1.5 GHz band GPS and GLONASS Front-End Module

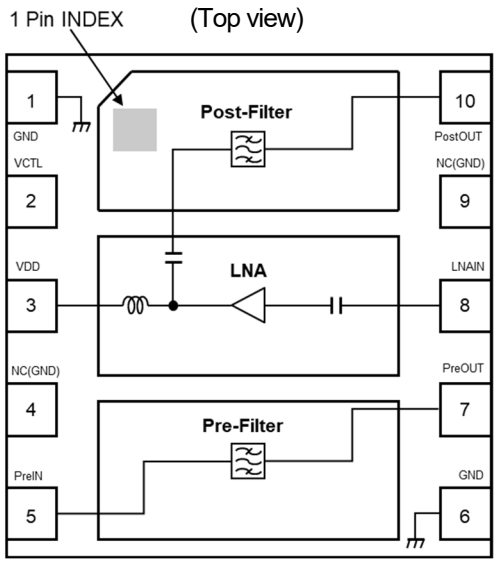
■ FEATURES

- Supply voltage 1.5 to 3.3 V
- Low current consumption
  3.6/4.6 mA typ. @ V_{DD} = 1.8/2.8 V
- High gain
  17.0/18.5 dB typ. @ V_{DD} = 1.8/2.8 V
- Low noise figure
  1.65/1.6 dB typ. @ V_{DD} = 1.8/2.8 V, f = 1575 MHz
  1.75/1.7 dB typ. @ V_{DD} = 1.8/2.8 V, f = 1597 to 1606 MHz
- High out band rejection
  85 dBc typ. @ f = 704 to 915 MHz, relative to 1575 MHz
  75 dBc typ. @ f = 1710 to 1980 MHz, relative to 1575 MHz
  72 dBc typ. @ f = 2400 to 2500 MHz, relative to 1575 MHz
- Integrated LNA, pre-filter, and post-filter
- Small package size
  2.5 mm x 2.5 mm (typ.), t = 0.63 mm (max.)
- RoHS compliant and Halogen Free, MSL1

■ APPLICATION

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

■ BLOCK DIAGRAM (HFFP10-CD)



■ GENERAL DESCRIPTION

The NJG1161PCD is a front-end module (FEM) designed for GPS and GLONASS applications. This FEM offers low noise figure, high linearity, and high out-band rejection characteristics brought by included high performance low noise amplifier (LNA), pre-filter, and post-filter. The stand-by mode contributes to reduce current consumption.

This FEM operates in wide temperature range from -40 to +105°C. The NJG1161PCD is suitable for small size application by included two SAW filters, only two external components, and very small package HFFP10-CD that is 2.5 x 2.5 mm.

■ TRUTH TABLE

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

V_{CTL}	Mode
H	Active mode
L	Stand-by mode

■ PIN CONFIGURATION

PIN NO.	SYMBOL	DESCRIPTION
1	GND	Ground terminal
2	VCTL	Control voltage terminal
3	VDD	Supply voltage terminal
4	NC(GND)	No connected terminal
5	PreIN	RF input terminal to pre-filter
6	GND	Ground terminal
7	PreOUT	RF output terminal from pre-filter
8	LNAIN	RF input terminal to LNA
9	NC(GND)	No connected terminal
10	PostOUT	RF output terminal from post-filter

■ PRODUCT NAME INFORMATION

NJG1161 PCD (TE1)

Part number	Package	Taping form

■ ORDERING INFORMATION

PART NUMBER	PACKAGE OUTLINE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs.)
NJG1161PCD	HFFP10-CD	Yes	Yes	Au	61C	18	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
Control voltage	V_{CTL}	5.0	V
Input power	P_{IN} (inband) (1)	+15	dBm
	P_{IN} (outband) (2)	+27	dBm
Power dissipation	P_D (3)	580	mW
Operating temperature	T_{opr}	-40 to +105	°C
Storage temperature	T_{stg}	-40 to +110	°C

(1): V_{DD} = 2.8 V, f = 1575, 1597 to 1606 MHz

(2): V_{DD} = 2.8 V, f = 50 to 1460, 1710 to 4000 MHz

(3): 4-layer FR4 PCB with through-hole (101.5 x 114.5 mm), T_j = 110°C

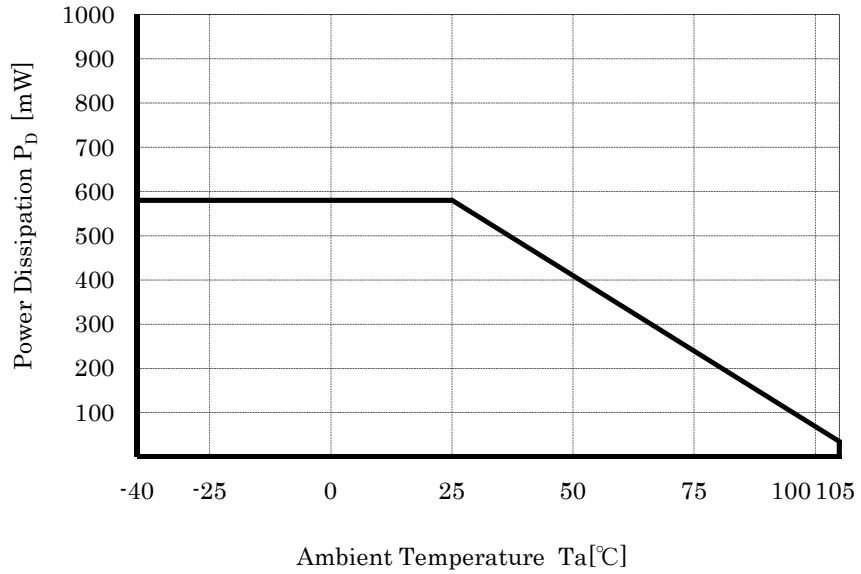
■ POWER DISSIPATION VS.AMBIENT TEMPERATURE

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

(Please note 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	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD}		1.5	-	3.3	V
Control Voltage (High)	V_{CTL}(H)		1.5	1.8	3.3	V
Control Voltage (Low)	V_{CTL}(L)		0	0	0.3	V
Supply Current 1	I_{DD}1	RF OFF, V_{DD} = 2.8 V, V_{CTL} = 1.8 V	-	4.6	6.4	mA
Supply Current 2	I_{DD}2	RF OFF, V_{DD} = 1.8 V, V_{CTL} = 1.8 V	-	3.6	5.9	mA
Supply Current 3	I_{DD}3	RF OFF, V_{DD} = 2.8 V, V_{CTL} = 0 V	-	0.1	5.0	μA
Supply Current 4	I_{DD}4	RF OFF, V_{DD} = 1.8 V, V_{CTL} = 0 V	-	0.1	5.0	μA
Control Current	I_{CTL}	V_{CTL} = 1.8 V	-	5.0	15.0	μA

■ **ELECTRICAL CHARACTERISTICS 2 (RF)**

General conditions: V_{DD} = 2.8 V, V_{CTL} = 1.8 V, f_{RF} = 1575 MHz, 1597 to 1606 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 (GPS) 1	Gain_GPS1	f = 1575 MHz (GPS) Exclude PCB, Connector Losses (0.19 dB)	17.0	18.5	-	dB
Small Signal Gain (GLONASS) 1	Gain_GLN1	f = 1597 to 1606 MHz (GLONASS) Exclude PCB, Connector Losses (0.19 dB)	17.0	18.5	-	dB
Noise Figure (GPS) 1	NF_GPS1	f = 1575 MHz (GPS) Exclude PCB, Connector Losses (0.09 dB)	-	1.6	2.1	dB
Noise Figure (GLONASS) 1	NF_GLN1	f = 1597 to 1606 MHz (GLONASS) Exclude PCB, Connector Losses (0.09 dB)	-	1.7	2.2	dB
Input Power at 1 dB Gain Compression Point 1	P-1dB(IN)1	f = 1575, 1597 to 1606 MHz	-	-15.0	-	dBm
Input 3rd Order Intercept Point 1	IIP3_1	f1 = 1575 MHz, f2 = f1 +/-1 MHz, P_{IN} = -30 dBm	-	-3.0	-	dBm
Out of Band Input 2nd Order Intercept Point 1	IIP2_OB1	f1 = 824.6 MHz at +15 dBm, f2 = 2400 MHz at +15 dBm, fmeas = 1575.4 MHz	-	+72	-	dBm
Out of Band Input 3rd Order Intercept Point 1	IIP3_OB1	f1 = 1712.7 MHz at +15 dBm, f2 = 1850 MHz at +15 dBm, fmeas = 1575.4 MHz	-	+50	-	dBm
700 MHz Harmonic 1	2fo1	Input jammer tone: 787.76 MHz at +15 dBm Measure the harmonic tone at 1575.52 MHz	-	-30	-	dBm
Out of Band Input Power 1 dB Compression 1	P-1dB(IN)_OB1-1	fjam = 900 MHz, fmeas = 1575 MHz at P_{IN} = -40 dBm	-	+24	-	dBm
	P-1dB(IN)_OB1-2	fjam = 1710 MHz, fmeas = 1575 MHz at P_{IN} = -40 dBm	-	+24	-	dBm
Low Band Rejection 1	BR_L1	f = 704 to 915 MHz, relative to 1575 MHz	-	85	-	dBc
High Band Rejection 1	BR_H1	f = 1710 to 1980 MHz, relative to 1575 MHz	-	75	-	dBc
WLAN Band Rejection 1	BR_W1	f = 2400 to 2500 MHz, relative to 1575 MHz	-	72	-	dBc
RF IN Return Loss (GPS) 1	RLi_GPS1	f = 1575 MHz (GPS)	-	10	-	dB
RF IN Return Loss (GLONASS) 1	RLi_GLN1	f = 1597 to 1606 MHz (GLONASS)	-	10	-	dB
RF OUT Return Loss (GPS) 1	RLo_GPS1	f = 1575 MHz (GPS)	-	11	-	dB
RF OUT Return Loss (GLONASS) 1	RLo_GLN1	f = 1597 to 1606 MHz (GLONASS)	-	15	-	dB
Group Delay Time Deviation 1	GDTD1	f = 1597 to 1606 MHz (GLONASS)	-	8.0	-	ns

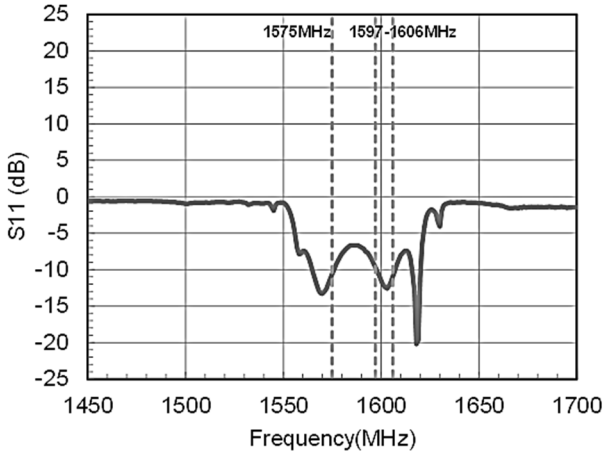
■ **ELECTRICAL CHARACTERISTICS 3 (RF)**

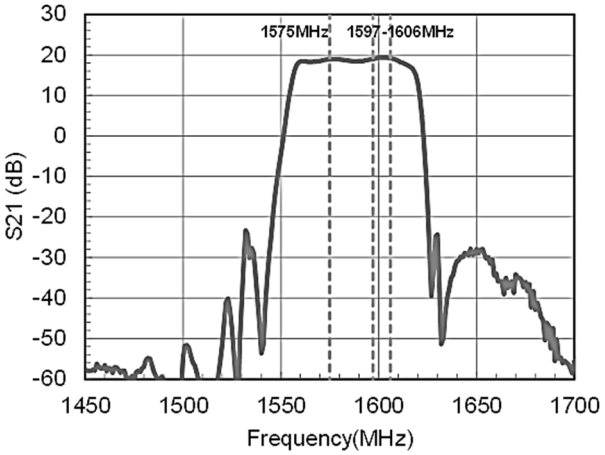
General conditions: V_{DD} = 1.8 V, V_{CTL} = 1.8 V, f_{RF} = 1575 MHz, 1597 to 1606 MHz, T_a = +25°C, Z_s = Z_l = 50 Ω, with application circuit

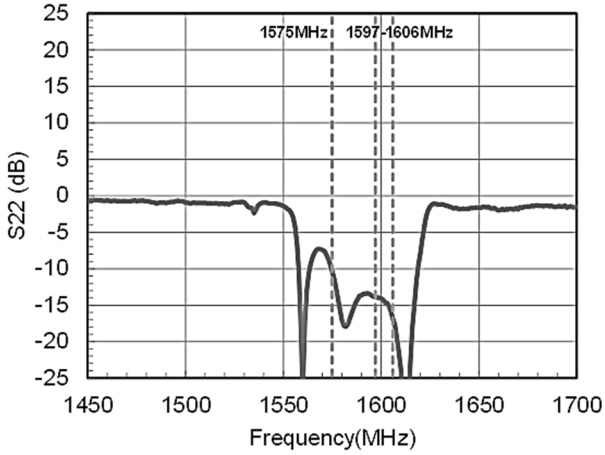
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Small Signal Gain (GPS) 2	Gain_GPS2	f = 1575 MHz (GPS) Exclude PCB, Connector Losses (0.19 dB)	15.5	17.5	-	dB
Small Signal Gain (GLONASS) 2	Gain_GLN2	f = 1597 to 1606 MHz (GLONASS) Exclude PCB, Connector Losses (0.19 dB)	15.5	17.5	-	dB
Noise Figure (GPS) 2	NF_GPS2	f = 1575 MHz (GPS) Exclude PCB, Connector Losses (0.09 dB)	-	1.65	2.20	dB
Noise Figure (GLONASS) 2	NF_GLN2	f = 1597 to 1606 MHz (GLONASS) Exclude PCB, Connector Losses (0.09 dB)	-	1.75	2.35	dB
Input Power at 1 dB Gain Compression Point 2	P-1dB(IN)2	f = 1575, 1597 to 1606 MHz	-	-17.0	-	dBm
Input 3rd Order Intercept Point 2	IIP3_2	f1 = 1575 MHz, f2 = f1 +/-1 MHz, P_{IN} = -30 dBm	-	-6.0	-	dBm
Out of Band Input 2nd Order Intercept Point 2	IIP2_OB2	f1 = 824.6 MHz at +15 dBm, f2 = 2400 MHz at +15 dBm, fmeas = 1575.4 MHz	-	+72	-	dBm
Out of Band Input 3rd Order Intercept Point 2	IIP3_OB2	f1 = 1712.7 MHz at +15 dBm, f2 = 1850 MHz at +15 dBm, fmeas = 1575.4 MHz	-	+50	-	dBm
700 MHz Harmonic 2	2fo2	Input jammer tone: 787.76 MHz at +15 dBm Measure the harmonic tone at 1575.52 MHz	-	-30	-	dBm
Out of Band Input Power 1 dB Compression 2	P-1dB(IN)_OB2-1	fjam = 900 MHz, fmeas = 1575 MHz at P_{IN} = -40 dBm	-	+24	-	dBm
	P-1dB(IN)_OB2-2	fjam = 1710 MHz, fmeas = 1575 MHz at P_{IN} = -40 dBm	-	+24	-	dBm
Low Band Rejection 2	BR_L2	f = 704 to 915 MHz, relative to 1575 MHz	-	85	-	dBc
High Band Rejection 2	BR_H2	f = 1710 to 1980 MHz, relative to 1575 MHz	-	75	-	dBc
WLAN Band Rejection 2	BR_W2	f = 2400 to 2500 MHz, relative to 1575 MHz	-	72	-	dBc
RF IN Return Loss (GPS) 2	RLi_GPS2	f = 1575 MHz (GPS)	-	10	-	dB
RF IN Return Loss (GLONASS) 2	RLi_GLN2	f = 1597 to 1606 MHz (GLONASS)	-	10	-	dB
RF OUT Return Loss (GPS) 2	RLo_GPS2	f = 1575 MHz (GPS)	-	10	-	dB
RF OUT Return Loss (GLONASS) 2	RLo_GLN2	f = 1597 to 1606 MHz (GLONASS)	-	13	-	dB
Group Delay Time Deviation 2	GDTD2	f = 1597 to 1606 MHz (GLONASS)	-	8.0	-	ns

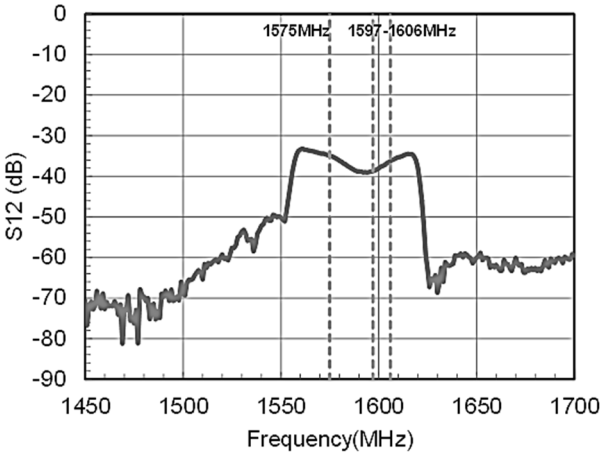
■ ELECTRICAL CHARACTERISTICS

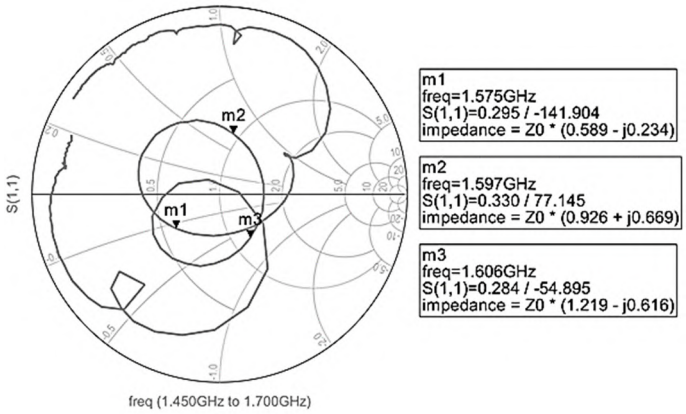
Conditions: V_{DD} = 2.8 V, V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit

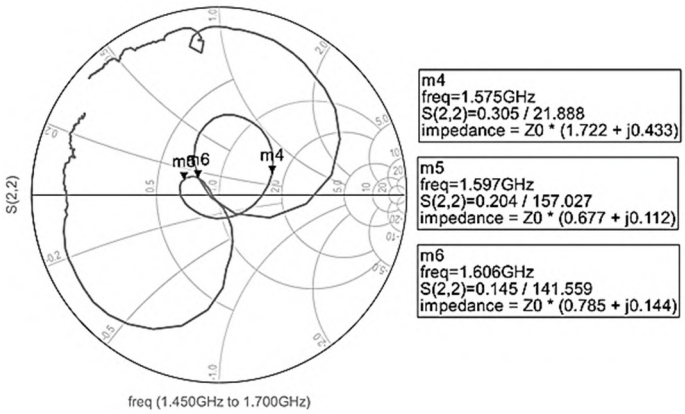








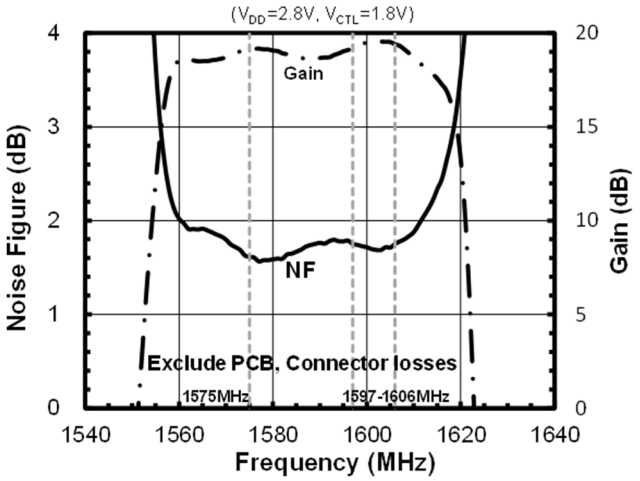




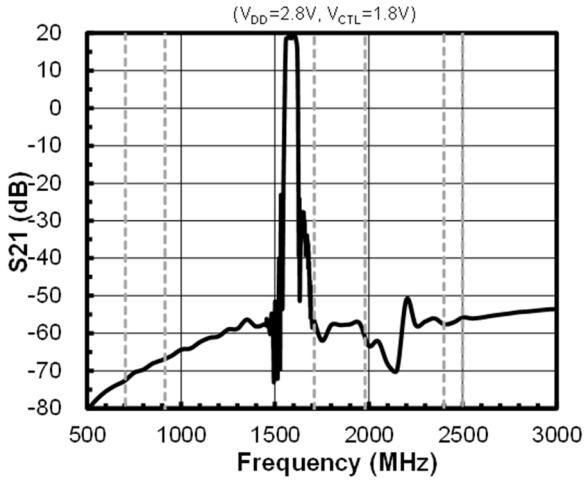
■ ELECTRICAL CHARACTERISTICS

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

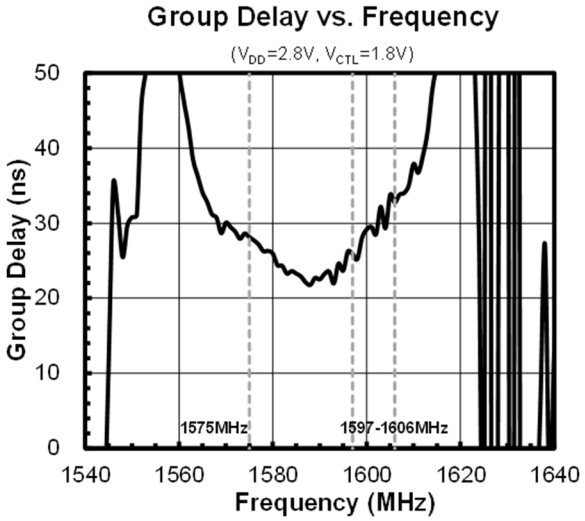
NF, Gain vs. Frequency



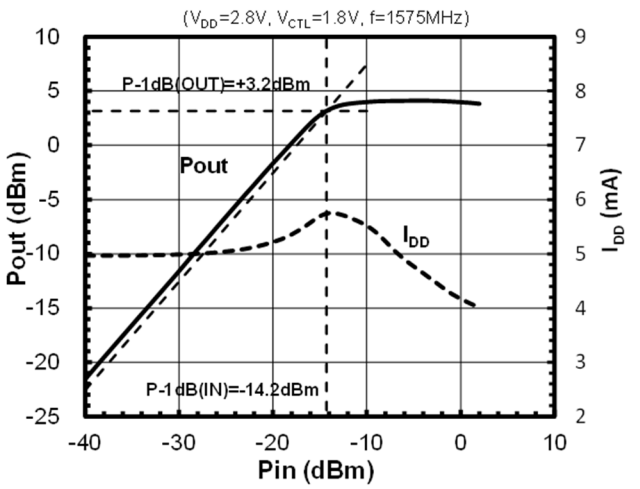
S21 vs. Frequency



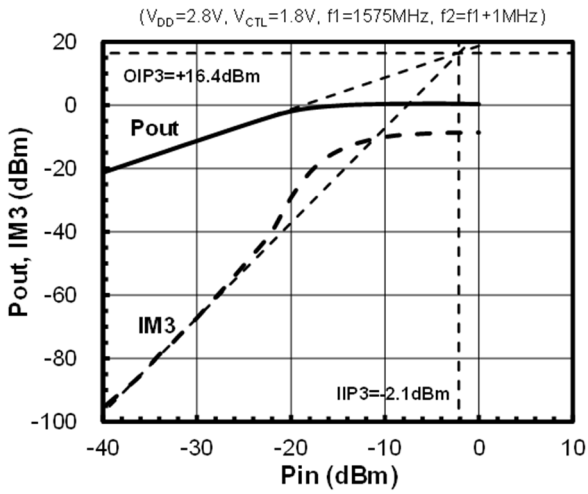
Group Delay vs. Frequency



Pout, I_{DD} vs. Pin



Pout, IM3 vs. Pin

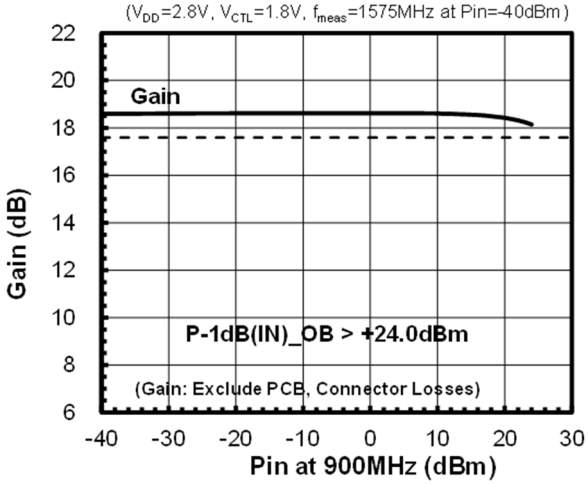


■ ELECTRICAL CHARACTERISTICS

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

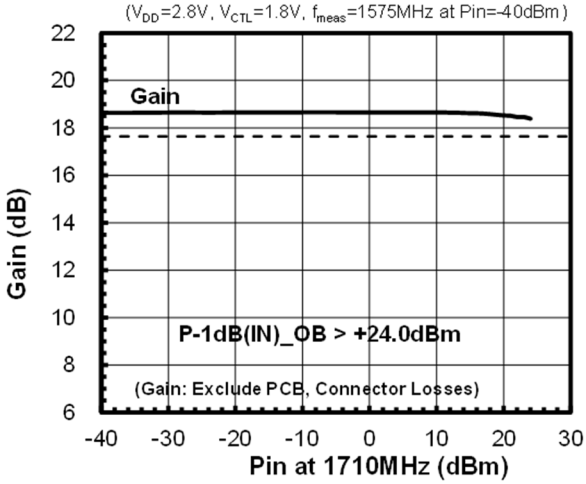
Out-of-band P-1dB (fjam=900MHz)

(V_{DD}=2.8V, V_{CTL}=1.8V, f_{meas}=1575MHz at Pin=-40dBm)



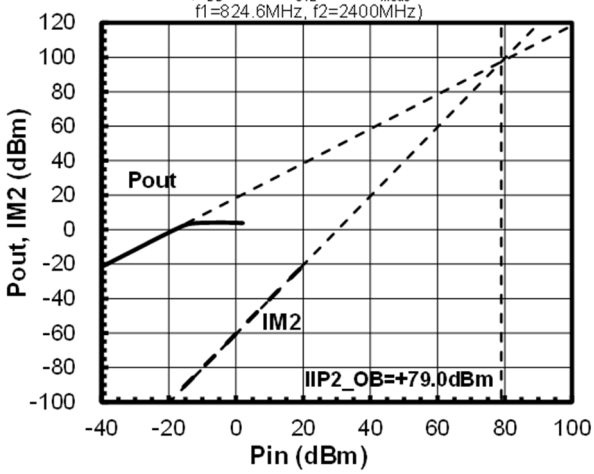
Out-of-band P-1dB (fjam=1710MHz)

(V_{DD}=2.8V, V_{CTL}=1.8V, f_{meas}=1575MHz at Pin=-40dBm)



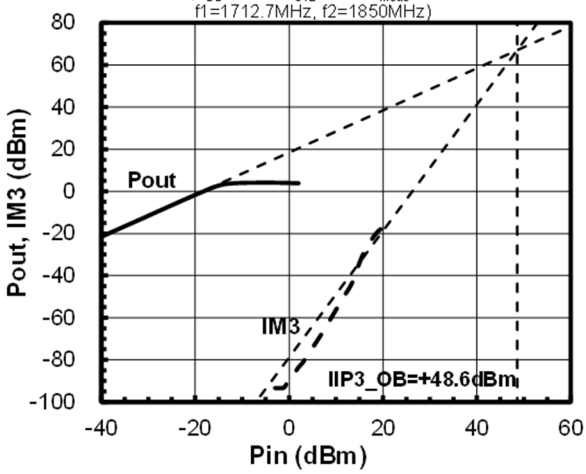
Out-of-band IIP2

(V_{DD}=2.8V, V_{CTL}=1.8V, f_{meas}=1575MHz, f1=824.6MHz, f2=2400MHz)



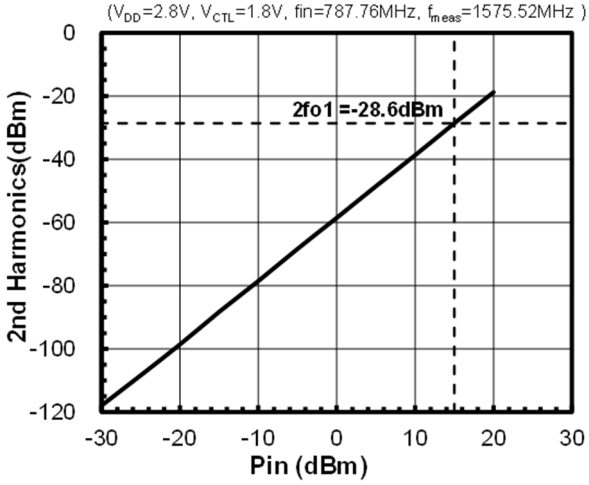
Out-of-band IIP3

(V_{DD}=2.8V, V_{CTL}=1.8V, f_{meas}=1575MHz, f1=1712.7MHz, f2=1850MHz)



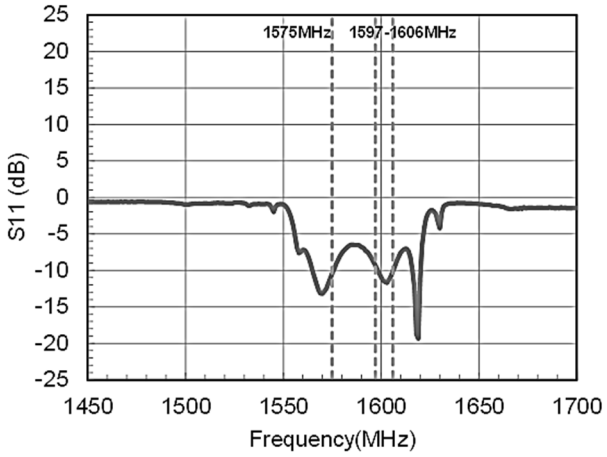
2nd Harmonics

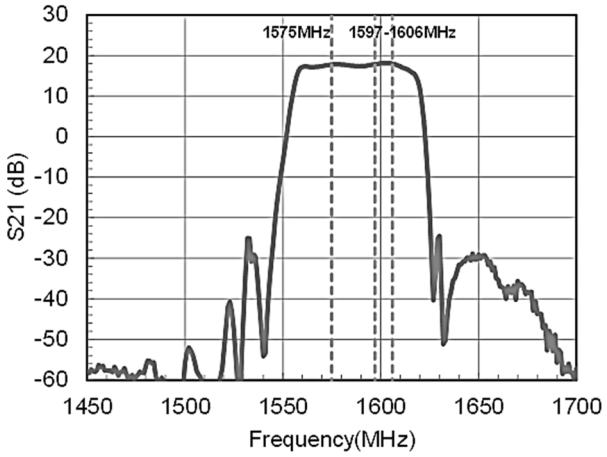
(V_{DD}=2.8V, V_{CTL}=1.8V, fin=787.76MHz, f_{meas}=1575.52MHz)

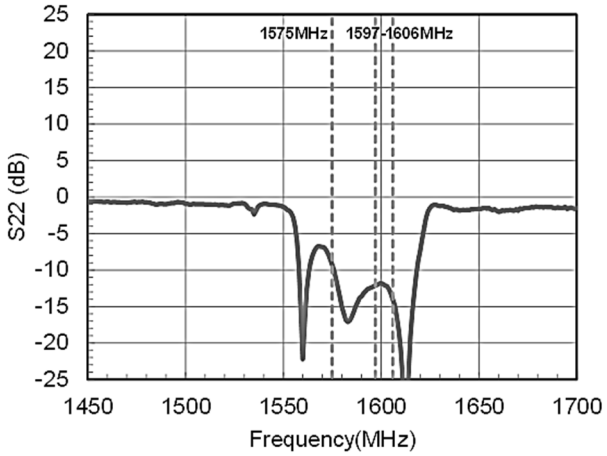


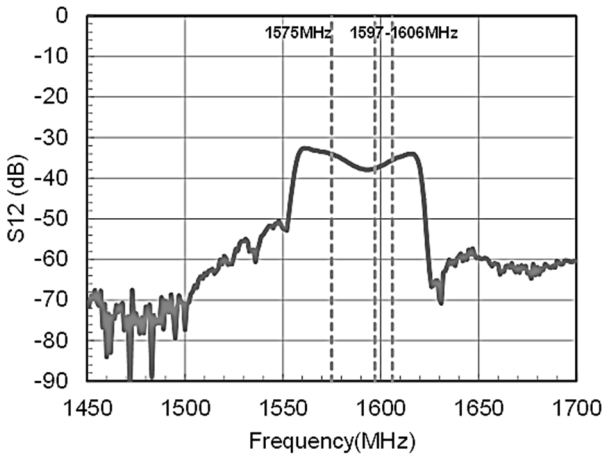
■ ELECTRICAL CHARACTERISTICS

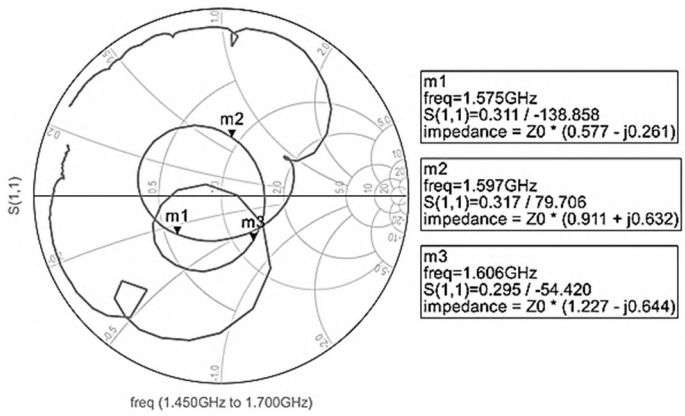
Conditions: V_{DD} = 1.8 V, V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit

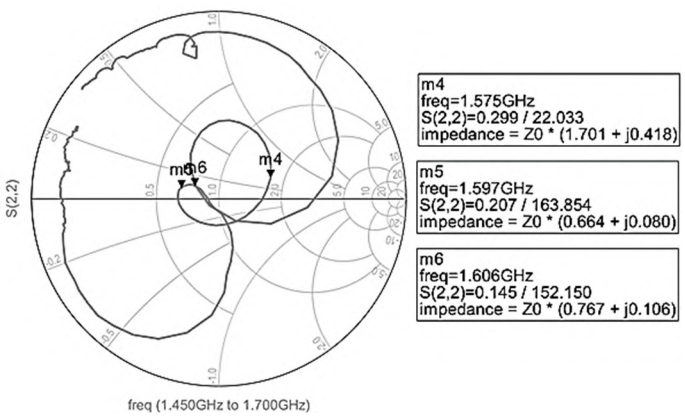








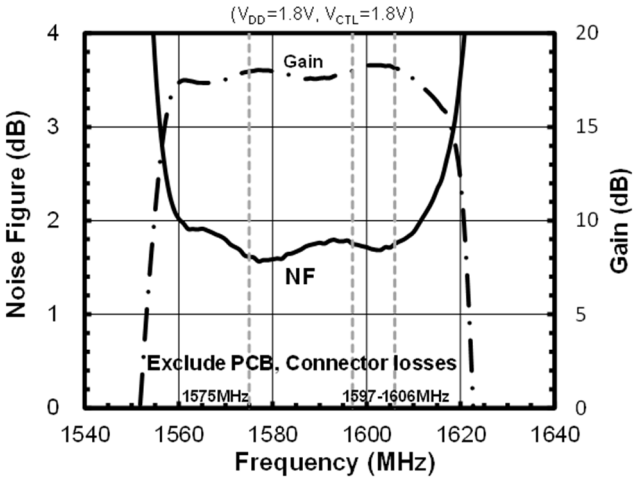




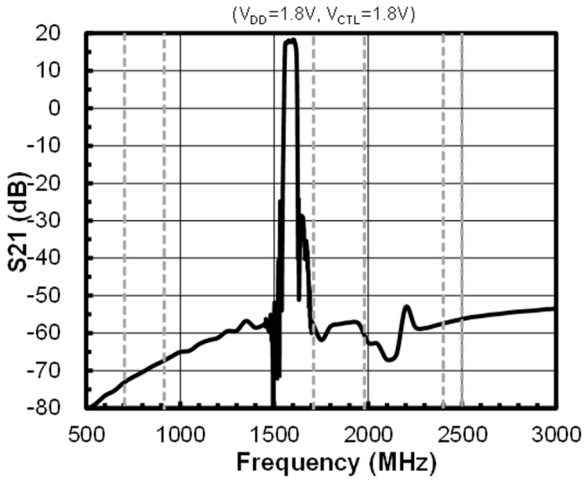
■ ELECTRICAL CHARACTERISTICS

Conditions: V_{DD} = 1.8 V, V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit

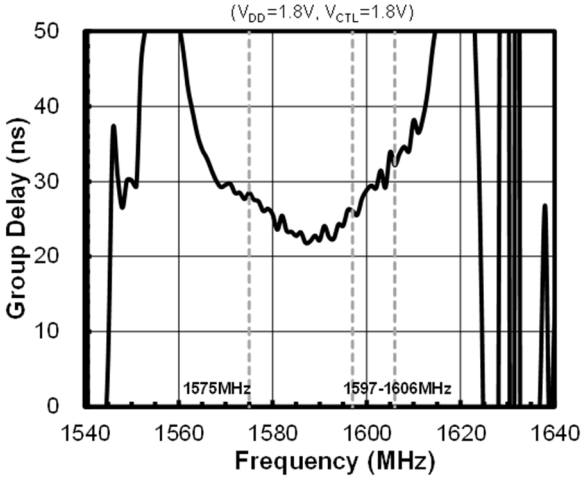
NF, Gain vs. Frequency



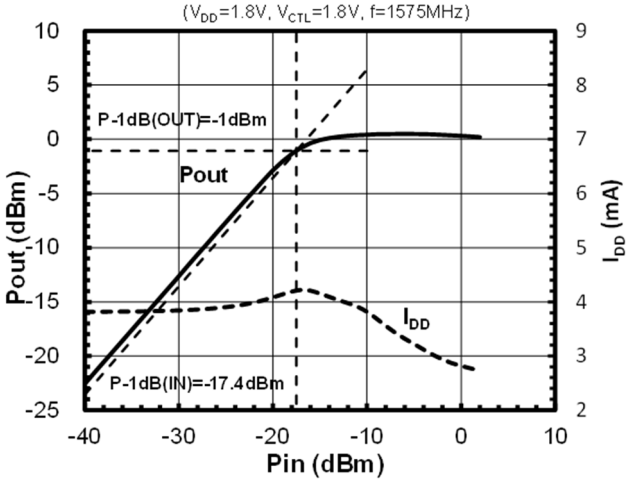
S21 vs. Frequency



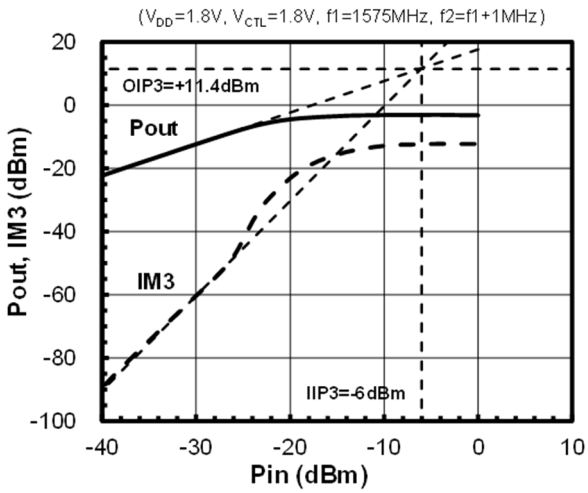
Group Delay vs. Frequency



Pout, I_{DD} vs. Pin

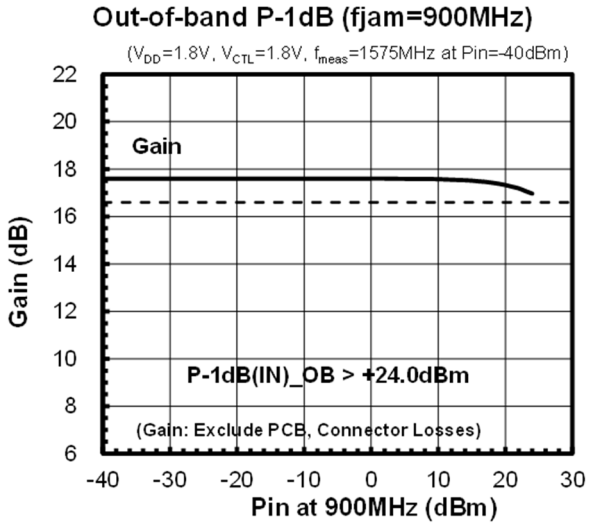


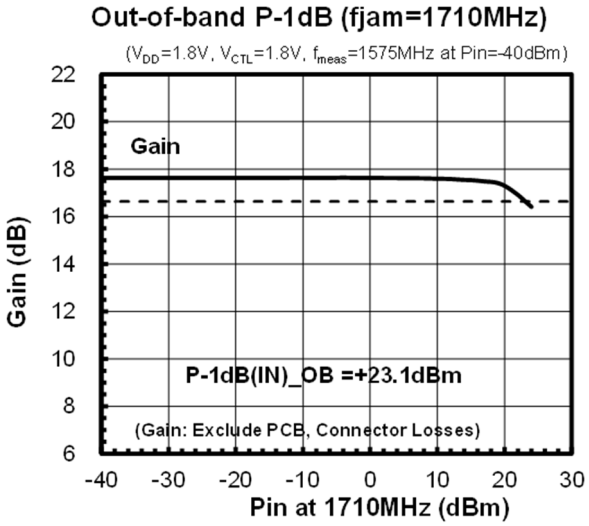
Pout, IM3 vs. Pin

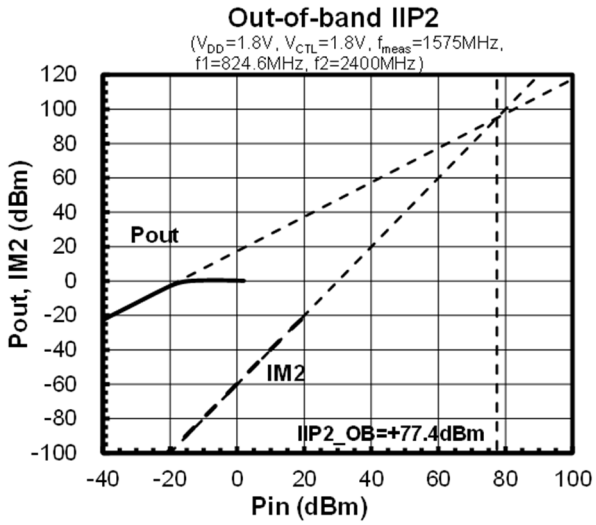


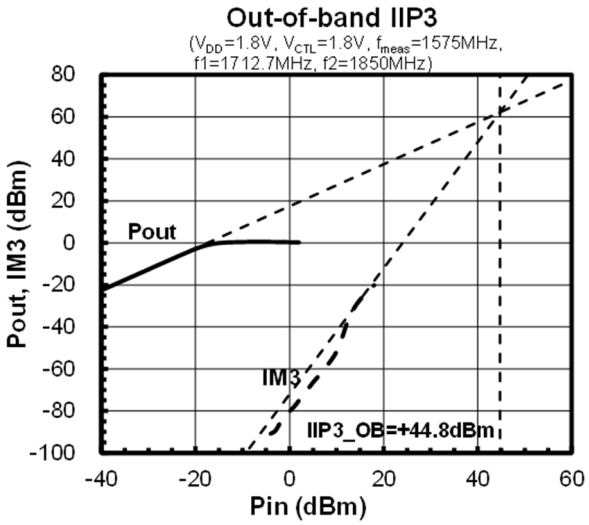
■ ELECTRICAL CHARACTERISTICS

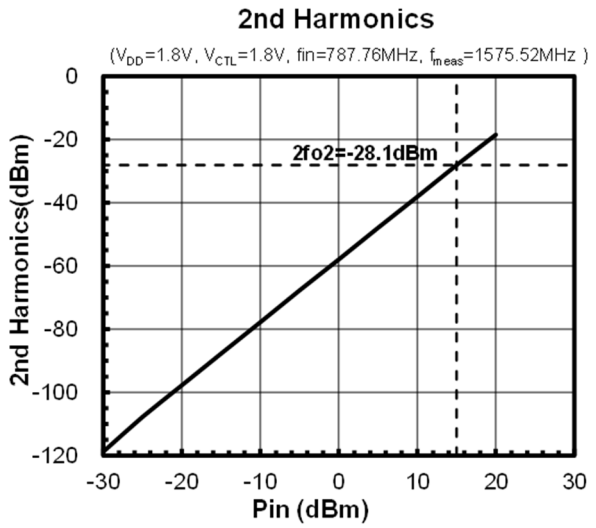
Conditions: V_{DD} = 1.8 V, V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit







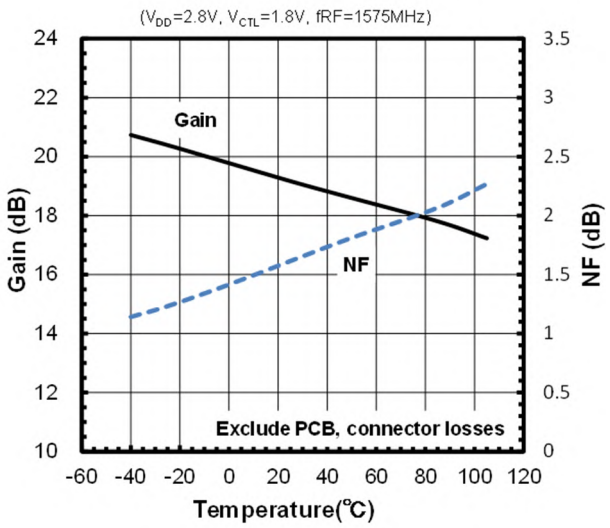




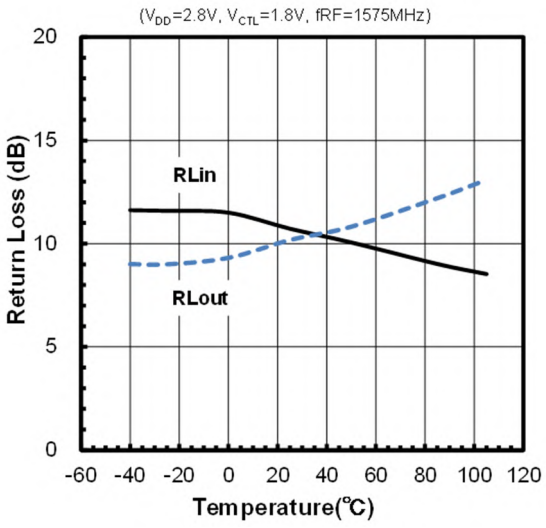
■ ELECTRICAL CHARACTERISTICS

Conditions: V_{DD} = 2.8 V, V_{CTL} = 1.8 V, Z_s = Z_l = 50 Ω, with application circuit

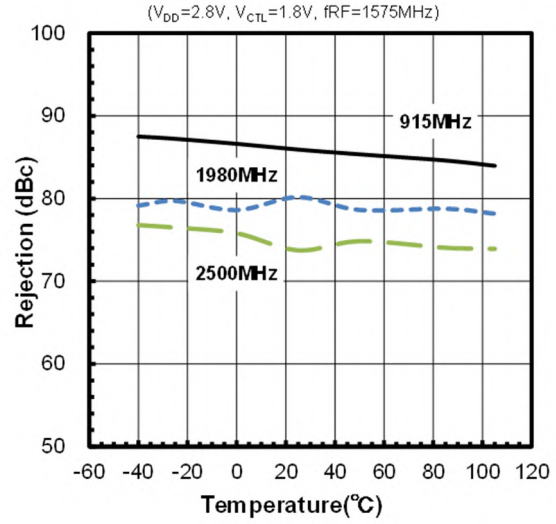
Gain, NF vs. Temperature



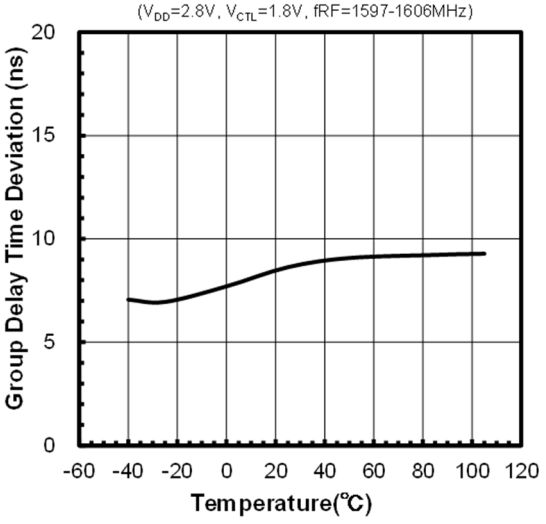
Return Loss vs. Temperature



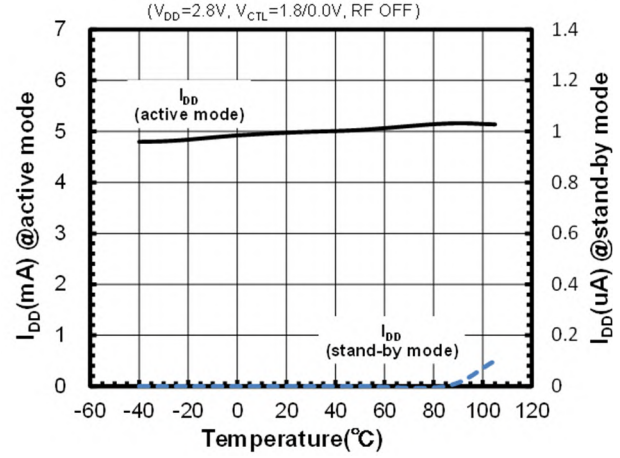
Rejection vs. Temperature



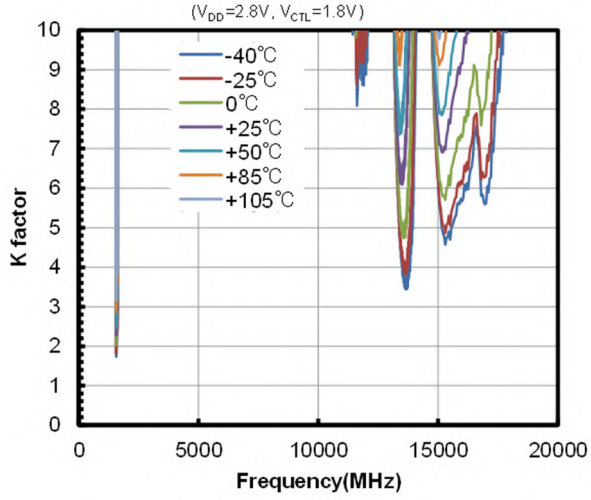
Group Delay Time Deviation vs. Temperature



I_{DD} vs. Temperature



K factor vs. Frequency

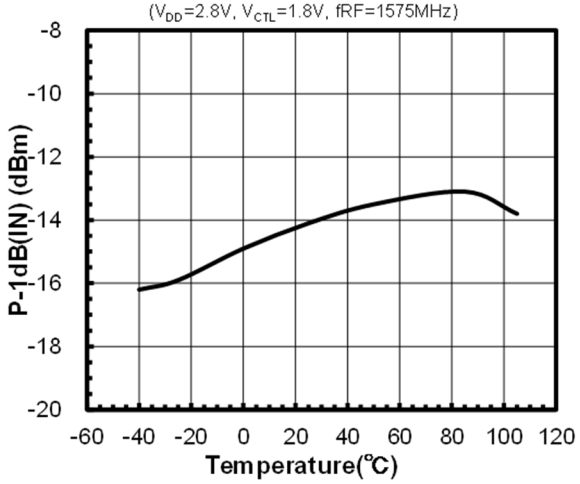


■ ELECTRICAL CHARACTERISTICS

Conditions: V_{DD} = 2.8 V, V_{CTL} = 1.8 V, Z_s = Z_l = 50 Ω, with application circuit

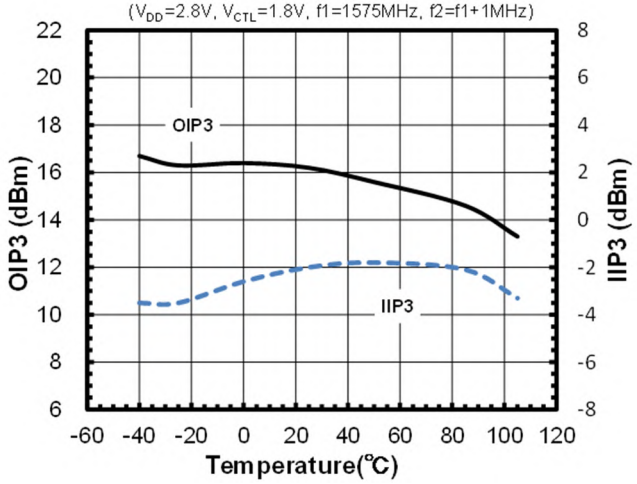
P-1dB(IN) vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, fRF=1575MHz)



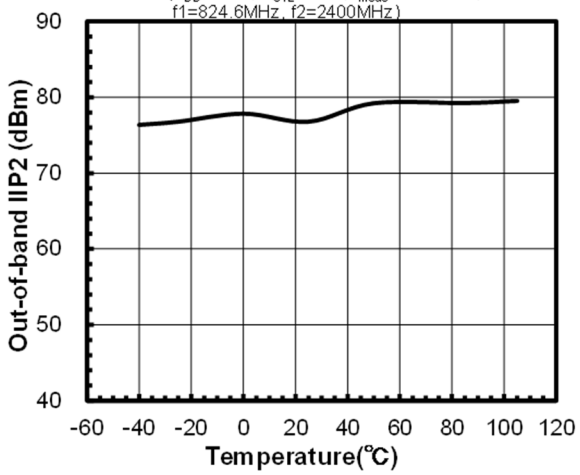
OIP3, IIP3 vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, f1=1575MHz, f2=f1+1MHz)



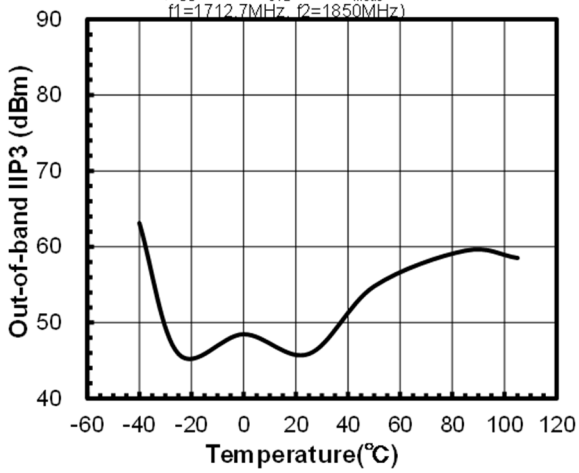
Out-of-band IIP2 vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, f_{meas}=1575MHz, f1=824.6MHz, f2=2400MHz)



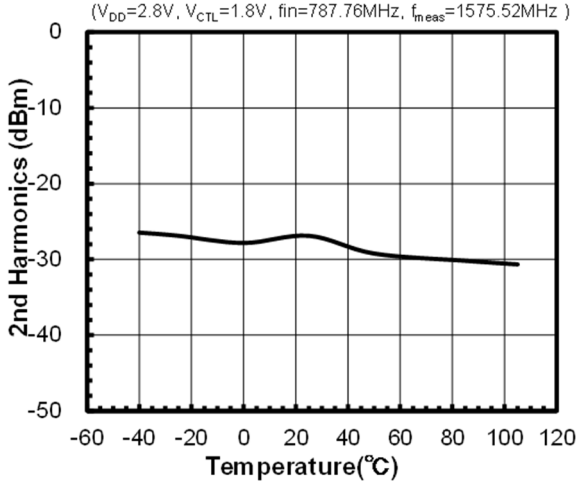
Out-of-band IIP3 vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, f_{meas}=1575MHz, f1=1712.7MHz, f2=1850MHz)



2nd Harmonics vs. Temperature

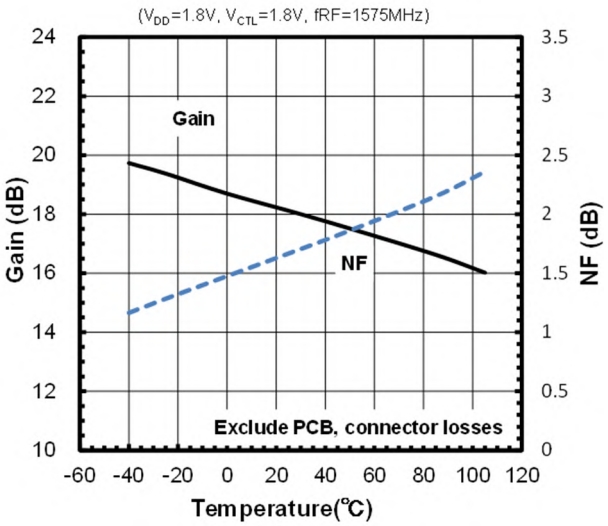
(V_{DD}=2.8V, V_{CTL}=1.8V, fin=787.76MHz, f_{meas}=1575.52MHz)



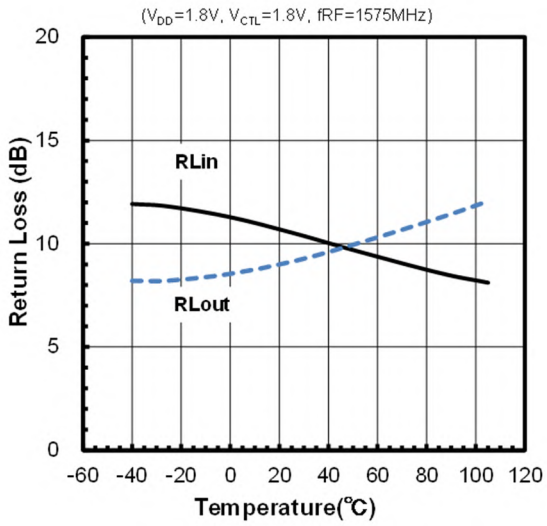
■ ELECTRICAL CHARACTERISTICS

Conditions: V_{DD} = 1.8 V, V_{CTL} = 1.8 V, Z_s = Z_l = 50 Ω, with application circuit

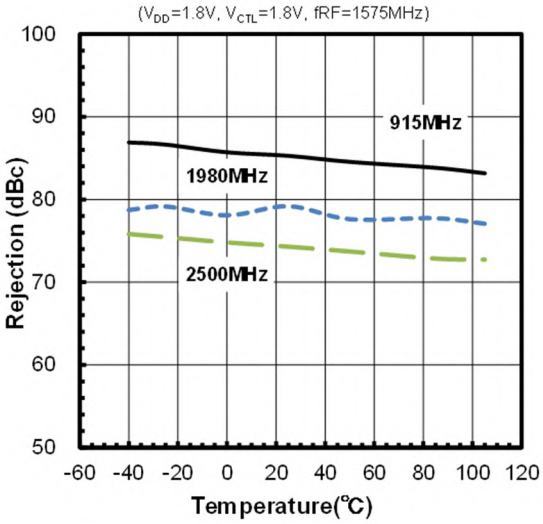
Gain, NF vs. Temperature



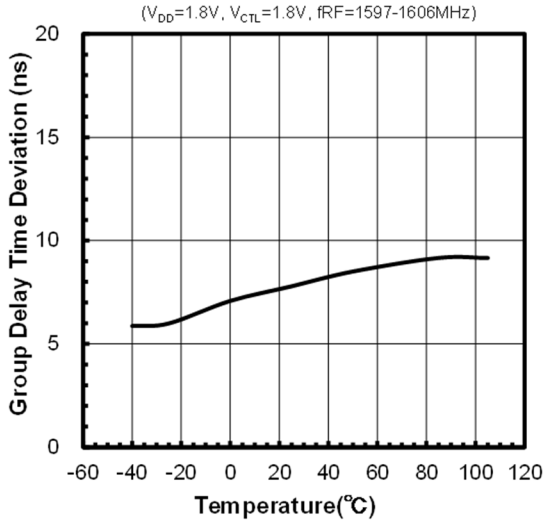
Return Loss vs. Temperature



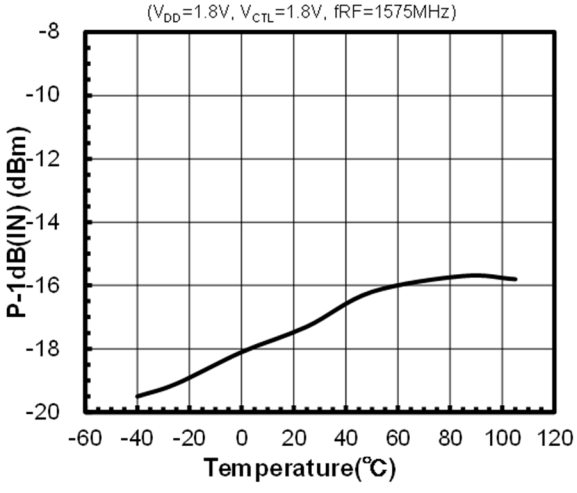
Rejection vs. Temperature



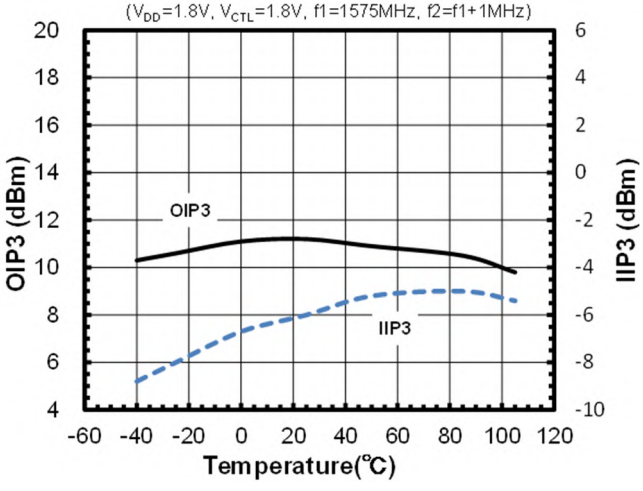
Group Delay Time Deviation vs. Temperature



P-1dB(IN) vs. Temperature

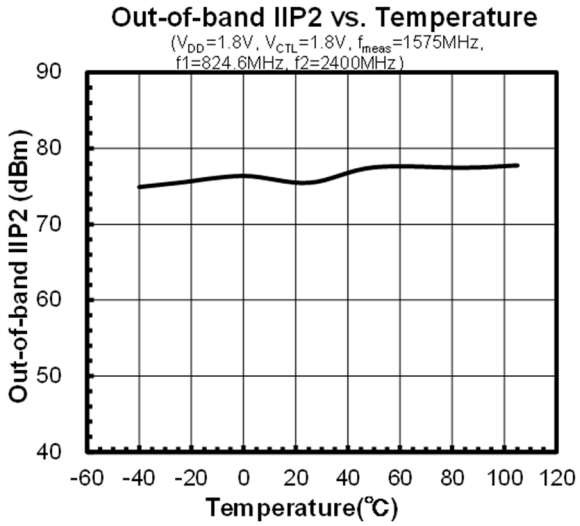


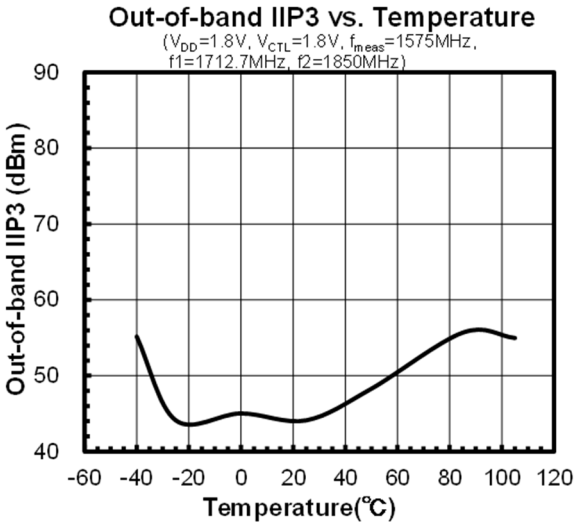
OIP3, IIP3 vs. Temperature

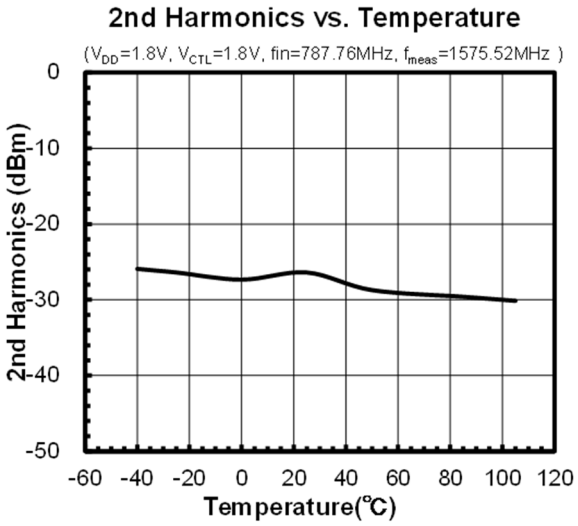


■ ELECTRICAL CHARACTERISTICS

Conditions: V_{DD} = 1.8 V, V_{CTL} = 1.8 V, Z_s = Z_l = 50 Ω, with application circuit



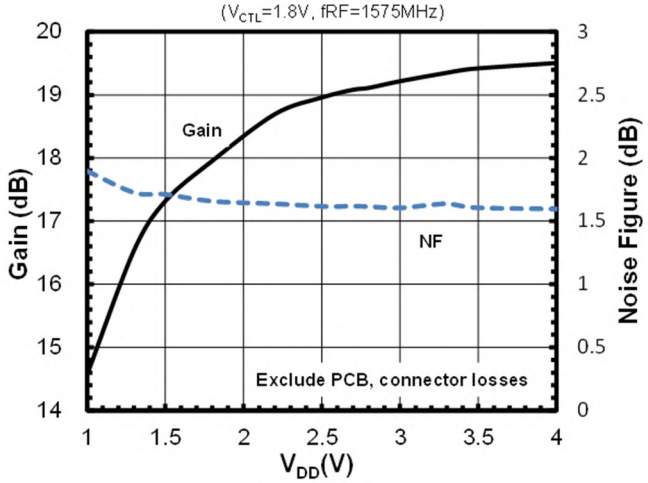




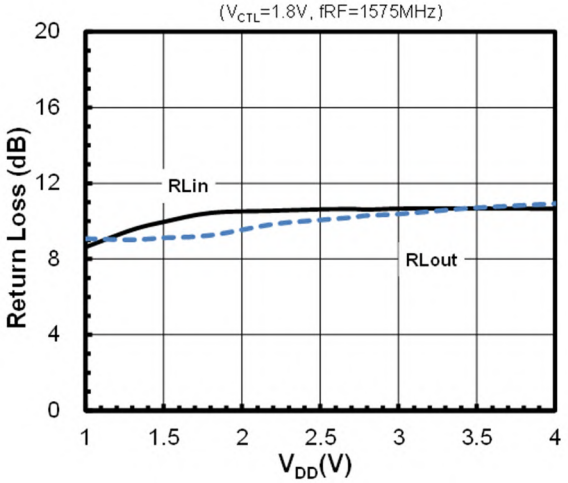
■ ELECTRICAL CHARACTERISTICS

Conditions: V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit

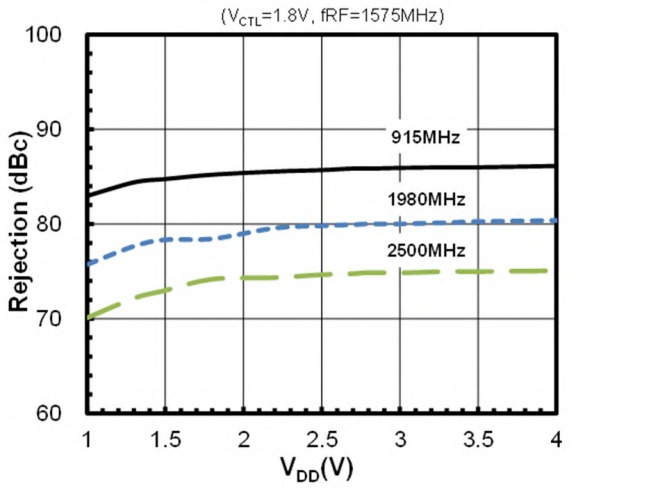
Gain, NF vs. V_{DD}



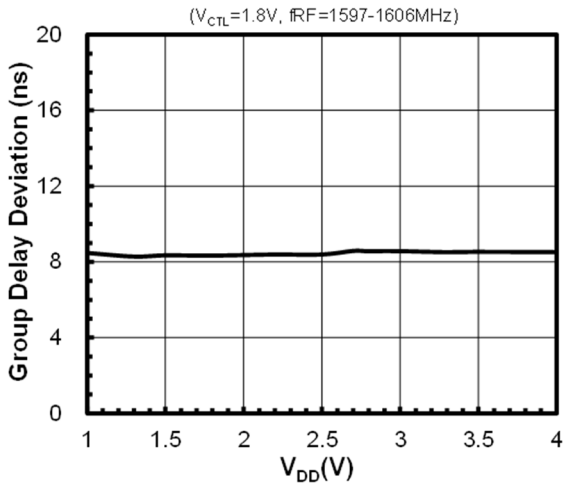
Return Loss vs. V_{DD}



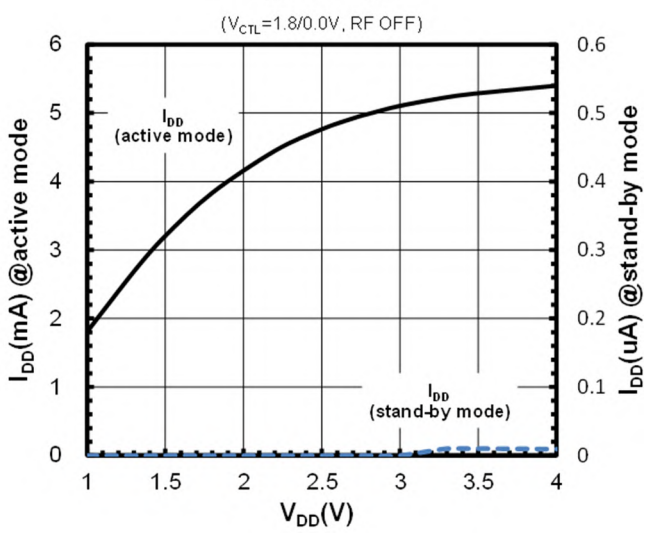
Rejection vs. V_{DD}



Group Delay Deviation vs. V_{DD}



I_{DD} vs. V_{DD}

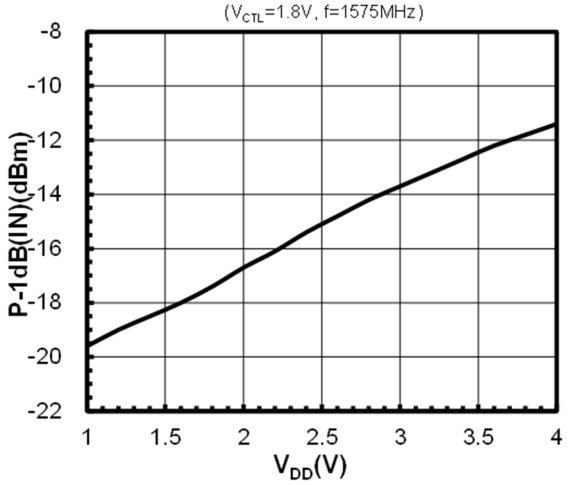


■ ELECTRICAL CHARACTERISTICS

Conditions: V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit

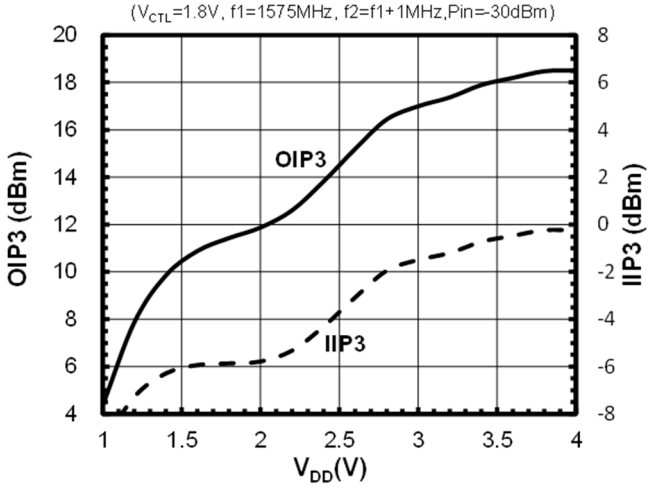
P-1dB(IN) vs. V_{DD}

(V_{CTL}=1.8V, f=1575MHz)



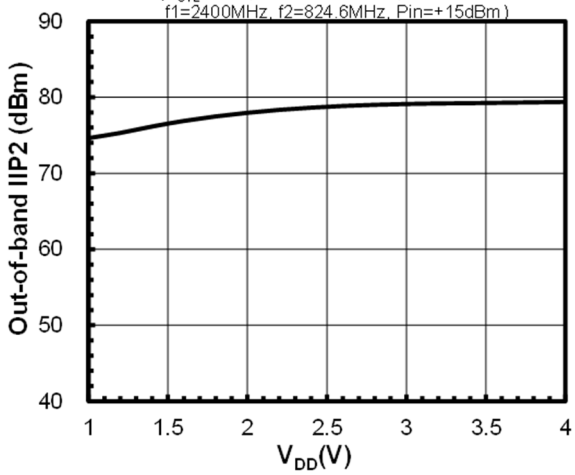
OIP3, IIP3 vs. V_{DD}

(V_{CTL}=1.8V, f1=1575MHz, f2=f1+1MHz,Pin=-30dBm)



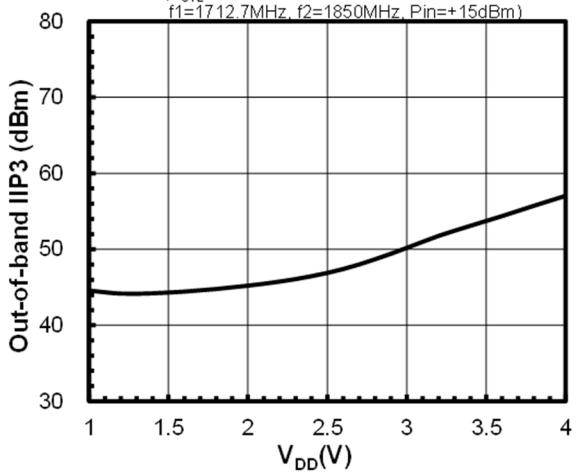
Out-of-band IIP2 vs. VDD

(V_{CTL}=1.8V, fmeas=1575MHz, f1=2400MHz, f2=824.6MHz, Pin=+15dBm)



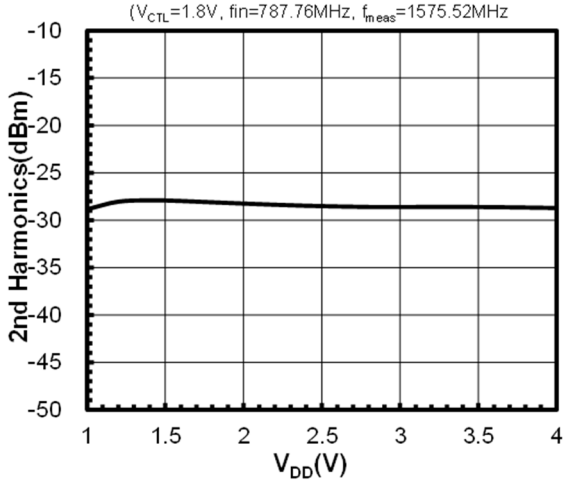
Out-of-band IIP3 vs. V_{DD}

(V_{CTL}=1.8V, fmeas=1575MHz, f1=1712.7MHz, f2=1850MHz, Pin=+15dBm)



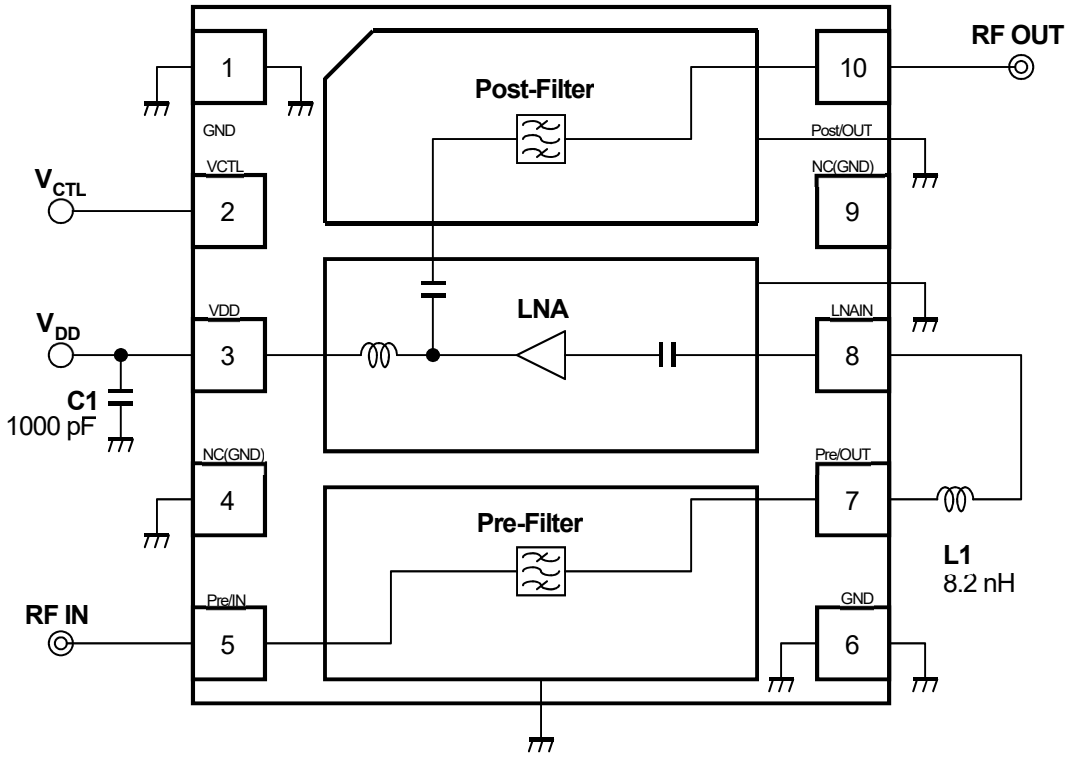
2nd Harmonics vs. V_{DD}

(V_{CTL}=1.8V, fin=787.76MHz, f_{meas}=1575.52MHz



■ **APPLICATION CIRCUIT**

(Top View)

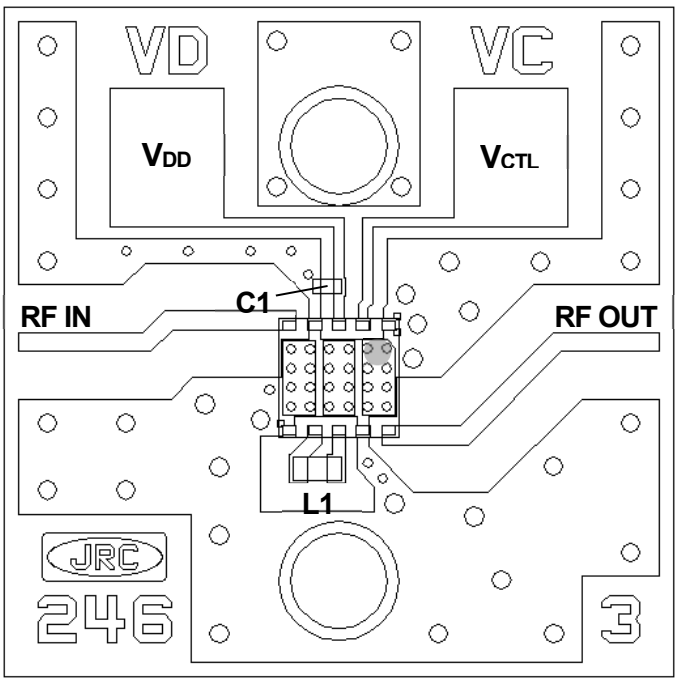


<PARTS LIST>

Part ID	Value	Notes
L1	8.2 nH	LQW15AN_00 Series (MURATA)
C1	1000 pF	GRM03 Series (MURATA)

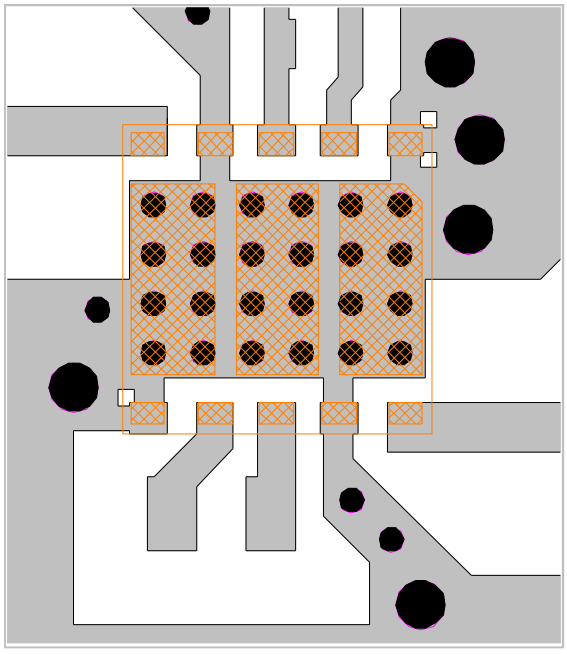
■ EVALUATION BOARD

(Top View)



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, 0.4 mm

PRECAUTIONS

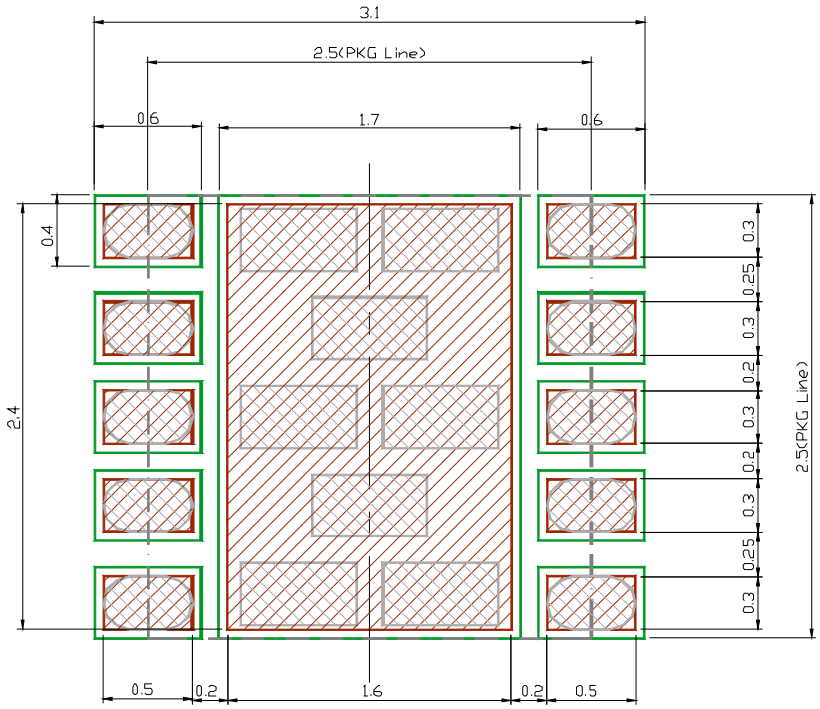
• Please layout ground pattern under this FEM in order not to couple with RFIN and RFOUT terminal.
• All external parts should be placed as close as possible to the FEM.
• For good RF performance, all GND terminals must be connected to PCB ground plane of substrate, and via-holes for GND should be placed near the FEM.

■ **RECOMMENDED FOOTPRINT PATTERN** (HFFP10-CD Package) <Reference>

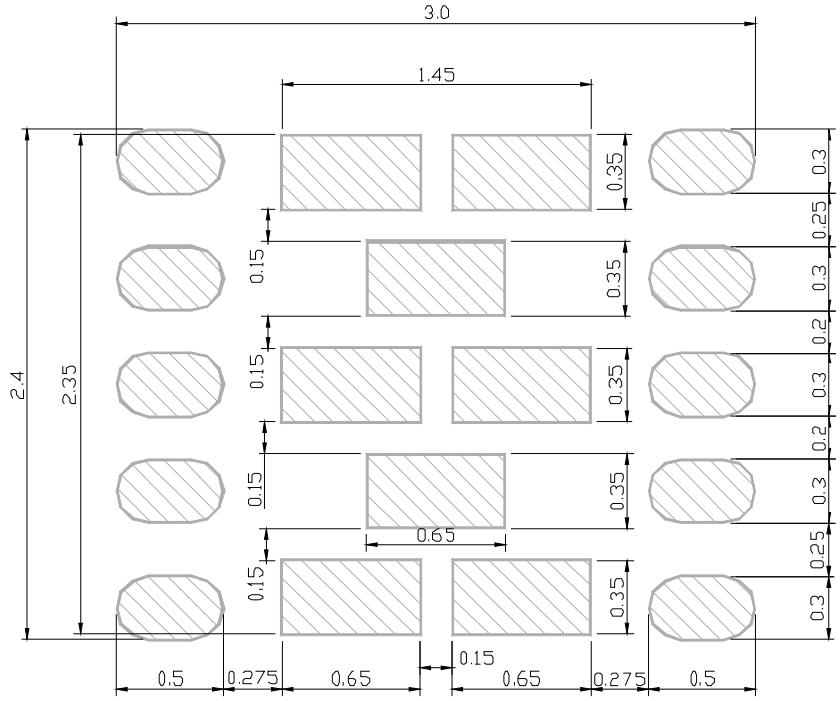
PKG: 2.5 mm x 2.5 mm

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

Unit: mm



Metal MASK Detail



■ 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

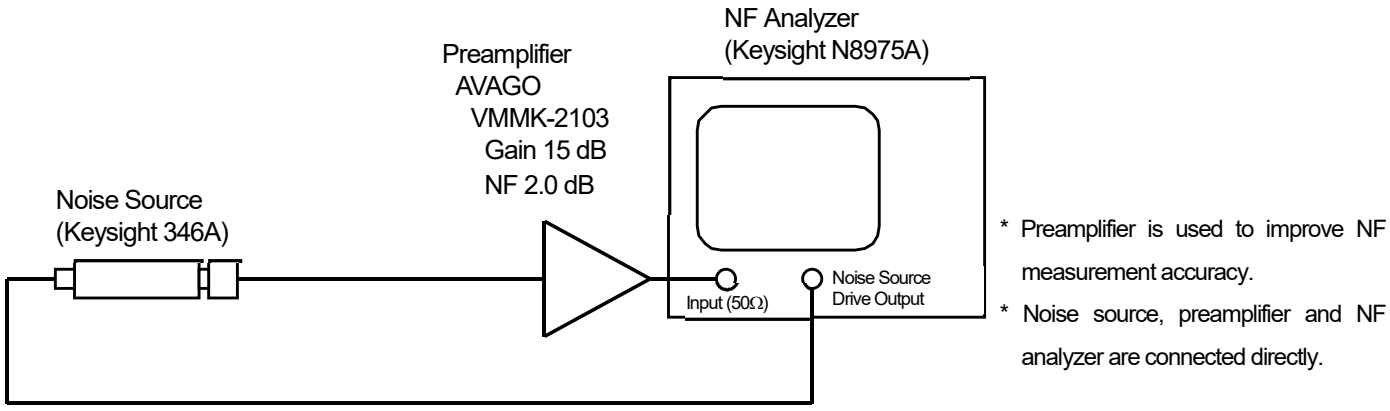
Averages : 8

Average mode : Point

Bandwidth : 4 MHz

Loss comp : off

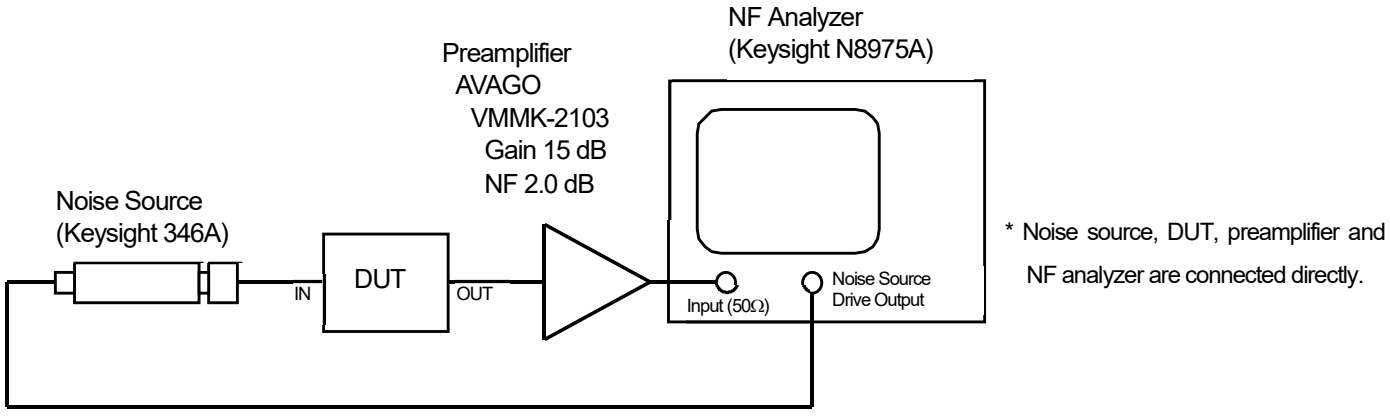
Tcold : setting the temperature of noise source (303.15K)



* Preamplifier is used to improve NF measurement accuracy.

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

Calibration setup

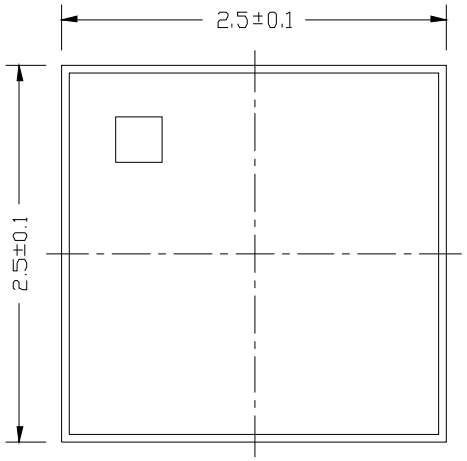


* Noise source, DUT, preamplifier and NF analyzer are connected directly.

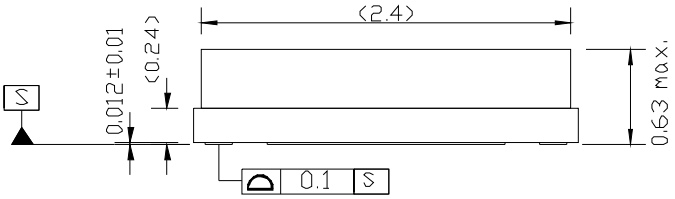
Measurement Setup

■ **PACKAGE OUTLINE (HFFP10-HH)**

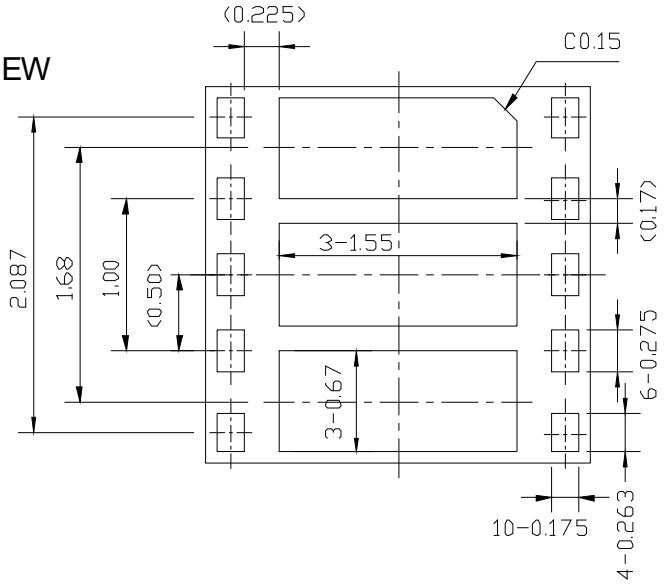
TOP VIEW



SIDE VIEW



BOTTOM VIEW



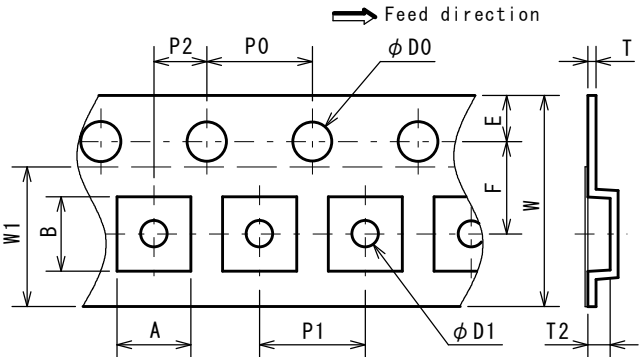
Package Size : 2.5 ± 0.1 mm
0.63 mm max.
Electrode Dimensions clearance
: ± 0.05 mm

Unit : mm
Substrate : Ceramic
Terminal treat : Au
Lid : SnAg/Kovar/Ni
Weight (typ.) : 18 mg

■ PACKING SPECIFICATION (HFFP10-CD)

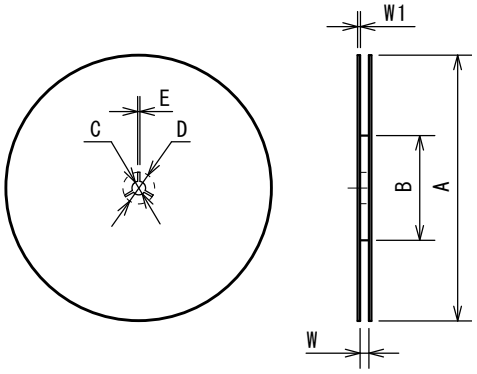
Unit: mm

TAPING DIMENSIONS



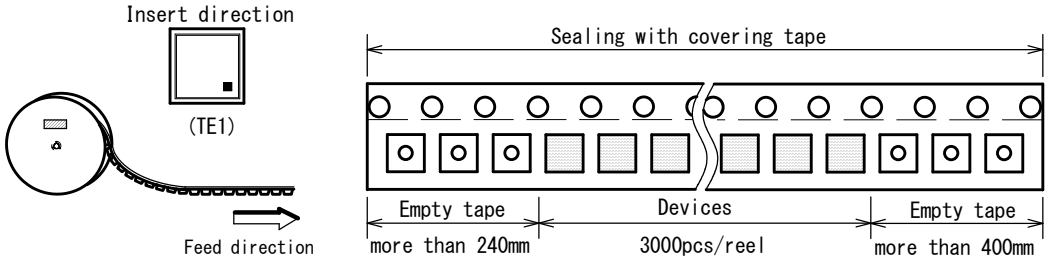
SYMBOL	DIMENSION	REMARKS
A	2.8±0.1	BOTTOM DIMENSION
B	2.8±0.1	BOTTOM DIMENSION
D0	$1.5^{+0.1}_{0}$	
D1	$1.0^{+0.1}_{0}$	
E	1.75±0.1	
F	3.5±0.05	
P0	4.0±0.1	
P1	4.0±0.1	
P2	2.0±0.1	
T	0.3±0.1	
T2	0.85±0.1	
W	8.0±0.2	
W1	5.3±0.2	THICKNESS100μm max

REEL DIMENSIONS

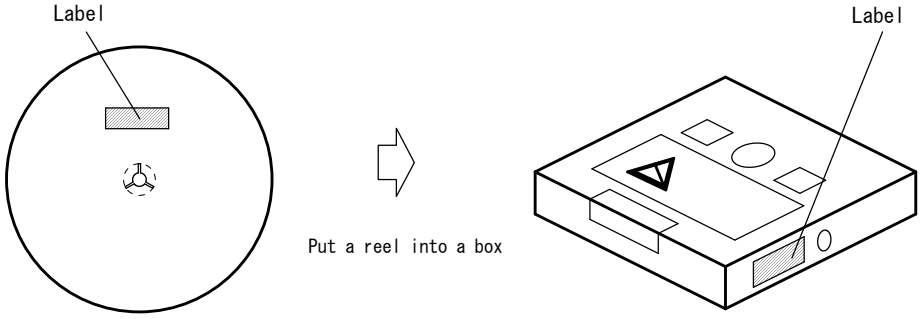


SYMBOL	DIMENSION
A	$\phi 180^{0}_{-1.5}$
B	φ 66±0.5
C	φ 13±0.2
D	φ 21±0.8
E	2±0.5
W	$9^{+1.0}_{0}$
W1	1.2

TAPING STATE



PACKING STATE



1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to our sales representatives for the latest information thereon.
2. The materials in this document may not be copied or otherwise reproduced in whole or in part without the prior written consent of us.
3. This product and any technical information relating thereto are subject to complementary export controls (so-called KNOW controls) under the Foreign Exchange and Foreign Trade Law, and related politics ministerial ordinance of the law. (Note that the complementary export controls are inapplicable to any application-specific products, except rockets and pilotless aircraft, that are insusceptible to design or program changes.) Accordingly, when exporting or carrying abroad this product, follow the Foreign Exchange and Foreign Trade Control Law and its related regulations with respect to the complementary export controls.
4. The technical information described in this document shows typical characteristics and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under our or any third party's intellectual property rights or any other rights.
5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death should first contact us.
    - Aerospace Equipment
    - Equipment Used in the Deep Sea
    - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
    - Life Maintenance Medical Equipment
    - Fire Alarms / Intruder Detectors
    - Vehicle Control Equipment (automotive, airplane, railroad, ship, etc.)
    - Various Safety Devices
    - Traffic control system
    - Combustion equipment

    In case your company desires to use this product for any applications other than general electronic equipment mentioned above, make sure to contact our company in advance. Note that the important requirements mentioned in this section are not applicable to cases where operation requirements such as application conditions are confirmed by our company in writing after consultation with your company.
6. We are making our continuous effort to improve the quality and reliability of our products, but electronic device products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. The products have been designed and tested to function within controlled environmental conditions. Do not use products under conditions that deviate from methods or applications specified in this datasheet. Failure to employ the products in the proper applications can lead to deterioration, destruction or failure of the products. We shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of the products.
8. Quality Warranty
    8-1. Quality Warranty Period
    In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
    8-2. Quality Warranty Remedies
    When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.
    Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
    8-3. Remedies after Quality Warranty Period
    With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. 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.
12. Front end module product is hollow seal package type, and it is with the structure susceptible to stress from the outside. Therefore, note the following in relation to the contents, after conducting an evaluation. please use.
    12-1. After mounting this product, to implement the potting and transfer molding, please the confirmation of resistance to temperature changes and shrinkage stress involved in the molding.
    12-2. When mounted on the product, collet diameter please use more than 1mmφ. In addition, the value of static load is recommended mounting less than 5N.
    12-3. For dynamic load at the time of mounting. please use it after confirming in consideration of the contact area /speed /load.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.