

## 2-way Active Splitter GaAs MMIC

### ■ GENERAL DESCRIPTION

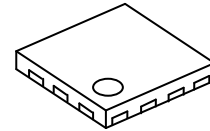
The NJG1151MD7 is 2-way active splitter with normally loop through switch GaAs MMIC for STB/Recorder/TV applications.

In order to simplify the tuner structure, the NJG1151MD7 does not only offer a 2-way active splitter, but also supply loop through switch for optimize the complicate circuit.

The NJG1151MD7 achieve better characteristics and high ESD tolerance with less external components.

A small and ultra-thin package of EQFN14-D7 is adopted.

### ■ PACKAGE OUTLINE



NJG1151MD7

### ■ FEATURES

- Operating frequency                      40 to 1000MHz
- Package                                        EQFN14-D7 (Package size: 1.6x1.6x0.397mm typ.)

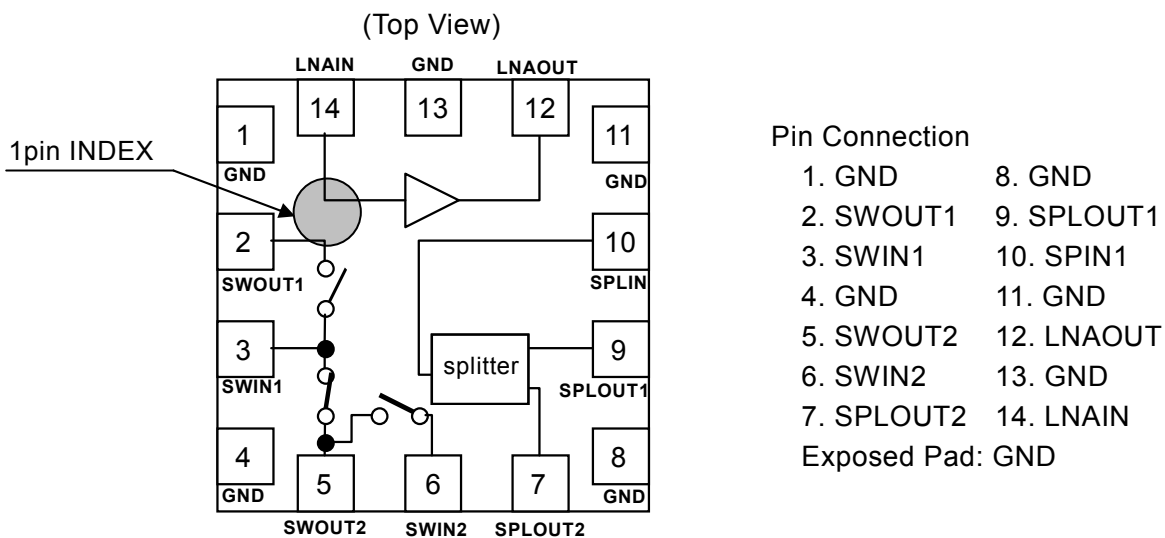
[ Active mode: Operating voltage 5.0V ]

- Operating current                          100mA typ.
- Gain    6.0dB typ. (Zs=Zl=50 ohm, Zs=Zl=75 ohm)
- Noise figure                                2.5dB typ. (Zs=Zl=50 ohm)
- CSO    60dBc typ. (Zs=Zl=75 ohm, 132ch, +15dBmV)
- CTB    65dBc typ. (Zs=Zl=75 ohm, 132ch, +15dBmV)
- Output to output isolation            20dB typ. (Zs=Zl=50 ohm, Zs=Zl=75 ohm)

[ Through mode: Operating voltage 0V ]

- Insertion loss                              0.4dB typ. (Zs=Zl=50 ohm)

### ■ PIN CONFIGURATION



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

# NJG1151MD7

## ■ ABSOLUTE MAXIMUM RATINGS

$T_a=+25^{\circ}\text{C}$ ,  $Z_s=Z_l=50\text{ ohm} / 75\text{ ohm}$

PARAMETER	SYMBOL	CONDITIONS	RATINGS	UNITS
Drain voltage	$V_{DD}$		6.0	V
Input power	$P_{IN}$	$V_{DD}=5.0\text{V}$	+10	dBm
Power dissipation	$P_D$	4-layer FR4 PCB with through-hole (76.2x114.3mm), $T_j=150^{\circ}\text{C}$	1300	mW
Operating temperature	$T_{opr}$		-40~+85	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$		-55~+150	$^{\circ}\text{C}$

## ■ ELECTRICAL CHARACTERISTICS (DC CHARACTERISTICS)

$V_{DD}=5.0\text{V}$ ,  $T_a=+25^{\circ}\text{C}$ , with application circuit1

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating voltage	$V_{DD}$		2.4	5.0	5.5	V
Operating current	$I_{DD}$	RF OFF	-	100	140	mA

**■ ELECTRICAL CHARACTERISTICS2** (RF CHARACTERISTICS: Active mode, 50 ohm)

$V_{DD}=5.0V$ , freq=40 to 1000MHz,  $T_a=+25^{\circ}C$ ,  $Z_S=Z_I=50ohm$ , with application circuit1

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain1_1	Gain1_1	Exclude PCB & connector losses (Note1) freq=40 to 900MHz	4.0	6.0	8.0	dB
Small signal gain1_2	Gain1_2	Exclude PCB & connector losses (Note1) freq=40 to 1000MHz	4.0	6.0	9.0	dB
Gain Flatness1_1	Gflat1_1	Exclude PCB & connector losses (Note1) freq=40 to 900MHz	-	1.0	2.0	dB
Gain Flatness1_2	Gflat1_2	Exclude PCB & connector losses (Note1) freq=40 to 1000MHz	-	1.0	3.0	dB
Noise figure1	NF1	Exclude PCB & connector losses (Note2)	-	2.5	3.7	dB
Input power 1dB compression1	P-1dB(IN)1		+1.0	+7.0	-	dBm
Input 3rd order intercept point1	IIP3_1	f1=freq, f2=freq+100kHz, $P_{IN}=-12dBm$	+10.0	+20.0	-	dBm
2nd order intermodulation distortion1	IM2_1	f1=40.75MHz, f2=813.25MHz, fmeas=854MHz, $P_{IN1}=P_{IN2}=-8dBm$	37.0	52.0	-	dB
3rd order intermodulation distortion1	IM3_1	f1=893.25MHz, f2=873.25MHz, fmeas=853.25MHz, $P_{IN1}=P_{IN2}=-8dBm$	49.0	60.0	-	dB
Reverse Isolation1	ISL1	RF OUT1 to RF IN RF OUT2 to RF IN	20.0	28.0	-	dB
Output to Output Isolation1	OISL1	RF OUT1 to RF OUT2	18.0	20.0	-	dB
RF IN Return loss1	RLi1	RF IN port	8.0	15.0	-	dB
RF OUT Return loss1	RLo1	RF OUT1, RF OUT2 port	13.0	20.0	-	dB

(Note1) Input and output PCB, connector losses (RFIN-RFOUT1): 0.02dB(40MHz), 0.16dB(1000MHz)

Input and output PCB, connector losses (RFIN-RFOUT2): 0.02dB(40MHz), 0.15dB(1000MHz)

(Note2) Input PCB and connector losses: 0.01dB(40MHz), 0.06dB(1000MHz)

# NJG1151MD7

## ■ ELECTRICAL CHARACTERISTICS3 (RF CHARACTERISTICS: Through mode, 50 ohm)

$V_{DD}=0V$ , freq=40 to 1000MHz,  $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50ohm$ , with application circuit1

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Insertion Loss2	Loss2	Exclude PCB & connector losses (Note1)	-	0.4	2.0	dB
Input power 1dB Compression2	P-1dB(IN)2		+1.0	+10.0	-	dBm
2nd order intermodulation distortion2	IM2_2	f1=90MHz, f2=100MHz, fmeas=190MHz, P <sub>IN1</sub> =P <sub>IN2</sub> =-5dBm	50.0	65.0	-	dB
3rd order intermodulation distortion2	IM3_2	f1=200MHz, f2=210MHz, fmeas=220MHz, P <sub>IN1</sub> =P <sub>IN2</sub> =-5dBm	53.0	70.0	-	dB
RF IN Return loss2	RLi2	RF IN port	8.0	15.0	-	dB
RF OUT Return loss2	RLo2	RF OUT2 port	8.0	15.0	-	dB

(Note1) Input and output PCB, connector losses (RFIN-RFOUT2): 0.02dB(40MHz), 0.15dB(1000MHz)

■ **ELECTRICAL CHARACTERISTICS4** (RF CHARACTERISTICS: Active mode, 75 ohm)

$V_{DD}=5.0V$ , freq=40 to 1000MHz,  $T_a=+25^{\circ}C$ ,  $Z_S=Z_I=75$  ohm, with application circuit1

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain3 (75 ohm)	Gain3	Exclude PCB & connector losses	-	6.0	-	dB
Composite Second Order3	CSO3	132channels, CW, $P_{IN}=+15dBmV$	-	60.0	-	dBc
Composite Triple Beat 3	CTB3	132channels, CW, $P_{IN}=+15dBmV$	-	65.0	-	dBc
Reverse Isolation3	ISL3	RF OUT1 to RF IN RF OUT2 to RF IN		28.0		dB
Output to Output Isolation3	OISL3	RF OUT1 to RF OUT2		20.0		dB
RF IN Return loss3 (75 ohm)	RLi3	RF IN port	-	15.0	-	dB
RF OUT Return loss3 (75 ohm)	RLo3	RF OUT1, RF OUT2 port	-	25.0	-	dB

■ **ELECTRICAL CHARACTERISTICS5** (RF CHARACTERISTICS: Through mode, 75 ohm)

$V_{DD}=0V$ , freq=40 to 1000MHz,  $T_a=+25^{\circ}C$ ,  $Z_S=Z_I=75$  ohm, with application circuit1

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Insertion Loss4 (75 ohm)	Loss4	Exclude PCB & connector losses	-	1.0	-	dB
Composite Second Order4	CSO4	132channels, CW, $P_{IN}=+15dBmV$	-	55.0	-	dBc
Composite Triple Beat4	CTB4	132channels, CW, $P_{IN}=+15dBmV$	-	60.0	-	dBc
RF IN Return loss4 (75 ohm)	RLi4	RF IN port	-	15.0	-	dB
RF OUT Return loss4 (75 ohm)	RLo4	RF OUT1, RF OUT2 port	-	15.0	-	dB

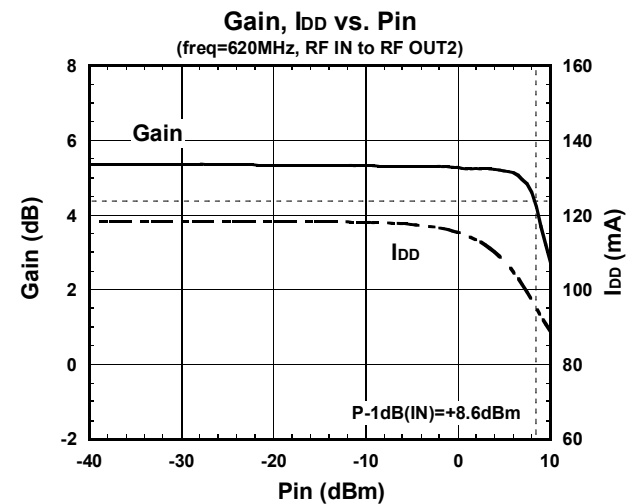
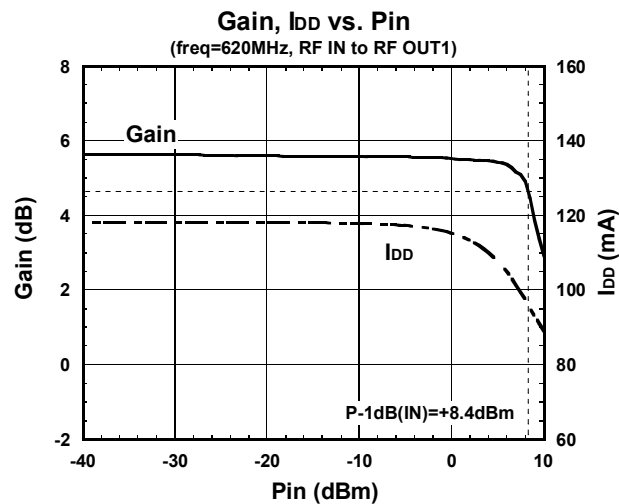
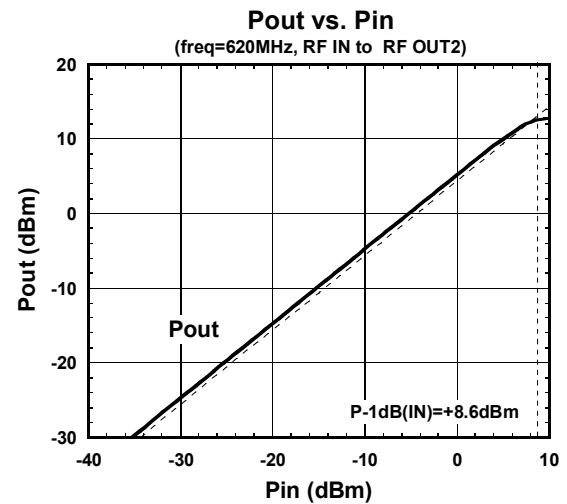
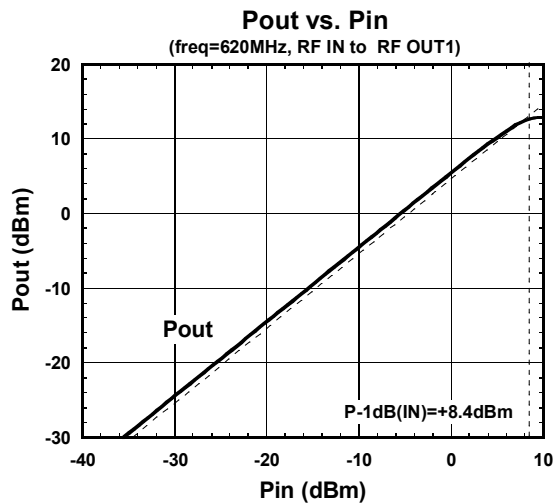
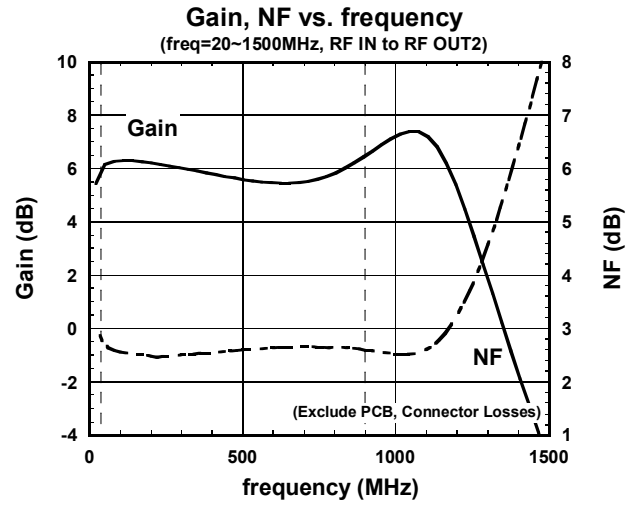
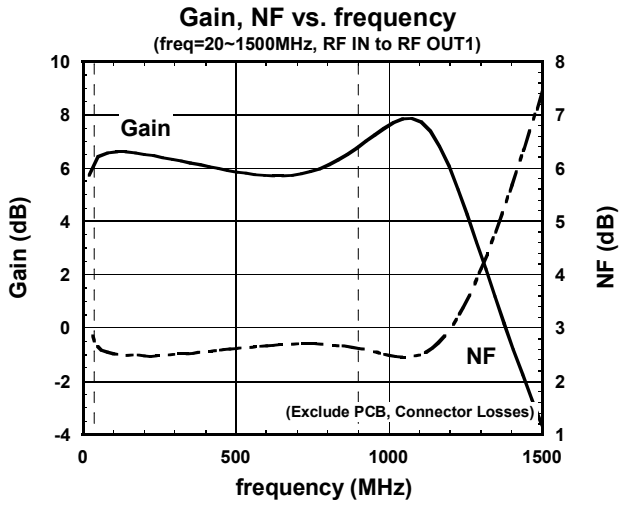
# NJG1151MD7

## ■ TERMINAL DESCRIPTION

Pin 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	SWOUT1	RF signal output terminal of the switch. RF signal is output through the external circuit. Please connect the DC blocking capacitor of the application circuit.
3	SWIN1	RF signal input terminal of the switch. RF signal is input through the external circuit. Please connect the DC blocking capacitor of the application circuit.
4	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
5	SWOUT2	RF signal output terminal of the switch. RF signal is output through the external circuit. Please connect the DC blocking capacitor of the application circuit.
6	SWIN2	RF signal input terminal of the switch. RF signal is input through the external circuit. Please connect the DC blocking capacitor of the application circuit.
7	SPLOUT2	RF signal output terminal of the splitter.
8	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
9	SPLOUT1	RF signal output terminal of the splitter.
10	SPLIN	RF signal input terminal of the splitter.
11	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
12	LNAOUT	RF signal output terminal of the LNA. RF signal is output through the external circuit. This terminal is also a voltage supply terminal of the switch and LNA, Please supply the voltage through an inductor of the application circuit.
13	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
14	LNAIN	RF signal input terminal of the LNA. RF signal is input through the external circuit. This terminal is also a current adjustment terminal of the LNA, Please connect to ground via a resistor of the application circuit.
Exposed Pad	GND	Ground terminal.

## ■ ELECTRICAL CHARACTERISTICS (Active mode, 50 ohm)

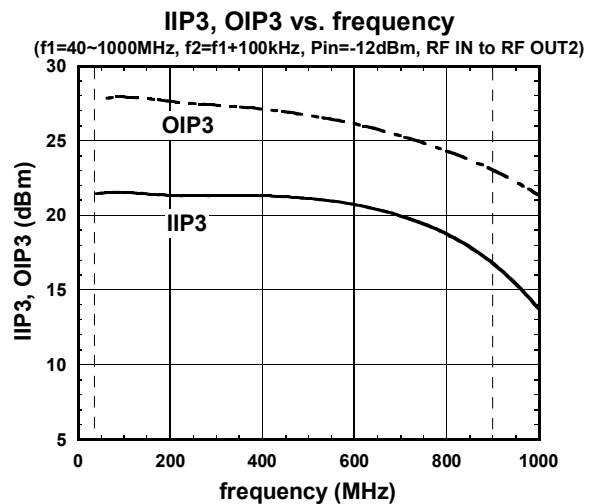
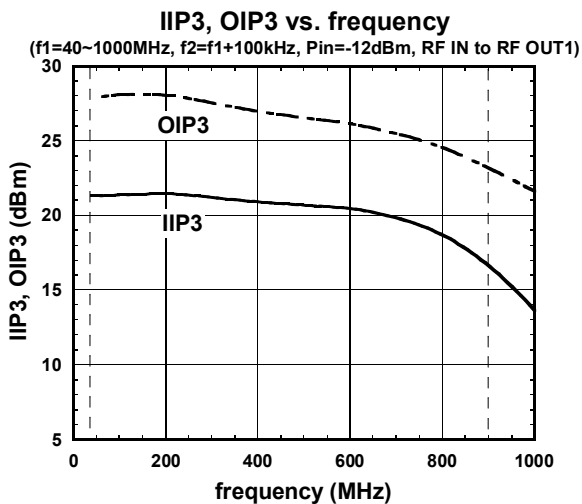
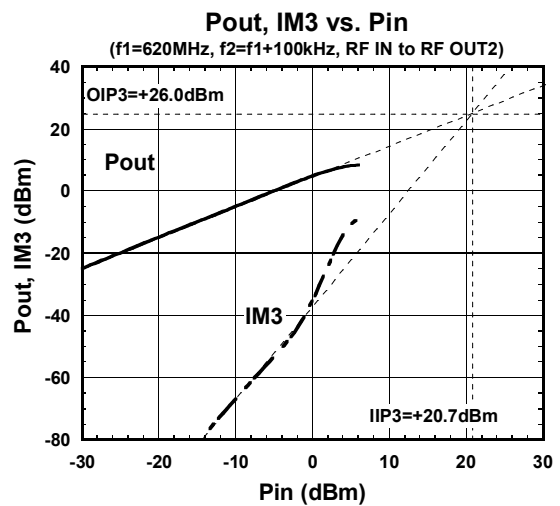
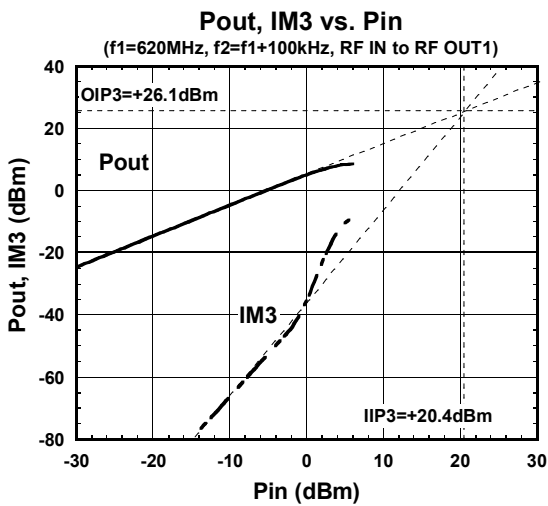
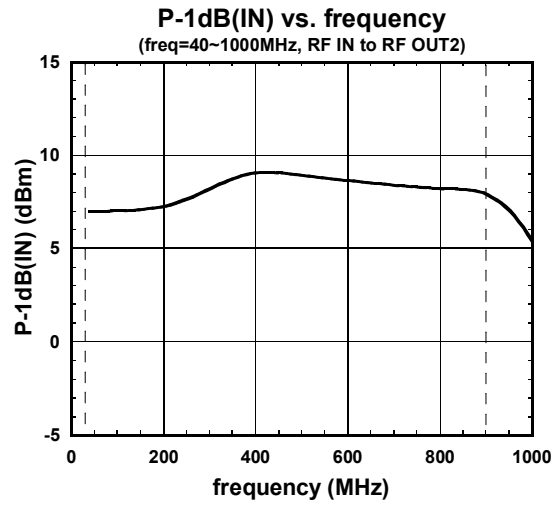
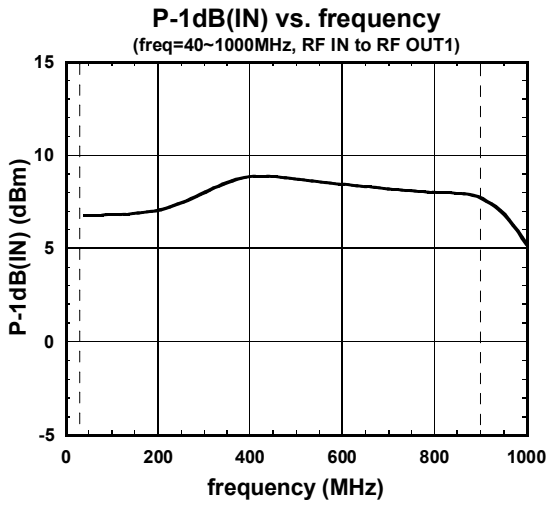
Conditions:  $V_{DD}=5.0V$ ,  $T_a=25^\circ C$ ,  $Z_s=Z_l=50\text{ ohm}$ , with application circuit1



# NJG1151MD7

## ■ ELECTRICAL CHARACTERISTICS (Active mode, 50 ohm)

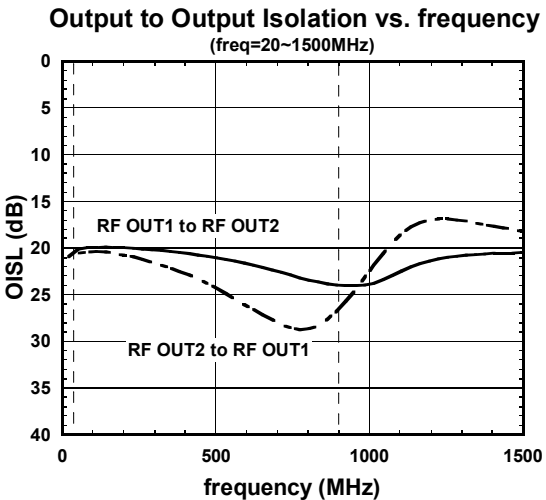
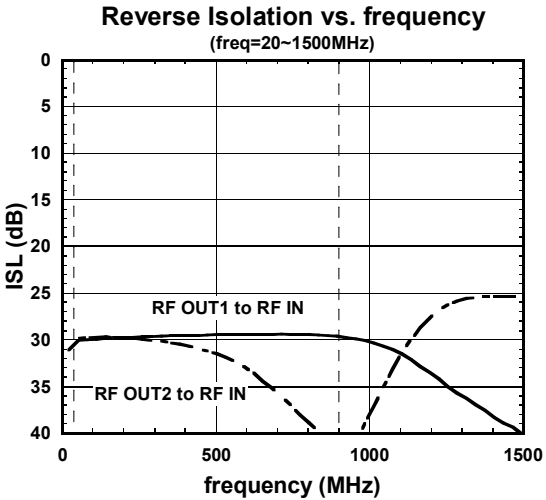
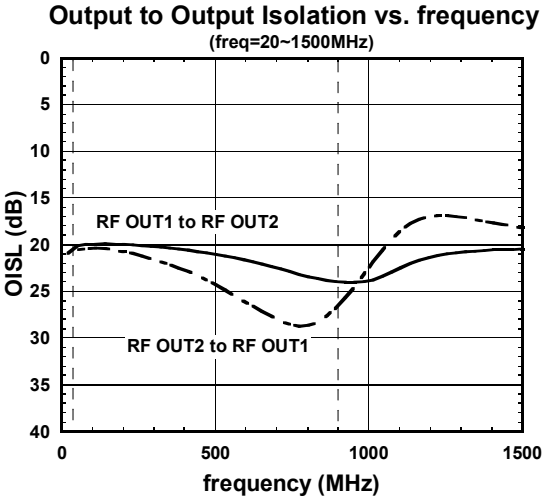
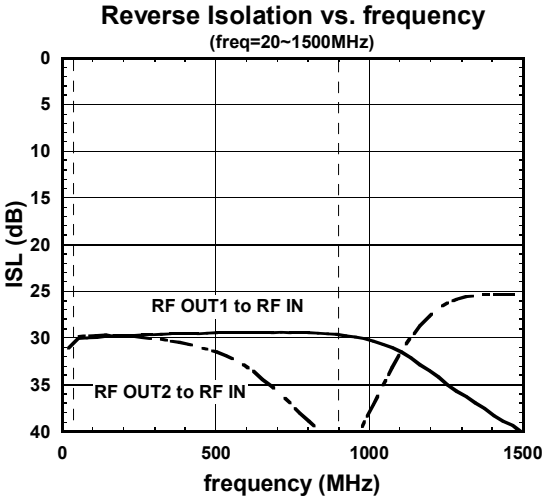
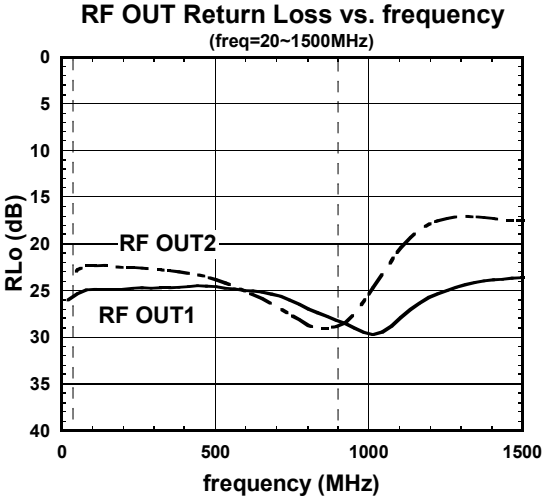
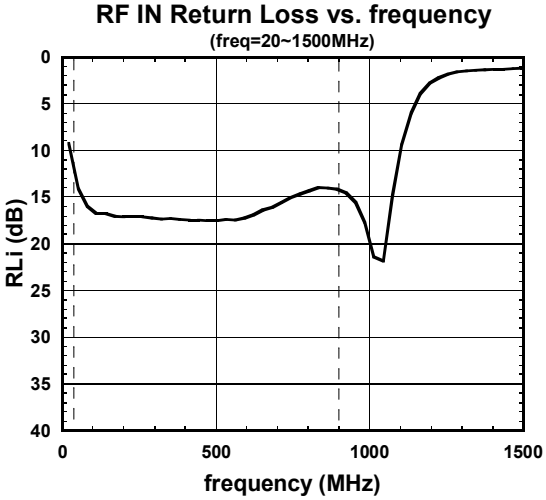
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■ ELECTRICAL CHARACTERISTICS (Active mode, 50 ohm)

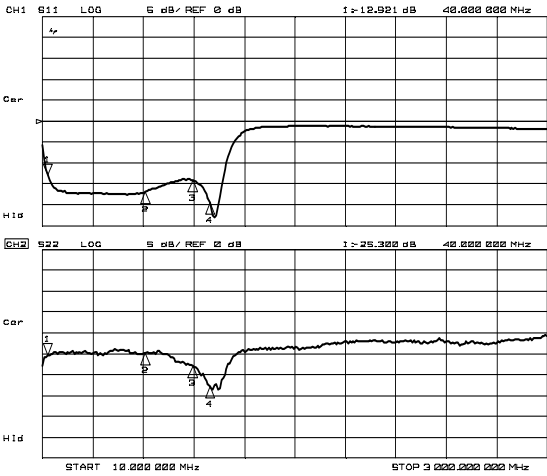
Conditions:  $V_{DD}=5.0V$ ,  $T_a=25^{\circ}C$ ,  $Z_s=Z_l=50\text{ ohm}$ , with application circuit1



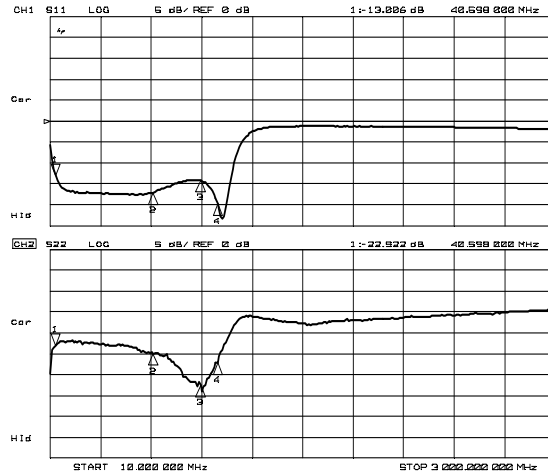
# NJG1151MD7

## ELECTRICAL CHARACTERISTICS (Active mode, 50 ohm)

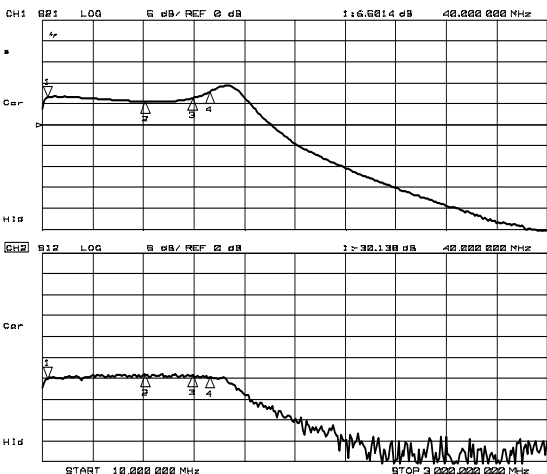
Conditions:  $V_{DD}=5.0V$ ,  $T_a=25^\circ C$ ,  $Z_s=Z_l=50\text{ ohm}$ , with application circuit1



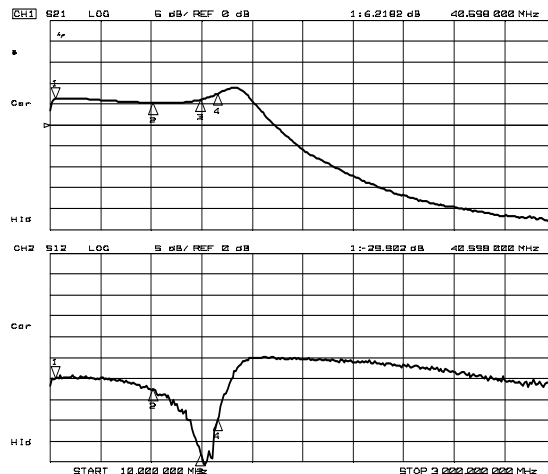
S11, S22 (RF OUT1)



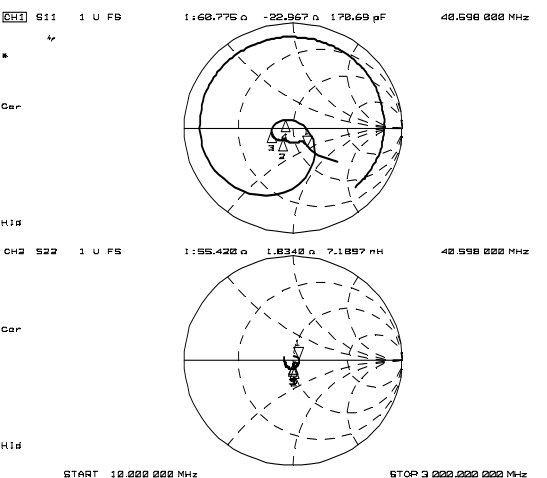
S11, S22 (RF OUT2)



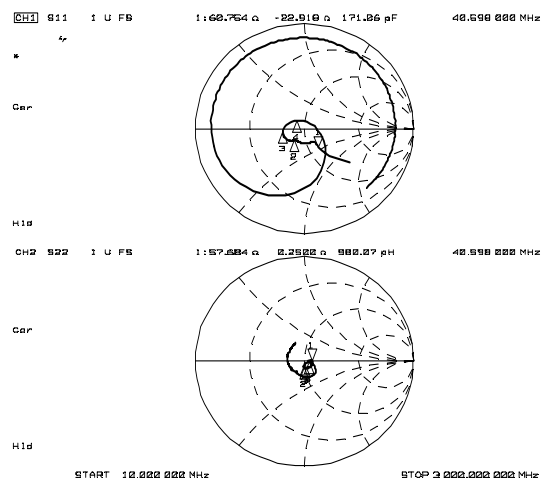
S21, S12 (RF OUT1)



S21, S12 (RF OUT2)



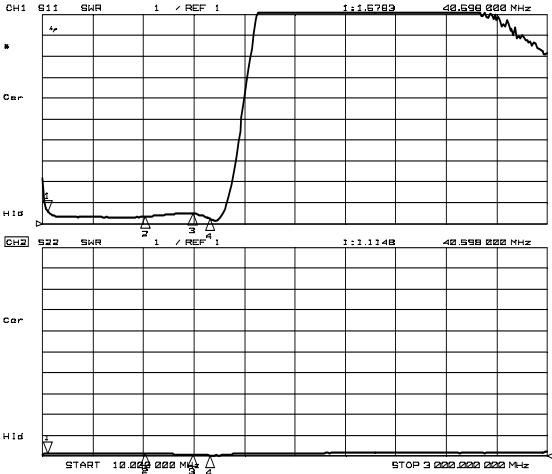
Zin, Zout (RF OUT1)



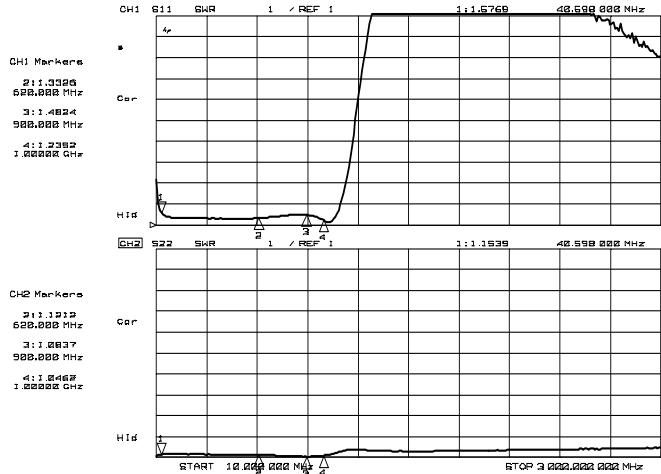
Zin, Zout (RF OUT2)

## ■ ELECTRICAL CHARACTERISTICS (Active mode, 50 ohm)

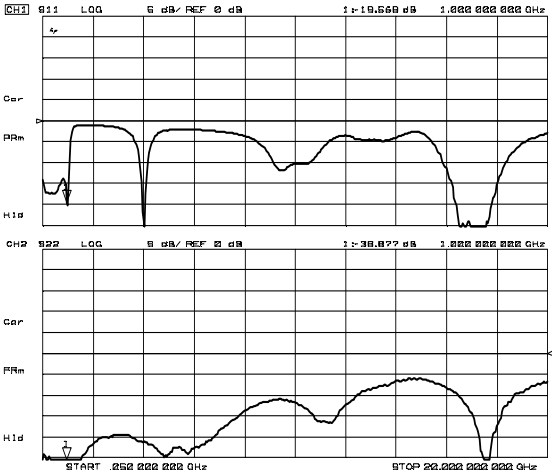
Conditions:  $V_{DD}=5.0V$ ,  $T_a=25^\circ C$ ,  $Z_s=Z_l=50\text{ ohm}$ , with application circuit1



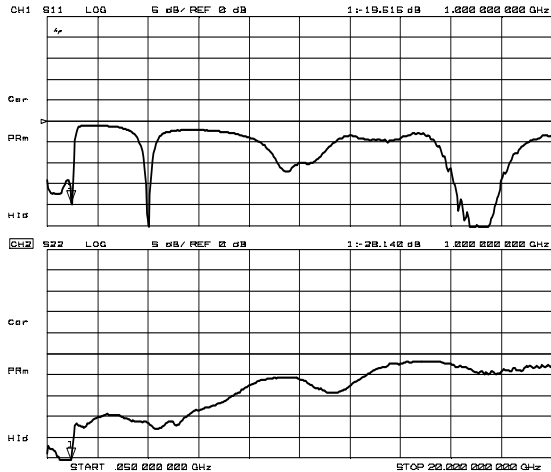
VSWRi, VSWRo (RF OUT1)



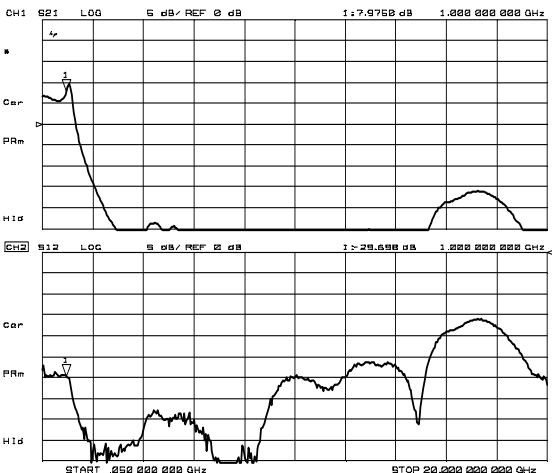
VSWRi, VSWRo (RF OUT2)



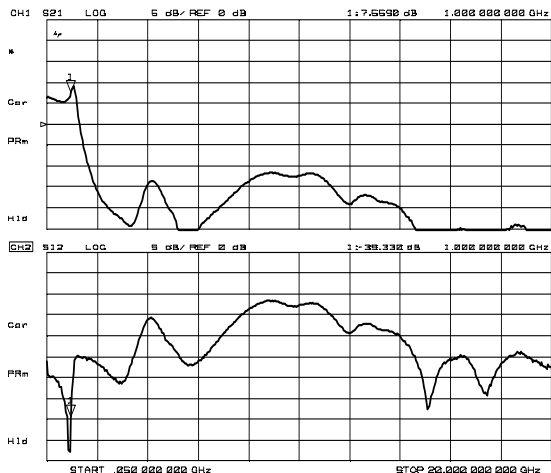
S11, S22 (50MHz~20GHz, RF OUT1)



S11, S22 (50MHz~20GHz, RF OUT2)



S21, S12 (50MHz~20GHz, RF OUT1)

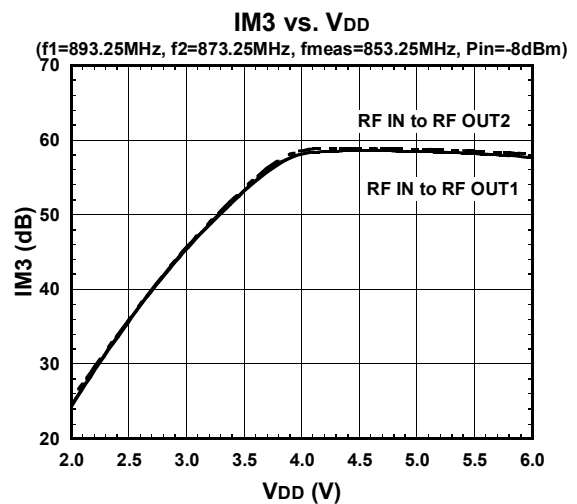
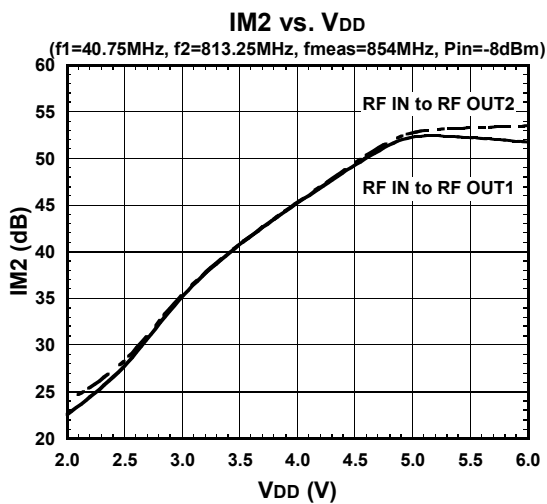
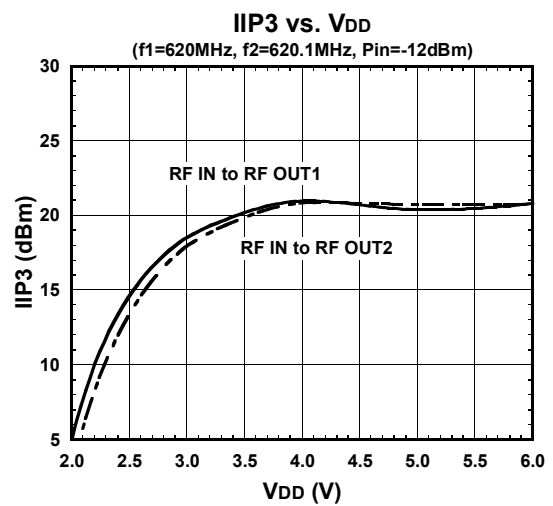
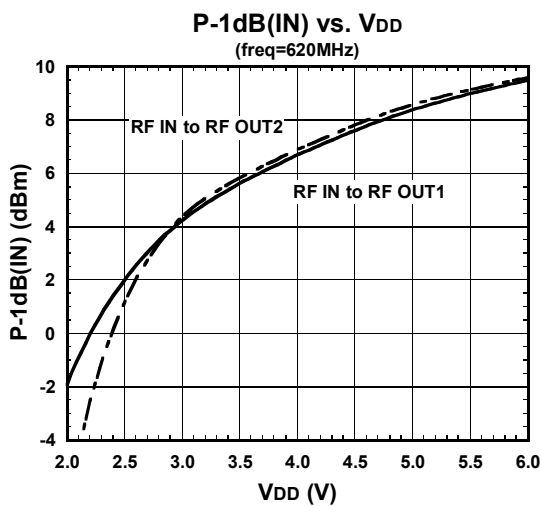
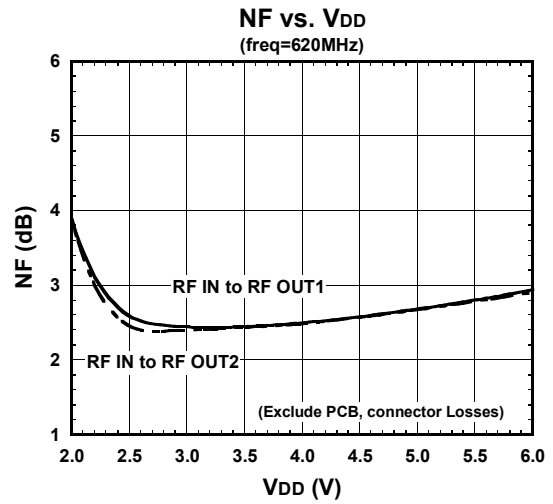
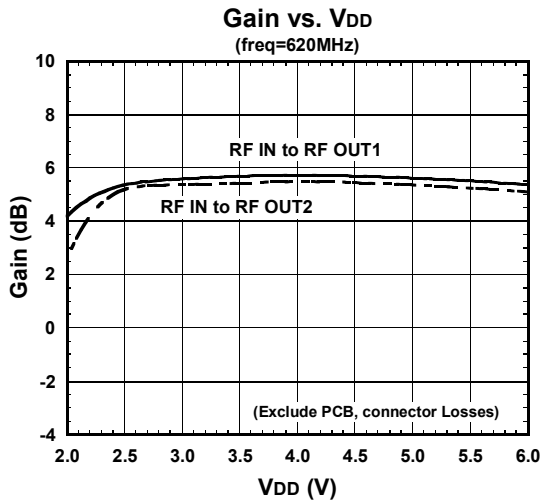


S21, S12 (50MHz~20GHz, RF OUT2)

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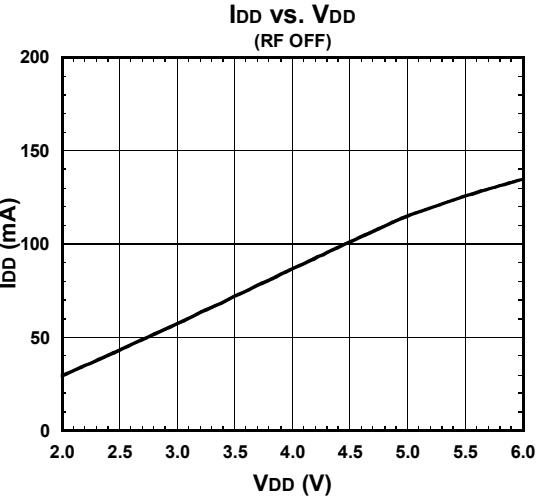
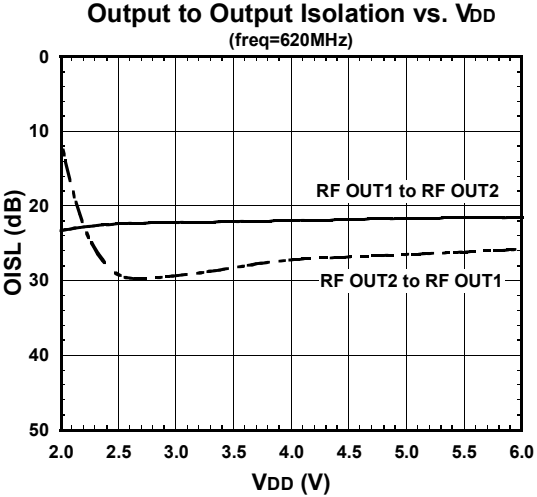
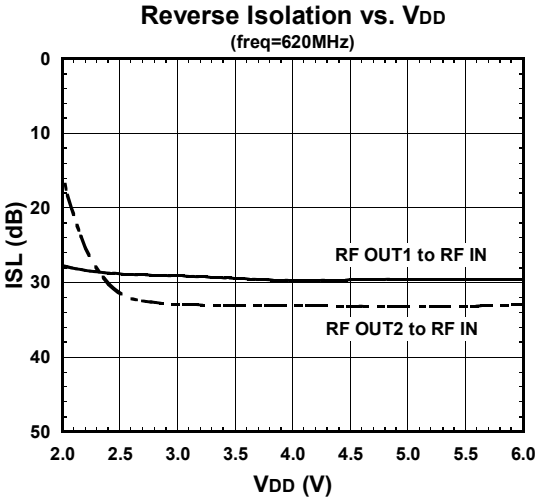
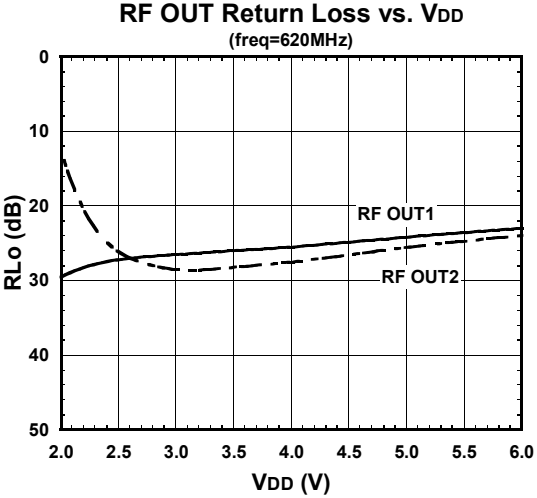
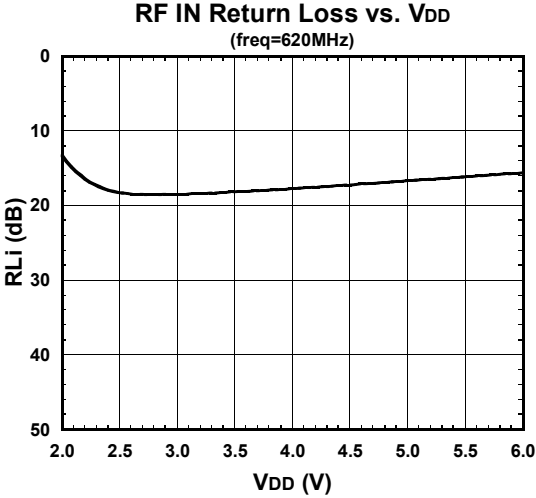
## ■ ELECTRICAL CHARACTERISTICS (Active mode, 50 ohm)

Conditions:  $T_a=25^\circ\text{C}$ ,  $Z_s=Z_L=50\text{ ohm}$ , with application circuit1



**ELECTRICAL CHARACTERISTICS** (Active mode, 50 ohm)

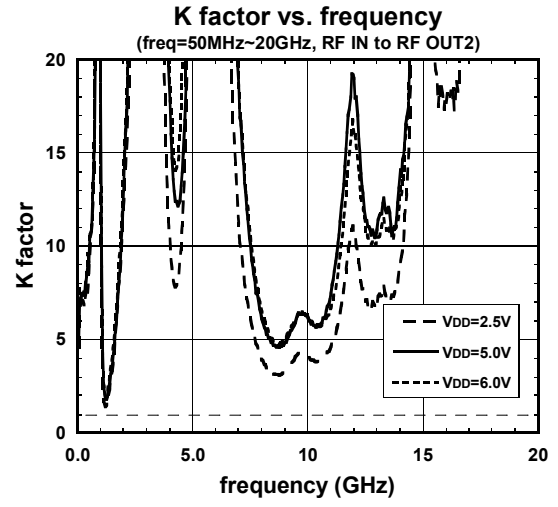
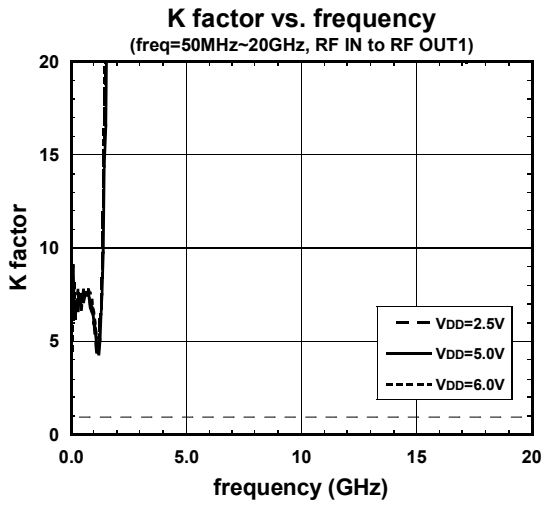
Conditions:  $T_a=25^\circ\text{C}$ ,  $Z_s=Z_l=50\text{ ohm}$ , with application circuit1



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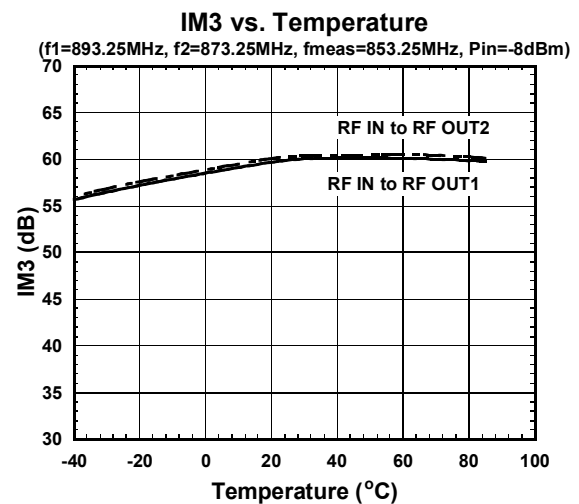
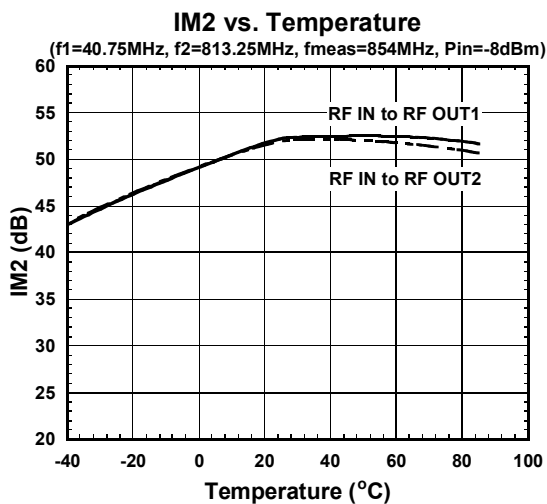
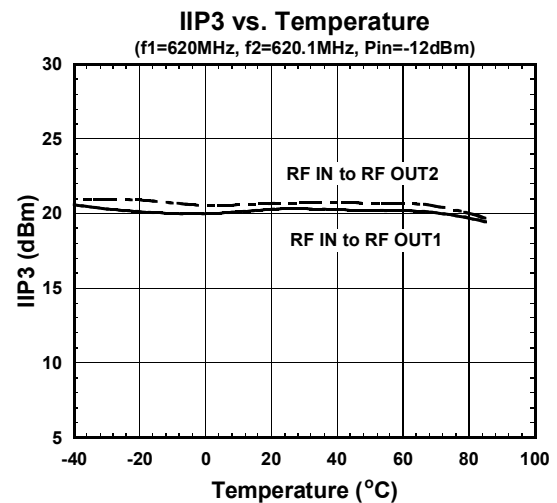
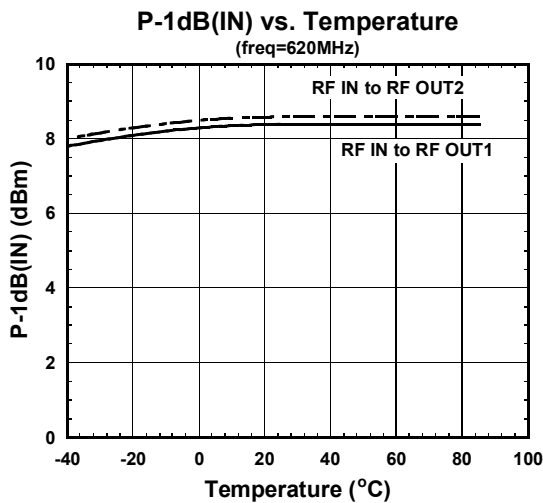
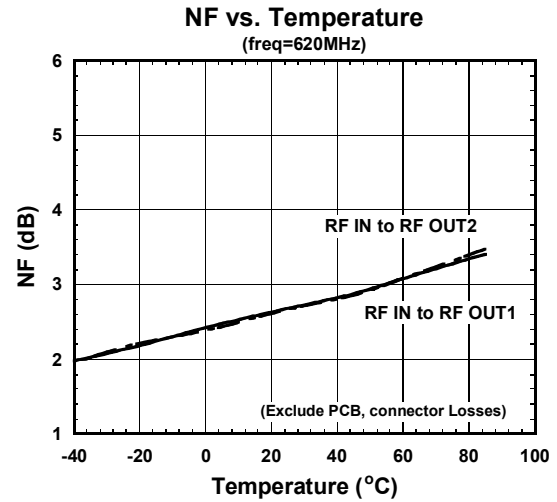
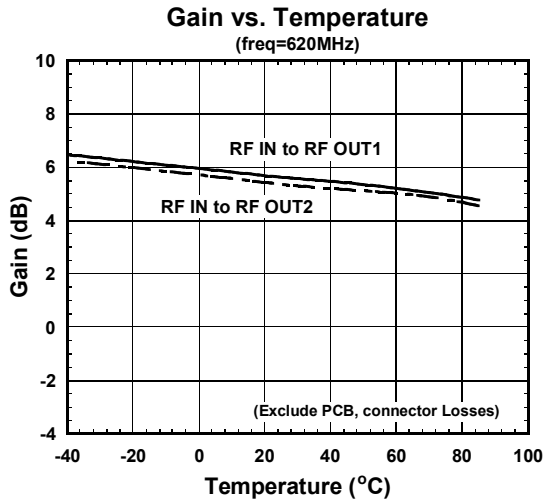
## ■ ELECTRICAL CHARACTERISTICS (Active mode, 50 ohm)

Conditions:  $T_a=25^\circ\text{C}$ ,  $Z_s=Z_l=50\text{ ohm}$ , with application circuit1



## ■ ELECTRICAL CHARACTERISTICS (Active mode, 50 ohm)

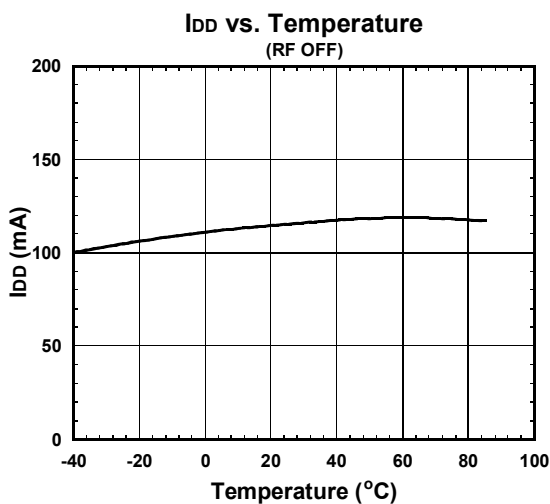
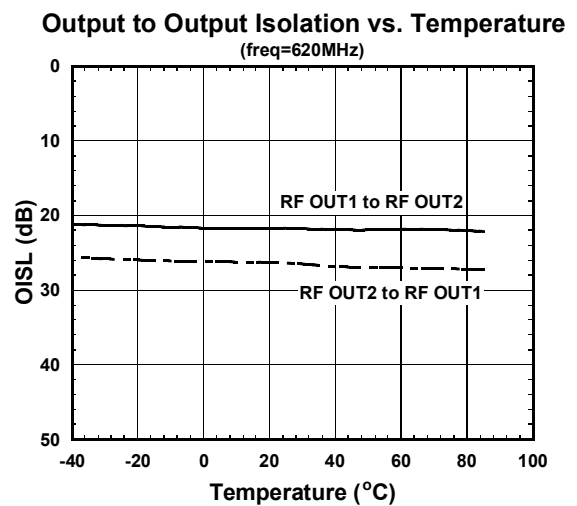
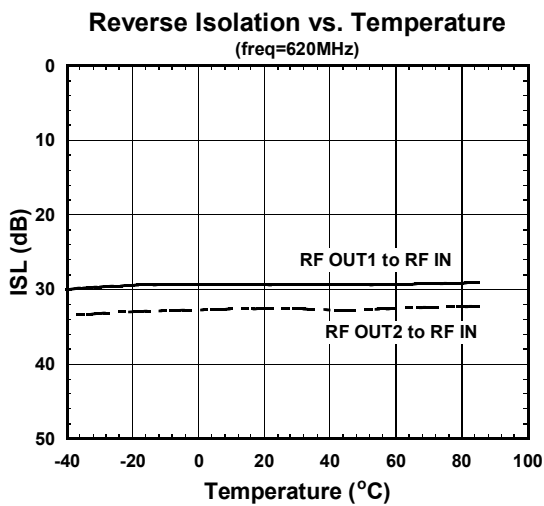
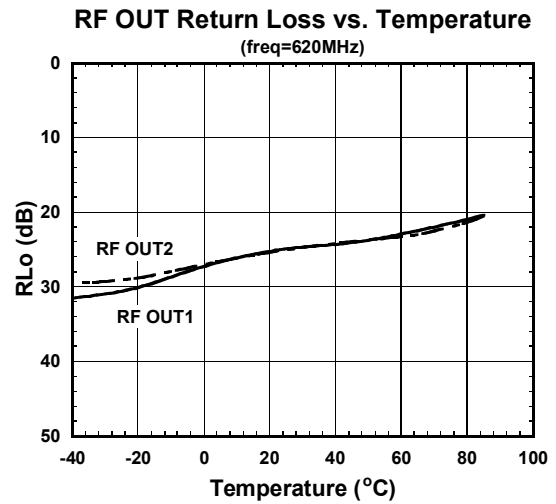
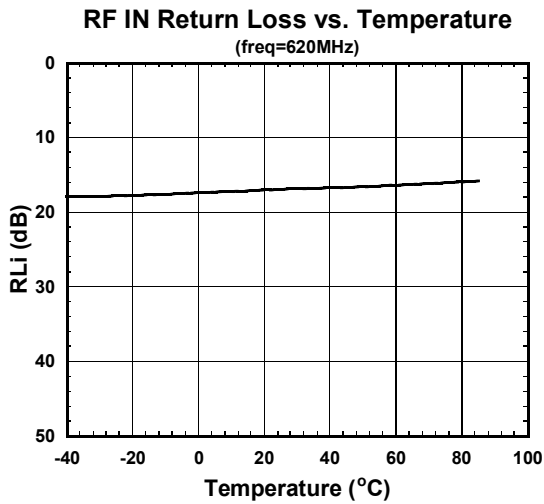
Conditions:  $V_{DD}=5.0V$ ,  $Z_s=Z_l=50\text{ ohm}$ , with application circuit1



# NJG1151MD7

## ■ ELECTRICAL CHARACTERISTICS (Active mode, 50 ohm)

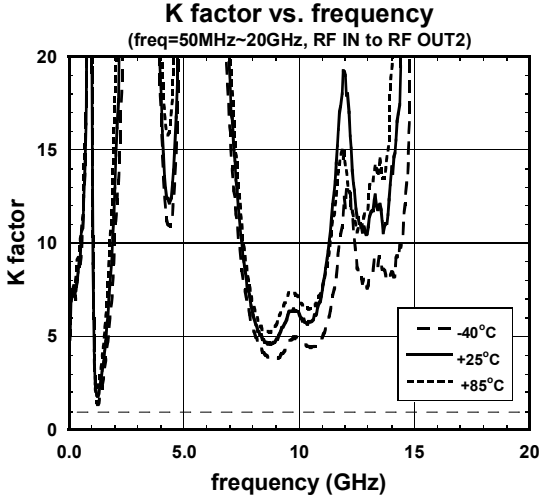
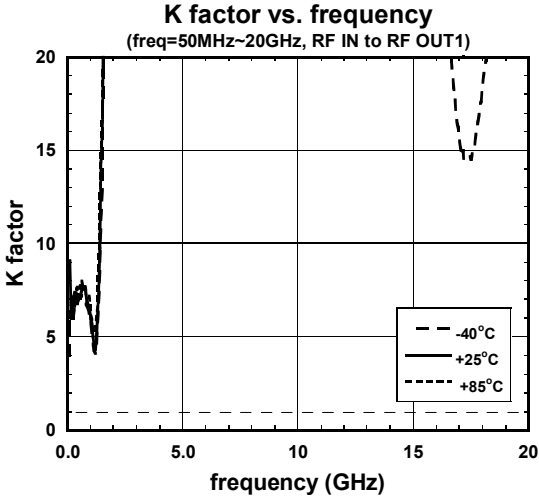
Conditions:  $V_{DD}=5.0V$ ,  $Z_s=Z_l=50\text{ ohm}$ , with application circuit1





■ ELECTRICAL CHARACTERISTICS (Active mode, 50 ohm)

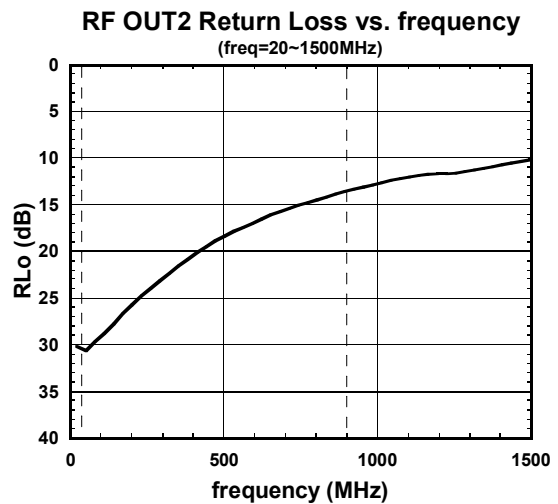
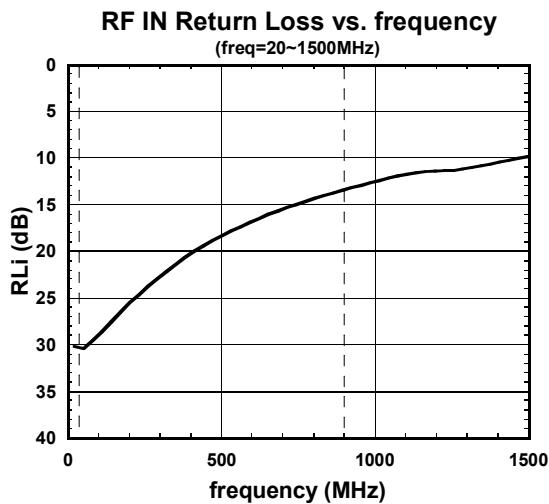
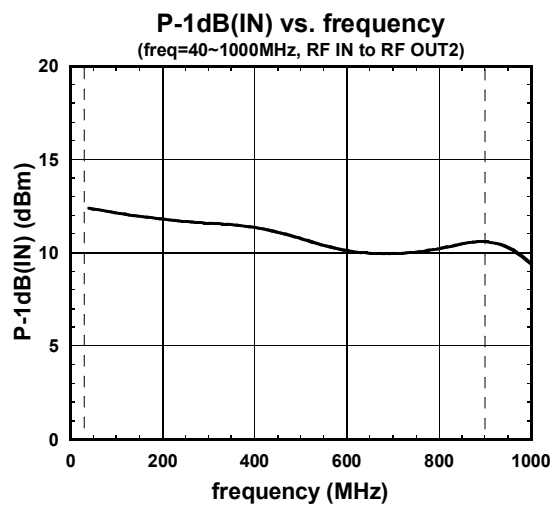
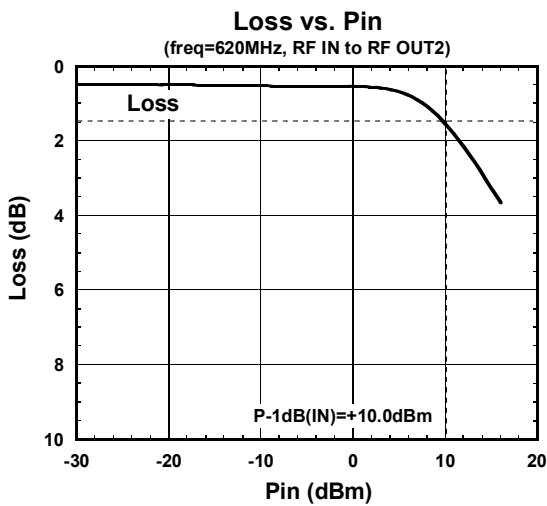
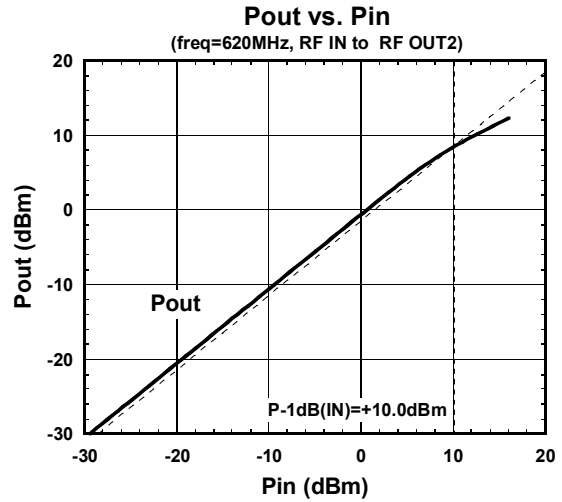
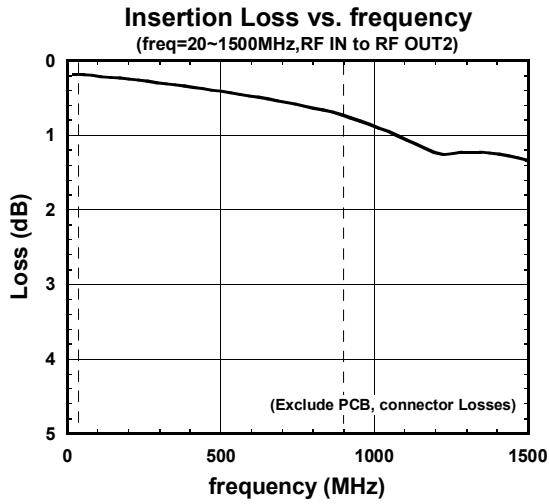
Conditions:  $V_{DD}=5.0V$ ,  $Z_s=Z_l=50\text{ ohm}$ , with application circuit1



# NJG1151MD7

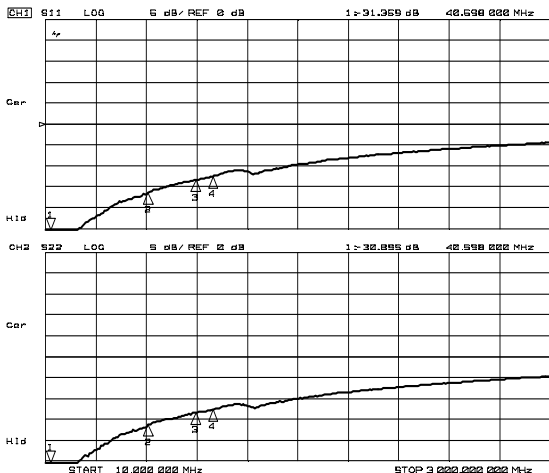
## ■ ELECTRICAL CHARACTERISTICS (Through mode, 50 ohm)

Conditions:  $V_{DD}=0V$ ,  $T_a=25^{\circ}C$ ,  $Z_s=Z_l=50\text{ ohm}$ , with application circuit1

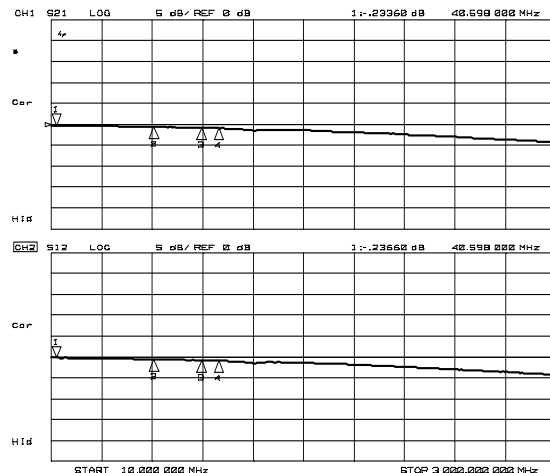


## ELECTRICAL CHARACTERISTICS (Through mode, 50 ohm)

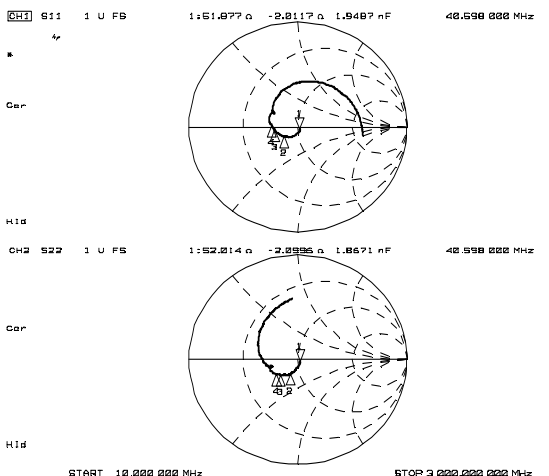
Conditions:  $V_{DD}=0V$ ,  $T_a=25^\circ C$ ,  $Z_s=Z_l=50\text{ ohm}$ , with application circuit1



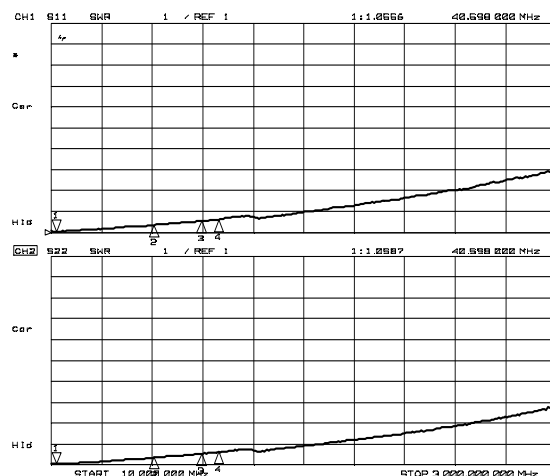
S11, S22



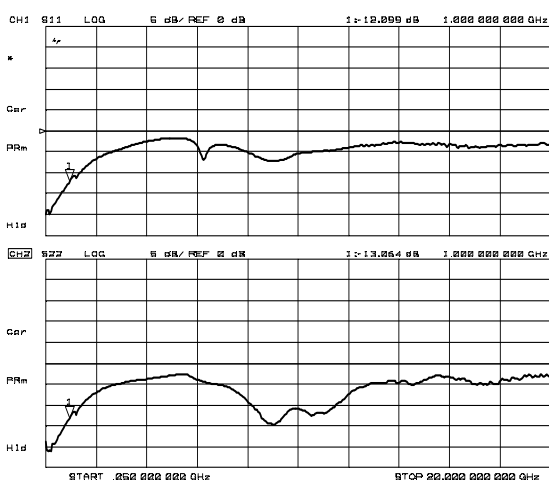
S21, S12



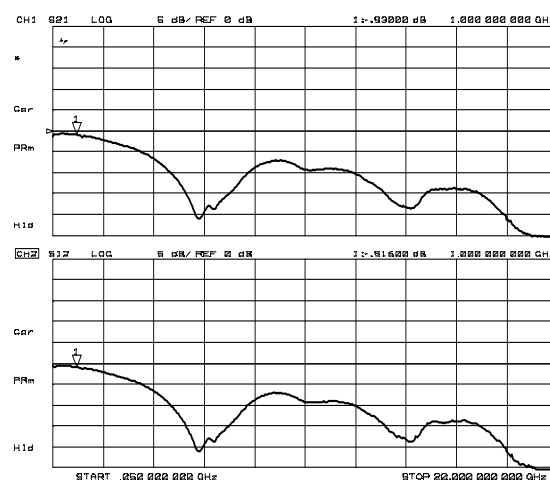
Zin, Zout



VSWRi, VSWRo



S11, S22 (50MHz~20GHz)

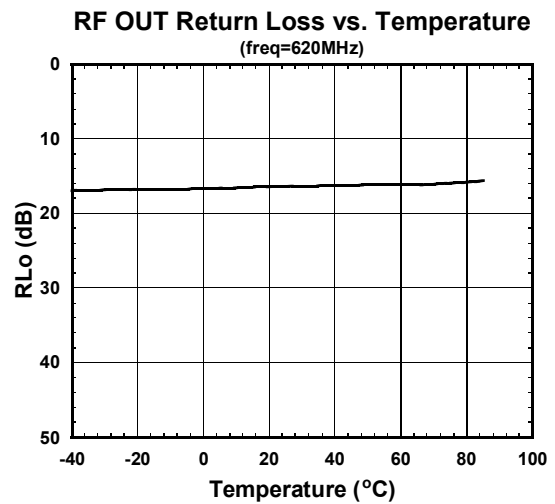
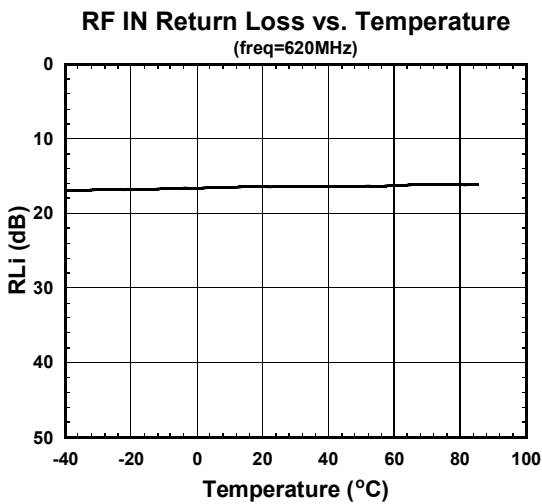
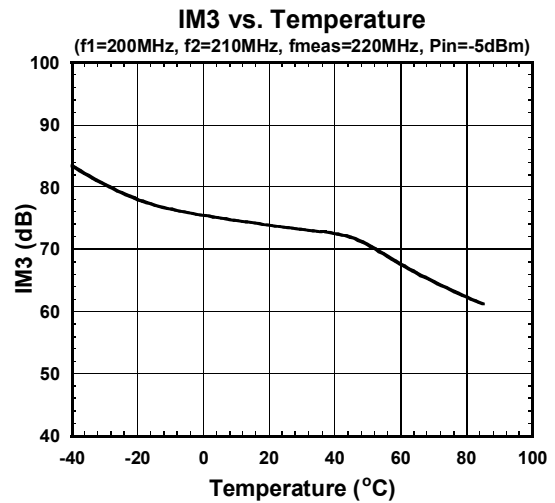
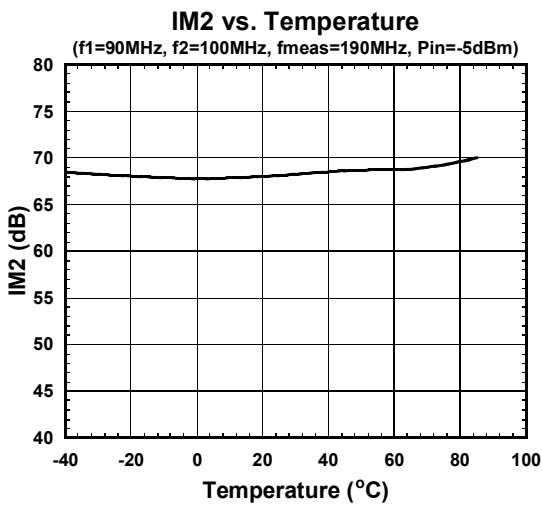
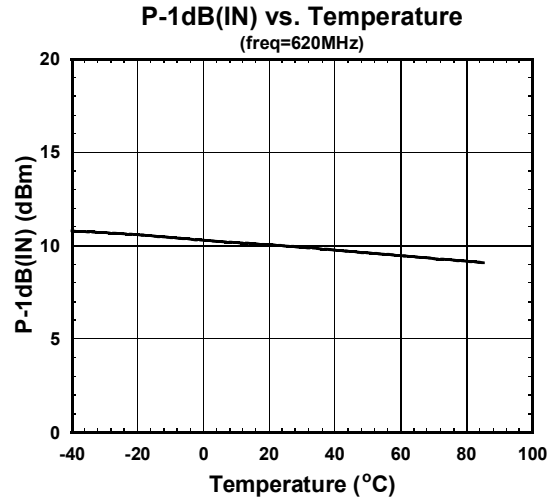
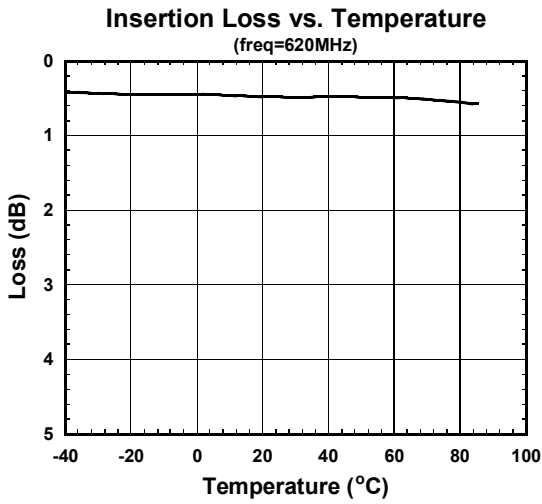


S21, S12 (50MHz~20GHz)

# NJG1151MD7

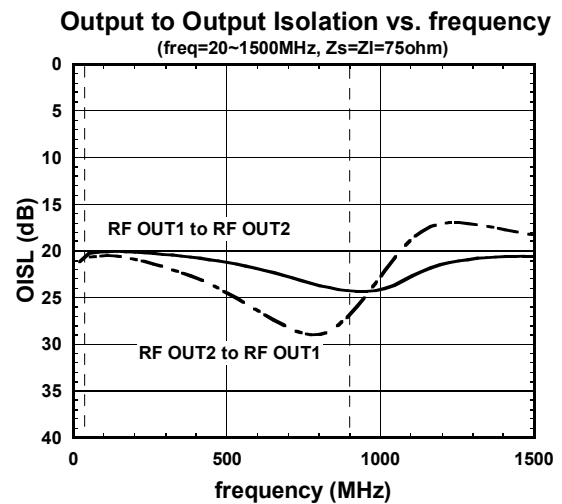
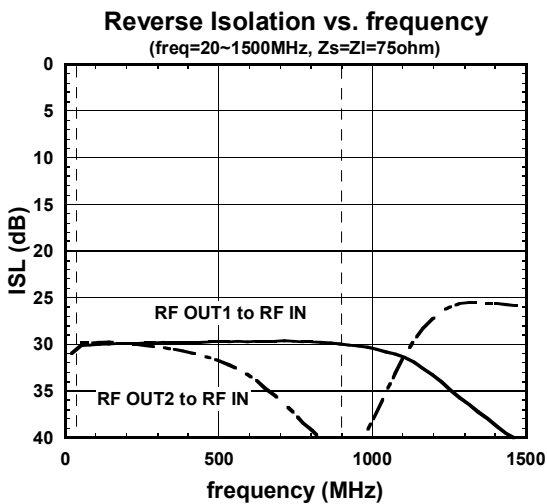
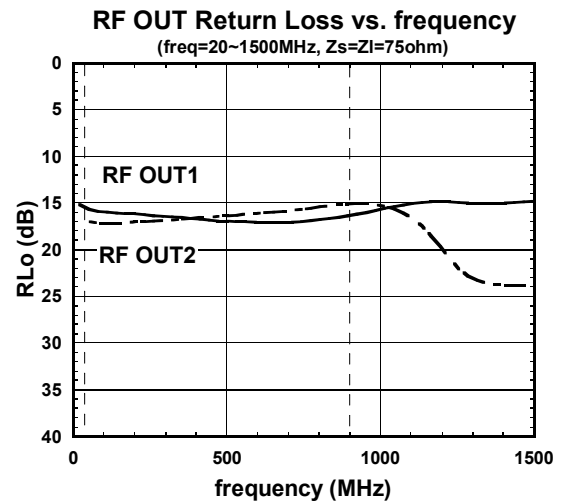
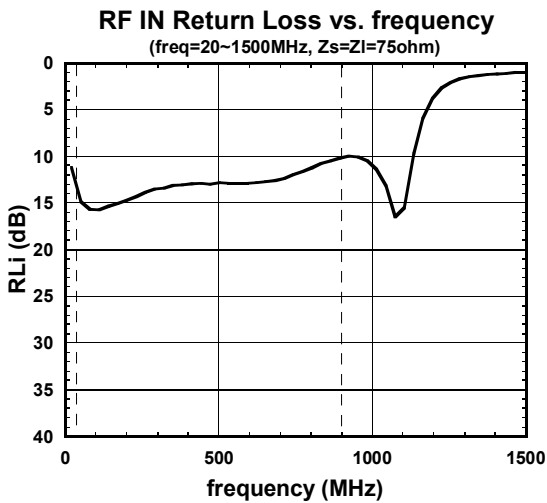
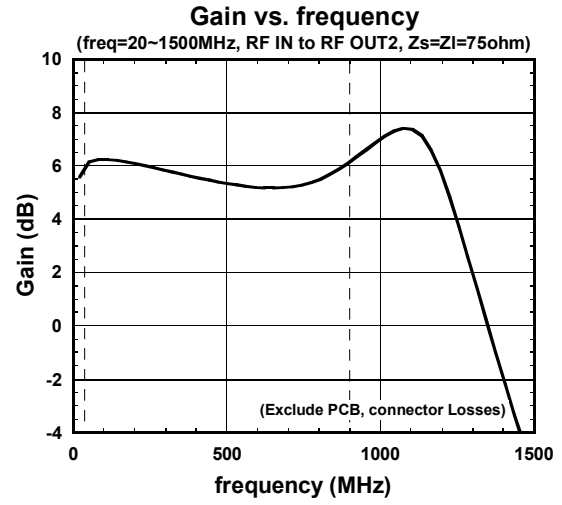
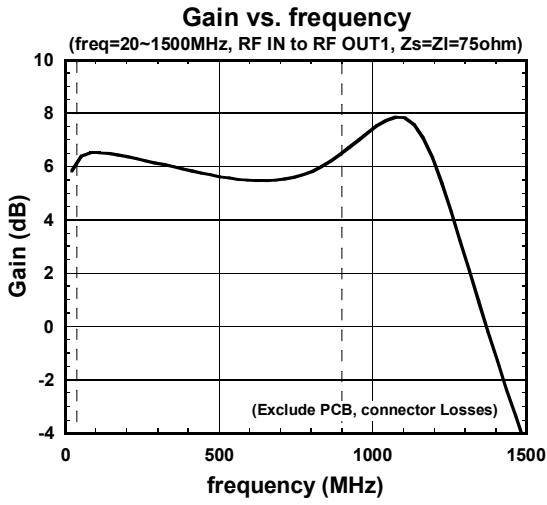
## ■ ELECTRICAL CHARACTERISTICS (Through mode, 50 ohm)

Conditions:  $V_{DD}=0V$ ,  $Z_s=Z_l=50\text{ ohm}$ , with application circuit1



## ■ ELECTRICAL CHARACTERISTICS (Active mode, 75 ohm)

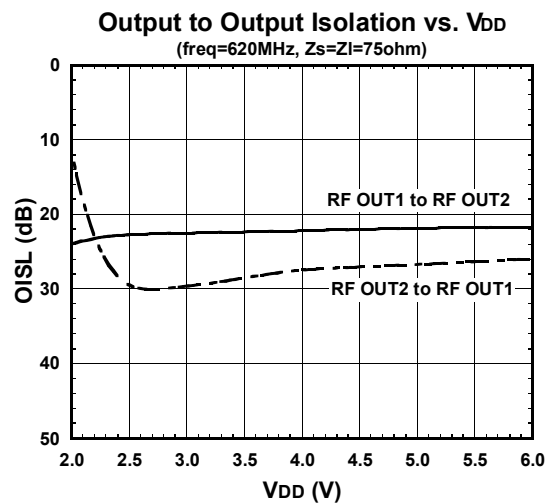
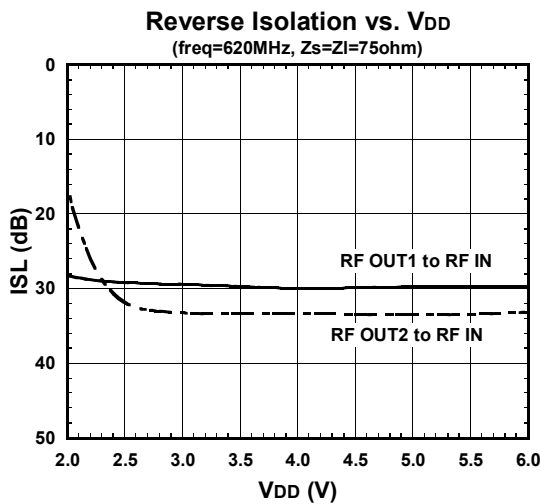
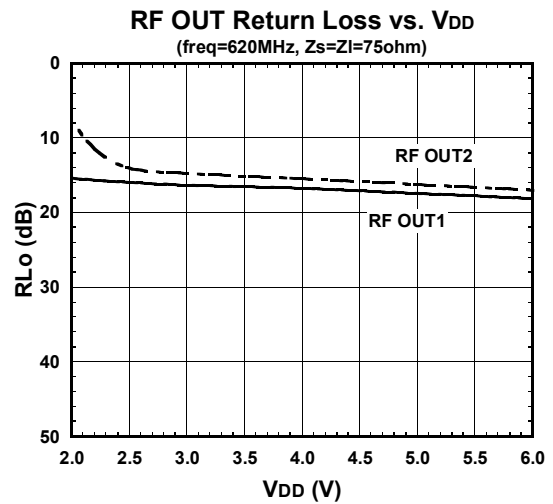
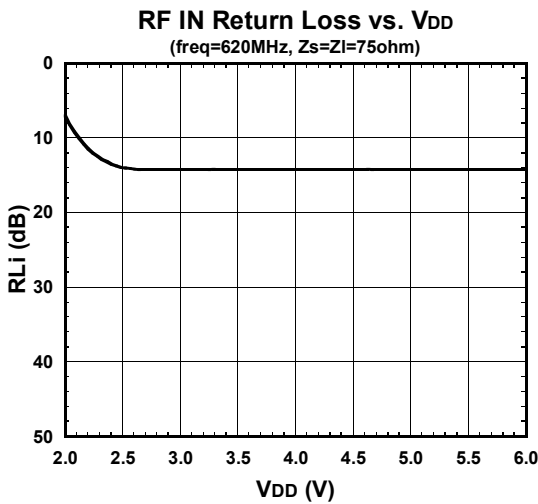
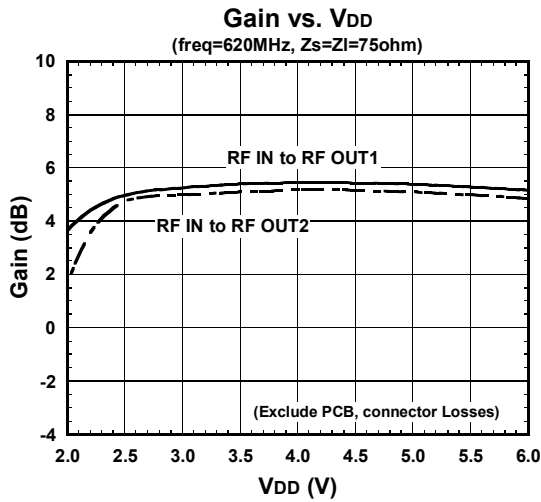
Conditions:  $V_{DD}=5.0V$ ,  $T_a=25^\circ C$ ,  $Z_s=Z_l=75\text{ohm}$ , with application circuit1



# NJG1151MD7

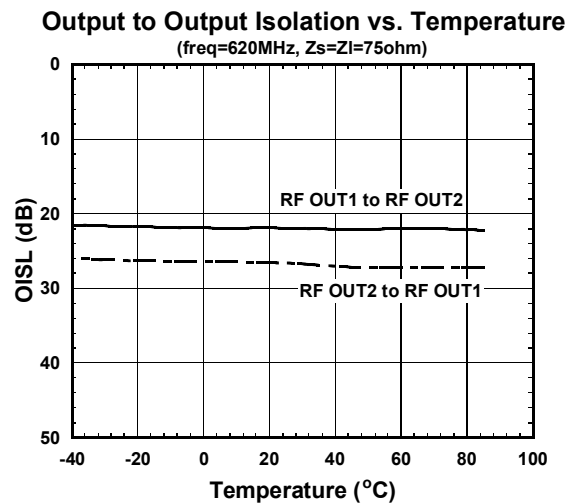
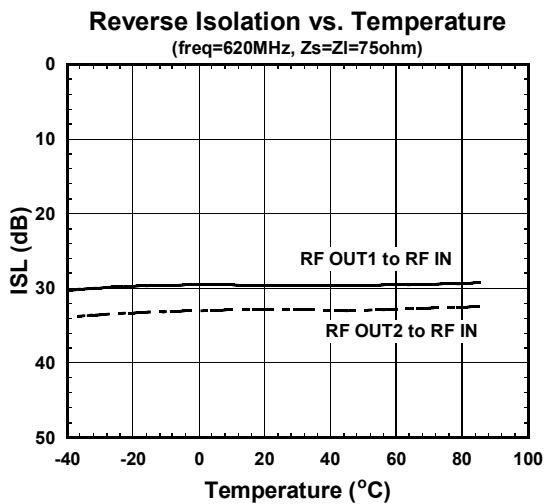
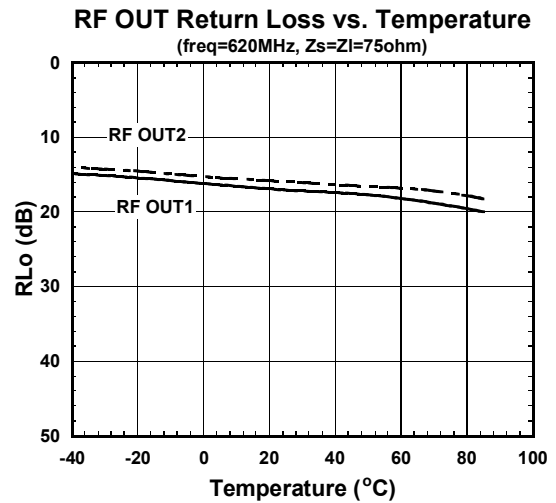
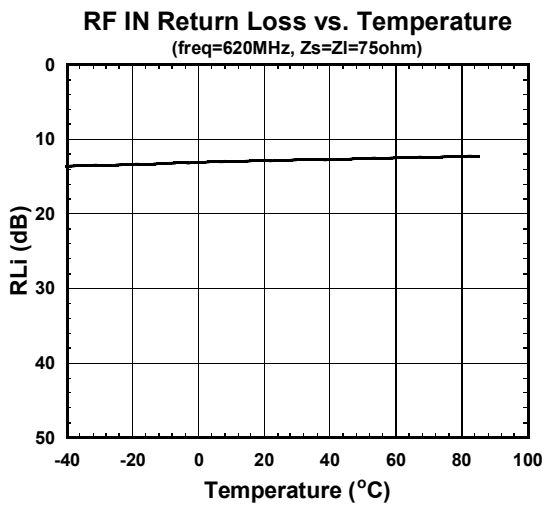
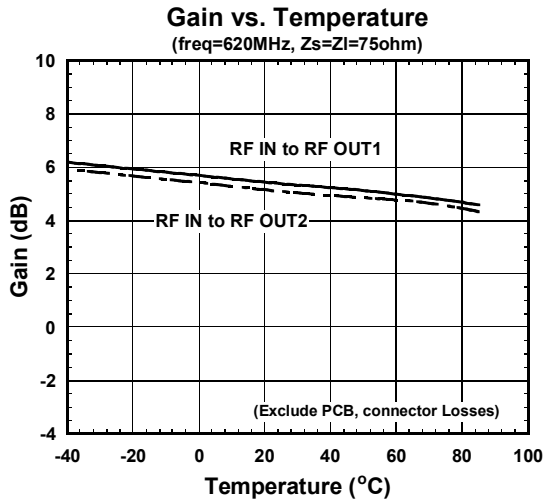
## ■ ELECTRICAL CHARACTERISTICS (Active mode, 75 ohm)

Conditions:  $T_a=25^\circ\text{C}$ ,  $Z_s=Z_l=75\text{ ohm}$ , with application circuit1



## ■ ELECTRICAL CHARACTERISTICS (Active mode, 75 ohm)

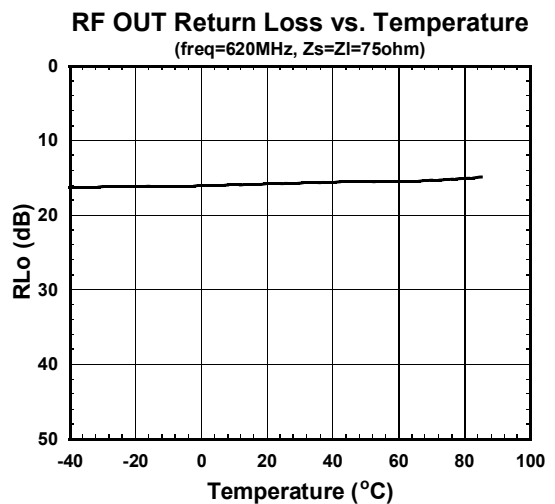
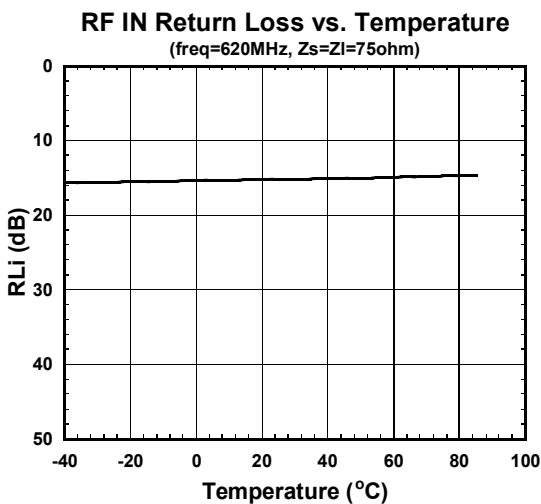
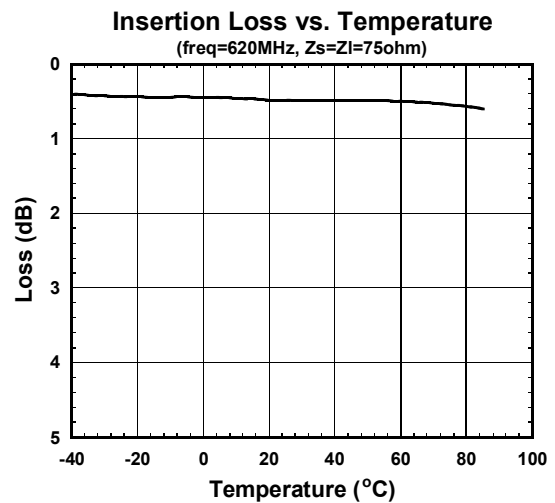
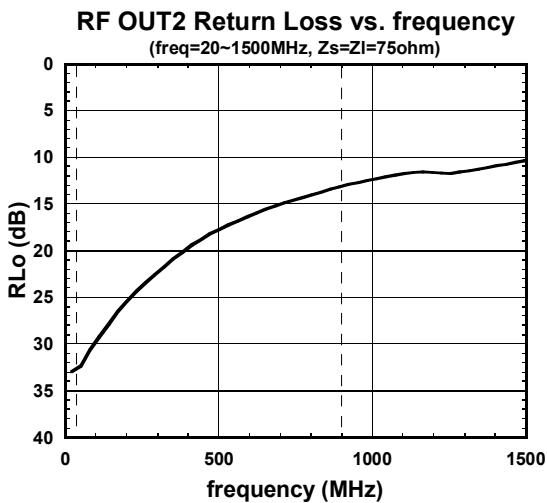
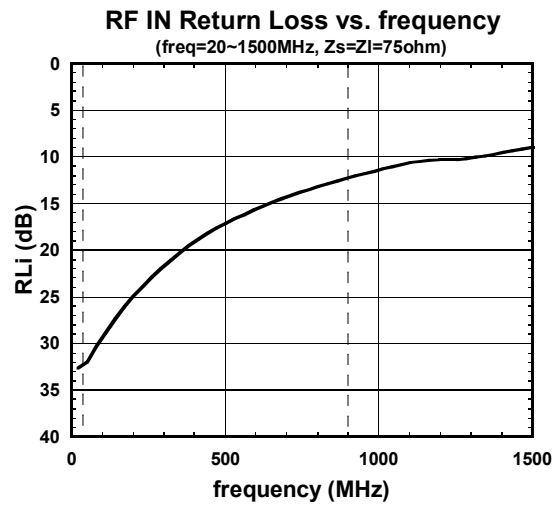
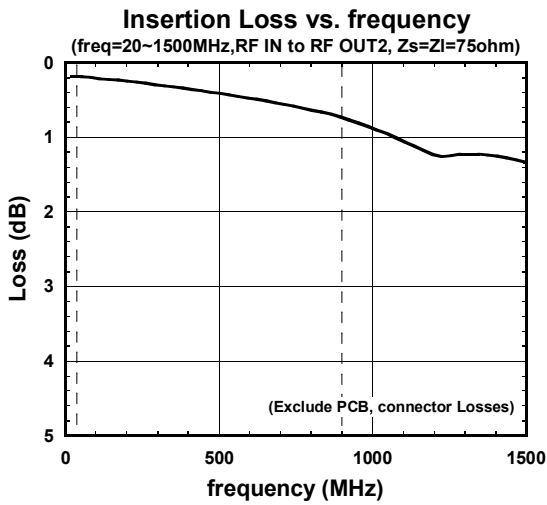
Conditions:  $V_{DD}=5.0V$ ,  $Z_s=Z_l=75\text{ ohm}$ , with application circuit1



# NJG1151MD7

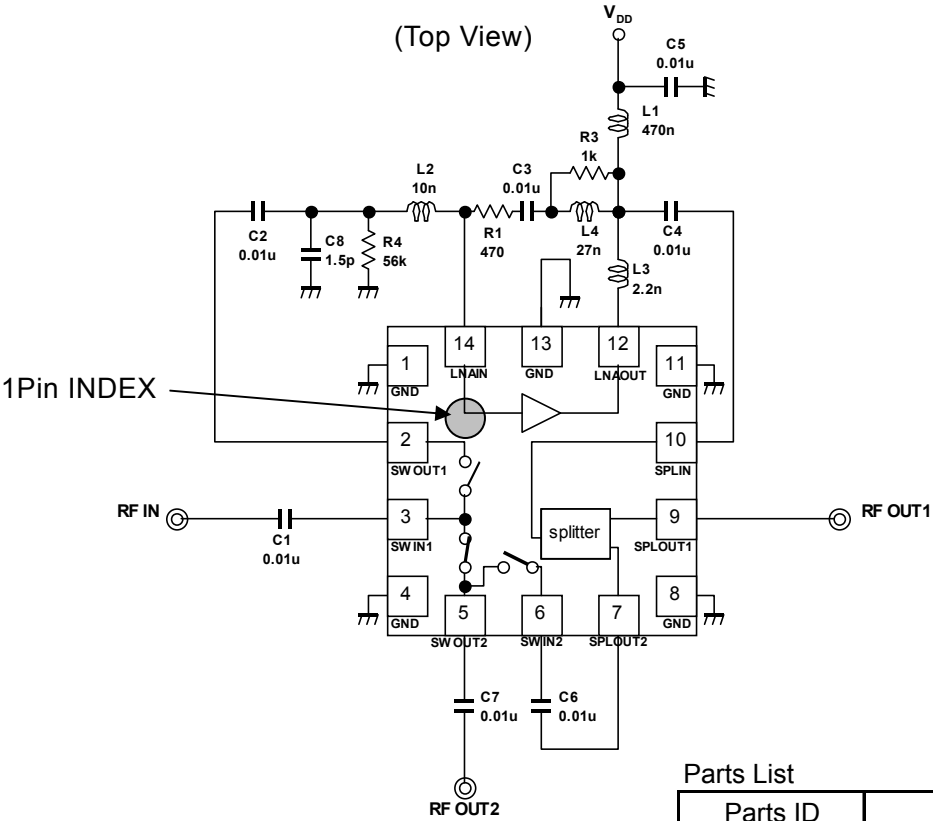
## ■ ELECTRICAL CHARACTERISTICS (Through mode, 75 ohm)

Conditions:  $V_{DD}=0V$ ,  $T_a=25^{\circ}C$ ,  $Z_s=Z_l=75\text{ohm}$ , with application circuit1





■ APPLICATION CIRCUIT1: with through SW



Parts List

Parts ID	Manufacture
L1	TAIYO-YUDEN HK1608 Series
L2~L4	TAIYO-YUDEN HK1005 Series
C1~C8	MURATA GRM15 Series
R1, R3, R4	KOA RK73 Series

■ FUNCTION STATE TABLE1

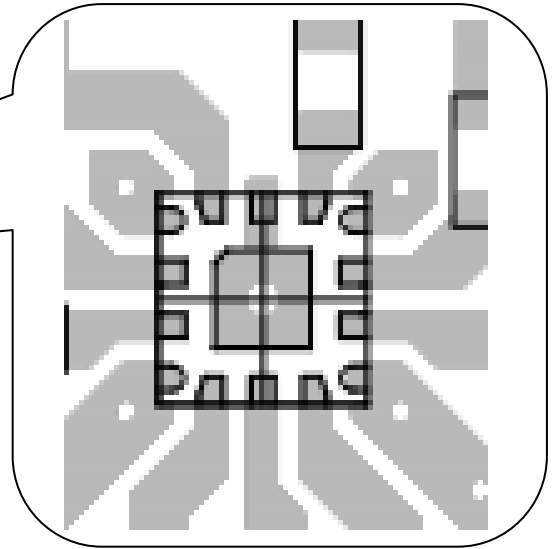
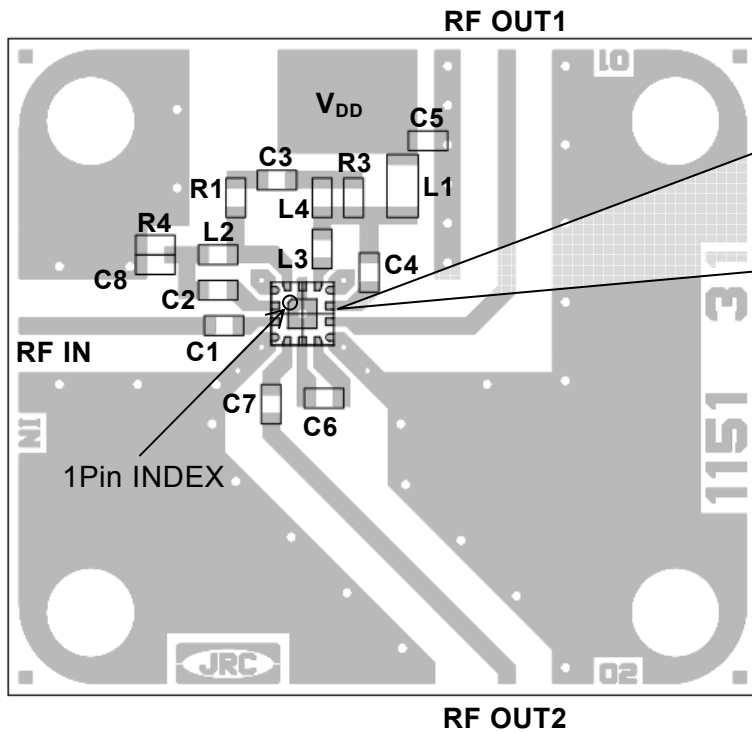
Application circuit1: with through SW

V <sub>DD</sub>	LNA	Loop through SW	RF IN to RF OUT1	RF IN to RF OUT2
0V	OFF	ON	Isolate mode (-28dB)	Through mode (-0.4dB)
5.0V	ON	OFF	Active mode (6dB)	Active mode (5.6dB)

# NJG1151MD7

## TEST PCB LAYOUT

(Top View)



PCB: FR-4,  $t=0.2\text{mm}$   
Microstrip line width: 0.4mm  
PCB size: 16.7mm x 19.1mm

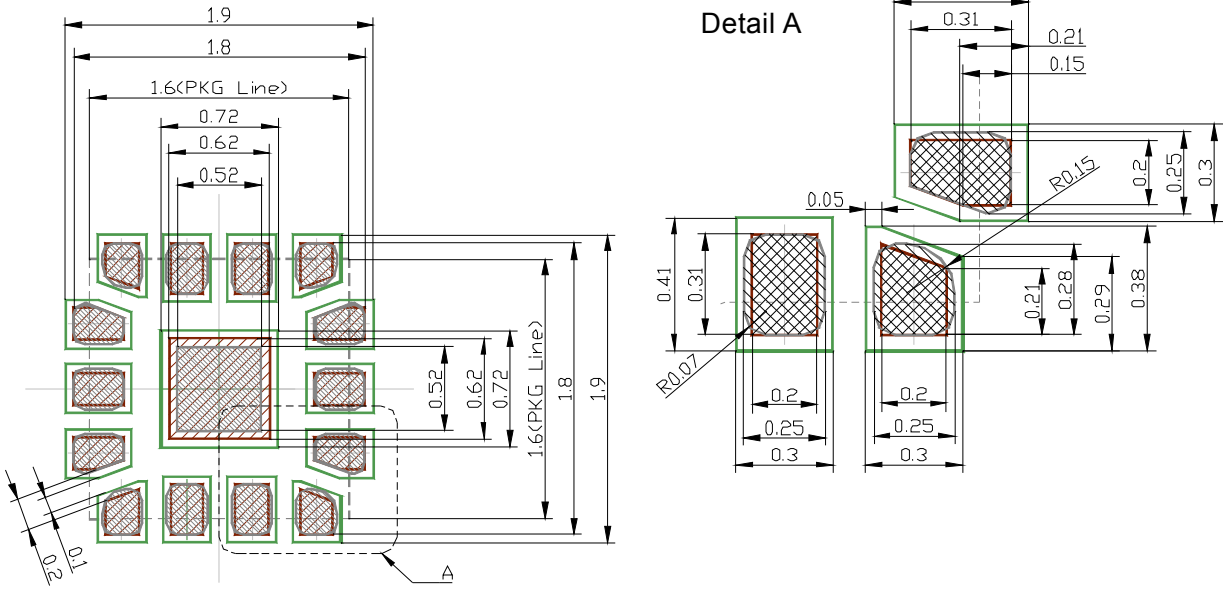
## PRECAUTIONS

- C1~C4, C6 and C7 are DC-Blocking capacitors, and C5 is a bypass capacitor.
- L1 is RF choke inductor. (DC feed inductor)
- R4 is the resistance to adjust the operating current.
- L2~L4, R1, R3 and C8 are negative feedback circuit and impedance matching.
- All external parts, please be placed as close to the IC.
- The backside exposed pad, because it is used to heat dissipation, please grounded via a through-hole near the IC.

RECOMMENDED FOOTPRINT PATTERN (EQFN14-D7 PACKAGE Reference)

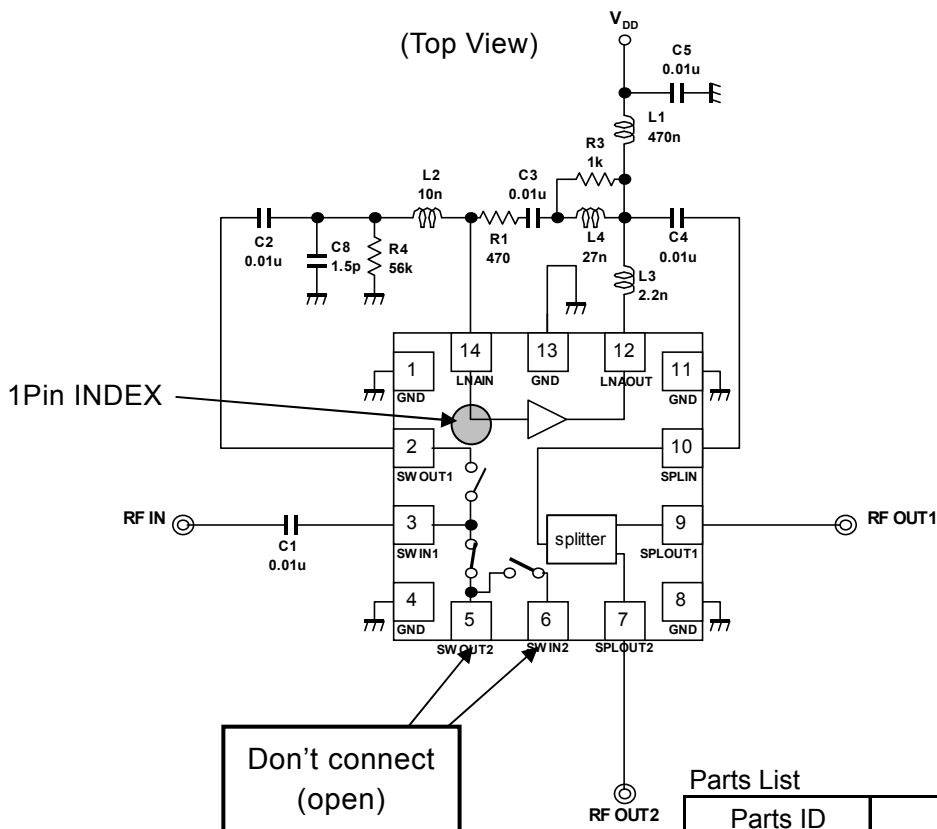
- Land
- Mask (Open area) \*Metal mask thickness: 100um
- Resist (Open area)

PKG: 1.6mm x 1.6mm  
Pin pitch: 0.4mm



# NJG1151MD7

## APPLICATION CIRCUIT2: without through SW



### Parts List

Parts ID	Manufacture
L1	TAIYO-YUDEN HK1608 Series
L2~L4	TAIYO-YUDEN HK1005 Series
C1~C5, C8	MURATA GRM15 Series
R1, R3, R4	KOA RK73 Series

## FUNCTION STATE TABLE2

### Application circuit2: without through SW

$V_{DD}$	LNA	RF IN to RF OUT1	RF IN to RF OUT2
0V	OFF	Isolate mode (-28dB)	Isolate mode (-28dB)
5.0V	ON	Active mode (6dB)	Active mode (6dB)

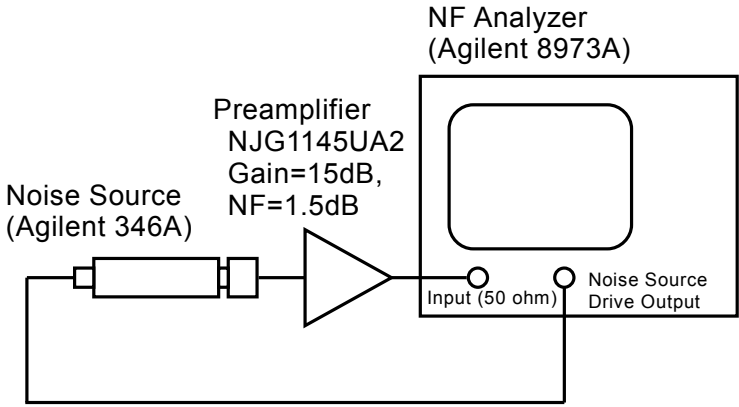
MEASUREMENT BLOCK DIAGRAM

Measuring instruments

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

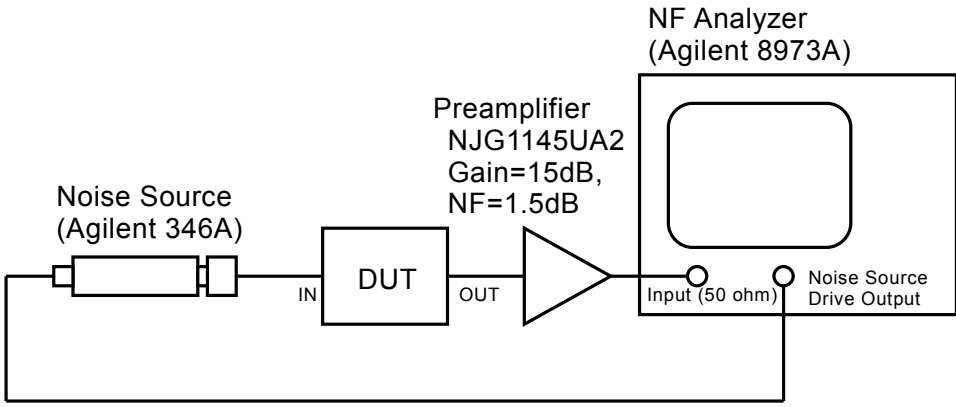
Setting the NF analyzer

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)



Calibration Setup

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

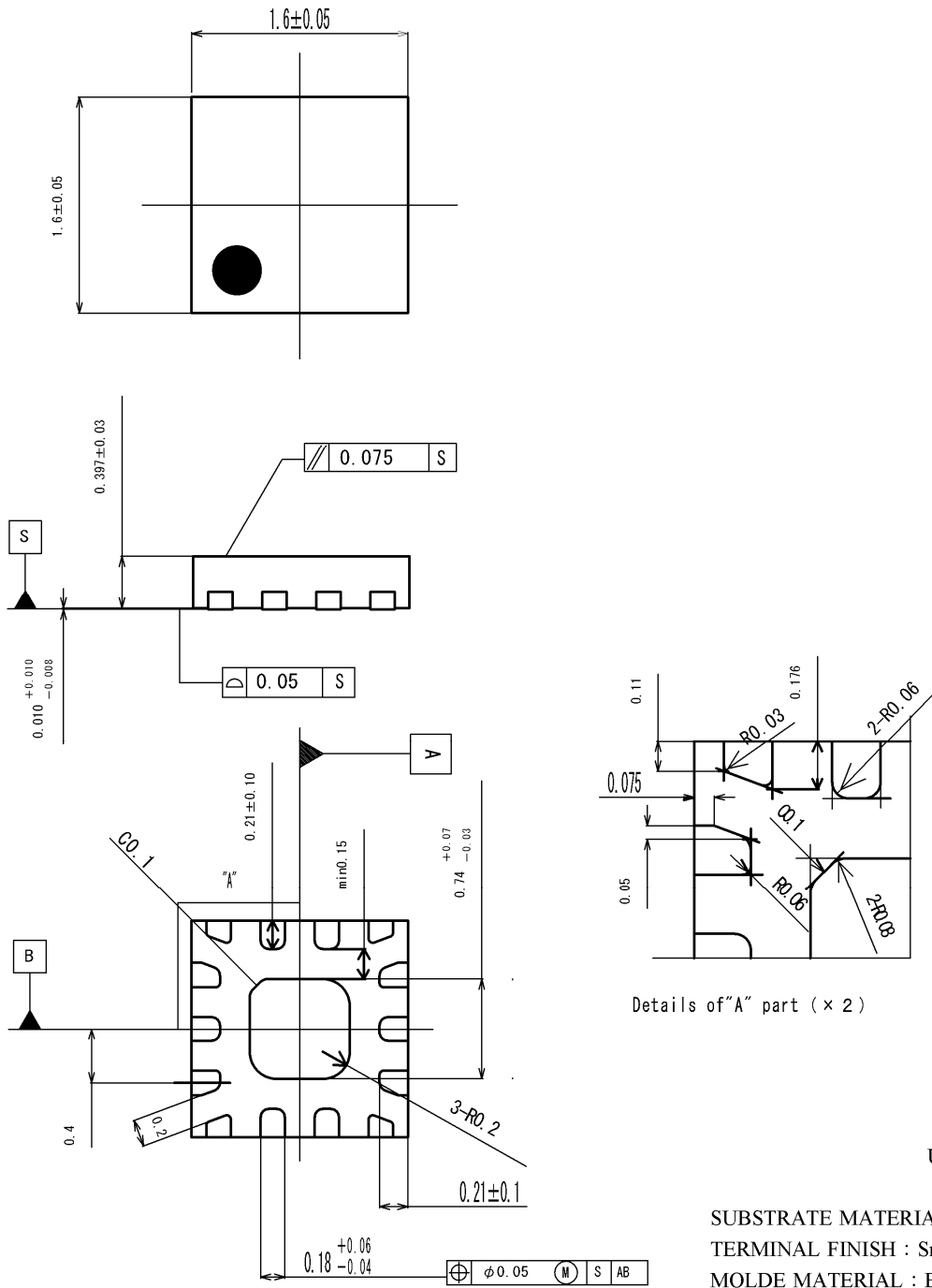


Measurement Setup

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

# NJG1151MD7

## PACKAGE OUTLINE (EQFN14-D7)



UNIT : mm

SUBSTRATE MATERIAL : Copper

TERMINAL FINISH : Sn-Bi plating

MOLDE MATERIAL : Epoxy resin

MASS (TYP.) : 0.0034 (g)

### 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.