WIDE BAND LOW NOISE AMPLIFIER GaAs MMIC

■ GENERAL DESCRIPTION

The NJG1145UA2 is a fully matched wide band low noise amplifier GaAs MMIC for terrestrial and satellite applications.

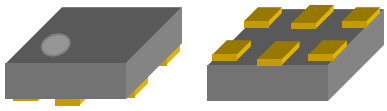
To achieve wide dynamic range, the NJG1145UA2 offers high gain mode and low gain mode. Selecting high gain mode for weak signals, the NJG1145UA2 helps improve receiver sensitivity through high gain and low noise figure. Selecting low gain mode for strong signals, it bypasses LNA circuit to offer higher linearity.

In high gain mode, the NJG1145UA2 achieves high gain and high IIP3 across the band.

The ESD protection circuits are integrated into the MMIC. They achieve high ESD protection voltage.

An ultra-small and ultra-thin package of EPFFP6-A2 is adopted.

■ PACKAGE OUTLINE



NJG1145UA2

■ APPLICATION

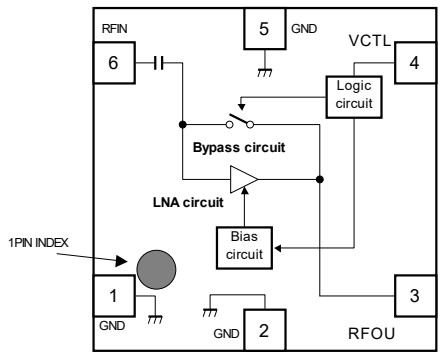
Terrestrial and Satellite applications from 90MHz to2150MHz
Digital TV, CATV, BS/CS and Set-top box
LTE Router, modem and Base Station

■ FEATURES

● Wide operating frequency range	90MHz~2150MHz
● Low voltage operation	2.8V typ.
● External components count	3pcs. (capacitor: 2pcs, inductor: 1pc)
● Small package size	EPFFP6-A2 (package size: 1.0mmx1.0mmx0.37mm typ.)
[High gain mode]	
● Current consumption	20mA typ.
● High gain	+15.0dB typ.
● Low noise figure	1.5dB typ.
[Low gain mode]	
● Low current consumption	11μA typ.
● Gain(Low loss)	-1.0dB typ.

■ PIN CONFIGURATION

(Top View)



Pin Connection
1. GND
2. GND
3. RFOUT
4. VCTL
5. GND
6. RFIN

■ TRUTH TABLE

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

V_{CTL}	LNA ON	Bypass	LNA mode
H	ON	OFF	High Gain mode
L	OFF	ON	Low Gain mode

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

■ ABSOLUTE MAXIMUM RATINGS

T_a=+25°C, Z_s=Z_l=50 ohm

PARAMETER	SYMBOL	CONDITIONS	RATINGS	UNITS
Supply voltage	V_{DD}		5.0	V
Control voltage	V_{CTL}		5.0	V
Input power	P_{IN}	V_{DD}=2.8V	+15	dBm
Power dissipation	P_D	4-layer FR4 PCB with through-hole (101.5x114.5mm), T_j=150°C	590	mW
Operating temperature	T_{opr}		-40~+85	°C
Storage temperature	T_{stg}		-55~+150	°C

■ ELECTRICAL CHARACTERISTICS1 (DC CHARACTERISTICS)

General conditions: V_{DD}=2.8V, T_a=+25°C, Z_s=Z_l=50 ohm

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating voltage	V_{DD}		2.3	2.8	3.6	V
Control voltage (High)	$V_{CTL(H)}$		1.3	1.8	3.6	V
Control voltage (Low)	$V_{CTL(L)}$		0.0	0.0	0.5	V
Operating current1	I_{DD1}	RF OFF, V_{CTL}=1.8V	-	20.0	27.0	mA
Operating current2	I_{DD2}	RF OFF, V_{CTL}=0V	-	11.0	25.0	μA
Control current	I_{CTL}	RF OFF, V_{CTL}=1.8V	-	6.0	10.0	μA

■ **ELECTRICAL CHARACTERISTICS2** (High Gain mode)

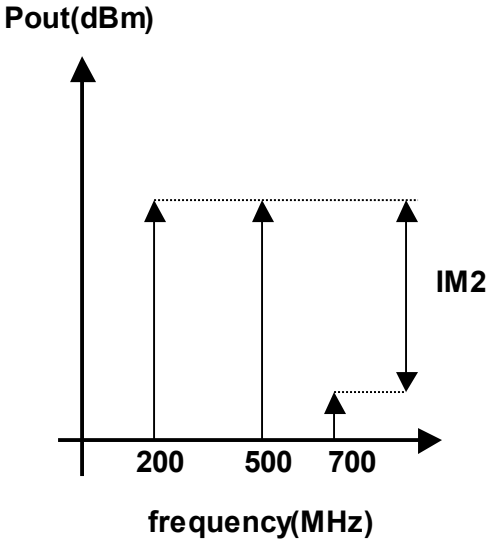
Conditions: freq=90~2150MHz, V_{DD}=2.8V, V_{CTL}=1.8V, T_a=+25°C, Z_s=Z_l=50 ohm

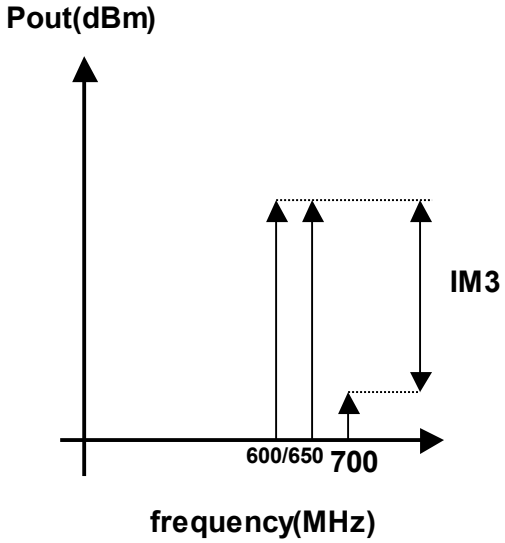
PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain1	Gain1	Exclude PCB, connector losses*1	12.0	15.0	18.0	dB
Noise figure1	NF1	Exclude PCB, connector losses*2	-	1.5	2.3	dB
Input power 1dB gain compression1	$P_{-1dB(IN)}1$		-5.0	+0.0	-	dBm
Input 3rd order intercept point1	IIP3_1	f1=freq, f2=freq+100kHz, P_{IN}=-26dBm	+2.0	+10.0	-	dBm
2nd order IMD1	IM2_1	f1=200MHz, f2=500MHz, fmeas=700MHz, $P_{IN}1$=$P_{IN}2$=-15dBm *3	20.0	28.0	-	dB
3rd order IMD1	IM3_1	f1=600MHz, f2=650MHz, fmeas=700MHz, $P_{IN}1$=$P_{IN}2$=-15dBm *3	35.0	45.0	-	dB
Isolation	ISL	S12	-	-19.0	-15.0	dB
RF IN VSWR1	VSWRi1		-	2.2	3.2	-
RF OUT VSWR1	VSWRo1		-	1.5	2.2	-

*1 Input & output PCB and connector losses: 0.037dB(90MHz), 0.092dB(620MHz), 0.274dB(2150MHz)

*2 Input PCB and connector losses: 0.019dB(90MHz), 0.046dB(620MHz), 0.122dB(2150MHz)

*3 Definitions of IM2 and IM3.





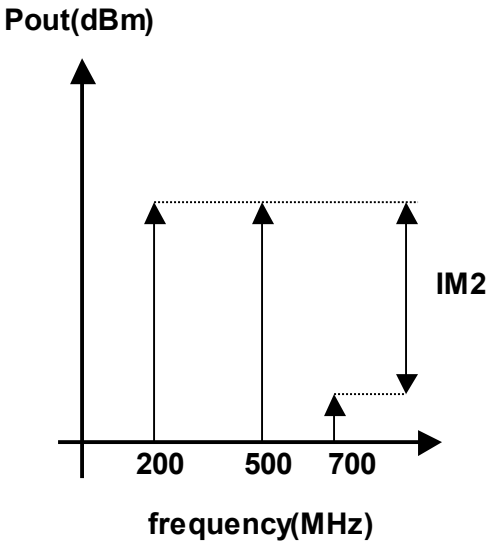
■ **ELECTRICAL CHARACTERISTICS3** (Low Gain mode)

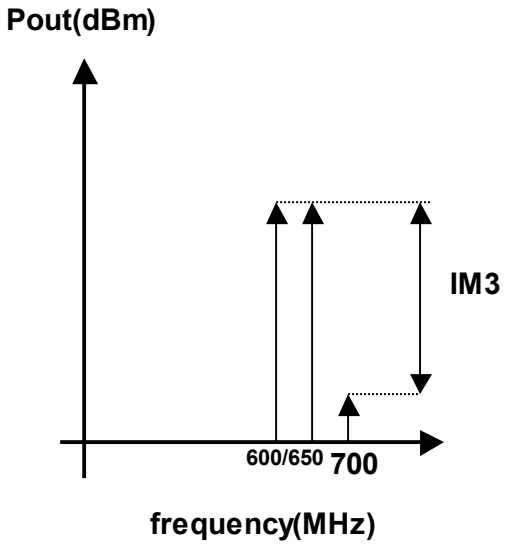
Conditions: freq=90~2150MHz, V_{DD}=2.8V, V_{CTL}=0V, T_a=+25°C, Z_s=Z_l=50 ohm

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain2	Gain2	Exclude PCB, connector losses*1	-6.0	-1.0	-	dB
Input power at 1dB gain compression2	$P_{-1dB(IN)}2$		+10.0	+15.0	-	dBm
Input 3rd order intercept point2	IIP3_2	f1=freq, f2=freq+100kHz, P_{IN}=-6dBm	+20.0	+30.0	-	dBm
2nd order IMD2	IMD2_2	f1=200MHz, f2=500MHz fmeas=700MHz, $P_{IN}1$=$P_{IN}2$=-8dBm *3	55.0	66.0	-	dB
3rd order IMD2	IMD3_2	f1=600MHz, f2=650MHz fmeas=700MHz, $P_{IN}1$=$P_{IN}2$=-8dBm *3	65.0	75.0	-	dB
RF IN VSWR2	VSWRi2		-	1.5	4.0	-
RF OUT VSWR2	VSWRo2		-	1.5	4.0	-

*1 Input & output PCB and connector losses: 0.037dB(90MHz), 0.092dB(620MHz), 0.274dB(2150MHz)

*3 Definitions of IM2 and IM3.



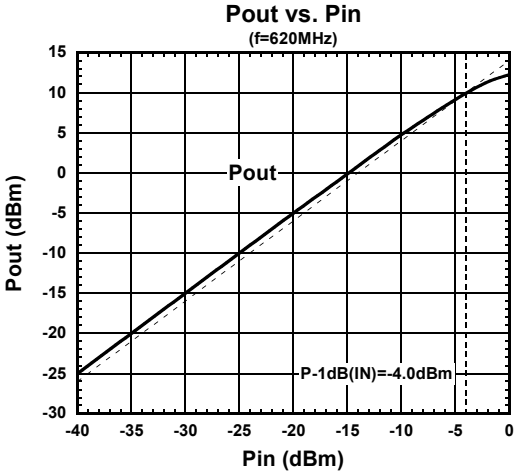


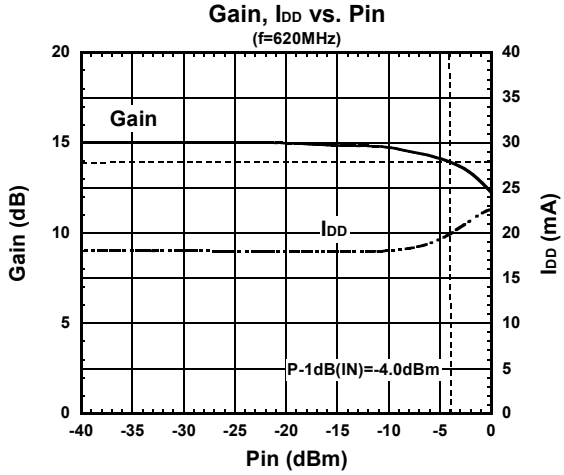
■ TERMINAL INFORMATION

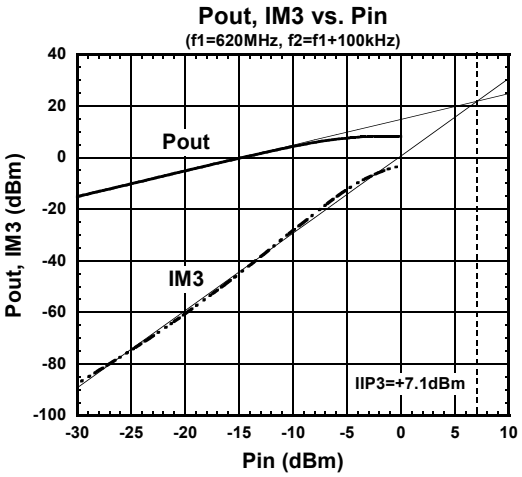
No.	SYMBOL	DESCRIPTION
1	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
2	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
3	RFOUT	RF output terminal. This terminal doubles as the drain terminal of the LNA. Please connect this terminal to the power supply(VDD) via inductor(L1).
4	VCTL	Control voltage terminal.
5	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
6	RFIN	RF input terminal. This IC integrates an input DC blocking capacitor.

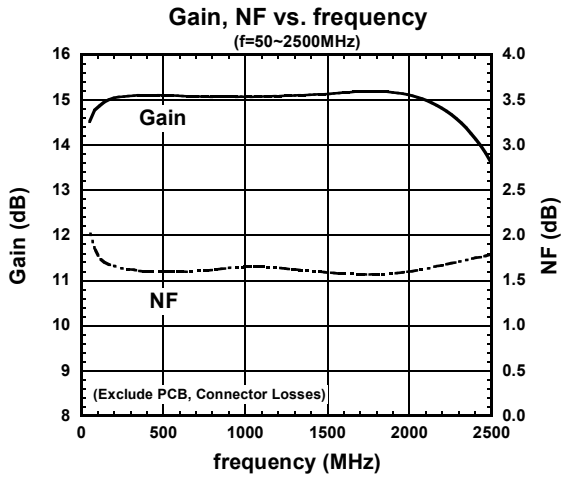
■ ELECTRICAL CHARACTERISTICS (High Gain mode)

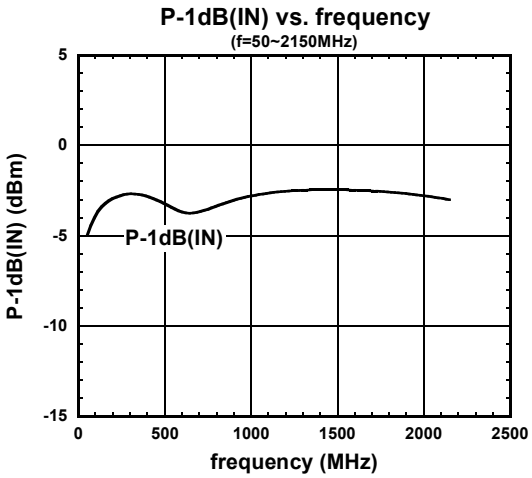
Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, Ta=25°C, Z_s=Z_l=50 ohm, with application circuit

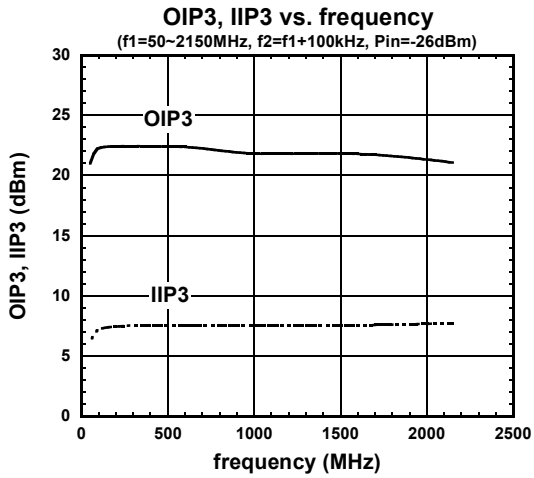








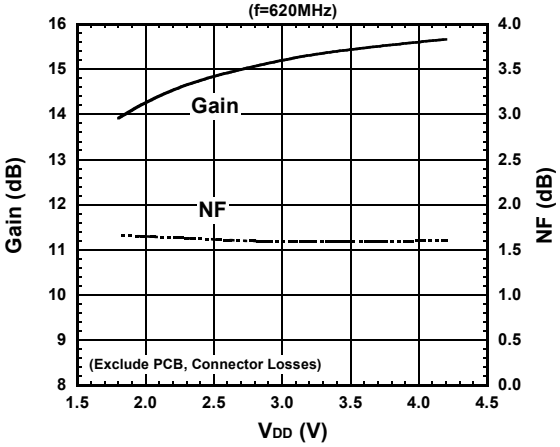




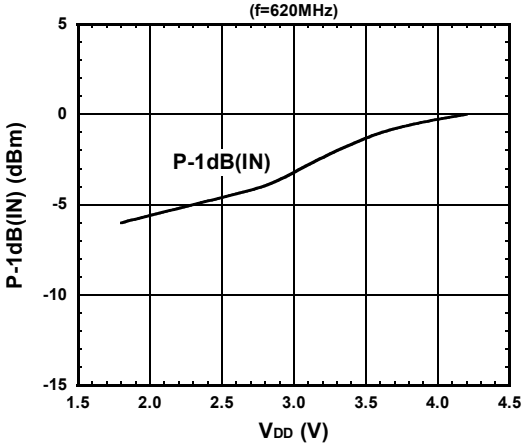
■ ELECTRICAL CHARACTERISTICS (High Gain mode)

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

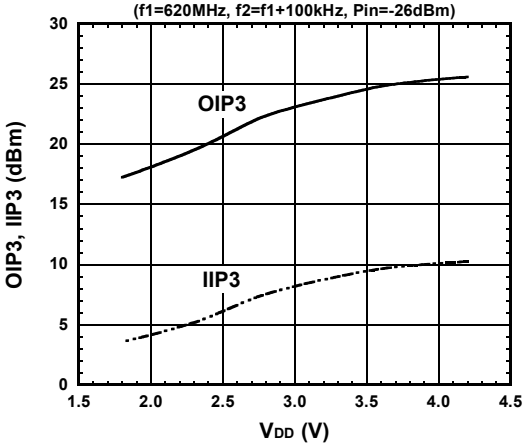
Gain, NF vs. V_{DD}
(f=620MHz)



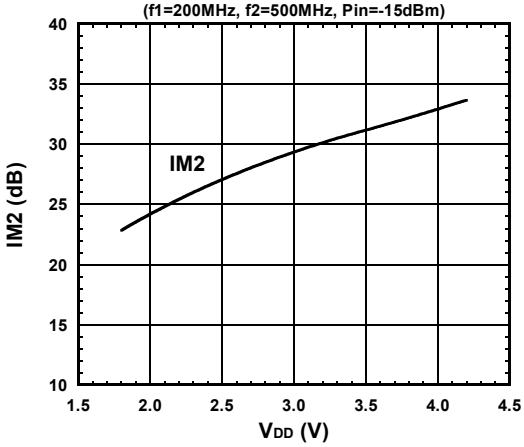
P-1dB(IN) vs. V_{DD}
(f=620MHz)



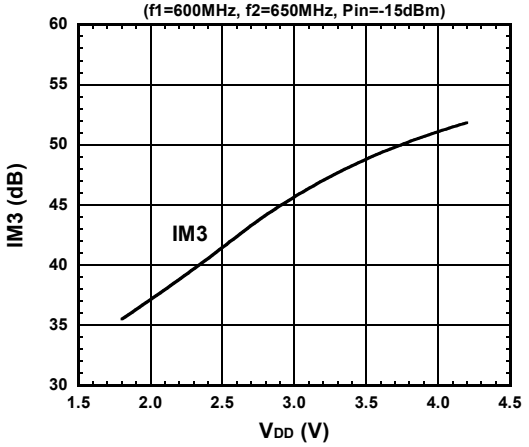
OIP3, IIP3 vs. V_{DD}
(f1=620MHz, f2=f1+100kHz, Pin=-26dBm)



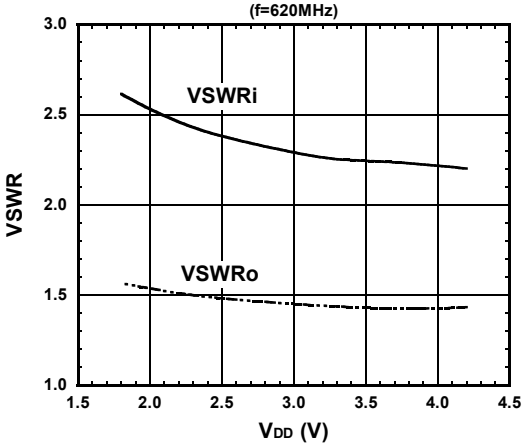
IM2 vs. V_{DD}
(f1=200MHz, f2=500MHz, Pin=-15dBm)



IM3 vs. V_{DD}
(f1=600MHz, f2=650MHz, Pin=-15dBm)

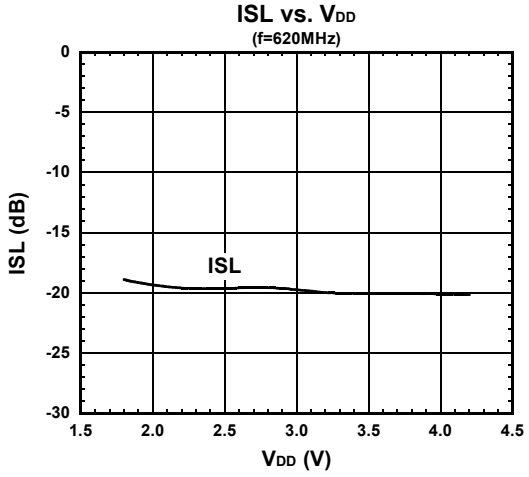


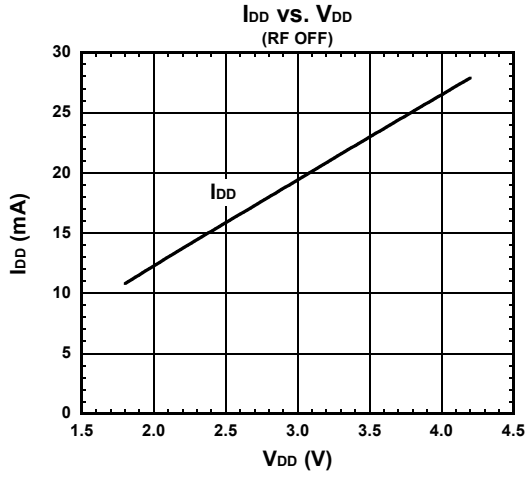
VSWR vs. V_{DD}
(f=620MHz)



■ **ELECTRICAL CHARACTERISTICS** (High Gain mode)

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

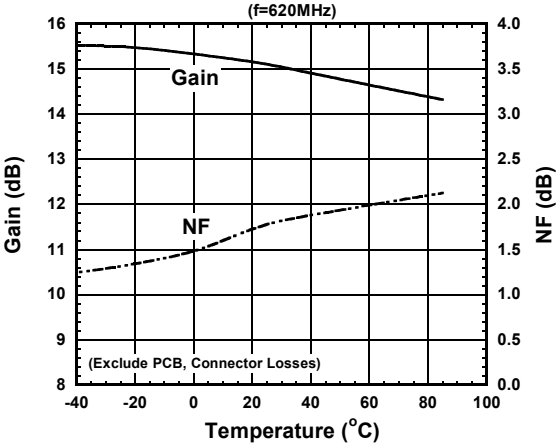




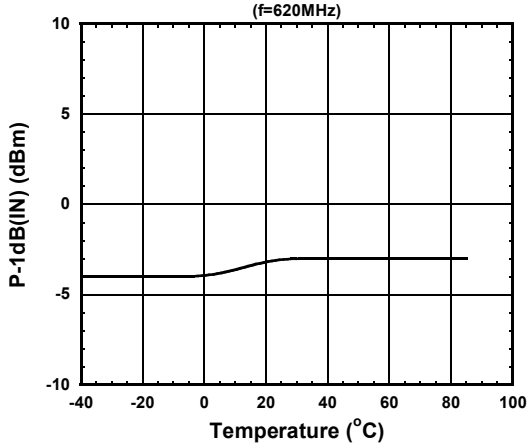
■ ELECTRICAL CHARACTERISTICS (High Gain mode)

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

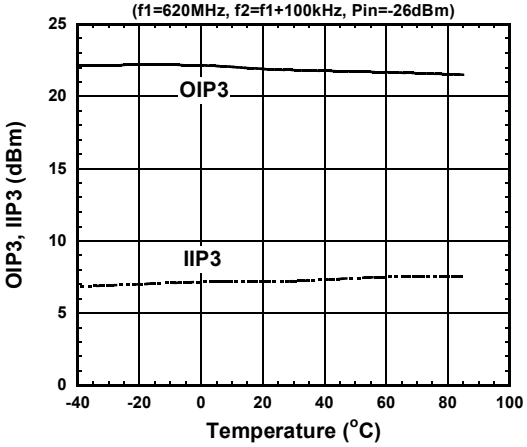
Gain, NF vs. Temperature
(f=620MHz)



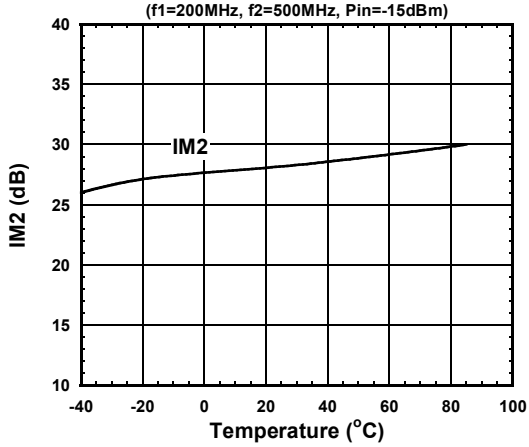
P-1dB(IN) vs. Temperature
(f=620MHz)



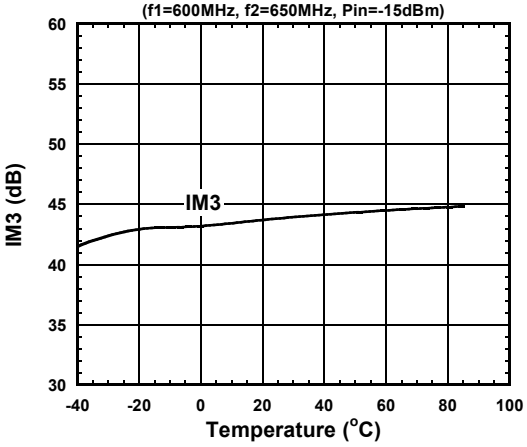
OIP3, IIP3 vs. Temperature
(f1=620MHz, f2=f1+100kHz, Pin=-26dBm)



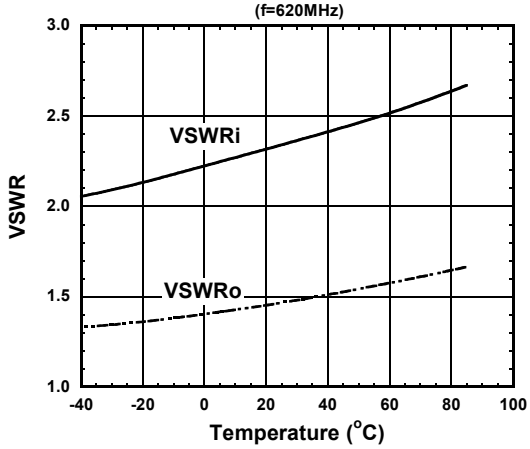
IM2 vs. Temperature
(f1=200MHz, f2=500MHz, Pin=-15dBm)



IM3 vs. Temperature
(f1=600MHz, f2=650MHz, Pin=-15dBm)

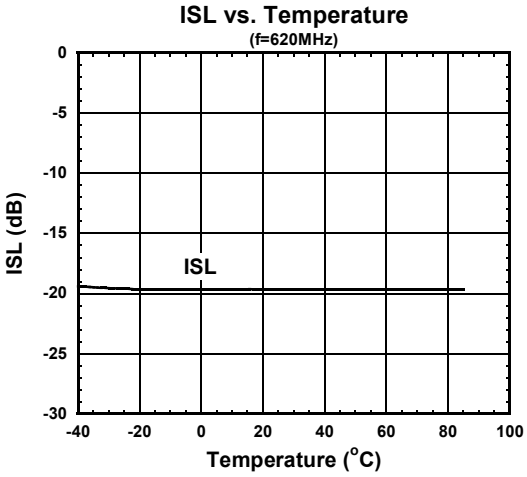


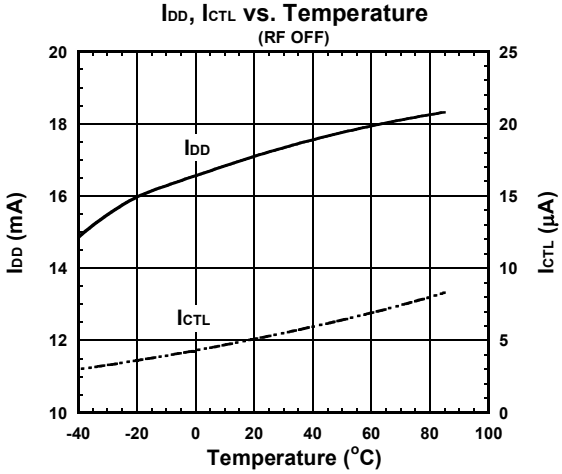
VSWR vs. Temperature
(f=620MHz)

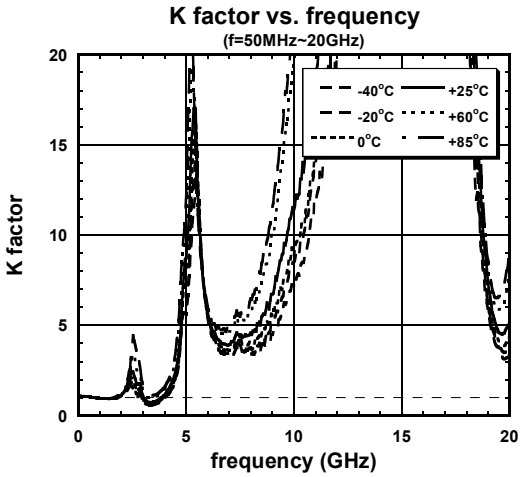


■ ELECTRICAL CHARACTERISTICS (High Gain mode)

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

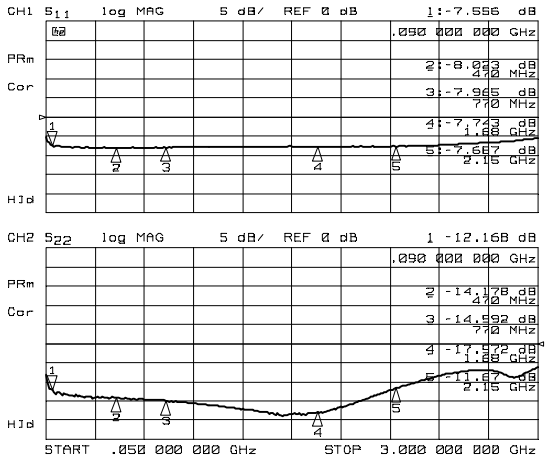




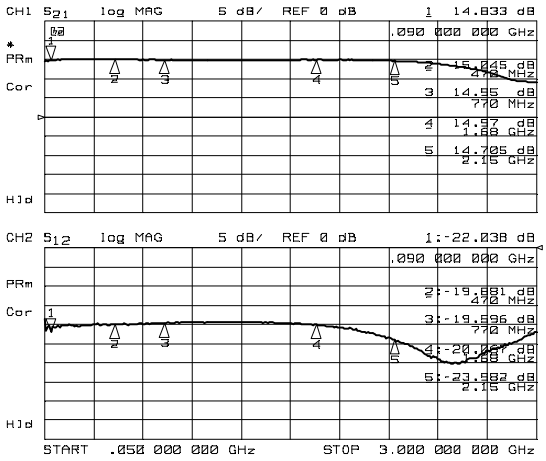


■ ELECTRICAL CHARACTERISTICS (Hgih Gain mode)

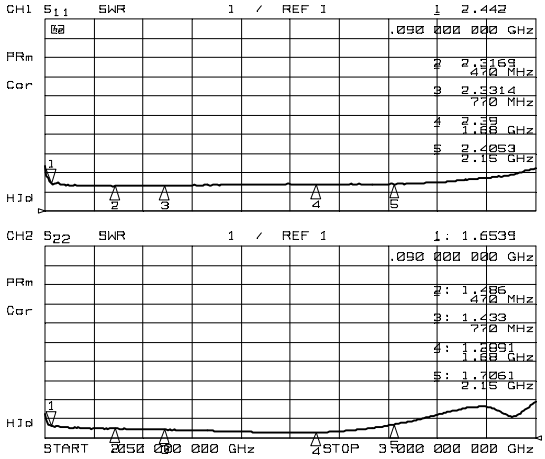
Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, T_a=25°C, Z_s=Z_l=50 ohm, with application circuit



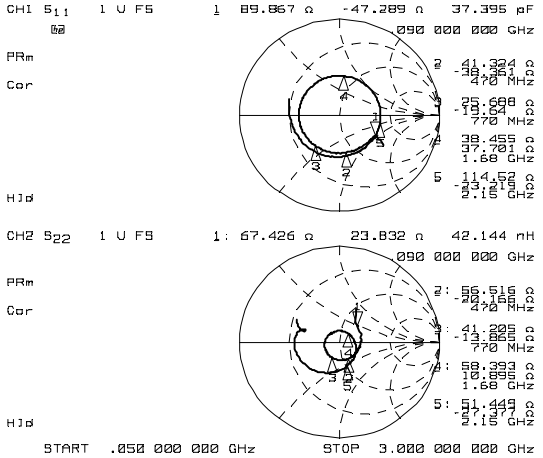
S11, S22 (f=0.05GHz to 3GHz)



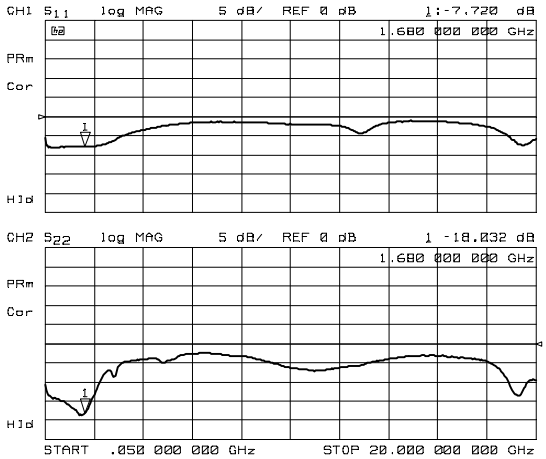
S21, S12 (f=0.05GHz to 3GHz)



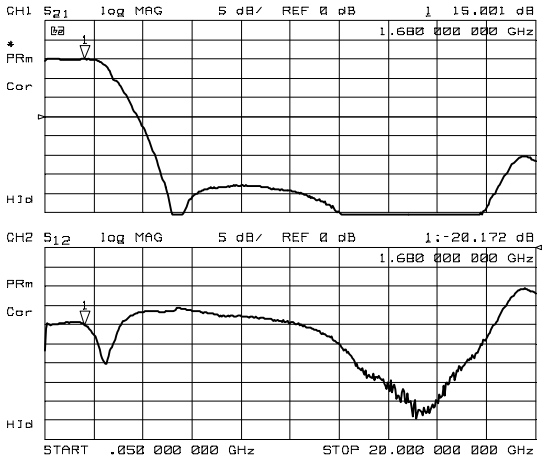
VSWR (f=0.05GHz to 3GHz)



Zin, Zout (f=0.05GHz to 3GHz)



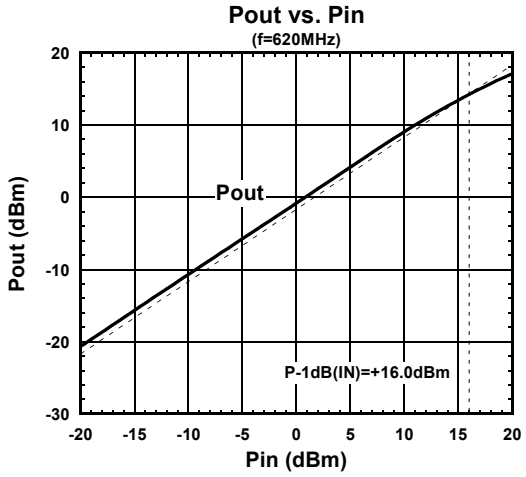
S11, S22 (f=0.05GHz to 20GHz)

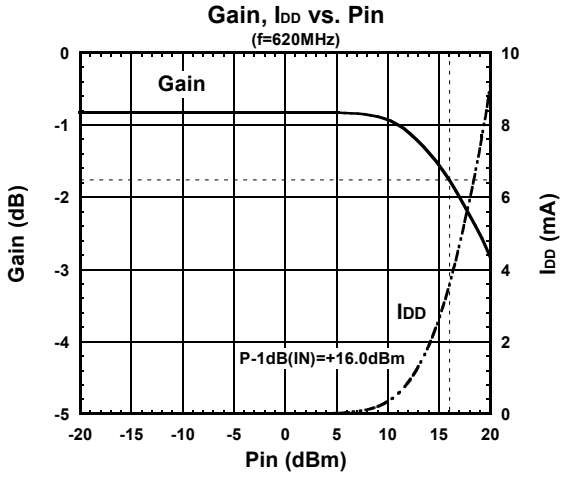


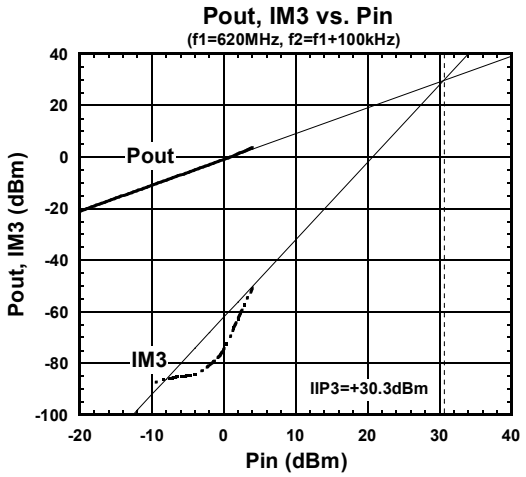
S21, S12 (f=0.05GHz to 20GHz)

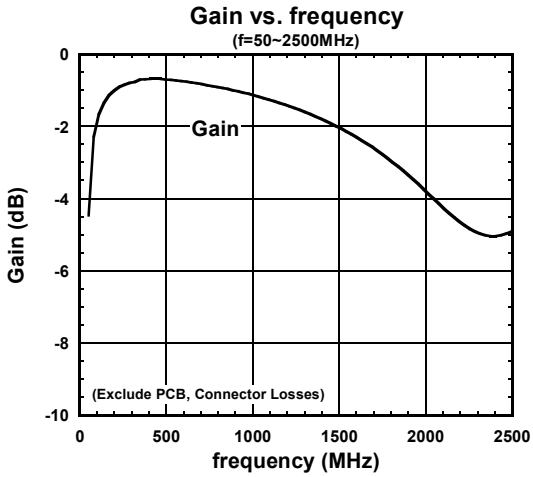
■ ELECTRICAL CHARACTERISTICS (Low Gain mode)

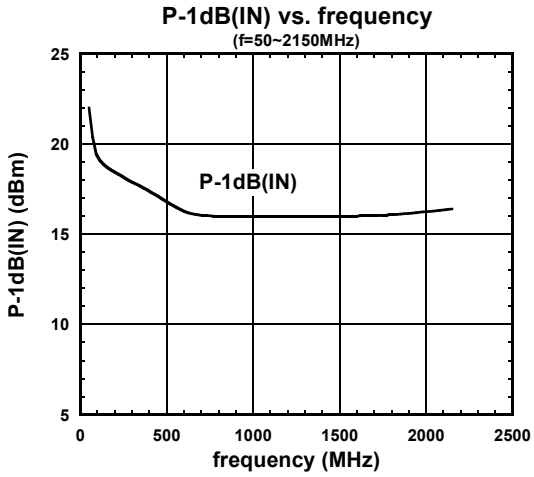
Conditions: V_{DD}=2.8V, V_{CTL}=0V, T_a=25°C, Z_s=Z_l=50 ohm, with application circuit

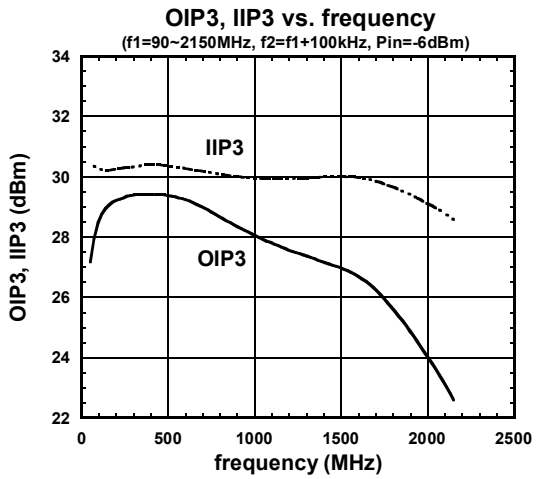






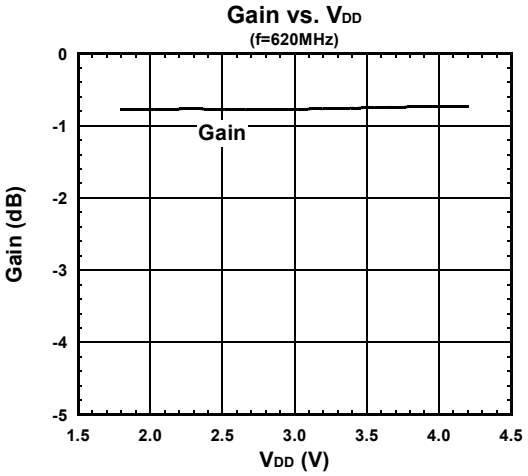


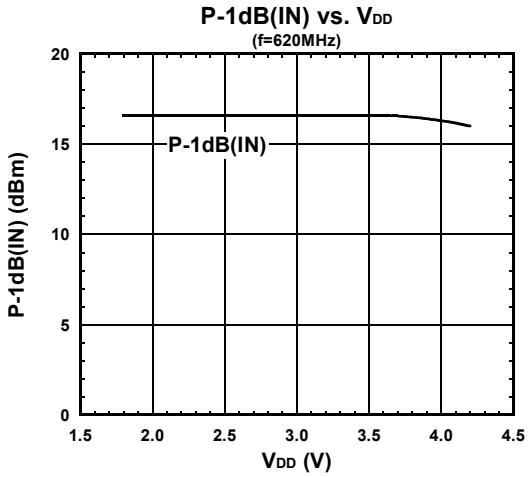


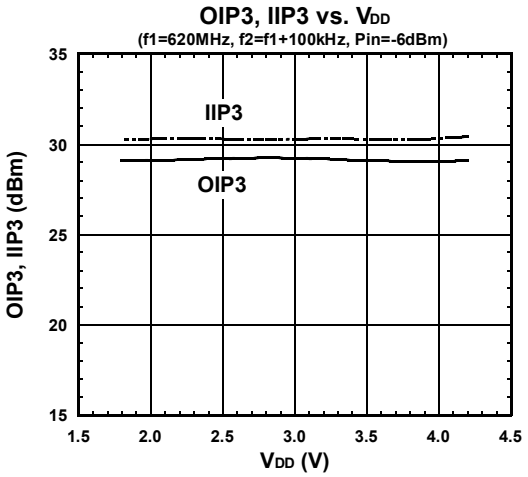


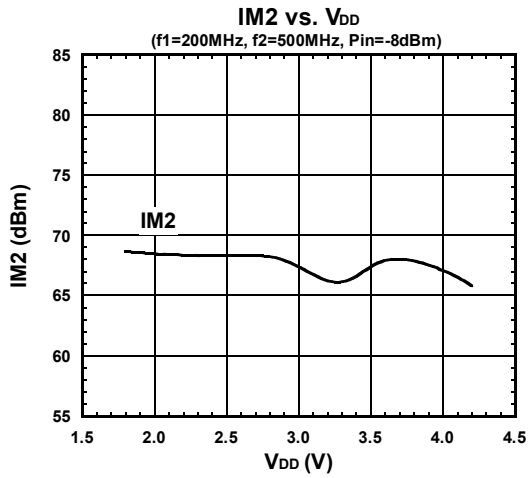
■ ELECTRICAL CHARACTERISTICS (Low Gain mode)

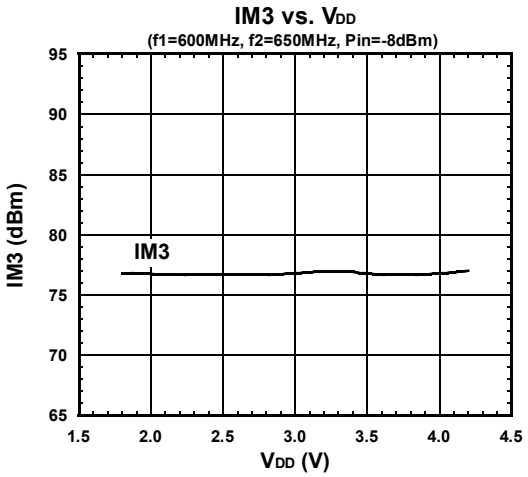
Conditions: V_{CTL}=0V, T_a=25°C, Z_s=Z_l=50 ohm, with application circuit

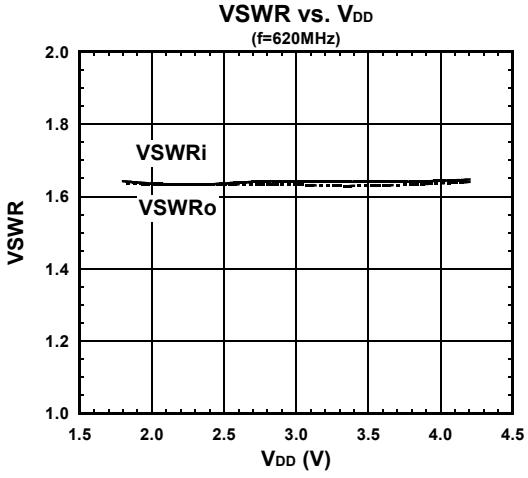






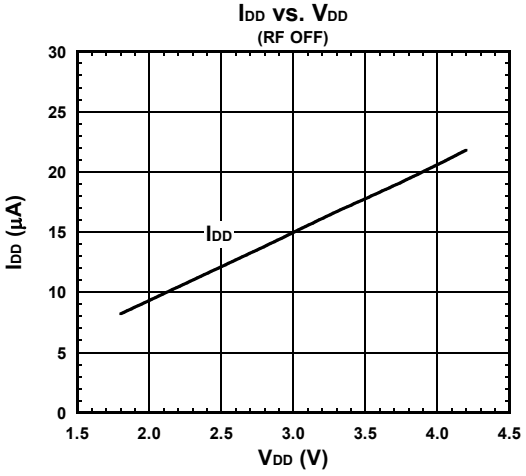






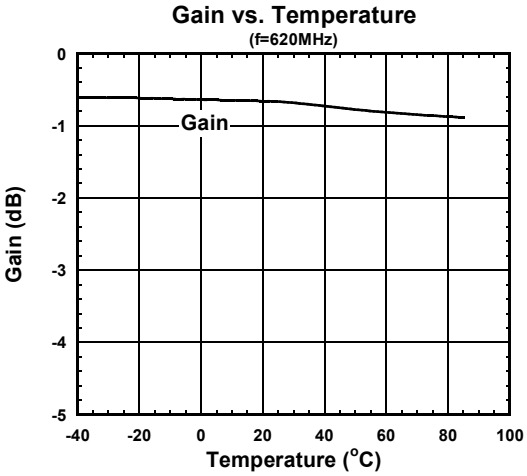
■ **ELECTRICAL CHARACTERISTICS** (Low Gain mode)

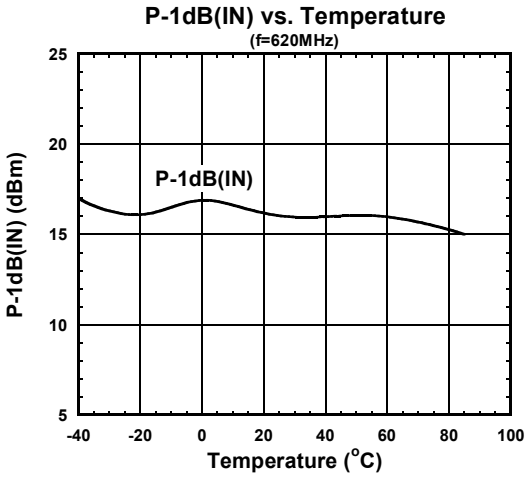
Conditions: V_{CTL}=0V, T_a=25°C, Z_s=Z_l=50 ohm, with application circuit

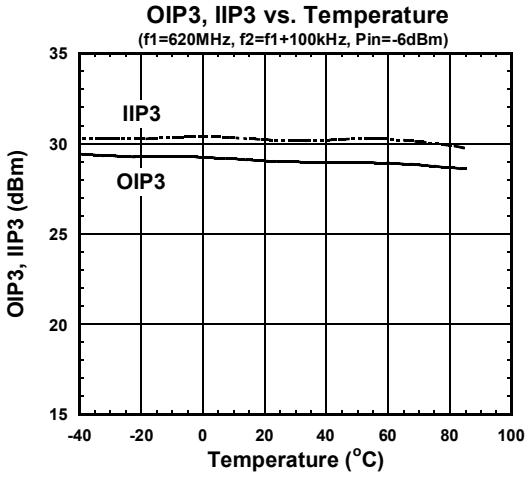


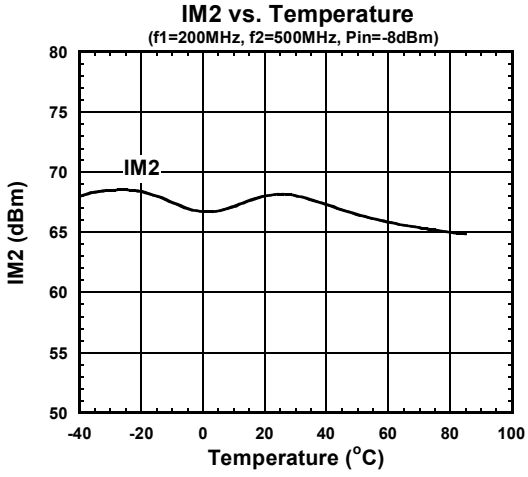
■ ELECTRICAL CHARACTERISTICS (Low Gain mode)

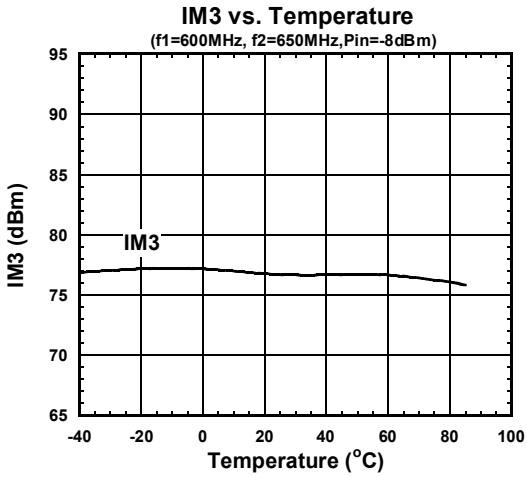
Conditions: V_{DD}=2.8V, V_{CTL}=0V, Z_s=Z_l=50 ohm, with application circuit

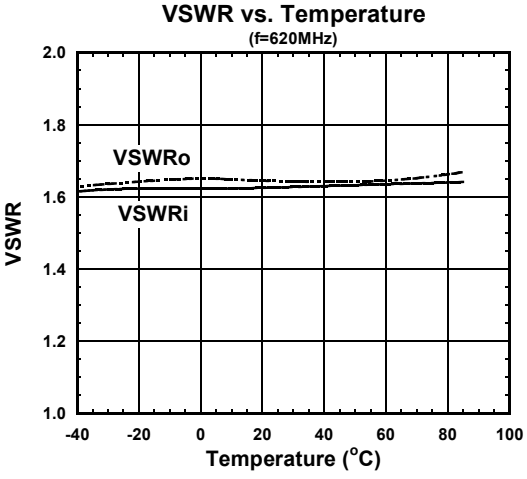






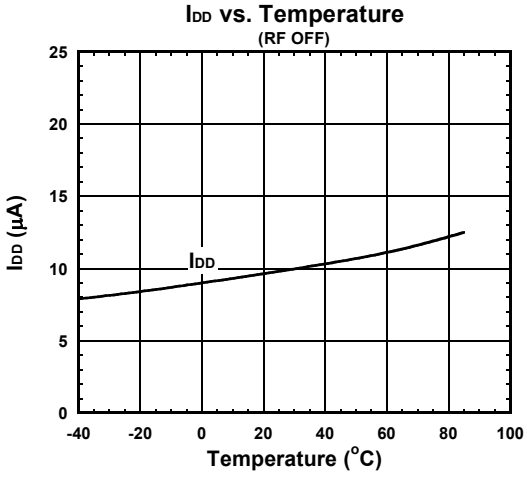


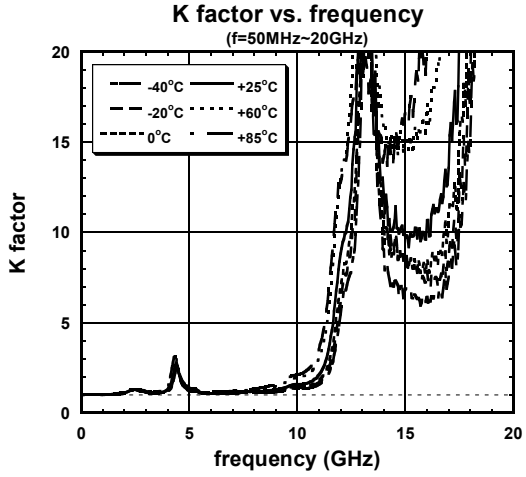


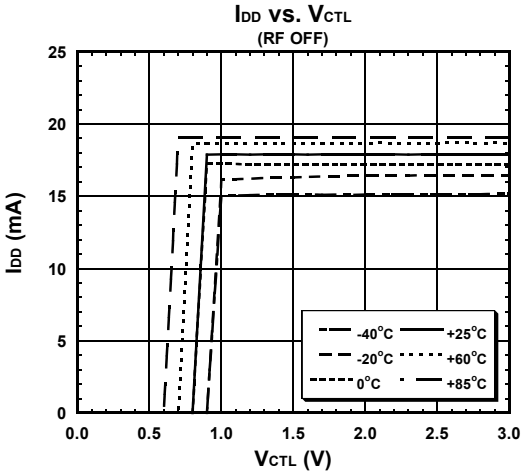


■ ELECTRICAL CHARACTERISTICS (Low Gain mode)

Conditions: V_{DD}=2.8V, V_{CTL}=0V, Z_s=Z_l=50 ohm, with application circuit







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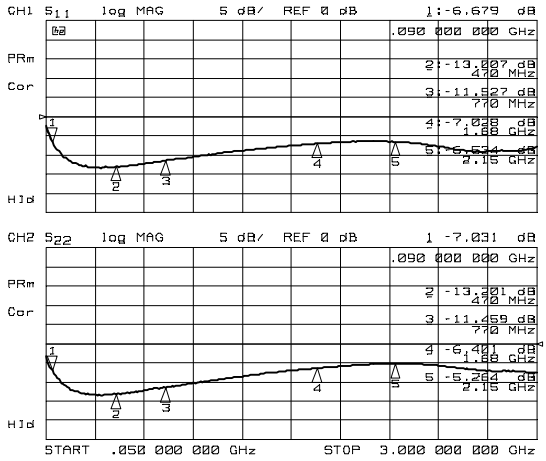
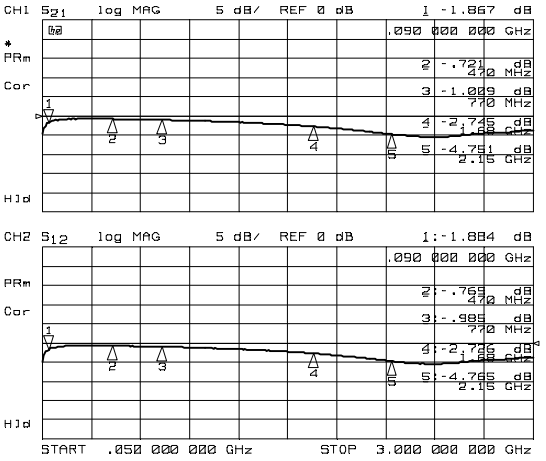
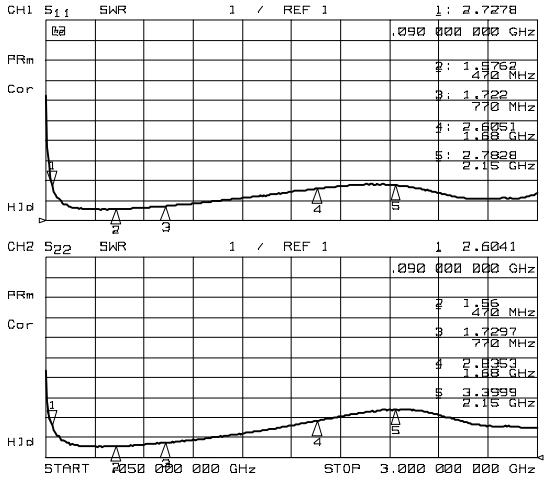
Conditions: V_{DD}=2.8V, V_{CTL}=0V, T_a=25ºC, Z_s=Z_l=50 ohm, with application circuit



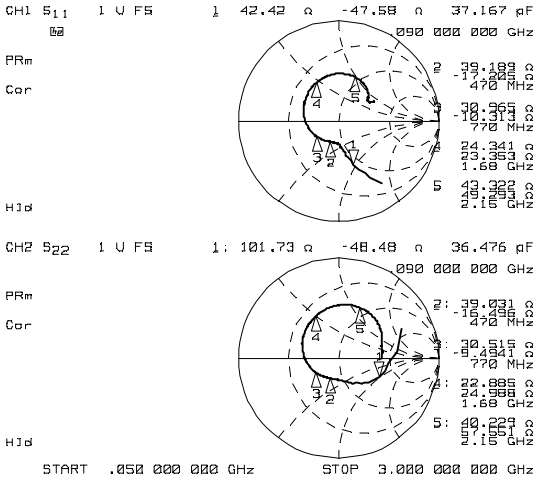
S11, S22 (f= 0.05GHz to 3GHz)



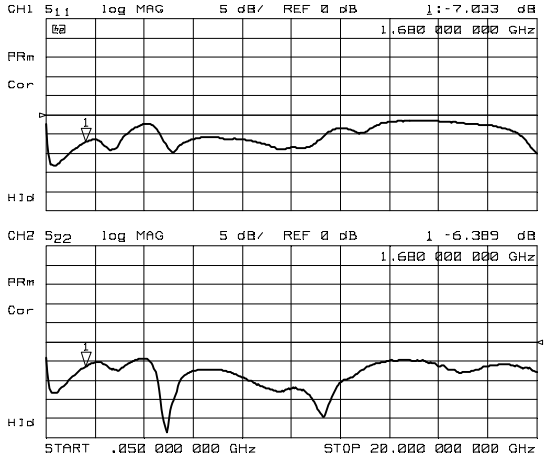
S21, S12 (f= 0.05GHz to 3GHz)



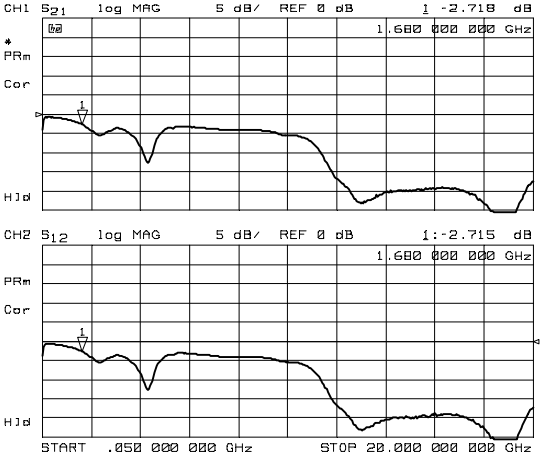
VSWR (f= 0.05GHz to 3GHz)



Zin, Zout (f=0.05GHz to 3GHz)

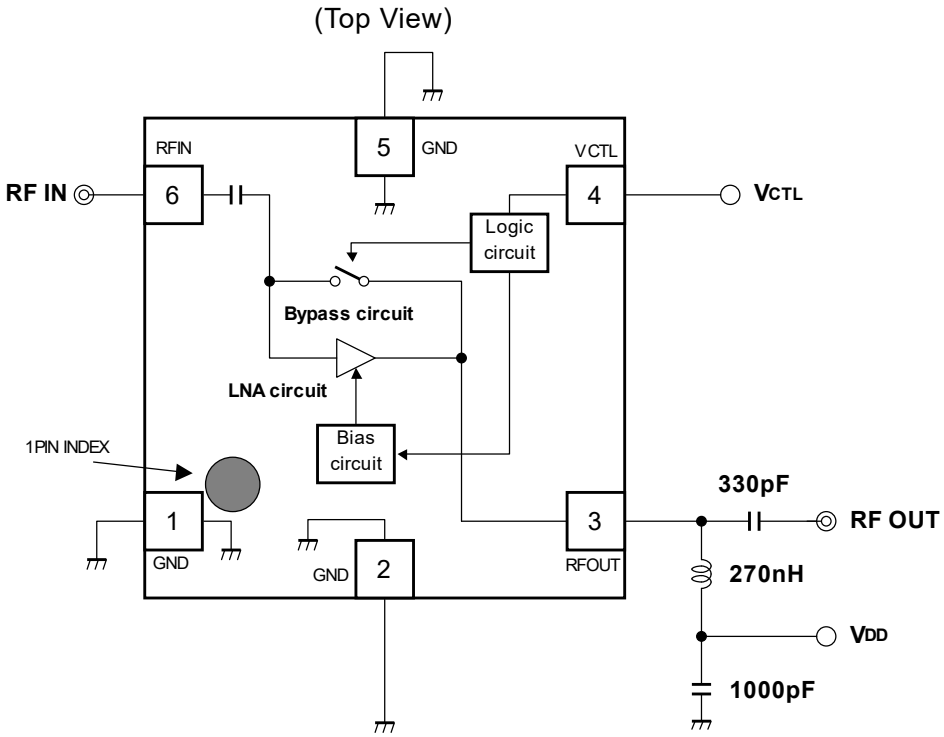


S11, S22 (f= 0.05GHz to 20GHz)



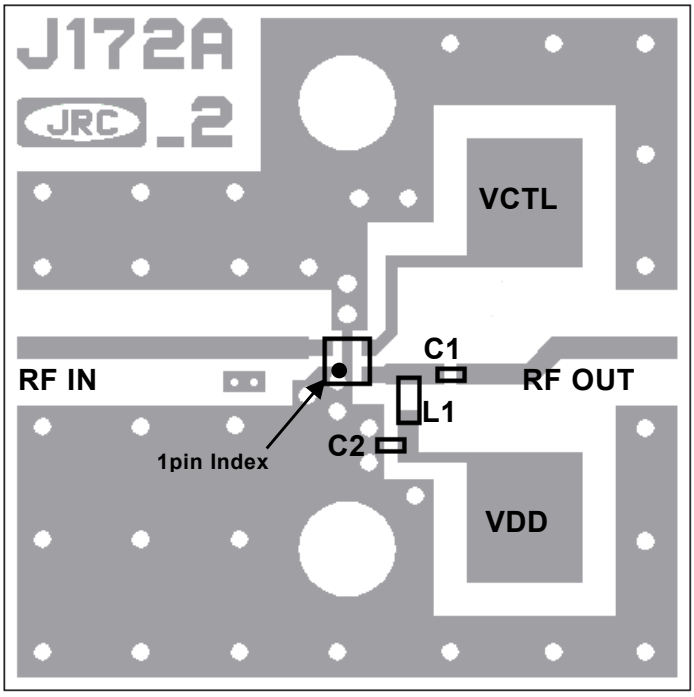
S21, S12 (f= 0.05GHz to 20GHz)

■ APPLICATION CIRCUIT



■ TEST PCB LAYOUT

(Top View)



■ PARTS LIST

Parts ID.	Manufacturer
L1	TAIYO-YUDEN HK1005 Series
C1, C2	MURATA GRM03 Series

PCB (FR-4):
t=0.2mm
MICROSTRIP LINE WIDTH
=0.40mm (Z_0=50 ohm)
PCB SIZE=14.0mm x 14.0mm

PRECAUTIONS

- C1 is a coupling and DC blocking capacitor at the output, and C2 is a bypass capacitor.
- L1 is an RF choke. (DC feed inductor)
- In order not to couple with terminal RFIN and RFOUT, please layout ground pattern under the IC.
- All external parts are placed as close as possible to the IC.

■ MEASUREMENT BLOCK DIAGRAM

Measuring instruments

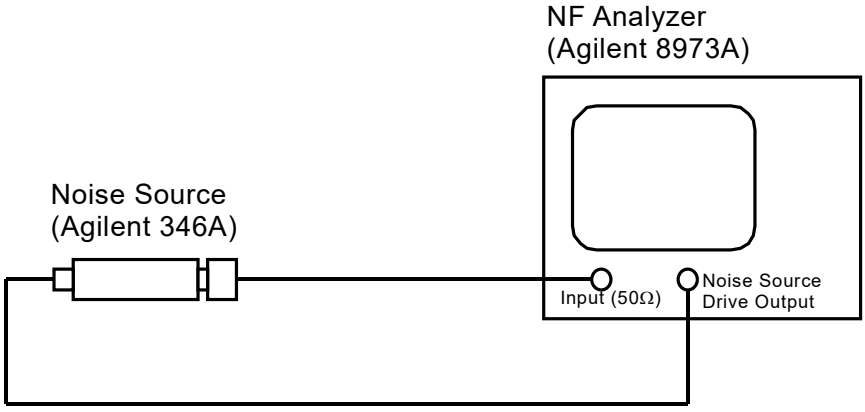
NF Analyzer : Agilent 8973A
Noise Source : Agilent 346A

Setting the NF analyzer

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

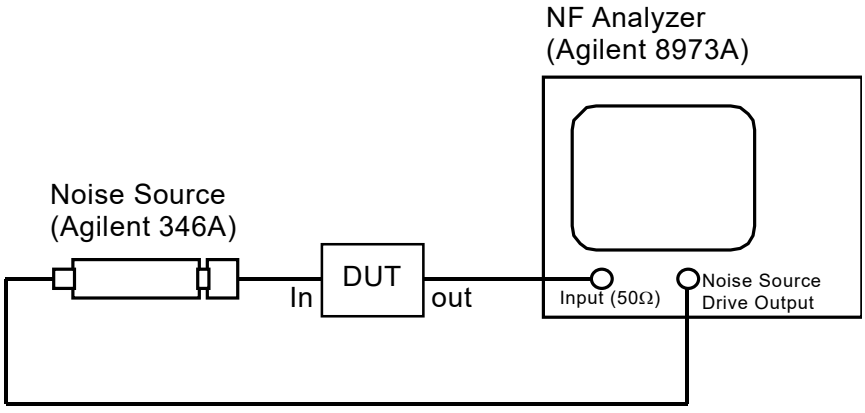
Mode setup form
- Sideband : LSB

Averages : 16
Average mode : Point
Bandwidth : 4MHz
Loss comp : off
Tcold : setting the temperature of noise source (300.0K)



* Noise source and NF analyzer are connected directly.

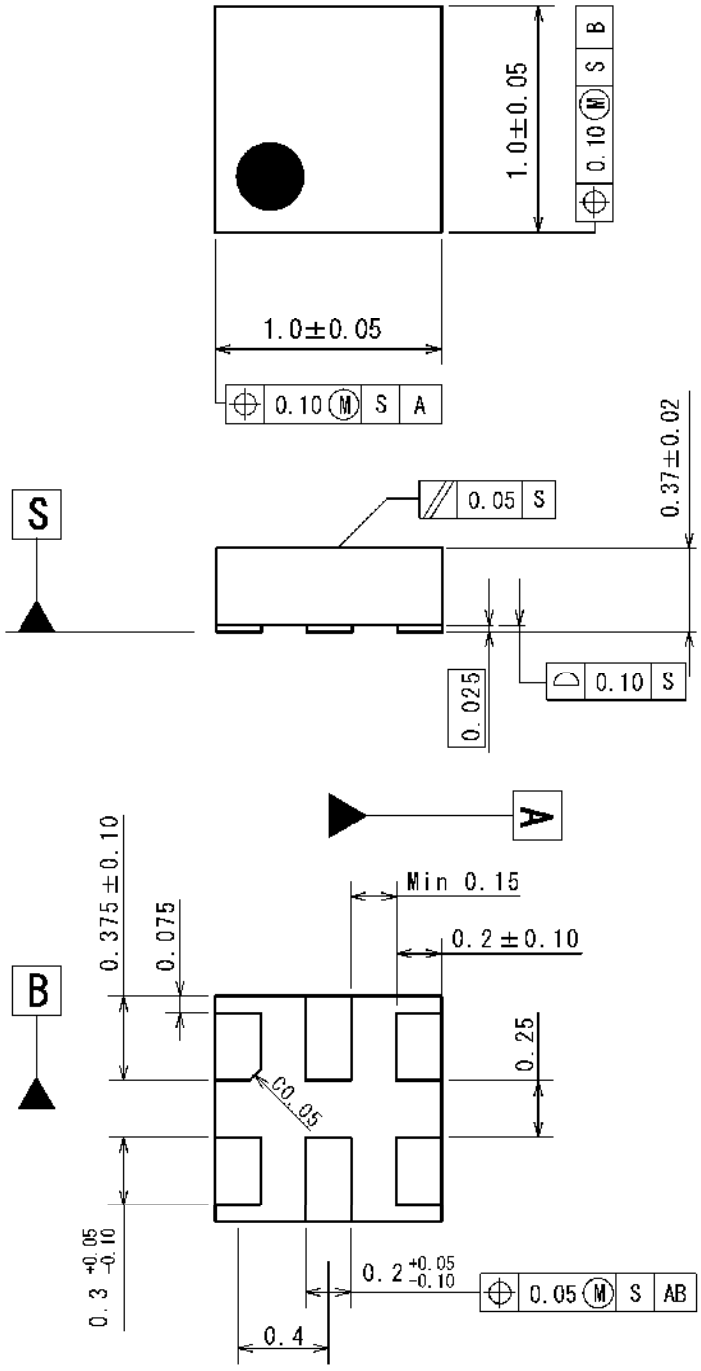
Calibration Setup



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

Measurement Setup

■ PACKAGE OUTLINE (EPFFP6-A2)



Unit	:mm
Substrate	:FR-4
Terminal Treat	:Au
Molding Material	:Epoxy Resin
Weight	:0.087mg

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.

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

1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to our sales representatives for the latest information thereon.
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    - Aerospace Equipment
    - Equipment Used in the Deep Sea
    - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
    - Life Maintenance Medical Equipment
    - Fire Alarms / Intruder Detectors
    - Vehicle Control Equipment (automotive, airplane, railroad, ship, etc.)
    - Various Safety Devices
    - Traffic control system
    - Combustion equipment

    In case your company desires to use this product for any applications other than general electronic equipment mentioned above, make sure to contact our company in advance. Note that the important requirements mentioned in this section are not applicable to cases where operation requirements such as application conditions are confirmed by our company in writing after consultation with your company.
6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. The products have been designed and tested to function within controlled environmental conditions. Do not use products under conditions that deviate from methods or applications specified in this datasheet. Failure to employ the products in the proper applications can lead to deterioration, destruction or failure of the products. We shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of the products.
8. Quality Warranty
    8-1. Quality Warranty Period
    In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
    8-2. Quality Warranty Remedies
    When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.
    Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
    8-3. Remedies after Quality Warranty Period
    With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
12. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.

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