

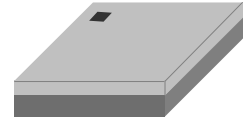
## GPS and GLONASS Front-End Module

### GENERAL DESCRIPTION

The NJG1157PCD is a front-end module (FEM) designed for GPS and GLONASS applications. This FEM offers high gain, low noise figure, high linearity and high out-band rejection characteristics brought by included high performance pre-SAW filter, low noise amplifier (LNA) and post-SAW filter. This FEM can operate from 1.5V to 3.3V single voltage in -40 to 105°C. This FEM has stand-by mode to save current consumption.

This FEM offers very small mounting area by included two SAW filters, only two external components and very small HFFP10-CD package that is 2.5x2.5mm.

### PACKAGE OUTLINE



NJG1157PCD

### FEATURES

- Available for GPS and GLONASS

- Low supply voltage

- Low current consumption

- High gain

- Low noise figure

- High out band rejection

- Small package size

- RoHS compliant and Halogen Free, MSL1

1.8/ 2.8V typ.

2.6/3.3mA typ. @ $V_{DD}=1.8/ 2.8V$ ,  $V_{CTL}=1.8V$

0.1 $\mu$ A typ. @ $V_{DD}=1.8/ 2.8V$ ,  $V_{CTL}=0V$  (Stand-by mode)

17.5/18.5dB typ. @ $V_{DD}=1.8/ 2.8V$ ,  $V_{CTL}=1.8V$ ,

$f=1575MHz$ , 1597 to 1606MHz

1.65/1.60dB typ. @ $V_{DD}=1.8/ 2.8V$ ,  $V_{CTL}=1.8V$ ,  $f=1575MHz$

1.75/1.70dB typ. @ $V_{DD}=1.8/ 2.8V$ ,  $V_{CTL}=1.8V$ ,  $f=1597$  to 1606MHz

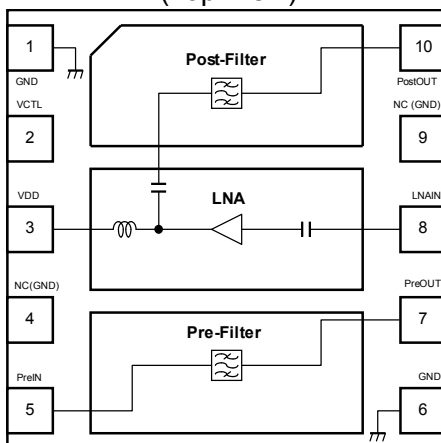
85dBc typ. @ $f=704$  to 915MHz, relative to 1575MHz

75dBc typ. @ $f=1710$  to 1980MHz, relative to 1575MHz

HFFP10-CD: 2.5mmx2.5mmx0.63mm max.

### PIN CONFIGURATION

(Top View)

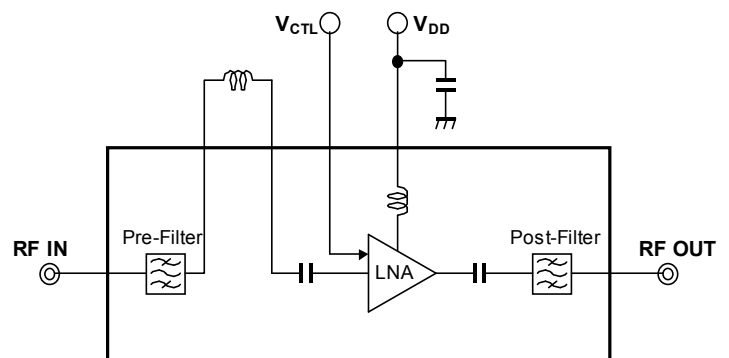


Pin connection

1. GND
2. VCTL
3. VDD
4. NC(GND)
5. PreIN
6. GND
7. PreOUT
8. LNAIN
9. NC(GND)
10. PostOUT

Exposed pad: GND

### BLOCK DIAGRAM



### TRUTH TABLE

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

| VCTL | Mode          |
|------|---------------|
| H    | Active mode   |
| L    | Stand-by mode |

Note: Specifications and description listed in this datasheet are subject to change without notice.

# NJG1157PCD

## ■ ABSOLUTE MAXIMUM RATINGS

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

| PARAMETERS            | SYMBOL             | CONDITIONS  | RATINGS     | UNITS              |
|-----------------------|--------------------|---|-------------|--------------------|
| Supply voltage        | $V_{DD}$           |   | 5.0         | V                  |
| Control voltage       | $V_{CTL}$          |   | 5.0         | V                  |
| Input power           | $P_{IN}$ (inband)  | $V_{DD}=2.8\text{V}$ ,<br>$f=1575, 1597$ to $1606\text{MHz}$                                      | +15         | dBm                |
|                       | $P_{IN}$ (outband) | $V_{DD}=2.8\text{V}$ ,<br>$f=50$ to $1460, 1710$ to $4000\text{MHz}$                              | +27         | dBm                |
| Power dissipation     | $P_D$              | 4-layer FR4 PCB with through-hole<br>( $101.5 \times 114.5\text{mm}$ ), $T_i=110^{\circ}\text{C}$ | 580         | mW                 |
| Operating temperature | $T_{opr}$          |   | -40 to +105 | $^{\circ}\text{C}$ |
| Storage temperature   | $T_{stg}$          |   | -40 to +110 | $^{\circ}\text{C}$ |

## ■ ELECTRICAL CHARACTERISTICS 1 (DC)

(General conditions:  $T_a=+25^{\circ}\text{C}$ )

| PARAMETER              | SYMBOL       | CONDITIONS  | MIN | TYP | MAX  | UNITS         |
|------------------------|--------------|---|-----|-----|------|---------------|
| 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,<br>$V_{DD}=2.8\text{V}$ , $V_{CTL}=1.8\text{V}$ | -   | 3.3 | 6.4  | mA            |
| Supply Current 2       | $I_{DD2}$    | RF OFF,<br>$V_{DD}=1.8\text{V}$ , $V_{CTL}=1.8\text{V}$ | -   | 2.6 | 5.9  | mA            |
| Supply Current 3       | $I_{DD3}$    | RF OFF,<br>$V_{DD}=2.8\text{V}$ , $V_{CTL}=0\text{V}$   | -   | 0.1 | 5.0  | $\mu\text{A}$ |
| Supply Current 4       | $I_{DD4}$    | RF OFF,<br>$V_{DD}=1.8\text{V}$ , $V_{CTL}=0\text{V}$   | -   | 0.1 | 5.0  | $\mu\text{A}$ |
| Control Current        | $I_{CTL}$    | $V_{CTL}=1.8\text{V}$                                   | -   | 5.0 | 15.0 | $\mu\text{A}$ |

## ■ ELECTRICAL CHARACTERISTICS 2 (RF)

General conditions:  $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $f_{RF}=1575MHz$ , 1597 to 1606MHz,  $T_a=+25^{\circ}C$ ,  $Z_s=Z_L=50\Omega$ , with application circuit

| PARAMETER                                     | SYMBOL          | CONDITIONS   | MIN  | TYP   | MAX | UNITS |
|---|-----------------|--|------|-------|-----|-------|
| Small Signal Gain (GPS)1                      | GainGPS1        | f=1575MHz (GPS), Exclude PCB, Connector Losses (0.19dB)                        | 17.0 | 18.5  | -   | dB    |
| Small Signal Gain (GLONASS)1                  | GainGLN1        | f=1597 to 1606MHz (GLONASS) Exclude PCB, Connector Losses (0.19dB)             | 17.0 | 18.5  | -   | dB    |
| Noise Figure (GPS)1                           | NFGPS1          | f=1575MHz (GPS) Exclude PCB, Connector Losses (0.09dB)                         | -    | 1.6   | 2.1 | dB    |
| Noise Figure (GLONASS)1                       | NFGLN1          | f=1597 to 1606MHz (GLONASS) Exclude PCB, Connector Losses (0.09dB)             | -    | 1.7   | 2.2 | dB    |
| Input Power at 1dB Gain Compression Point 1   | P-1dB(IN)1      | f=1575, 1597 to 1606MHz  | -    | -15.0 | -   | dBm   |
| Input 3rd Order Intercept Point 1             | IIP3_1          | f1=1575MHz, f2=f1+/- 1MHz, Pin=-30dBm  | -    | -3.0  | -   | dBm   |
| Out of Band Input 2nd Order Intercept Point 1 | IIP2_OB1        | f1=824.6MHz at +15dBm, f2=2400MHz at +15dBm, fmeas=1575.4MHz                   | -    | +72   | -   | dBm   |
| Out of Band Input 3rd Order Intercept Point 1 | IIP3_OB1        | f1=1712.7MHz at +15dBm, f2=1850MHz at +15dBm, fmeas=1575.4MHz                  | -    | +50   | -   | dBm   |
| 700MHz Harmonic1                              | 2fo1            | Input jammer tone: 787.76MHz at +15dBm Measure the harmonic tone at 1575.52MHz | -    | -30   | -   | dBm   |
| Out-of-Band Input Power 1dB Compression 1     | P-1dB(IN)_OB1-1 | fjam=900MHz, fmeas=1575MHz at Pin=-40dBm                                       | -    | +24   | -   | dBm   |
|   | P-1dB(IN)_OB1-2 | fjam=1710MHz, fmeas=1575MHz at Pin=-40dBm                                      | -    | +24   | -   | dBm   |
| Low Band Rejection 1                          | BR_L1           | f=704 to 915MHz, relative to 1575MHz   | -    | 85    | -   | dBc   |
| High Band Rejection 1                         | BR_H1           | f=1710 to 1980MHz, relative to 1575MHz   | -    | 75    | -   | dBc   |
| WLAN Band Rejection 1                         | BR_W1           | f=2400 to 2500MHz, relative to 1575MHz   | -    | 72    | -   | dBc   |
| RF IN Return Loss (GPS)1                      | RLiGPS1         | f=1575MHz (GPS)  | -    | 7.5   | -   | dB    |
| RF IN Return Loss (GLONASS)1                  | RLiGLN1         | f=1597 to 1606MHz (GLONASS)  | -    | 7.5   | -   | dB    |
| RF OUT Return Loss (GPS)1                     | RLoGPS1         | f=1575MHz (GPS)  | -    | 11    | -   | dB    |
| RF OUT Return Loss (GLONASS)1                 | RLoGLN1         | f=1597 to 1606MHz (GLONASS)  | -    | 15    | -   | dB    |
| Group Delay Time Deviation 1                  | GDTD1           | f=1597 to 1606MHz (GLONASS)  | -    | 8.0   | -   | ns    |

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## ■ ELECTRICAL CHARACTERISTICS 3 (RF)

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

| PARAMETER                                     | SYMBOL                 | CONDITIONS  | MIN  | TYP   | MAX  | UNITS |
|---|------------------------|---|------|-------|------|-------|
| Small Signal Gain (GPS) <sup>2</sup>          | GainGPS2               | f=1575MHz (GPS) Exclude PCB, Connector Losses (0.19dB)                            | 15.5 | 17.5  | -    | dB    |
| Small Signal Gain (GLONASS) <sup>2</sup>      | GainGLN2               | f=1597 to 1606MHz (GLONASS) Exclude PCB, Connector Losses (0.19dB)                | 15.5 | 17.5  | -    | dB    |
| Noise Figure (GPS) <sup>2</sup>               | NFGPS2                 | f=1575MHz (GPS) Exclude PCB, Connector Losses (0.09dB)                            | -    | 1.65  | 2.20 | dB    |
| Noise Figure (GLONASS) <sup>2</sup>           | NFGLN2                 | f=1597 to 1606MHz (GLONASS) Exclude PCB, Connector Losses (0.09dB)                | -    | 1.75  | 2.35 | dB    |
| Input Power at 1dB Gain Compression Point 2   | P-1dB(IN) <sup>2</sup> | f=1575, 1597 to 1606MHz   | -    | -17.0 | -    | dBm   |
| Input 3rd Order Intercept Point 2             | IIP3_2                 | f1=1575MHz, f2=f1+/- 1MHz, Pin=-30dBm   | -    | -6.0  | -    | dBm   |
| Out of Band Input 2nd Order Intercept Point 2 | IIP2_OB2               | f1=824.6MHz at +15dBm, f2=2400MHz at +15dBm, fmeas=1575.4MHz                      | -    | +72   | -    | dBm   |
| Out of Band Input 3rd Order Intercept Point 2 | IIP3_OB2               | f1=1712.7MHz at +15dBm, f2=1850MHz at +15dBm, fmeas=1575.4MHz                     | -    | +50   | -    | dBm   |
| 700MHz Harmonic <sup>2</sup>                  | 2fo2                   | Input jammer tone: 787.76MHz at +15dBm<br>Measure the harmonic tone at 1575.52MHz | -    | -30   | -    | dBm   |
| Out-of-Band Input Power 1dB Compression 2     | P-1dB(IN)_OB2-1        | fjam=900MHz, fmeas=1575MHz at Pin=-40dBm  | -    | +24   | -    | dBm   |
|   | P-1dB(IN)_OB2-2        | fjam=1710MHz, fmeas=1575MHz at Pin=-40dBm   | -    | +24   | -    | dBm   |
| Low Band Rejection 2                          | BR_L2                  | f=704 to 915MHz, relative to 1575MHz  | -    | 85    | -    | dBc   |
| High Band Rejection 2                         | BR_H2                  | f=1710 to 1980MHz, relative to 1575MHz  | -    | 75    | -    | dBc   |
| WLAN Band Rejection 2                         | BR_W2                  | f=2400 to 2500MHz, relative to 1575MHz  | -    | 72    | -    | dBc   |
| RF IN Return Loss (GPS) <sup>2</sup>          | RLiGPS2                | f=1575MHz (GPS)   | -    | 7.5   | -    | dB    |
| RF IN Return Loss (GLONASS) <sup>2</sup>      | RLiGLN2                | f=1597 to 1606MHz (GLONASS)   | -    | 7.5   | -    | dB    |
| RF OUT Return Loss (GPS) <sup>2</sup>         | RLoGPS2                | f=1575MHz (GPS)   | -    | 10    | -    | dB    |
| RF OUT Return Loss (GLONASS) <sup>2</sup>     | RLoGLN2                | f=1597 to 1606MHz (GLONASS)   | -    | 13    | -    | dB    |
| Group Delay Time Deviation 2                  | GDTD2                  | f=1597 to 1606MHz (GLONASS)   | -    | 8.0   | -    | ns    |

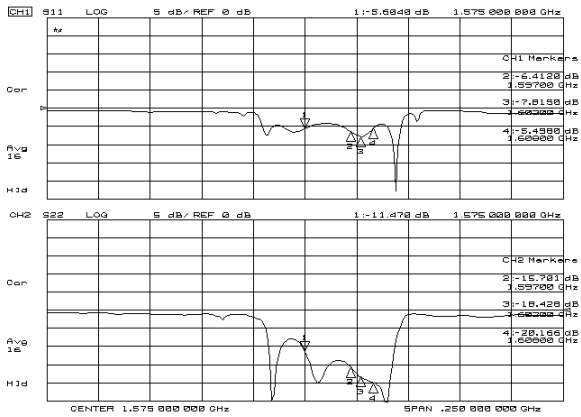
## ■ TERMINAL INFORMATION

| No.         | SYMBOL  | DESCRIPTION  |
|-------------|---------|--|
| 1           | GND     | Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.                                      |
| 2           | VCTL    | Control voltage terminal.  |
| 3           | VDD     | Supply voltage terminal. Please connect bypass capacitor C1 with ground as close as possible.  |
| 4           | NC(GND) | No connected terminal. This terminal is not connected with internal circuit. Please connect to the PCB ground Plane.   |
| 5           | PreIN   | RF input terminal. This terminal connects to input of pre-SAW filter.  |
| 6           | GND     | Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.                                      |
| 7           | PreOUT  | Pre-SAW filter output terminal. This terminal connects to LNAIN with L1.   |
| 8           | LNAIN   | RF input terminal. This terminal requires only a matching inductor L1, and does not require DC blocking capacitor because of integrated capacitor.             |
| 9           | NC(GND) | No connected terminal. This terminal is not connected with internal circuit. Please connect to the PCB ground Plane.   |
| 10          | PostOUT | RF output terminal. This terminal requires no DC blocking capacitor since this terminal has integrated SAW that also works as DC blocking capacitor in nature. |
| Exposed Pad | GND     | Ground terminal.   |

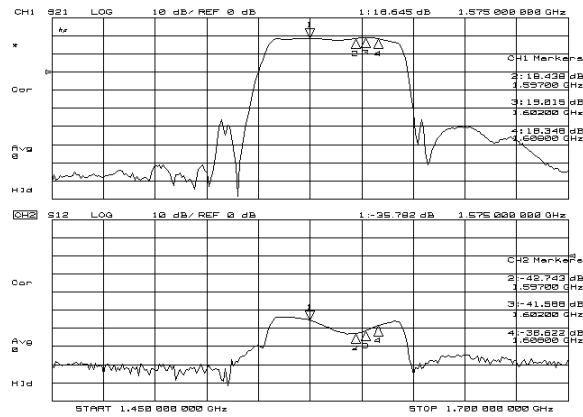
# NJG1157PCD

## ELECTRICAL CHARACTERISTICS

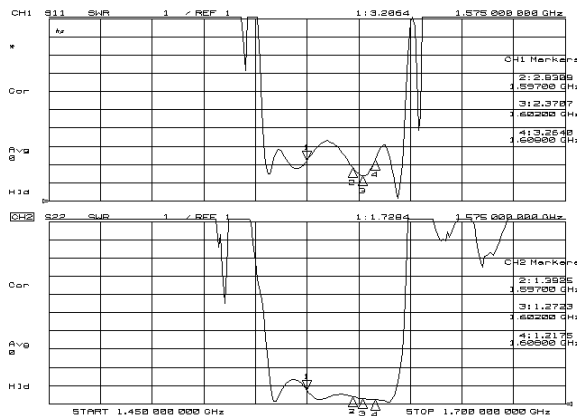
Conditions:  $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $T_a=25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit



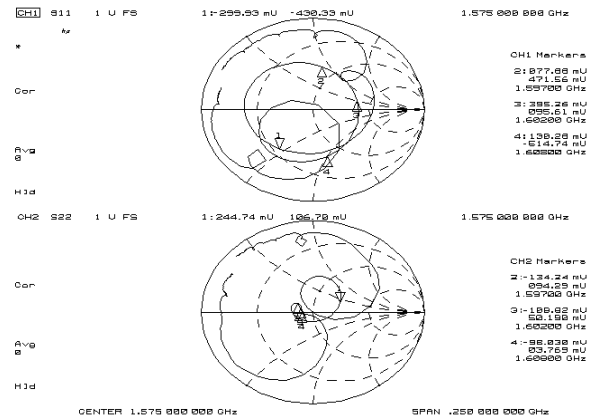
S11, S22



S21, S12



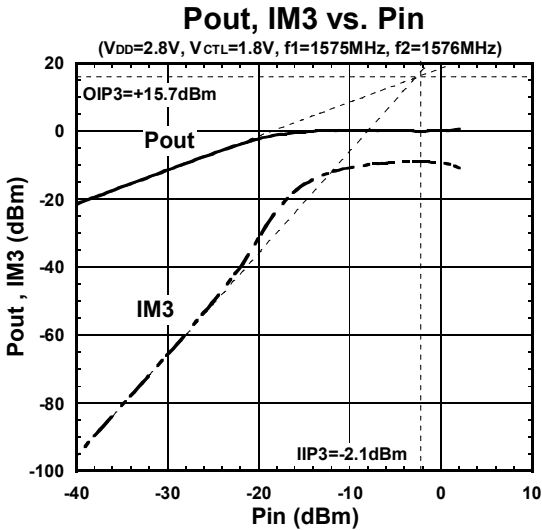
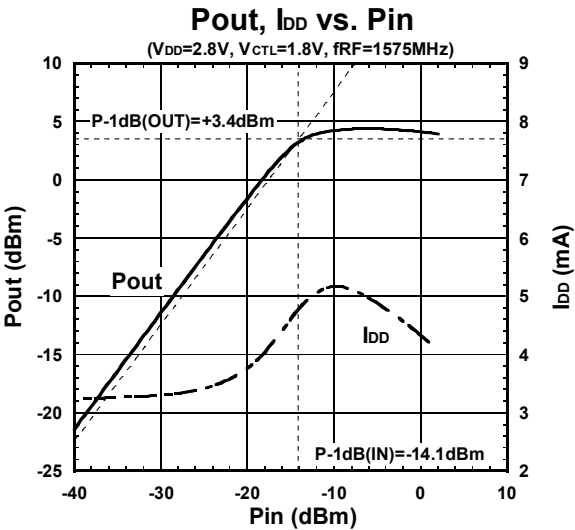
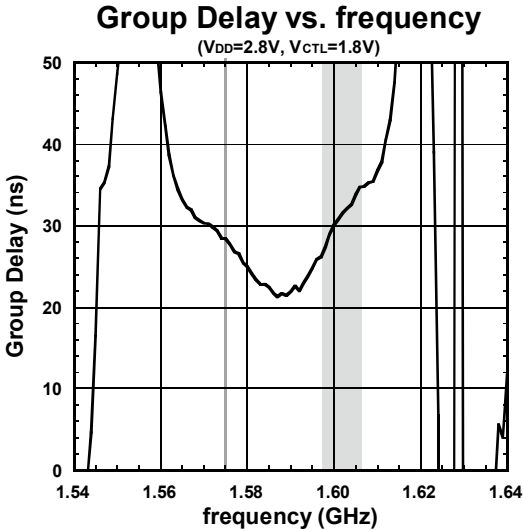
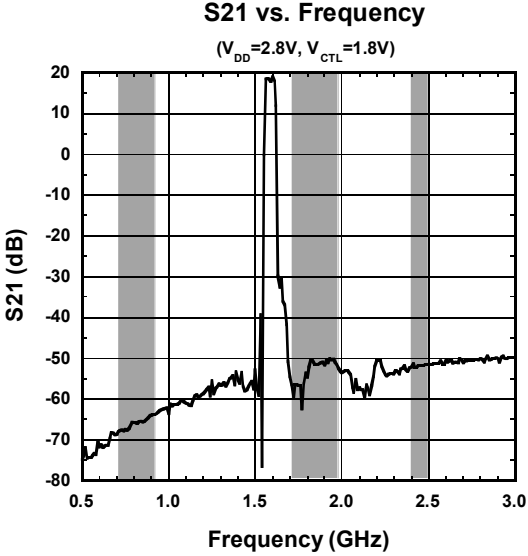
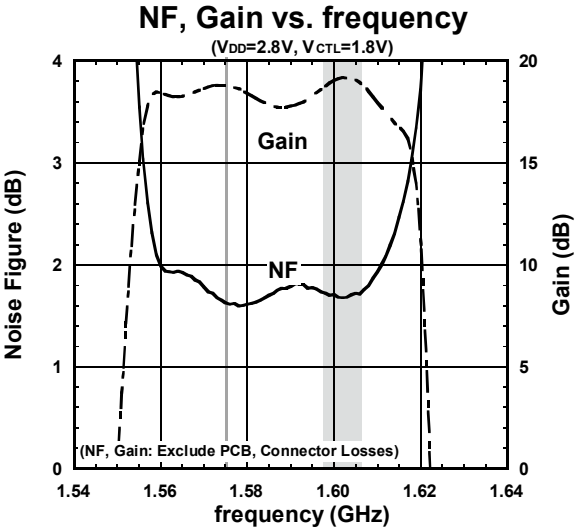
VSWR



Zin, Zout

**ELECTRICAL CHARACTERISTICS**

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



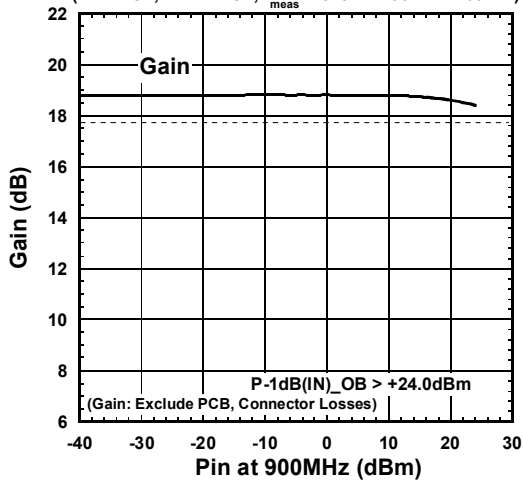
# NJG1157PCD

## ■ ELECTRICAL CHARACTERISTICS

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

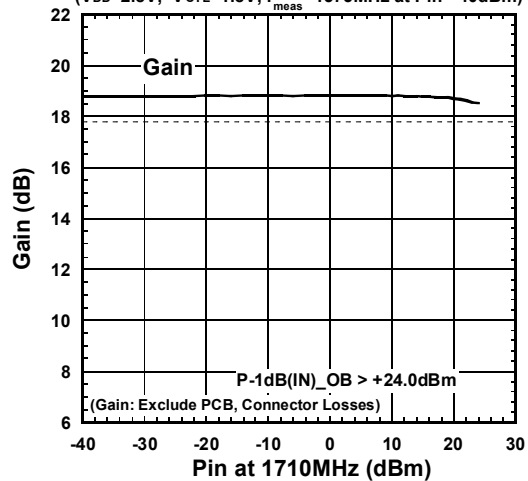
**Out-of-band P-1dB (fjam=900MHz)**

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



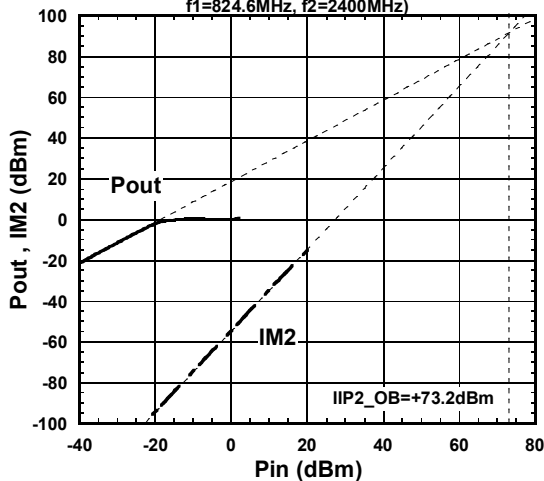
**Out-of-band P-1dB (fjam=1710MHz)**

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



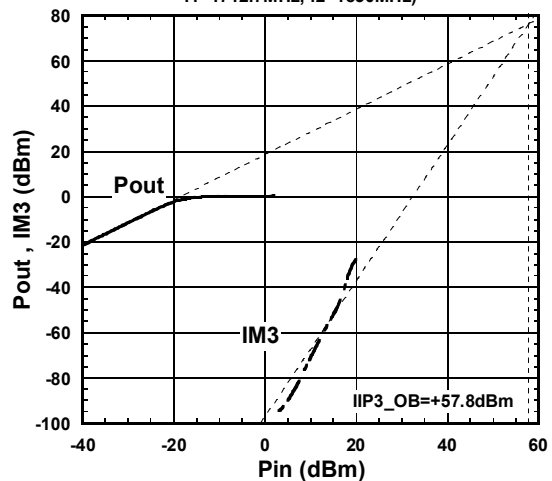
**Out-of-band IIP2**

( $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $f_{meas}=1575.4MHz$ ,  
 $f_1=824.6MHz$ ,  $f_2=2400MHz$ )



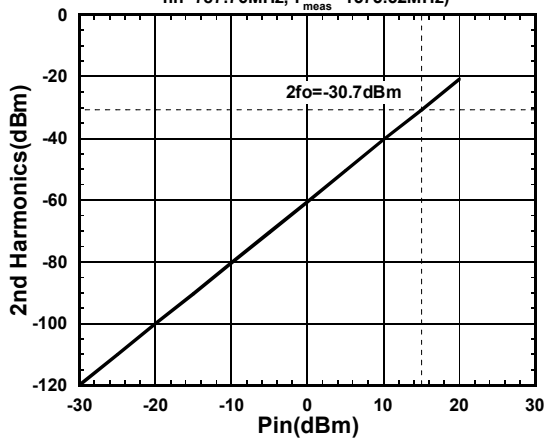
**Out-of-band IIP3**

( $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $f_{meas}=1575.4MHz$ ,  
 $f_1=1712.7MHz$ ,  $f_2=1850MHz$ )



**2nd Harmonics**

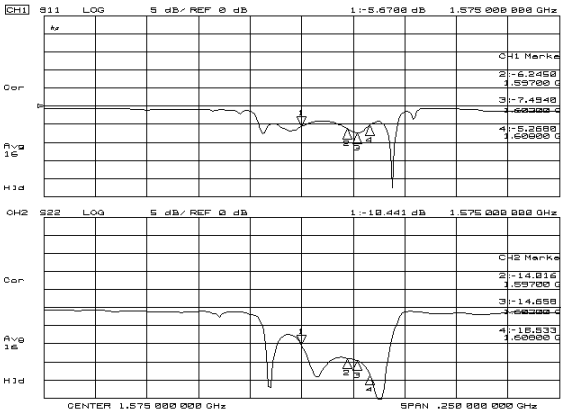
( $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  
 $f_{in}=787.76MHz$ ,  $f_{meas}=1575.52MHz$ )



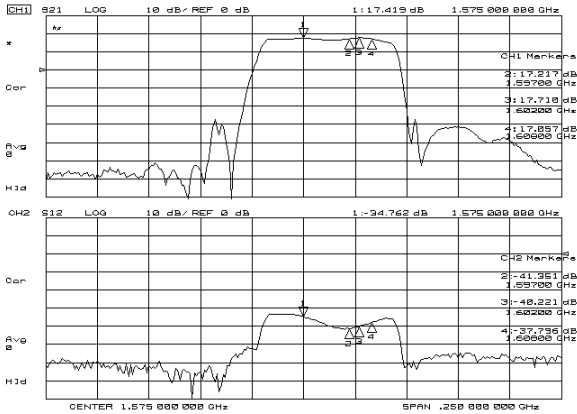


## ■ ELECTRICAL CHARACTERISTICS

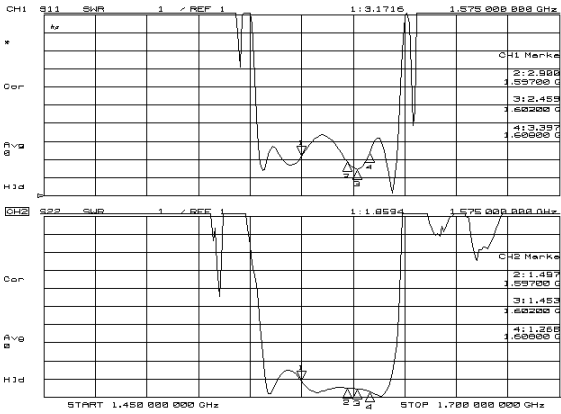
Conditions:  $V_{DD}=1.8V$ ,  $V_{CTL}=1.8V$ ,  $T_a=25^{\circ}C$ ,  $Z_S=Z_I=50\Omega$ , with application circuit



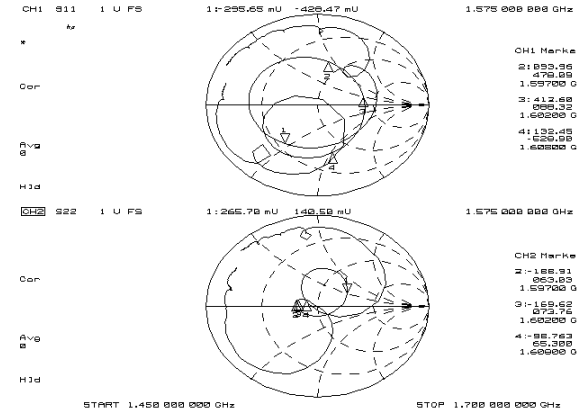
S11, S22



S21, S12



VSWR

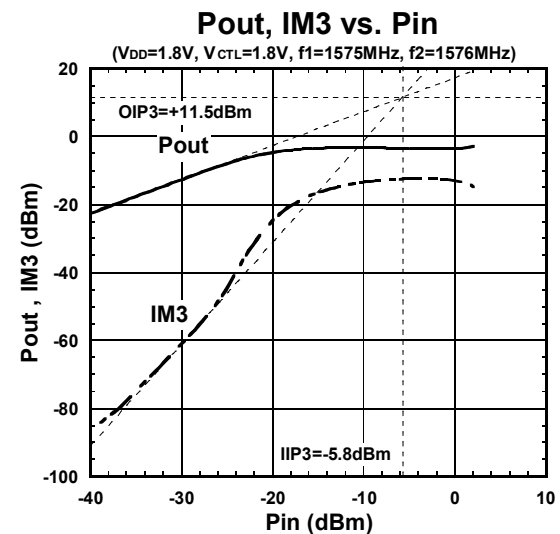
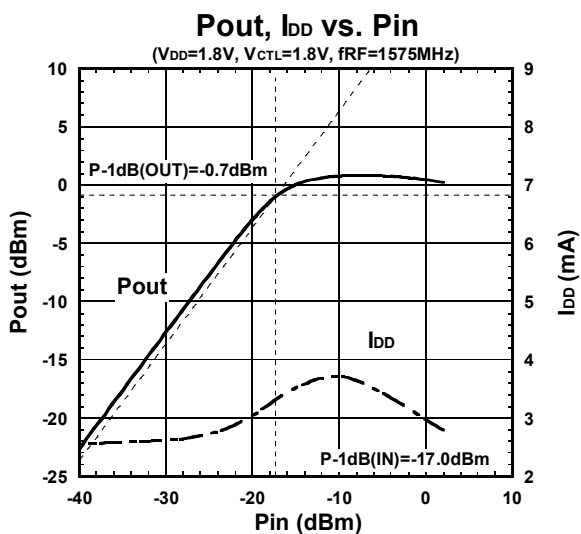
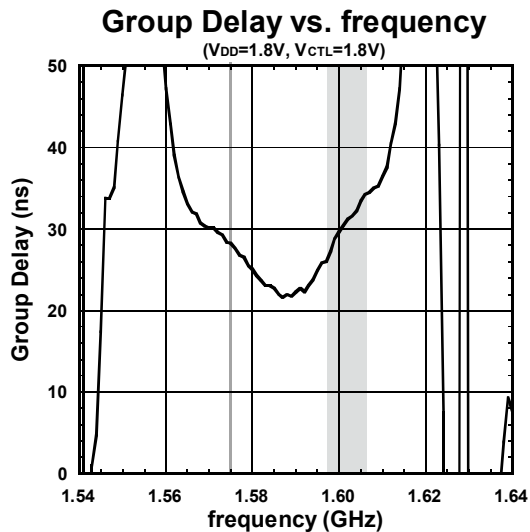
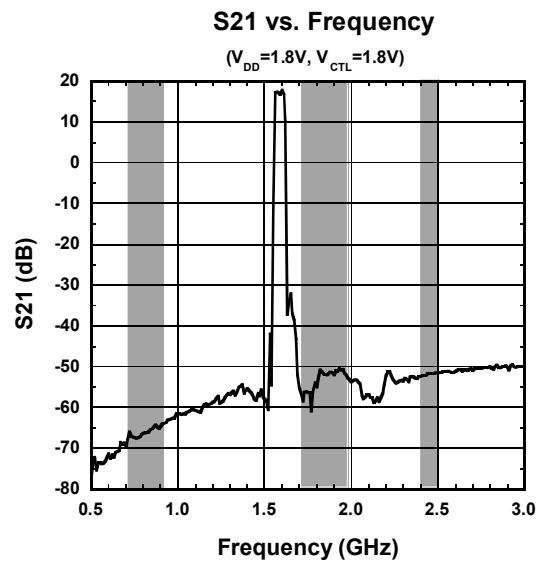
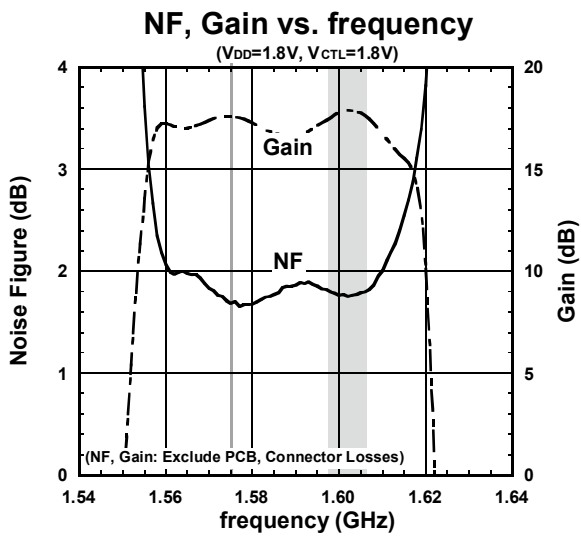


Zin, Zout

# NJG1157PCD

## ■ 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

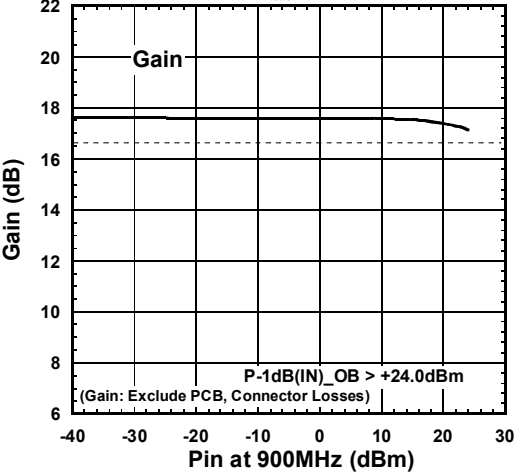


**■ ELECTRICAL CHARACTERISTICS**

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

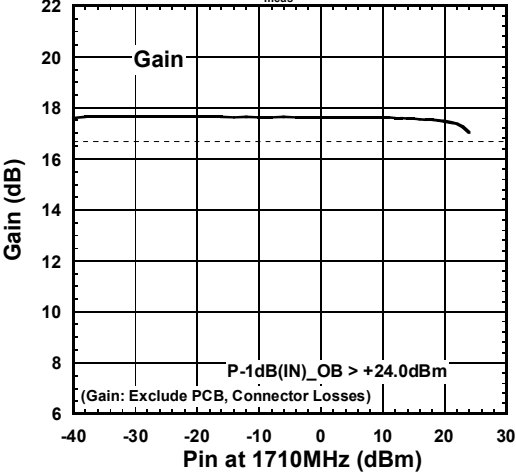
**Out-of-band P-1dB (fjam=900MHz)**

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



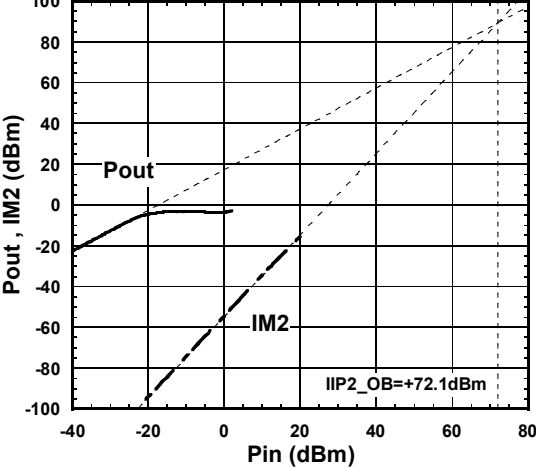
**Out-of-band P-1dB (fjam=1710MHz)**

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



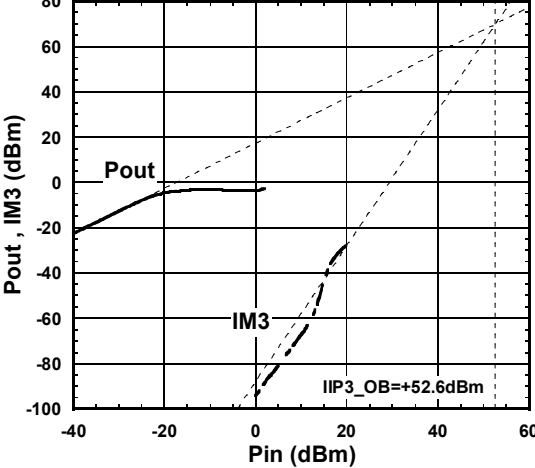
**Out-of-band IIP2**

( $V_{DD}=1.8V$ ,  $V_{CTL}=1.8V$ ,  $f_{meas}=1575.4MHz$ ,  
 $f_1=824.6MHz$ ,  $f_2=2400MHz$ )



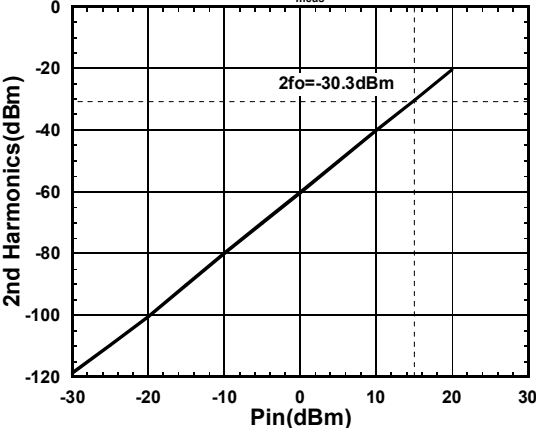
**Out-of-band IIP3**

( $V_{DD}=1.8V$ ,  $V_{CTL}=1.8V$ ,  $f_{meas}=1575.4MHz$ ,  
 $f_1=1712.7MHz$ ,  $f_2=1850MHz$ )



**2nd Harmonics**

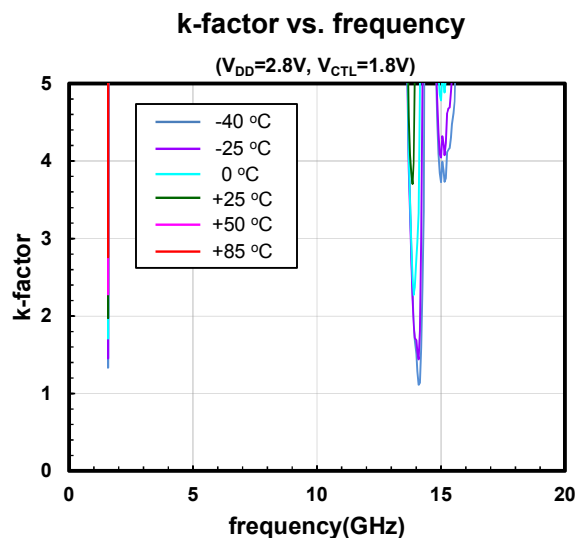
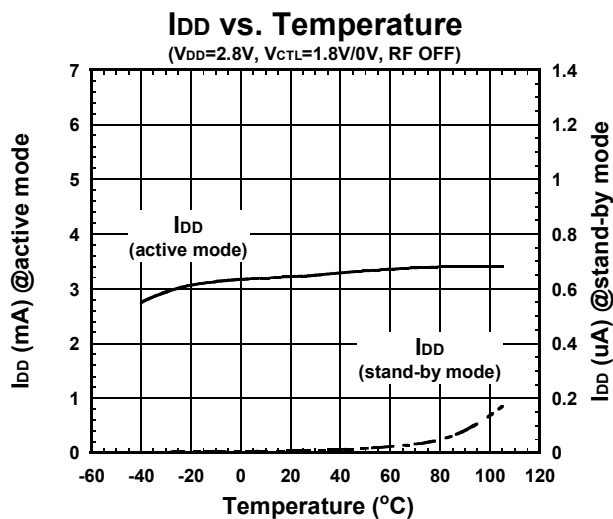
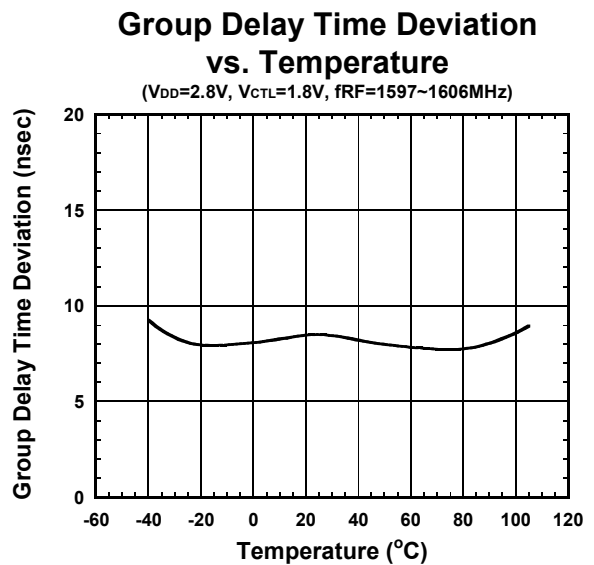
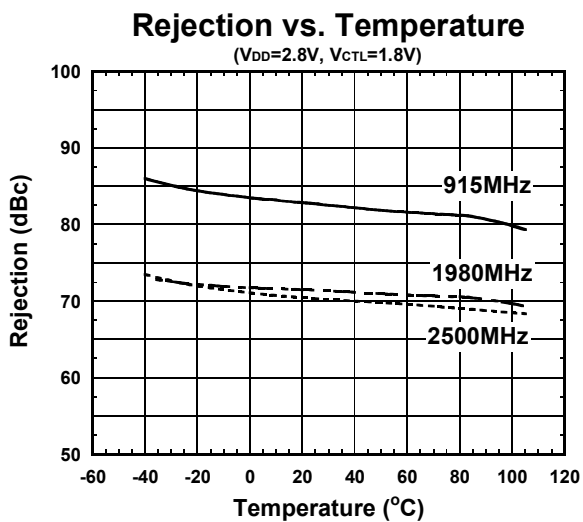
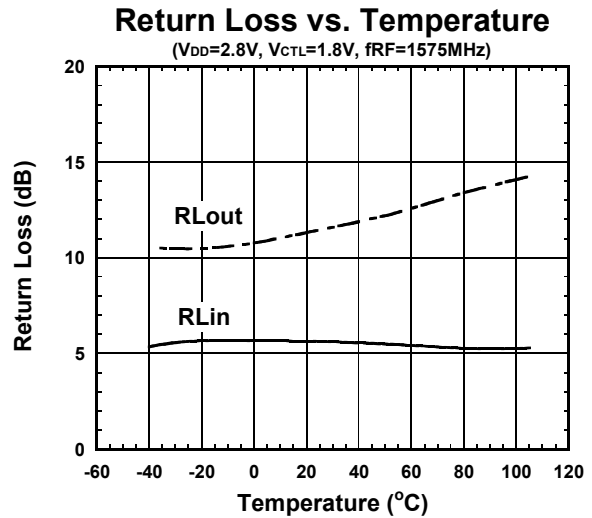
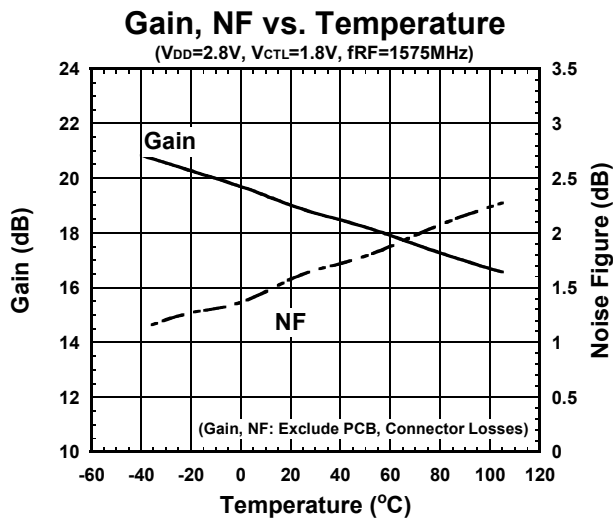
( $V_{DD}=1.8V$ ,  $V_{CTL}=1.8V$ ,  
 $f_{in}=787.76MHz$ ,  $f_{meas}=1575.52MHz$ )



# NJG1157PCD

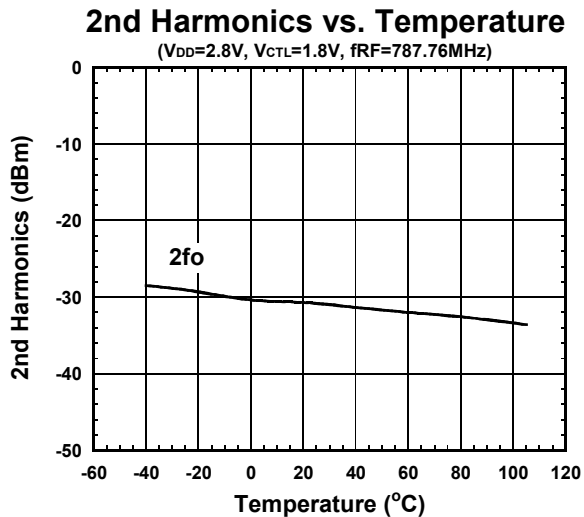
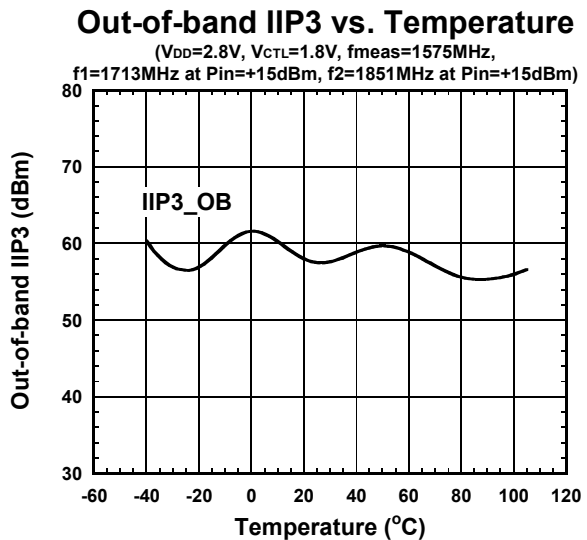
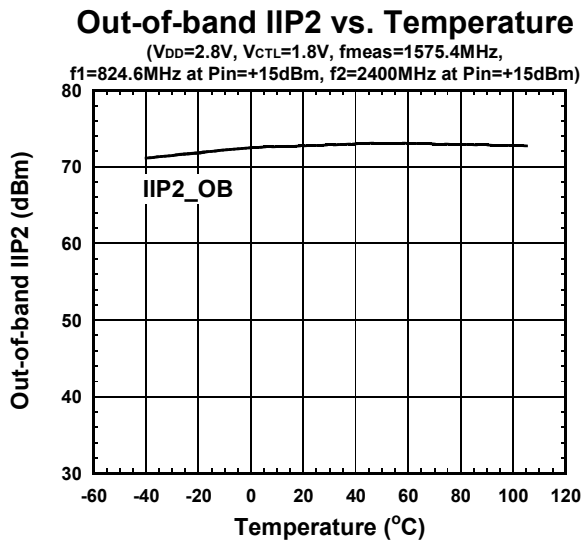
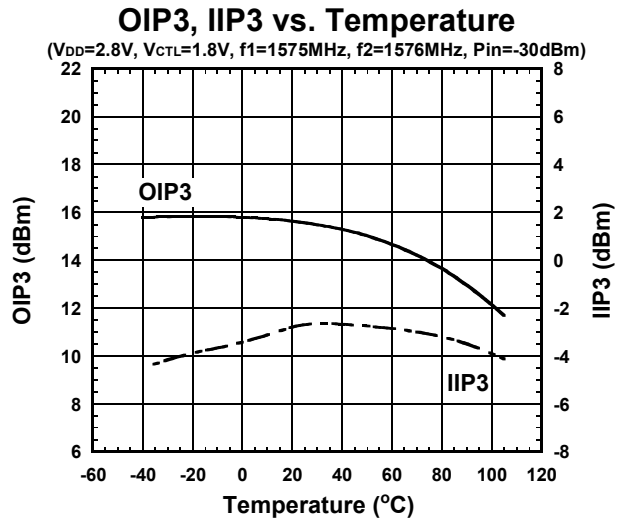
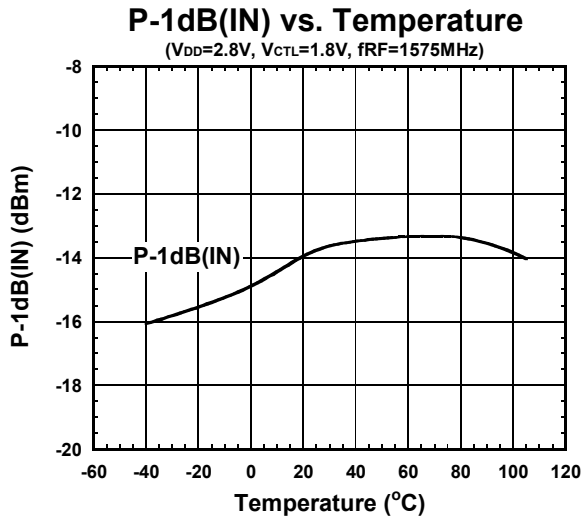
## ■ ELECTRICAL CHARACTERISTICS

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



## ■ ELECTRICAL CHARACTERISTICS

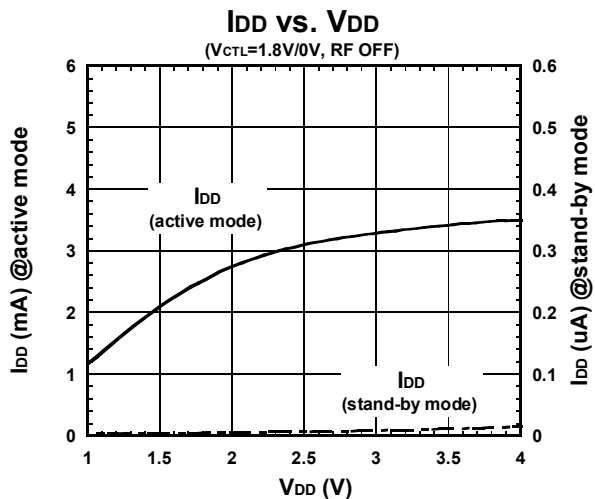
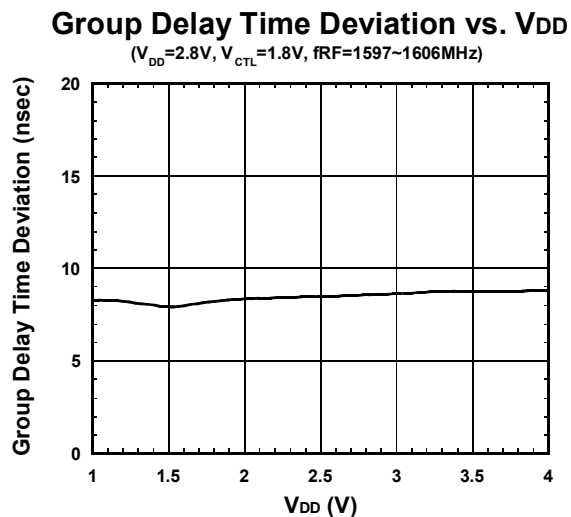
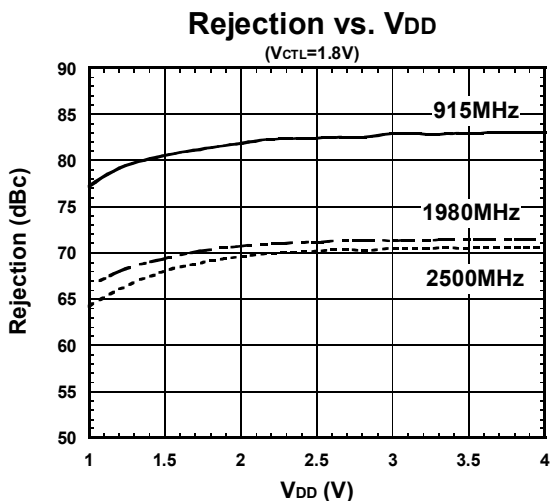
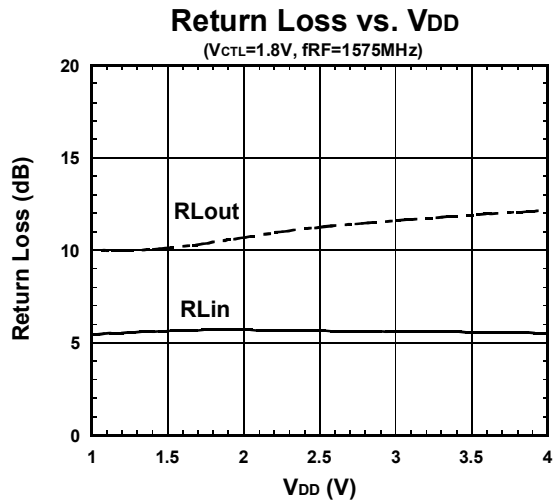
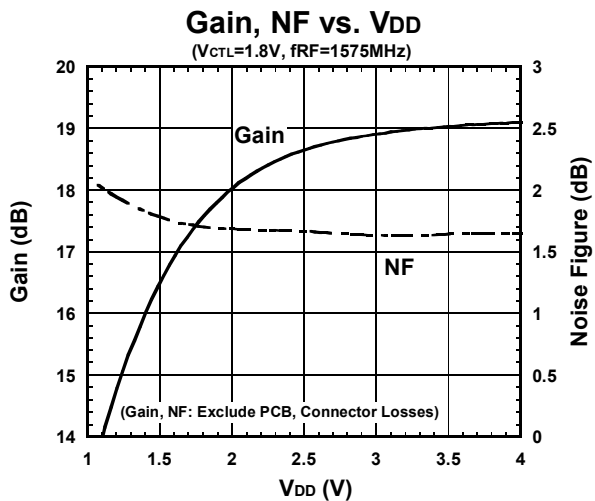
Conditions:  $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $Z_s=Z_l=50\Omega$ , with application circuit



# NJG1157PCD

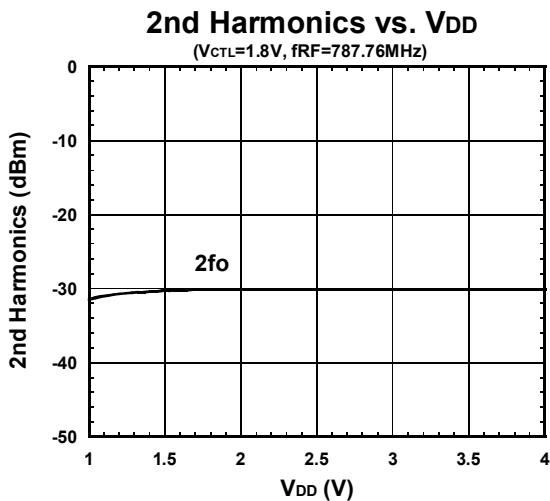
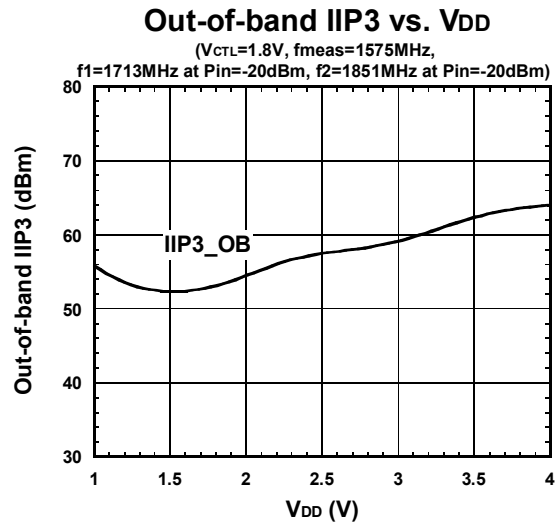
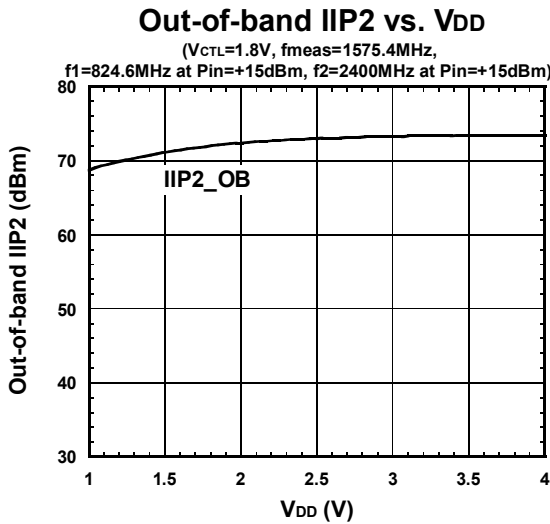
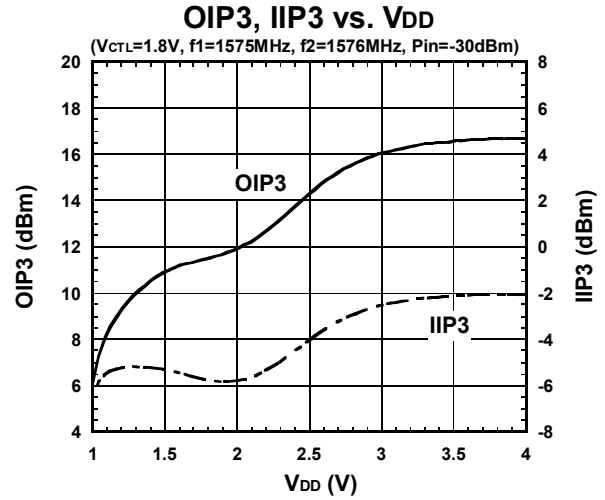
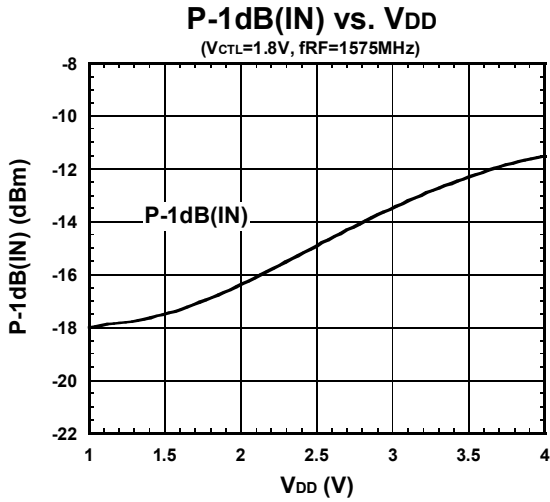
## ELECTRICAL CHARACTERISTICS

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



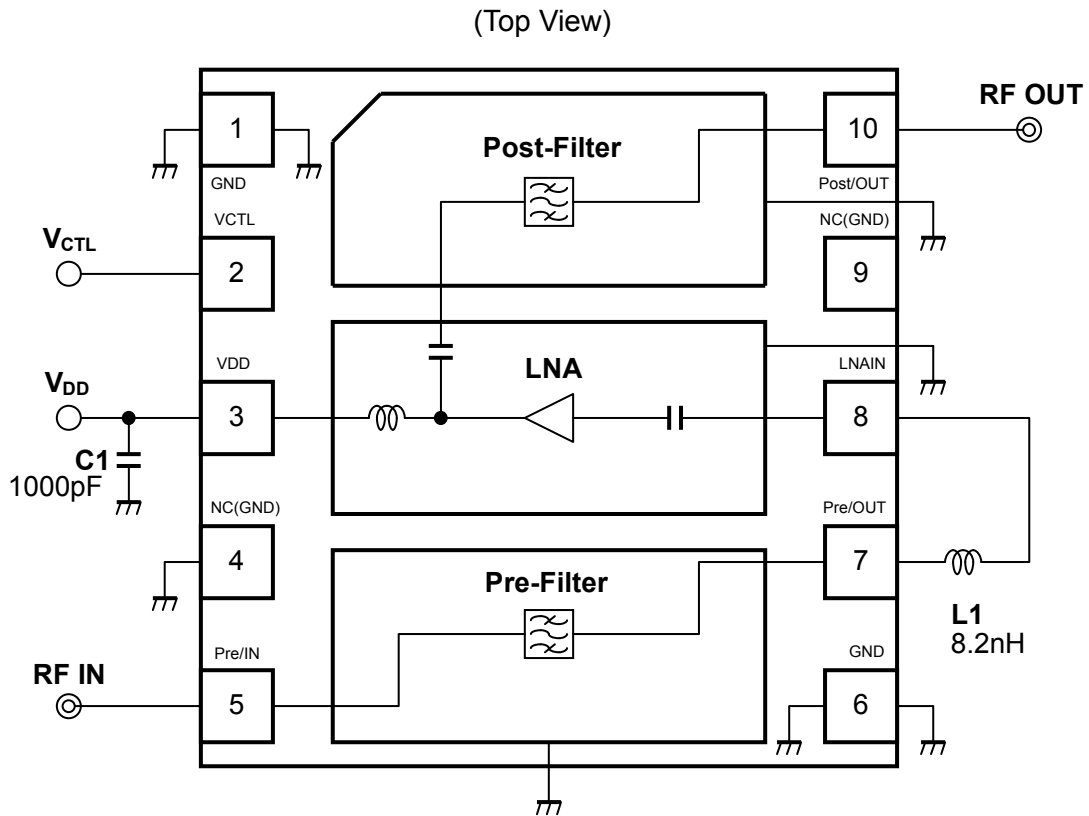
## ■ ELECTRICAL CHARACTERISTICS

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



# NJG1157PCD

## APPLICATION CIRCUIT

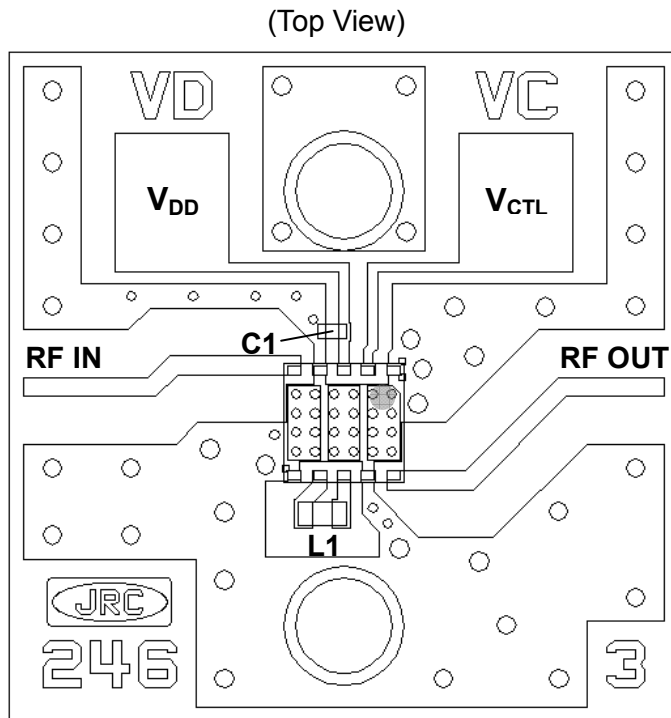


### Parts list

| Parts ID | Manufacture               |
|----------|---------------------------|
| L1       | LQW15A Series<br>(MURATA) |
| C1       | GRM03 Series<br>(MURATA)  |

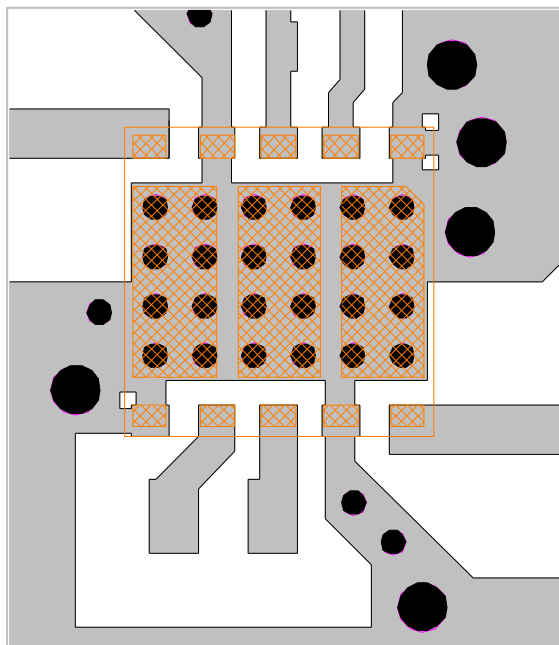


## ■ Evaluation board



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

## <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.



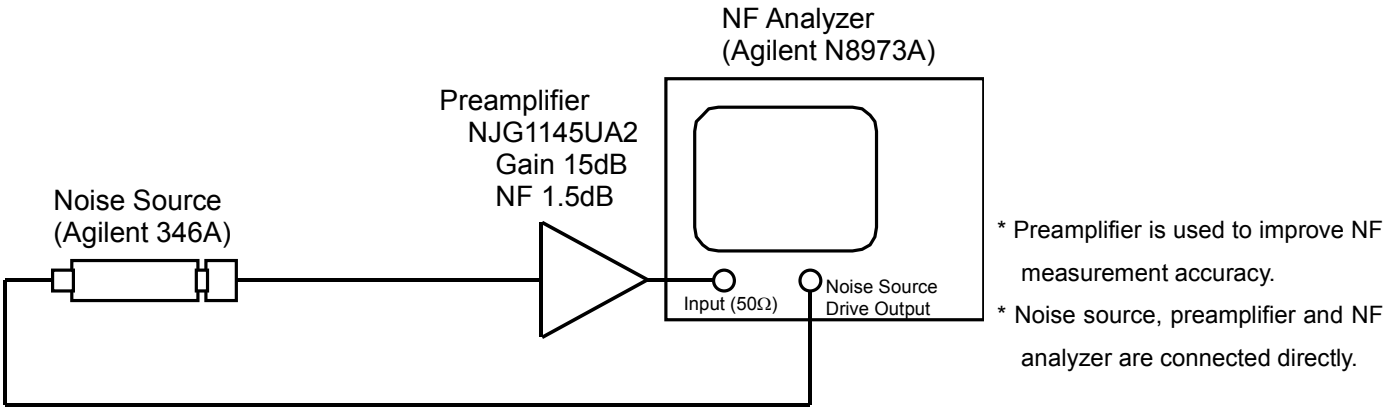
■ NOISE FIGURE MEASUREMENT BLOCK DIAGRAM

Measuring instruments

NF Analyzer : Agilent N8973A  
Noise Source : Agilent 346A

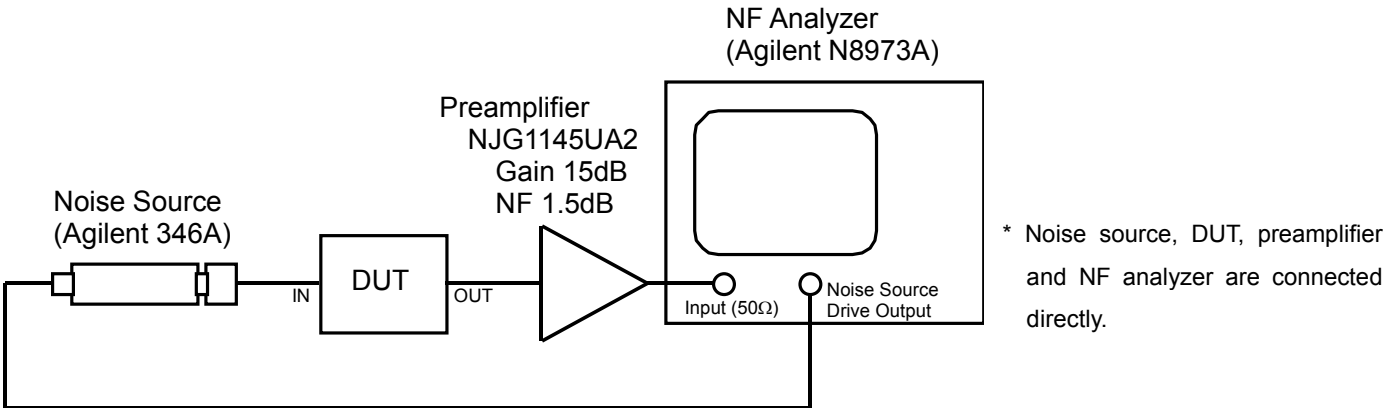
Setting the NF analyzer

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)



\* Pre-amplifier is used to improve NF measurement accuracy.  
\* Noise source, pre-amplifier and NF analyzer are connected directly.

Calibration setup



\* Noise source, DUT, pre-amplifier and NF analyzer are connected directly.

Measurement Setup



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