

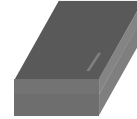
GNSS LOW NOISE AMPLIFIER

■ GENERAL DESCRIPTION

The NJG1155UX2 is a low noise amplifier GaAs MMIC designed for GNSS (Global Navigation Satellite Systems). The NJG1155UX2 is featured low noise figure, and operates from 1.5V to 3.3V single voltage. The NJG1155UX2 has stand-by mode to save the supply current, has the on-chip ESD protection devices.

The NJG1155UX2 achieves ultra small mounting area by only two external components and ultra small package that is lead-free and halogen-free 6-pin EPFFP6-X2 package.

■ PACKAGE OUTLINE



NJG1155UX2

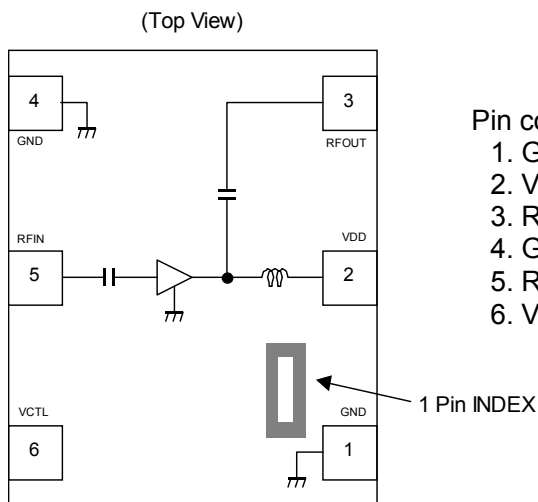
■ APPLICATIONS

GNSS applications, like GPS, Galileo, GLONASS and COMPASS.

■ FEATURES

- Operating frequencies 1550 to 1615MHz
- Low supply voltage 2.8 / 1.8V typ.
- Low current consumption 3.5 / 3.1mA typ. @ $V_{DD}=2.8 / 1.8V$, $V_{CTL}=1.8V$
0.1 μ A typ. @ $V_{DD}=2.8 / 1.8V$, $V_{CTL}=0V$ (Stand-by mode)
- High gain 19.0 / 18.5dB typ. @ $V_{DD}=2.8 / 1.8V$, $V_{CTL}=1.8V$
- Low noise figure 0.75dB typ. @ $V_{DD}=2.8 / 1.8V$, $V_{CTL}=1.8V$
- Ultra small package EPFFP6-X2 (Package size: 1.1mm x 0.7mm x 0.37mm typ.)
- Low external component count 2pcs.
- RoHS compliant and Halogen Free
- MSL1

■ PIN CONFIGURATION



■ TRUTH TABLE

| V_{CTL} | LNA mode |
|-----------|---------------|
| H | Active mode |
| L | Stand-by mode |

“H”= $V_{CTL(H)}$, “L”= $V_{CTL(L)}$

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

NJG1155UX2

■ ABSOLUTE MAXIMUM RATINGS

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

| PARAMETERS | SYMBOL | CONDITIONS | RATINGS | UNITS |
|-----------------------|-----------|---|-------------|--------------------|
| Supply voltage | V_{DD} | | 5.0 | V |
| Control voltage | V_{CTL} | | 5.0 | V |
| Input power | P_{IN} | $V_{DD}=2.8\text{V}$ | +15 | dBm |
| Power dissipation | P_D | 4-layer FR4 PCB without through-hole (101.5mm x 114.5mm), $T_j=150^{\circ}\text{C}$ | 430 | mW |
| Operating temperature | T_{opr} | | -40 to +85 | $^{\circ}\text{C}$ |
| Storage temperature | T_{stg} | | -55 to +150 | $^{\circ}\text{C}$ |

■ ELECTRICAL CHARACTERISTICS 1 (DC)

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

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---------------------------------|--------------|--|-----|-----|------|---------------|
| Supply Voltage | V_{DD} | | 1.5 | - | 3.3 | V |
| Control Voltage (High) | $V_{CTL(H)}$ | | 1.2 | 1.8 | 3.3 | V |
| Control Voltage (Low) | $V_{CTL(L)}$ | | 0 | 0 | 0.3 | V |
| Supply Current1 (Active mode) | I_{DD1} | $V_{DD}=2.8\text{V}$, $V_{CTL}=1.8\text{V}$ | - | 3.5 | 6.0 | mA |
| Supply Current2 (Active mode) | I_{DD2} | $V_{DD}=1.8\text{V}$, $V_{CTL}=1.8\text{V}$ | - | 3.1 | 5.5 | mA |
| Supply Current3 (Stand-by mode) | I_{DD3} | $V_{DD}=2.8\text{V}$, $V_{CTL}=0\text{V}$ | - | 0.1 | 3.0 | μA |
| Supply Current4 (Stand-by mode) | I_{DD4} | $V_{DD}=1.8\text{V}$, $V_{CTL}=0\text{V}$ | - | 0.1 | 3.0 | μA |
| Control Current | I_{CTL} | $V_{CTL}=1.8\text{V}$ | - | 5.0 | 12.0 | μA |

■ ELECTRICAL CHARACTERISTICS 2 (RF, V_{DD}=2.8V)

General conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=1550 to 1615MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|-------------------------|--|-------|-------|------|-------|
| Small Signal Gain1 | Gain1 | Exclude PCB and connector losses (0.18dB) | 16.5 | 19.0 | 21.0 | dB |
| Noise Figure1 | NF1 | Exclude PCB and connector losses (0.08dB) | - | 0.75 | 1.0 | dB |
| Isolation1 | ISL1 | | 25.0 | 35.0 | - | dB |
| Input Power at 1dB Gain Compression Point1 | P _{-1dB} (IN)1 | | -17.0 | -12.5 | - | dBm |
| Input 3rd Order Intercept Point1 | IIP3_1 | f ₁ =f _{RF} , f ₂ =f ₁ +/-1MHz, Pin=-30dBm | -5.0 | -1.5 | - | dBm |
| Out of Band Input 3rd Order Intercept Point1 | IIP3_OB1 | f ₁ =1712.7MHz, Pin=-20dBm, f ₂ =1850MHz, Pin=-20dBm, f _{meas} =1575.4MHz | -4.0 | 0.0 | - | dBm |
| RFIN Port Return Loss1 | RLi1 | | 6.0 | 10.0 | - | dB |
| RFOUT Port Return Loss1 | RLo1 | | 8.0 | 12.0 | - | dB |

■ ELECTRICAL CHARACTERISTICS 3 (RF, V_{DD}=1.8V)

General conditions: V_{DD}=1.8V, V_{CTL}=1.8V, f_{RF}=1550 to 1615MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|-------------------------|--|-------|-------|------|-------|
| Small Signal Gain2 | Gain2 | Exclude PCB and connector losses (0.18dB) | 15.0 | 18.5 | 21.0 | dB |
| Noise Figure2 | NF2 | Exclude PCB and connector losses (0.08dB) | - | 0.75 | 1.1 | dB |
| Isolation2 | ISL2 | | 25.0 | 35.0 | - | dB |
| Input Power at 1dB Gain Compression Point2 | P _{-1dB} (IN)2 | | -20.0 | -16.0 | - | dBm |
| Input 3rd Order Intercept Point2 | IIP3_2 | f ₁ =f _{RF} , f ₂ =f ₁ +/-1MHz, Pin=-30dBm | -10.0 | -5.0 | - | dBm |
| Out of Band Input 3rd Order Intercept Point2 | IIP3_OB2 | f ₁ =1712.7MHz, Pin=-20dBm, f ₂ =1850MHz, Pin=-20dBm, f _{meas} =1575.4MHz | -7.0 | -3.0 | - | dBm |
| RF IN Port Return Loss2 | RLi2 | | 6.0 | 10.0 | - | dB |
| RF OUT Port Return Loss2 | RLo2 | | 7.0 | 12.0 | - | dB |

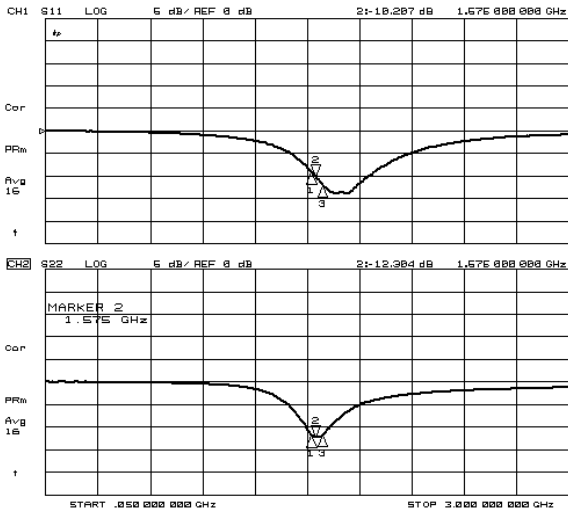
NJG1155UX2

■ TERMINAL INFORMATION

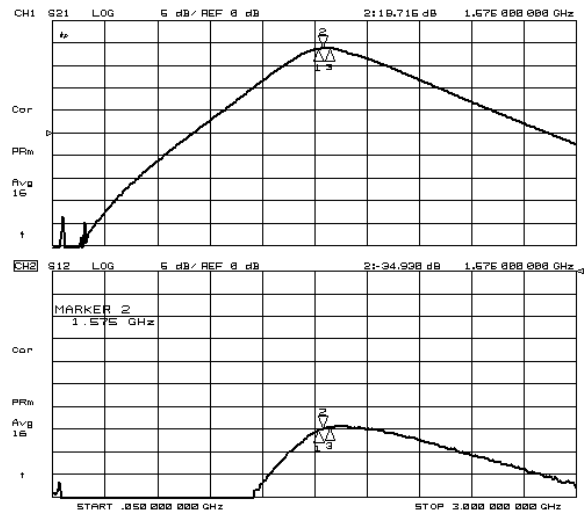
| No. | SYMBOL | DESCRIPTION |
|-----|--------|---|
| 1 | GND | Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance. |
| 2 | VDD | Supply voltage terminal. Please connect bypass capacitor C1 with ground as close as possible. |
| 3 | RFOUT | RF output terminal. This terminal requires no DC blocking capacitor since this IC has internal output matching circuit including DC blocking capacitor. |
| 4 | GND | Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance. |
| 5 | RFIN | RF input terminal. This terminal requires only a matching inductor L1, and does not require DC blocking capacitor. |
| 6 | VCTL | Control voltage terminal. |

ELECTRICAL CHARACTERISTICS

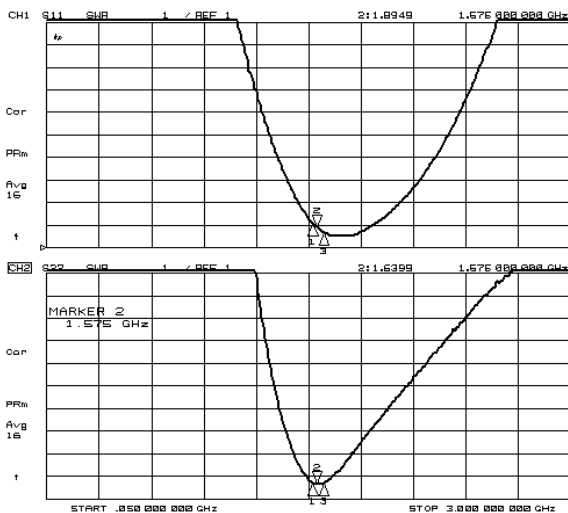
Conditions: $V_{DD}=2.8V$, $V_{CTL}=1.8V$, $T_a=25^\circ C$, $Z_s=Z_l=50\Omega$



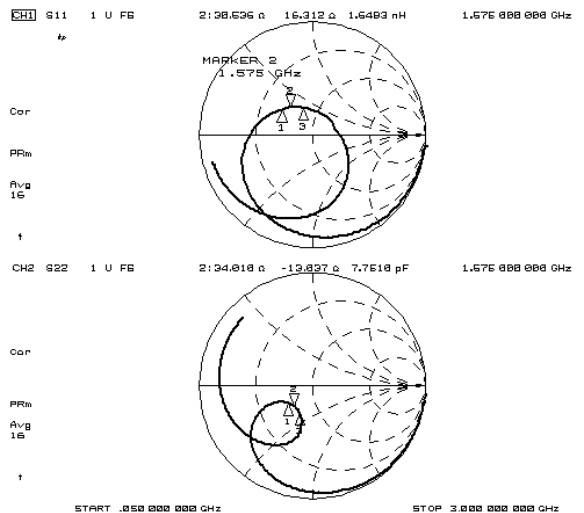
S11, S22



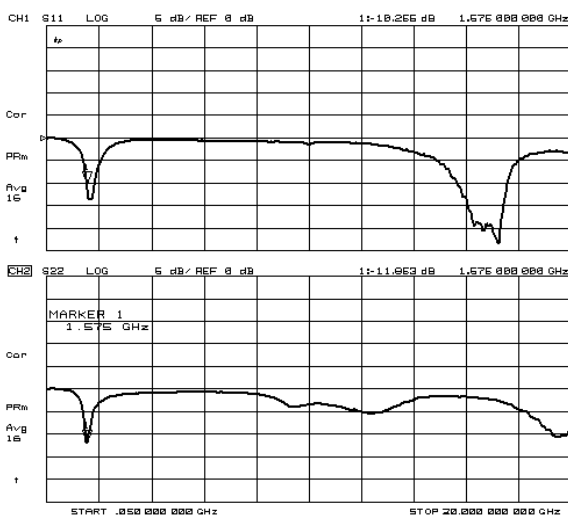
S21, S12



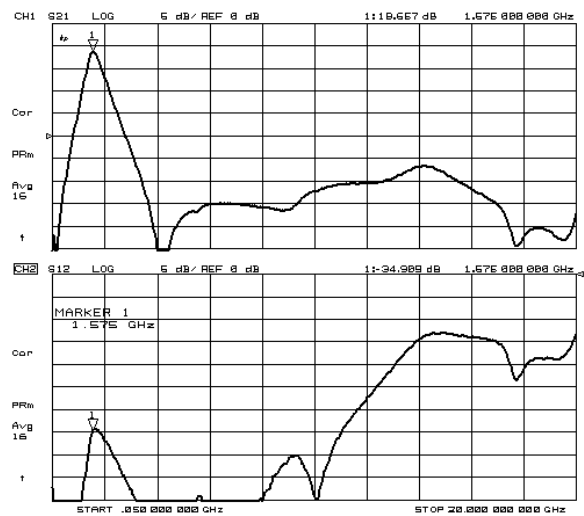
VSWR



Zin, Zout



S11, S22 (f=50M to 20GHz)

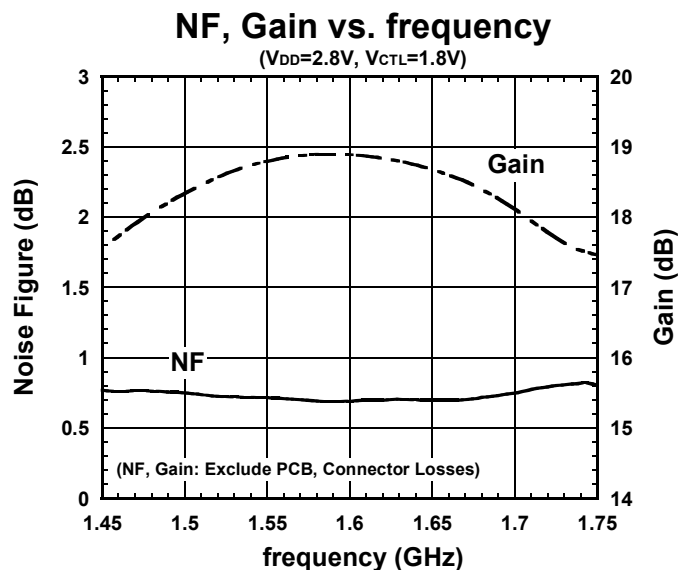
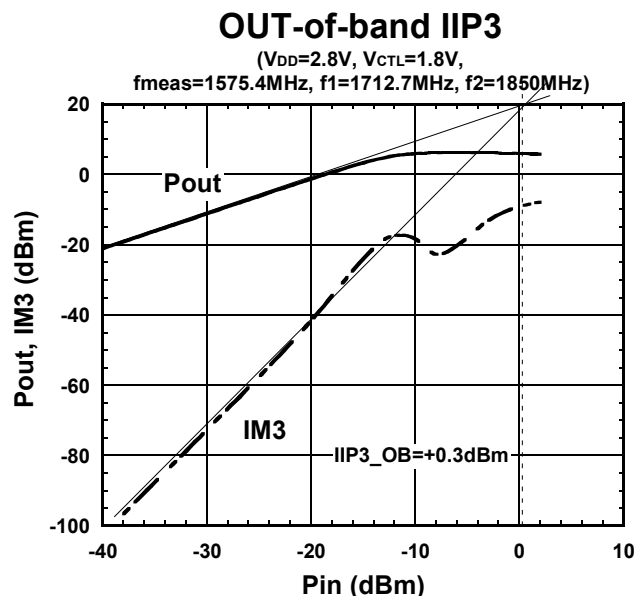
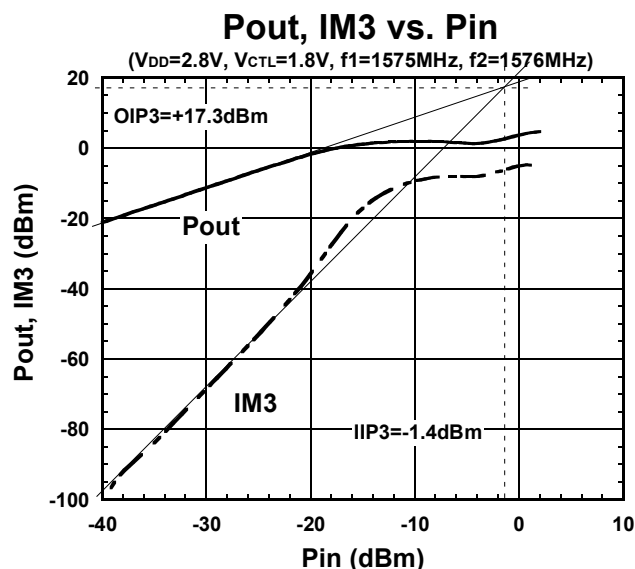
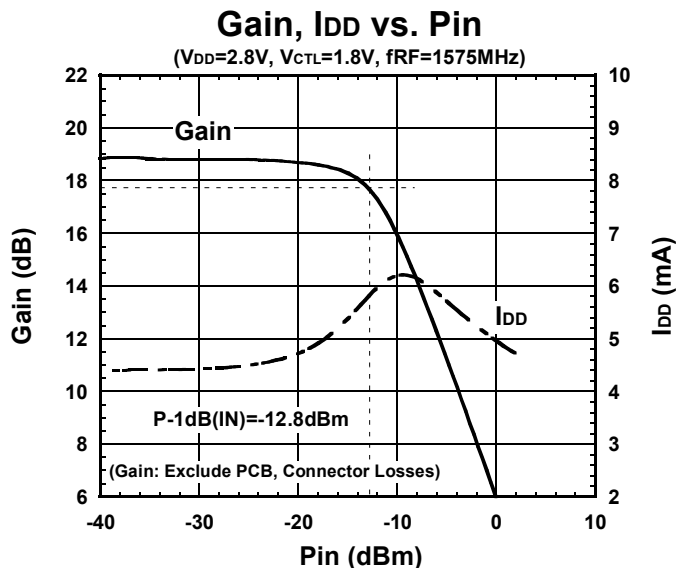
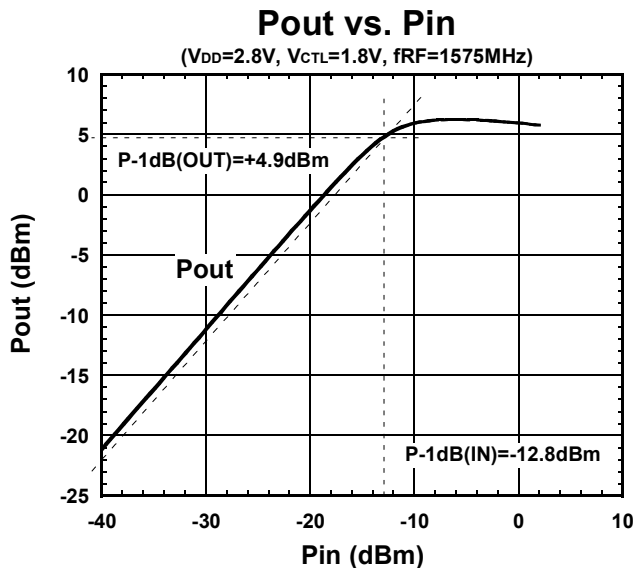


S21, S12 (f=50M to 20GHz)

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ELECTRICAL CHARACTERISTICS

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

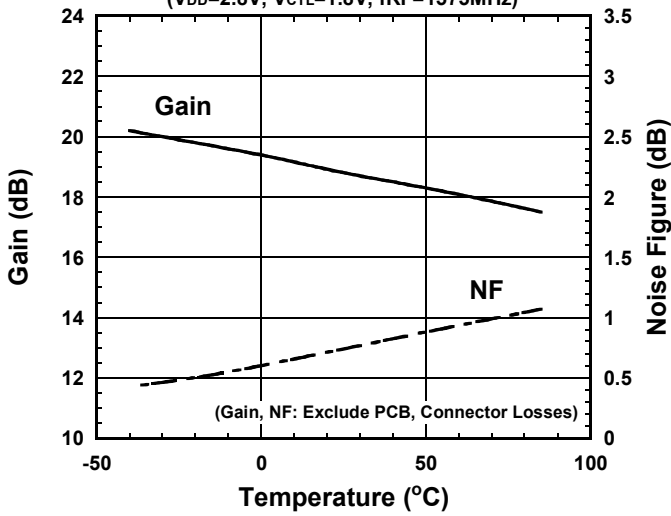


ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD}=2.8V$, $V_{CTL}=1.8V$, $f_{RF}=1575MHz$, $Z_S=Z_I=50\Omega$

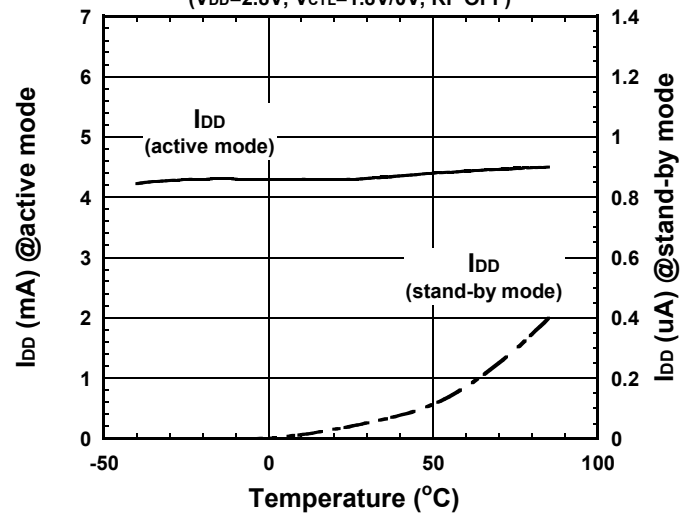
Gain, NF vs. Temperature

($V_{DD}=2.8V$, $V_{CTL}=1.8V$, $f_{RF}=1575MHz$)



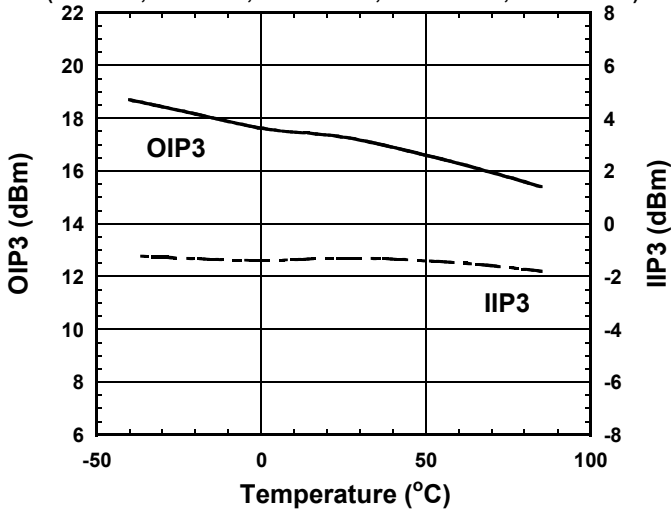
I_{DD} vs. Temperature

($V_{DD}=2.8V$, $V_{CTL}=1.8V/0V$, RF OFF)



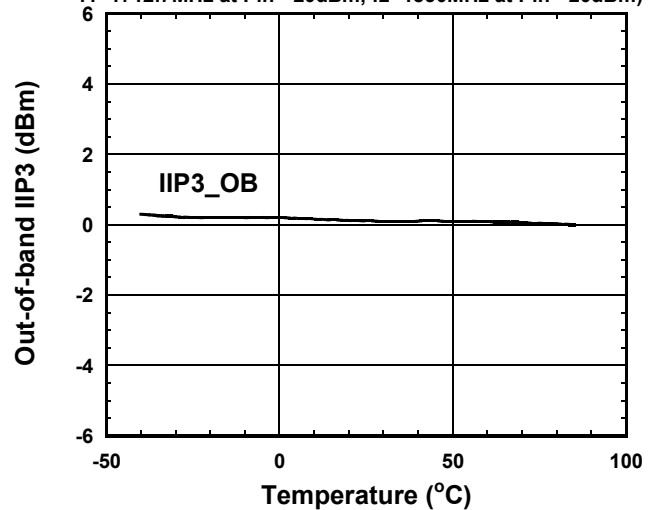
OIP3, IIP3 vs. Temperature

($V_{DD}=2.8V$, $V_{CTL}=1.8V$, $f_1=1575MHz$, $f_2=1576MHz$, $Pin=-30dBm$)



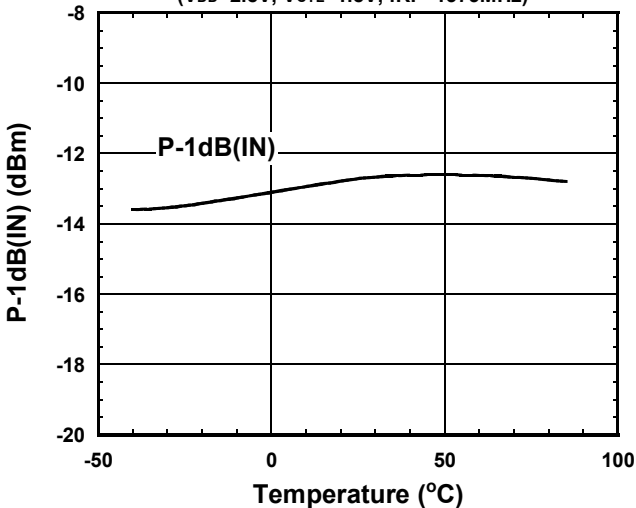
Out-of-band IIP3 vs. Temperature

($V_{DD}=2.8V$, $V_{CTL}=1.8V$, $f_{meas}=1575.4MHz$, $f_1=1712.7MHz$ at $Pin=-20dBm$, $f_2=1850MHz$ at $Pin=-20dBm$)



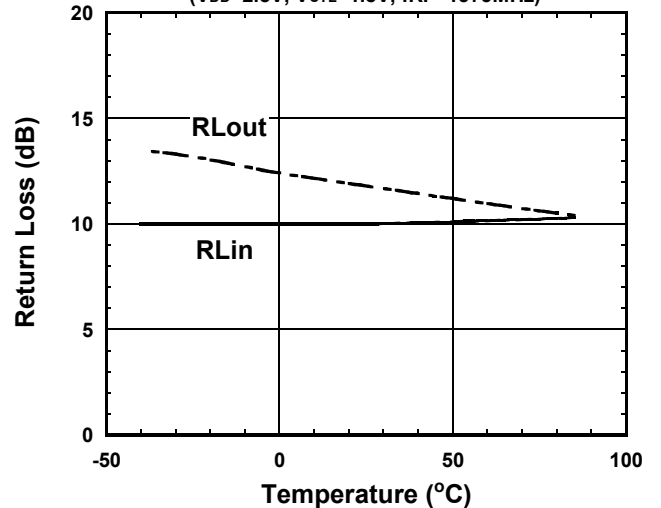
P-1dB(IN) vs. Temperature

($V_{DD}=2.8V$, $V_{CTL}=1.8V$, $f_{RF}=1575MHz$)



Return Loss vs. Temperature

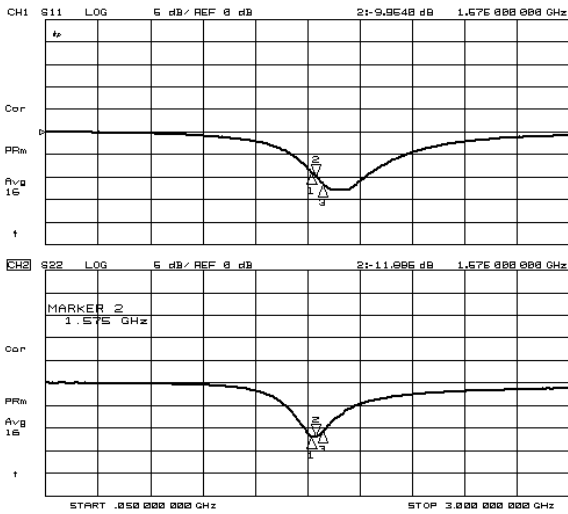
($V_{DD}=2.8V$, $V_{CTL}=1.8V$, $f_{RF}=1575MHz$)



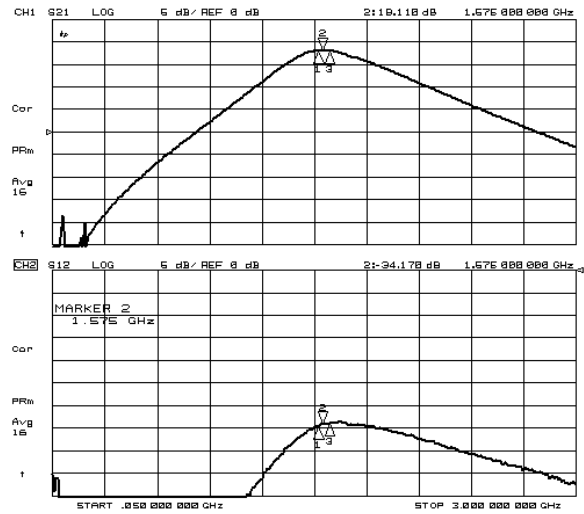
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ELECTRICAL CHARACTERISTICS

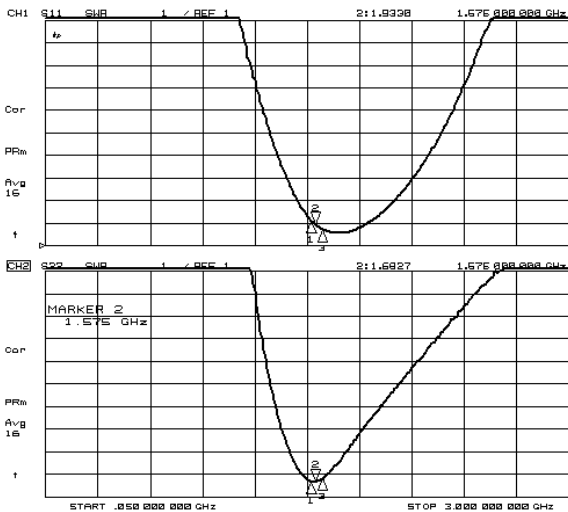
Conditions: $V_{DD}=1.8V$, $V_{CTL}=1.8V$, $T_a=25^\circ C$, $Z_S=Z_L=50\Omega$



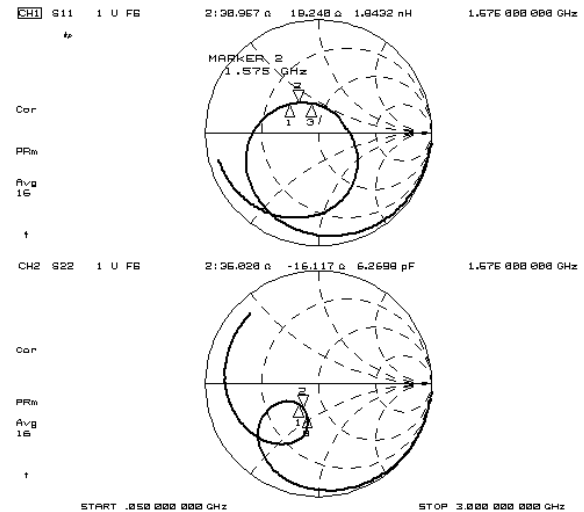
S11, S22



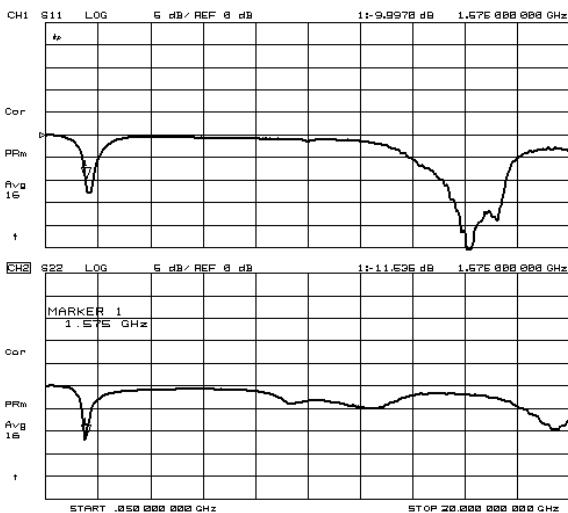
S21, S12



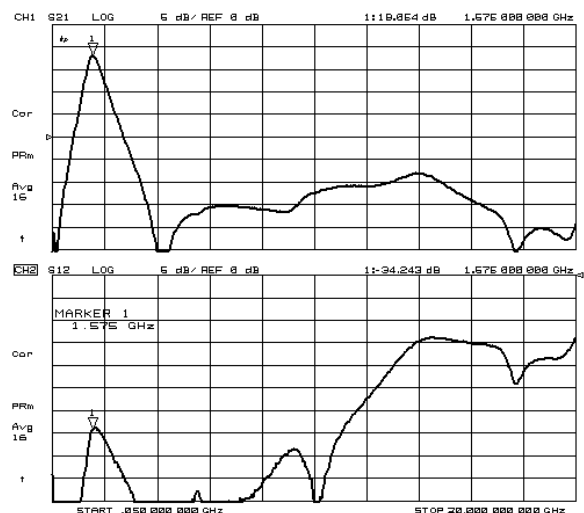
VSWR



Zin, Zout



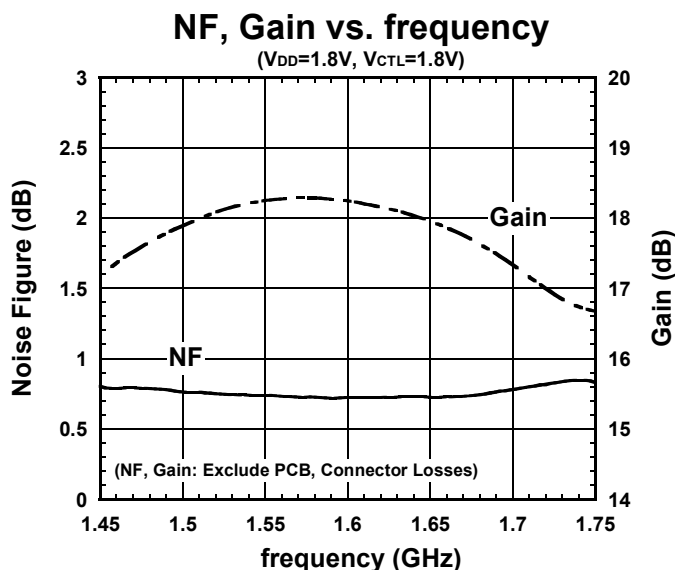
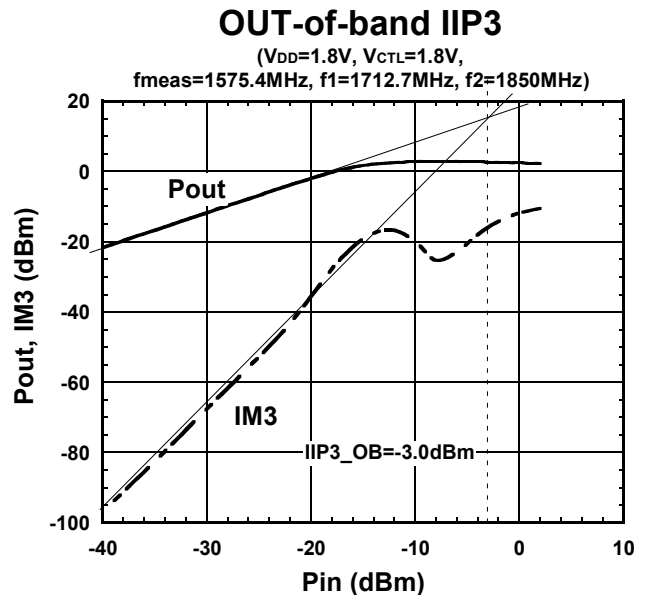
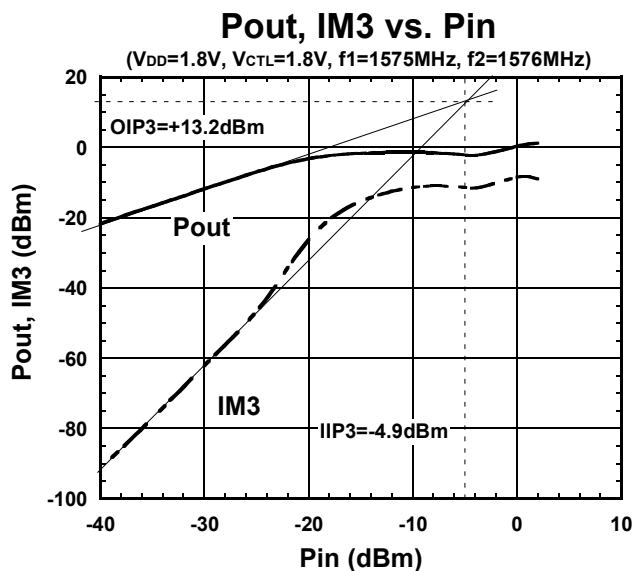
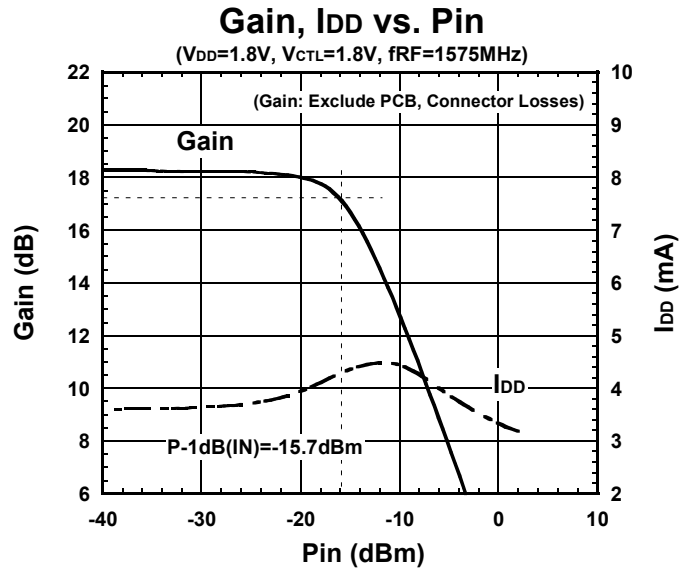
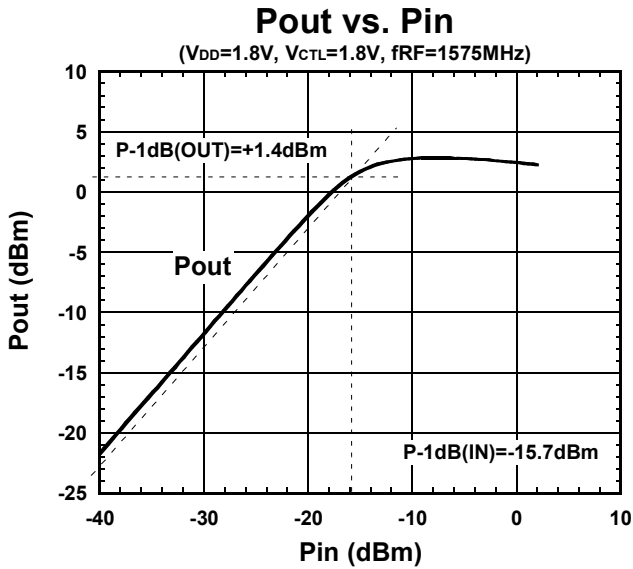
S11, S22 (f=50M to 20GHz)



S21, S12 (f=50M to 20GHz)

ELECTRICAL CHARACTERISTICS

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



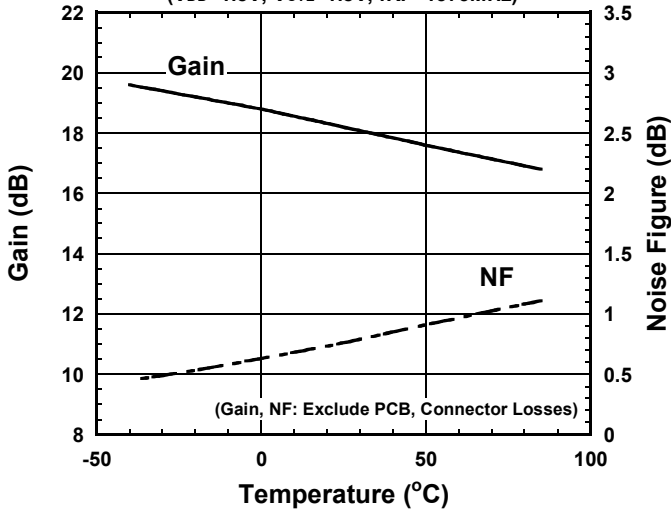
NJG1155UX2

ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD}=1.8V$, $V_{CTL}=1.8V$, $f_{RF}=1575MHz$, $Z_S=Z_L=50\Omega$

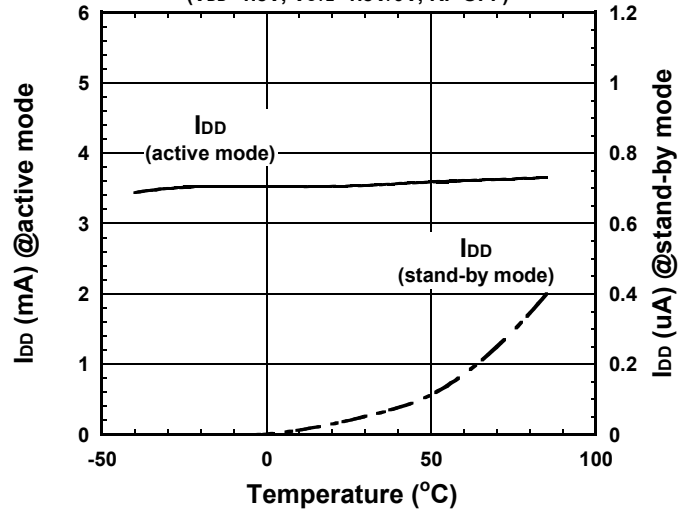
Gain, NF vs. Temperature

($V_{DD}=1.8V$, $V_{CTL}=1.8V$, $f_{RF}=1575MHz$)



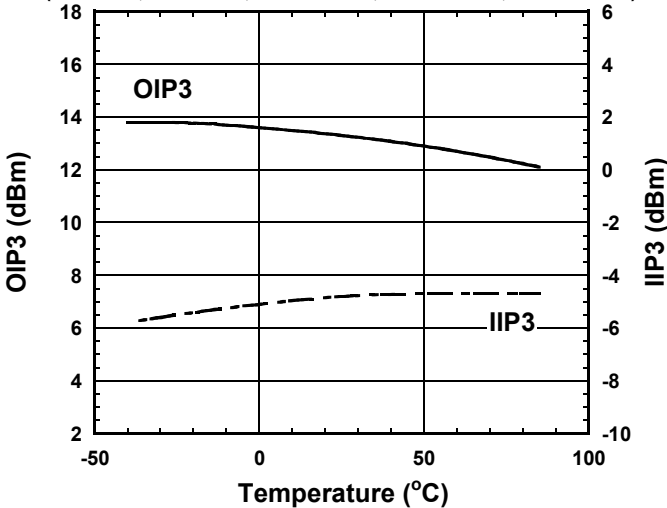
I_{DD} vs. Temperature

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



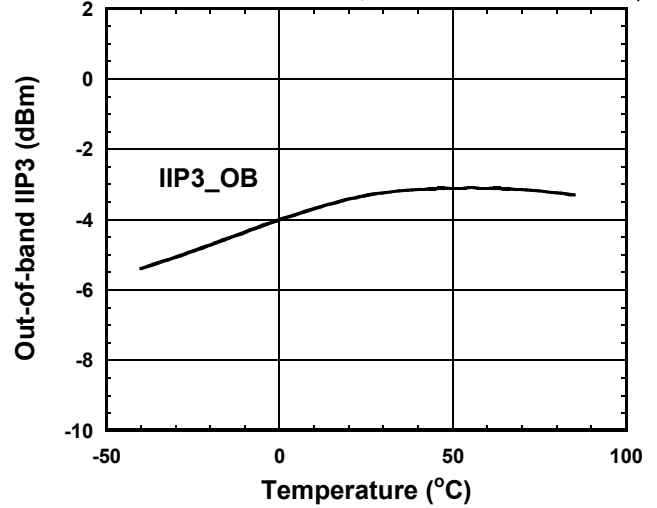
OIP3, IIP3 vs. Temperature

($V_{DD}=1.8V$, $V_{CTL}=1.8V$, $f_1=1575MHz$, $f_2=1576MHz$, $Pin=-30dBm$)



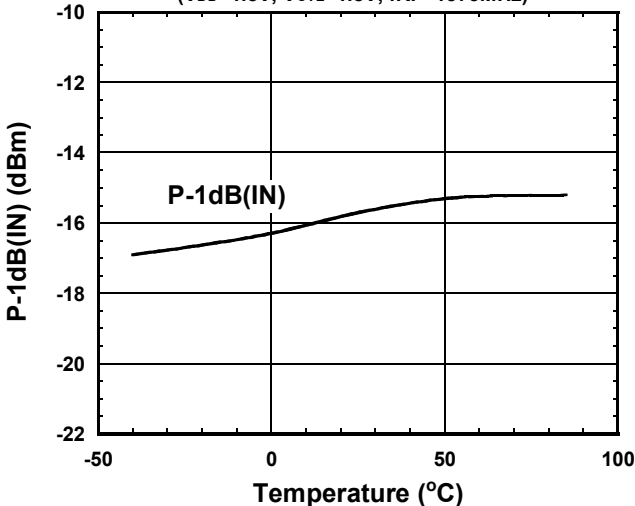
Out-of-band IIP3 vs. Temperature

($V_{DD}=1.8V$, $V_{CTL}=1.8V$, $f_{meas}=1575.4MHz$, $f_1=1712.7MHz$ at $Pin=-20dBm$, $f_2=1850MHz$ at $Pin=-20dBm$)



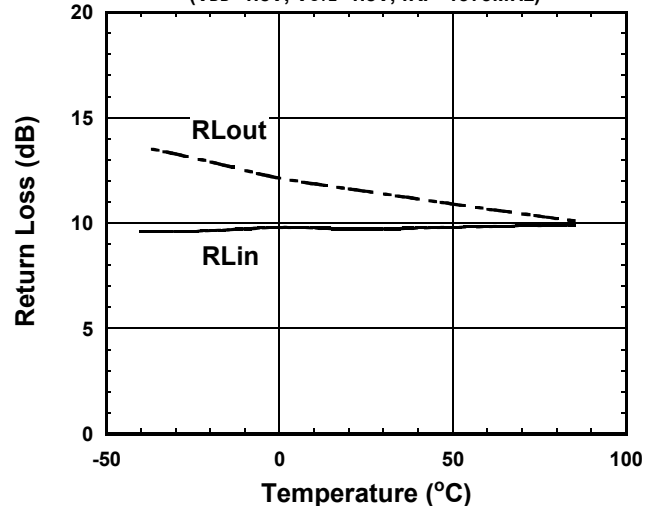
P-1dB(IN) vs. Temperature

($V_{DD}=1.8V$, $V_{CTL}=1.8V$, $f_{RF}=1575MHz$)



Return Loss vs. Temperature

($V_{DD}=1.8V$, $V_{CTL}=1.8V$, $f_{RF}=1575MHz$)

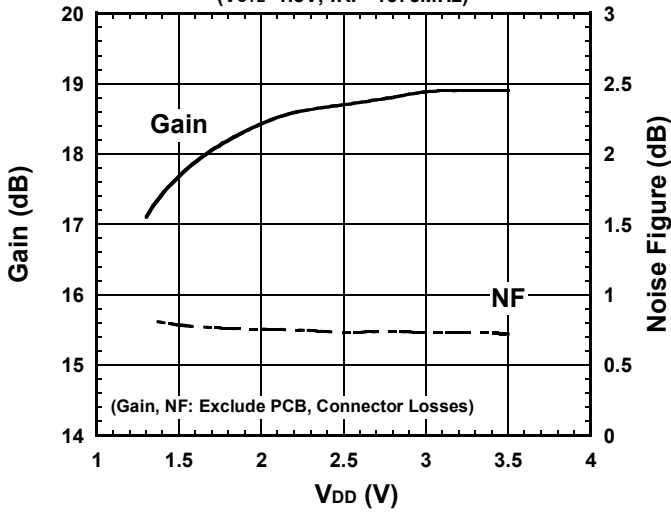


ELECTRICAL CHARACTERISTICS

Conditions: $V_{CTL}=1.8V$, $f_{RF}=1575MHz$, $T_a=25^\circ C$, $Z_s=Z_l=50\Omega$

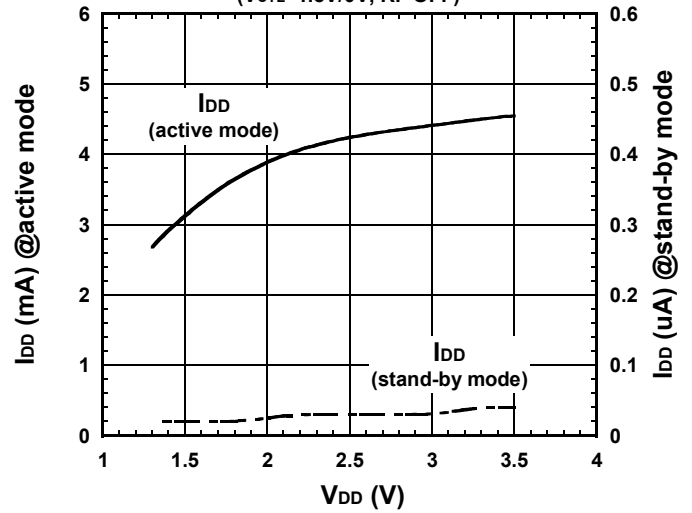
Gain, NF vs. VDD

($V_{CTL}=1.8V$, $f_{RF}=1575MHz$)



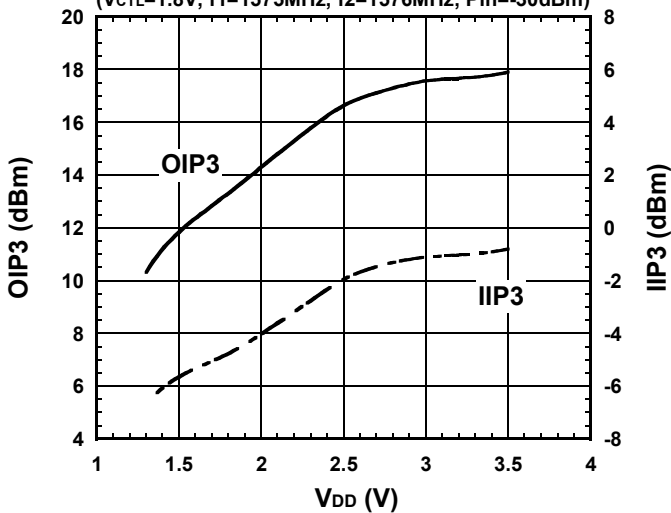
IDD vs. VDD

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



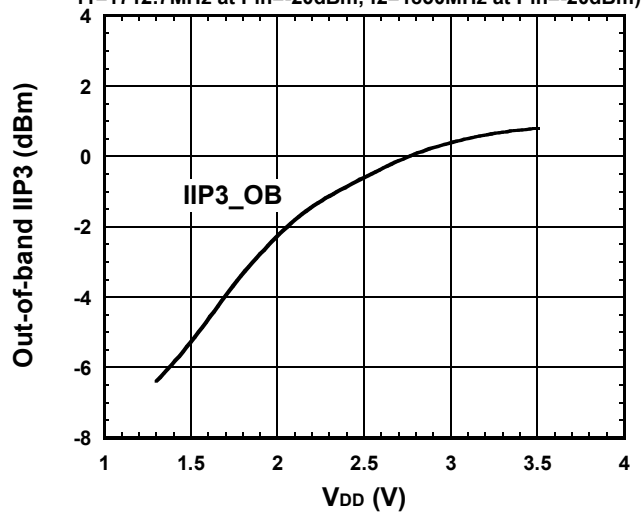
OIP3, IIP3 vs. VDD

($V_{CTL}=1.8V$, $f_1=1575MHz$, $f_2=1576MHz$, $Pin=-30dBm$)



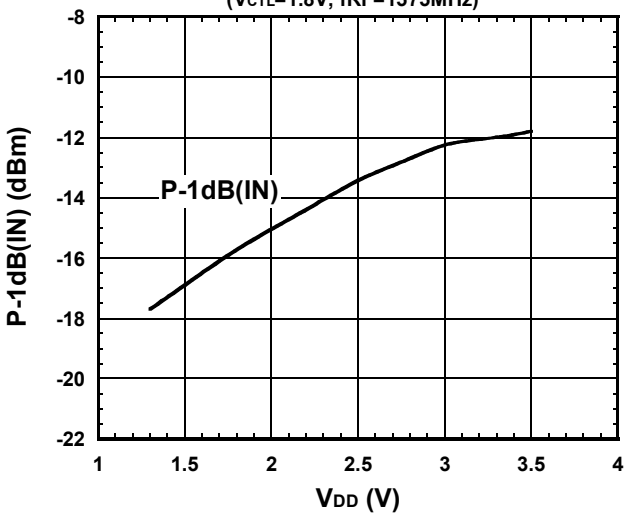
Out-of-band IIP3 vs. VDD

($V_{CTL}=1.8V$, $f_{meas}=1575.4MHz$, $f_1=1712.7MHz$ at $Pin=-20dBm$, $f_2=1850MHz$ at $Pin=-20dBm$)



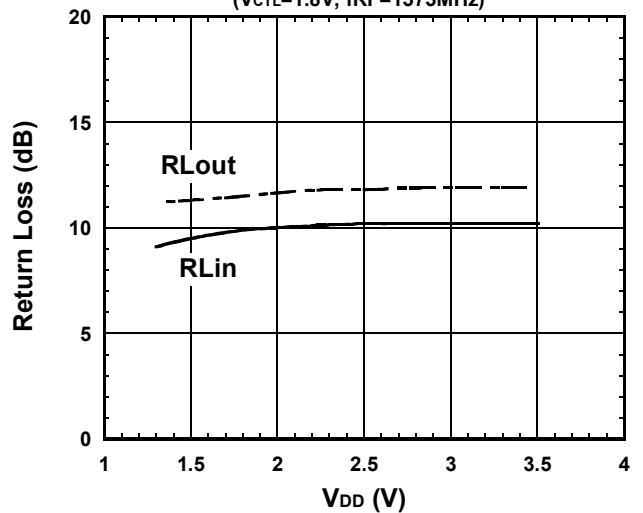
P-1dB(IN) vs. VDD

($V_{CTL}=1.8V$, $f_{RF}=1575MHz$)



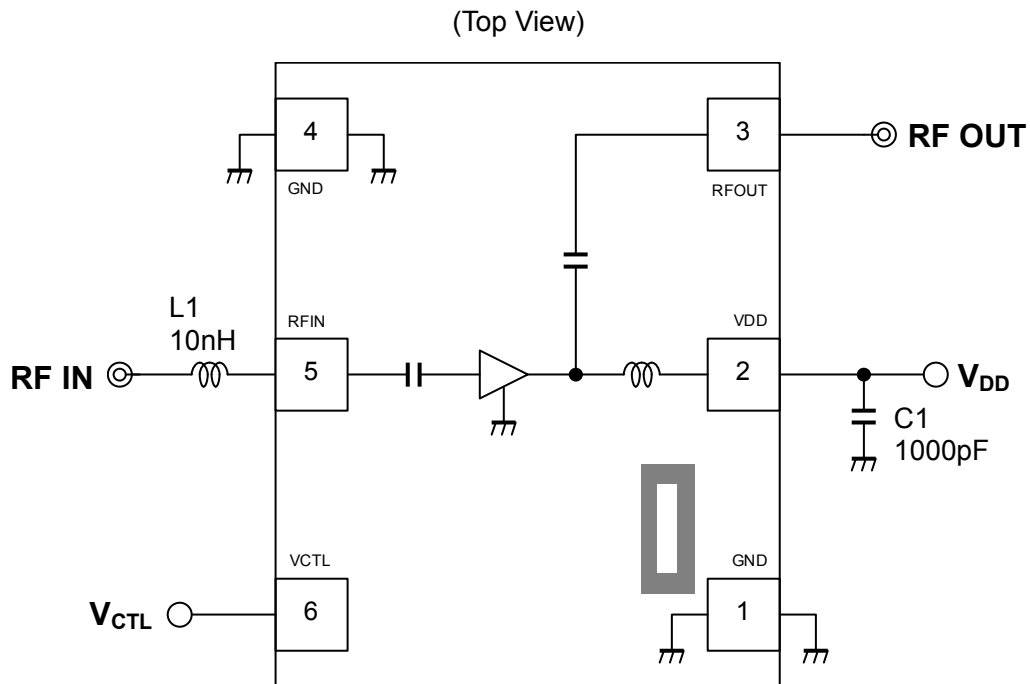
Return Loss vs. VDD

($V_{CTL}=1.8V$, $f_{RF}=1575MHz$)



NJG1155UX2

APPLICATION CIRCUIT

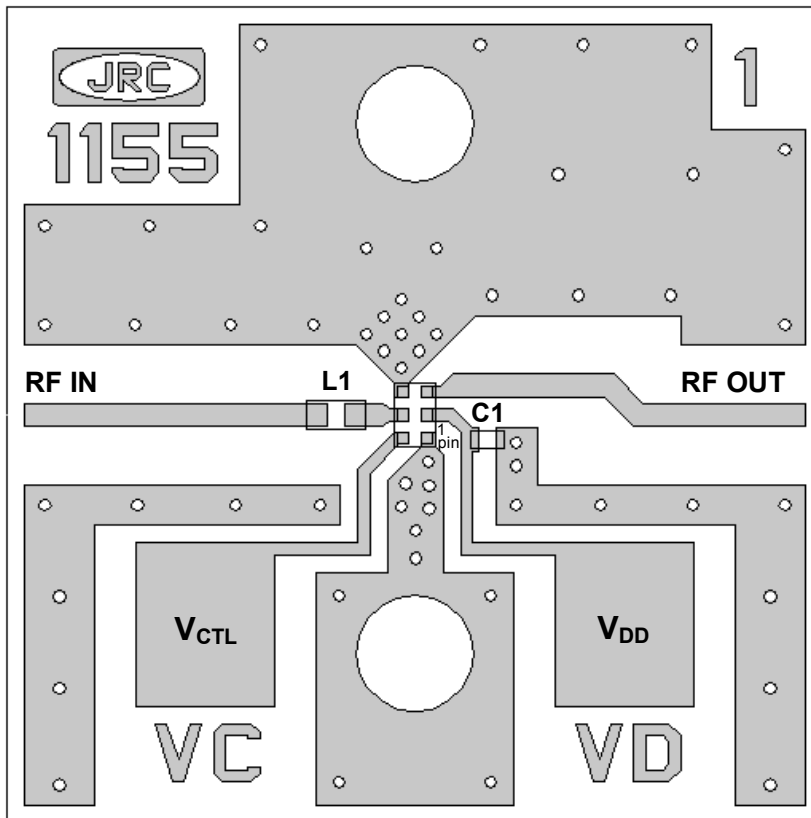


Parts list

| Parts ID | Manufacture |
|----------|-------------------------|
| L1 | LQG15HS Series (MURATA) |
| C1 | GRM03 Series (MURATA) |

■ EVALUATION BOARD

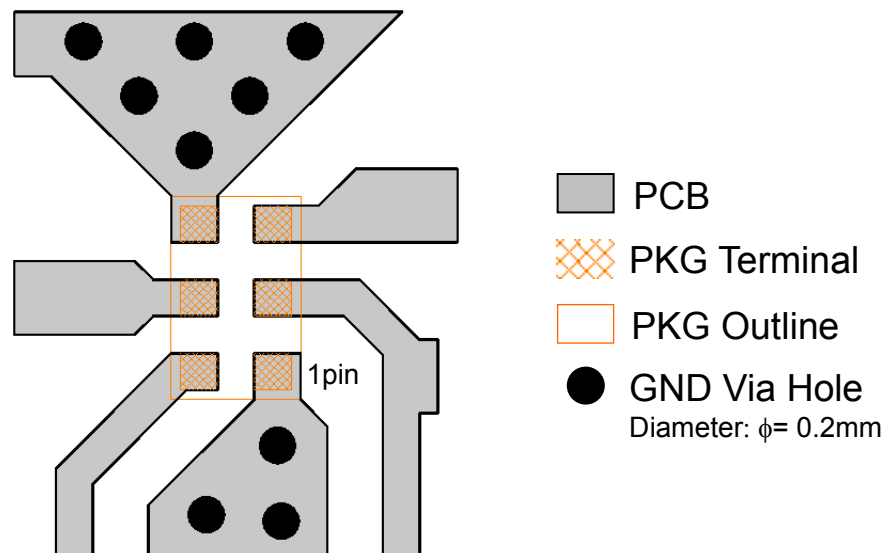
(Top View)



PCB Information

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

<PCB LAYOUT GUIDELINE>






PRECAUTIONS

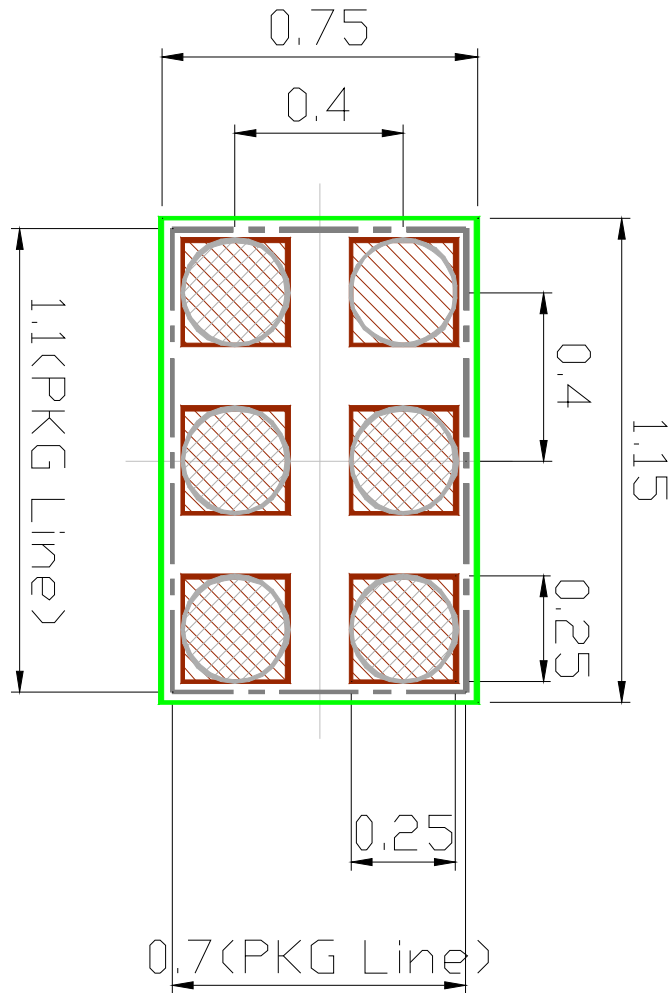
- All external parts should be placed as close as possible to the IC.
- For good RF performance, all GND terminals must be connected to PCB ground plane of substrate, and via-holes for GND should be placed near the IC.

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RECOMMENDED FOOTPRINT PATTERN (EPFFP6-X2 PACKAGE)

PKG: 1.1mm x 0.7mm
Pin pitch: 0.4mm

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



APPLICATION NOTE FOR ULTRA LOW NOISE FIGURE (Using LQW15A Series high-Q inductor)

This application note shows an example in order to achieve ultra low noise figure (NF).
LQW15A (MURATA) Series inductor is used for this application.

The example of electrical characteristics are shown as follows:

■ ELECTRICAL CHARACTERISTICS (DC)

General conditions: $T_a=+25^{\circ}\text{C}$, $Z_s=Z_i=50\Omega$

| PARAMETER | SYMBOL | CONDITIONS | MEASURED DATA | UNITS |
|------------------------------------|--------------|--|---------------|---------------|
| Supply Voltage | V_{DD} | | 2.8 / 1.8 | V |
| Control Voltage (High) | $V_{CTL(H)}$ | | 1.8 | V |
| Control Voltage (Low) | $V_{CTL(L)}$ | | 0 | V |
| Supply Current1 (Active mode) | I_{DD} | $V_{DD}=2.8\text{V}$, $V_{CTL}=1.8\text{V}$ | 4.13 | mA |
| Supply Current2 (Active mode) | I_{DD} | $V_{DD}=1.8\text{V}$, $V_{CTL}=1.8\text{V}$ | 3.43 | mA |
| Supply Current3 (Stand-by mode) | I_{DD} | $V_{DD}=2.8\text{V}$, $V_{CTL}=0\text{V}$ | 0.1 | μA |
| Supply Current4 (Stand-by mode) | I_{DD} | $V_{DD}=1.8\text{V}$, $V_{CTL}=0\text{V}$ | 0.0 | μA |
| Control Current | I_{CTL} | $V_{CTL}=1.8\text{V}$ | 6.6 | μA |

NJG1155UX2

■ Electrical characteristics (RF, V_{DD}=2.8V)

General conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=1550 to 1615MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

| PARAMETER | SYMBOL | CONDITIONS | MEASURED DATA | UNITS |
|---|-----------------------|--|----------------|-------|
| Small Signal Gain | Gain | Exclude PCB and connector losses (0.18dB) | 19.0 to 19.1 | dB |
| Noise Figure | NF | Exclude PCB and connector losses (0.08dB) | 0.56 to 0.59 | dB |
| Input Power at 1dB Gain Compression Point | P _{-1dB(IN)} | | -13.6 to -13.2 | dBm |
| Input 3rd Order Intercept Point | IIP3 | f ₁ =f _{RF} , f ₂ =f ₁ +/-1MHz, Pin=-30dBm | -2.1 | dBm |
| Out of Band Input 3 rd Order Intercept Point | IIP3_OB | f ₁ =1712.7MHz, Pin=-20dBm, f ₂ =1850MHz, Pin=-20dBm, f _{meas} =1575.4MHz | -0.4 | dBm |
| RF IN Port Return Loss | RLi | | 8.8 to 10.3 | dB |
| RF OUT Port Return Loss | RLo | | 11.1 to 11.8 | dB |

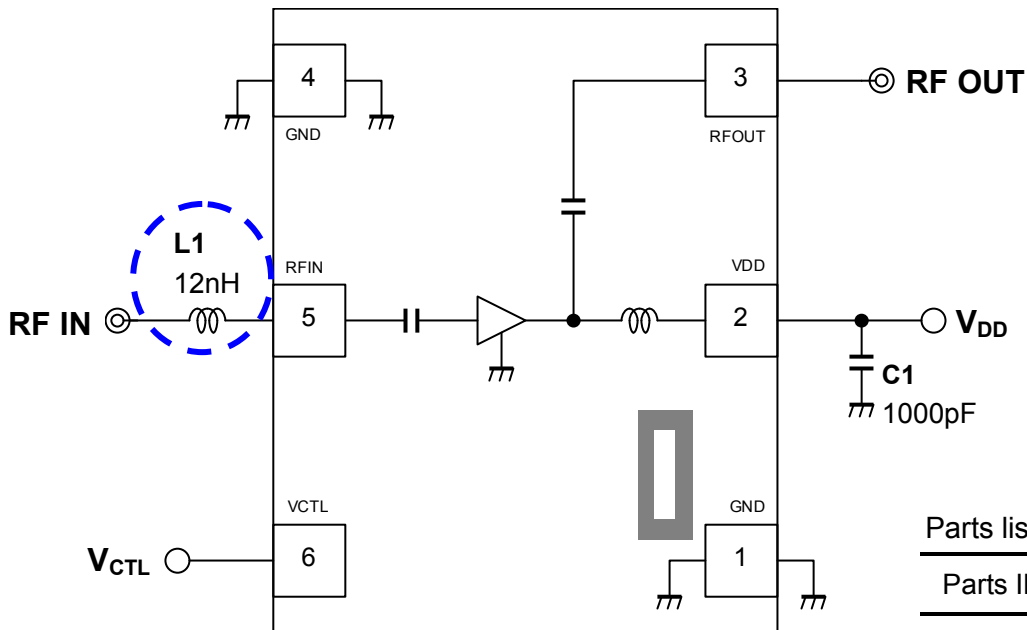
■ ELECTRICAL CHARACTERISTICS (RF, V_{DD}=1.8V)

General conditions: V_{DD}=1.8V, V_{CTL}=1.8V, f_{RF}=1550 to 1615MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

| PARAMETER | SYMBOL | CONDITIONS | MEASURED DATA | UNITS |
|---|------------------------|--|----------------|-------|
| Small Signal Gain | Gain | Exclude PCB and connector losses (0.18dB) | 18.3 to 18.5 | dB |
| Noise Figure | NF | Exclude PCB and connector losses (0.08dB) | 0.59 to 0.62 | dB |
| Input Power at 1dB Gain Compression Point | P _{-1dB (IN)} | | -16.5 to -16.1 | dBm |
| Input 3rd Order Intercept Point | IIP3 | f ₁ =f _{RF} , f ₂ =f ₁ +/-1MHz, Pin=-30dBm | -5.3 | dBm |
| Out of Band Input 3rd Order Intercept Point | IIP3_OB | f ₁ =1712.7MHz, Pin=-20dBm, f ₂ =1850MHz, Pin=-20dBm, f _{meas} =1575.4MHz | -3.6 | dBm |
| RF IN Port Return Loss | RLi | | 8.4 to 9.8 | dB |
| RF OUT Port Return Loss | RLo | | 10.3 to 11.5 | dB |

APPLICATION CIRCUIT (Using LQW15A Series high-Q inductor)

(Top View)

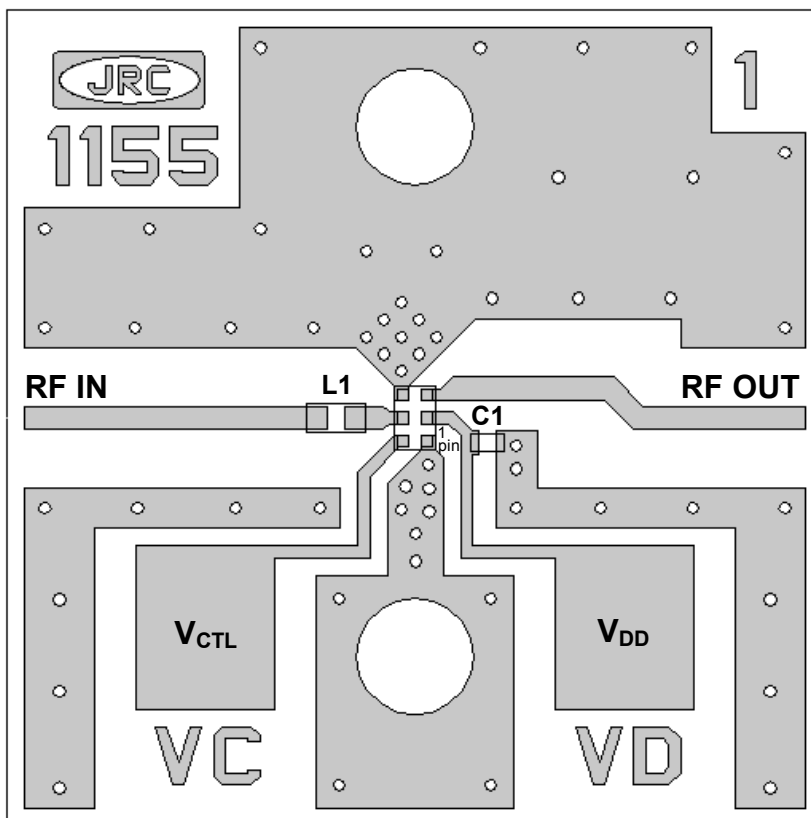


Parts list

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

EVALUATION BOARD (Using LQW15A Series high-Q inductor)

(Top View)



PCB Information

Material: FR-4
 Thickness: 0.2mm
 Microstrip line width: 0.4mm ($Z_0=50\Omega$)
 Outline size: 14.0mm x 14.0mm

NJG115UX2

■ NOISE FIGURE MEASUREMENT BLOCK DIAGRAM

Measuring instruments

NF Analyzer : Agilent N8973A
Noise Source : Agilent 346A

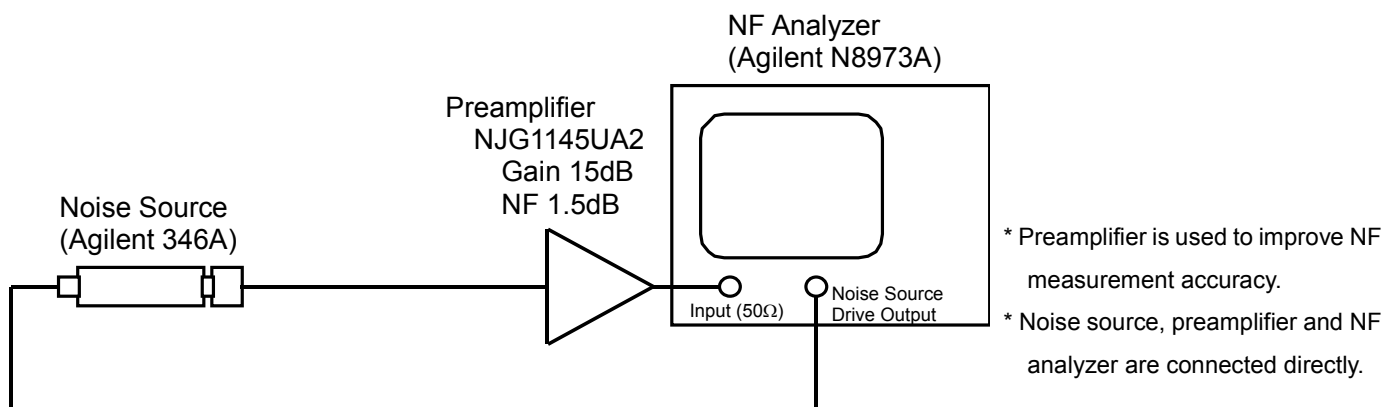
Setting the NF analyzer

Measurement mode form

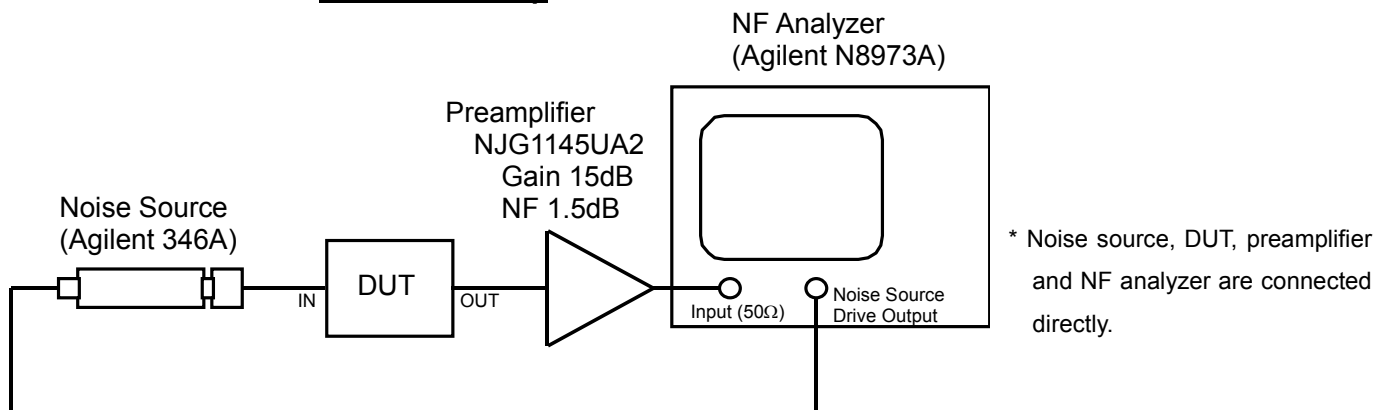
Device under test : Amplifier
System downconverter : off

Mode setup form

Sideband : LSB
Averages : 16
Average mode : Point
Bandwidth : 4MHz
Loss comp : off
Tcold : setting the temperature of noise source (303.15K)



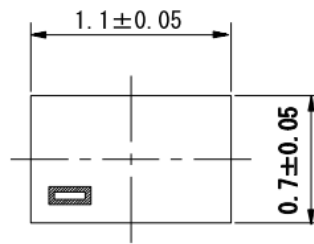
Calibration setup



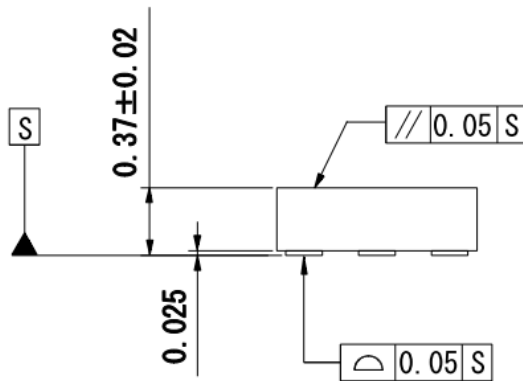
Measurement Setup

PACKAGE OUTLINE (EPFFP6-X2)

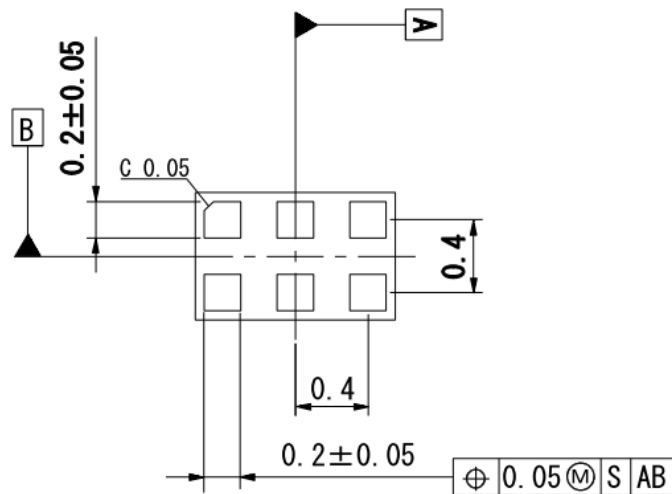
TOP VIEW



SIDE VIEW



BOTTOM VIEW



| | |
|------------------|---------------|
| Unit | : mm |
| Substrate | : FR4 |
| Terminal treat | : Au |
| Molding material | : Epoxy resin |
| Weight (typ.) | : 0.7mg |

Cautions on using this product

This product contains Gallium-Arsenide (GaAs) which is a harmful material.

- Do NOT eat or put into mouth.
- Do NOT dispose in fire or break up this product.
- Do NOT chemically make gas or powder with this product.
- To waste this product, please obey the relating law of your country.

[CAUTION]

The specifications on this databook are only given for information, without any guarantee as regards either mistakes or omissions.

The application circuits in this databook are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial rights.

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

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