1.5 GHz band GPS and GLONASS Front-End Module

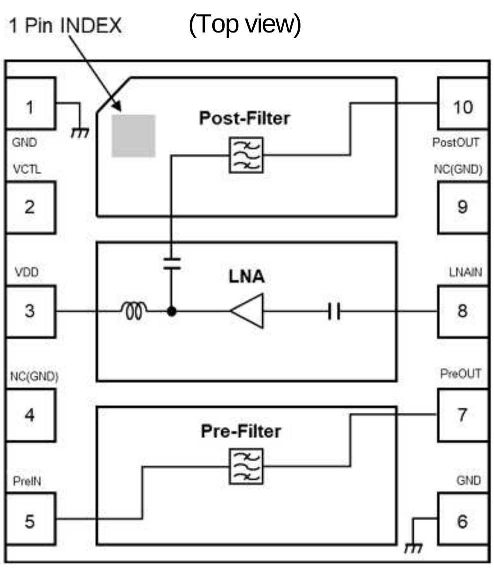
■ FEATURES

- 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 — NJG1161; Package — PCD; Taping form — (TE1)

■ 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

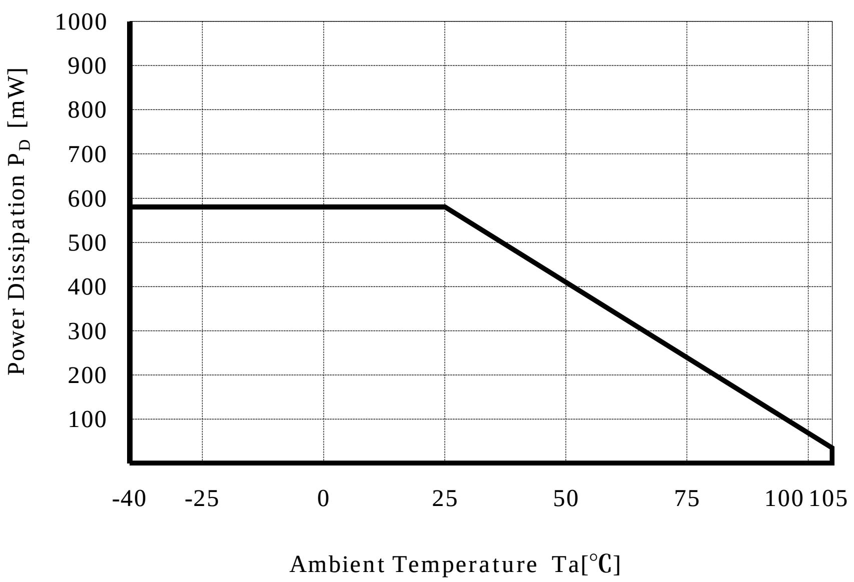
■ POWER DISSIPATION VS.AMBIENT TEMPERATURE

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

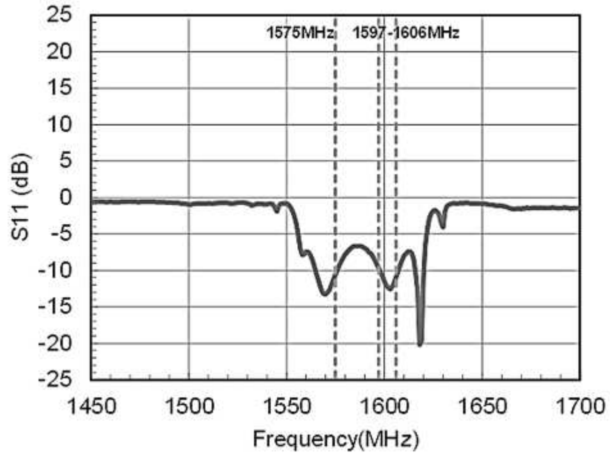
■ **ELECTRICAL CHARACTERISTICS 3 (RF)**

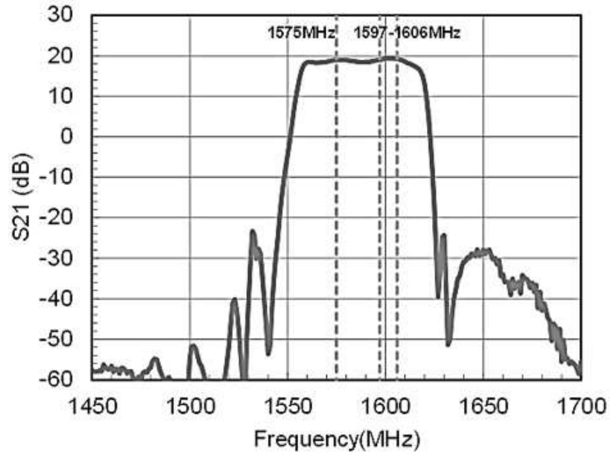
General conditions: V_{DD} = 1.8 V, V_{CTL} = 1.8 V, f_{RF} = 1575 MHz, 1597 to 1606 MHz, T_a = +25°C, Z_s = Z_l = 50 Ω, with application circuit

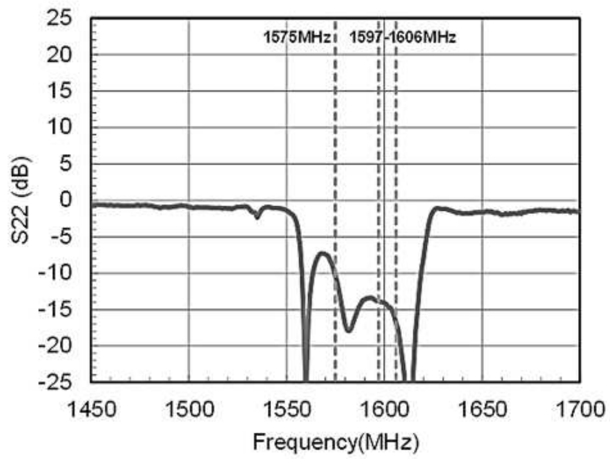
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Small Signal Gain (GPS) 2	Gain_GPS2	f = 1575 MHz (GPS) Exclude PCB, Connector Losses (0.19 dB)	15.5	17.5	-	dB
Small Signal Gain (GLONASS) 2	Gain_GLN2	f = 1597 to 1606 MHz (GLONASS) Exclude PCB, Connector Losses (0.19 dB)	15.5	17.5	-	dB
Noise Figure (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

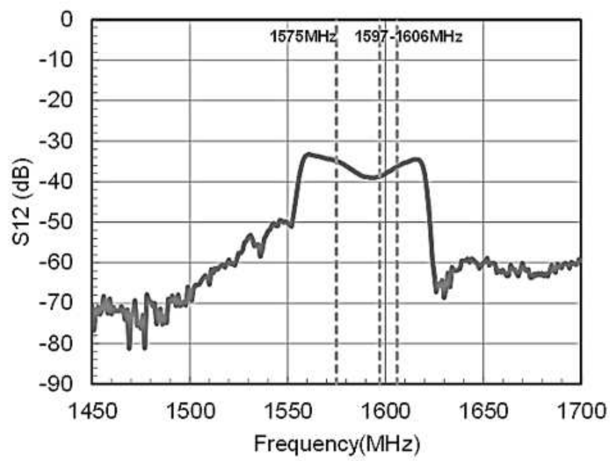
■ ELECTRICAL CHARACTERISTICS

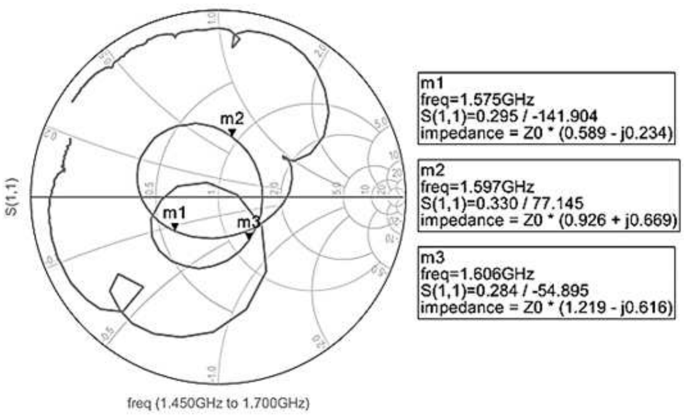
Conditions: V_{DD} = 2.8 V, V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit

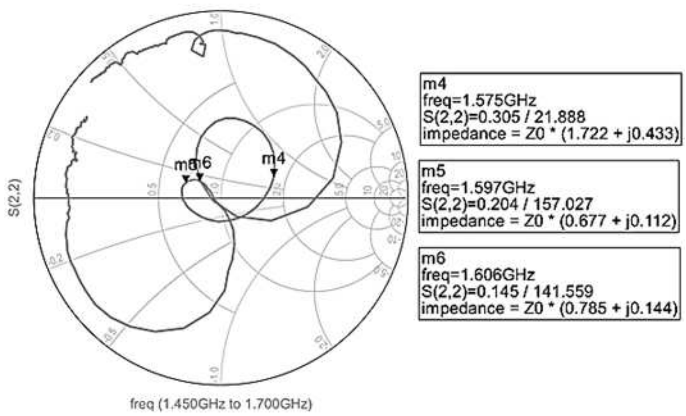






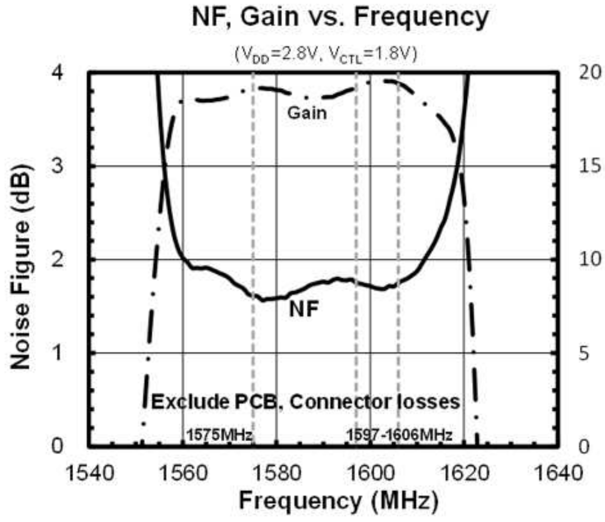


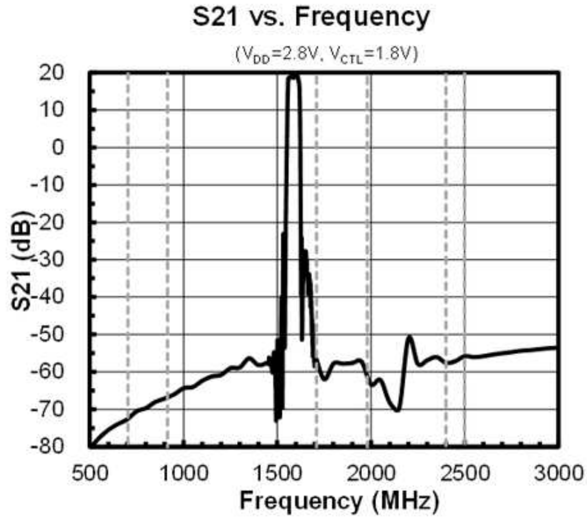


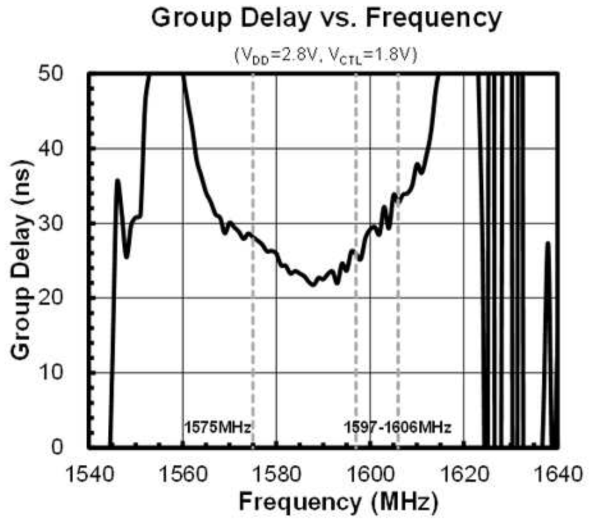


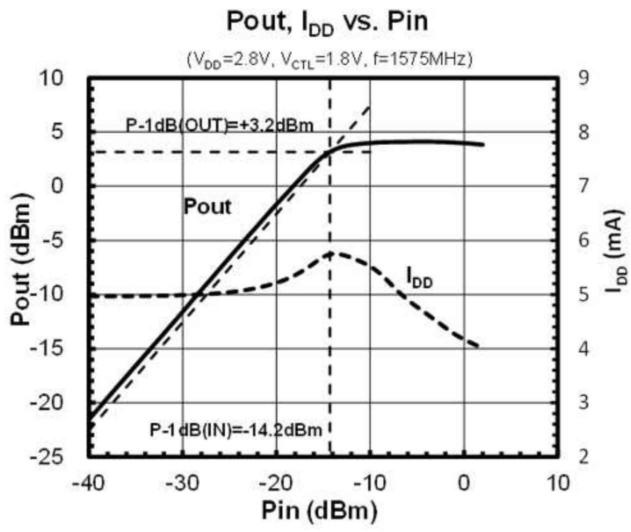
■ **ELECTRICAL CHARACTERISTICS**

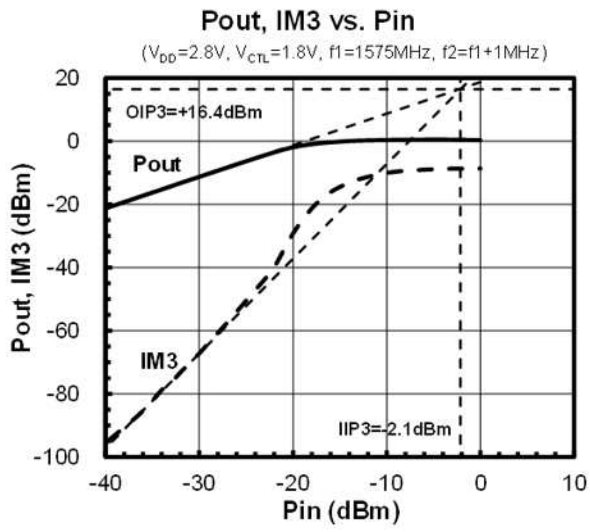
Conditions: V_{DD} = 2.8 V, V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit











■ ELECTRICAL CHARACTERISTICS

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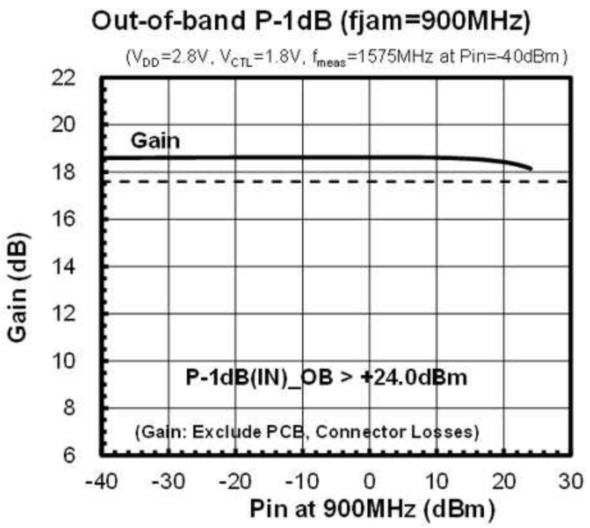
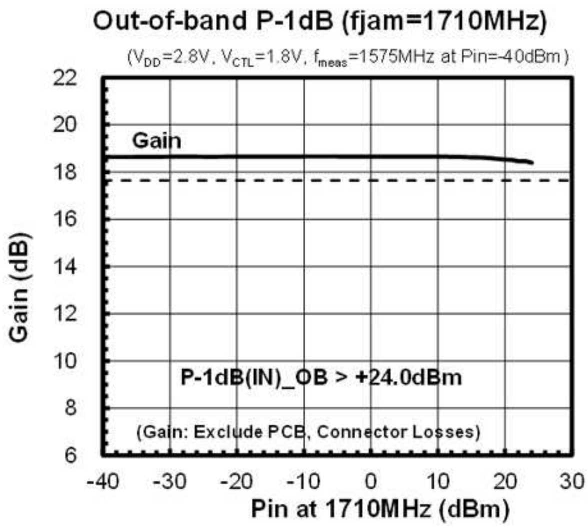
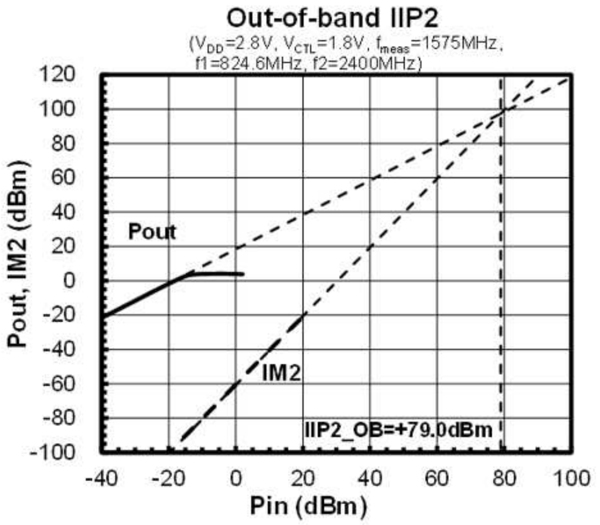
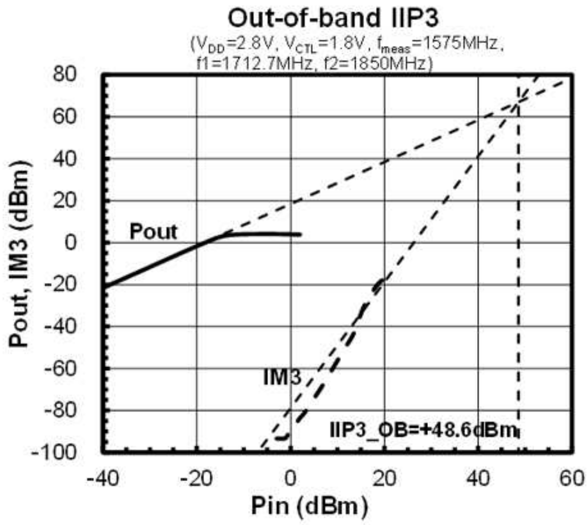
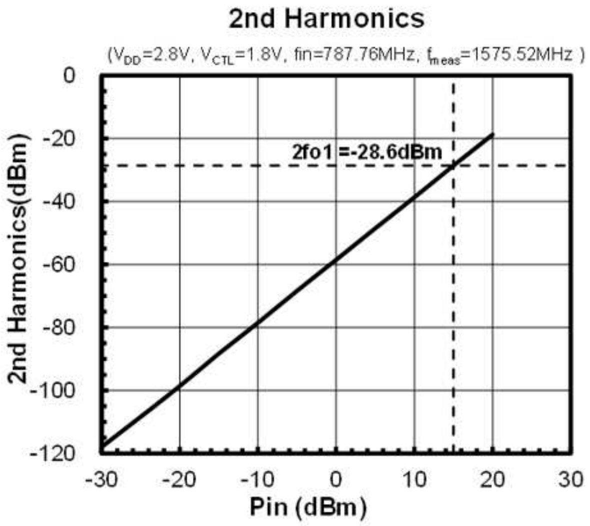




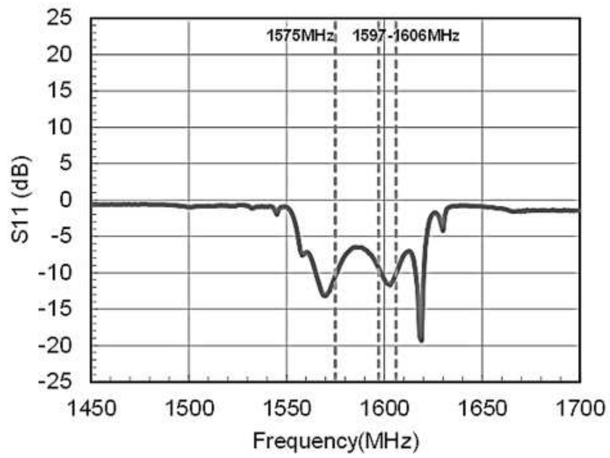


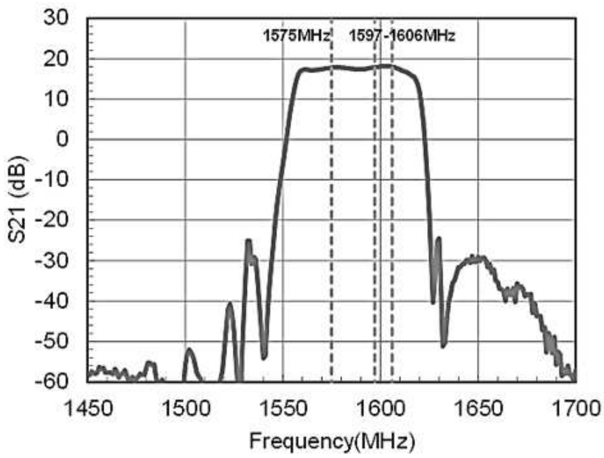


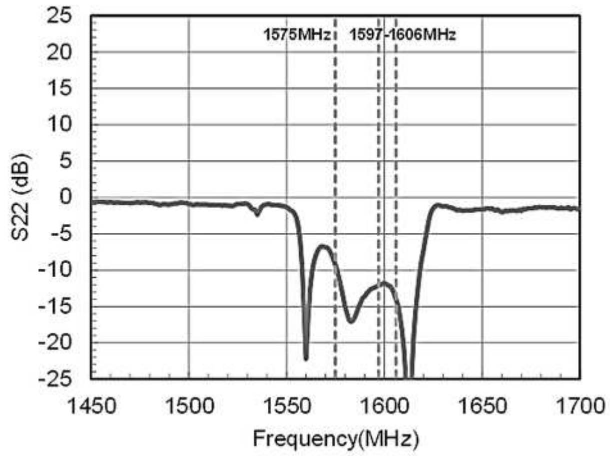


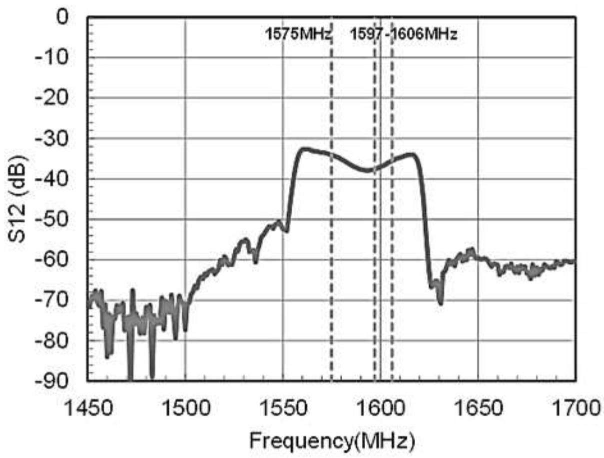
■ ELECTRICAL CHARACTERISTICS

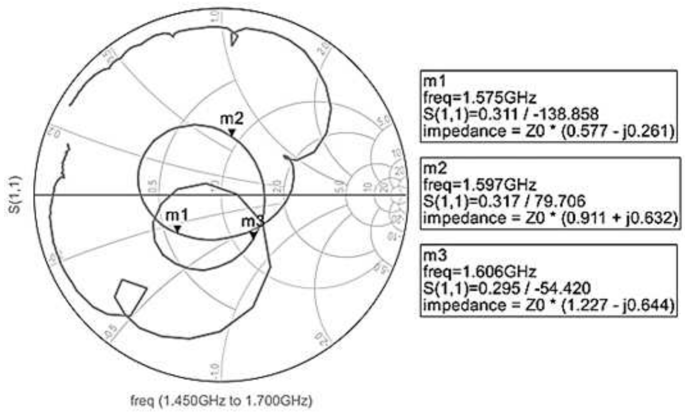
Conditions: V_{DD} = 1.8 V, V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit

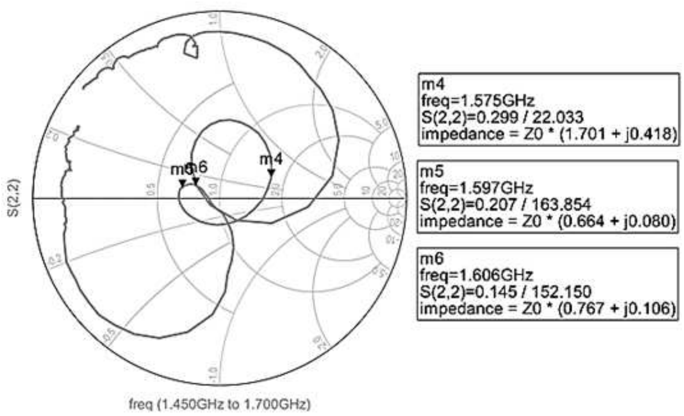






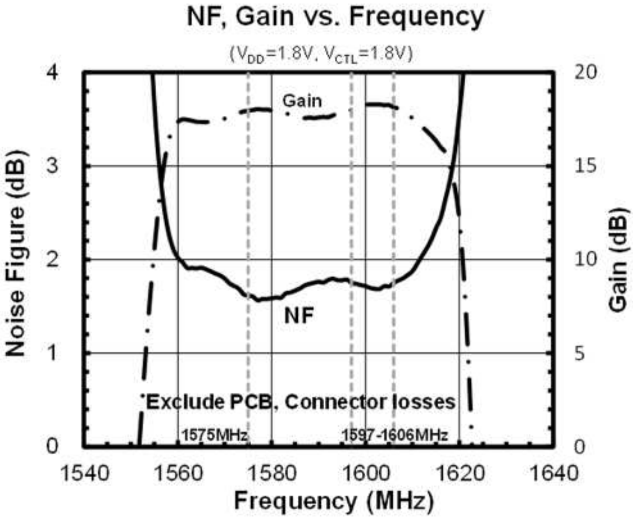


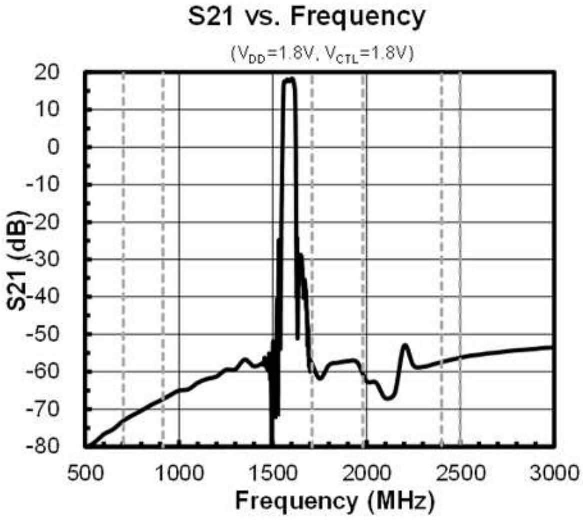


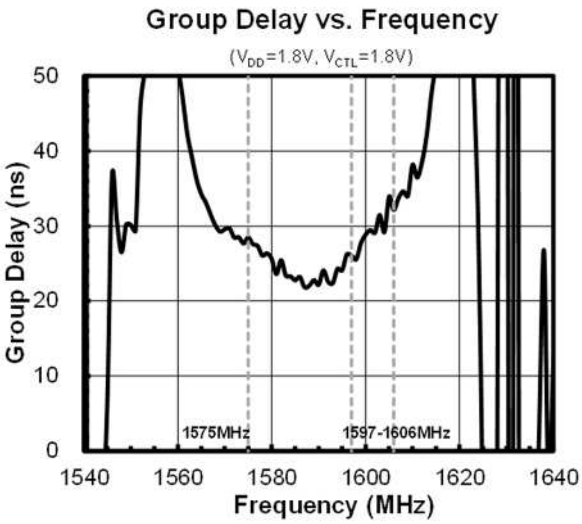


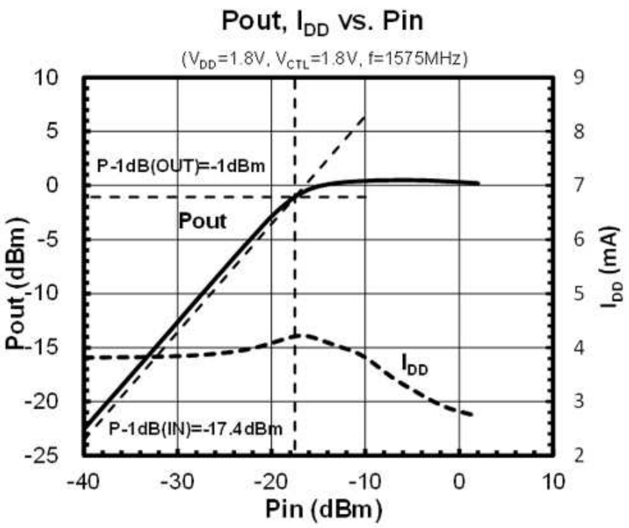
■ ELECTRICAL CHARACTERISTICS

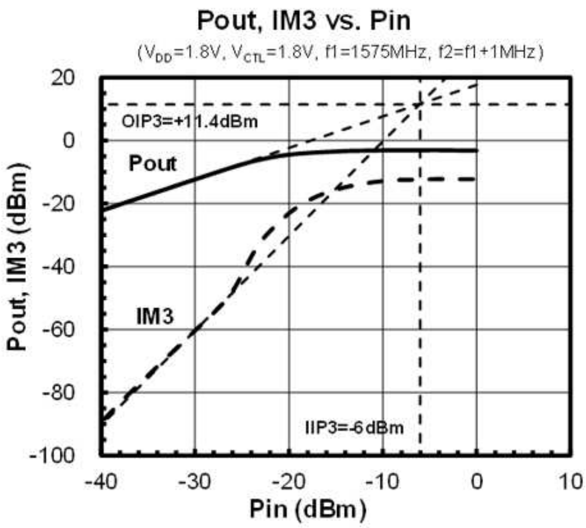
Conditions: V_{DD} = 1.8 V, V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit





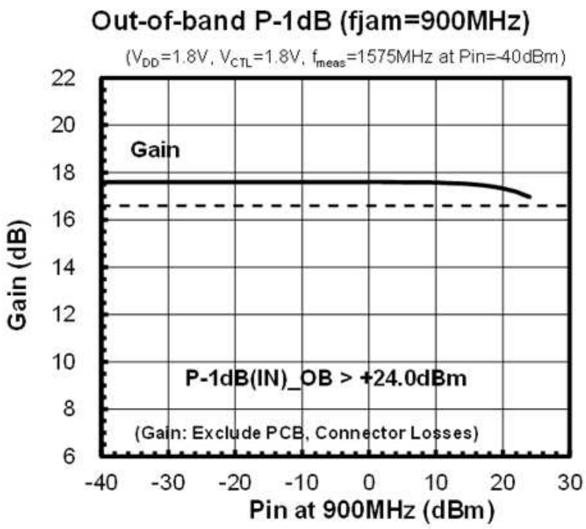


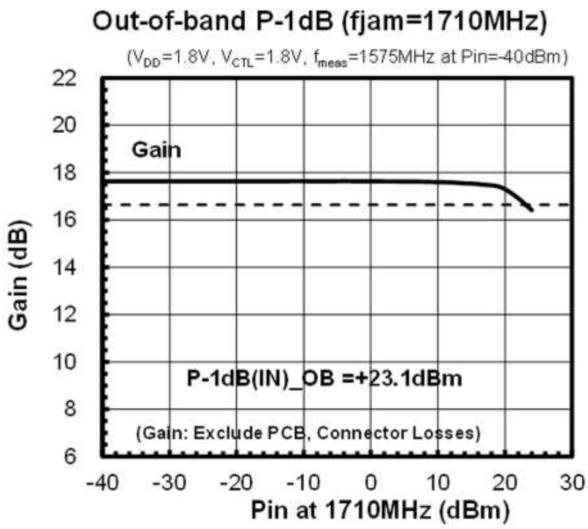


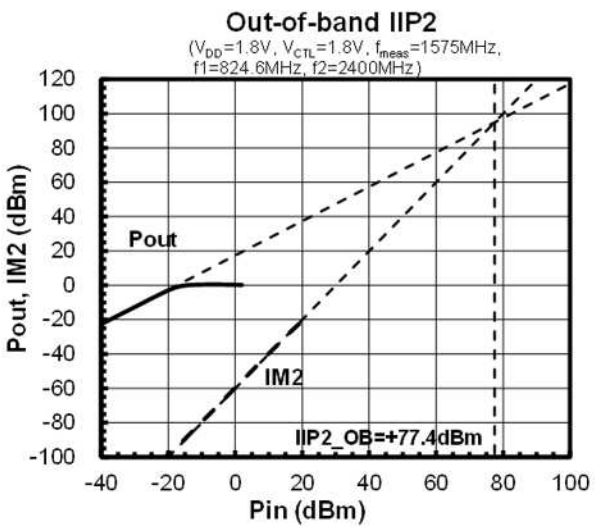


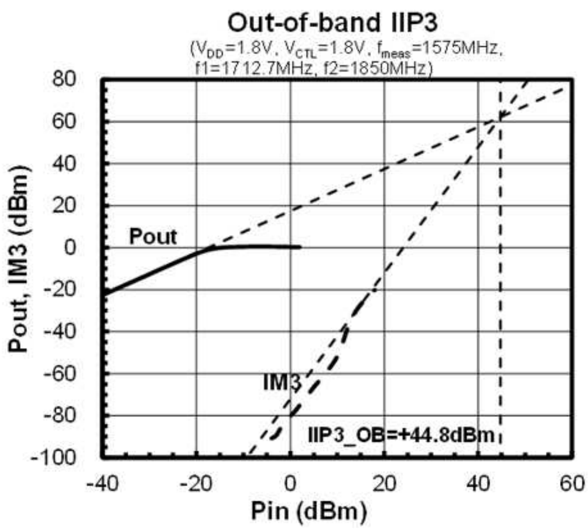
■ ELECTRICAL CHARACTERISTICS

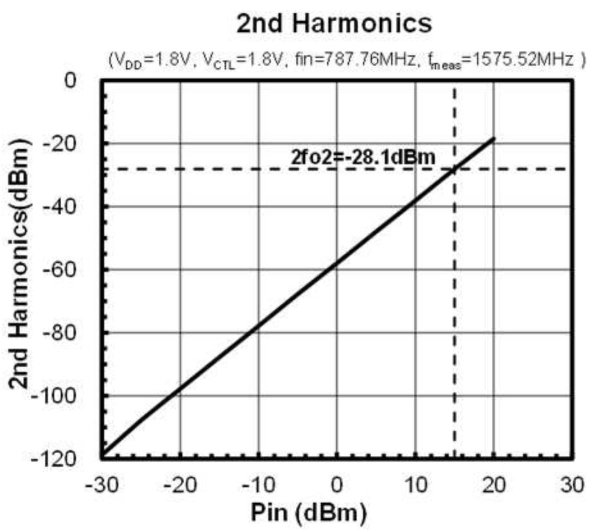
Conditions: V_{DD} = 1.8 V, V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit





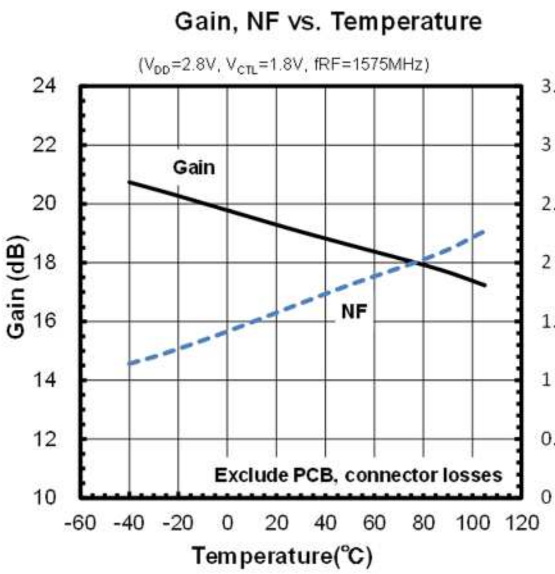


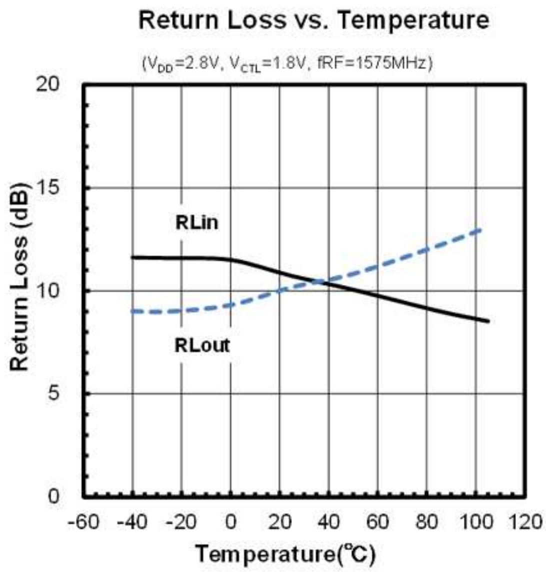


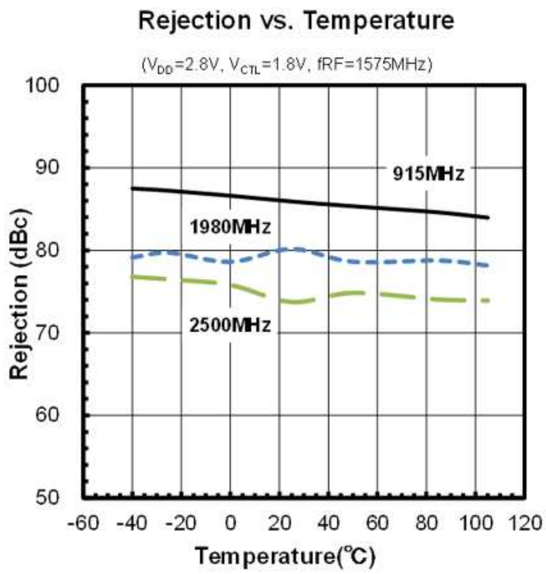


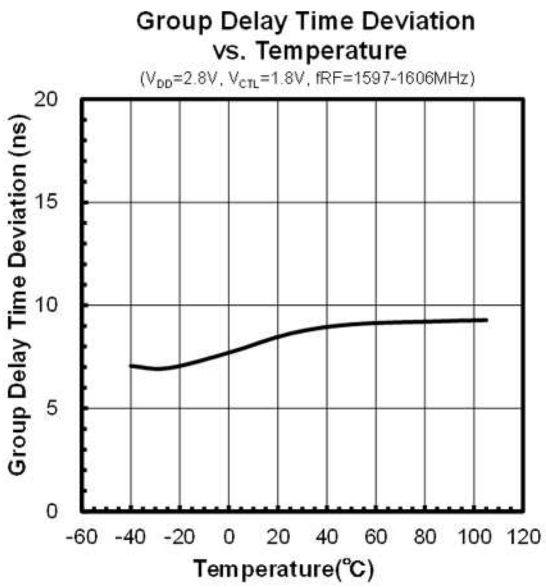
■ ELECTRICAL CHARACTERISTICS

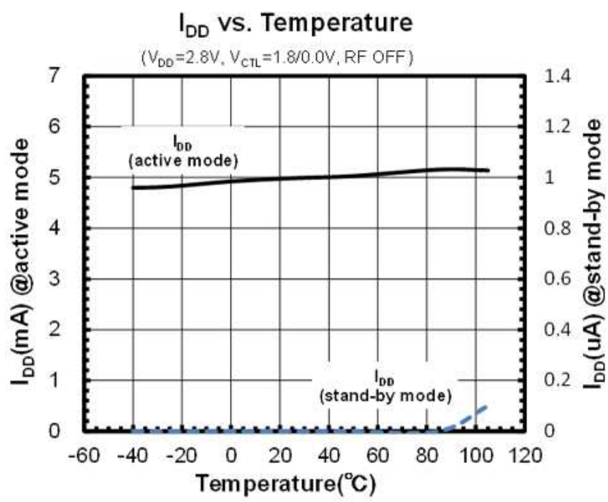
Conditions: V_{DD} = 2.8 V, V_{CTL} = 1.8 V, Z_s = Z_l = 50 Ω, with application circuit

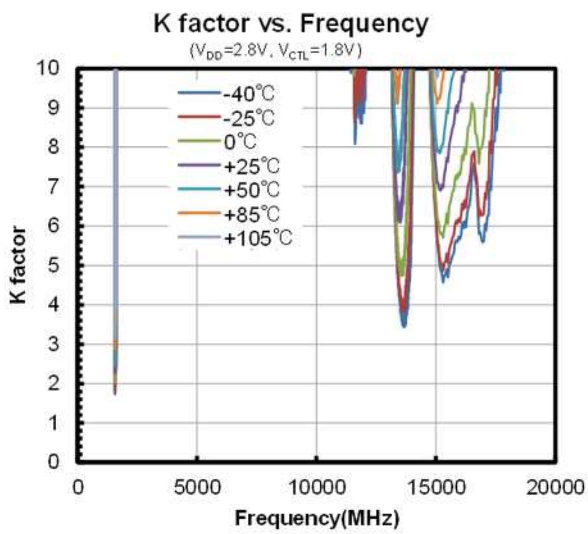






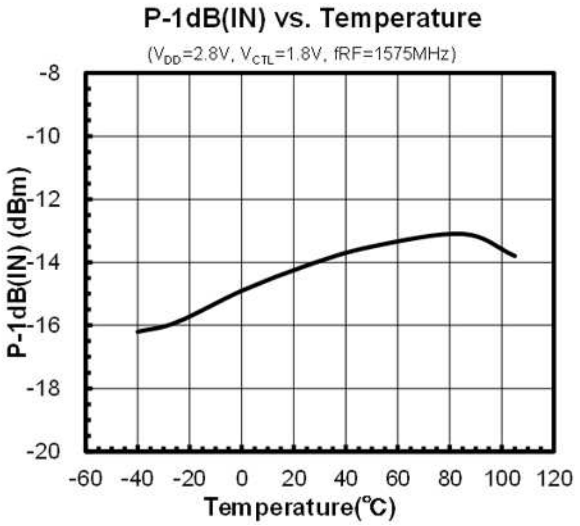


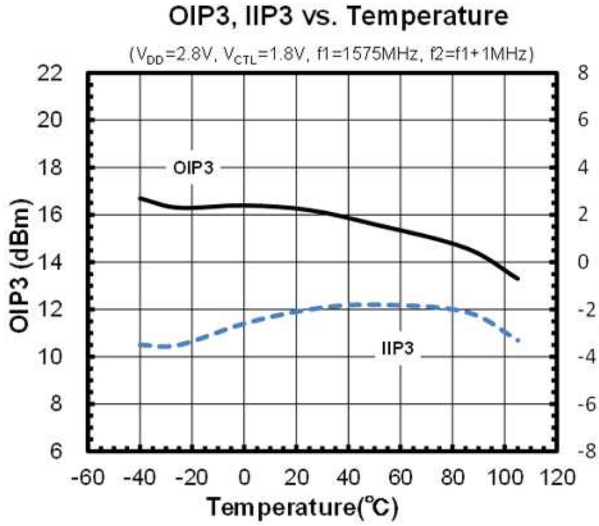


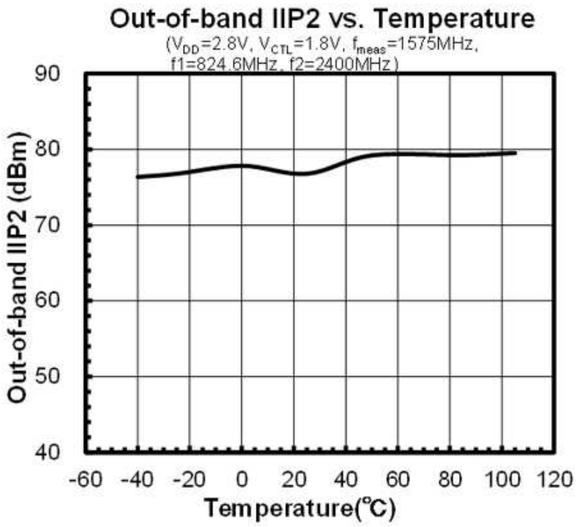


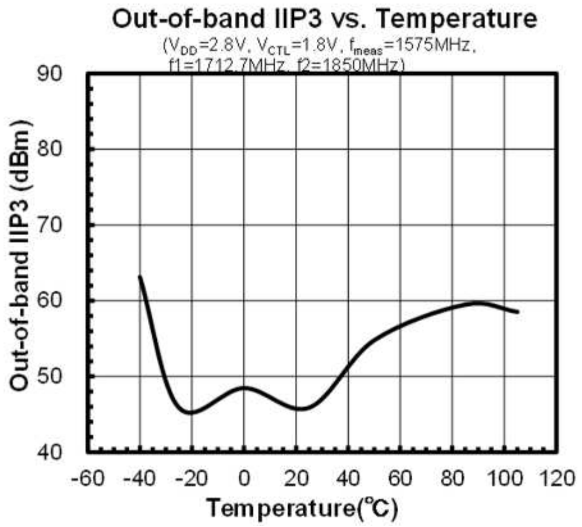
■ ELECTRICAL CHARACTERISTICS

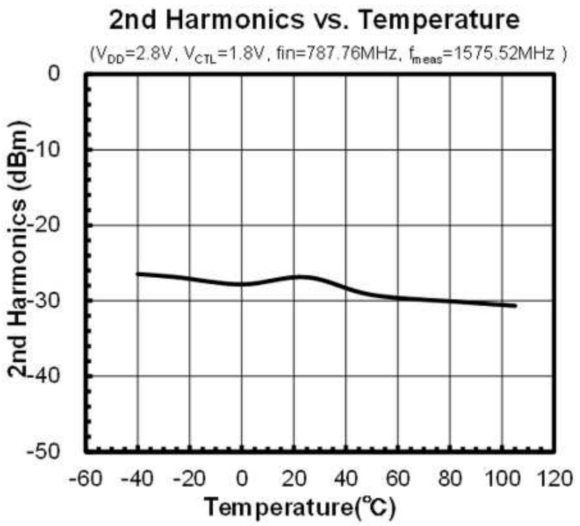
Conditions: V_{DD} = 2.8 V, V_{CTL} = 1.8 V, Z_s = Z_l = 50 Ω, with application circuit







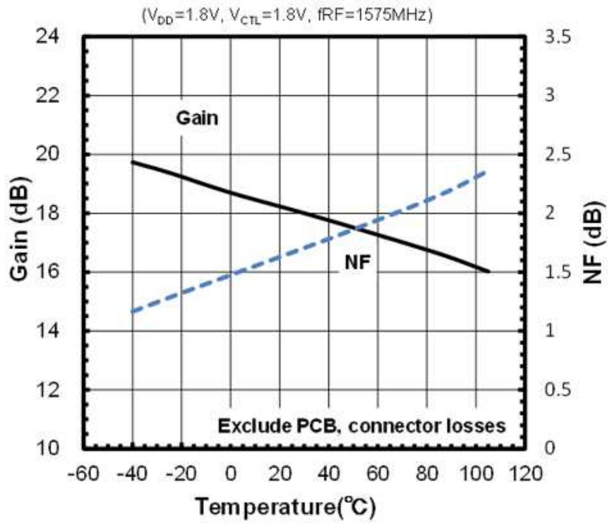




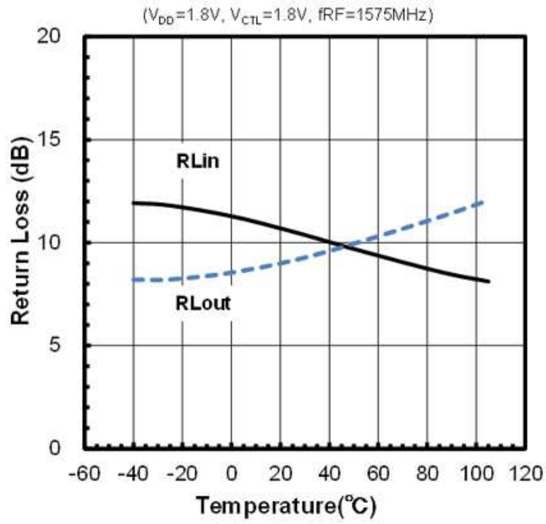
■ **ELECTRICAL CHARACTERISTICS**

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

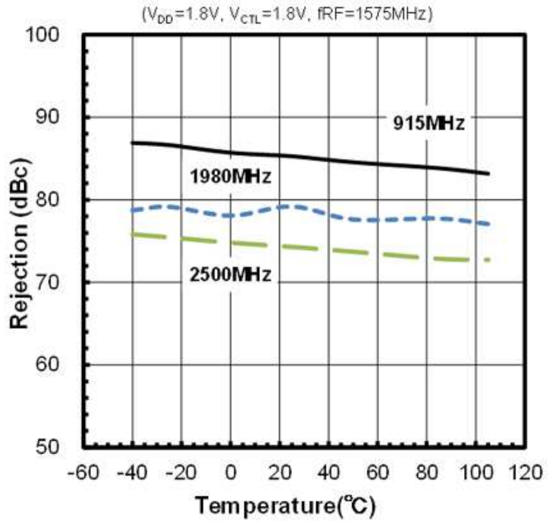
Gain, NF vs. Temperature



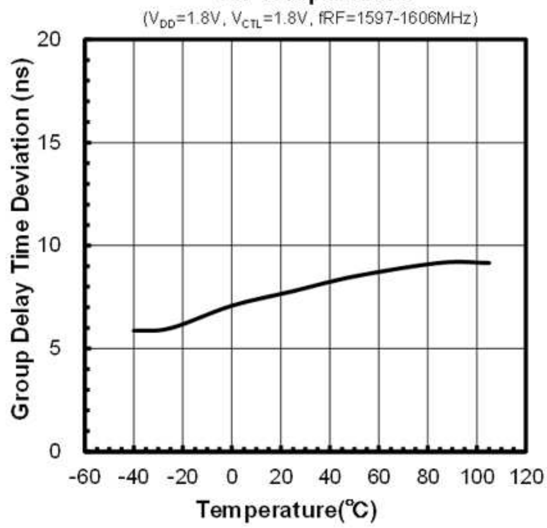
Return Loss vs. Temperature



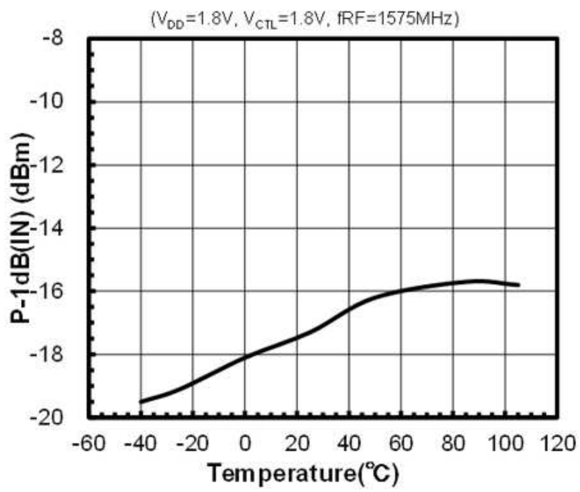
Rejection vs. Temperature



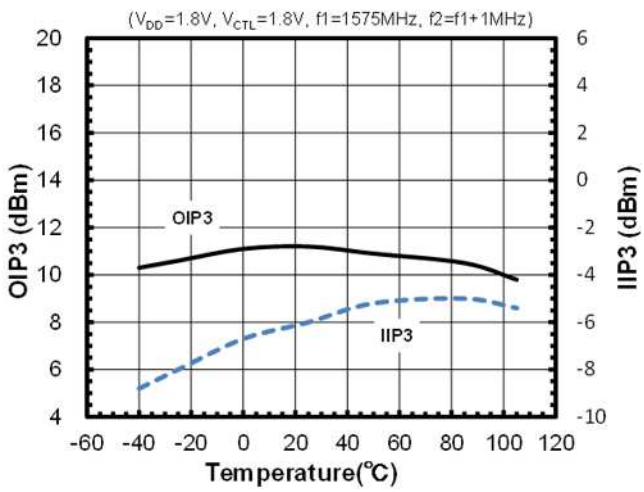
Group Delay Time Deviation vs. Temperature



P-1dB(IN) vs. Temperature

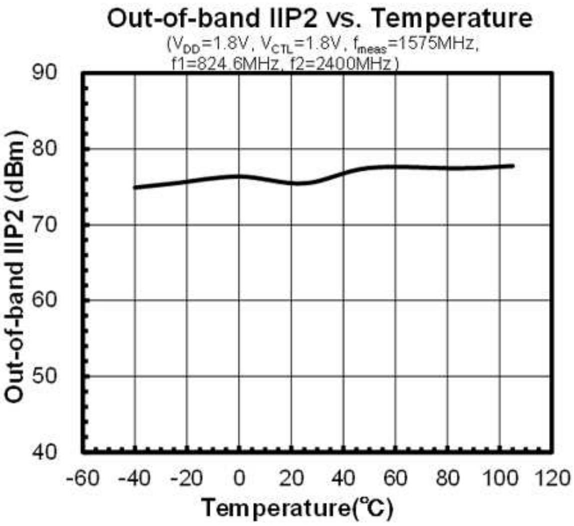


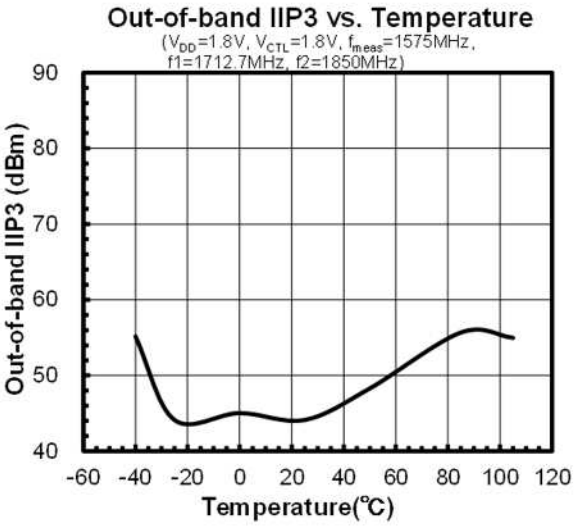
OIP3, IIP3 vs. Temperature

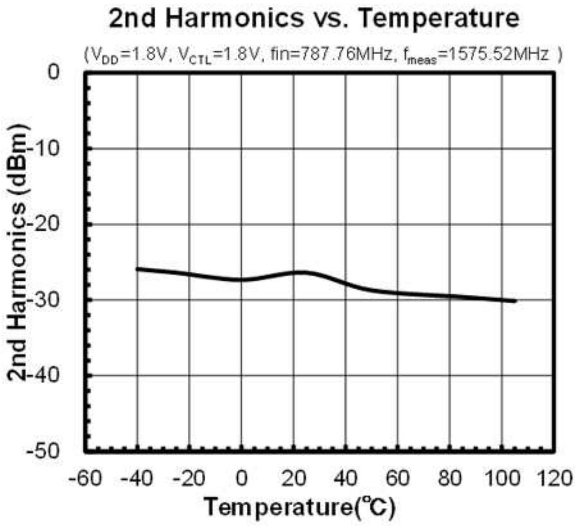


■ ELECTRICAL CHARACTERISTICS

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

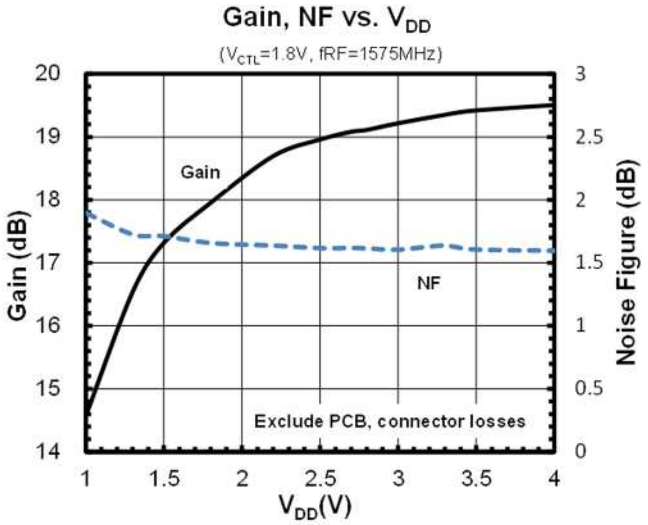


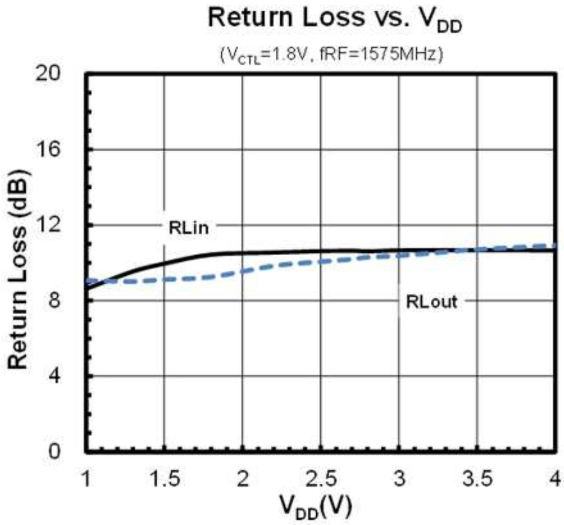


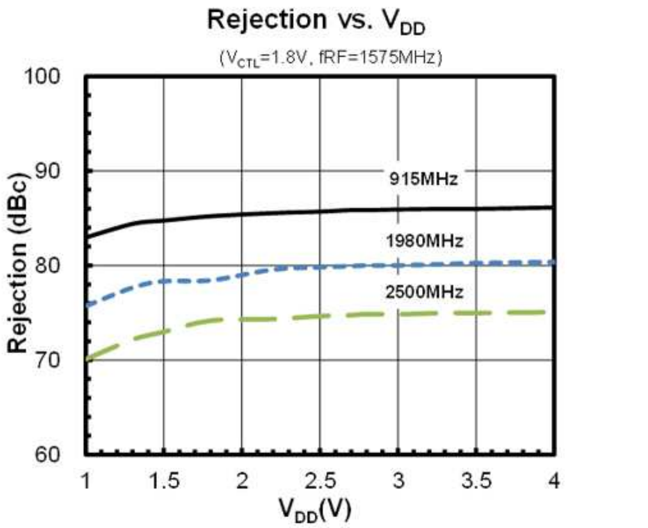


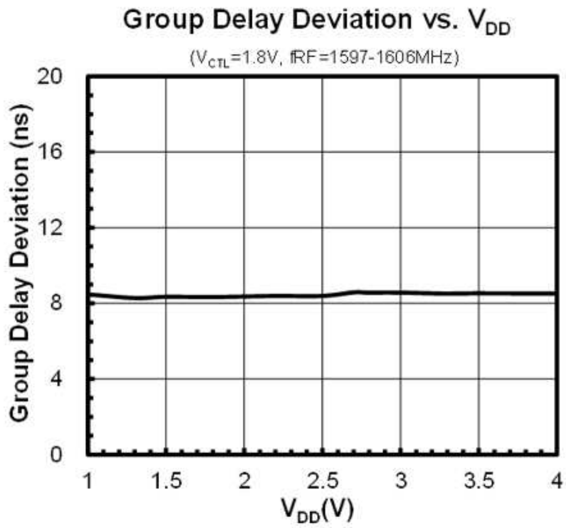
■ **ELECTRICAL CHARACTERISTICS**

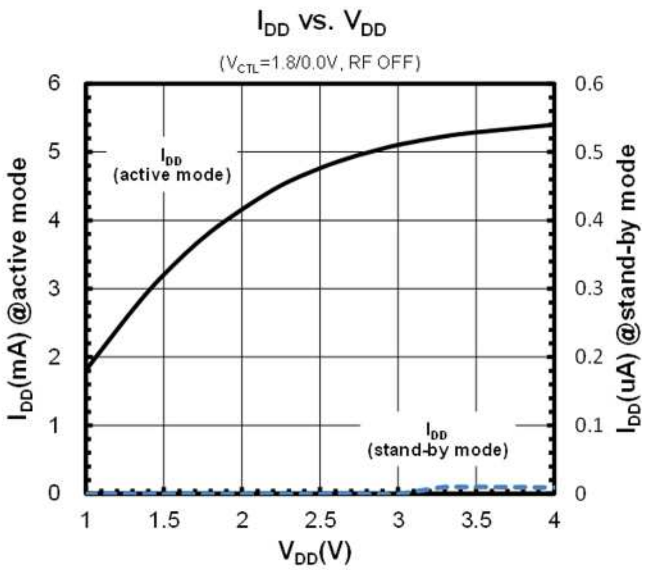
Conditions: V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit





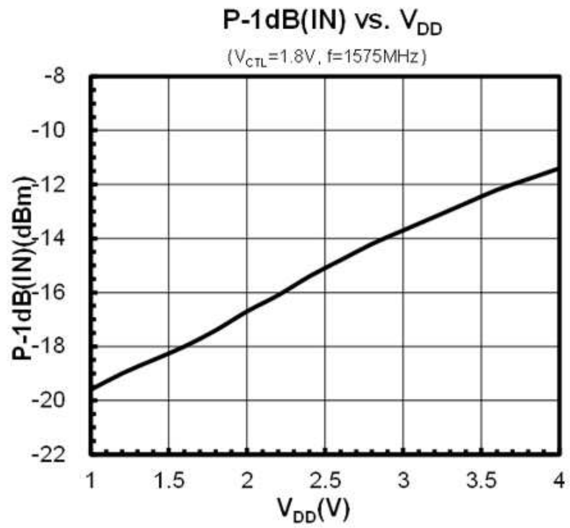


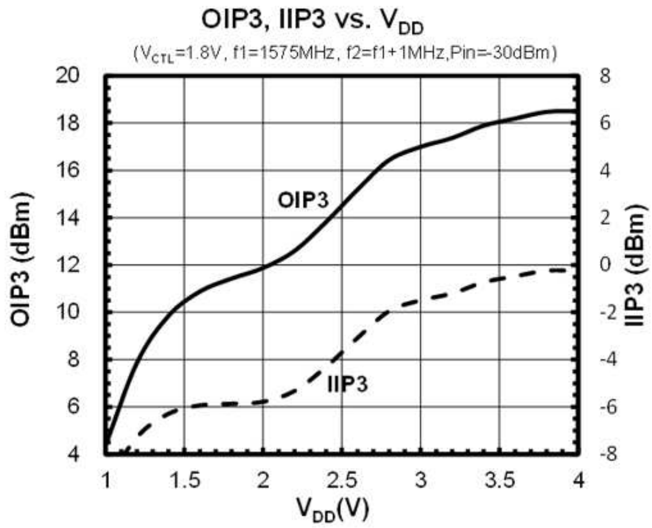


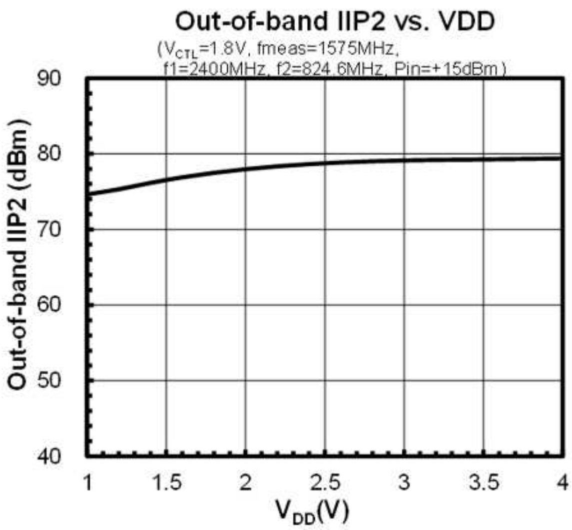


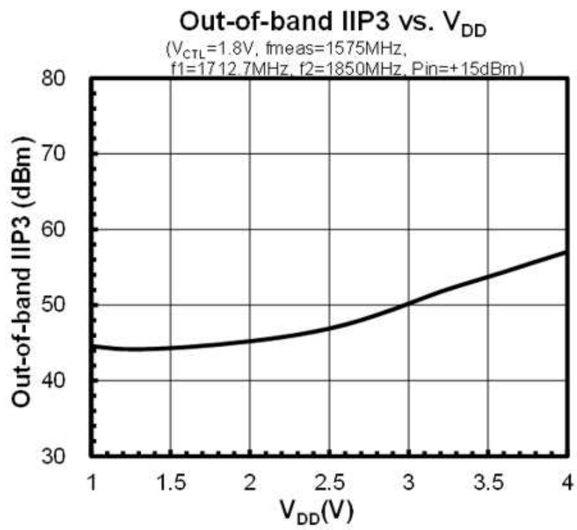
■ **ELECTRICAL CHARACTERISTICS**

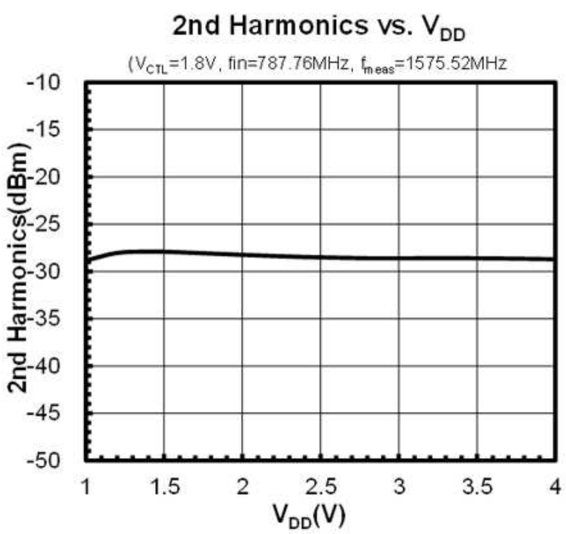
Conditions: V_{CTL} = 1.8 V, T_a = 25°C, Z_s = Z_l = 50 Ω, with application circuit



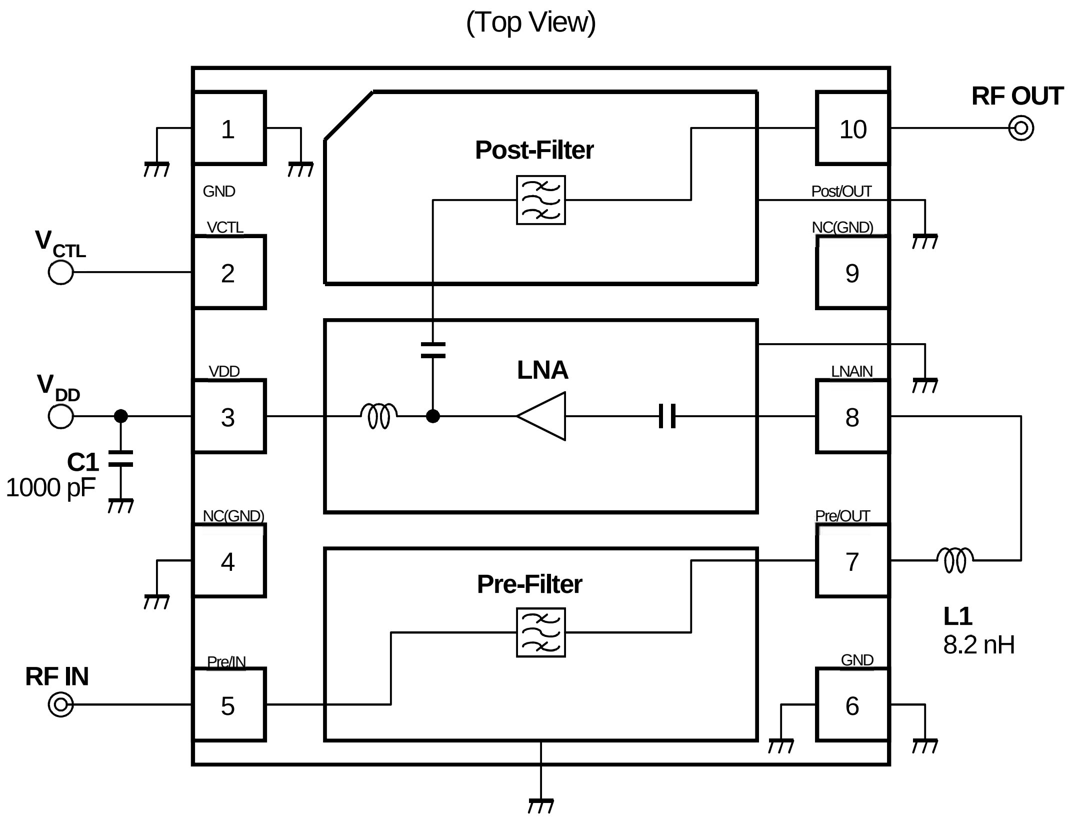








■ APPLICATION CIRCUIT

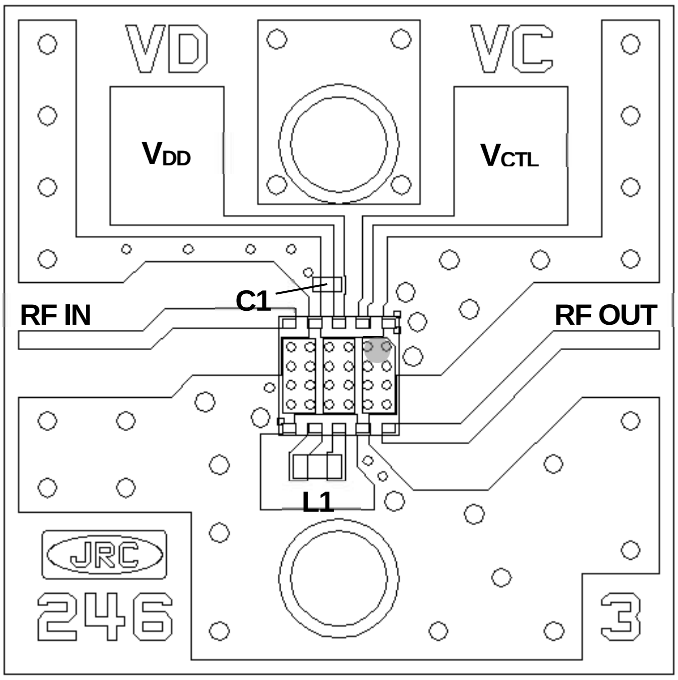


<PARTS LIST>

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

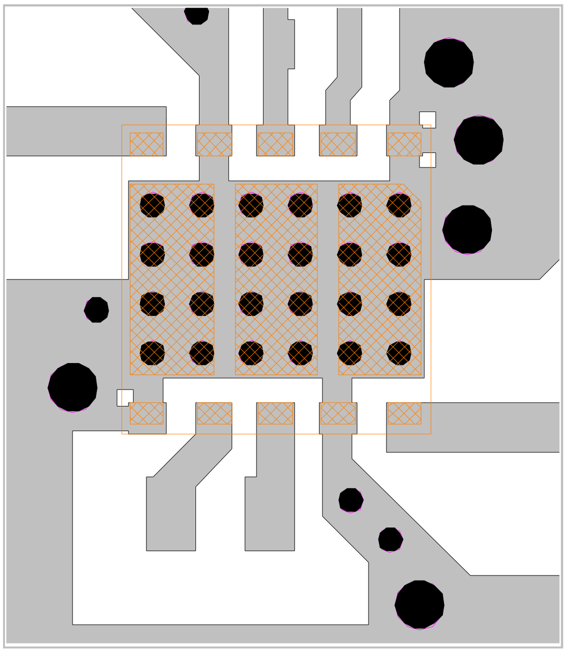
■ **EVALUATION BOARD**

(Top View)



PCB
Substrate: FR-4
Thickness: 0.2 mm
Microstrip line width: 0.4 mm (Z_0 = 50 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

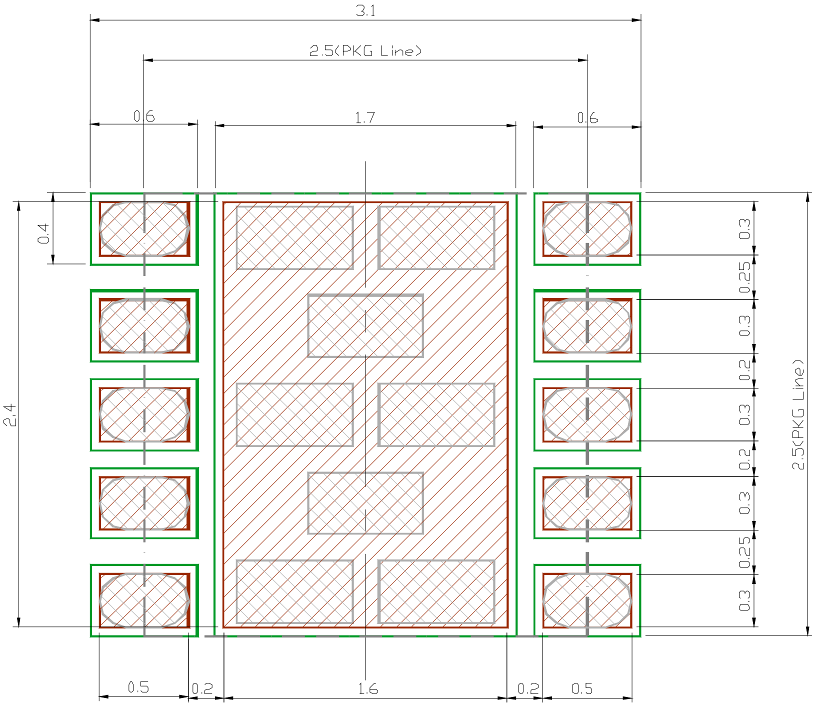
• Please layout ground pattern under this FEM in order not to couple with RFIN and RFOUT terminal.
• All external parts should be placed as close as possible to the FEM.
• For good RF performance, all GND terminals must be connected to PCB ground plane of substrate, and via-holes for GND should be placed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

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

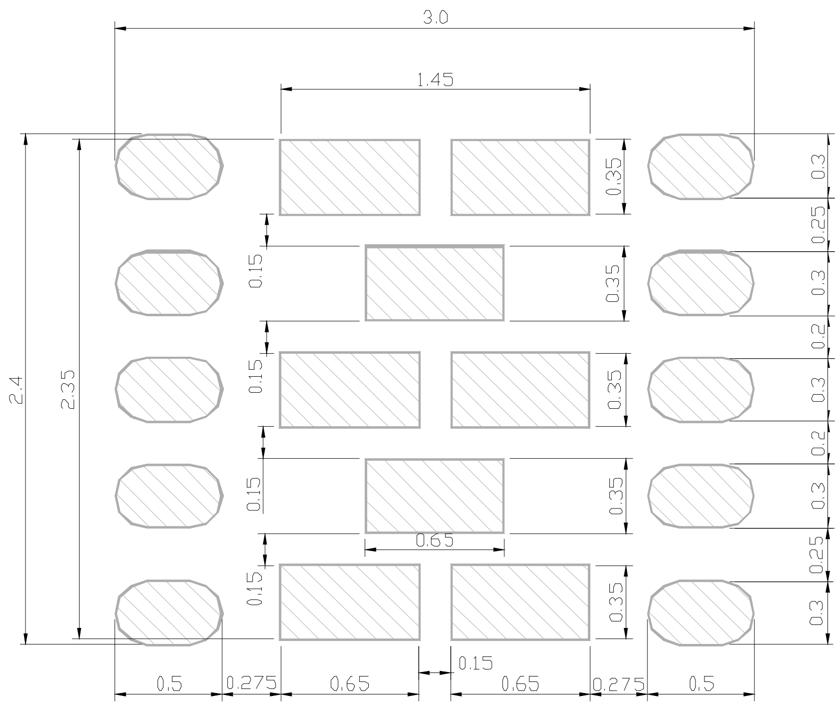
PKG: 2.5 mm x 2.5 mm

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

Unit: mm



Metal MASK Detail



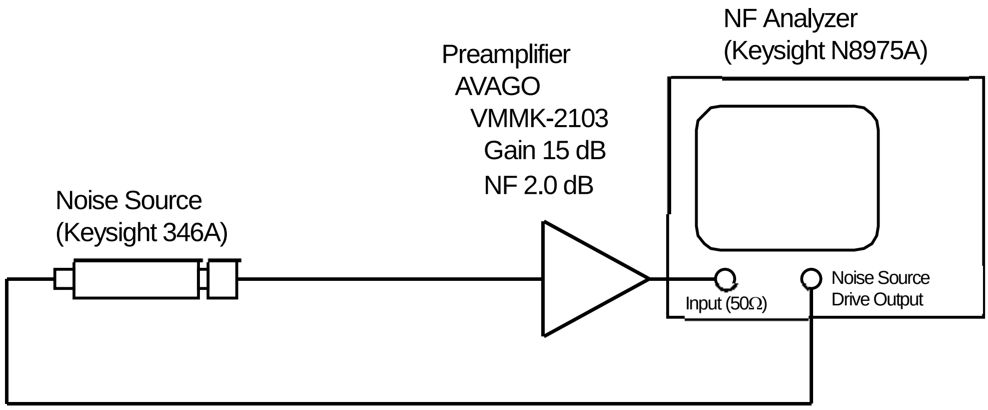
■ NOISE FIGURE MEASUREMENT BLOCK DIAGRAM

Measuring instruments

NF Analyzer : Keysight N8975A
Noise Source : Keysight 346A

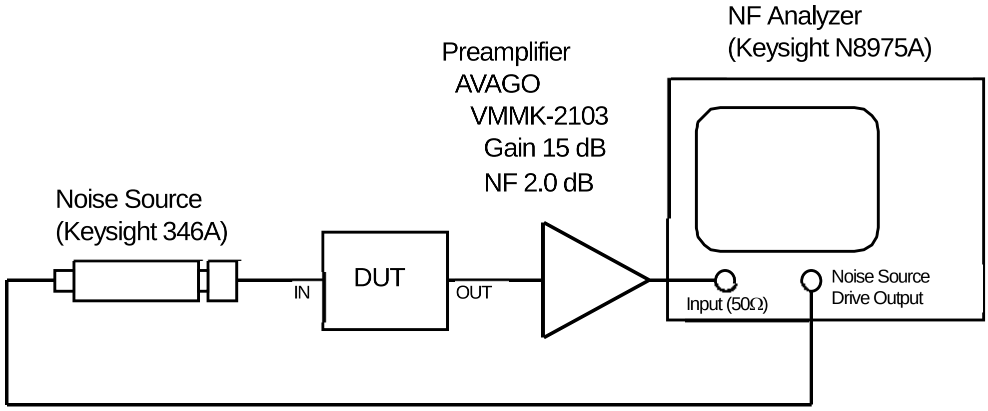
Setting the NF analyzer

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

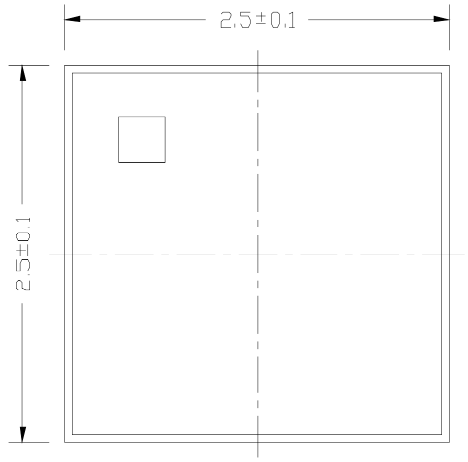


* Noise source, DUT, preamplifier and NF analyzer are connected directly.

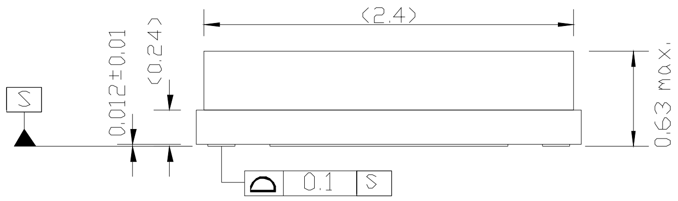
Measurement Setup

■ PACKAGE OUTLINE (HFFP10-HH)

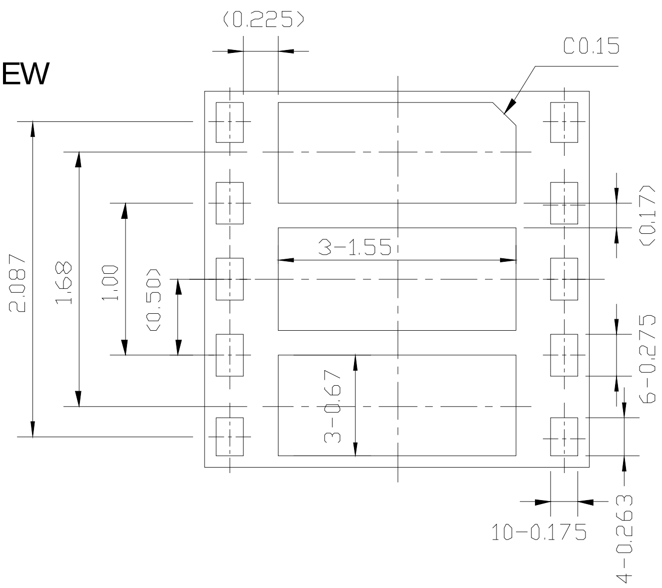
TOP VIEW



SIDE VIEW



BOTTOM VIEW



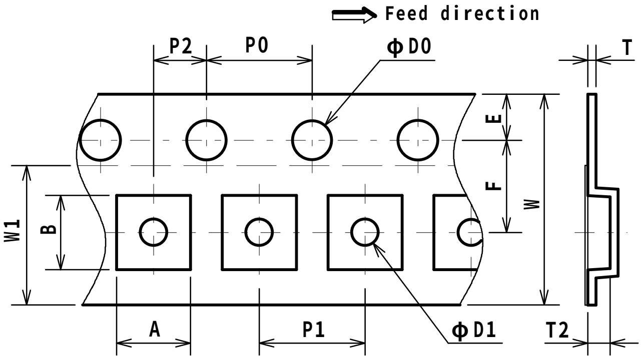
Package Size	: 2.5 ± 0.1 mm 0.63 mm max.
Electrode Dimensions clearance	: ± 0.05 mm

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

■ PACKING SPECIFICATION (HFFP10-CD)

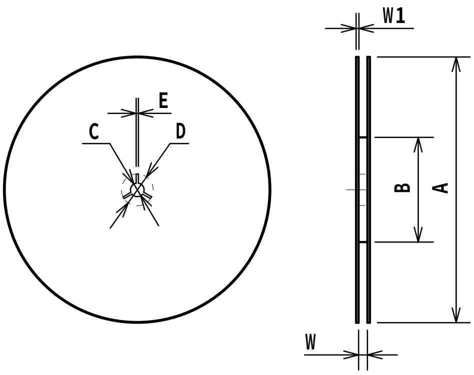
Unit: mm

TAPING DIMENSIONS



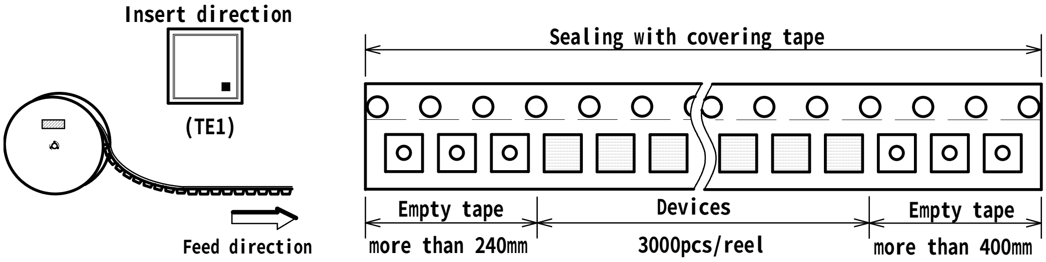
SYMBOL	DIMENSION	REMARKS
A	2.8±0.1	BOTTOM DIMENSION
B	2.8±0.1	BOTTOM DIMENSION
D0	$1.5^{+0.1}_{0}$	
D1	$1.0^{+0.1}_{0}$	
E	1.75±0.1	
F	3.5±0.05	
P0	4.0±0.1	
P1	4.0±0.1	
P2	2.0±0.1	
T	0.3±0.1	
T2	0.85±0.1	
W	8.0±0.2	
W1	5.3±0.2	THICKNESS100μm max

REEL DIMENSIONS

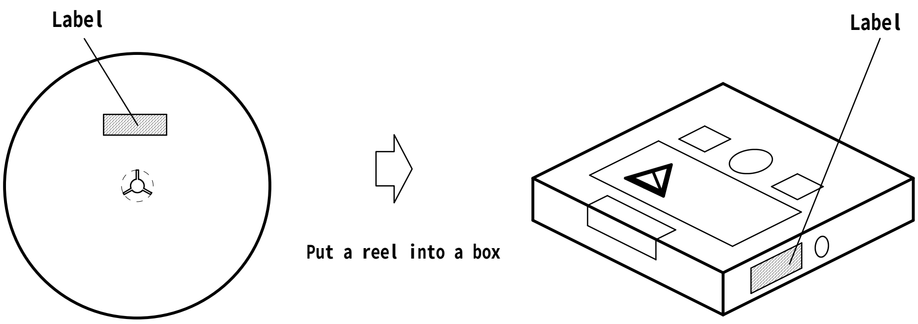


SYMBOL	DIMENSION
A	$\phi 180^{\ 0}_{-1.5}$
B	ϕ 66±0.5
C	ϕ 13±0.2
D	ϕ 21±0.8
E	2±0.5
W	$9^{+1.0}_{0}$
W1	1.2

TAPING STATE



PACKING STATE



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    ・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 (Automobile, airplane, railroad, ship, etc.)
    ・Various Safety Devices

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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.