

1.5 GHz band GPS and GLONASS Front-End Module

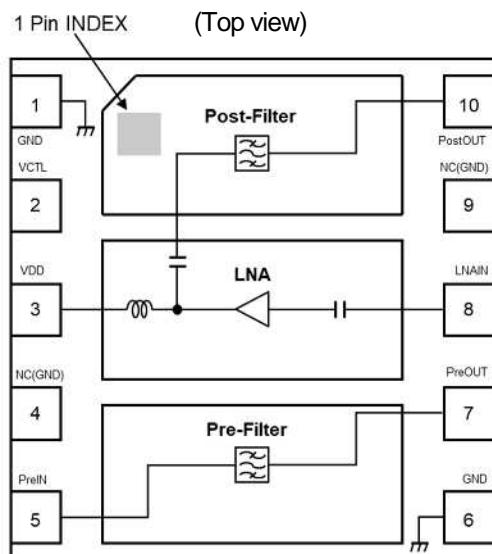
■ FEATURES

- 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
- High out band rejection 85 dBc typ. @ $f = 704$ to 915 MHz, relative to 1575 MHz
- 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

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

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	61B	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} (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

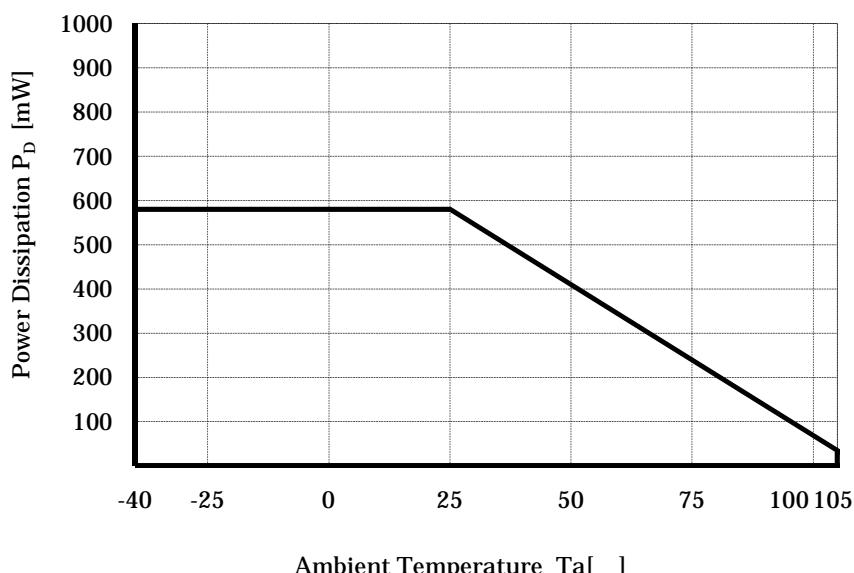
(3): 4-layer FR4 PCB with through-hole (101.5 x 114.5 mm), $T_j = 110^\circ\text{C}$

■ 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: $V_{DD} = 2.8$ V, $V_{CTL} = 1.8$ V, $f_{RF} = 1575$ MHz, 1597 to 1606 MHz, $T_a = +25^\circ\text{C}$, $Z_s = Z_i = 50 \Omega$, 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	$f_1 = 1575$ MHz, $f_2 = f_1 \pm 1$ MHz, $P_{IN} = -30$ dBm	-	-3.0	-	dBm
Out of Band Input 2nd Order Intercept Point 1	IIP2_OB1	$f_1 = 824.6$ MHz at +15 dBm, $f_2 = 2400$ MHz at +15 dBm, $f_{meas} = 1575.4$ MHz	-	+72	-	dBm
Out of Band Input 3rd Order Intercept Point 1	IIP3_OB1	$f_1 = 1712.7$ MHz at +15 dBm, $f_2 = 1850$ MHz at +15 dBm, $f_{meas} = 1575.4$ MHz	-	+50	-	dBm
700 MHz Harmonic 1	2f ₀₁	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

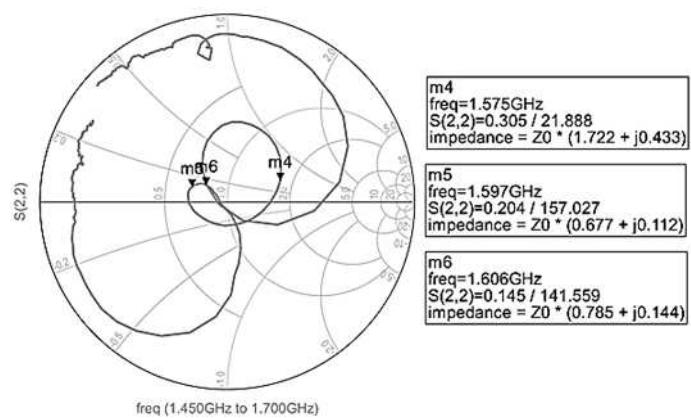
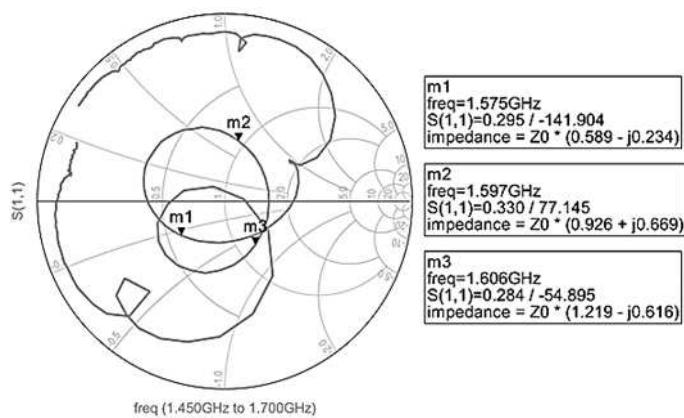
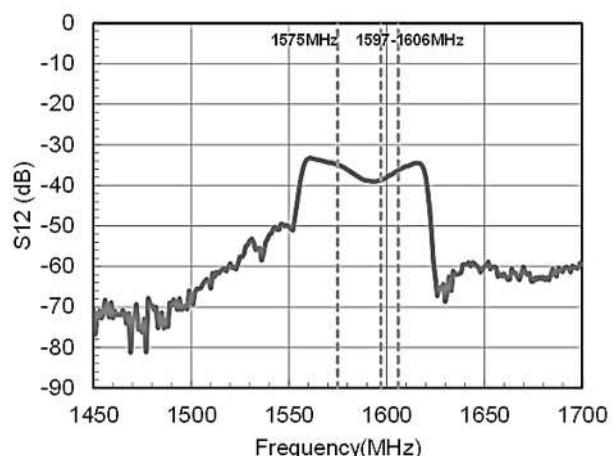
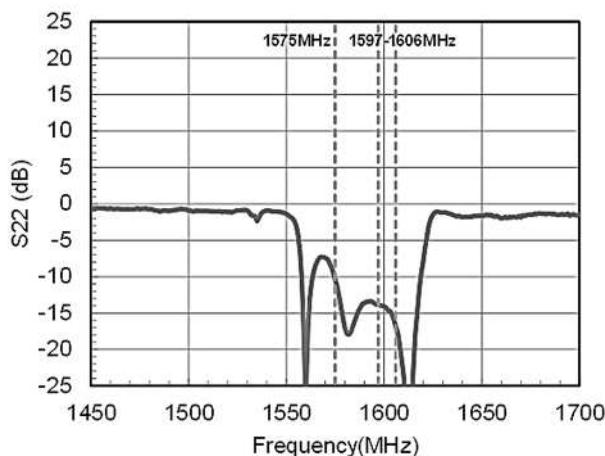
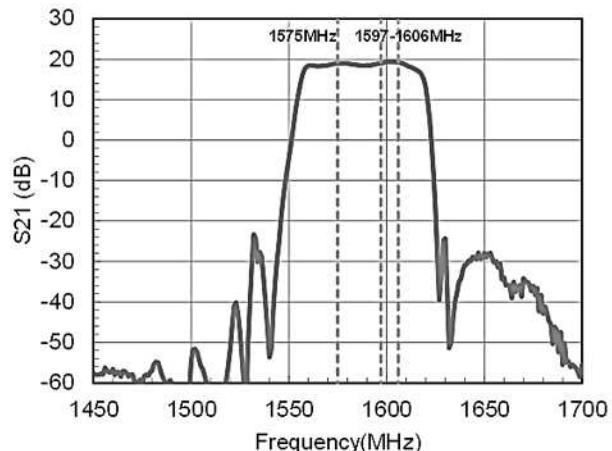
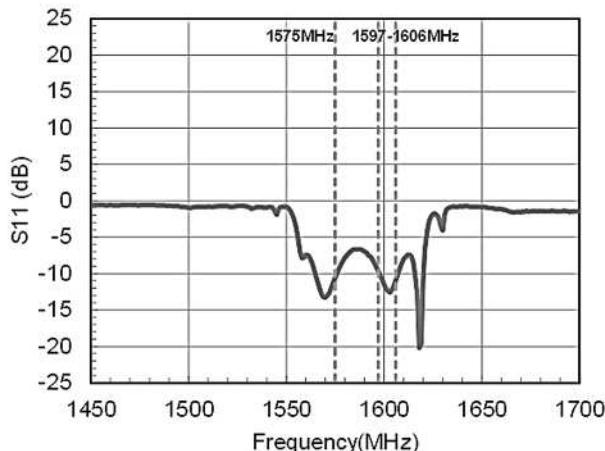
■ ELECTRICAL CHARACTERISTICS 3 (RF)

General conditions: $V_{DD} = 1.8$ V, $V_{CTL} = 1.8$ V, $f_{RF} = 1575$ MHz, 1597 to 1606 MHz, $T_a = +25^\circ\text{C}$, $Z_s = Z_i = 50 \Omega$, 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	$f_1 = 1575$ MHz, $f_2 = f_1 \pm 1$ MHz, $P_{IN} = -30$ dBm	-	-6.0	-	dBm
Out of Band Input 2nd Order Intercept Point 2	IIP2_OB2	$f_1 = 824.6$ MHz at +15 dBm, $f_2 = 2400$ MHz at +15 dBm, $f_{meas} = 1575.4$ MHz	-	+72	-	dBm
Out of Band Input 3rd Order Intercept Point 2	IIP3_OB2	$f_1 = 1712.7$ MHz at +15 dBm, $f_2 = 1850$ MHz at +15 dBm, $f_{meas} = 1575.4$ MHz	-	+50	-	dBm
700 MHz Harmonic 2	2f02	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

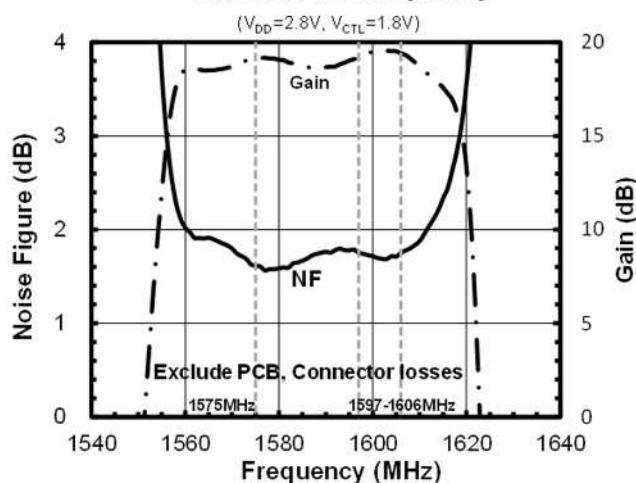
Conditions: $V_{DD} = 2.8$ V, $V_{CTL} = 1.8$ V, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50 \Omega$, with application circuit



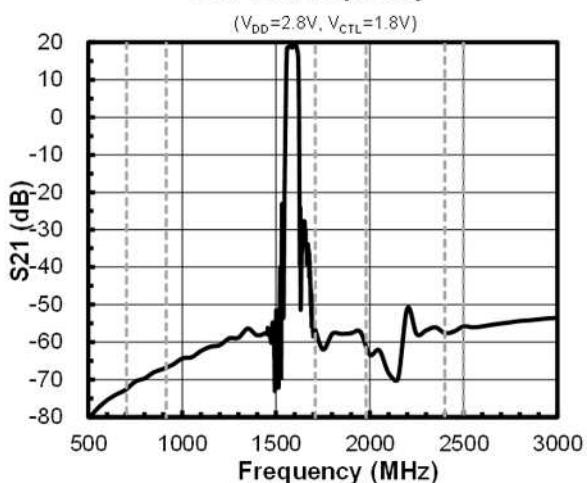
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Conditions: $V_{DD} = 2.8$ V, $V_{CTL} = 1.8$ V, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50 \Omega$, with application circuit

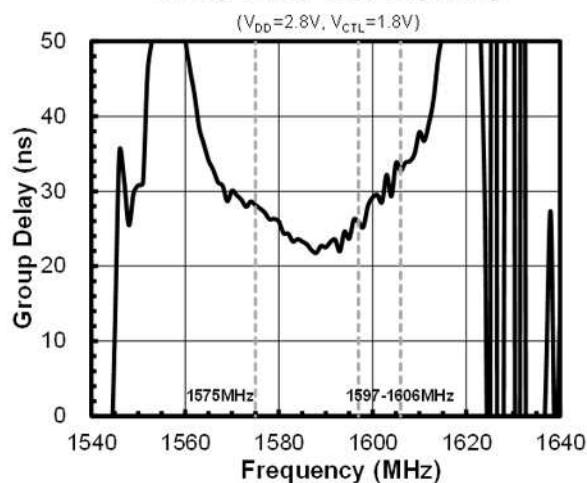
NF, Gain vs. Frequency



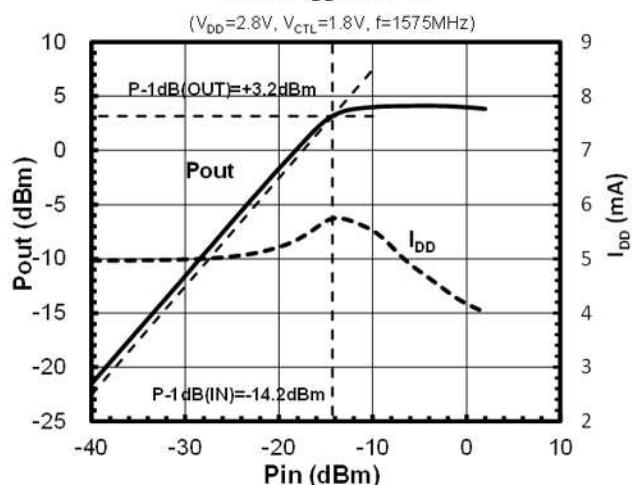
S21 vs. Frequency



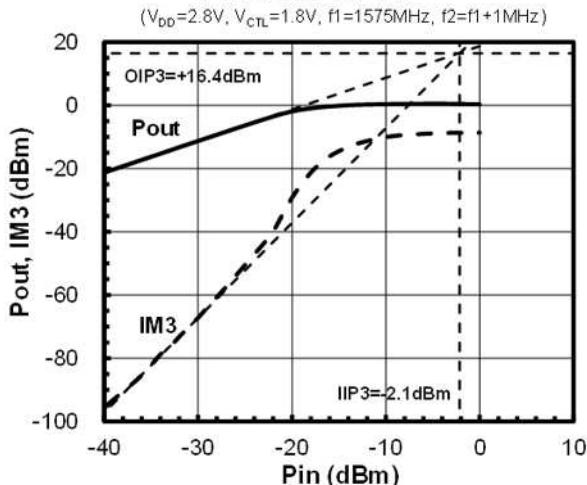
Group Delay vs. Frequency



Pout, I_{DD} vs. Pin



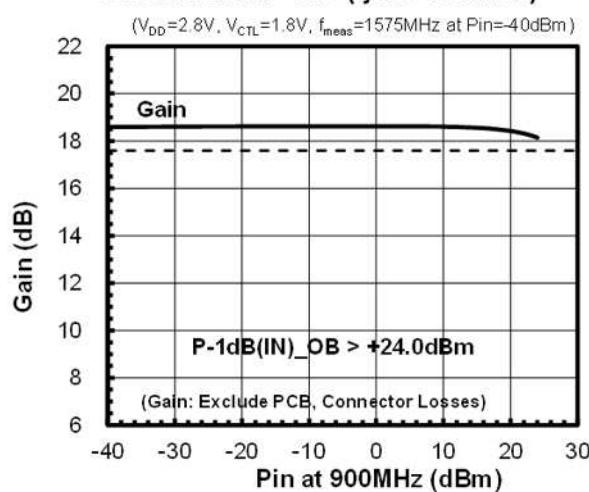
Pout, IM3 vs. Pin



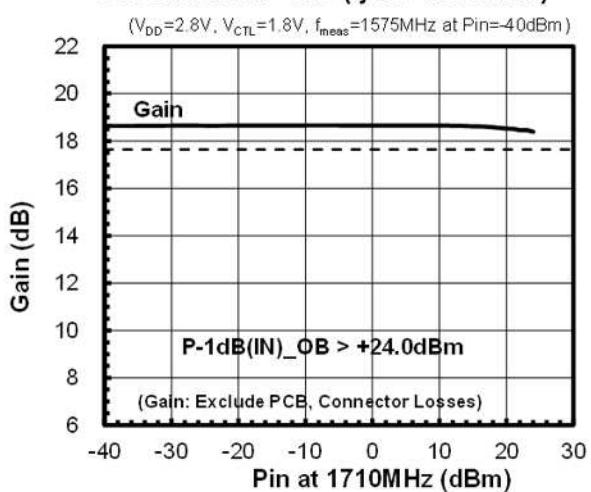
■ ELECTRICAL CHARACTERISTICS

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

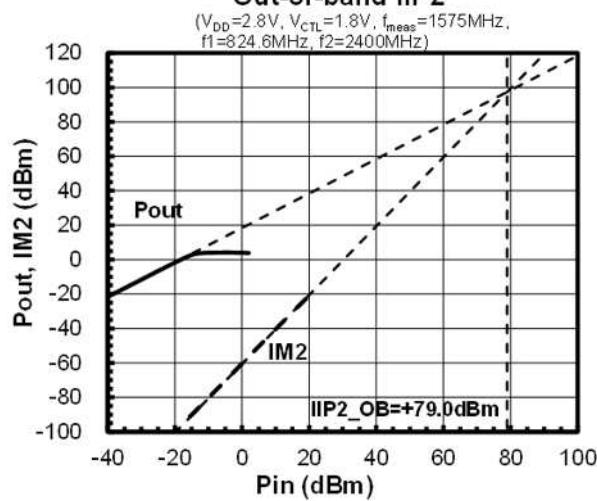
Out-of-band P-1dB (fjam=900MHz)



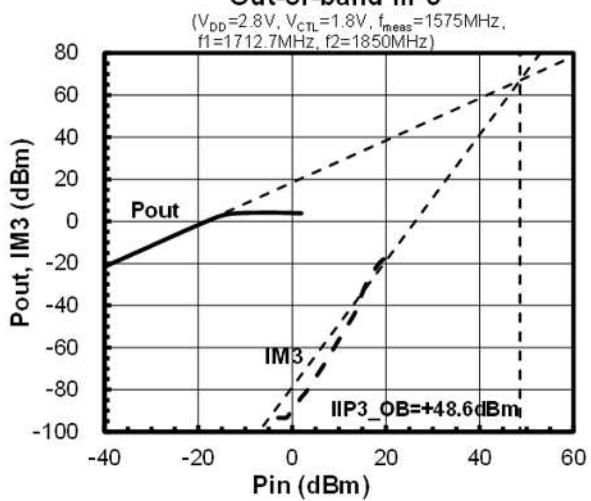
Out-of-band P-1dB (fjam=1710MHz)



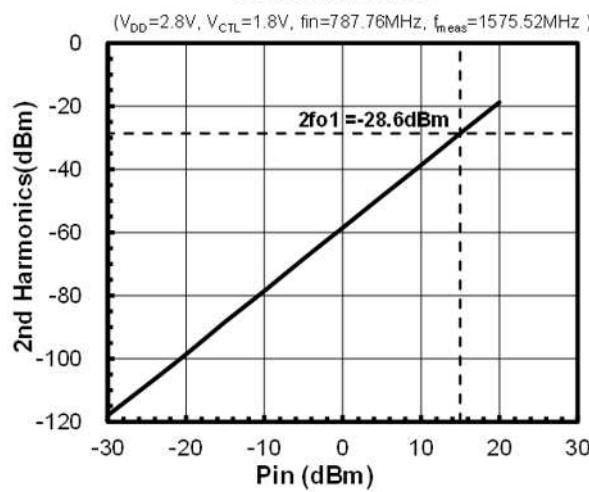
Out-of-band IIP2



Out-of-band IIP3

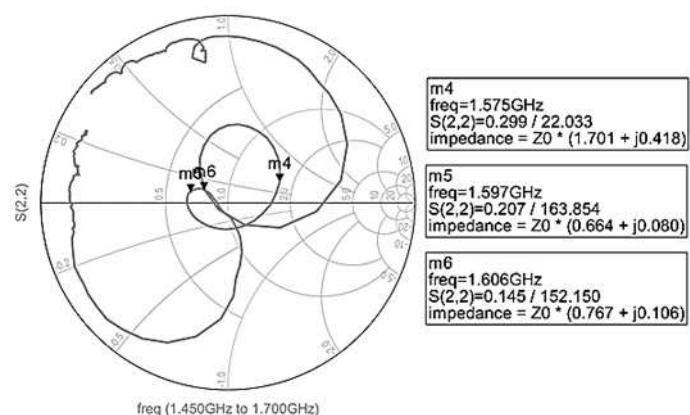
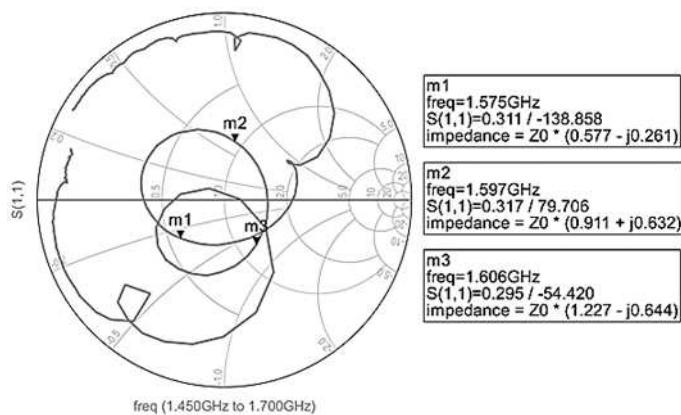
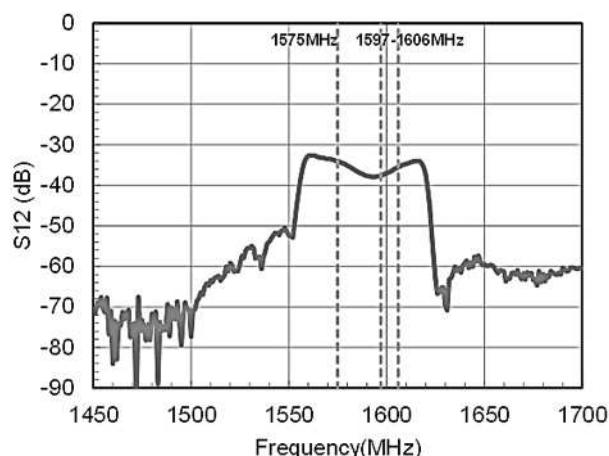
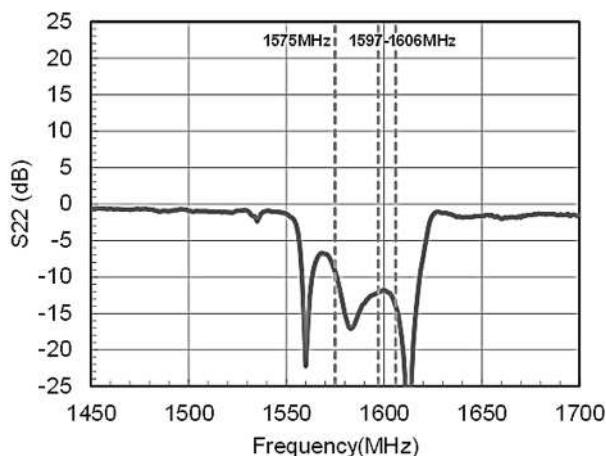
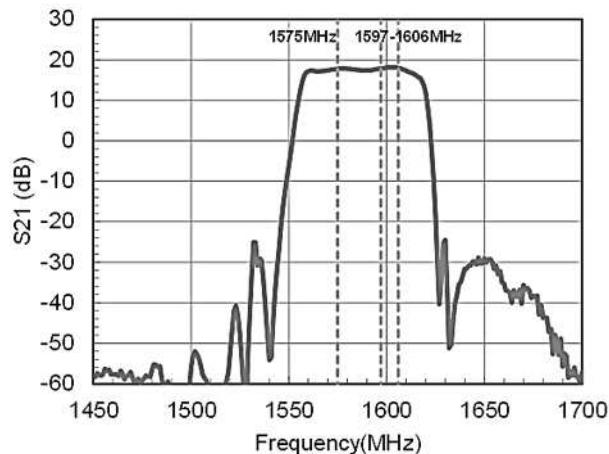
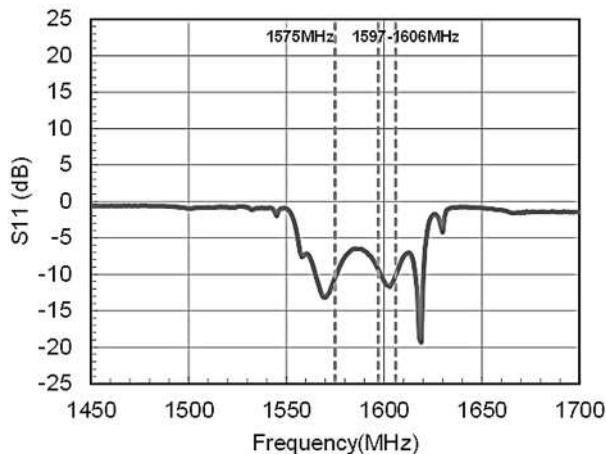


2nd Harmonics



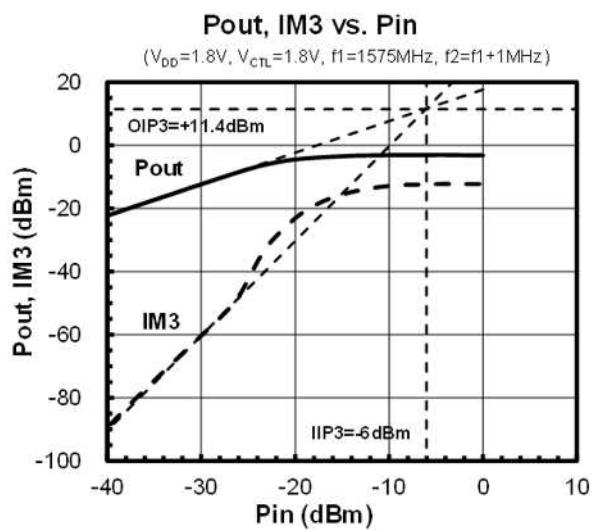
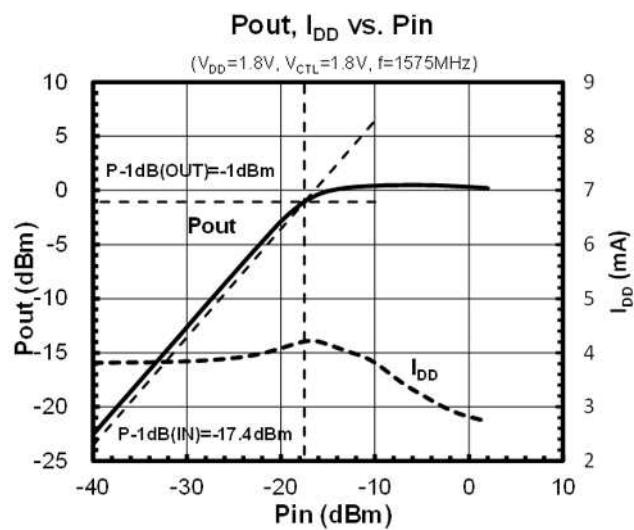
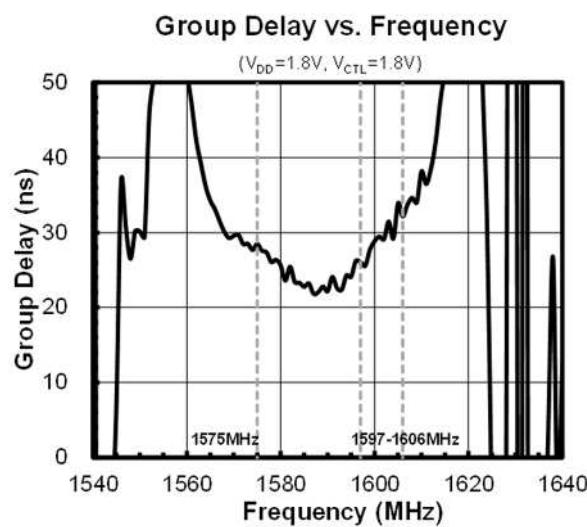
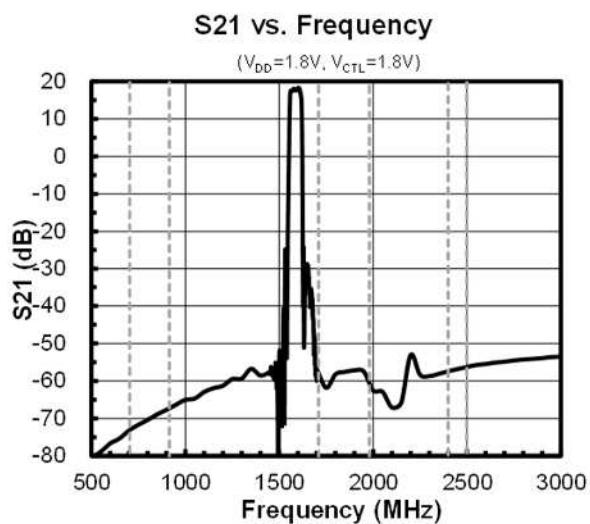
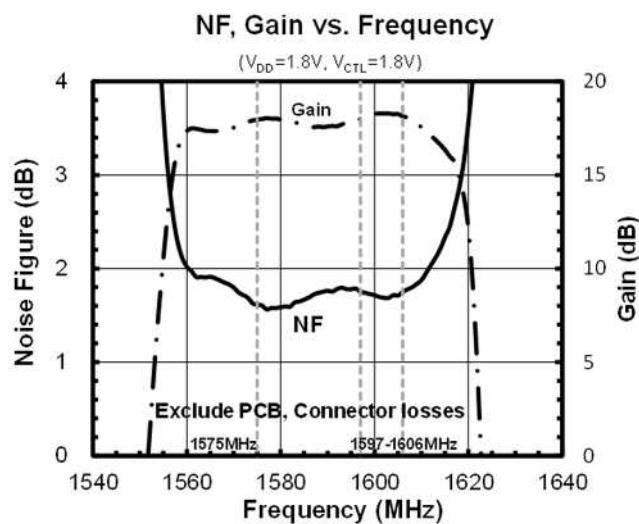
■ ELECTRICAL CHARACTERISTICS

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



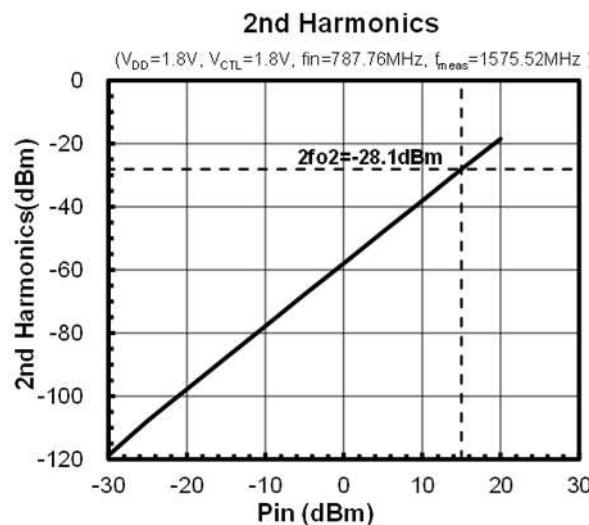
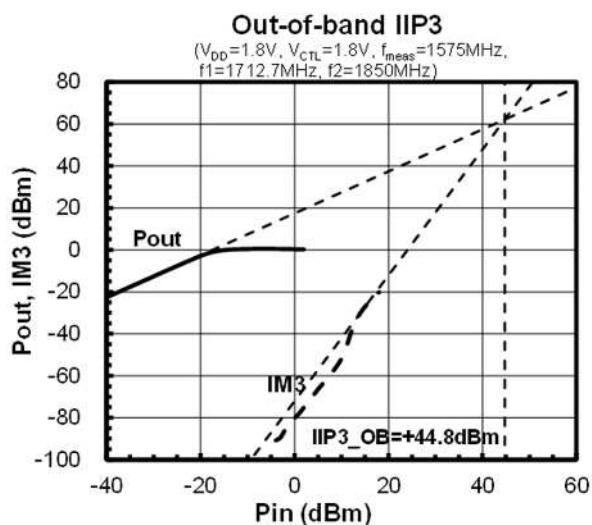
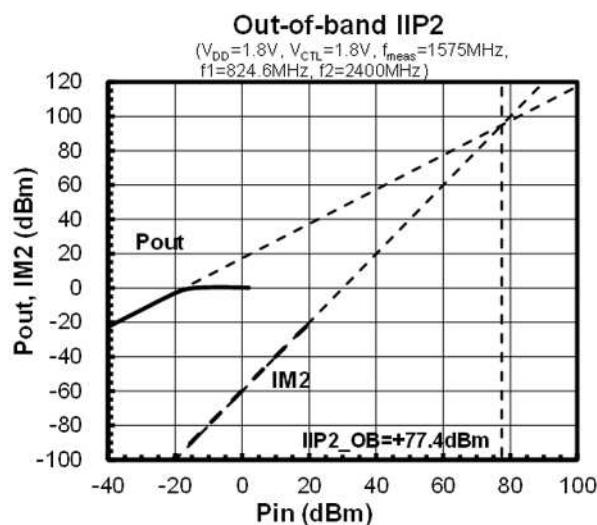
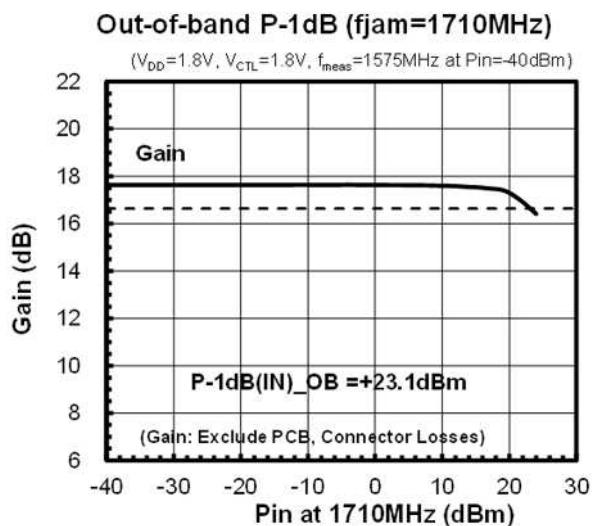
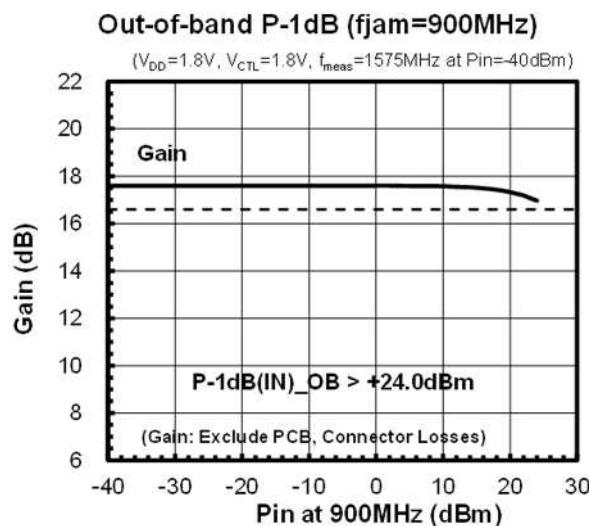
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Conditions: $V_{DD} = 1.8 \text{ V}$, $V_{CTL} = 1.8 \text{ V}$, $T_a = 25^\circ\text{C}$, $Z_s = Z_l = 50 \Omega$, with application circuit



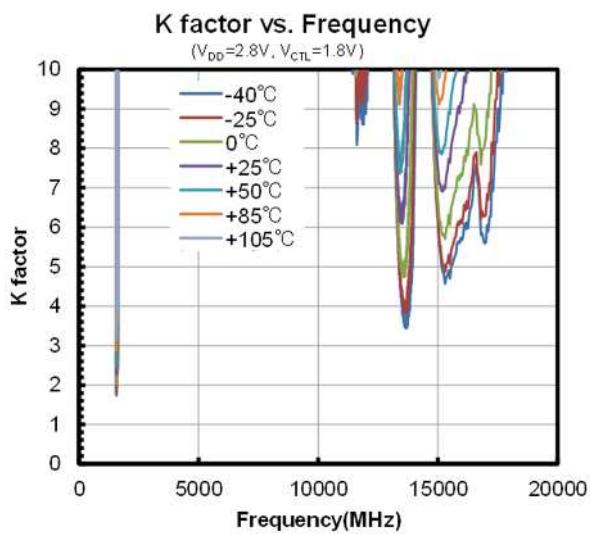
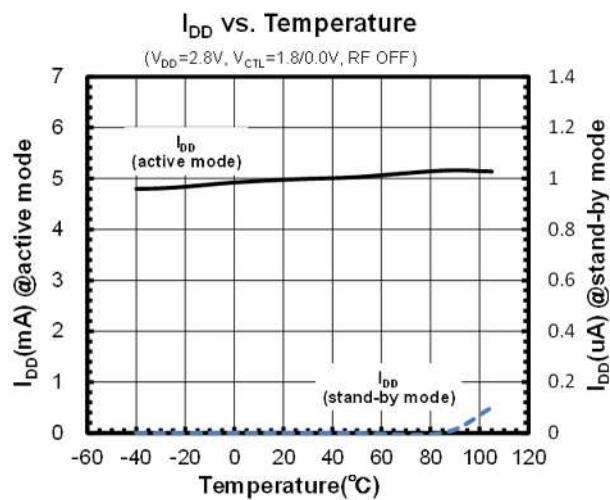
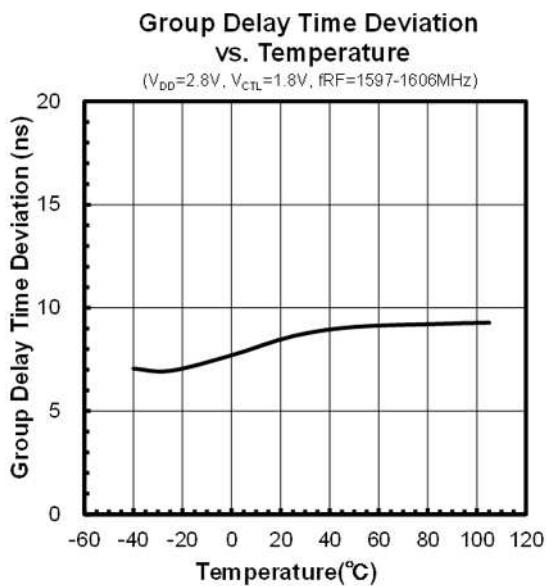
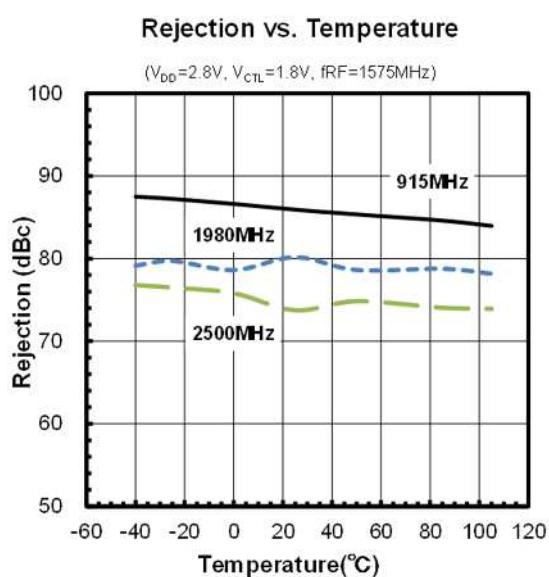
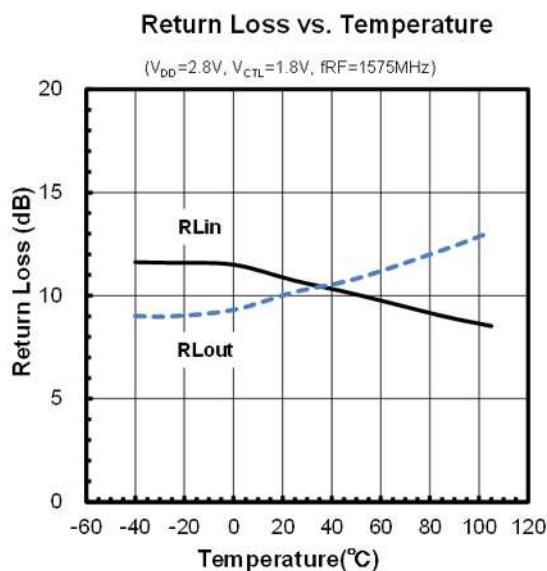
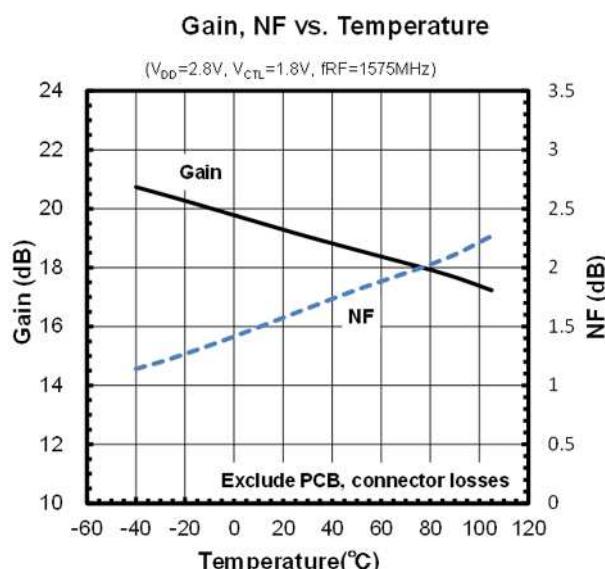
■ ELECTRICAL CHARACTERISTICS

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



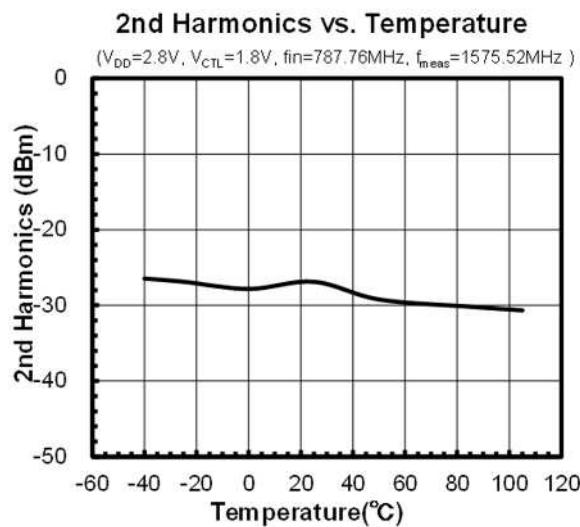
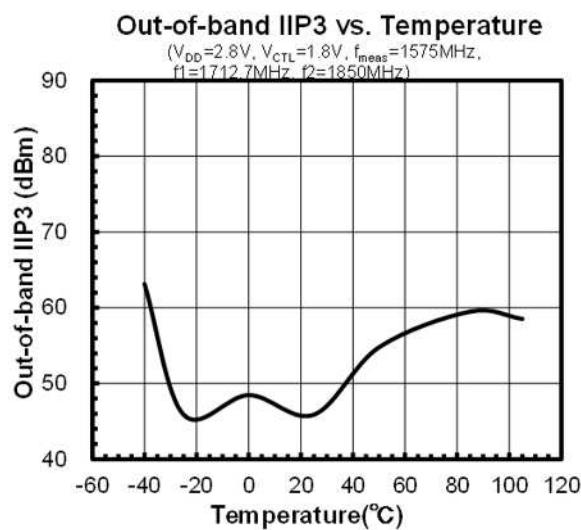
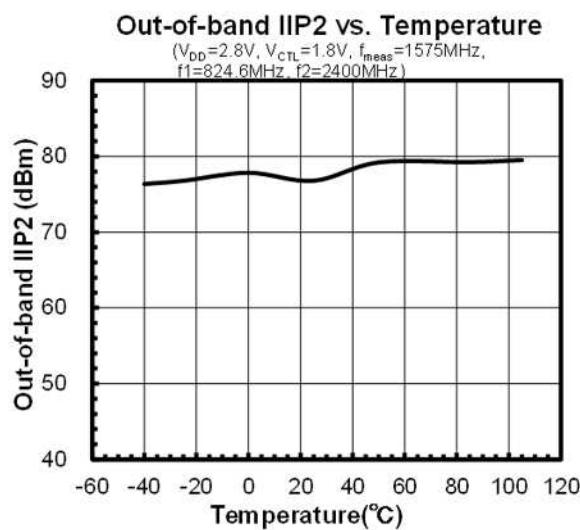
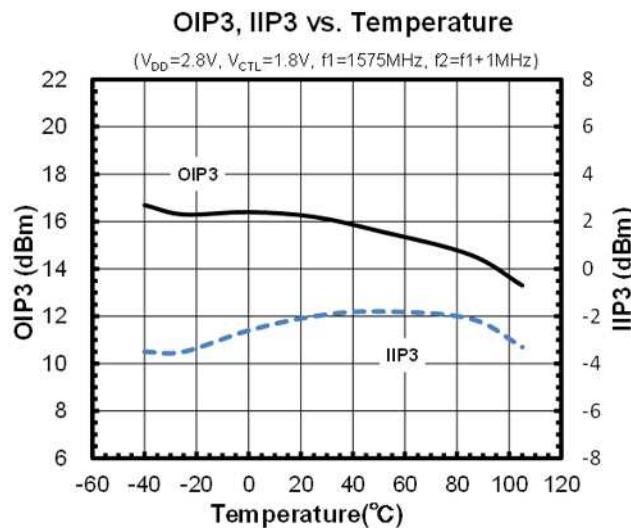
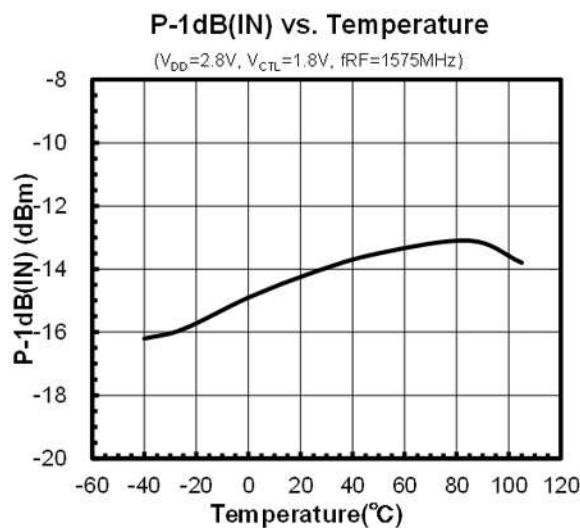
■ ELECTRICAL CHARACTERISTICS

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



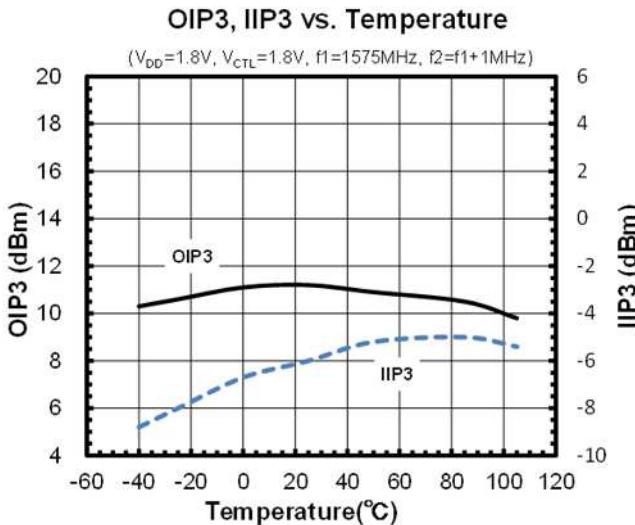
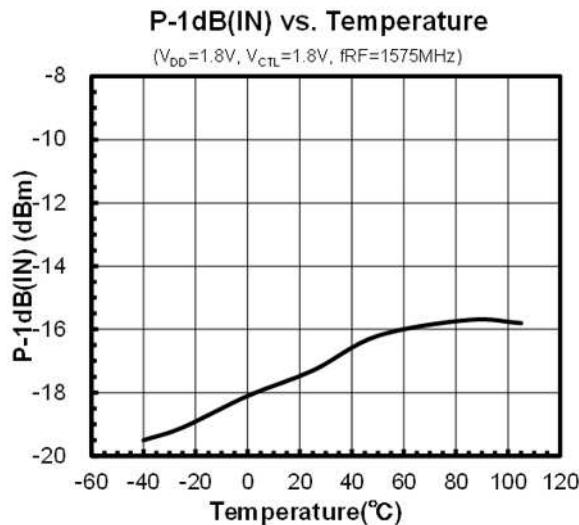
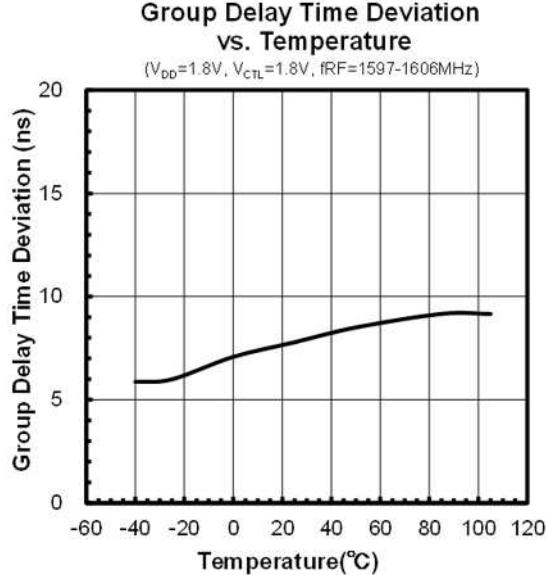
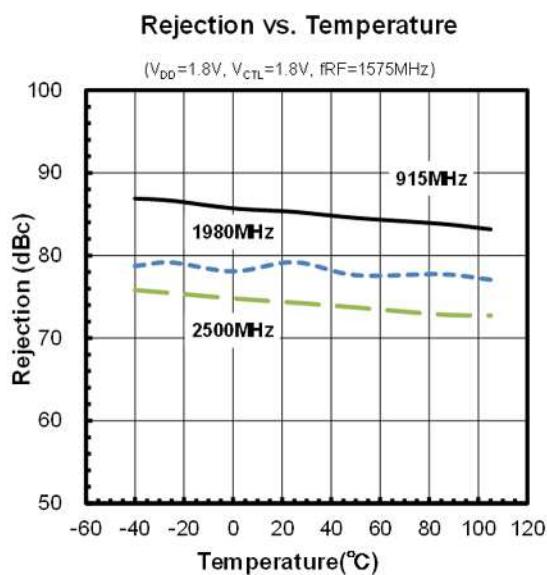
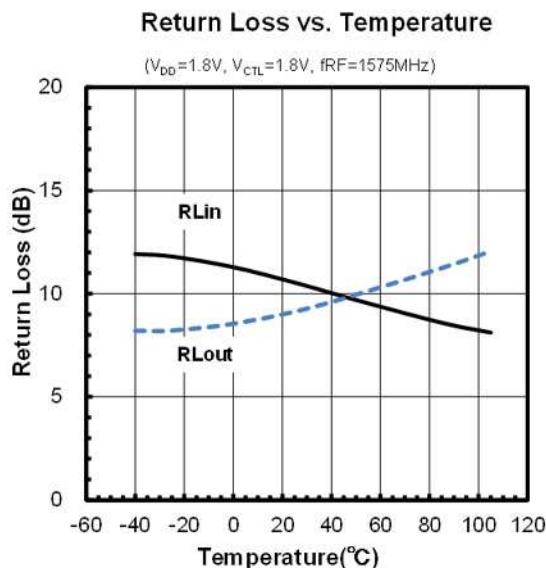
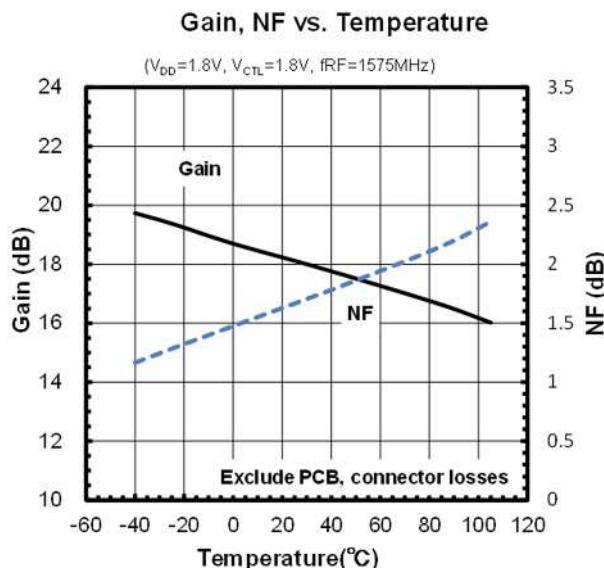
■ ELECTRICAL CHARACTERISTICS

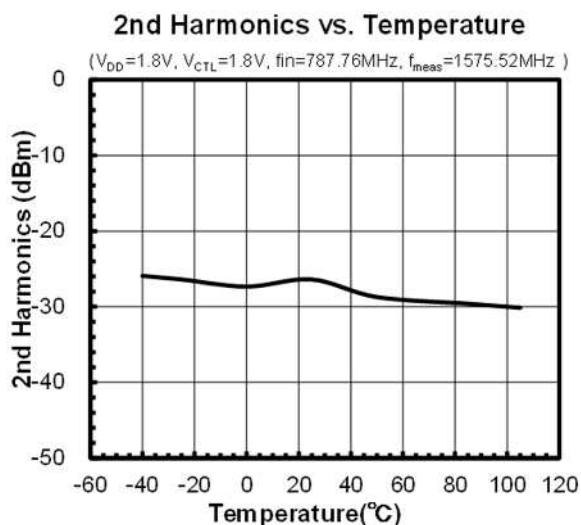
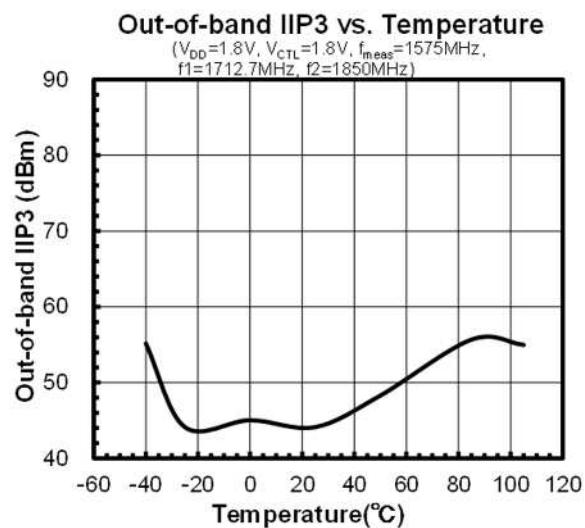
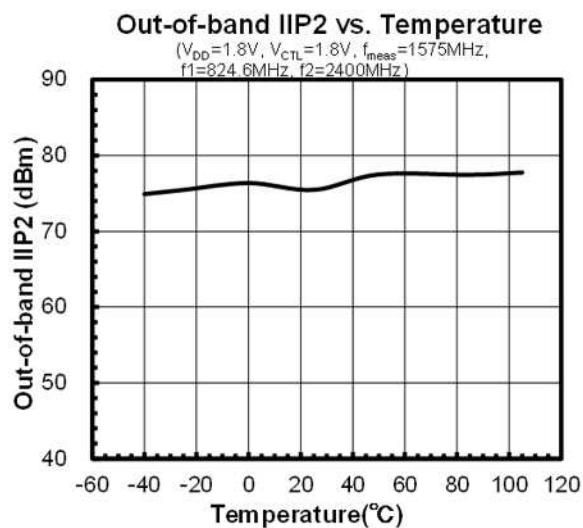
Conditions: $V_{DD} = 2.8 \text{ V}$, $V_{CTL} = 1.8 \text{ V}$, $Z_s = Z_l = 50 \Omega$, with application circuit



■ ELECTRICAL CHARACTERISTICS

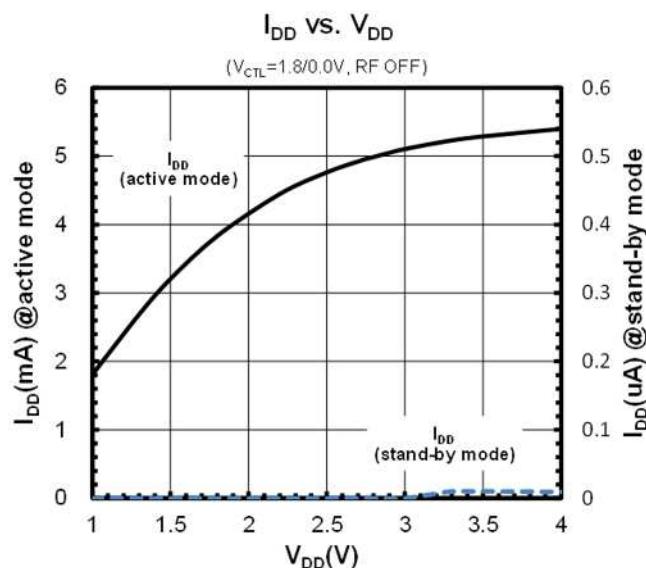
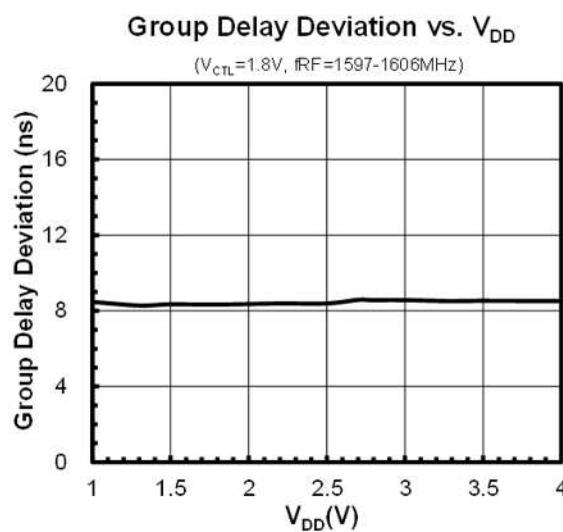
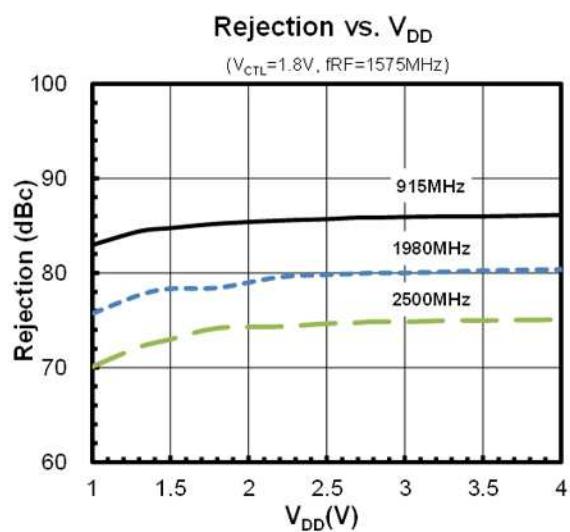
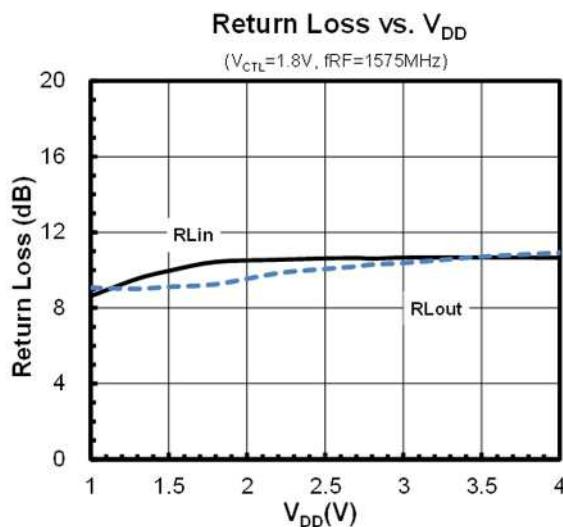
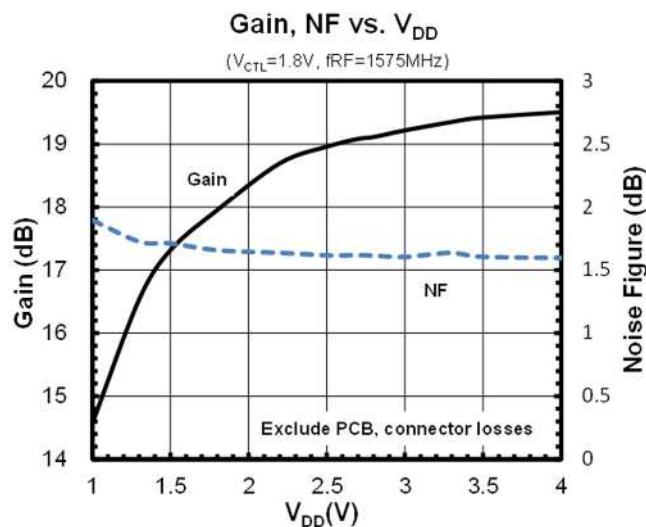
Conditions: $V_{DD} = 1.8 \text{ V}$, $V_{CTL} = 1.8 \text{ V}$, $Z_s = Z_l = 50 \Omega$, with application circuit



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

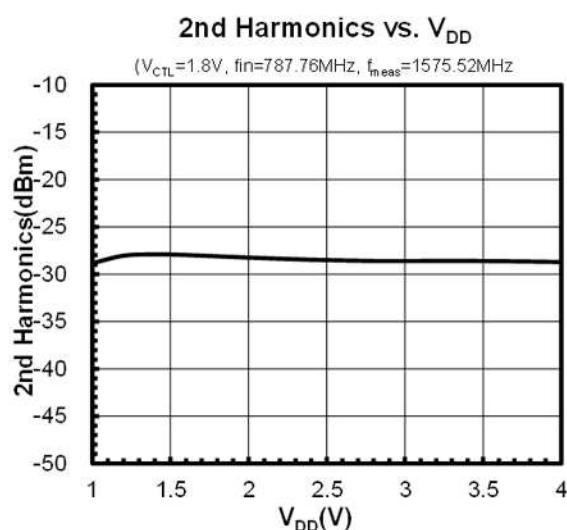
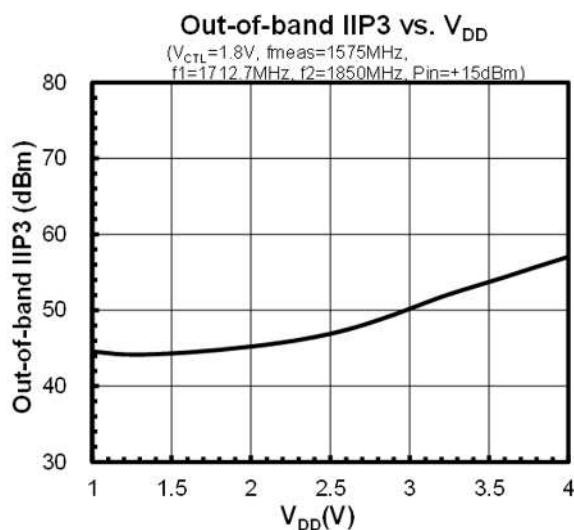
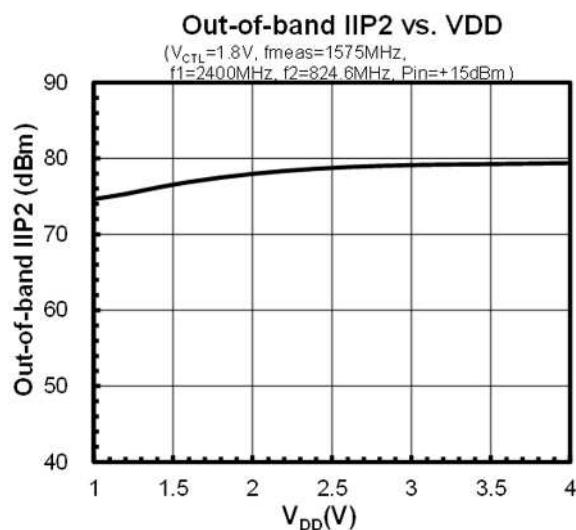
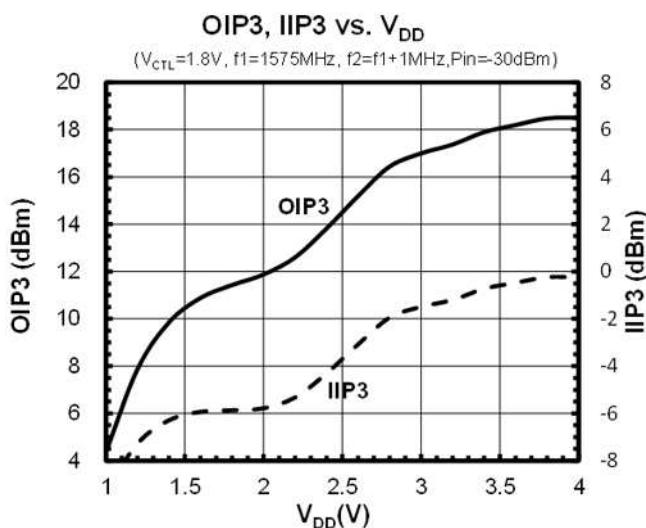
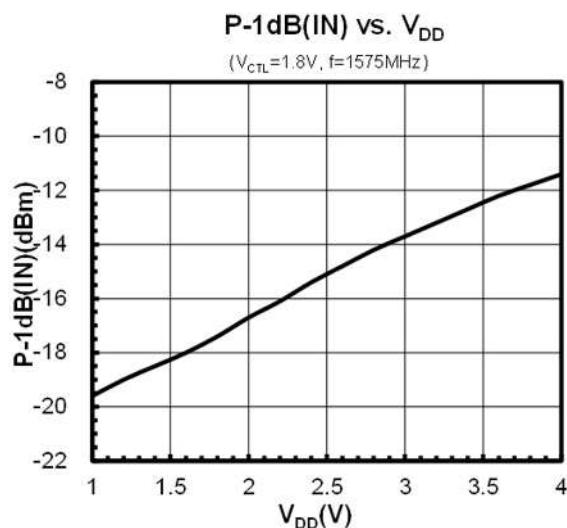
■ ELECTRICAL CHARACTERISTICS

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

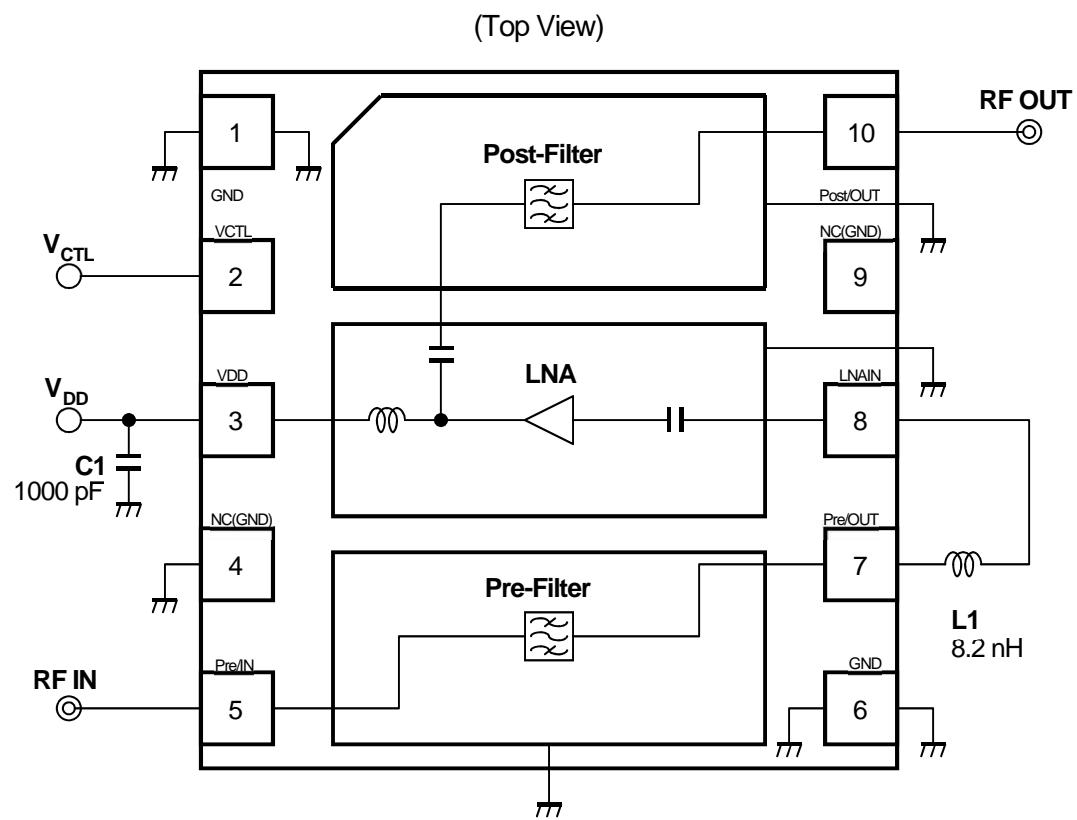


■ ELECTRICAL CHARACTERISTICS

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



■ APPLICATION CIRCUIT

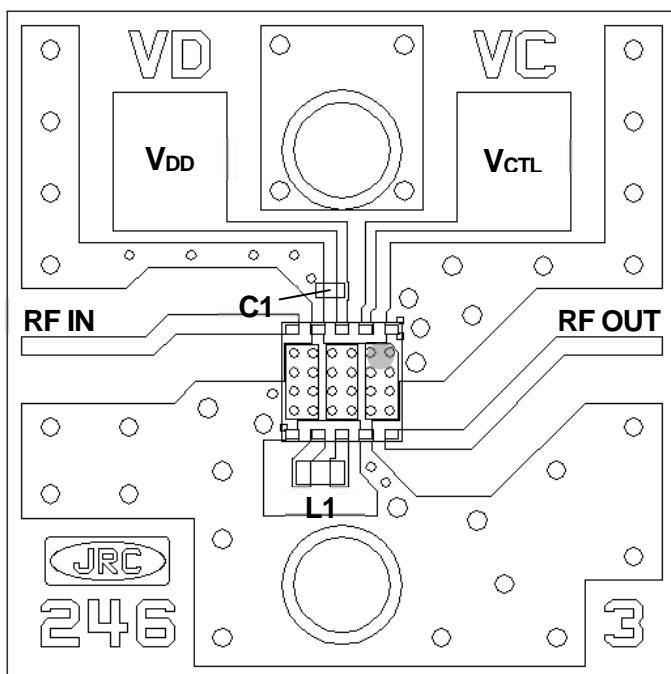


<PARTS LIST>

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

■ EVALUATION BOARD

(Top View)



PCB

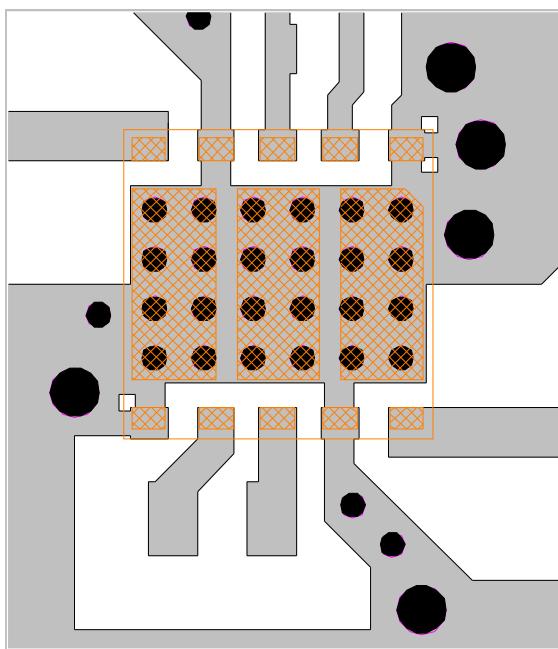
Substrate: FR-4

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.

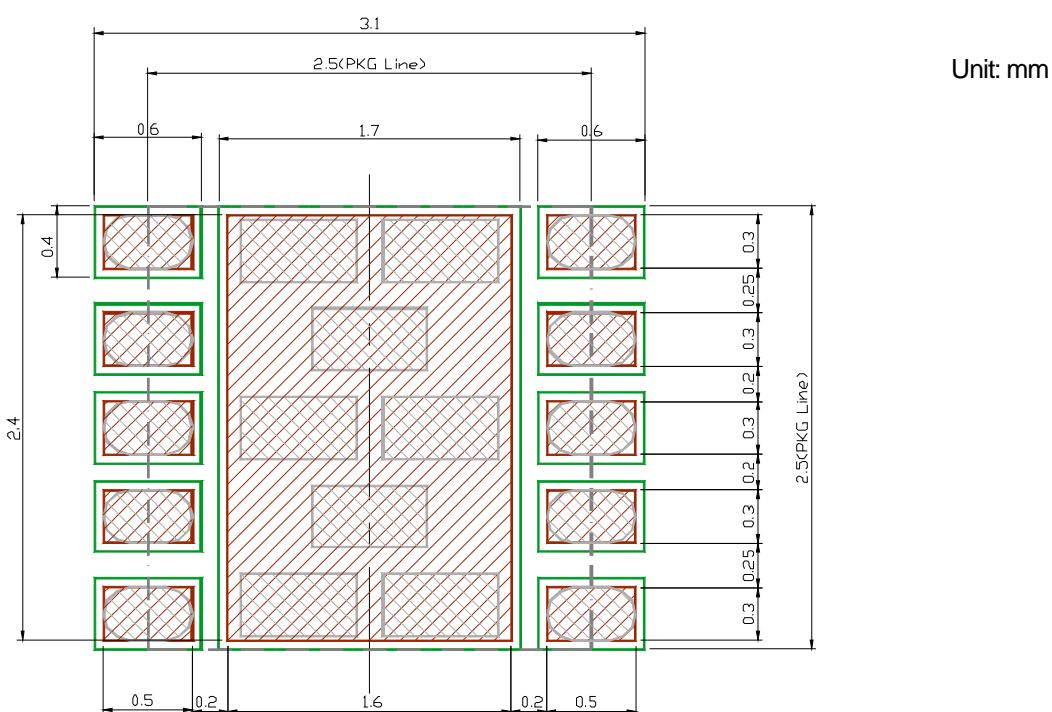
■ RECOMMENDED FOOTPRINT PATTERN (HFFP10-CD Package) <Reference>

PKG: 2.5 mm x 2.5 mm

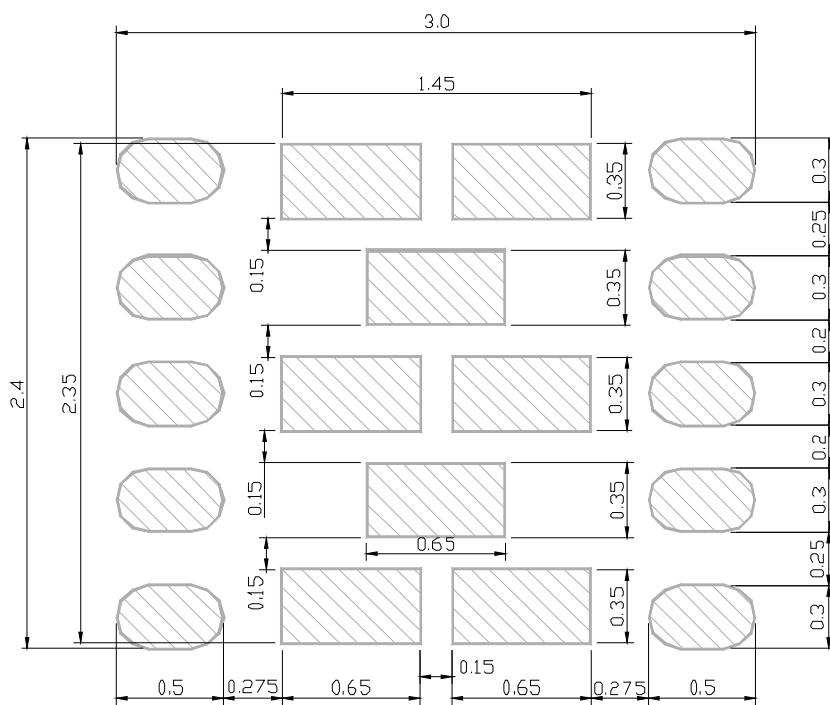
: Land

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

 : Mask (Open area)



Metal MASK Detail



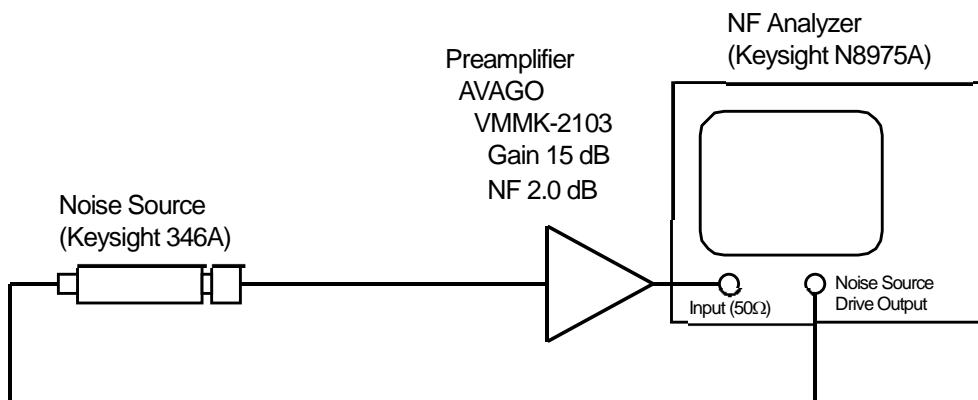
■ NOISE FIGURE MEASUREMENT BLOCK DIAGRAM

Measuring instruments

NF Analyzer : Keysight N8975A
 Noise Source : Keysight 346A

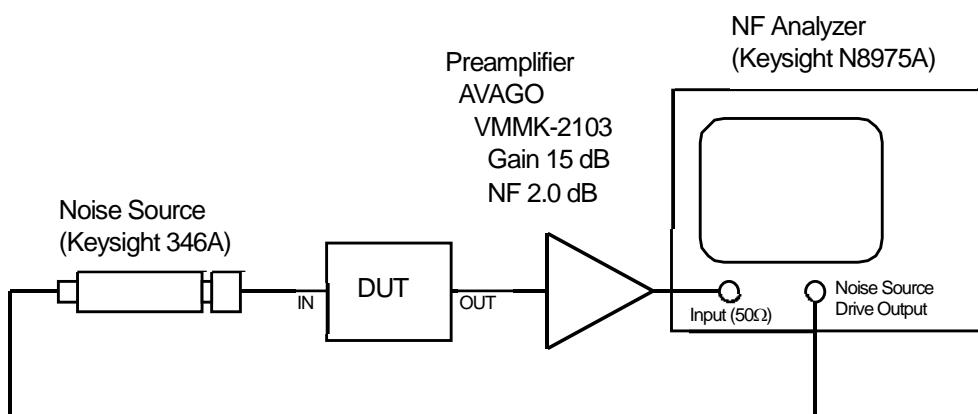
Setting the NF analyzer

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

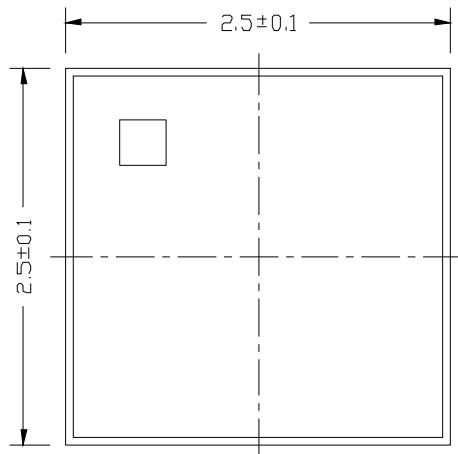


- * Noise source, DUT, preamplifier and NF analyzer are connected directly.

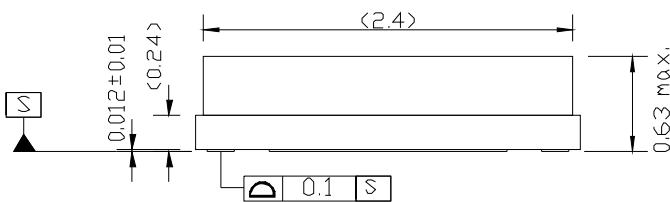
Measurement Setup

■ PACKAGE OUTLINE (HFFP10-HH)

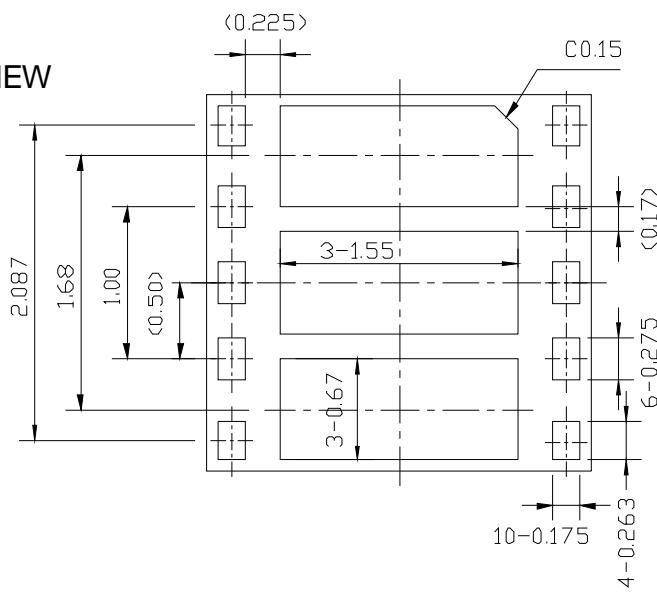
TOP VIEW



SIDE VIEW



BOTTOM VIEW



Package Size : 2.5 ± 0.1 mm
0.63 mm max

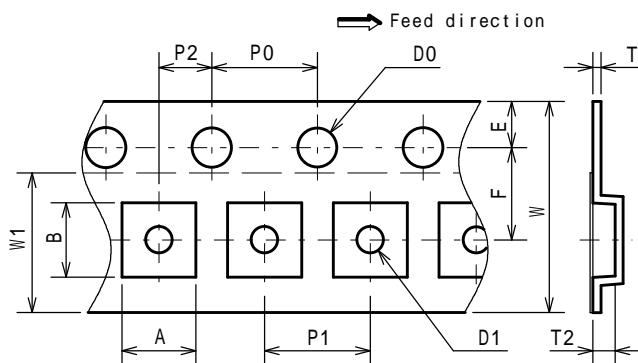
Electrode Dimensions clearance
: +0.05 mm

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

■ PACKING SPECIFICATION (HFFP10-CD)

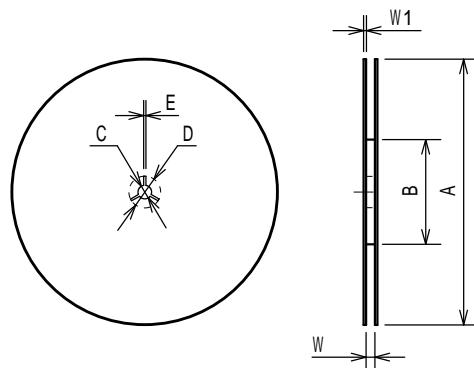
Unit: mm

TAPING DIMENSIONS



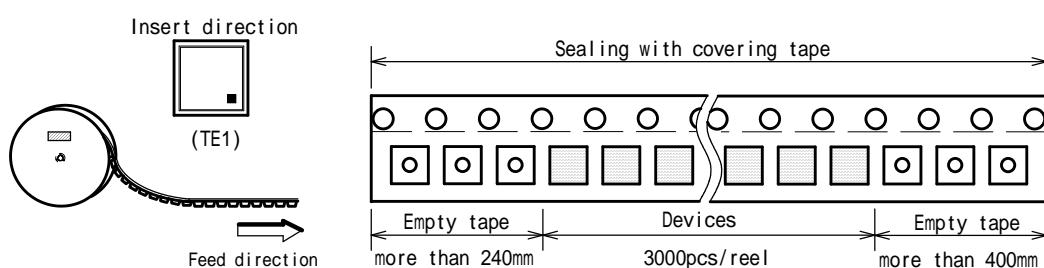
SYMBOL	DIMENSION	REMARKS
A	2.8 ± 0.1	BOTTOM DIMENSION
B	2.8 ± 0.1	BOTTOM DIMENSION
D0	$1.5^{+0.1}_0$	
D1	$1.0^{+0.1}_0$	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.1	
T	0.3 ± 0.1	
T2	0.85 ± 0.1	
W	8.0 ± 0.2	
W1	5.3 ± 0.2	THICKNESS 100 μm max

REEL DIMENSIONS

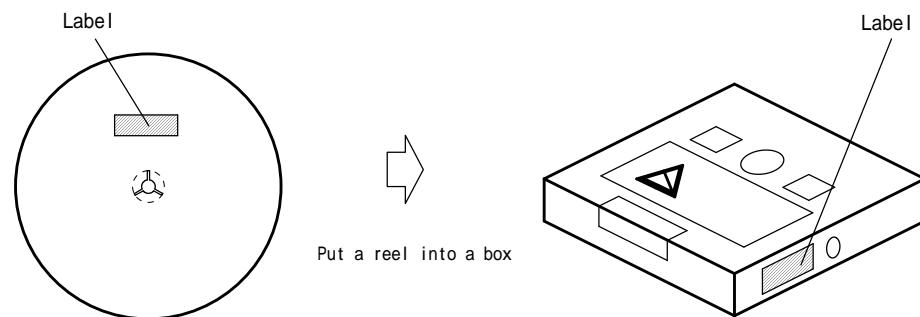


SYMBOL	DIMENSION
A	$180^{+0}_{-1.5}$
B	66 ± 0.5
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	$9^{+1.0}_0$
W1	1.2

TAPING STATE



PACKING STATE



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9. This product may be damaged with electric static discharge (ESD) or spike voltage. Please handle with care to avoid these damages.
10. This 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.

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.
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.
For dynamic load at the time of mounting, please use it after confirming in consideration of the contact area / speed / load.
11. The product specifications and descriptions listed in this datasheet are subject to change at any time, without notice.



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