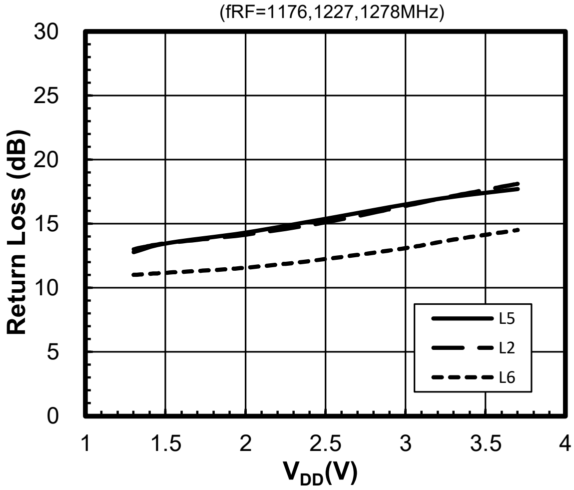
Isolation vs. V_{DD}

(fRF=1176,1227,1278MHz)



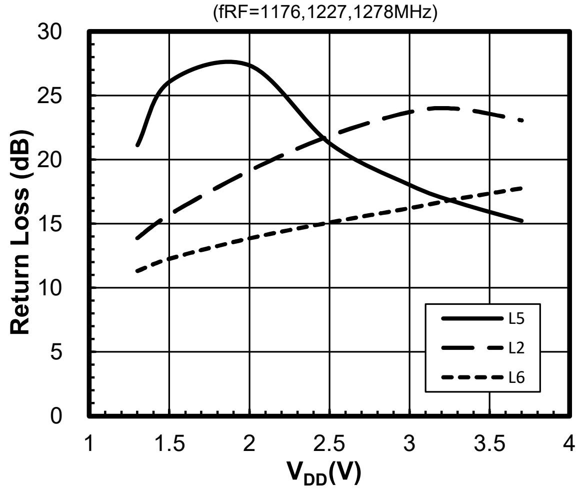
RF IN Return Loss vs. V_{DD}

(fRF=1176,1227,1278MHz)



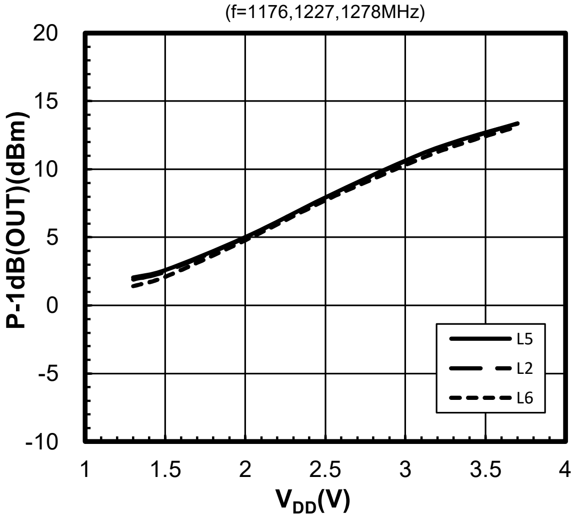
RF OUT Return Loss vs. V_{DD}

(fRF=1176,1227,1278MHz)



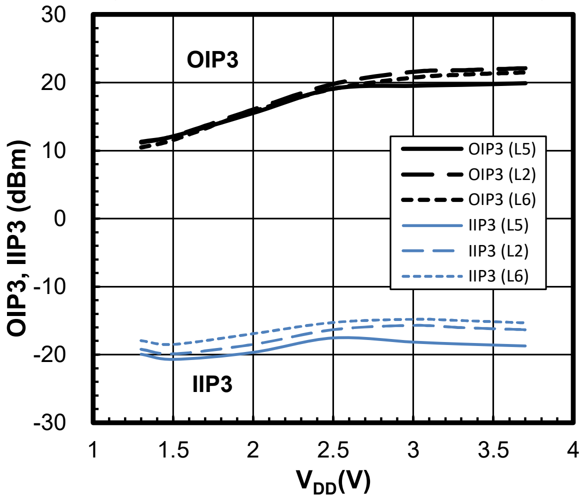
P-1dB(OUT) vs. V_{DD}

(f=1176,1227,1278MHz)



OIP3, IIP3 vs. V_{DD}

(f1=1176,1227, 1278MHz, f2=f1+1MHz,Pin=-42dBm)

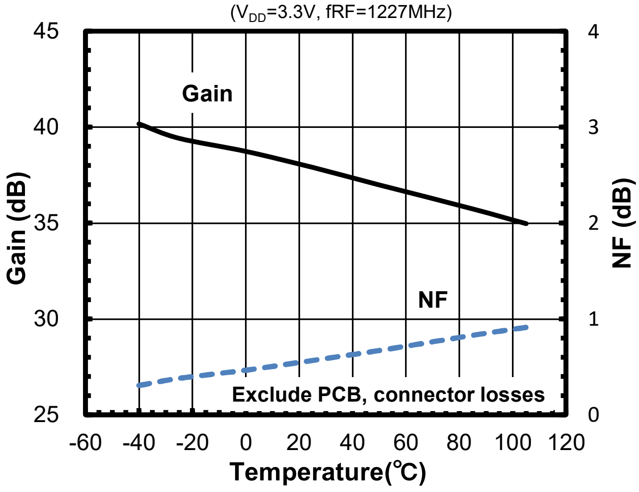


■ **ELECTRICAL CHARACTERISTICS** (L2/5/6 band application)

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

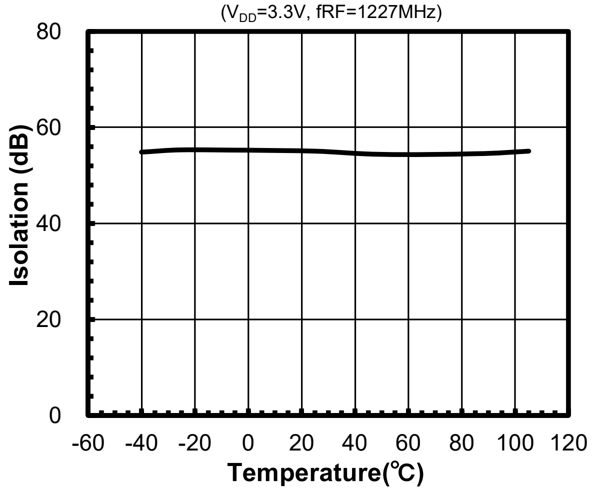
Gain, NF vs. Temperature

(V_{DD}=3.3V, fRF=1227MHz)



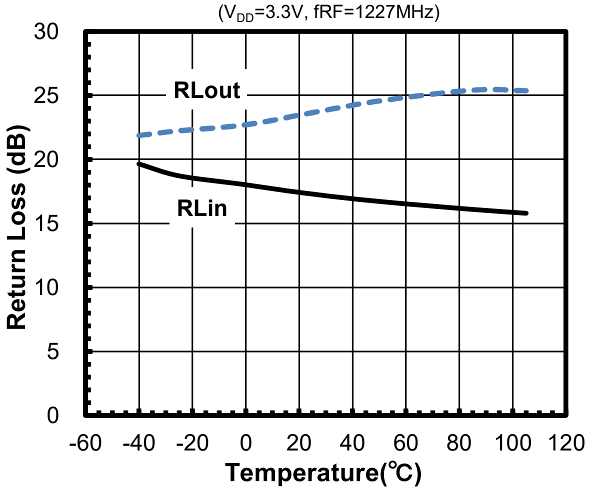
Isolation vs. Temperature

(V_{DD}=3.3V, fRF=1227MHz)



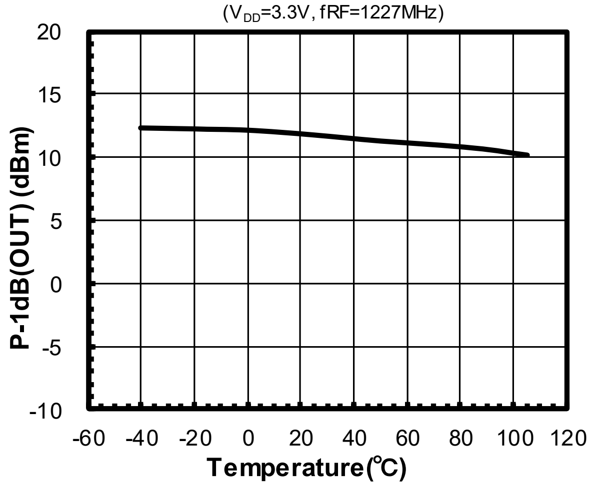
Return Loss vs. Temperature

(V_{DD}=3.3V, fRF=1227MHz)



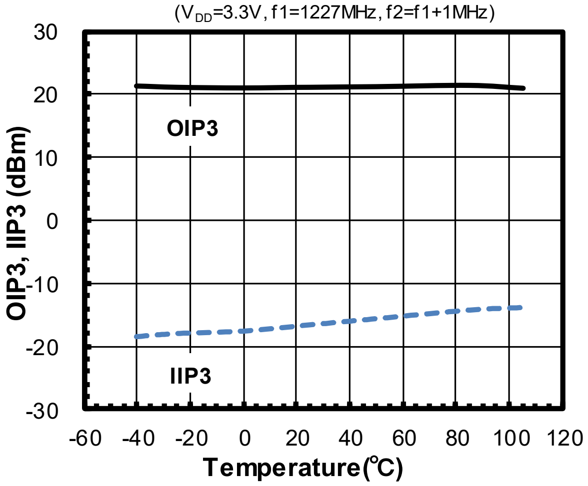
P-1dB(OUT) vs. Temperature

(V_{DD}=3.3V, fRF=1227MHz)

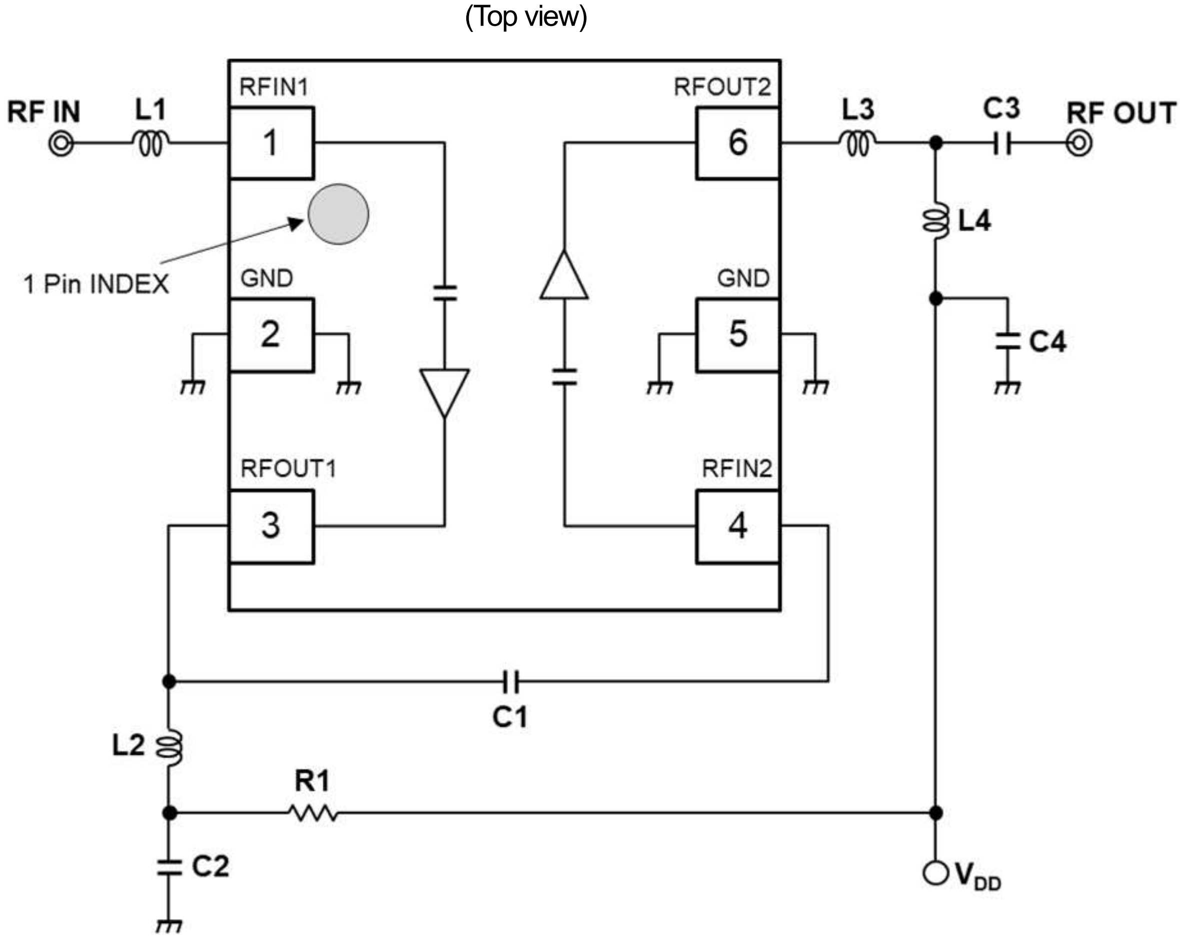


OIP3, IIP3 vs. Temperature

(V_{DD}=3.3V, f1=1227MHz, f2=f1+1MHz)



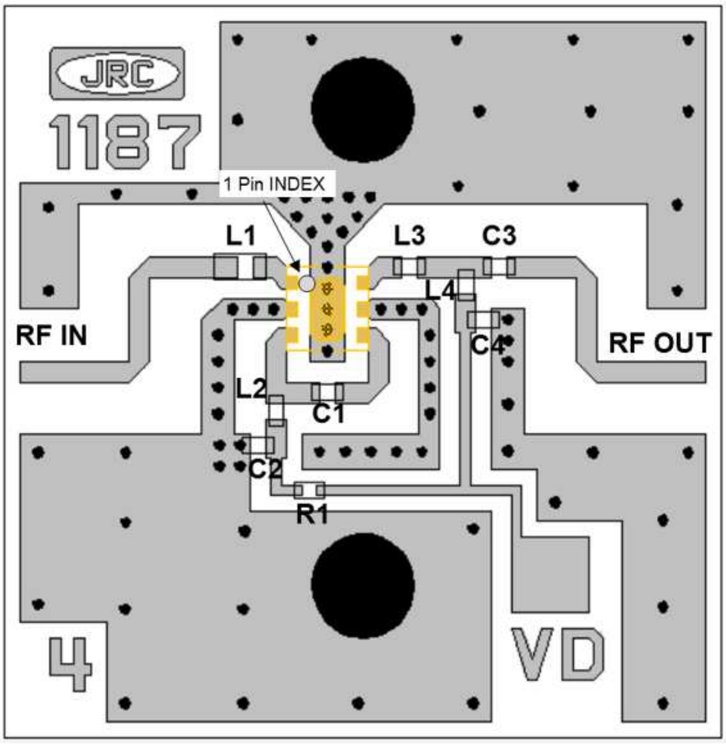
■ APPLICATION CIRCUIT



<PARTS LIST>

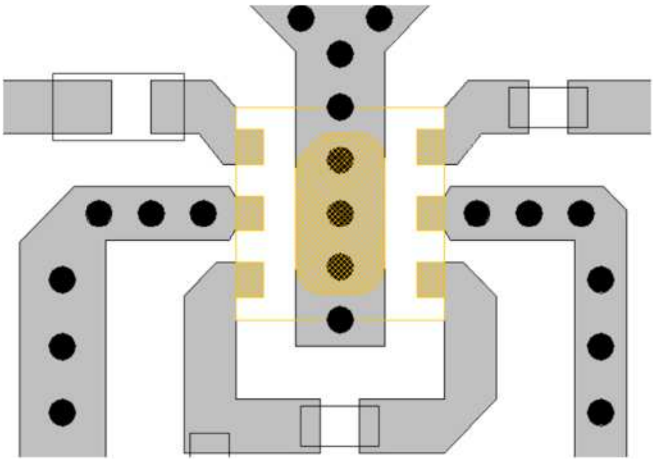
Part ID	Value		Notes
	1559 to 1610 MHz (L1 band)	1164 to 1300 MHz (L2/5/6 band)	
L1	10 nH	16 nH	LQW15AN_00 Series (Murata)
L2	4.7 nH	8.2 nH	LQP03TN_02 Series (Murata)
L3	6.8 nH	9.1 nH	
L4	27 nH	12 nH	
C1	3.3 pF	2.2 pF	GRM03 Series (Murata)
C2	1000 pF	1000 pF	
C3	18 pF	18 pF	
C4	1000 pF	1000 pF	
R1	180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

■ **EVALUATION BOARD**



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

<PCB LAYOUT GUIDELINE>



PCB
PKG Terminal
PKG Outline
GND Via Hole
Diameter ϕ = 0.2 mm

PRECAUTIONS

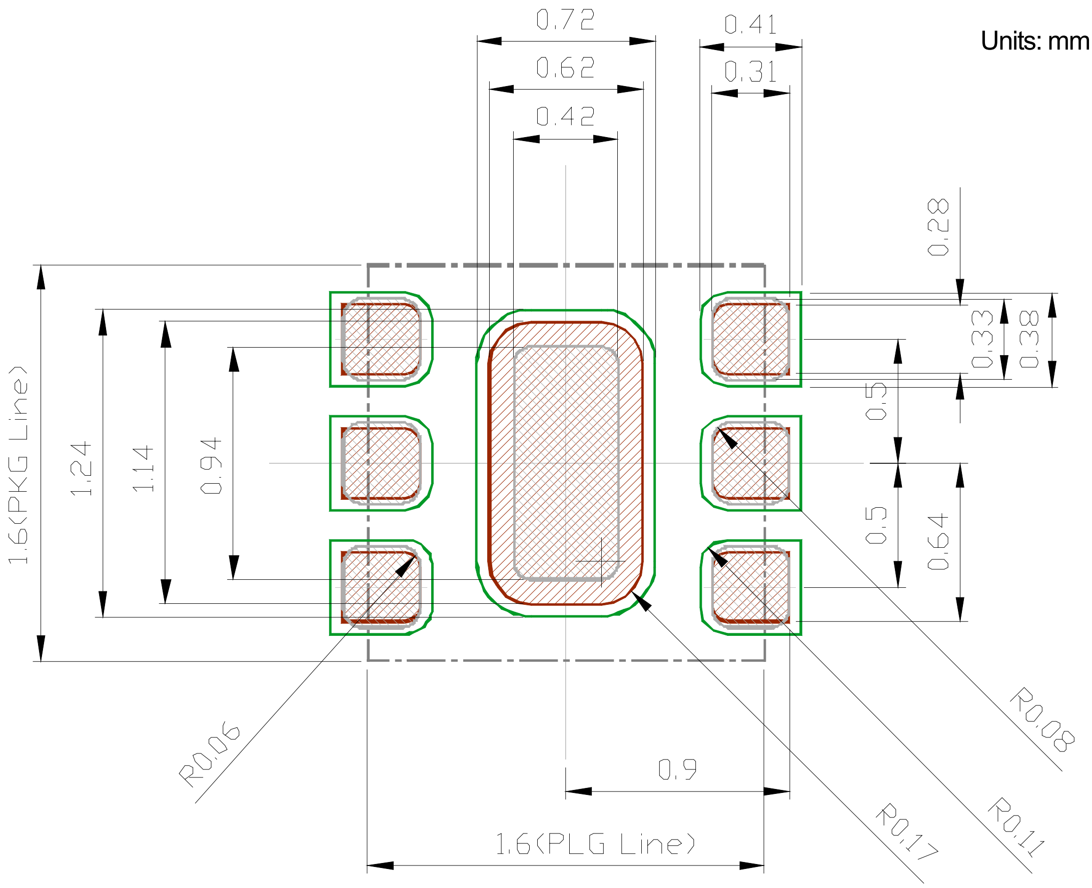
- All external parts should be placed as close as possible to the IC.
- For good RF performance, all GND terminals must be connected to PCB ground plane of substrate, and via-holes for GND should be placed near the IC.

■ **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)

Units: mm



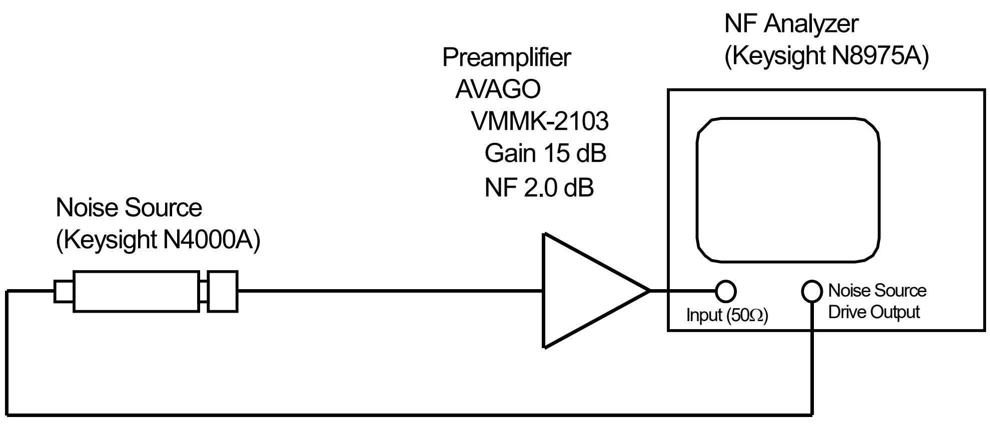
■ NOISE FIGURE MEASUREMENT BLOCK DIAGRAM

Measuring instruments

NF Analyzer	: Keysight N8975A
Noise Source	: Keysight N4000A

Setting the NF analyzer

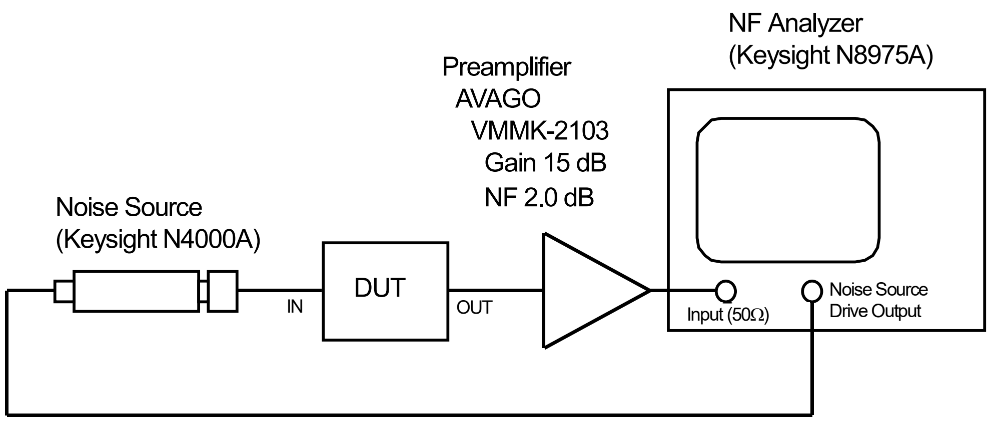
Measurement mode form	
Device under test	: Amplifier
System downconverter	: off
Mode setup form	
Sideband	: LSB
Averages	: 8
Average mode	: Point
Bandwidth	: 4 MHz
Loss comp	: off
Tcold	: Auto



* Preamplifier is used to improve NF measurement accuracy.

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

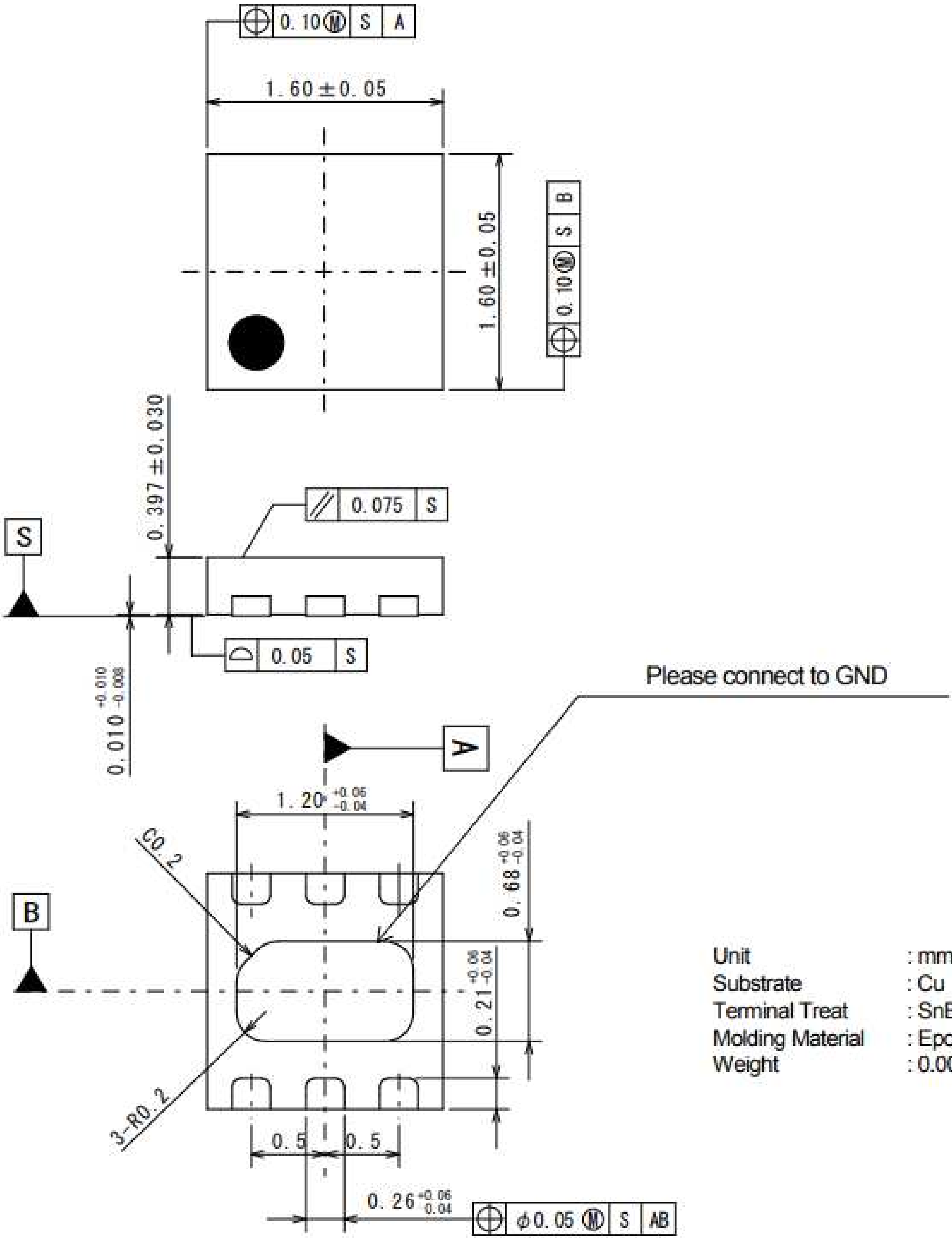
Calibration setup



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

Measurement Setup

■ PACKAGE OUTLINE (ESON6-G1)

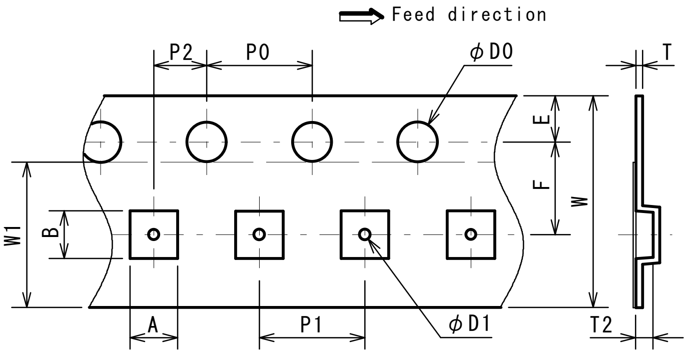


Unit	: mm
Substrate	: Cu
Terminal Treat	: SnBi
Molding Material	: Epoxy Resin
Weight	: 0.0035 (g)

■PACKING SPEC

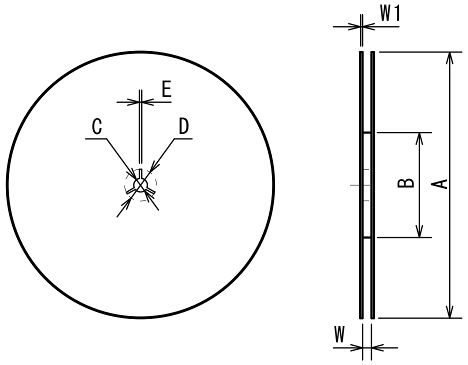
Unit: mm

TAPING DIMENSIONS



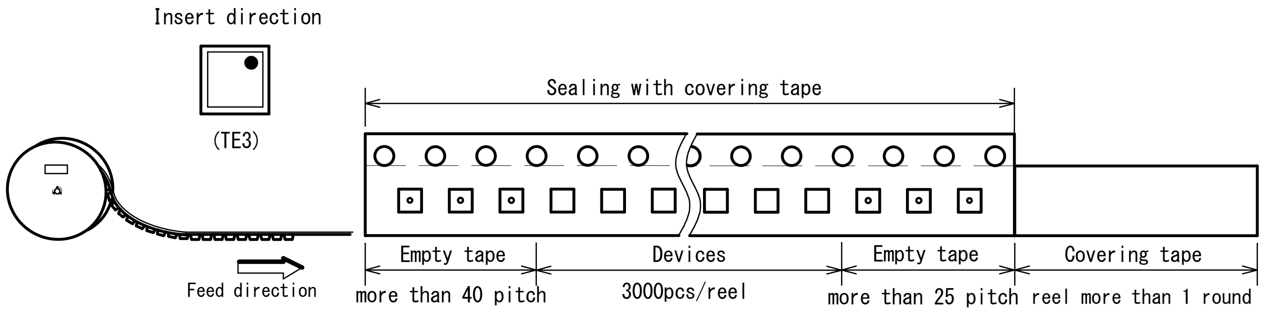
SYMBOL	DIMENSION	REMARKS
A	1.85±0.05	BOTTOM DIMENSION
B	1.85±0.05	BOTTOM DIMENSION
D0	$1.5^{+0.1}_{0}$	
D1	0.5±0.1	
E	1.75±0.1	
F	3.5±0.05	
P0	4.0±0.1	
P1	4.0±0.1	
P2	2.0±0.05	
T	0.25±0.05	
T2	0.65±0.05	
W	8.0±0.2	
W1	5.5	THICKNESS 0.1max

REEL DIMENSIONS

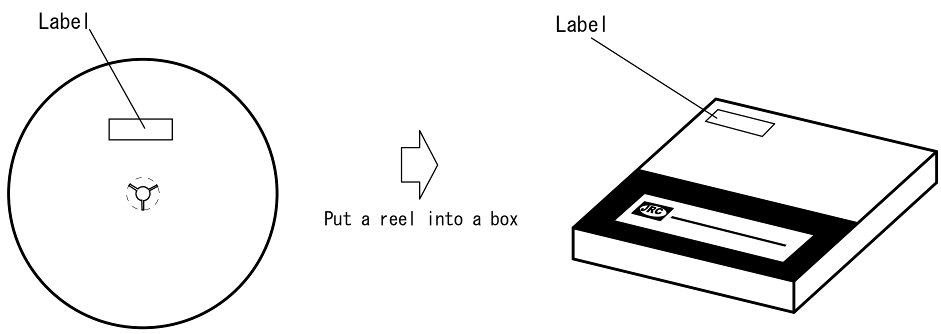


SYMBOL	DIMENSION
A	$\phi 180^{\ 0}_{-1.5}$
B	$\phi\ 60^{+1}_{0}$
C	φ 13±0.2
D	φ 21±0.8
E	2±0.5
W	$9^{+0.3}_{0}$
W1	1.2

TAPING STATE



PACKING STATE



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   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.
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