Satellite Broadcasting Application

1. Summary

The characterisitics of Sastellite Broadcasting (1000MHz～2150MHz) have evaluated as follows. The evaluation circuit structure and measured data are reviewed.

2.1 Measurement data of assembled evaluation board

DC Characteristics

Condition : V_{DD}=5.0V, T_a=+25°C

Parameter	Symbol	Condition	Mesurement data	Units
Supply Voltage	V_{DD}		5.0	V
Operating Current	I_{DD}	RF OFF	124.1	mA

2.2-1 Measurement data of assembled evaluation board <50ohm>

RF Characteristics1 (Active mode)

Condition : V_{DD}=5.0V, f_{RF}=1000~2150MHz, T_a=+25°C, Z_s=Z_l=50ohm, with application circuit

Parameter	Symbol	Condition	Mesurement data	Units
Small Signal Gain 1	Gain1	Exclude PCB, connector losses *1*2	2.2 ~ 3.7	dB
Noise Figure 1	NF1	Exclude PCB, connector losses *3	3.4 ~ 4.2	dB
Input Power 1dB Compression 1	P-1dB(IN)1		+7.5 ~ +10.4	dBm
Input 3rd Order Intercept Point 1	IIP3_1	f1=fRF, f2=fRF+100kHz, Pin=-14dBm	+14.0 ~ +21.9	dBm
2nd order intermodulation distortion 1	IM2_1	f1=40/200/494/40/1150MHz, f2=960/800/506/1040/2150MHz, fmeas=1000MHz, Pin1=Pin2=-8dBm	44.1 ~ 54.8	dB
3rd order intermodulation distortion 1	IM3_1	f1=40/920/1080/2150MHz, f2=520/960/1040/1575MHz, fmeas=1000MHz, Pin1=Pin2=-8dBm	60.5 ~ 68.2	dB
Reverse Isolation 1	ISL1	RF OUT1 - RF IN RF OUT2 - RF IN	22.0 ~ 36.8	dB
Output to Output Isolation 1	OISL1	RF OUT1 - RF OUT2	14.6 ~ 27.0	dB
RF IN port Return Loss 1	RLi1	RF IN port	6.4 ~ 10.9	dB
RF OUT port Return Loss 1	RLo1	RF OUT1, RF OUT2 port	11.4 ~ 29.4	dB

*1 Input and output PCB, connector losses(RFIN-RFOUT1): 0.156dB(1000MHz), 0.238dB(1600MHz), 0.307dB(2150MHz)
*2 Input and output PCB, connector losses(RFIN-RFOUT2): 0.150dB(1000MHz), 0.228dB(1600MHz), 0.294dB(2150MHz)
*3 Input PCB, connector losses: 0.064dB(1000MHz), 0.095dB(1600MHz), 0.122dB(2150MHz)

2.2-2 Measurement data of assembled evaluation board <50ohm>

RF Characteristics3 (Active mode)

Condition : V_{DD}=5.0V, f_{RF}=1000~2150MHz, T_a=+25°C, Z_s=Z_l=75ohm, with application circuit

Parameter	Symbol	Condition	Mesurement data	Units
Small Signal Gain(75ohm) 3	Gain3	Exclude PCB, connector losses *1*2	1.9 ~ 4.1	dB
Reverse Isolation 3	ISL3	RF OUT1 - RF IN RF OUT2 - RF IN	22.1 ~ 36.8	dB
Output to Output Isolation 3	OISL3	RF OUT1 - RF OUT2	14.9 ~ 27.5	dB
RF IN port Return Loss (75ohm) 3	RLi3	RF IN port	6.5 ~ 11.7	dB
RF OUT port Return Loss (75ohm) 3	RLo3	RF OUT1, RF OUT2 port	9.6 ~ 13.1	dB

*1 Input and output PCB, connector losses(RFIN-RFOUT1)
*2 Input and output PCB, connector losses(RFIN-RFOUT2)

2.3-1 Measurement data of assembled evaluation board <75ohm>

RF Characteristics3 (Active mode)

Condition : V_{DD}=5.0V, f_{RF}=1000~2150MHz, T_a=+25°C, Z_s=Z_l=75ohm, with application circuit

Parameter	Symbol	Condition	Mesurement data	Units
Small Signal Gain(75ohm) 3	Gain3	Exclude PCB, connector losses *1*2	1.9 ~ 4.1	dB
Reverse Isolation 3	ISL3	RF OUT1 - RF IN RF OUT2 - RF IN	22.1 ~ 36.8	dB
Output to Output Isolation 3	OISL3	RF OUT1 - RF OUT2	14.9 ~ 27.5	dB
RF IN port Return Loss (75ohm) 3	RLi3	RF IN port	6.5 ~ 11.7	dB
RF OUT port Return Loss (75ohm) 3	RLo3	RF OUT1, RF OUT2 port	9.6 ~ 13.1	dB

*1 Input and output PCB, connector losses(RFIN-RFOUT1)
*2 Input and output PCB, connector losses(RFIN-RFOUT2)

2-3-2 Measurement data of assembled evaluation board <75ohm>

RF Characteristics4 (Through mode)

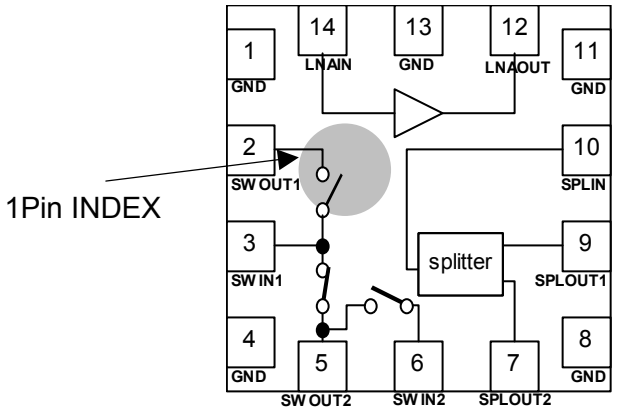
Condition : V_{DD}=0V, f_{RF}=1000~2150MHz, T_a=+25°C, Z_s=Z_l=75ohm, with application circuit

Parameter	Symbol	Condition	Mesurement data	Units
Insertion Loss (75ohm) 4	Loss4	Exclude PCB, connector losses *2	1.8 ~ 2.4	dB
RF IN port Return Loss (75ohm) 4	RLi4	RF IN port	5.1 ~ 8.1	dB
RF OUT port Return Loss (75ohm) 4	RLo4	RF OUT1, RF OUT2 port	5.3 ~ 9.3	dB

*2 Input and output PCB, connector losses(RFIN-RFOUT2)

3. Pin configuration

EQFN14-D7
(Top View)



Pin connection
1. GND
2. SWOUT1
3. SWIN1
4. GND
5. SWOUT2
6. SWIN2
7. SPLOUT2
8. GND
9. SPLOUT1
10. SPLIN1
11. GND
12. LNAOUT
13. GND
14. LNAIN

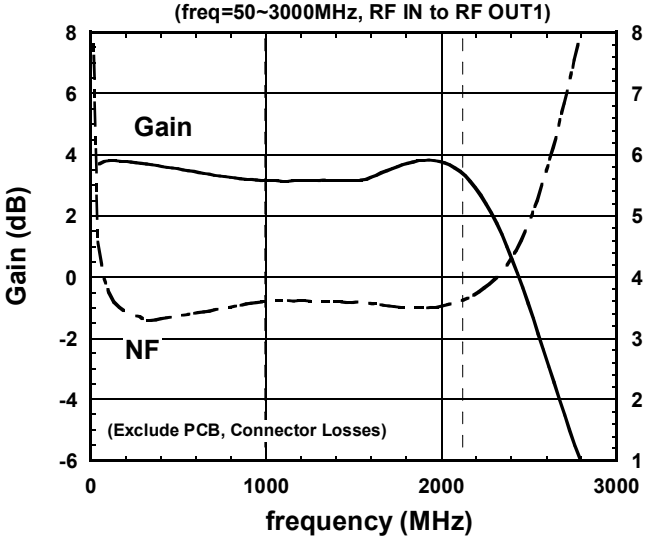
4. Function state table

V_{DD}	LNA	Loop through SW	RF IN to RF OUT1	RF IN to RF OUT2
0V	OFF	ON	Isolate mode (-22dB)	Through mode (-2dB)
5.0V	ON	OFF	Active mode (3dB)	Active mode (3dB)

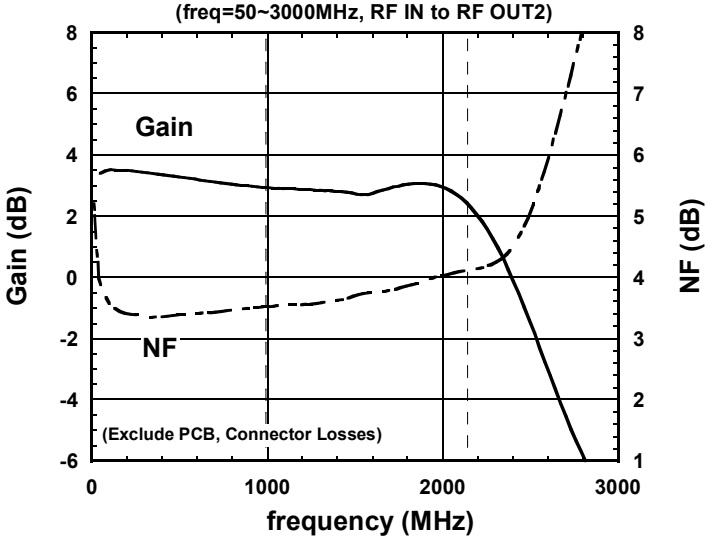
5.1-1 Typical characteristics (Active Mode) <50ohm>

Condition : V_{DD}=5.0V, Ta=+25°C, Z_s=Z_l=50ohm

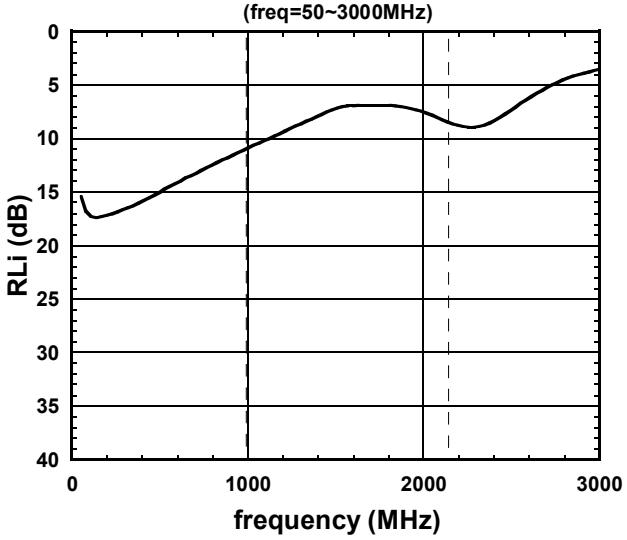
NF, Gain vs. frequency
(freq=50~3000MHz, RF IN to RF OUT1)



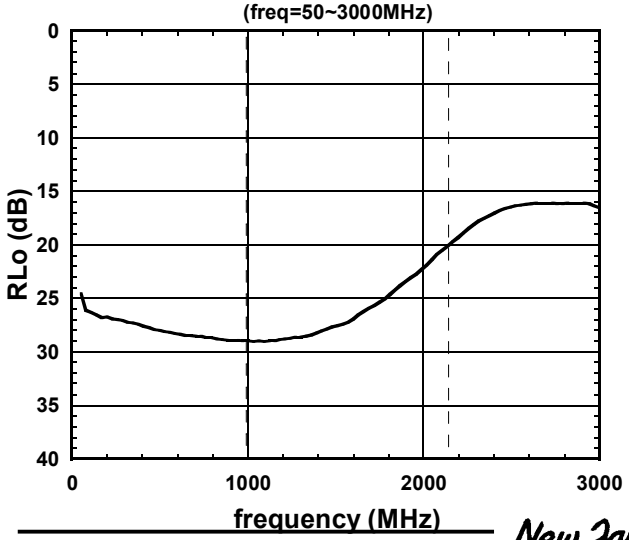
NF, Gain vs. frequency
(freq=50~3000MHz, RF IN to RF OUT2)



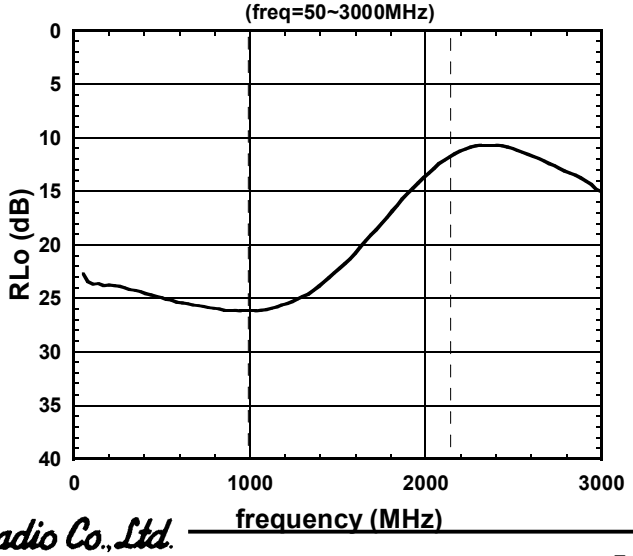
RF IN Return Loss vs. frequency
(freq=50~3000MHz)



RF OUT1 Return Loss vs. frequency
(freq=50~3000MHz)



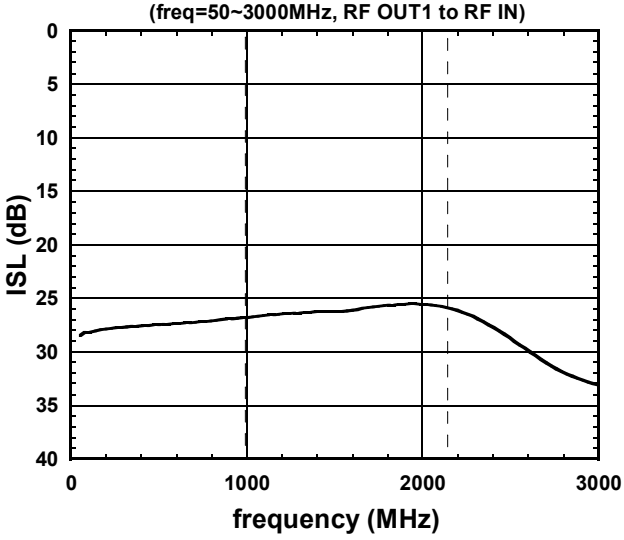
RF OUT2 Return Loss vs. frequency
(freq=50~3000MHz)



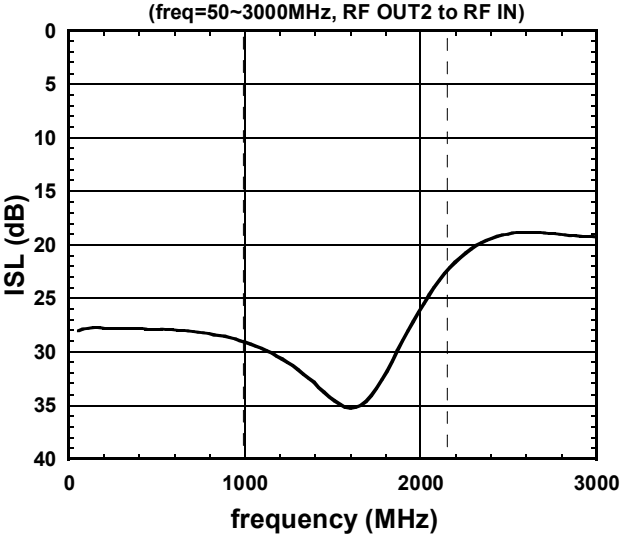
5.1-1 Typical characteristics (Active Mode) <50ohm>

Condition : V_{DD}=5.0V, Ta=+25°C, Z_s=Z_l=50ohm

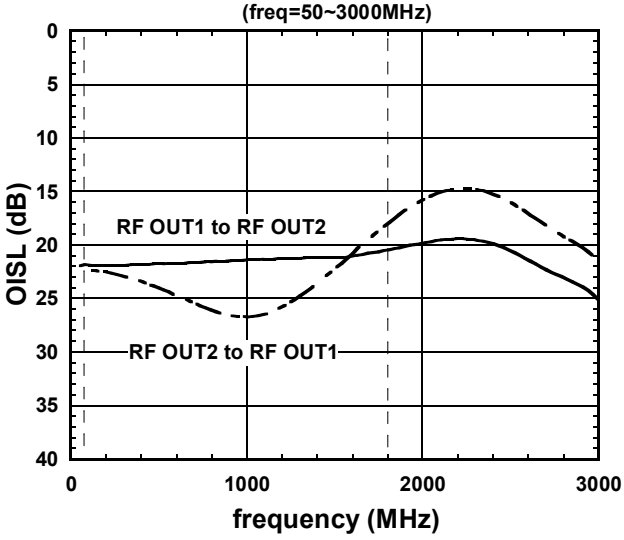
Reverse Isolation vs. frequency
(freq=50~3000MHz, RF OUT1 to RF IN)



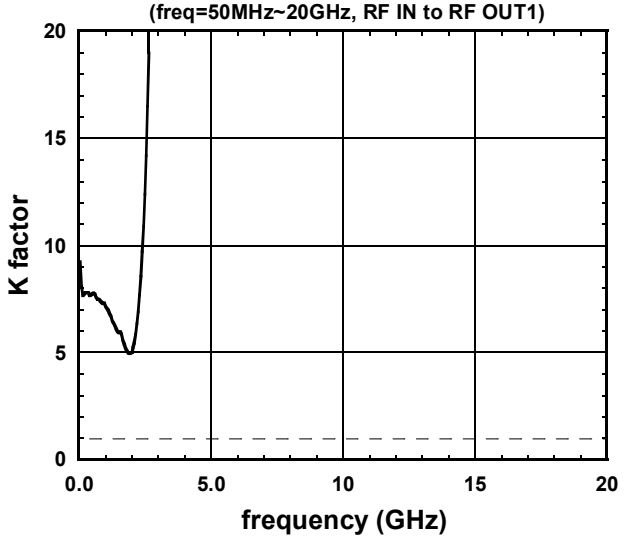
Reverse Isolation vs. frequency
(freq=50~3000MHz, RF OUT2 to RF IN)



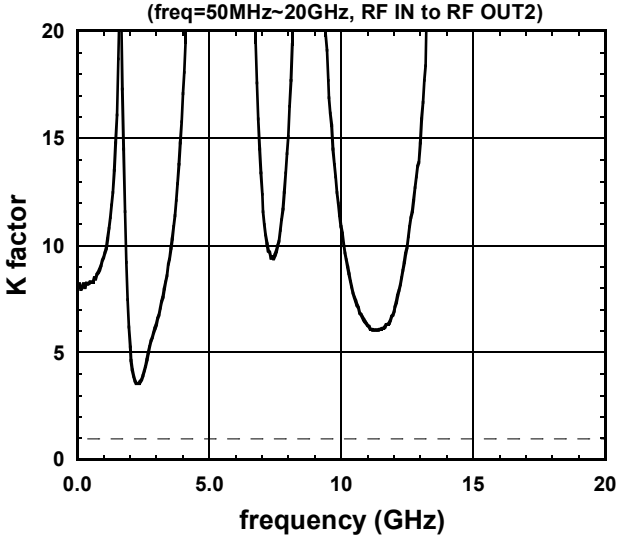
Output to Output Isolation vs. frequency
(freq=50~3000MHz)



K factor vs. frequency
(freq=50MHz~20GHz, RF IN to RF OUT1)

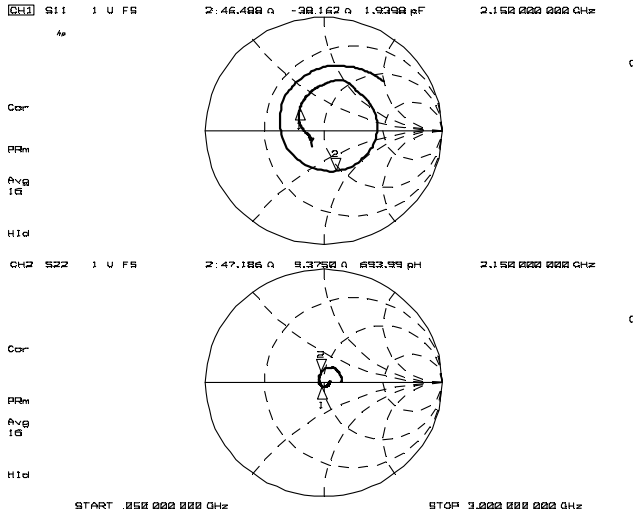


K factor vs. frequency
(freq=50MHz~20GHz, RF IN to RF OUT2)

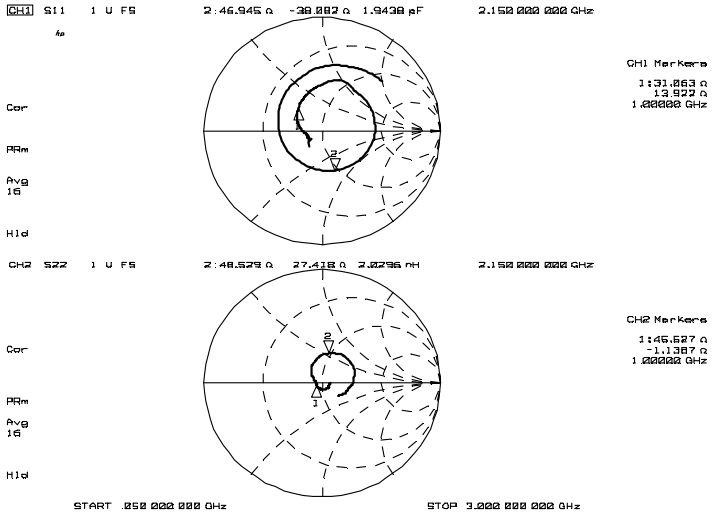


5.1-1 Typical characteristics (Active Mode) <50ohm>

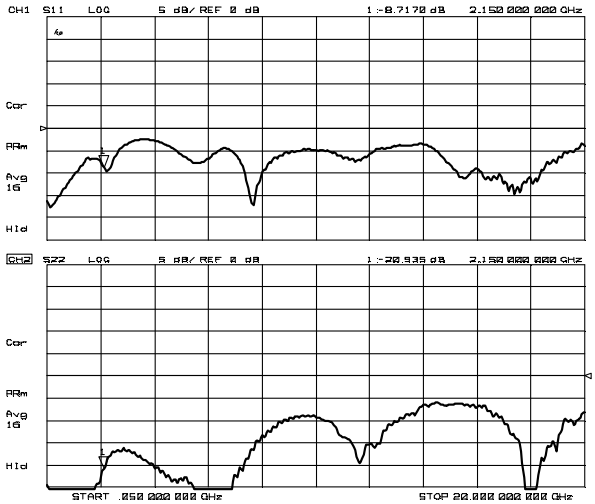
Condition : V_{DD}=5.0V, Ta=+25°C, Z_s=Z_l=50ohm



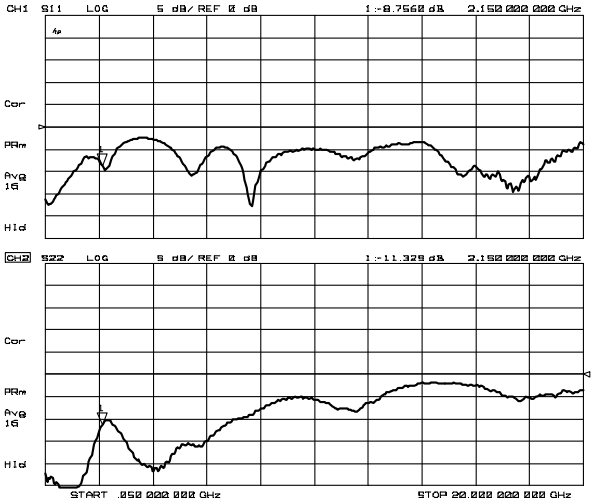
Zin, Zout (RF IN to RF OUT1)



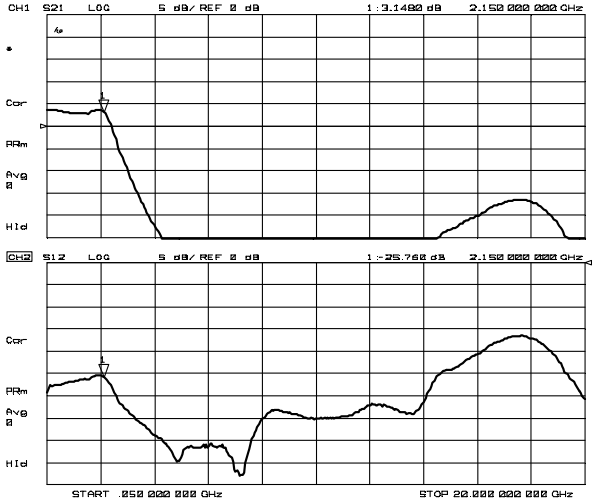
Zin, Zout(RF IN to RF OUT2)



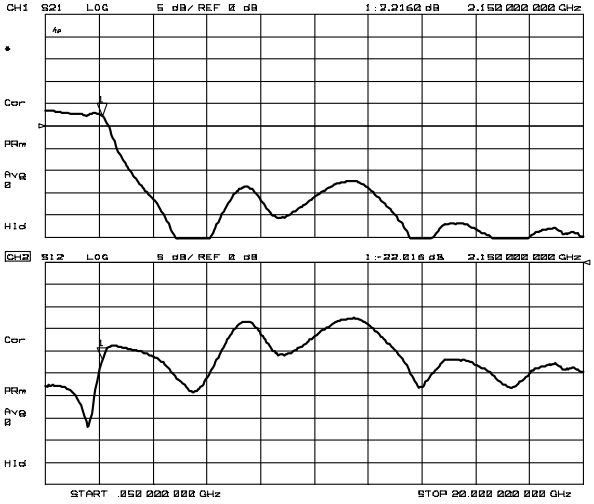
S11, S22 f=50MHz~20GHz (RF IN to RF OUT1)



S11, S22 f=50MHz~20GHz (RF IN to RF OUT2)



S21, S12 f=50MHz~20GHz (RF IN to RF OUT1)

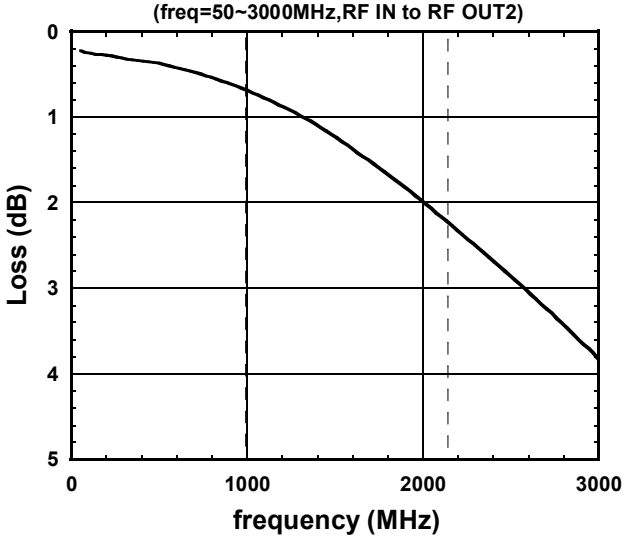


S21, S12 f=50MHz~20GHz (RF IN to RF OUT2)

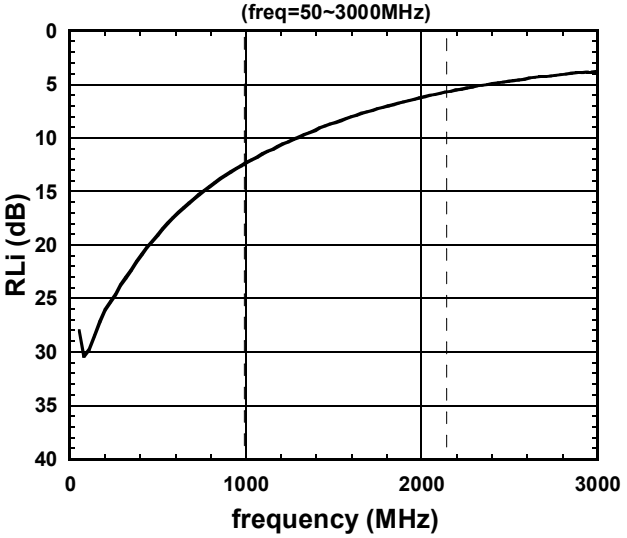
5.1-2 Typical characteristics (Through Mode) <50ohm>

Condition : V_{DD}=0V, Ta=+25°C, Z_s=Z_l=50ohm

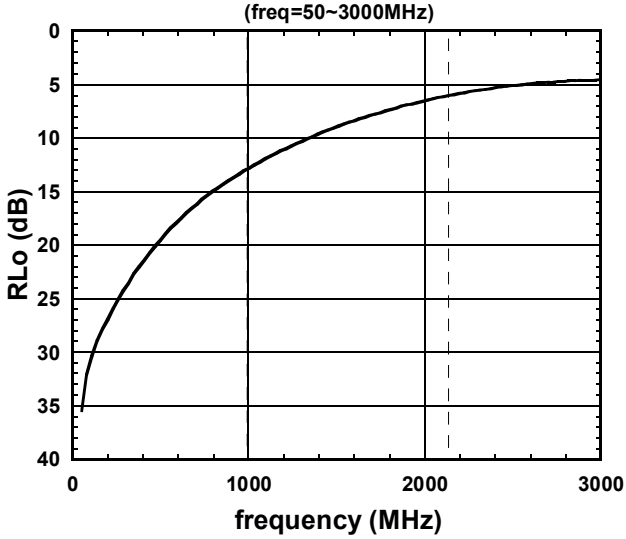
Insertion Loss vs. frequency
(freq=50~3000MHz,RF IN to RF OUT2)



RF IN Return Loss vs. frequency
(freq=50~3000MHz)

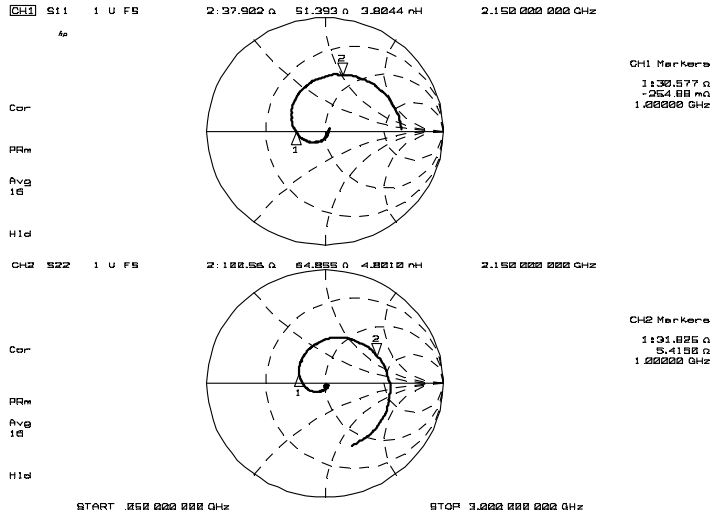


RF OUT2 Return Loss vs. frequency
(freq=50~3000MHz)

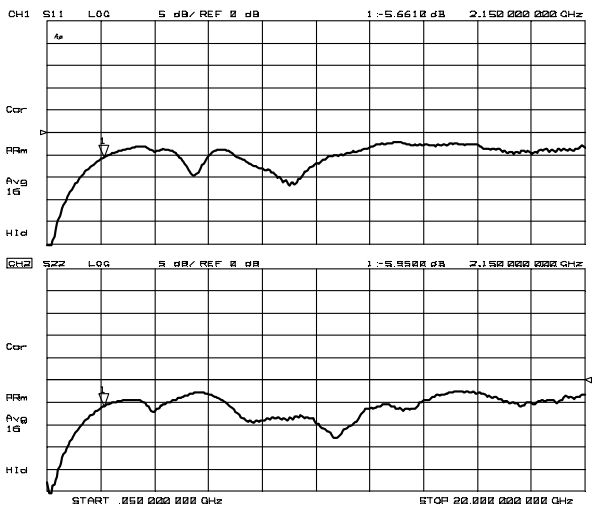


5.1-2 Typical characteristics (Through Mode) <50ohm>

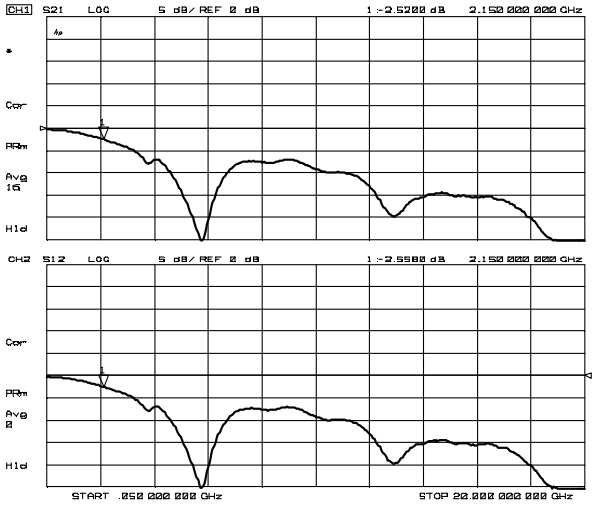
Condition : V_{DD}=0V, Ta=+25°C, Z_s=Z_l=50ohm



Zin, Zout(RF IN to RF OUT2)



S11, S22 f=50MHz~20GHz (RF IN to RF OUT2)

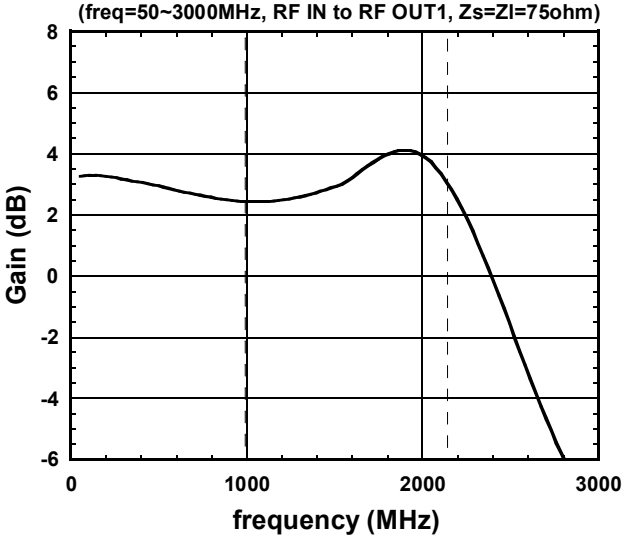


S21, S12 f=50MHz~20GHz (RF IN to RF OUT2)

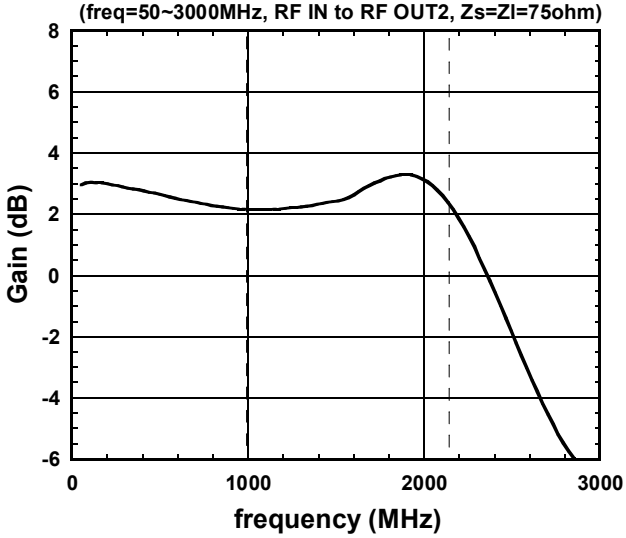
5.2-1 Typical characteristics (Active Mode) <75ohm>

Condition : V_{DD}=5.0V, Ta=+25°C, Z_s=Z_l=75ohm

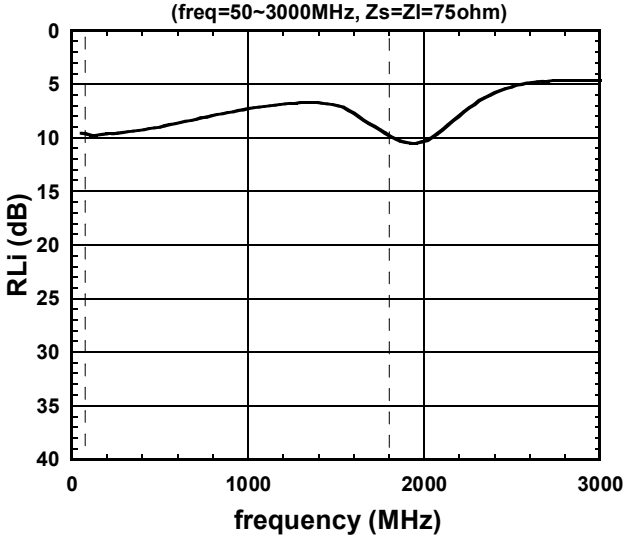
Gain vs. frequency
(freq=50~3000MHz, RF IN to RF OUT1, Zs=Zl=75ohm)



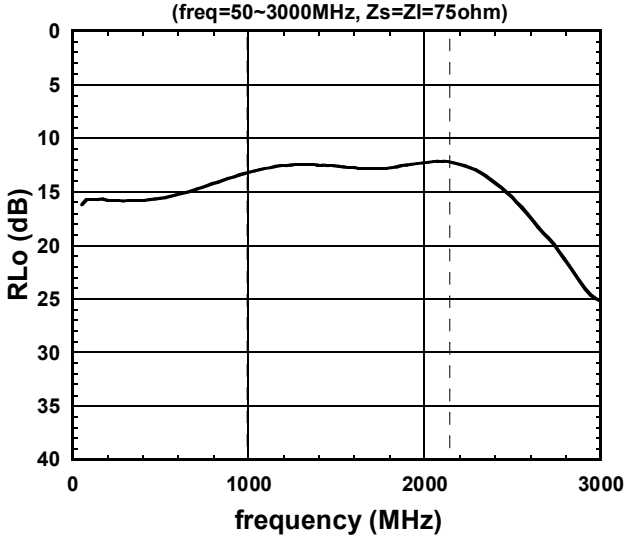
Gain vs. frequency
(freq=50~3000MHz, RF IN to RF OUT2, Zs=Zl=75ohm)



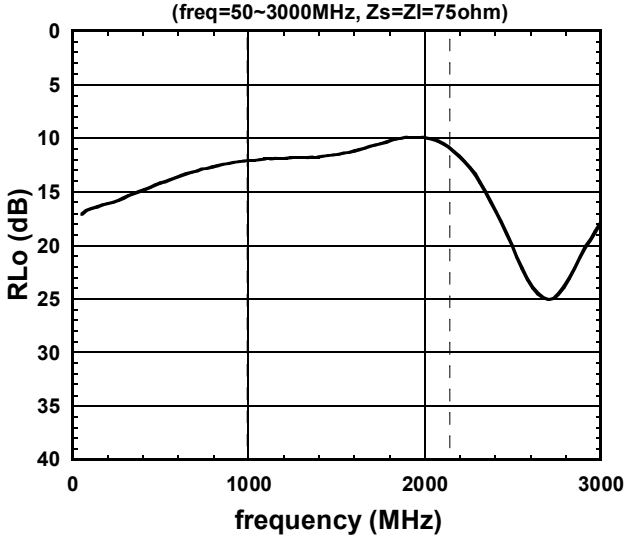
RF IN Return Loss vs. frequency
(freq=50~3000MHz, Zs=Zl=75ohm)



RF OUT1 Return Loss vs. frequency
(freq=50~3000MHz, Zs=Zl=75ohm)

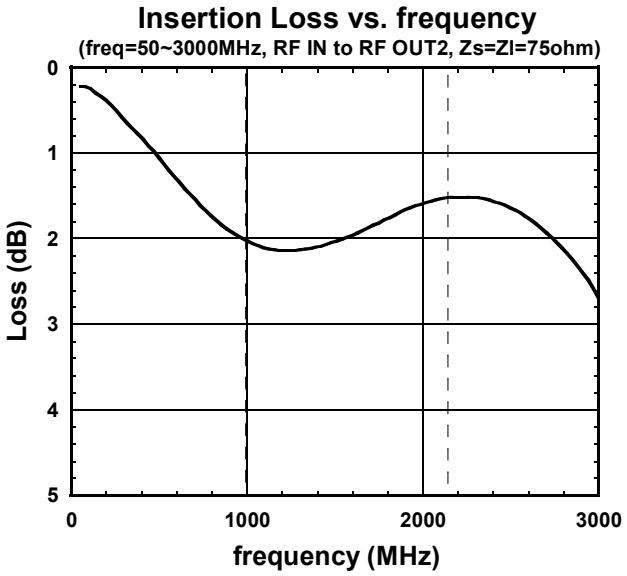


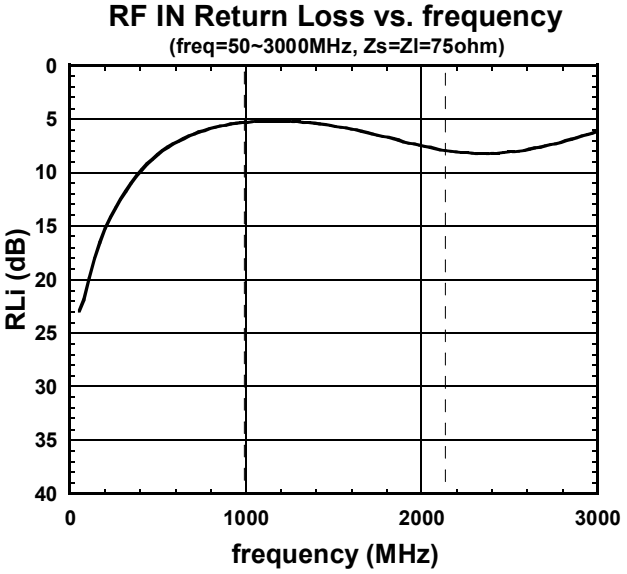
RF OUT2 Return Loss vs. frequency
(freq=50~3000MHz, Zs=Zl=75ohm)

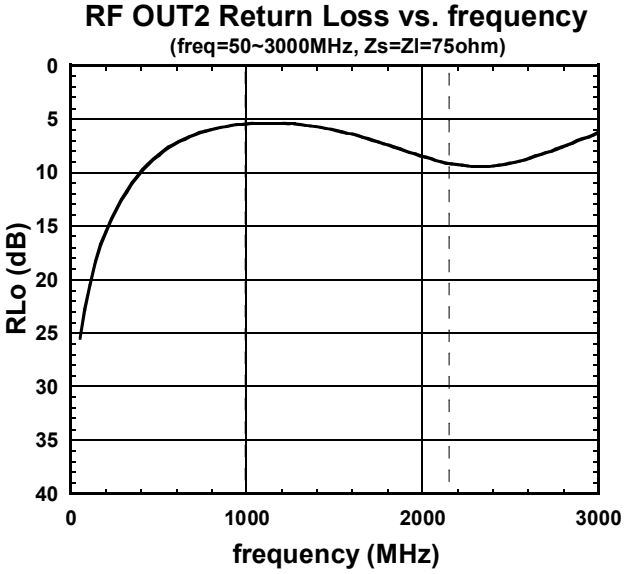


5.2-2 Typical characteristics (Through Mode) <75ohm>

Condition : V_{DD}=0V, Ta=+25°C, Z_s=Z_l=75ohm







6. Noise figure measurements

Measuring instruments

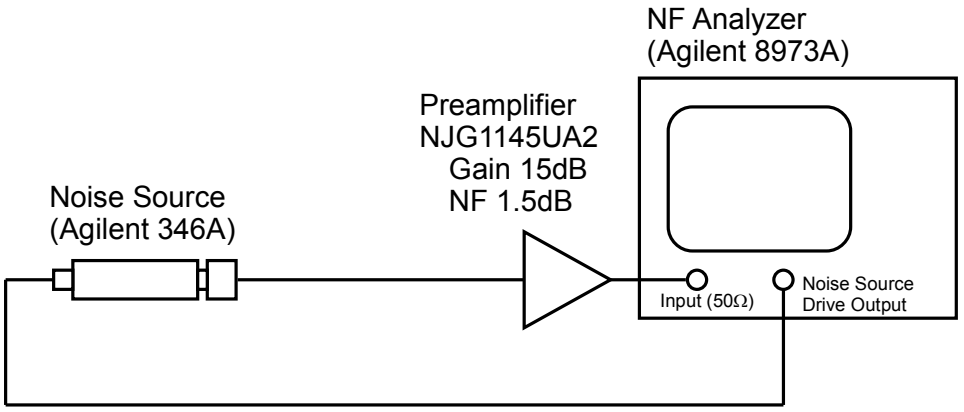
NF Analyzer : Agilent 8973A
Noise Source : Agilent 346A

Setting the NF analyzer

Measurement mode form
- Device under test : Amplifier
- System downconverter : off

Mode setup form
- Sideband : LSB

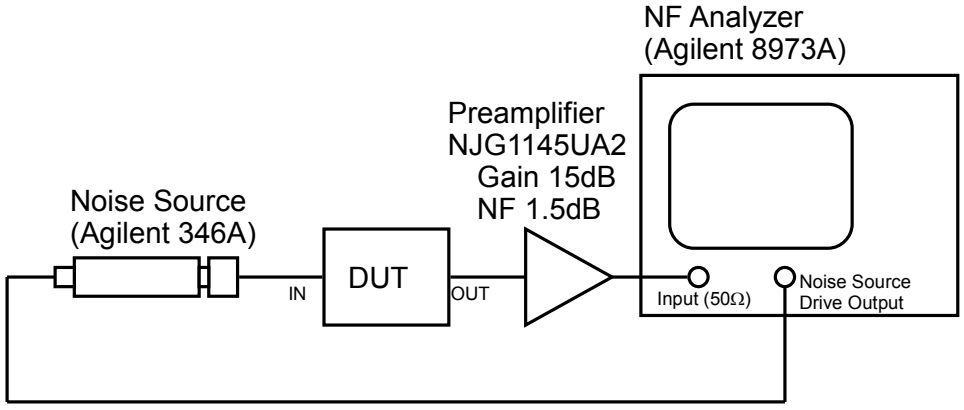
Averages : 4
Average mode : Point
Bandwidth : 4MHz
Loss comp : off
Tcold : setting the temperature of noise source (303K)



* Preamplifier is to improve NF measurement accuracy.

* Noise source and NF analyzer are connected directly.

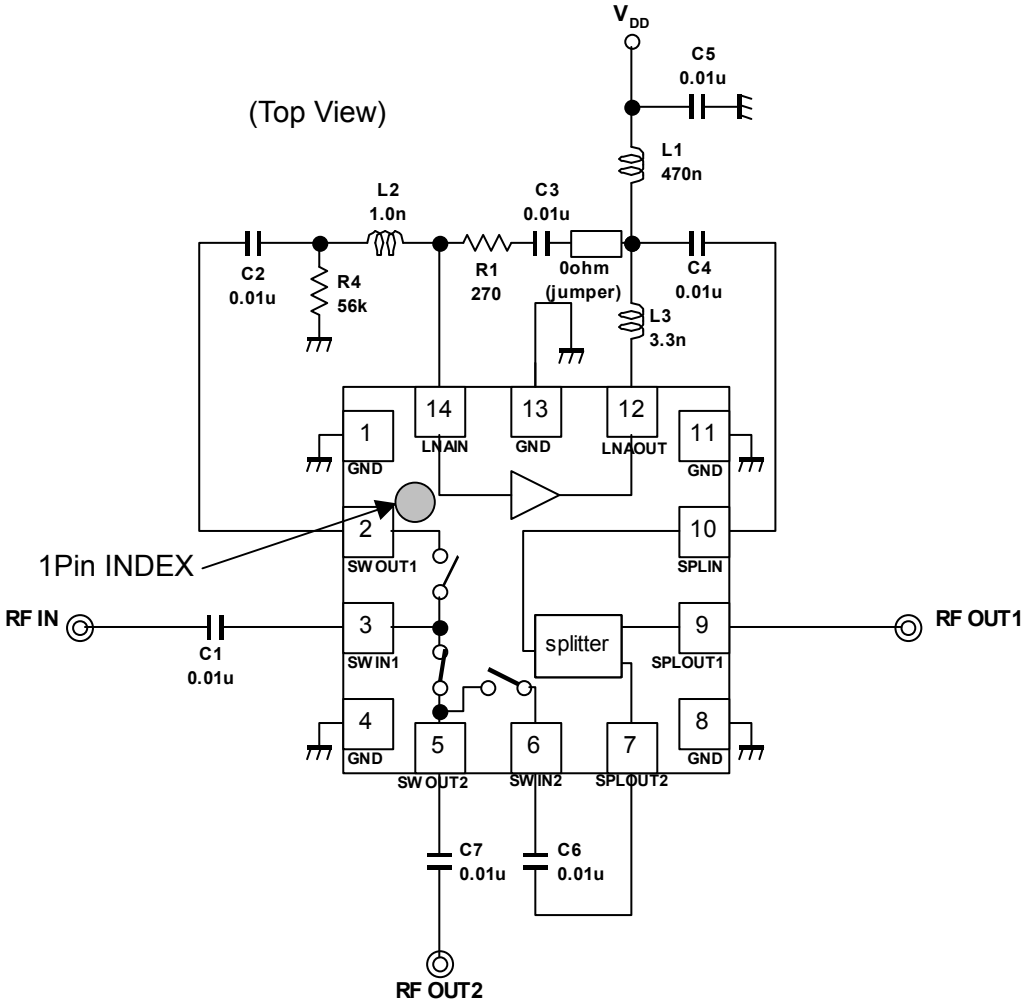
Calibration setup



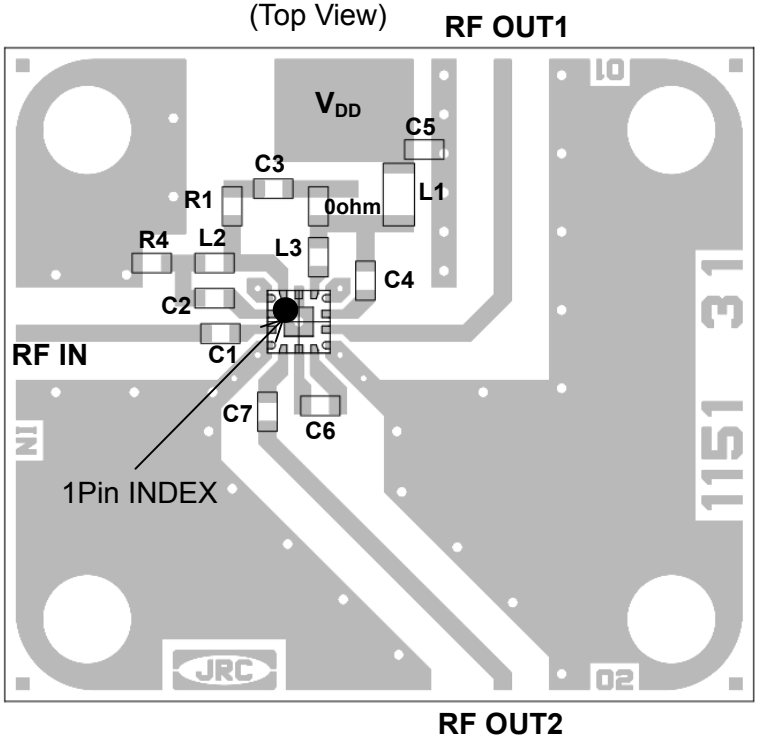
* Noise source and DUT, DUT and NF analyzer are connected directly.

Measurement Setup

7. Block diagram, Application circuit



8. Evaluation board



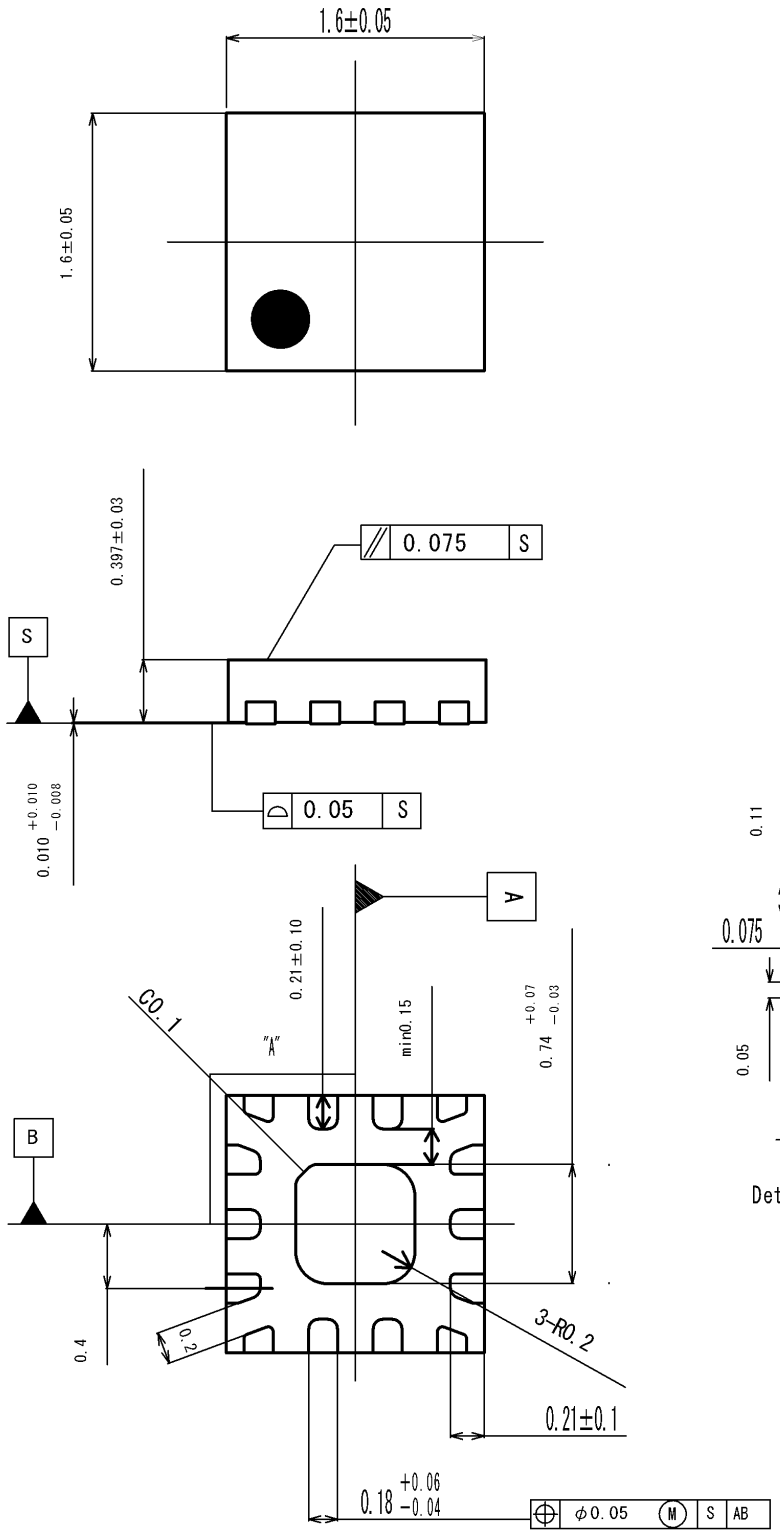
Parts List

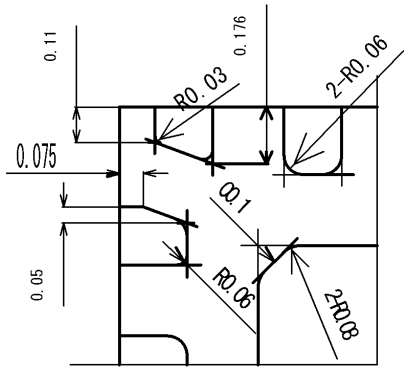
Parts ID	Manufacture
L1	TAIYO-YUDEN HK1608 Series
L2~L3	TAIYO-YUDEN HK1005 Series
C1~C7	MURATA GRM15 Series
R1~R4	KOA RK73 Series

PCB (FR-4):t=0.2mm
MICROSTRIP LINE WIDTH=0.4mm (Z_0=50Ω)
PCB SIZE=16.7mm x 19.1mm

CAUTION
In order not to couple with terminal LNAIN and LNAOUT, please layout ground pattern under the IC.

9. Package outline (EQFN14-D7)





Details of"A" part (×2)

UNIT : mm

SUBSTRATE MATERIAL : Copper
TERMINAL FINISH : Sn-Bi plating
MOLDE MATERIAL : Epoxy resin
MASS (TYP.) : 0.0034 (g)