

1.5 GHz band GPS and GLONASS Front-End Module

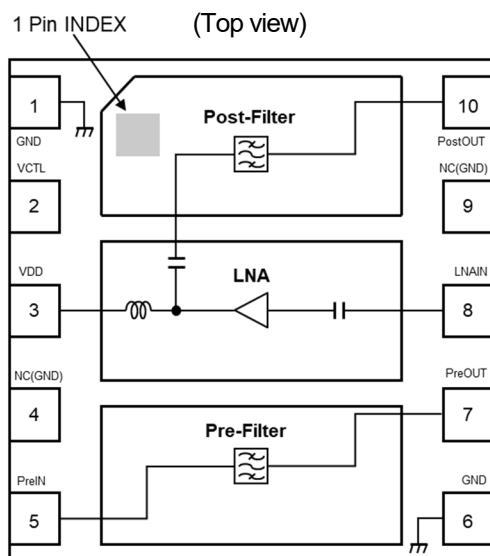
■ FEATURES

- 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 $+105^{\circ}\text{C}$. 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 2.5×2.5 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

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

PARAMETER	SYMBOL	RATINGS	UNIT
Supply voltage	V_{DD}	5.0	V
Control voltage	V_{CTL}	5.0	V
Input power	$P_{IN}(\text{inband})^{(1)}$	+15	dBm
	$P_{IN}(\text{outband})^{(2)}$	+27	dBm
Power dissipation	$P_D^{(3)}$	580	mW
Operating temperature	T_{opr}	-40 to +105	$^\circ\text{C}$
Storage temperature	T_{stg}	-40 to +110	$^\circ\text{C}$

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

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

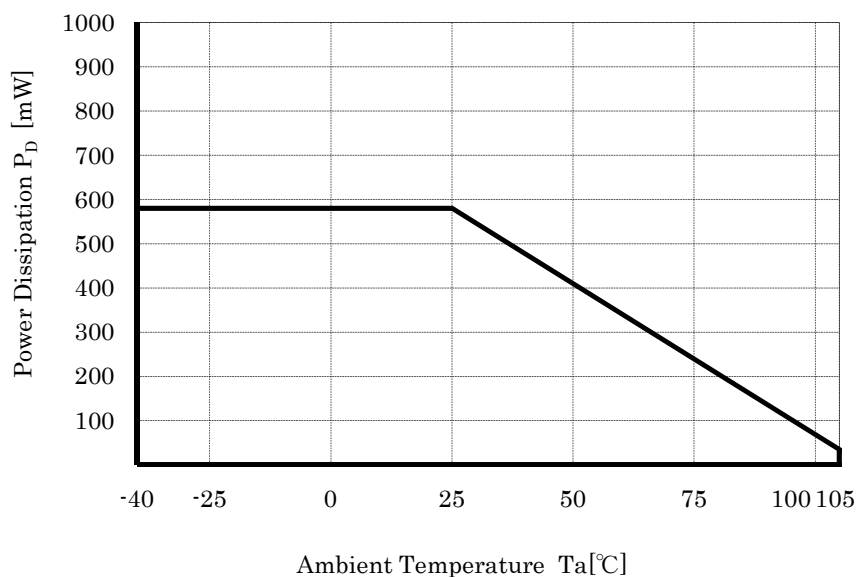
(3): 4-layer FR4 PCB with through-hole ($101.5 \times 114.5\ \text{mm}$), $T_j = 110^\circ\text{C}$

■ 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: $T_a = 25^\circ\text{C}$, 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_{DD1}	RF OFF, $V_{DD} = 2.8\text{ V}$, $V_{CTL} = 1.8\text{ V}$	-	4.6	6.4	mA
Supply Current 2	I_{DD2}	RF OFF, $V_{DD} = 1.8\text{ V}$, $V_{CTL} = 1.8\text{ V}$	-	3.6	5.9	mA
Supply Current 3	I_{DD3}	RF OFF, $V_{DD} = 2.8\text{ V}$, $V_{CTL} = 0\text{ V}$	-	0.1	5.0	μA
Supply Current 4	I_{DD4}	RF OFF, $V_{DD} = 1.8\text{ V}$, $V_{CTL} = 0\text{ V}$	-	0.1	5.0	μA
Control Current	I_{CTL}	$V_{CTL} = 1.8\text{ V}$	-	5.0	15.0	μA

■ ELECTRICAL CHARACTERISTICS 2 (RF)

General conditions: $V_{DD} = 2.8\text{ V}$, $V_{CTL} = 1.8\text{ V}$, $f_{RF} = 1575\text{ MHz}$, 1597 to 1606 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 (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, f _{meas} = 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, f _{meas} = 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	f _{jam} = 900 MHz, f _{meas} = 1575 MHz at P _{IN} = -40 dBm	-	+24	-	dBm
	P-1dB(IN)_OB1-2	f _{jam} = 1710 MHz, f _{meas} = 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

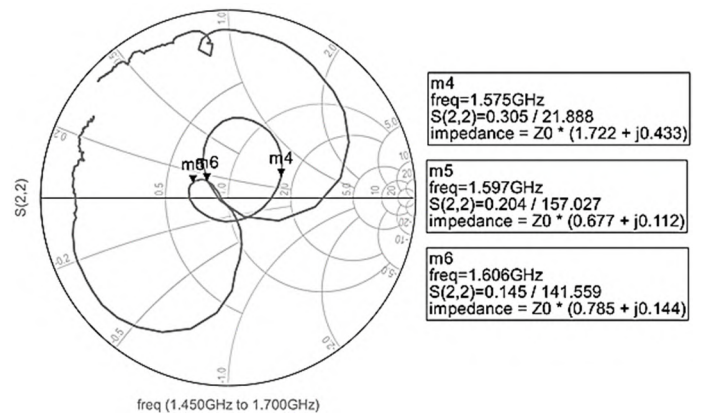
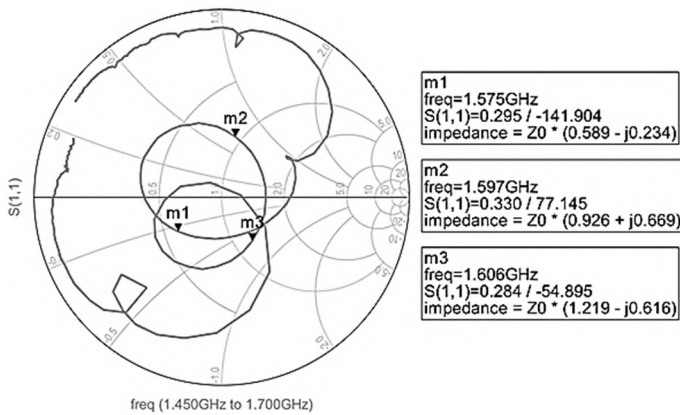
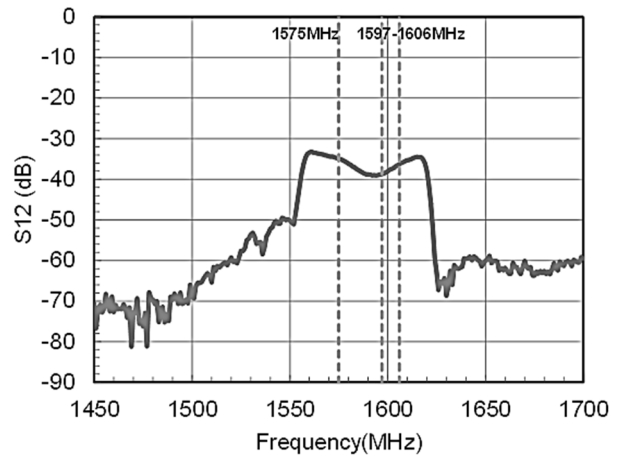
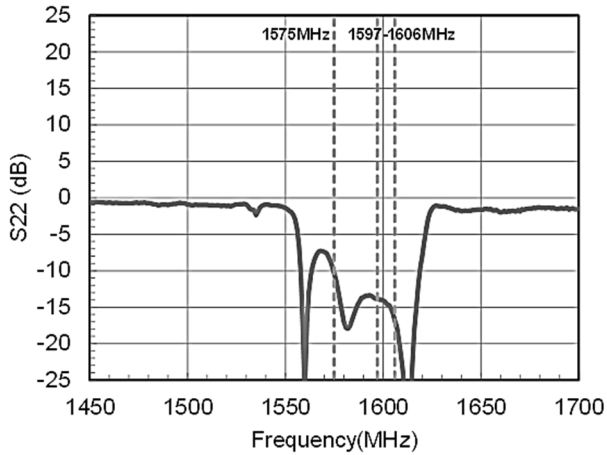
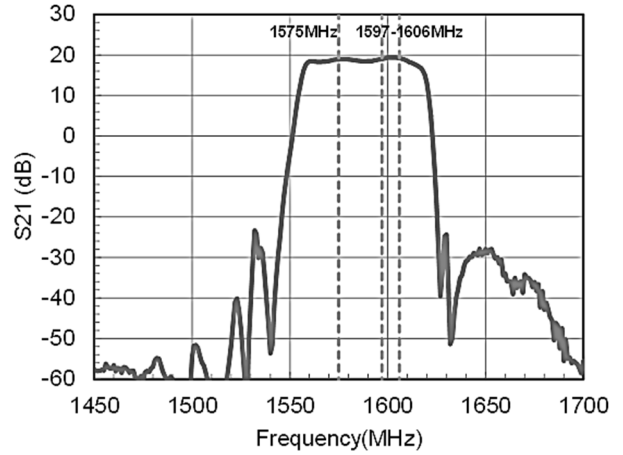
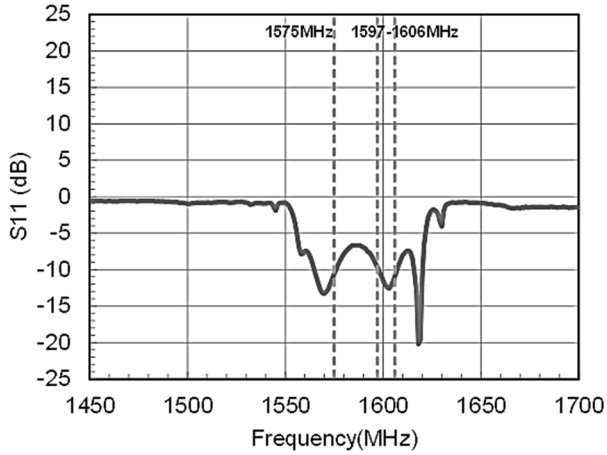
■ ELECTRICAL CHARACTERISTICS 3 (RF)

General conditions: $V_{DD} = 1.8\text{ V}$, $V_{CTL} = 1.8\text{ V}$, $f_{RF} = 1575\text{ MHz}$, 1597 to 1606 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 (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, f _{meas} = 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, f _{meas} = 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	f _{jam} = 900 MHz, f _{meas} = 1575 MHz at P _{IN} = -40 dBm	-	+24	-	dBm
	P-1dB(IN)_OB2-2	f _{jam} = 1710 MHz, f _{meas} = 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

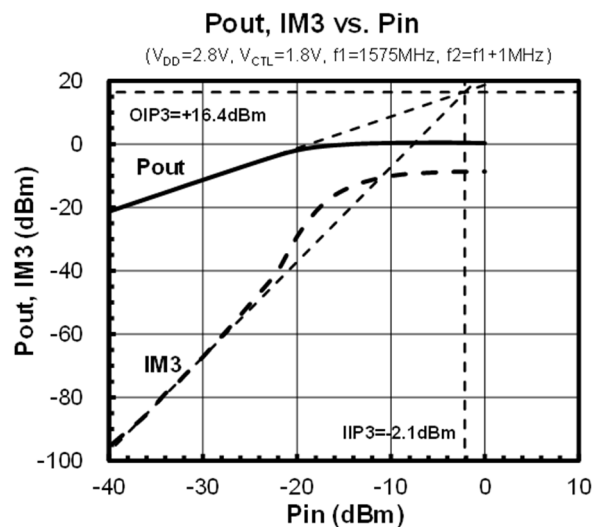
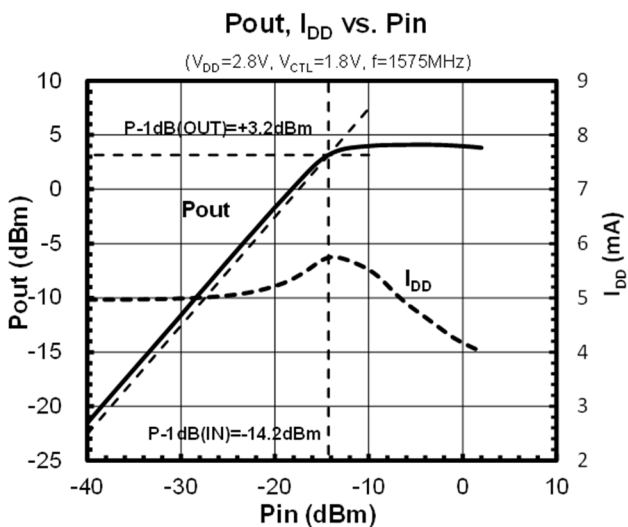
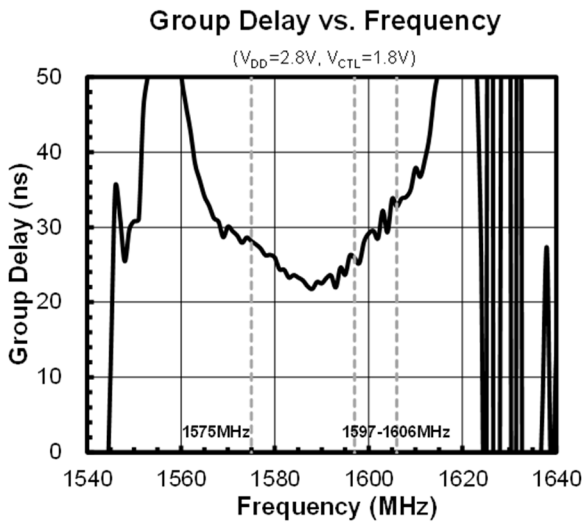
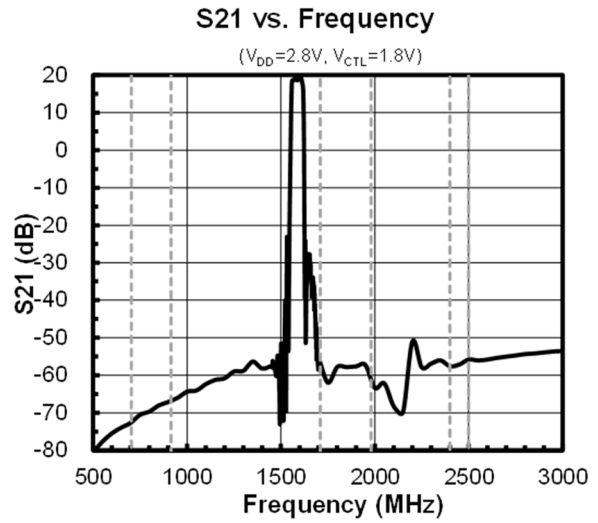
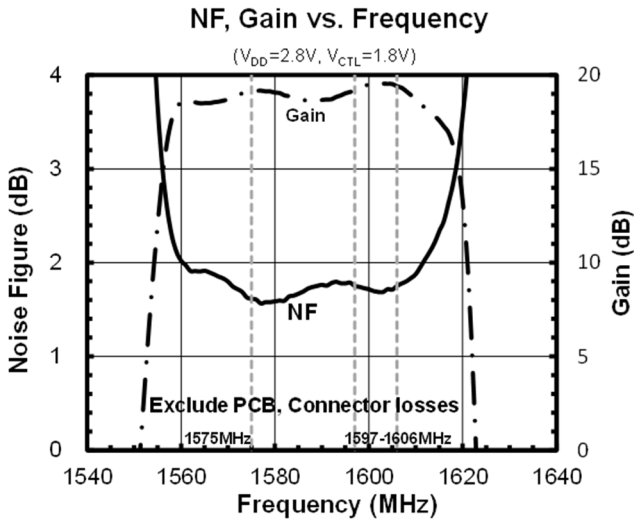
ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD} = 2.8\text{ V}$, $V_{CTL} = 1.8\text{ V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50\ \Omega$, with application circuit



■ ELECTRICAL CHARACTERISTICS

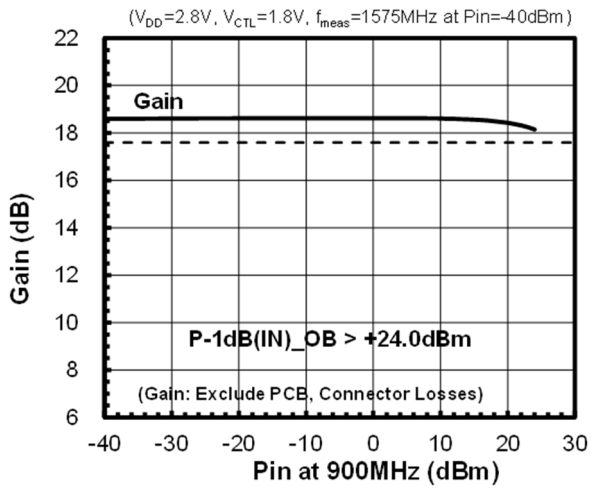
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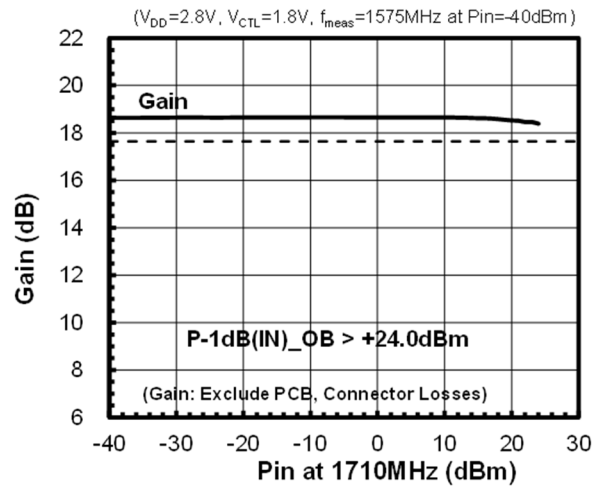
ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD} = 2.8\text{ V}$, $V_{CTL} = 1.8\text{ V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50\ \Omega$, with application circuit

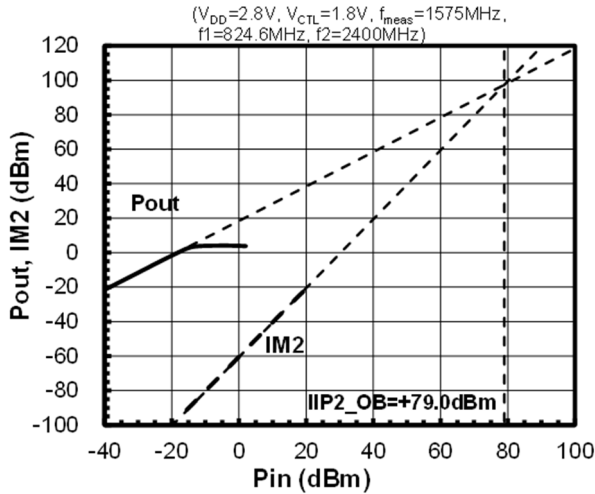
Out-of-band P-1dB (fjam=900MHz)



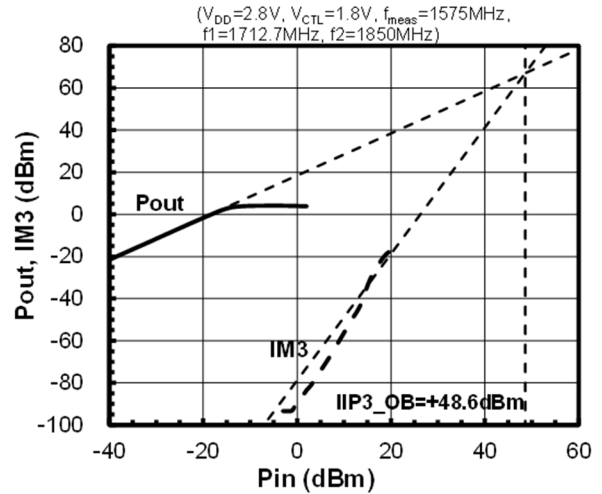
Out-of-band P-1dB (fjam=1710MHz)



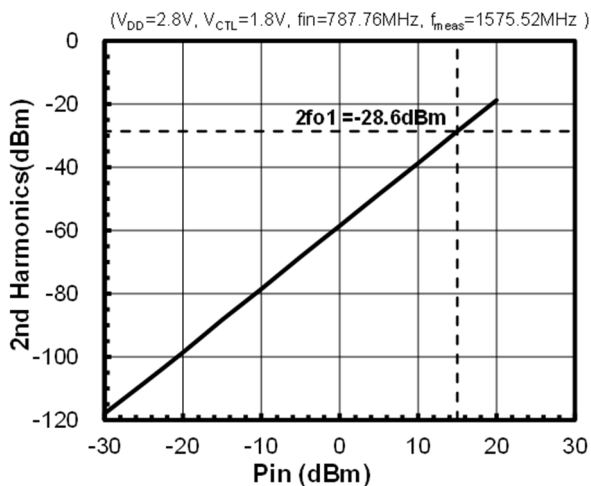
Out-of-band IIP2



Out-of-band IIP3

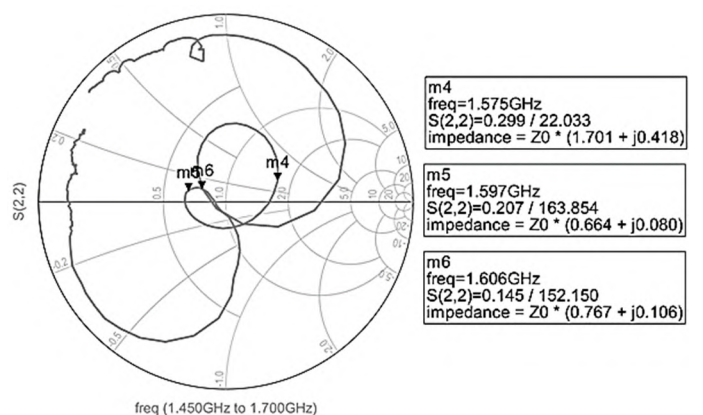
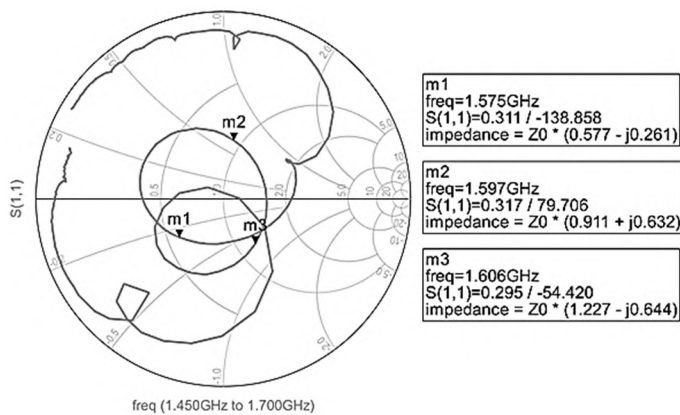
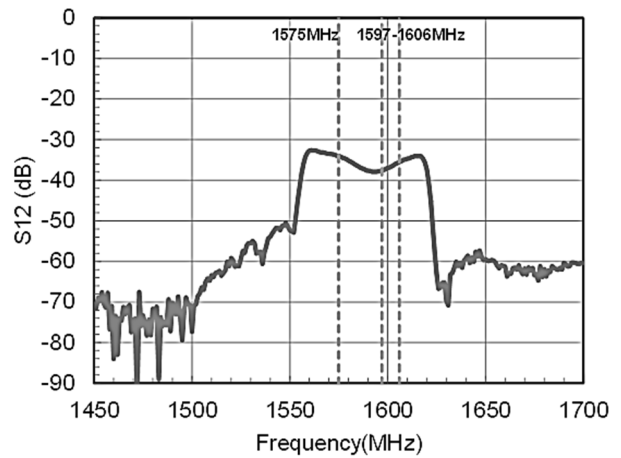
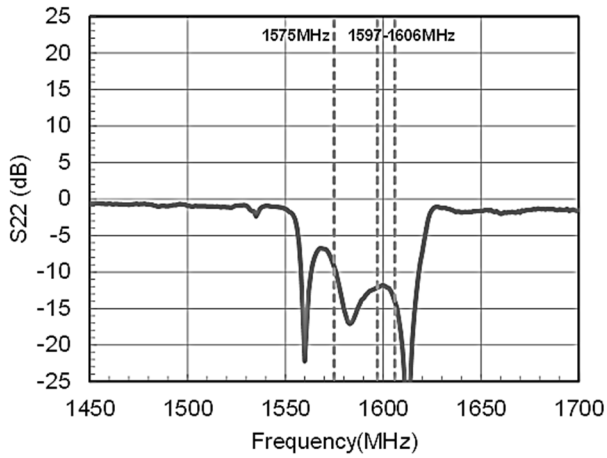
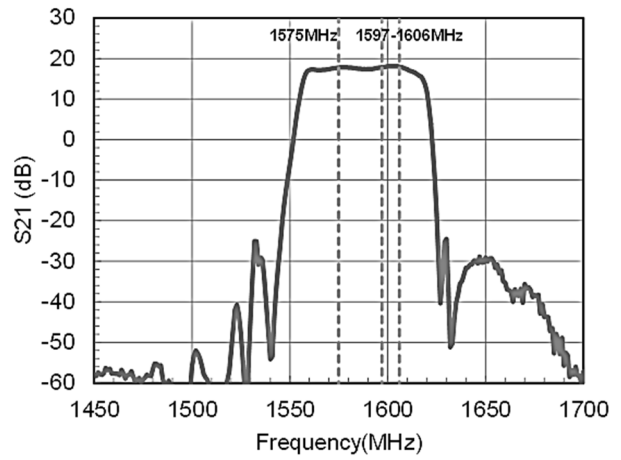
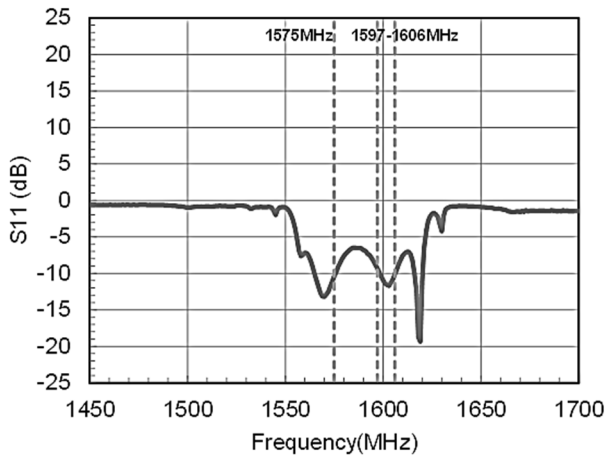


2nd Harmonics



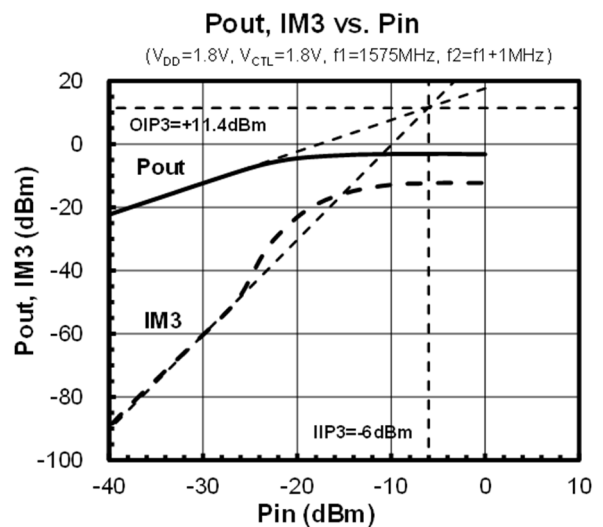
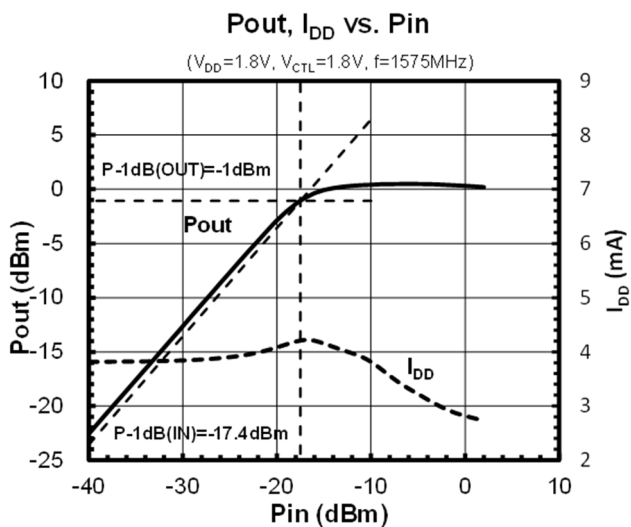
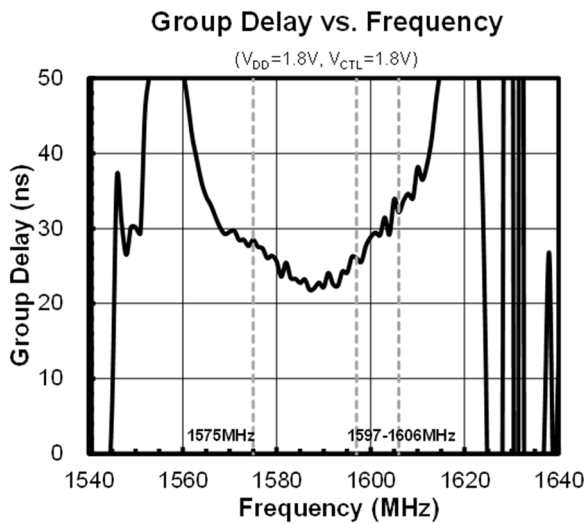
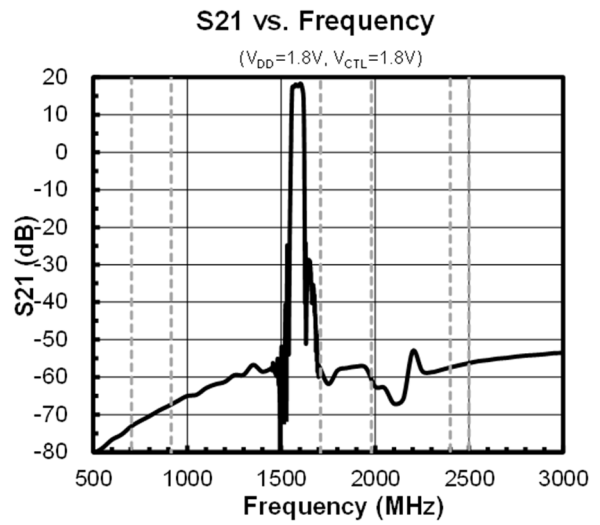
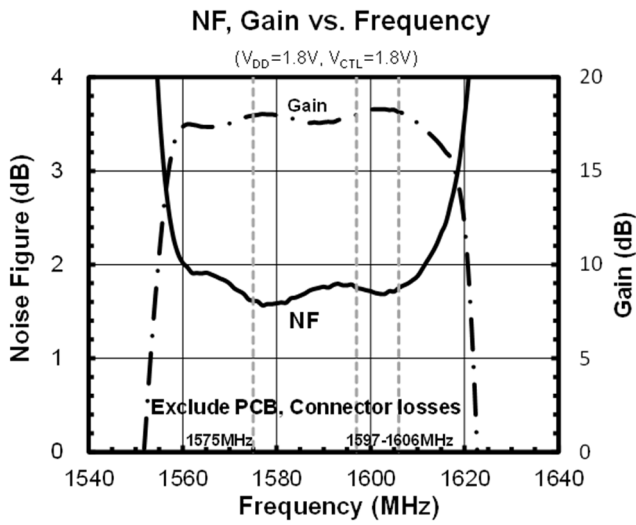
ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD} = 1.8\text{ V}$, $V_{CTL} = 1.8\text{ V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50\ \Omega$, with application circuit



■ ELECTRICAL CHARACTERISTICS

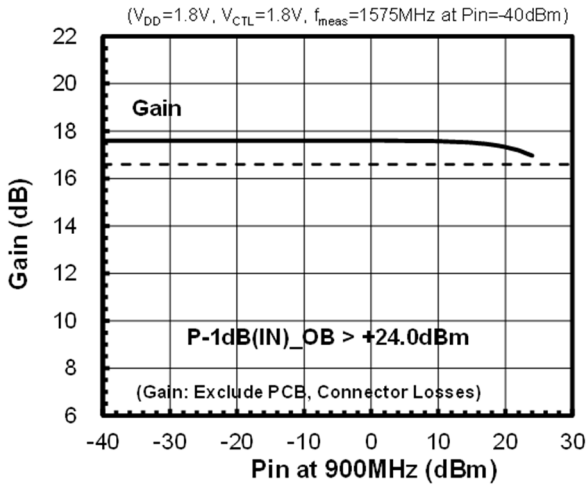
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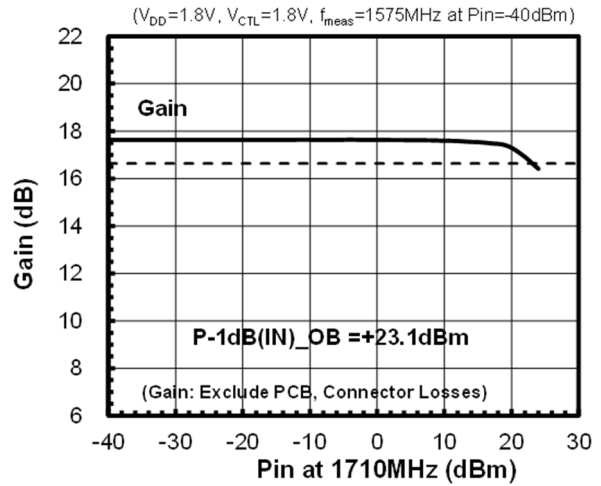
■ ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD} = 1.8V$, $V_{CTL} = 1.8V$, $T_a = 25^\circ C$, $Z_s = Z_l = 50\ \Omega$, with application circuit

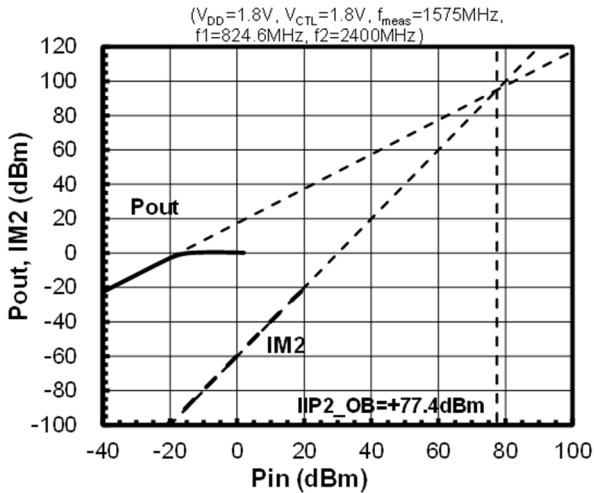
Out-of-band P-1dB (fjam=900MHz)



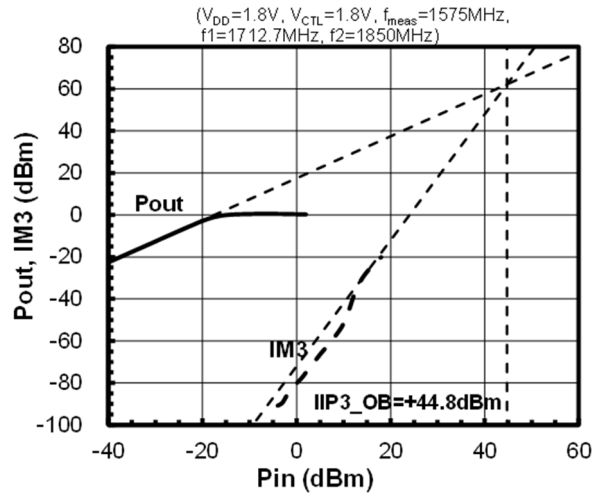
Out-of-band P-1dB (fjam=1710MHz)



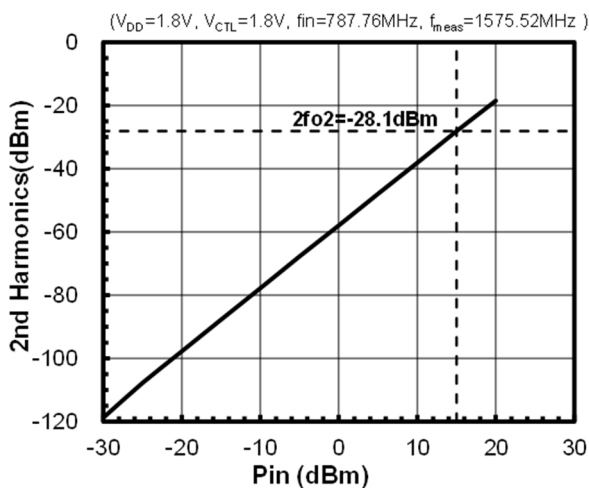
Out-of-band IIP2



Out-of-band IIP3

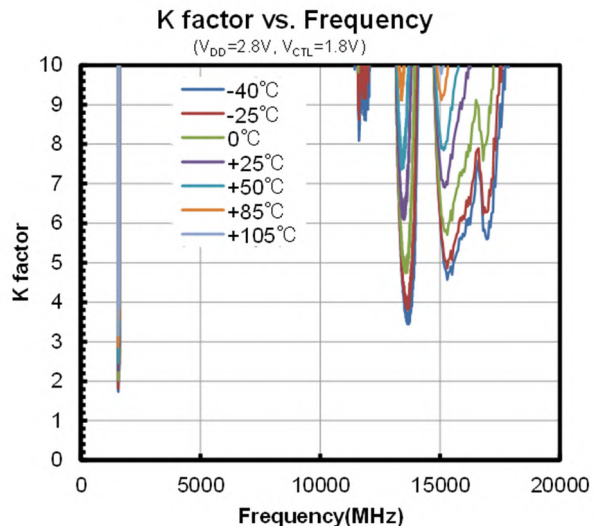
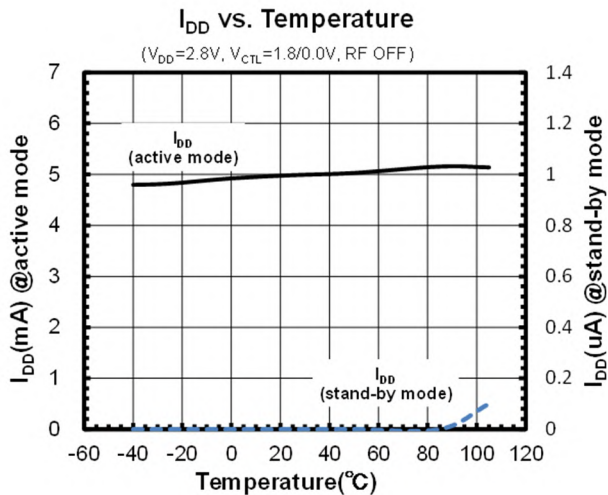
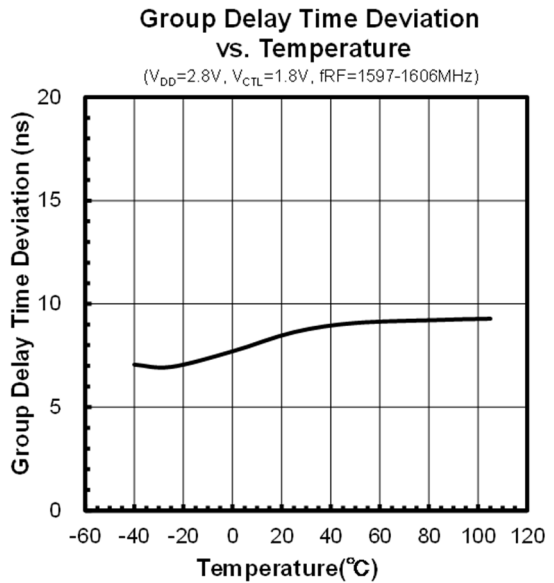
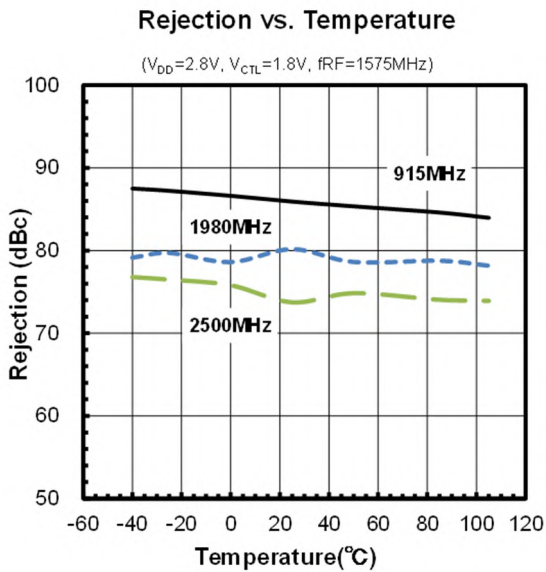
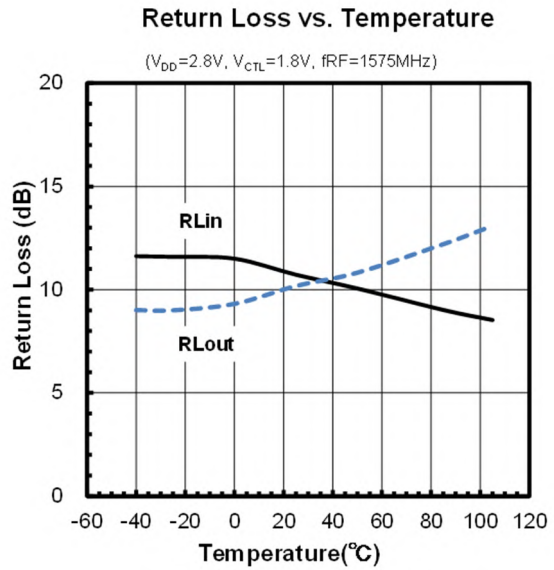
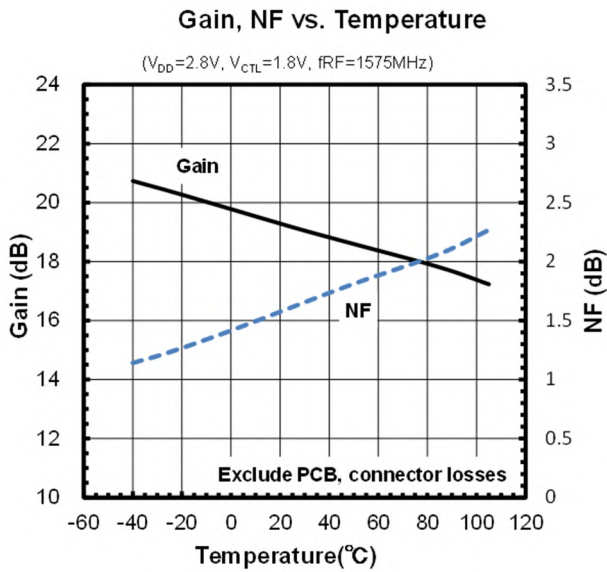


2nd Harmonics



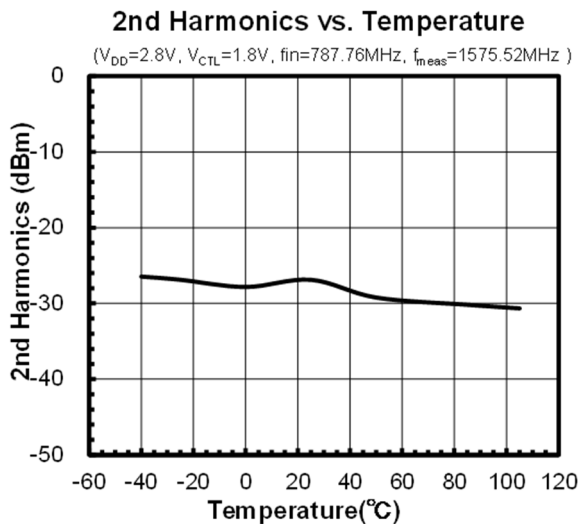
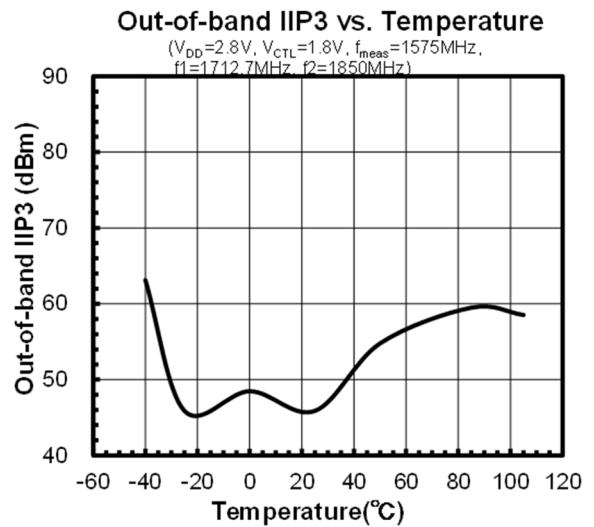
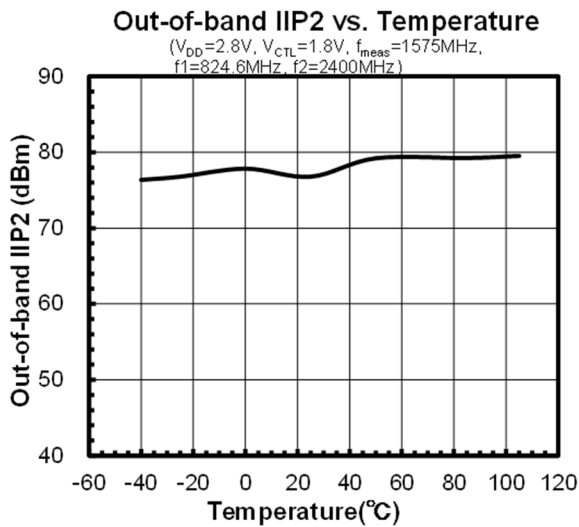
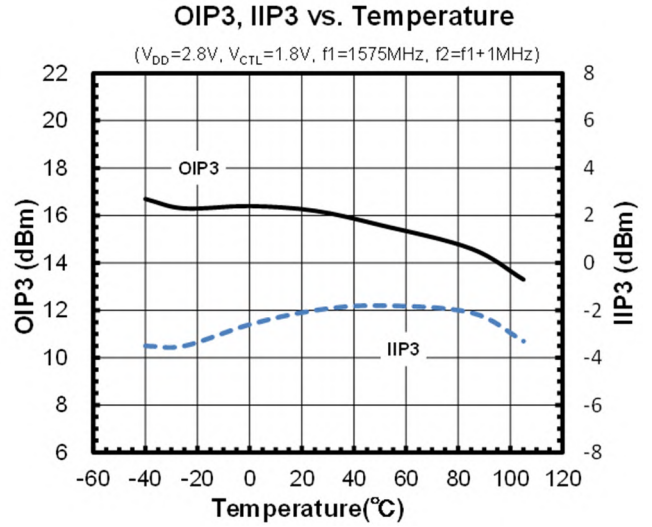
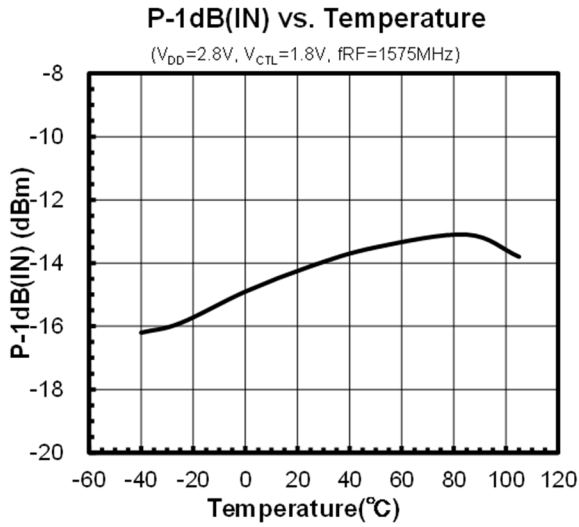
■ ELECTRICAL CHARACTERISTICS

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



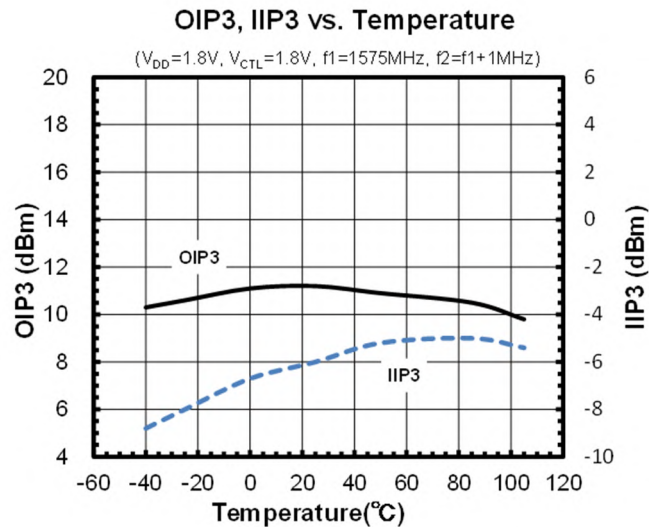
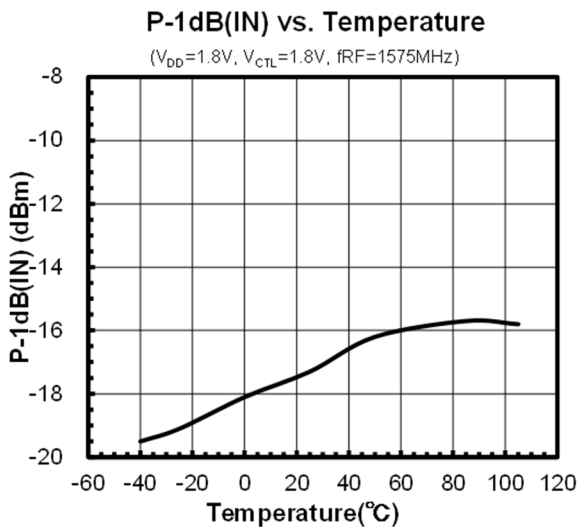
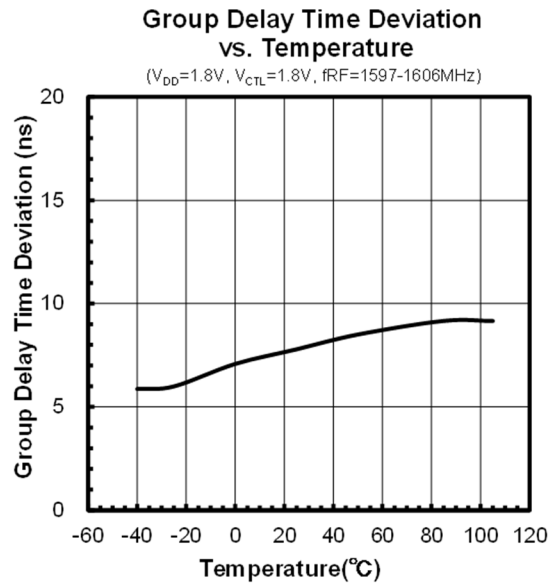
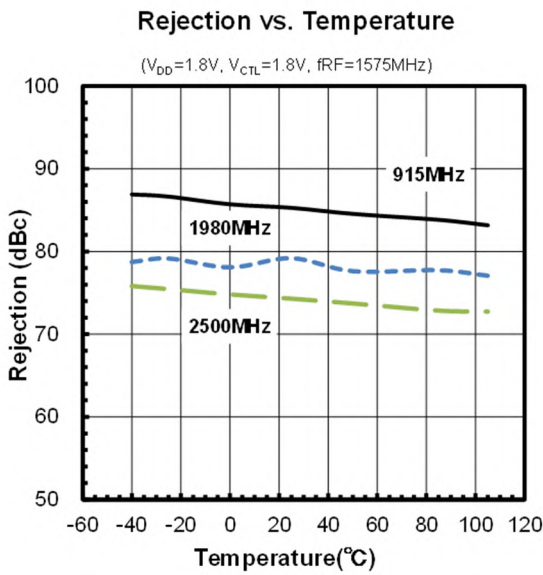
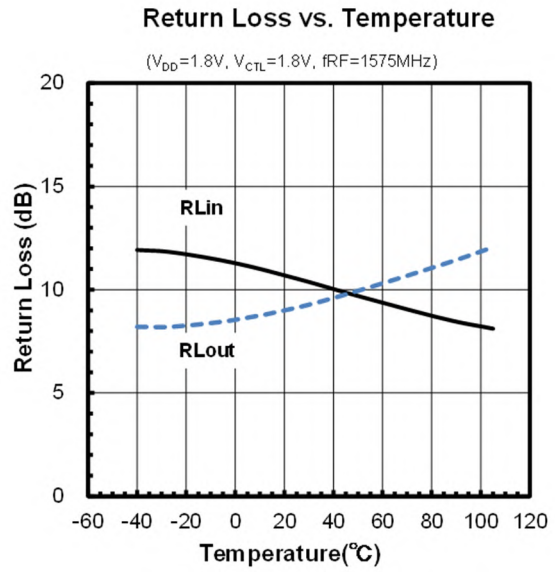
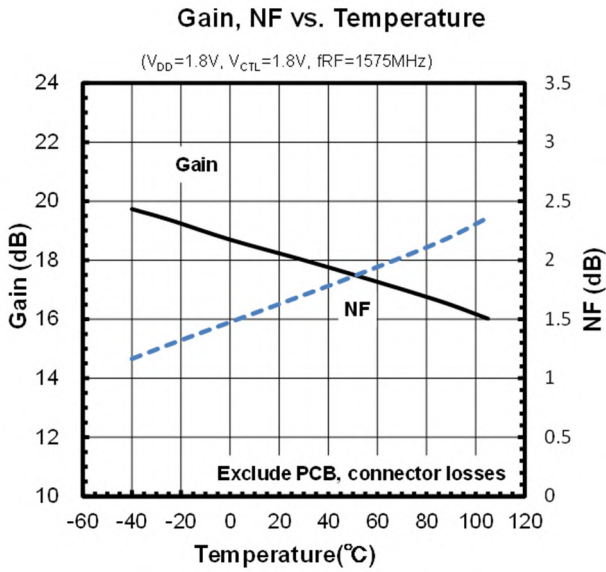
■ ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD} = 2.8\text{ V}$, $V_{CTL} = 1.8\text{ V}$, $Z_s = Z_l = 50\ \Omega$, with application circuit



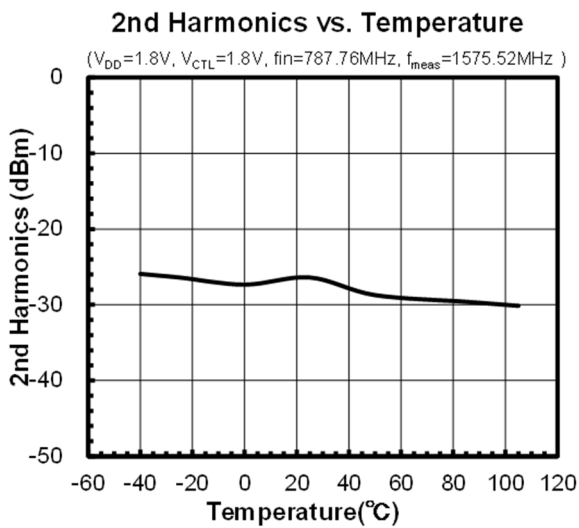
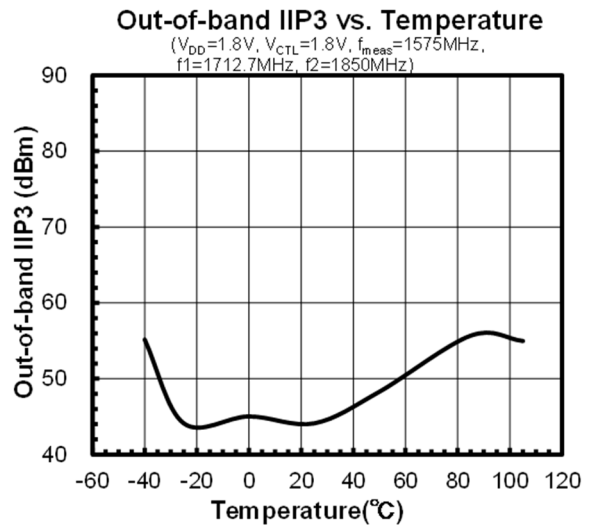
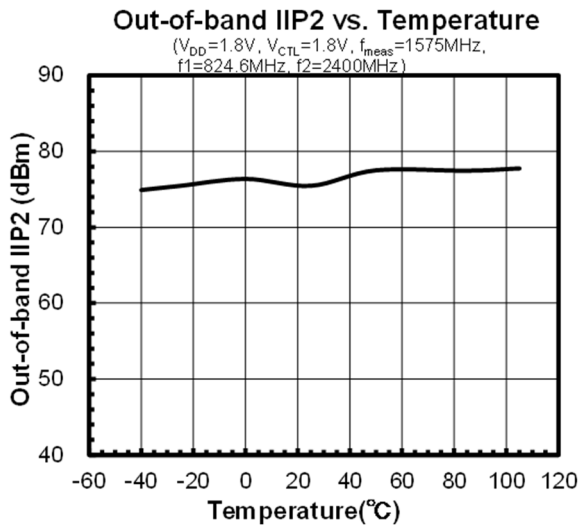
ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD} = 1.8\text{ V}$, $V_{CTL} = 1.8\text{ V}$, $Z_s = Z_l = 50\ \Omega$, with application circuit



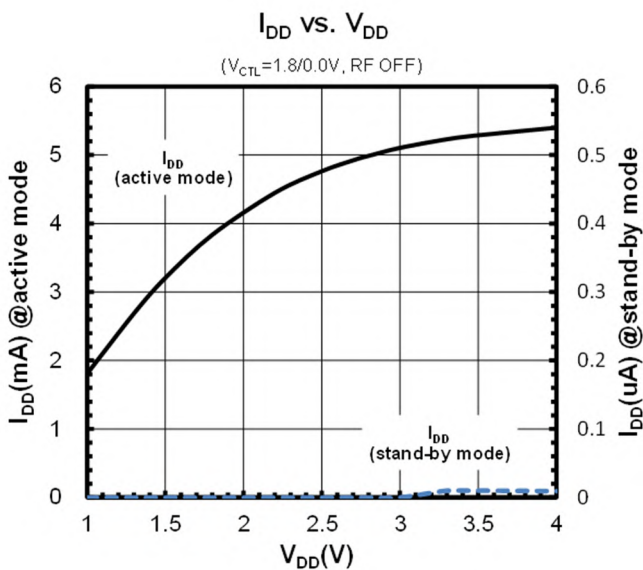
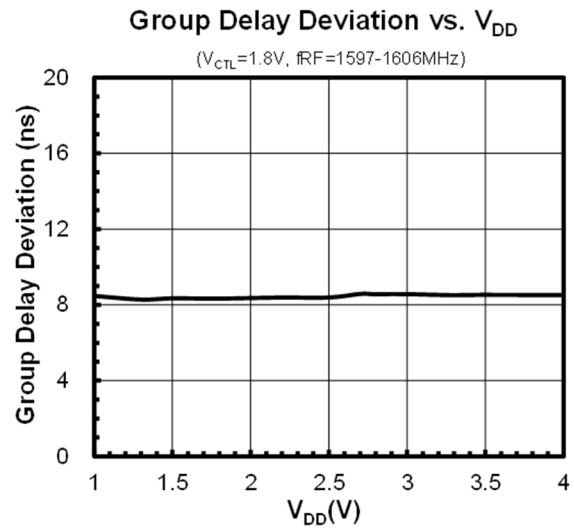
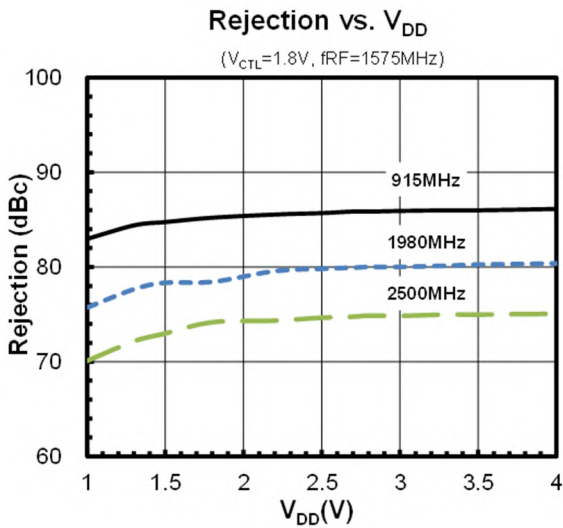
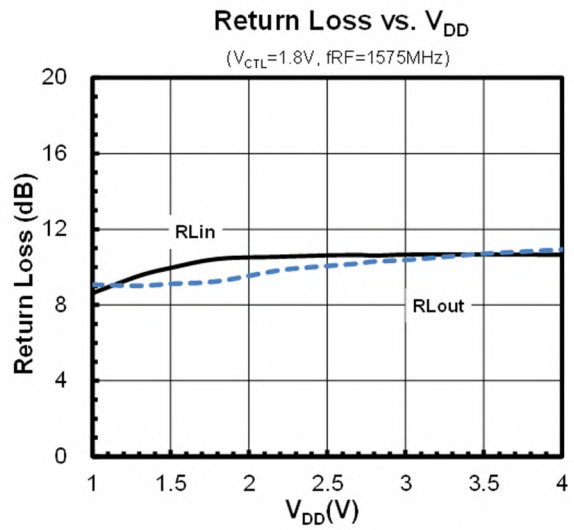
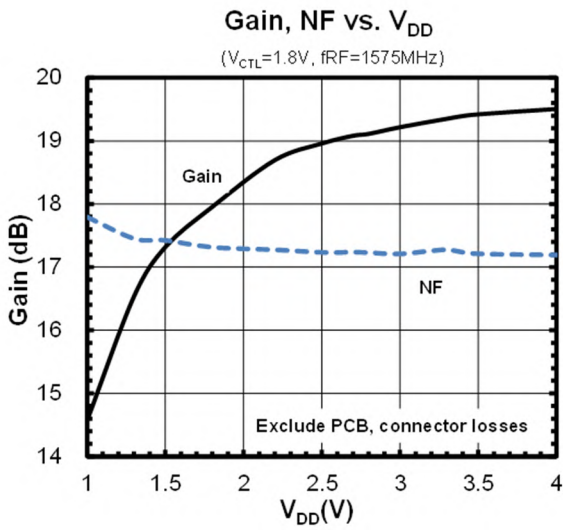
■ ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD} = 1.8\text{ V}$, $V_{CTL} = 1.8\text{ V}$, $Z_s = Z_l = 50\ \Omega$, with application circuit



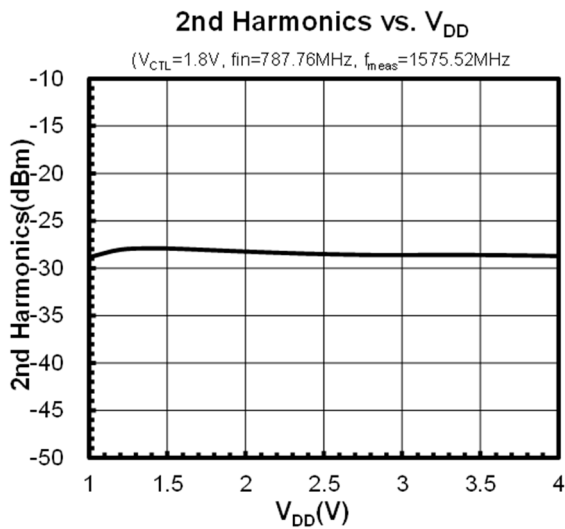
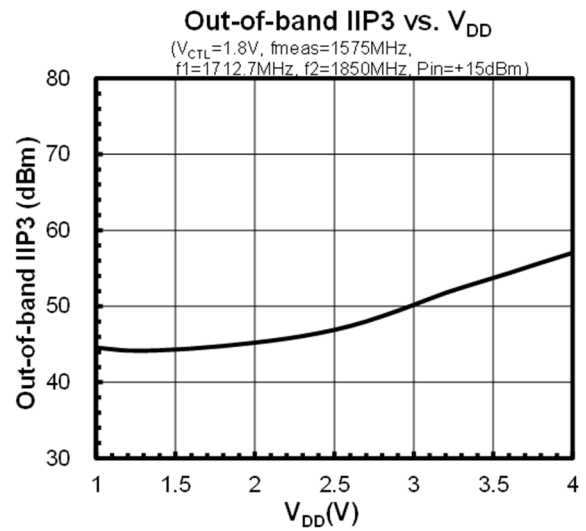
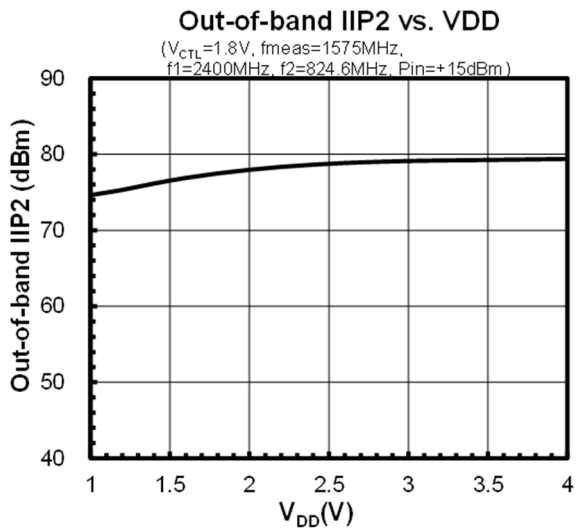
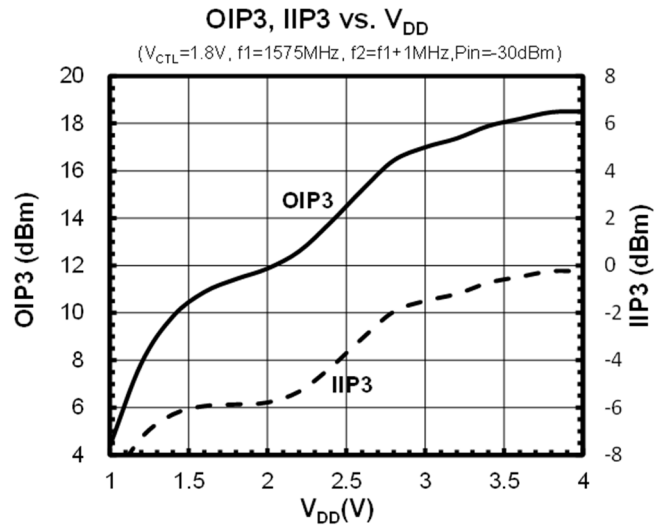
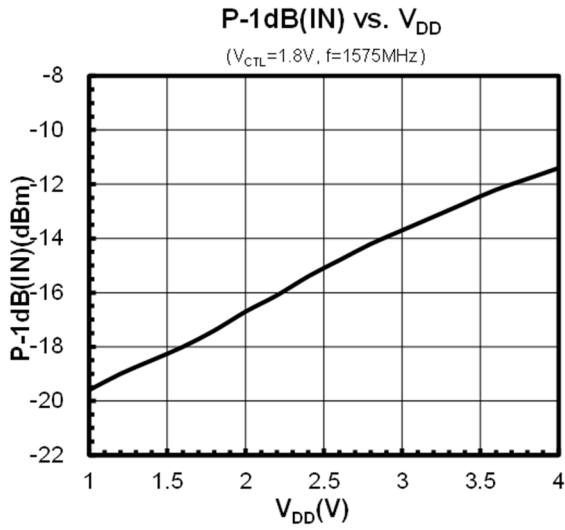
ELECTRICAL CHARACTERISTICS

Conditions: $V_{CTL} = 1.8\text{ V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50\ \Omega$, with application circuit

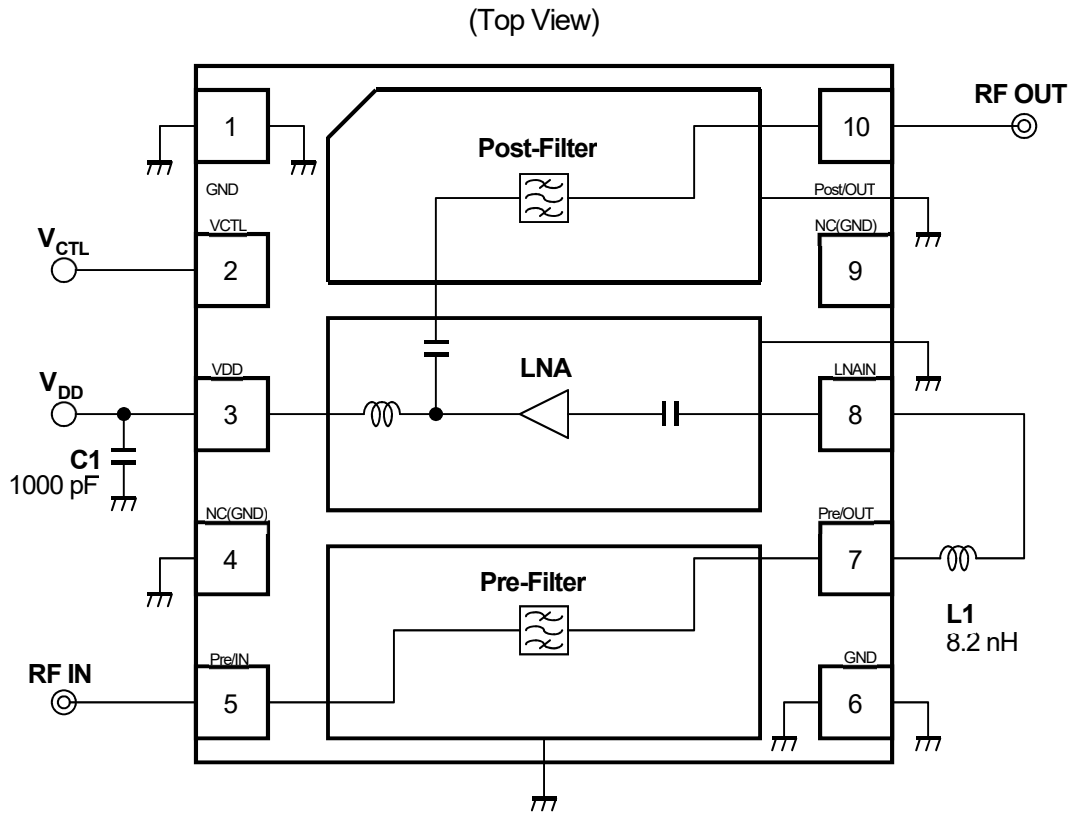


ELECTRICAL CHARACTERISTICS

Conditions: $V_{CTL} = 1.8\text{ V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50\ \Omega$, with application circuit



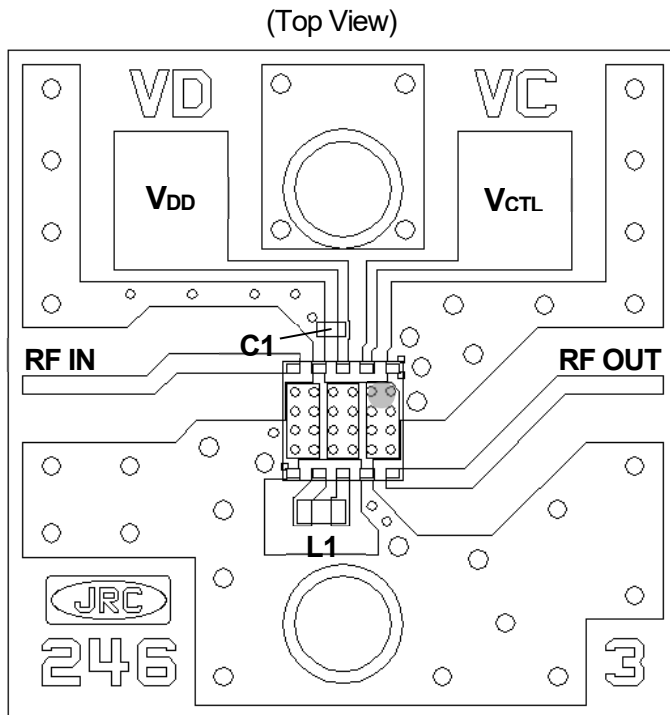
APPLICATION CIRCUIT



<PARTS LIST>

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

■ EVALUATION BOARD



PCB

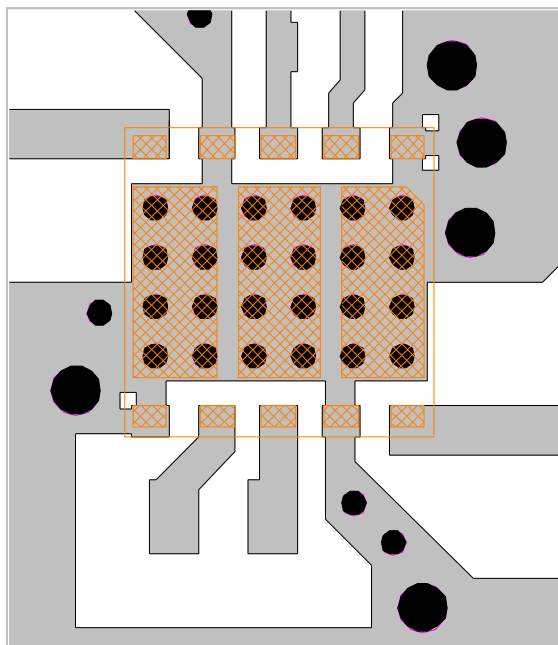
Substrate: FR-4

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 $\phi = 0.2 \text{ mm}, 0.4 \text{ mm}$

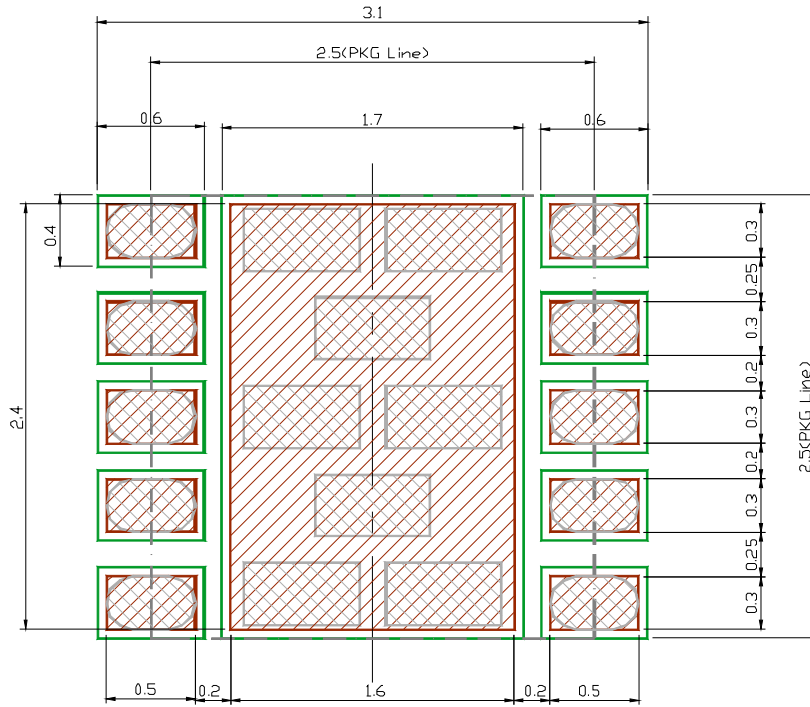
PRECAUTIONS

- 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>

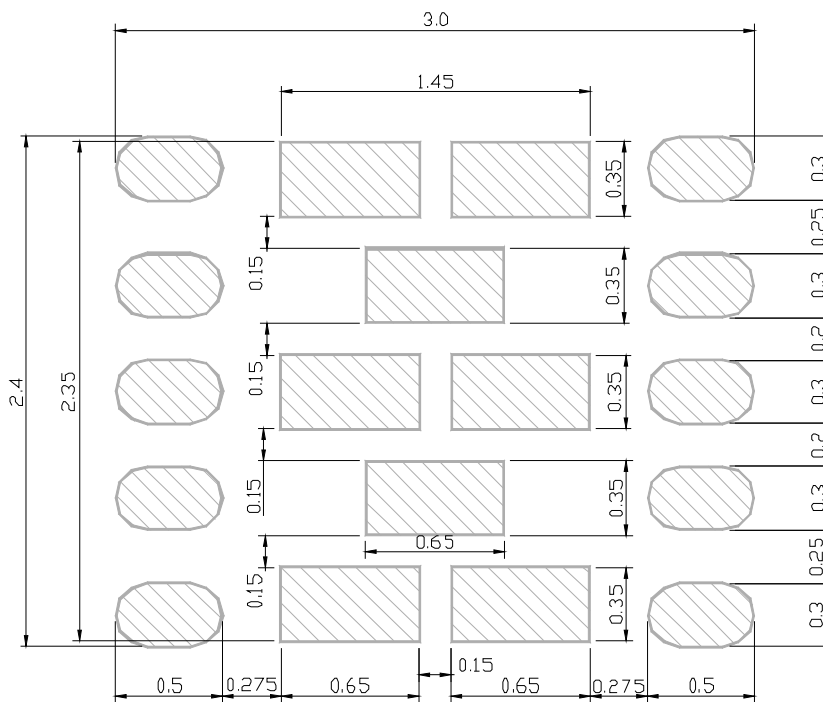
PKG: 2.5 mm x 2.5 mm

-  : 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

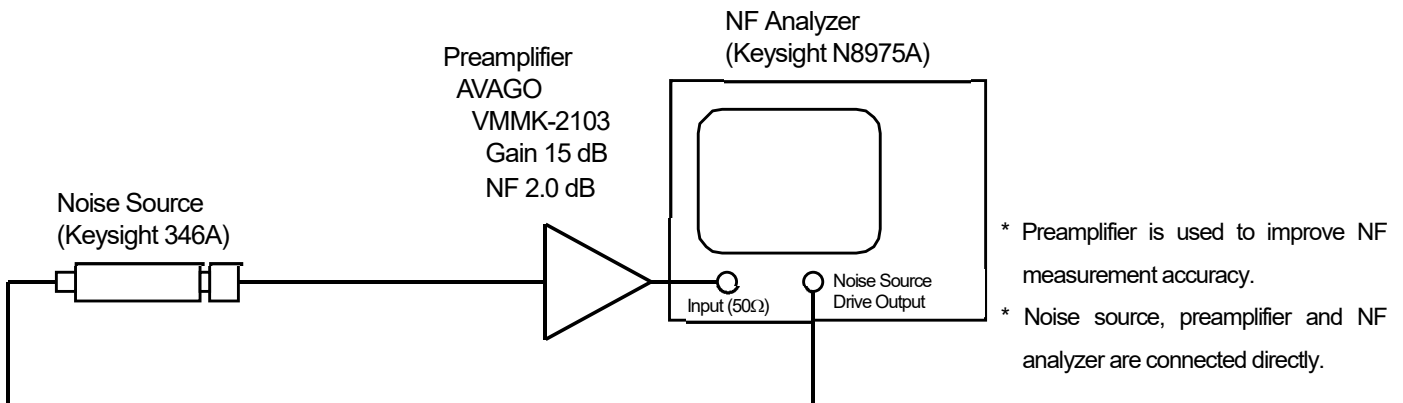
Setting the NF analyzer

Measurement mode form

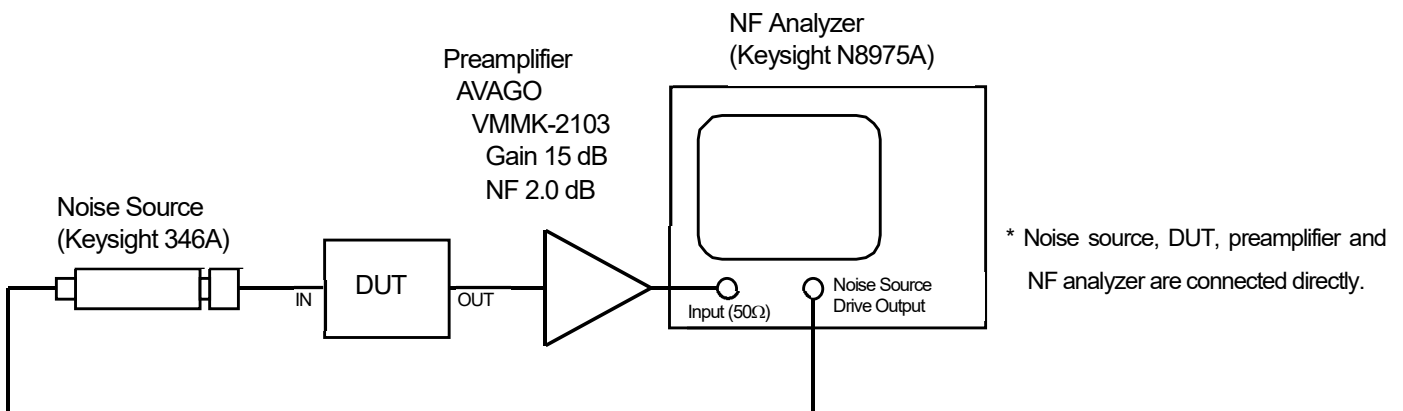
Device under test : Amplifier
 System downconverter : off

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)

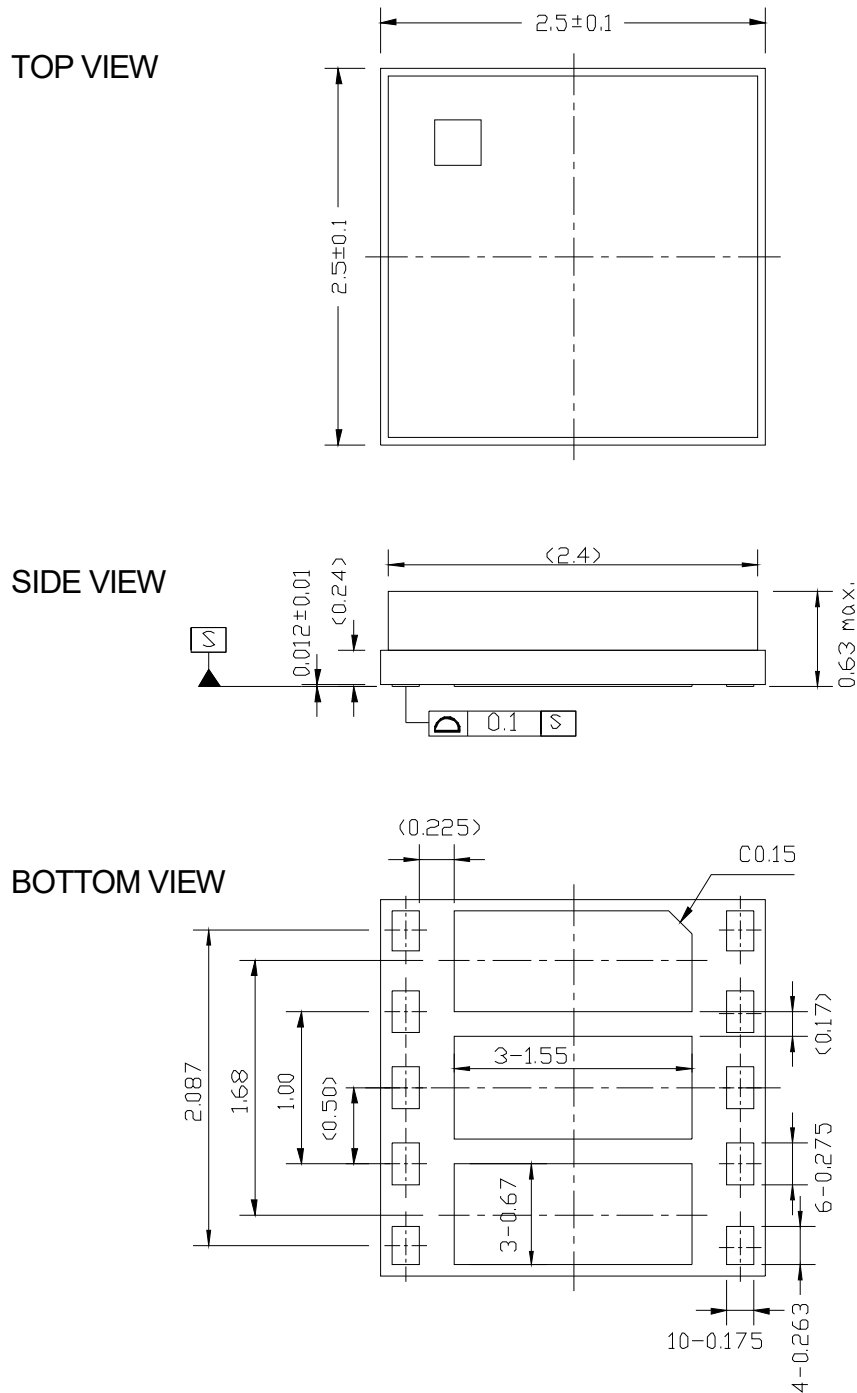


Calibration setup



Measurement Setup

■ PACKAGE OUTLINE (HFFP10-HH)



Package Size : 2.5 ± 0.1 mm
0.63 mm max.

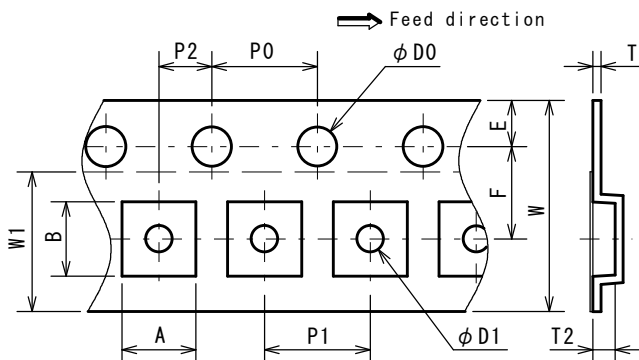
Electrode Dimensions clearance : ± 0.05 mm

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

PACKING SPECIFICATION (HFFP10-CD)

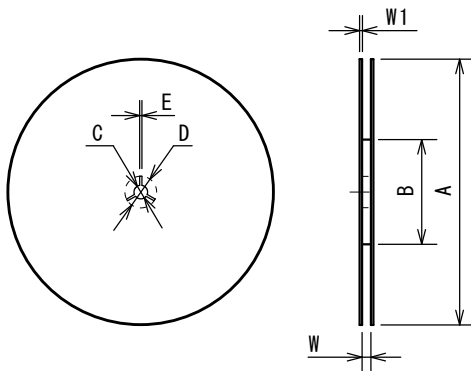
Unit: mm

TAPING DIMENSIONS



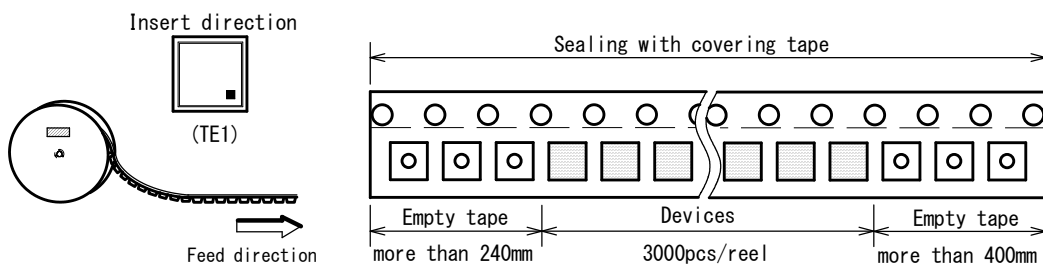
SYMBOL	DIMENSION	REMARKS
A	2.8±0.1	BOTTOM DIMENSION
B	2.8±0.1	BOTTOM DIMENSION
D0	1.5 ^{+0.1} ₀	
D1	1.0 ^{+0.1} ₀	
E	1.75±0.1	
F	3.5±0.05	
P0	4.0±0.1	
P1	4.0±0.1	
P2	2.0±0.1	
T	0.3±0.1	
T2	0.85±0.1	
W	8.0±0.2	
W1	5.3±0.2	THICKNESS 100 μm max

REEL DIMENSIONS

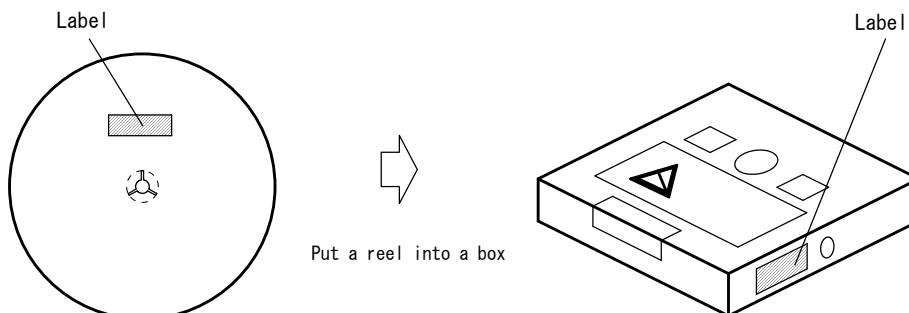


SYMBOL	DIMENSION
A	φ 180 ⁰ _{-1.5}
B	φ 66±0.5
C	φ 13±0.2
D	φ 21±0.8
E	2±0.5
W	9 ^{+1.0} ₀
W1	1.2

TAPING STATE



PACKING STATE



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 - Fire Alarms / Intruder Detectors
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 - Traffic control system
 - Combustion equipment

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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.



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