GNSS Front-End Module

■ FEATURES

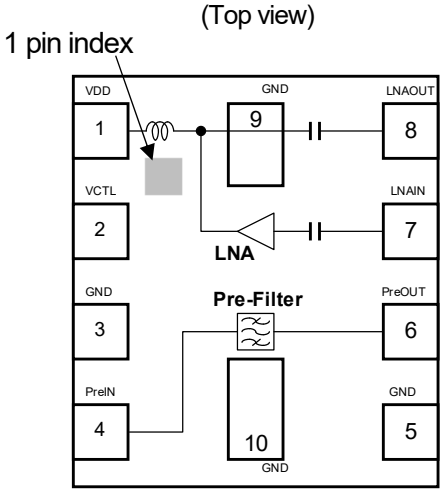
- AEC-Q100 grade 2 qualified
- Low supply voltage 2.8V typ.
- Low current consumption 3.7mA typ.
- High gain 16.0dB typ.
- Low noise figure
  - 1.50dB typ. @f=1575MHz
  - 1.65dB typ. @f=1597 to 1606MHz
  - 1.70dB typ. @f=1559 to 1591MHz
- High out band rejection
  - 55dBc typ. @f=704 to 915MHz, relative to 1575MHz
  - 43dBc typ. @f=1710 to 1980MHz, relative to 1575MHz
  - 51dBc typ. @f=2400 to 2500MHz, relative to 1575MHz
- Integrated pre-SAW filter and LNA
- Small package size
  - HFFP10-HH 1.5mmx1.1mm (typ.), t=0.5mm (max.)
- RoHS compliant and Halogen Free, MSL1

■ APPLICATION

- GNSS application for automotive
- GNSS active antenna

■ BLOCK DIAGRAM (HFFP10-HH)

(Top view)



■ GENERAL DESCRIPTION

The NJG1159PHH-A is a front-end module (FEM) designed for GNSS including GPS, GLONASS, BeiDou, and Galileo applications. This FEM offers low noise figure, high linearity, and high out-band rejection characteristics brought by included high performance pre-SAW filter and low noise amplifier (LNA). The stand-by mode contributes to reduce current consumption.

Its wide operating temperature range from -40 to +105°C is suitable for automotive application.

This FEM is suitable for small size application by included one SAW filter, only two external components, and very small package HFFP10-HH that is 1.5x1.1mm.

■ 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	VDD	Supply voltage terminal
2	VCTL	Control voltage terminal
3	GND	Ground terminal
4	PreIN	RF input terminal to Pre-SAW filter
5	GND	Ground terminal
6	PreOUT	RF output terminal from Pre-SAW filter
7	LNAIN	RF input terminal to LNA
8	LNAOUT	RF output terminal from LNA
9	GND	Ground terminal
10	GND	Ground terminal

■ PRODUCT NAME INFORMATION

NJG1159 PHH -A (TE1)

Part number | Package | Automotive | Taping form

■ ORDERING INFORMATION

PART NUMBER	PACKAGE OUTLINE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs.)
NJG1159PHH-A	HFFP10-HH	Yes	Yes	Au	59A	4.6	3,000

■ ABSOLUTE MAXIMUM RATINGS

T_a=+25°C, Z_s=Z_l=50Ω

PARAMETER	SYMBOL	RATINGS	UNIT
Supply voltage	V_{DD}	5.0	V
Control voltage	V_{CTL}	5.0	V
Input power	P_{IN}(inband) (1)	+10	dBm
	P_{IN}(outband) (2)	+25	dBm
Power dissipation	P_D (3)	560	mW
Operating temperature	T_{opr}	-40 to +105	°C
Storage temperature	T_{stg}	-40 to +110	°C

(1): V_{DD}=2.8V, f=1575, 1597 to 1606, 1559 to 1591MHz

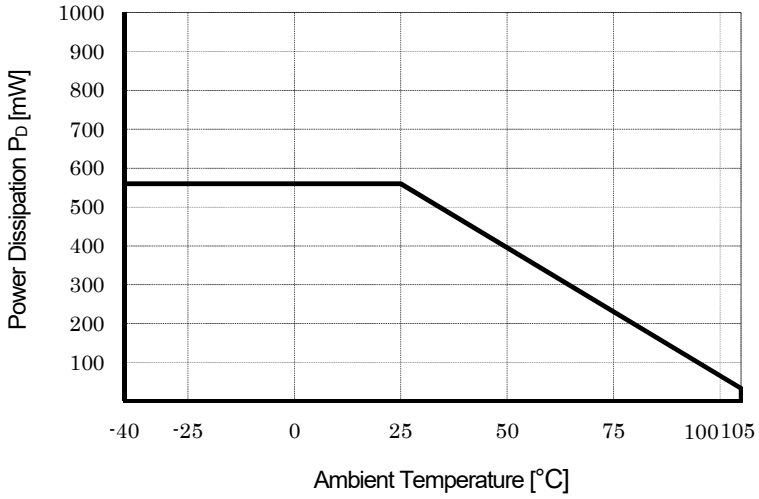
(2): V_{DD}=2.8V, f=50 to 1460, 1710 to 4000MHz

(3): 4-layer FR4 PCB without through-hole (101.5x114.5mm), T_j=110°C

■ POWER DISSIPATION VS.AMBIENT TEMPERATURE

Please note small non-lead package generally has low thermal dissipation characteristic, attention is recommended in designing of thermal radiation.

Power Dissipation—Ambient Temperature Characteristic



■ 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	2.8	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}=2.8V, V_{CTL}=1.8V	-	3.7	6.5	mA
Supply Current 2	I_{DD2}	RF OFF, V_{DD}=2.8V, V_{CTL}=0V	-	0.1	5.0	µA
Control Current	I_{CTL}	V_{CTL}=1.8V	-	5.0	15.0	µA

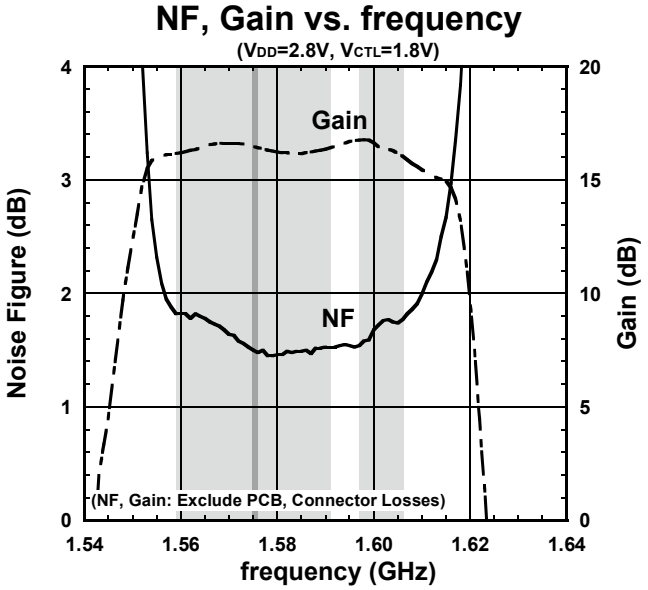
■ ELECTRICAL CHARACTERISTICS 2 (RF)

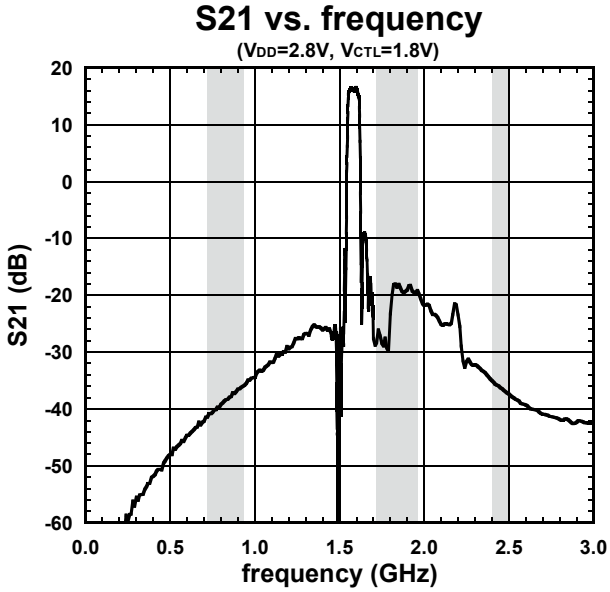
General conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=1575MHz, 1597 to 1606MHz, 1559 to 1591MHz,
T_a=+25°C, Z_S=Z_L=50Ω, with application circuit

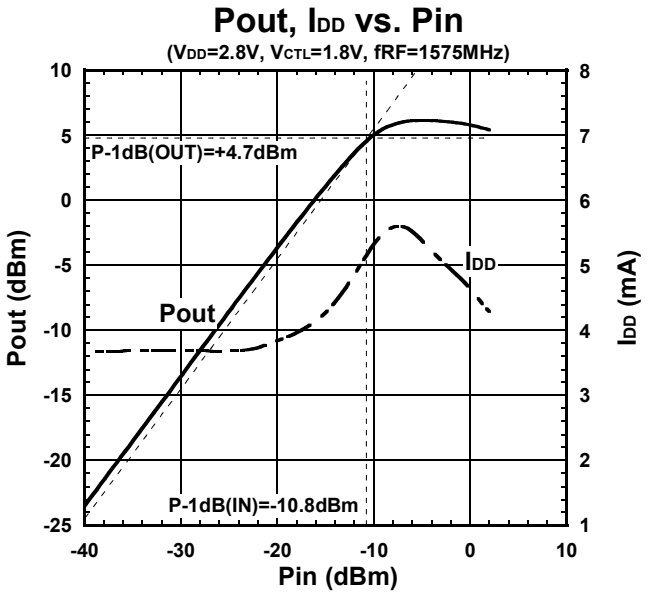
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Small Signal Gain (GPS)	GainGPS	f=1575MHz (GPS) Exclude PCB, Connector Losses (0.17dB)	13.5	16.0	-	dB
Small Signal Gain (GLONASS)	GainGLN	f=1597 to 1606MHz (GLONASS) Exclude PCB, Connector Losses (0.17dB)	13.0	16.5	-	dB
Small Signal Gain (BeiDou, Galileo)	GainBG	f=1559 to 1591MHz (BeiDou, Galileo) Exclude PCB, Connector Losses (0.17dB)	13.0	16.0	-	dB
Noise Figure (GPS)	NFGPS	f=1575MHz (GPS)Exclude PCB, Connector Losses (0.09dB)	-	1.50	2.35	dB
Noise Figure (GLONASS)	NFGLN	f=1597 to 1606MHz (GLONASS) Exclude PCB, Connector Losses (0.09dB)	-	1.65	2.70	dB
Noise Figure (BeiDou, Galileo)	NFBG	f=1559 to 1591MHz (BeiDou, Galileo) Exclude PCB, Connector Losses (0.09dB)	-	1.70	2.80	dB
Input Power at 1dB Gain Compression Point	P-1dB(IN)	f=1575, 1597 to 1606, 1559 to 1591MHz	-15.0	-10.0	-	dBm
Low Band Rejection	BR_L	f=704 to 915MHz, relative to 1575MHz	41	55	-	dBc
High Band Rejection	BR_H	f=1710 to 1980MHz, relative to 1575MHz	23	43	-	dBc
WLAN Band Rejection	BR_W	f=2400 to 2500MHz, relative to 1575MHz	38	51	-	dBc

■ ELECTRICAL CHARACTERISTICS

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

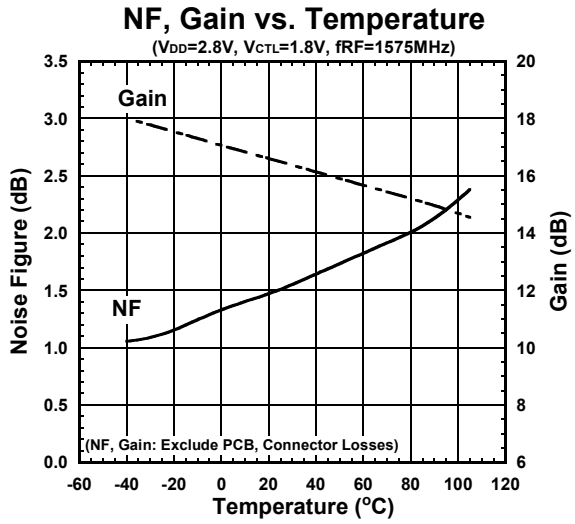


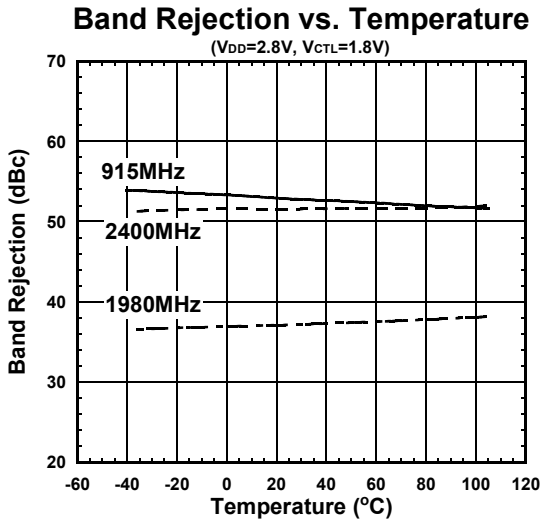


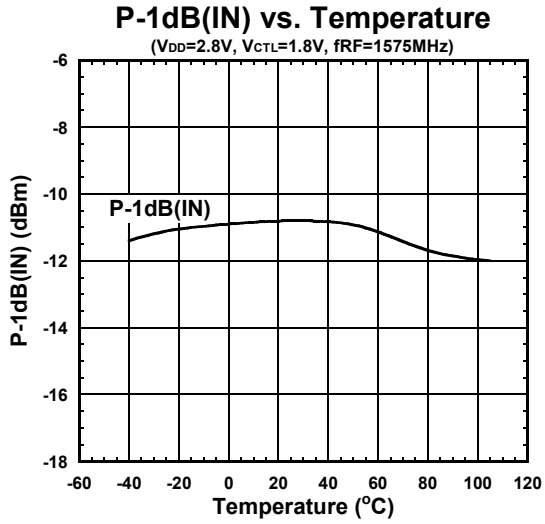


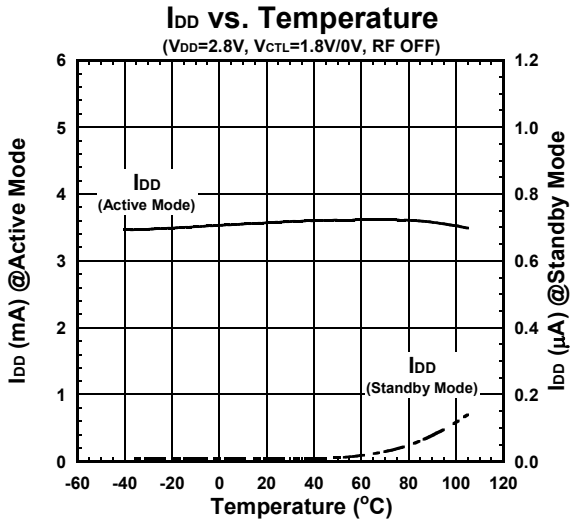
■ ELECTRICAL CHARACTERISTICS

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







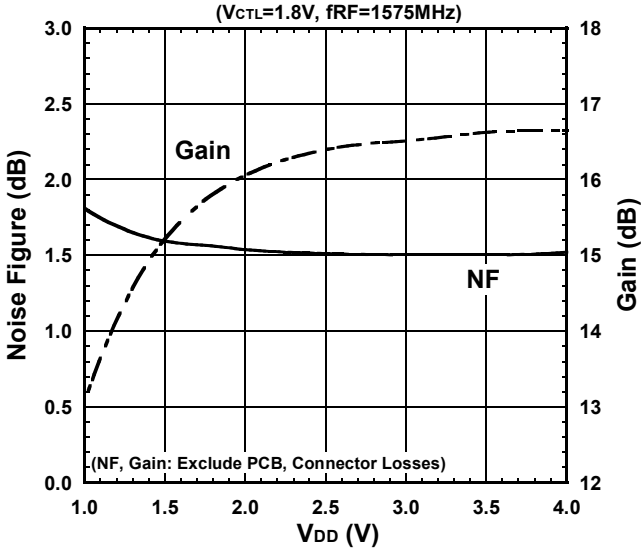


■ ELECTRICAL CHARACTERISTICS

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

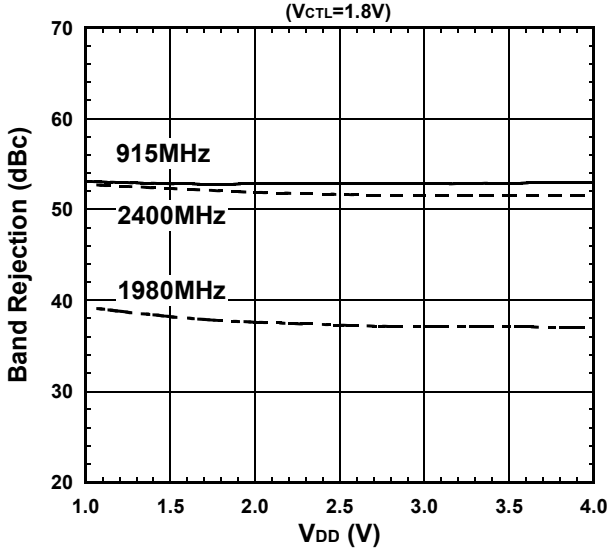
NF, Gain vs. V_{DD}

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



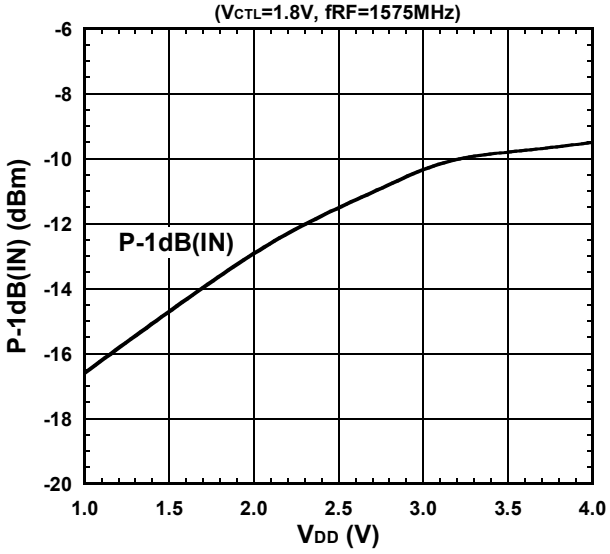
Band Rejection vs. V_{DD}

(V_{CTL}=1.8V)



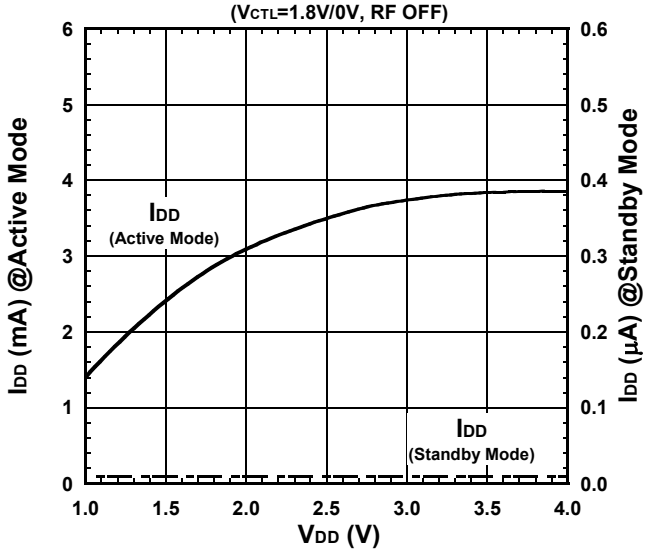
P-1dB(IN) vs. V_{DD}

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



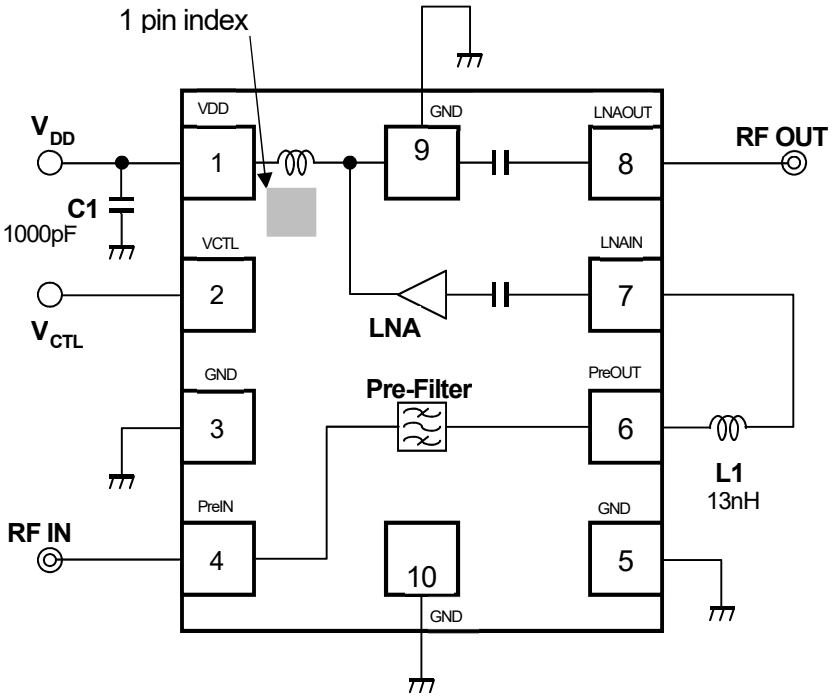
I_{DD} vs. V_{DD}

(V_{CTL}=1.8V/0V, RF OFF)



■ **APPLICATION CIRCUIT**

(Top View)

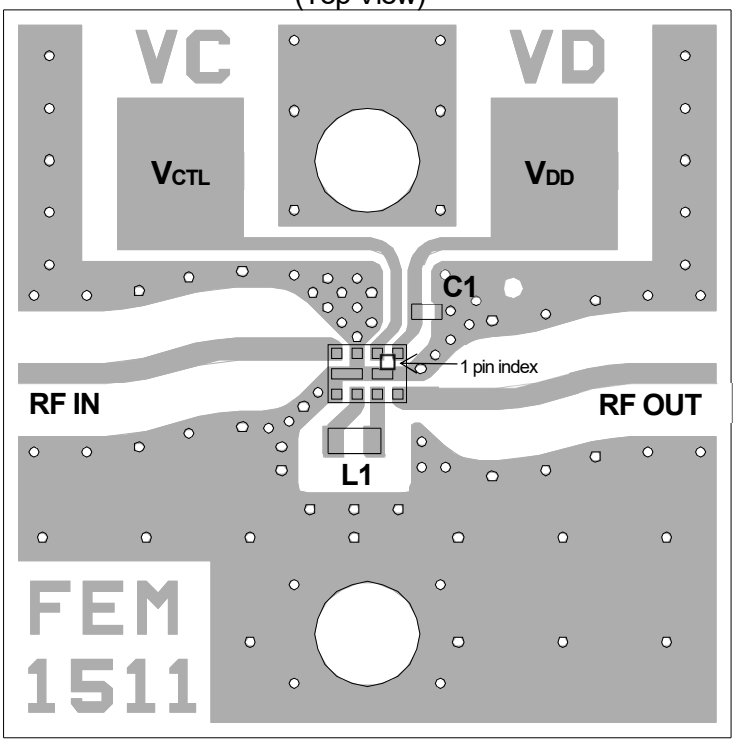


<PARTS LIST>

Part ID	Note
L1	LQW15AN_00 Series (MURATA)
C1	GRM03 Series (MURATA)

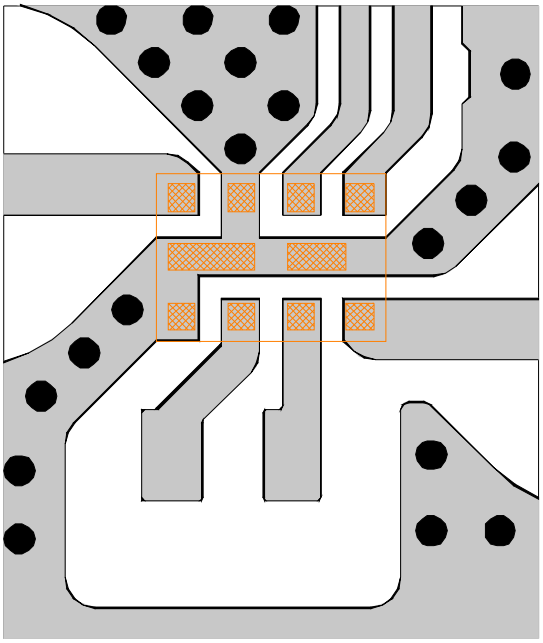
■ EVALUATION BOARD

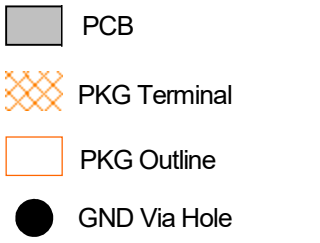
(Top View)



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

<PCB LAYOUT GUIDELINE>





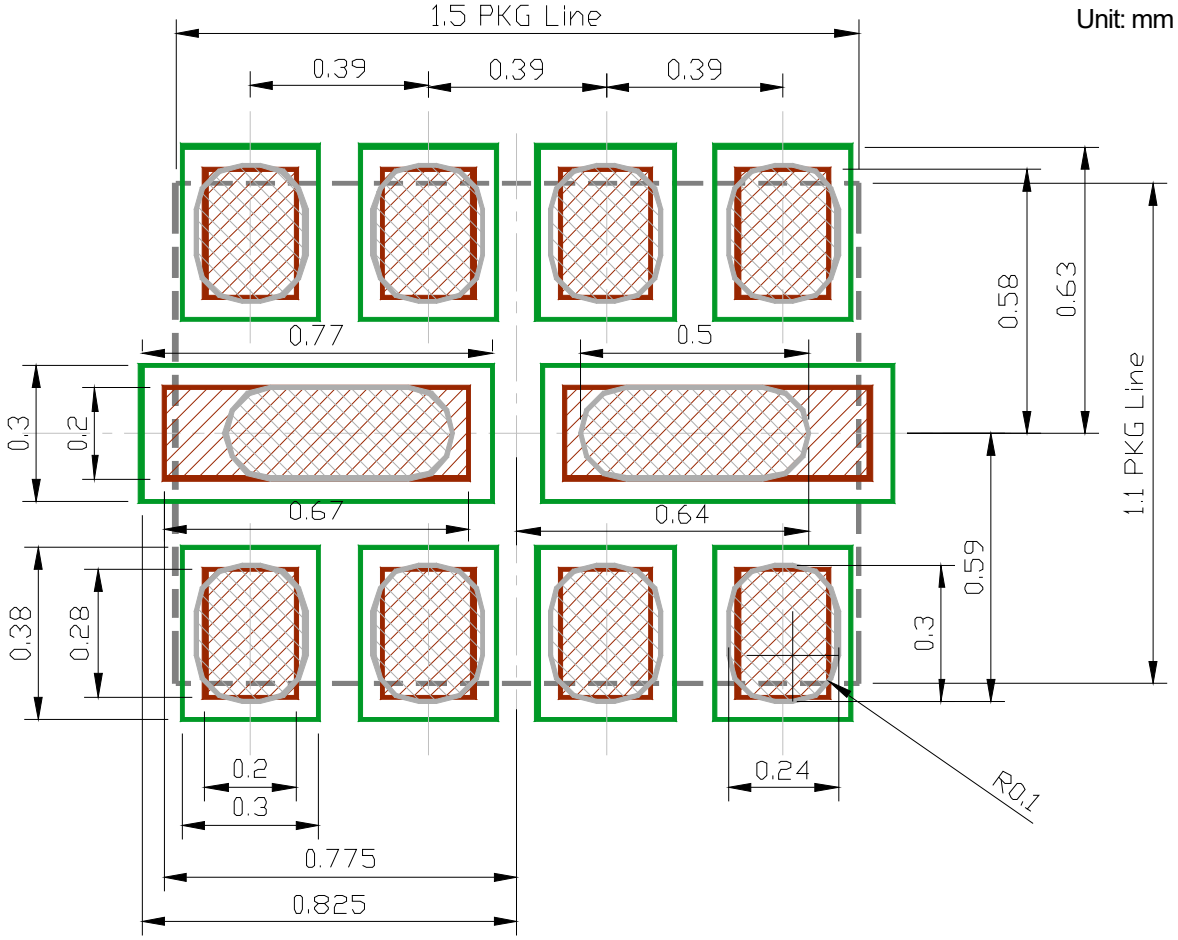
PRECAUTIONS

• 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-HH Package) <Reference>**

PKG : 1.5mm x 1.1mm
Pin pitch : 0.39mm

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



■ **NOISE FIGURE MEASUREMENT BLOCK DIAGRAM**

Measuring instruments

NF Analyzer : Keysight N8973A

Noise Source : Keysight 346A

Setting the NF analyzer

Measurement mode form

Device under test : Amplifier

System downconverter : off

Mode setup form

Sideband : LSB

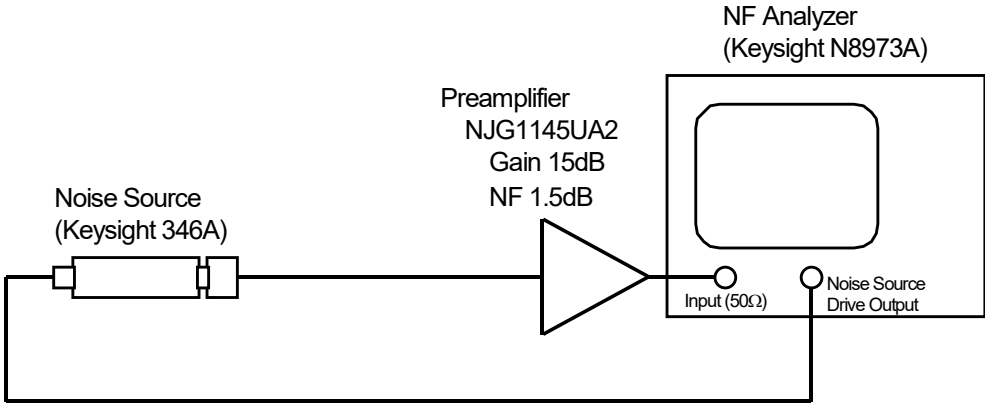
Averages : 16

Average mode : Point

Bandwidth : 4MHz

Loss comp : off

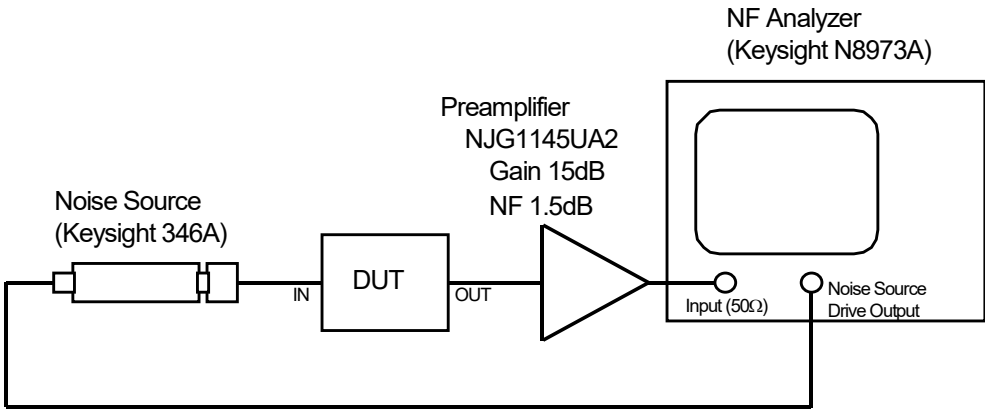
Tcold : setting the temperature of noise source (303.15K)



* Preamplifier is used to improve NF measurement accuracy.

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

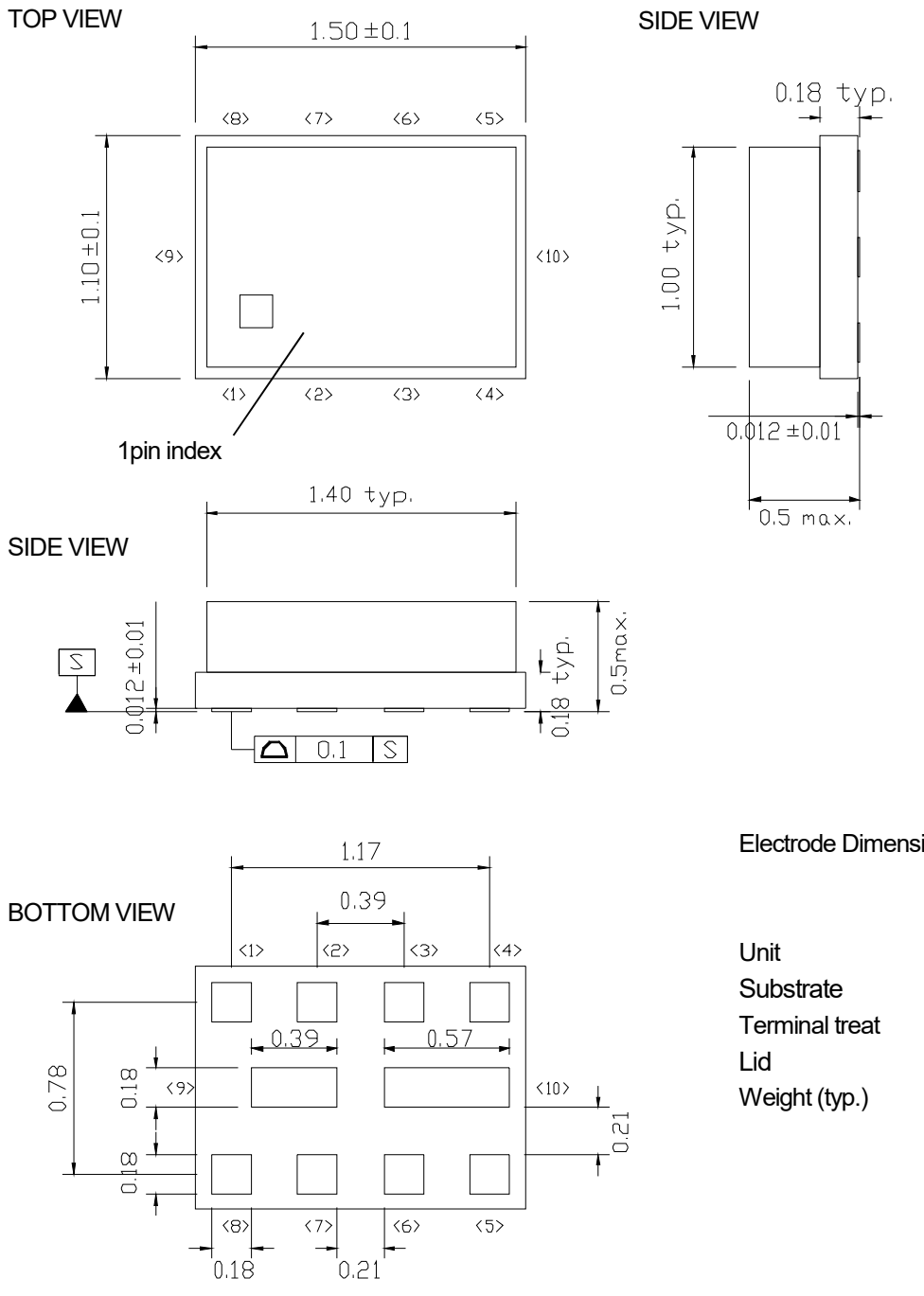
Calibration setup



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

Measurement Setup

■ **PACKAGE OUTLINE (HFFP10-HH)**



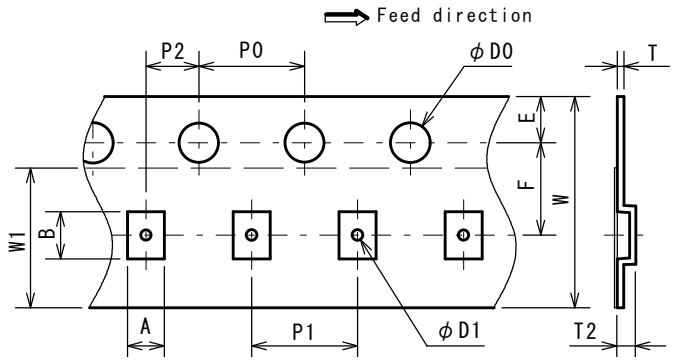
Electrode Dimensions clearance : ±0.05mm

Unit	: mm
Substrate	: Ceramic
Terminal treat	: Au
Lid	: SnAg/Kovar/Ni
Weight (typ.)	: 4.6mg

■ PACKING SPECIFICATION (HFFP10-HH)

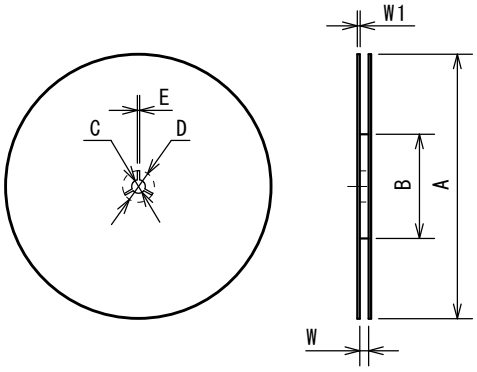
Unit: mm

TAPING DIMENSIONS



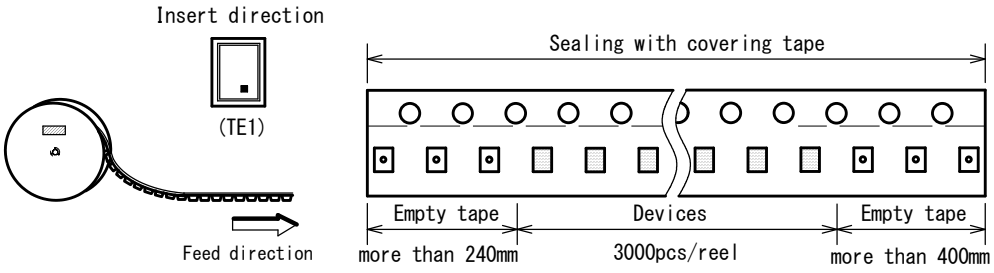
SYMBOL	DIMENSION	REMARKS
A	1.4±0.1	BOTTOM DIMENSION
B	1.8±0.1	BOTTOM DIMENSION
D0	$1.5^{+0.1}_{0}$	
D1	0.5±0.05	
E	1.75±0.1	
F	3.5±0.05	
P0	4.0±0.1	
P1	4.0±0.1	
P2	2.0±0.05	
T	0.25±0.05	
T2	0.7±0.1	
W	8.0±0.2	
W1	5.3±0.2	THICKNESS100μm max

REEL DIMENSIONS

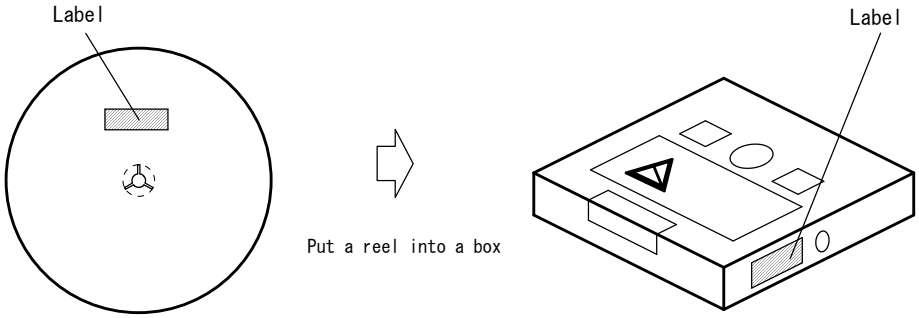


SYMBOL	DIMENSION
A	$\phi 180^{0}_{-1.5}$
B	φ 66±0.5
C	φ 13±0.2
D	φ 21±0.8
E	2±0.5
W	$9^{+1.0}_{0}$
W1	1.2

TAPING STATE



PACKING STATE



■ **REVISION HISTORY**

Date	Revision	Changes
15.Nov.2016	Ver.1.0	New Release Automotive spec
19.Jul.2017	Ver.1.1	Changed package suffix from H to A Updated ELECTRICAL CHARACTERISTICS 1 (DC) Updated ELECTRICAL CHARACTERISTICS 2 (RF) Added packing specification
19.Oct.2018	Ver.1.2	Revised features Revised caution
08.Nov.2018	Ver.1.3	Revised MARK INFORMATION Revised ORDERING INFORMATION Revised weight
08.Jan.2019	Ver.1.4	Revised features Added APPLICATION Revised PRODUCT NAME INFORMATION Revised ORDERING INFORMATION Revised ELECTRICAL CHARACTERISTICS 2 (RF) Added POWER DISSIPATION VS.AMBIENT TEMPERATURE Revised caution

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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 (airplane, railroad, ship, etc.)
    - Various Safety Devices
    - Traffic control system
    - Combustion equipment

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7. The products have been designed and tested to function within controlled environmental conditions. Do not use products under conditions that deviate from methods or applications specified in this datasheet. Failure to employ the products in the proper applications can lead to deterioration, destruction or failure of the products. We shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of the products.
8. Quality Warranty
    8-1. Quality Warranty Period
    In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
    8-2. Quality Warranty Remedies
    When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.
    Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
    8-3. Remedies after Quality Warranty Period
    With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.
12. Front end module product is hollow seal package type, and it is with the structure susceptible to stress from the outside. Therefore, note the following in relation to the contents, after conducting an evaluation. please use.
    12-1. After mounting this product, to implement the potting and transfer molding, please the confirmation of resistance to temperature changes and shrinkage stress involved in the molding.
    12-2. When mounted on the product, collet diameter please use more than 1mmφ. In addition, the value of static load is recommended mounting less than 5N.
    12-3. For dynamic load at the time of mounting. please use it after confirming in consideration of the contact area /speed /load.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.