Wide Band Low Noise Amplifier GaAs MMIC

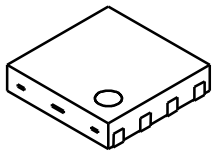
■ GENERAL DESCRIPTION

The NJG1162K64 is a fully matched wide band low noise amplifier GaAs MMIC for digital TV applications.

To achieve wide dynamic range, the NJG1162K64 offers LNA mode and bypass mode. Selecting LNA mode for weak signals, the NJG1162K64 helps improve receiver sensitivity through high gain and low noise figure.

The ultra small and ultra thin DFN8-64 package is adopted.

■ PACKAGE OUTLINE



NJG1162K64

■ APPLICATION

- Terrestrial application like Digital TV
- Set-top box

■ FEATURES

● Operating frequency	40 to 1000MHz
● Package	DFN8-64 (Package size: 1.5 x 1.5 x 0.375mm)
● RoHS compliant and Halogen free, MSL1	

[LNA mode]

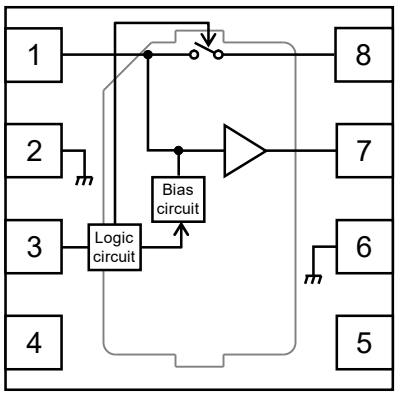
● Operating current	50mA typ.
● Small signal gain	13.0dB typ.
● Noise figure	2.5dB typ. @f=40 to 80MHz 2.2dB typ. @f=80 to 1000MHz

[Bypass mode]

● Insertion loss	1.0dB typ.

■ PIN CONFIGURATION

(TOP VIEW)



1. RFIN
2. GND
3. VCTL
4. NC (GND)
5. NC (GND)
6. GND
7. RFOUT1
8. RFOUT2

Exposed pad: GND

■ TRUTH TABLE

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

V_{CTL}	LNA	Bypass	Mode select
H	ON	OFF	LNA mode
L	OFF	ON	Bypass mode

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

■ ABSOLUTE MAXIMUM RATINGS

Ta=+25°C, Zs=Zl=50Ω

PARAMETER	SYMBOL	CONDITIONS	RATINGS	UNITS
Supply voltage	V_{DD}		5.5	V
Control voltage	V_{CTL}		5.5	V
Input power	P_{IN}	V_{DD}=3.3V	+10	dBm
Power dissipation	P_D	Four-layer FR4 PCB with through holes (76.2 x 114.3mm), Tj=150°C	520	mW
Operating temperature	T_{opr}		-40 to +85	°C
Storage temperature	T_{stg}		-55 to +150	°C

■ ELECTRICAL CHARACTERISTICS1 (DC CHARACTERISTICS)

V_{DD}=3.3V, Ta=+25°C, with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply voltage	V_{DD}		2.4	3.3	5.0	V
Control voltage (High)	V_{CTL}(H)		1.4	1.8	5.0	V
Control voltage (Low)	V_{CTL}(L)		0.0	0.0	0.4	V
Operating current1	I_{DD}1	RF OFF, V_{CTL}=1.8V	-	50	70	mA
Operating current2	I_{DD}2	RF OFF, V_{CTL}=0V	-	20	40	μA
Control current	I_{CTL}	RF OFF, V_{CTL}=1.8V	-	6	12	μA

■ **ELECTRICAL CHARACTERISTICS2** (RF CHARACTERISTICS: LNA mode)

V_{DD}=3.3V, V_{CTL}=1.8V, freq=40 to 1000MHz, Ta=+25°C, Zs=Zl=50Ω, with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain1	Gain1	Exclude PCB and connector losses *1	10.0	13.0	15.0	dB
Noise figure1_1	NF1_1	freq=40 to 80MHz, Exclude PCB and connector losses *2	-	2.5	4.0	dB
Noise figure1_2	NF1_2	freq=80 to 1000MHz, Exclude PCB and connector losses *2	-	2.2	3.0	dB
Input power 1dB compression1	$P_{-1dB(IN)}1$		-1.0	+4.0	-	dBm
Input 3rd order intercept point1	IIP3_1	f1=freq, f2=freq+100kHz, P_{IN}=-12dBm	+12.0	+20.0	-	dBm
2nd order intermodulation distortion1	IM2_1	f1=200MHz, f2=500MHz, fmeas=700MHz, $P_{IN}1=P_{IN}2$=-15dBm	42.0	47.0	-	dB
3rd order intermodulation distortion1	IM3_1	f1=600MHz, f2=650MHz, fmeas=700MHz, $P_{IN}1=P_{IN}2$=-15dBm	47.0	66.0	-	dB
RFIN Port return loss1	RLi1		7	12	-	dB
RFOUT Port return loss1	RLo1		7	12	-	dB

*1 Input and output PCB, connector losses: 0.014dB(40MHz), 0.088dB(620MHz), 0.132dB(1000MHz)
*2 Input PCB, connector losses: 0.007dB(40MHz), 0.011dB(80MHz), 0.044dB(620MHz), 0.066dB(1000MHz)

■ **ELECTRICAL CHARACTERISTICS3** (RF CHARACTERISTICS: Bypass mode)

V_{DD}=3.3V, V_{CTL}=0V, freq=40 to 1000MHz, Ta=+25°C, Zs=Zl=50Ω, with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Insertion loss2	LOSS2	Exclude PCB and connector losses *1	-	1.0	2.5	dB
Input power 1dB compression2	$P_{-1dB(IN)}2$		+9.0	+16.0	-	dBm
Input 3rd order intercept point2	IIP3_2	f1=freq, f2=freq+100kHz, P_{IN}=-2dBm	+19.0	+33.0		dBm
RFIN Port return loss2	RLi2		8	15	-	dB
RFOUT Port return loss2	RLo2		7	15	-	dB

*1 Input and output PCB, connector losses: 0.014dB(40MHz), 0.088dB(620MHz), 0.132dB(1000MHz)

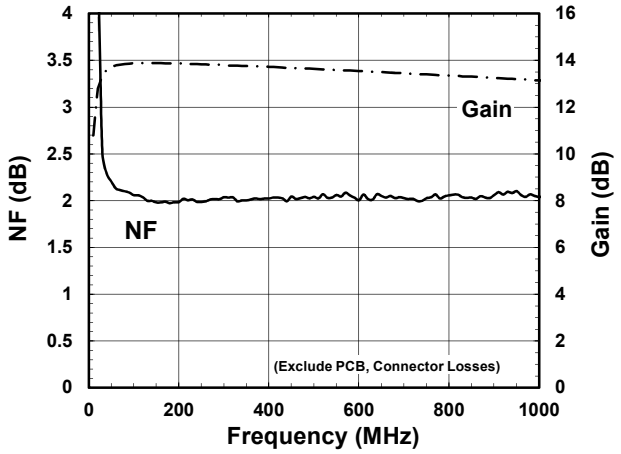
■ TERMINAL INFORMATION

No.	SYMBOL	DESCRIPTION
1	RFIN	RF input terminal. External capacitor C1 is required to block the DC bias voltage of internal circuit.
2	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
3	VCTL	Control voltage terminal. At this terminal, the switching of the LNA mode and Bypass mode is possible.
4	NC(GND)	No connected terminal. This terminal is not connected with internal circuit. Connect to the PCB ground plane.
5	NC(GND)	No connected terminal. This terminal is not connected with internal circuit. Connect to the PCB ground plane.
6	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
7	RFOUT1	The RF output terminal of the LNA mode. This terminal doubles as the drain terminal of the LNA. Please connect this terminal to the power supply via choke inductor.
8	RFOUT2	The RF output terminal of the Bypass mode. Please connect this terminal with RFOUT1 terminal through DC blocking capacitor shown in the application circuit.
Exposed Pad	GND	Ground terminal. Connect exposed pad to ground plane as close as possible for excellent RF performance.

■ ELECTRICAL CHARACTERISTICS (LNA mode, 50Ω)

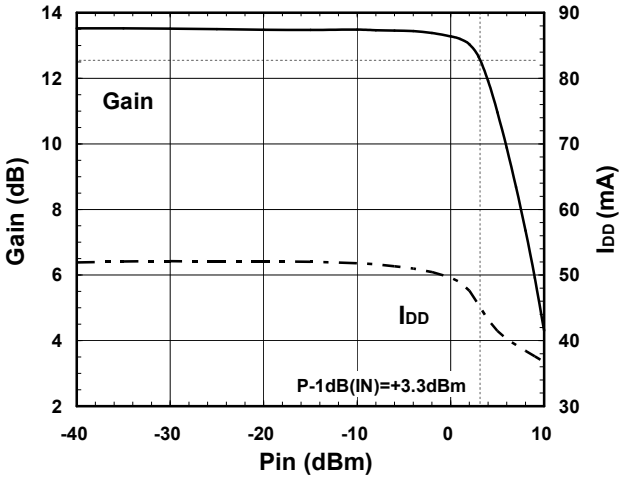
Conditions: V_{DD}=3.3V, V_{CTL}=1.8V, Ta=25°C, Zs=Zl=50Ω, with application circuit

NF, Gain vs. Frequency



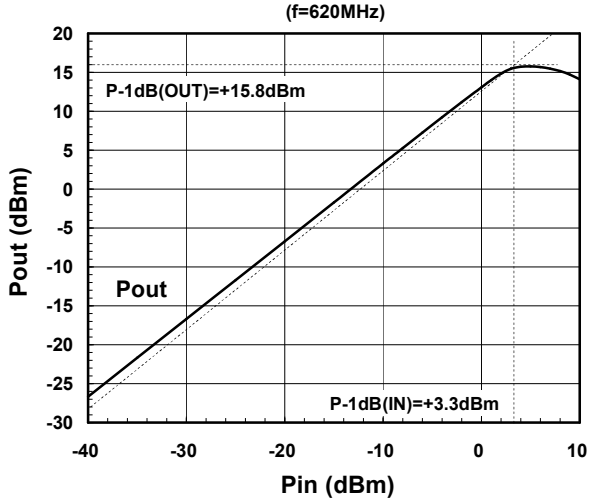
Gain, IDD vs. Pin

(f=620MHz)

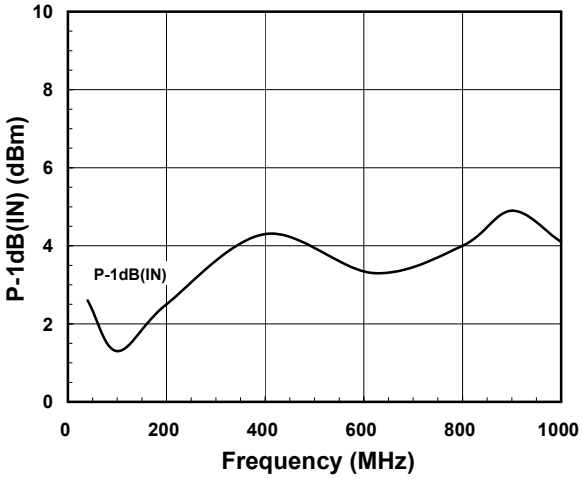


Pout vs. Pin

(f=620MHz)

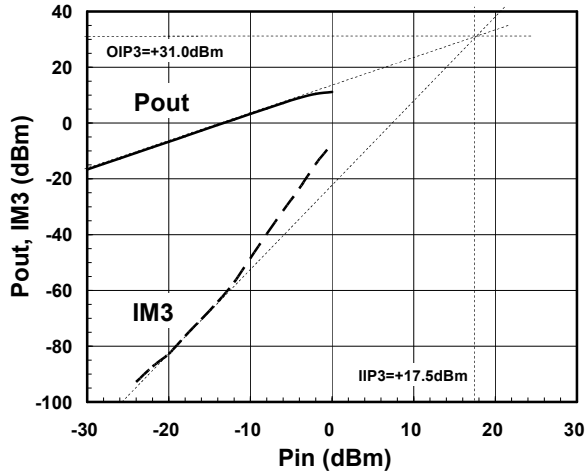


P-1dB(IN) vs. Frequency



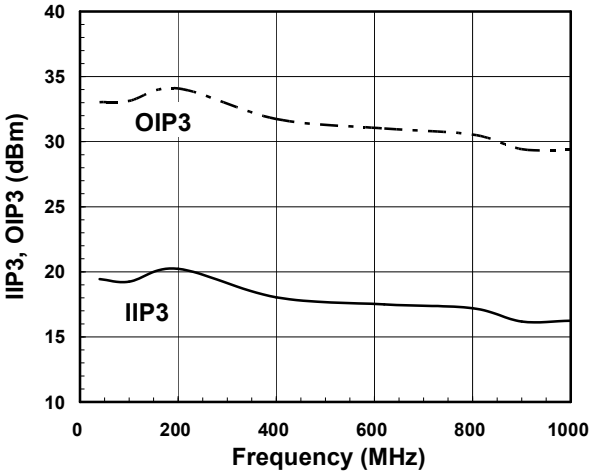
Pout, IM3 vs. Pin

(f1=620MHz, f2=620.1MHz)



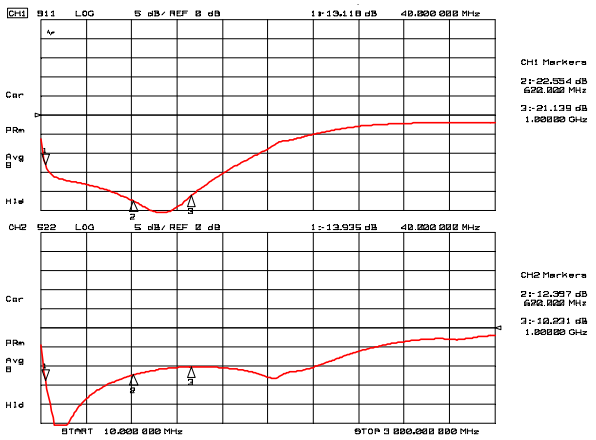
IIP3, OIP3 vs. Frequency

(f1=Frequency, f2=f1+100kHz, Pin=-14dBm)

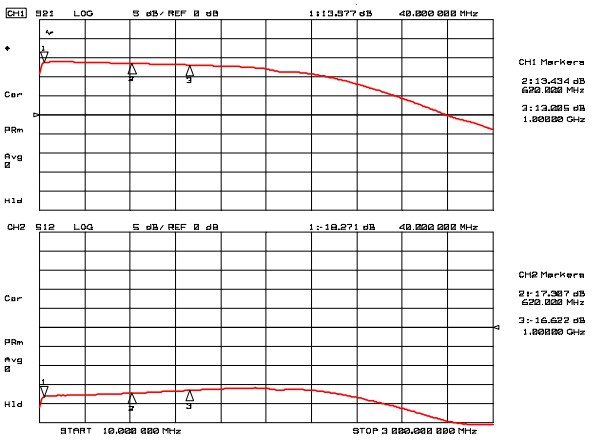


■ ELECTRICAL CHARACTERISTICS (LNA mode, 50Ω)

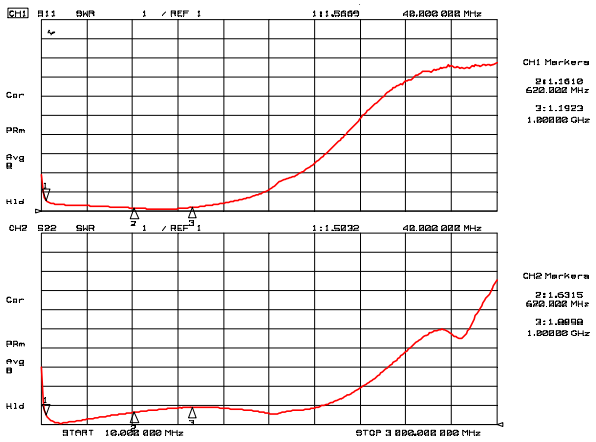
Conditions: V_{DD}=3.3V, V_{CTL}=1.8V, Ta=25°C, Zs=Zl=50Ω, with application circuit



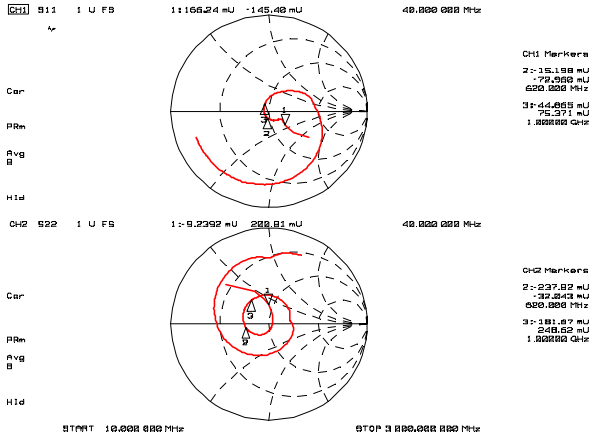
S11, S22 (f=10MHz to 3GHz)



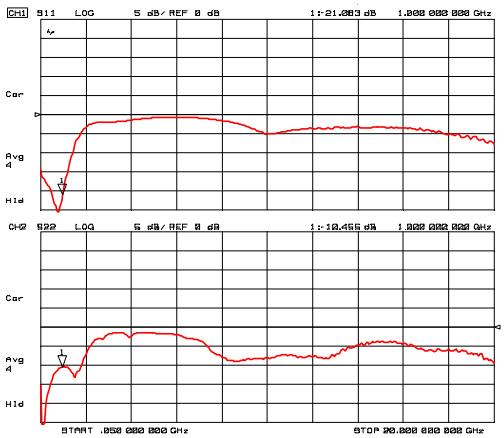
S21, S12 (f=10MHz to 3GHz)



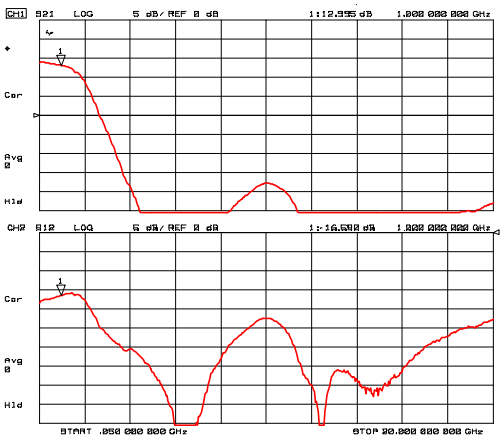
VSWRi, VSWRo (f=10MHz to 3GHz)



Zin, Zout (f=10MHz to 3GHz)



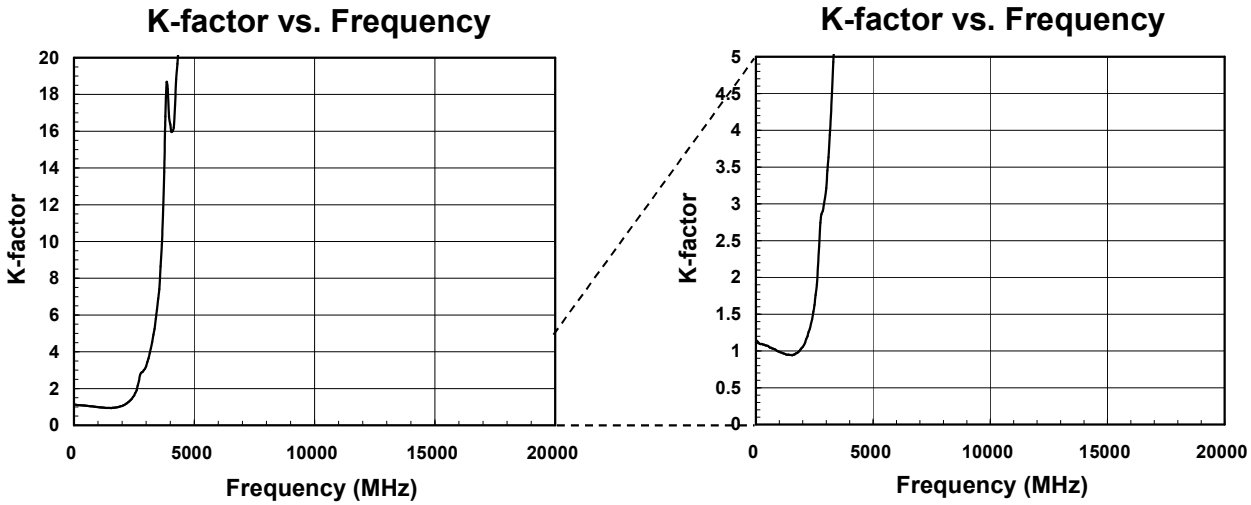
S11, S22 (f=50MHz to 20GHz)



S21, S11 (f=50MHz to 20GHz)

■ **ELECTRICAL CHARACTERISTICS** (LNA mode, 50Ω)

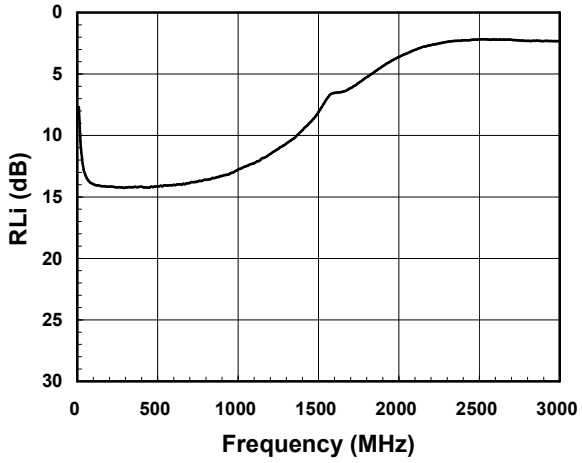
Conditions: V_{DD}=3.3V, V_{CTL}=1.8V, Ta=25°C, Zs=Zl=50Ω, with application circuit



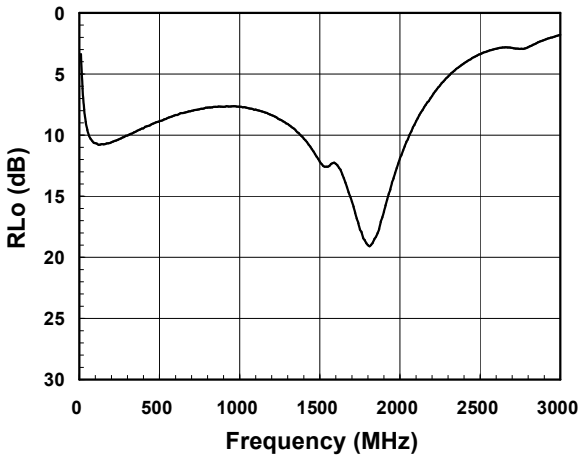
■ **ELECTRICAL CHARACTERISTICS** (LNA mode, 75Ω)

Conditions: V_{DD}=3.3V, V_{CTL}=1.8V, Ta=25°C, Zs=Zl=75Ω, with application circuit

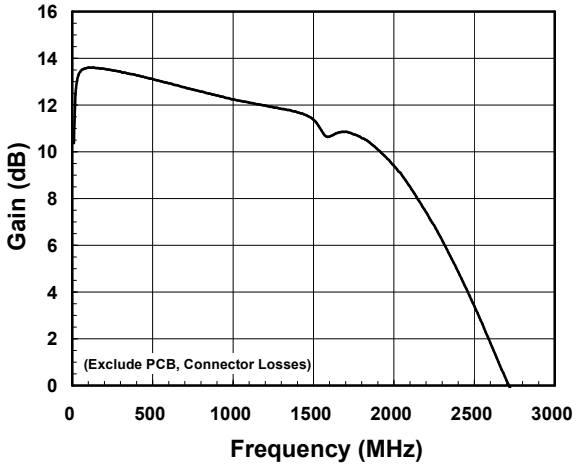
RFIN Port Return Loss vs. Frequency



RFOUT Port Return Loss vs. Frequency



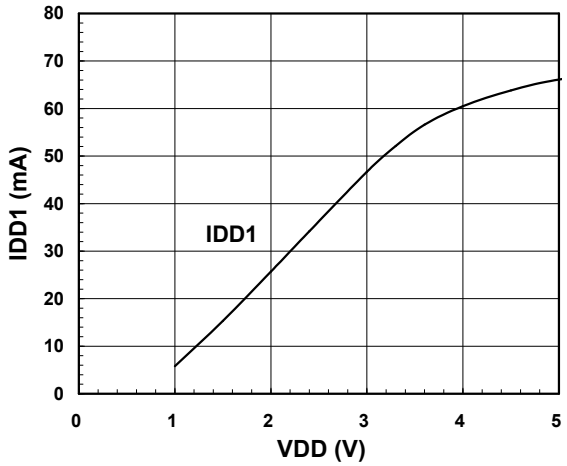
Gain vs. Frequency



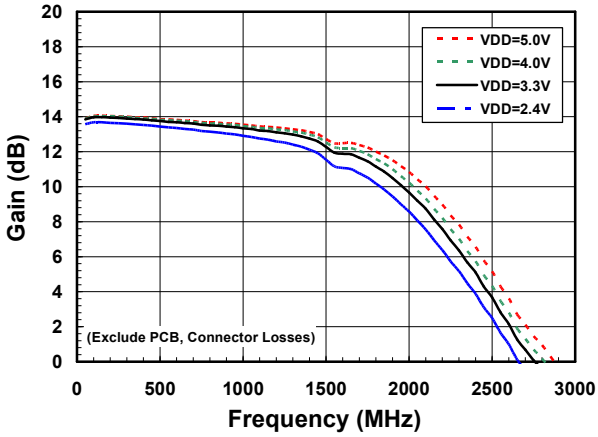
■ ELECTRICAL CHARACTERISTICS (LNA mode, 50Ω)

Conditions: V_{CTL}=1.8V, Ta=25°C, Zs=Zl=50Ω, with application circuit

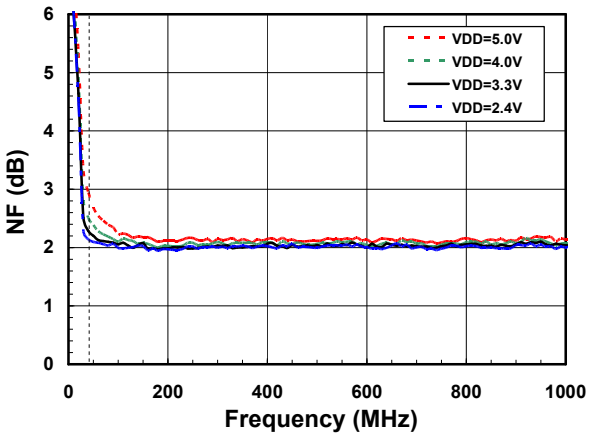
IDD1 vs. VDD



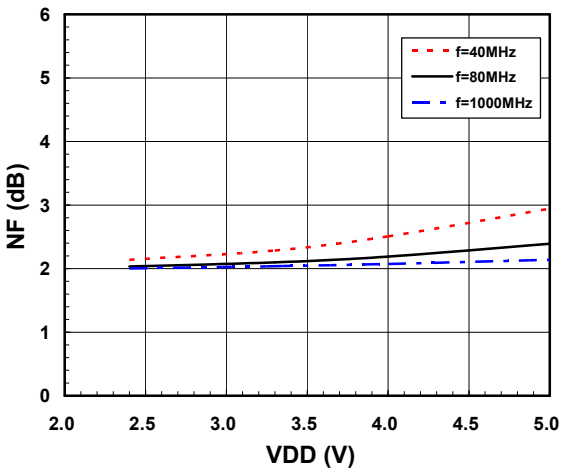
Gain vs. Frequency



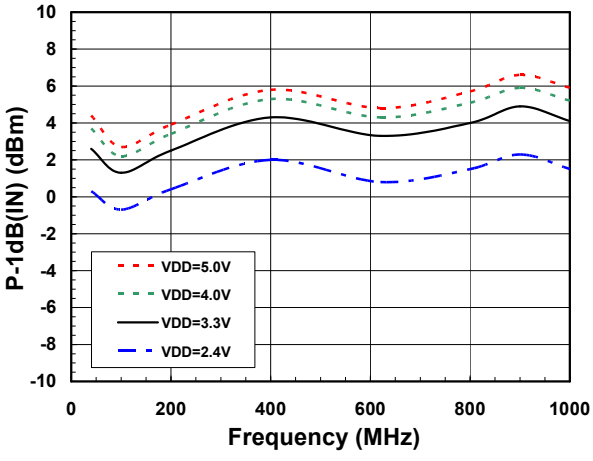
NF vs. Frequency



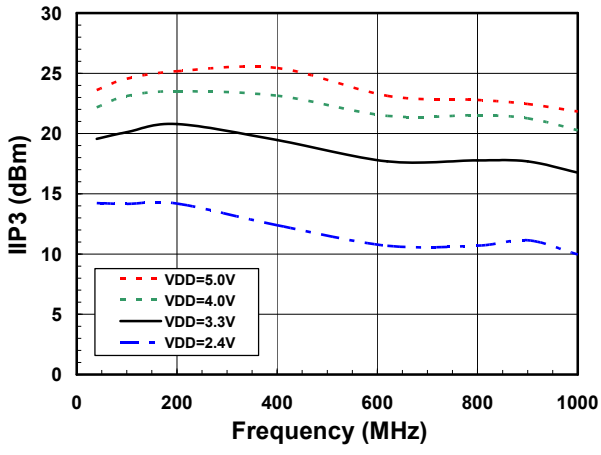
NF vs. VDD



P-1dB(IN) vs. Frequency



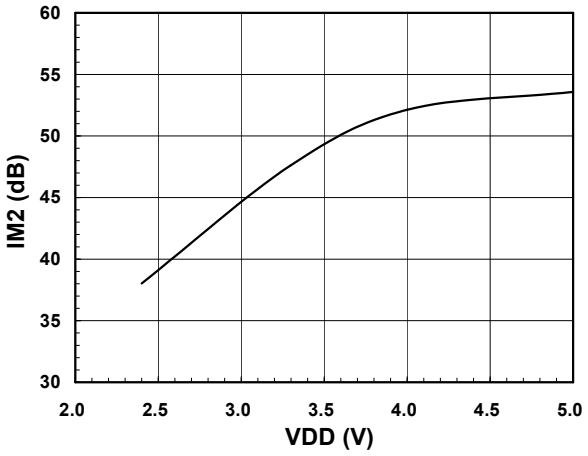
IIP3 vs. Frequency



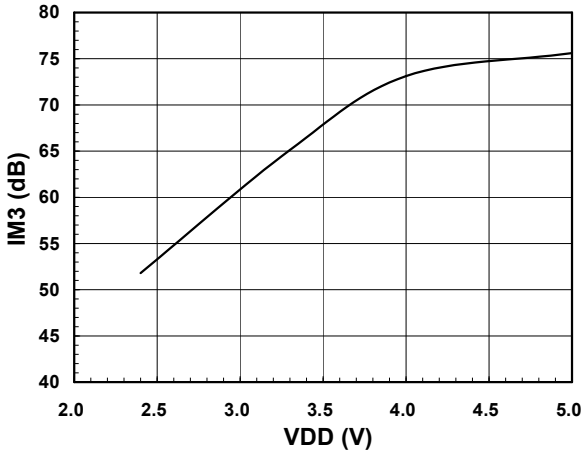
■ ELECTRICAL CHARACTERISTICS (LNA mode, 50Ω)

Conditions: V_{CTL}=1.8V, Ta=25°C, Zs=Zl=50Ω, with application circuit

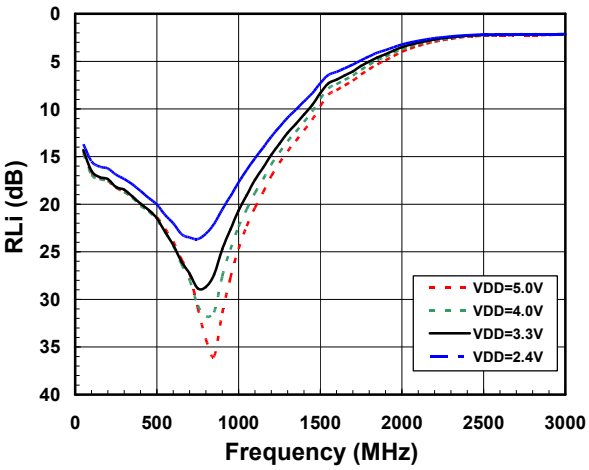
IM2 vs. VDD



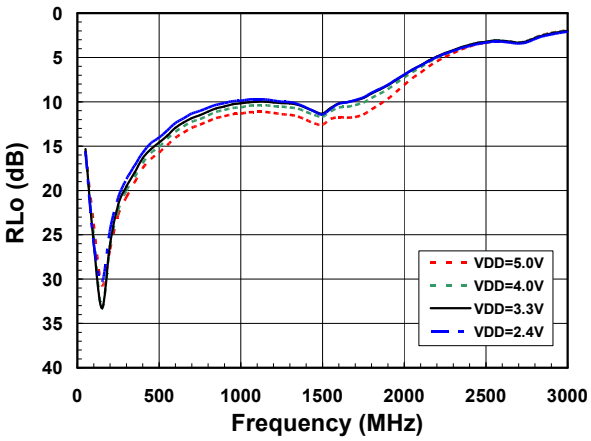
IM3 vs. VDD



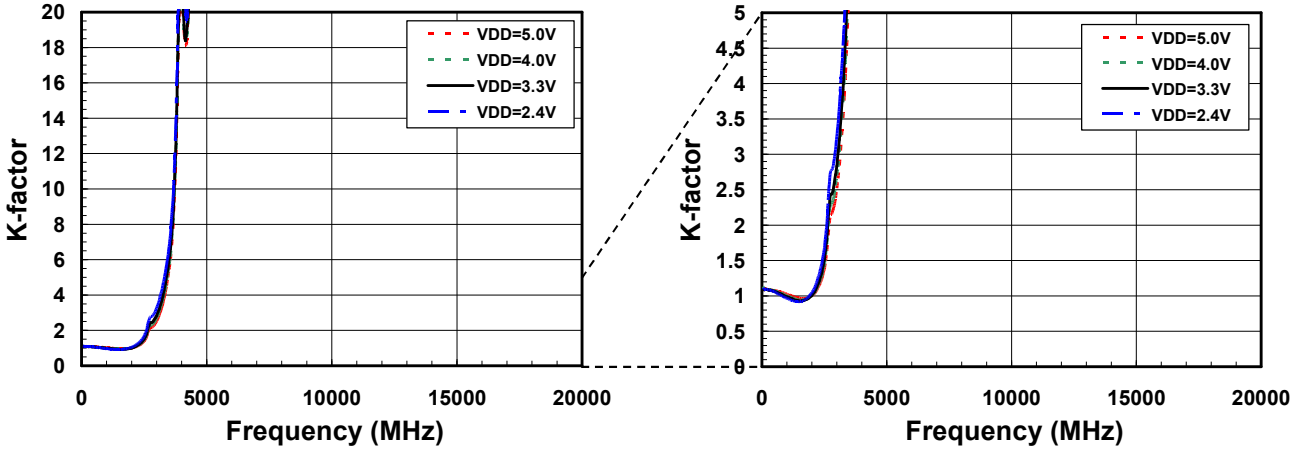
RFIN Port Return Loss vs. Frequency



RFOUT Port Return Loss vs. Frequency



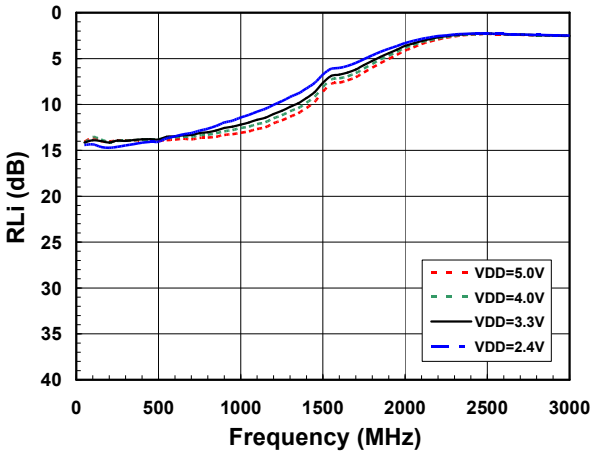
K-factor vs. Frequency



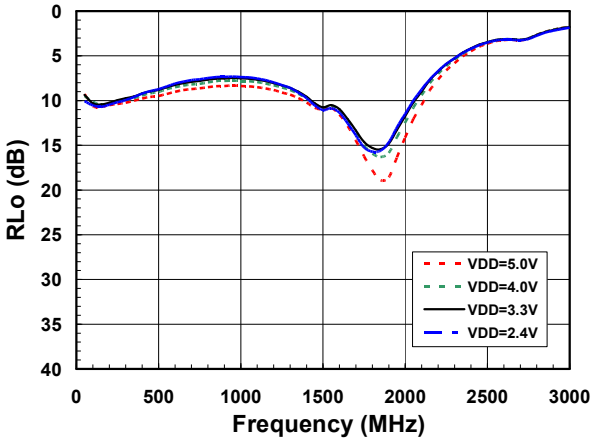
■ ELECTRICAL CHARACTERISTICS (LNA mode, 75Ω)

Conditions: V_{CTL}=1.8V, Ta=25°C, Zs=Zl=75Ω, with application circuit

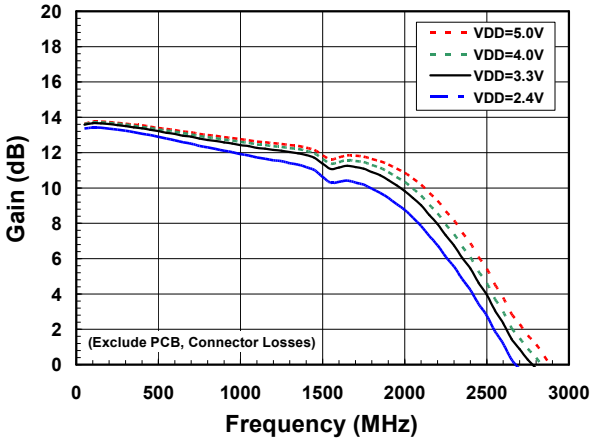
RFIN Port Return Loss vs. Frequency



RFOUT Port Return Loss vs. Frequency



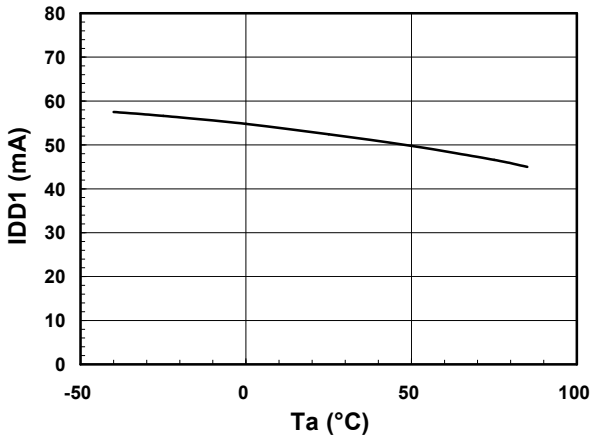
Gain vs. Frequency



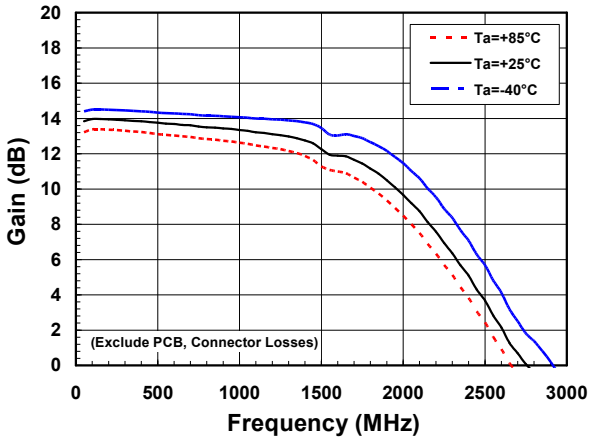
■ ELECTRICAL CHARACTERISTICS (LNA mode, 50Ω)

Conditions: V_{DD}=3.3V, V_{CTL}=1.8V, Zs=Zl=50Ω, with application circuit

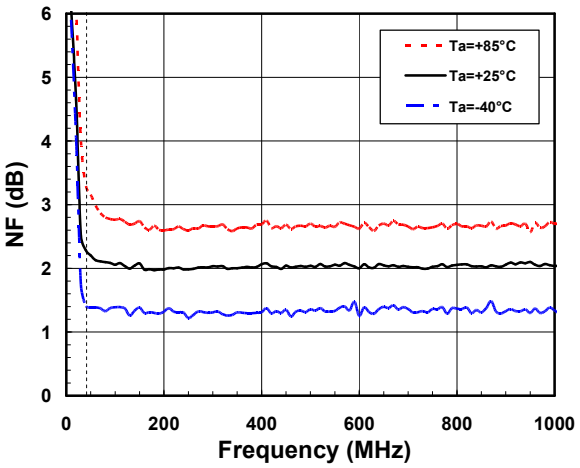
IDD1 vs. Ta



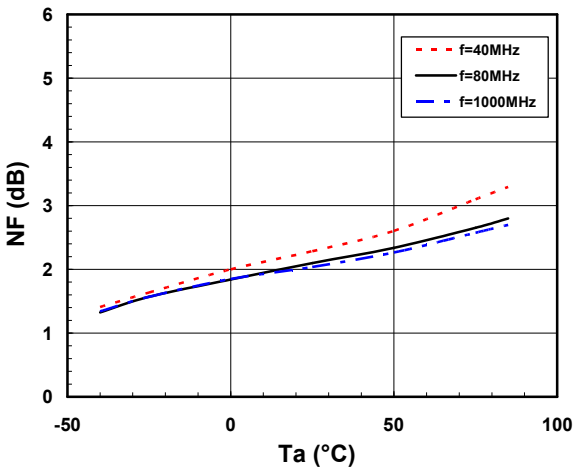
Gain vs. Frequency



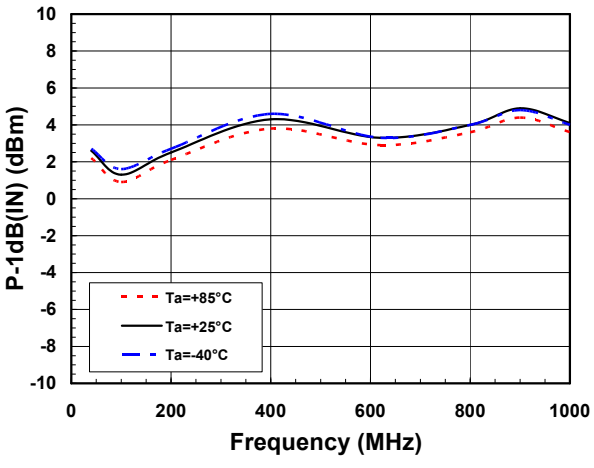
NF vs. Frequency



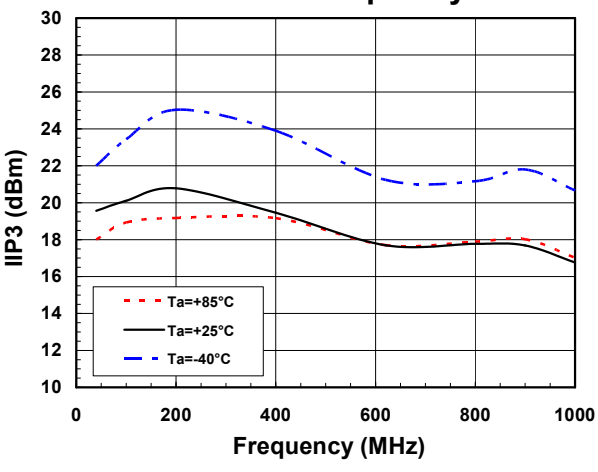
NF vs. Ta



P-1dB(IN) vs. Frequency



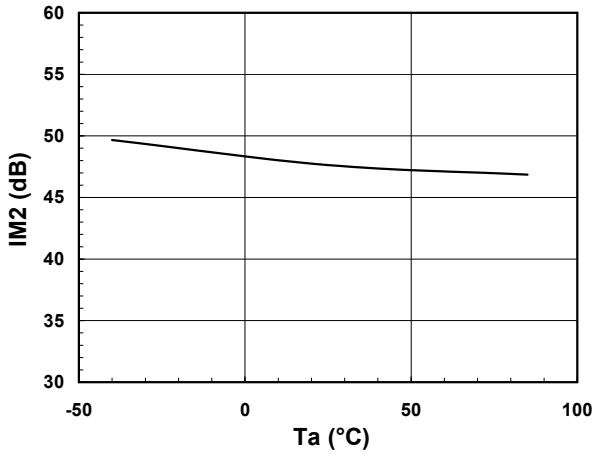
IIP3 vs. Frequency



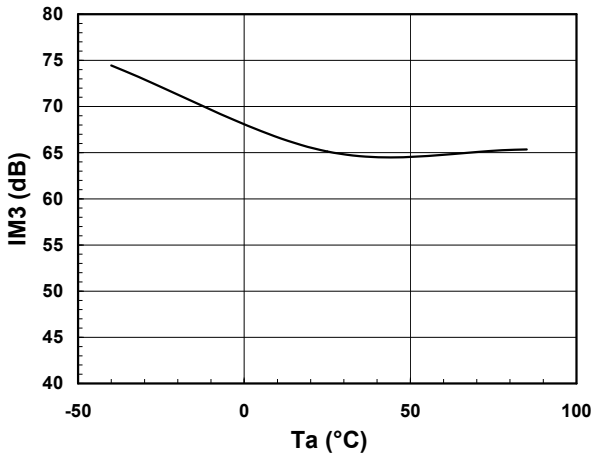
■ ELECTRICAL CHARACTERISTICS (LNA mode, 50Ω)

Conditions: V_{DD}=3.3V, V_{CTL}=1.8V, Zs=Zl=50Ω, with application circuit

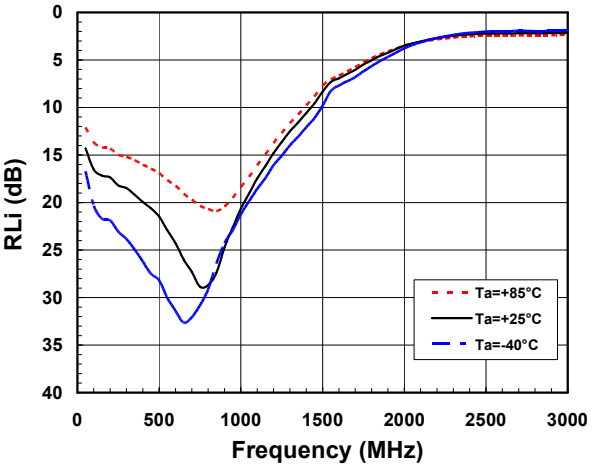
IM2 vs. Ta



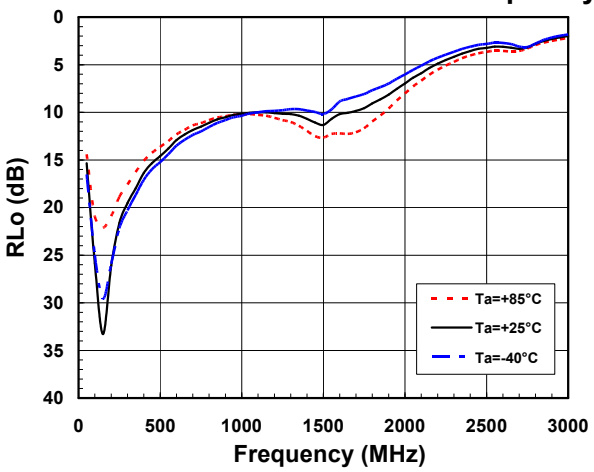
IM3 vs. Ta



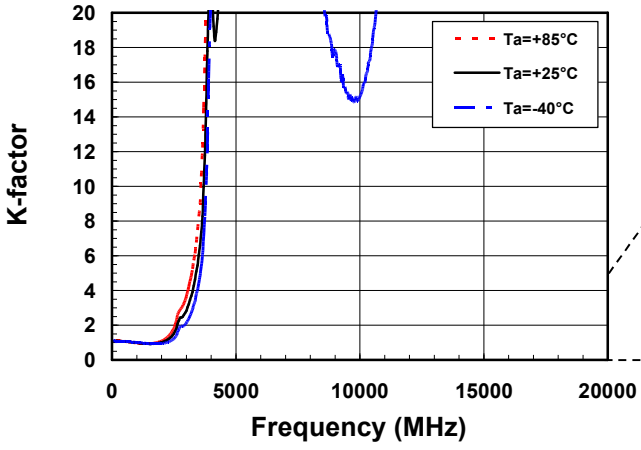
RFIN Port Return Loss vs. Frequency



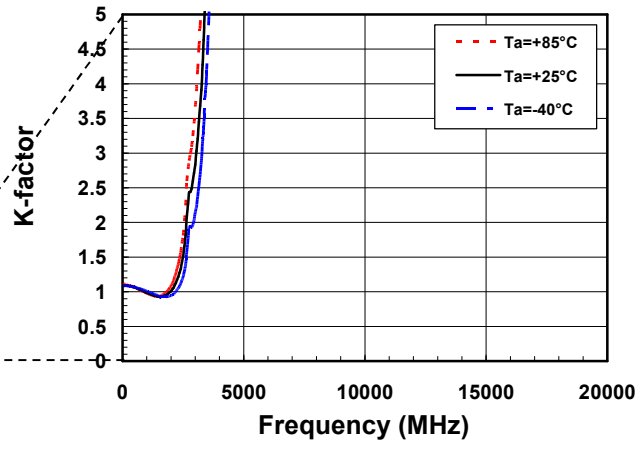
RFOUT Port Return Loss vs. Frequency



K-factor vs. Frequency



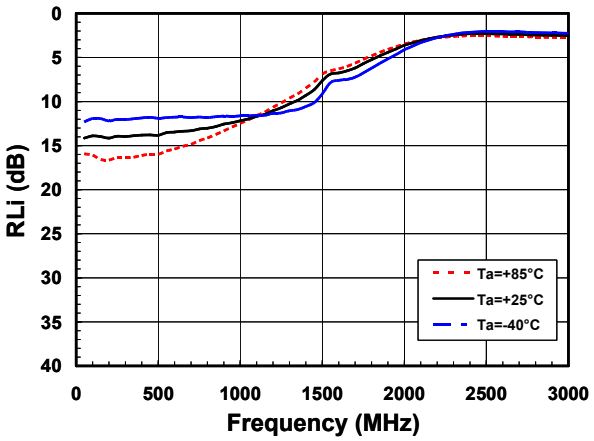
K-factor vs. Frequency



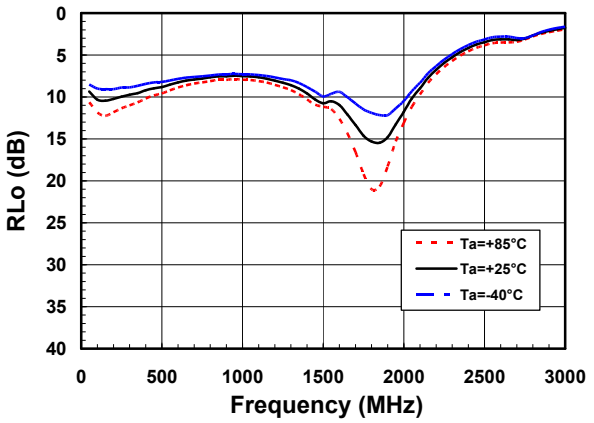
■ ELECTRICAL CHARACTERISTICS (LNA mode, 75Ω)

Conditions: V_{DD}=3.3V, V_{CTL}=1.8V, Zs=Zl=75Ω, with application circuit

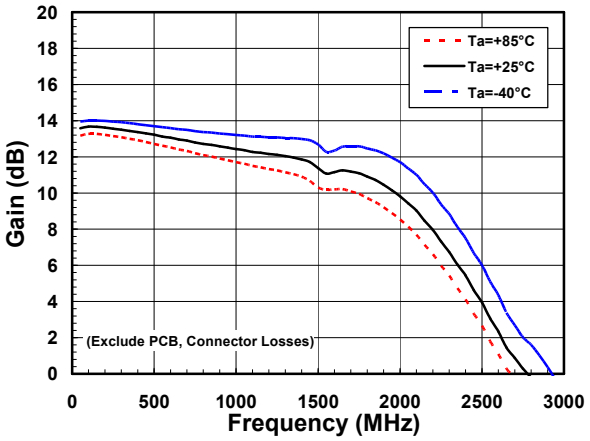
RFIN Port Return Loss vs. Frequency



RFOUT Port Return Loss vs. Frequency



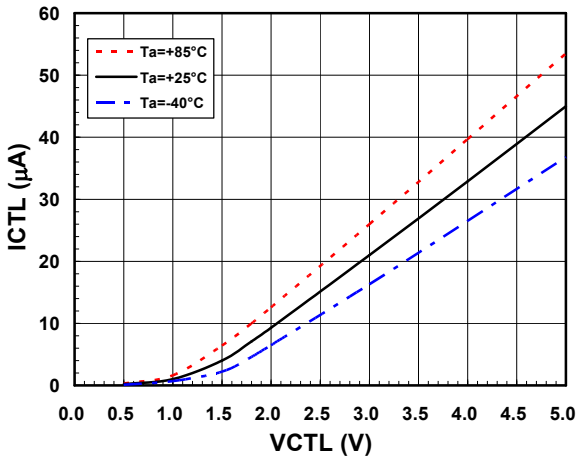
Gain vs. Frequency



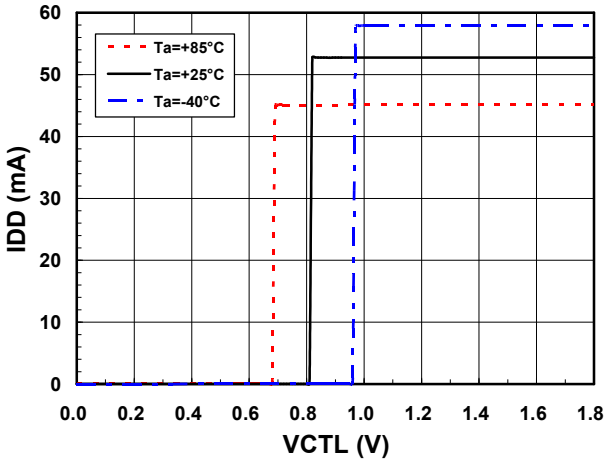
■ **ELECTRICAL CHARACTERISTICS** (LNA mode, 50Ω)

Conditions: V_{DD}=3.3V, Zs=Zl=50Ω, with application circuit

ICTL vs. VCTL



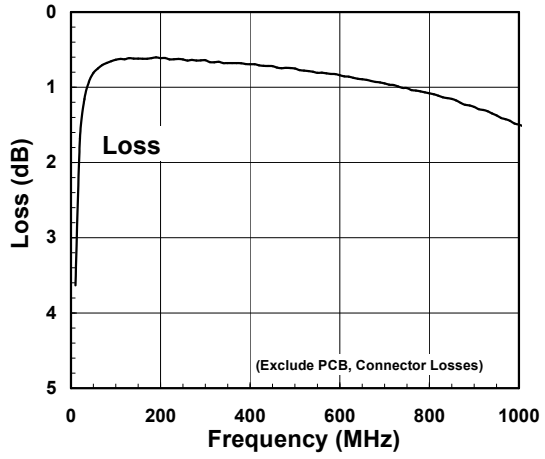
IDD vs. VCTL



■ **ELECTRICAL CHARACTERISTICS** (Bypass mode, 50Ω)

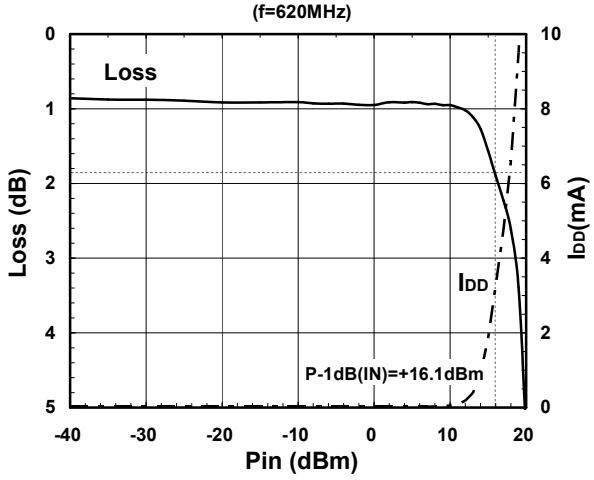
Conditions: V_{DD}=3.3V, V_{CTL}=0V, Ta=25°C, Zs=Zl=50Ω, with application circuit

Loss vs. Frequency



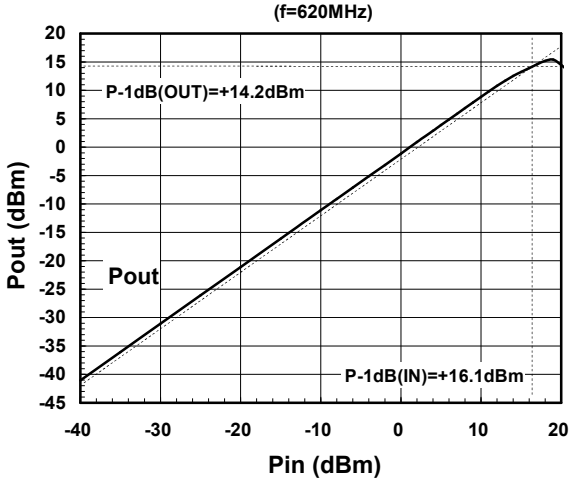
Loss, IDD vs. Pin

(f=620MHz)

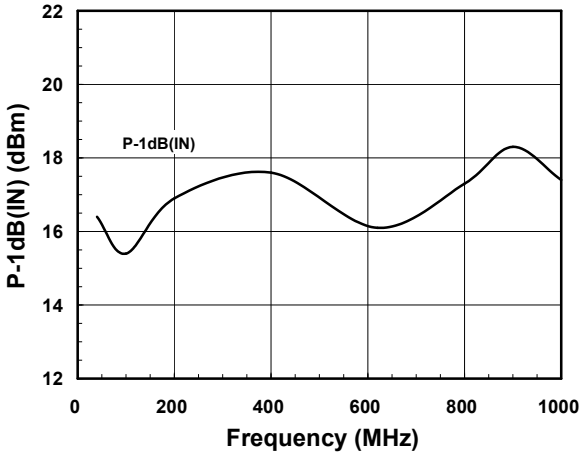


Pout vs. Pin

(f=620MHz)

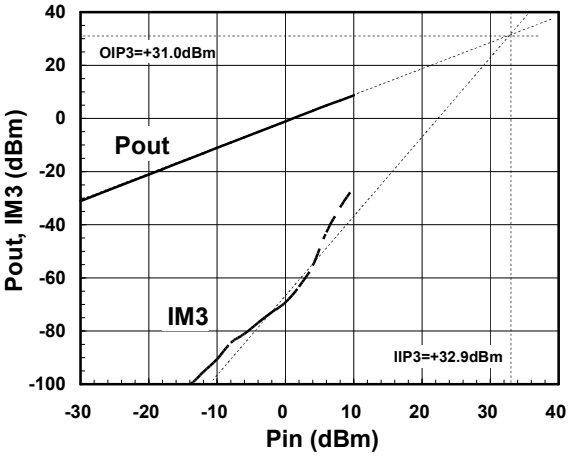


P-1dB(IN) vs. Frequency



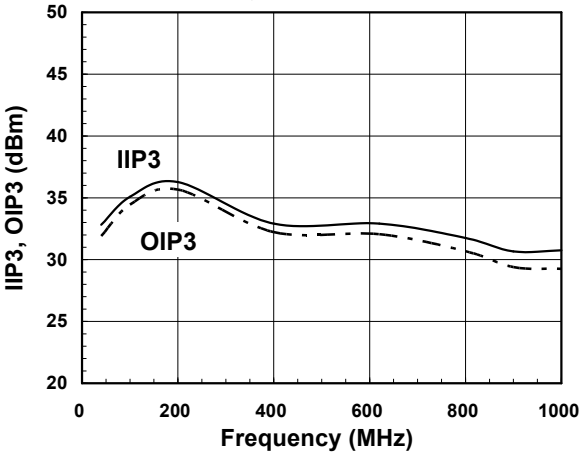
Pout, IM3 vs. Pin

(f1=620MHz, f2=620.1MHz)



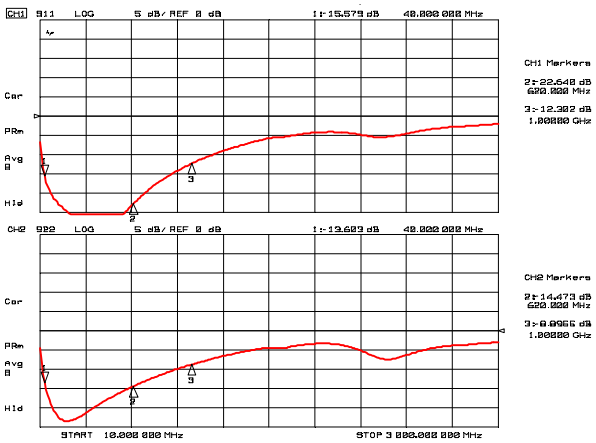
IIP3, OIP3 vs. Frequency

(f1=Frequency, f2=f1+100kHz, Pin=-2dBm)

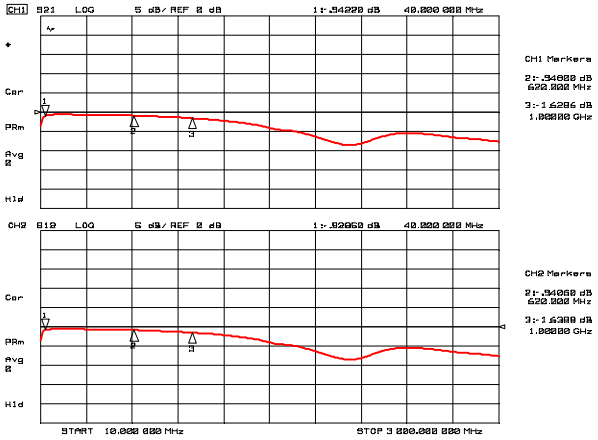


■ ELECTRICAL CHARACTERISTICS (Bypass mode, 50Ω)

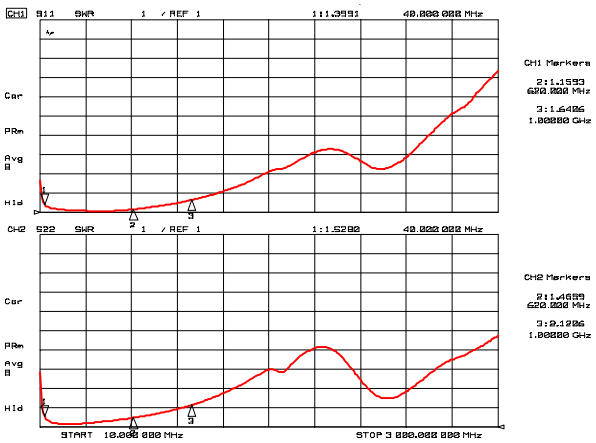
Conditions: V_{DD}=3.3V, V_{CTL}=0V, Ta=25°C, Zs=Zl=50Ω, with application circuit



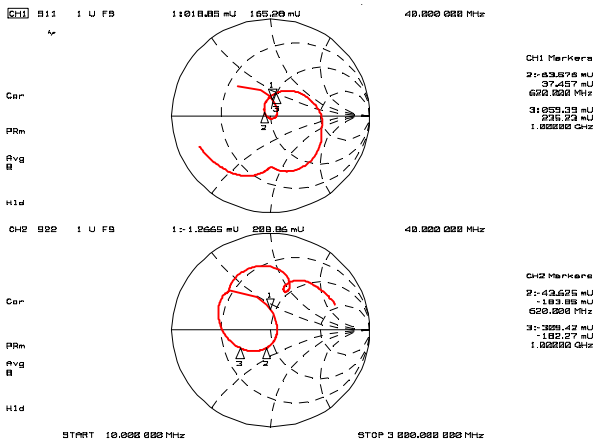
S11, S22 (f=10MHz to 3GHz)



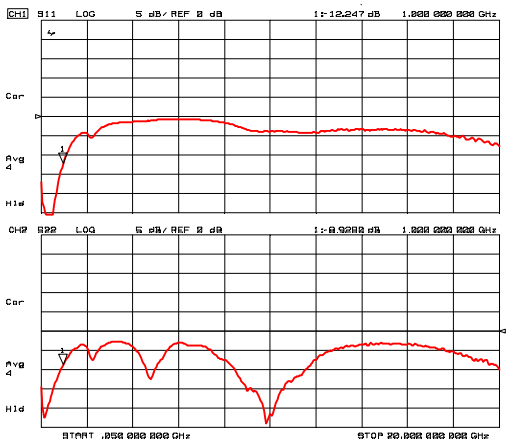
S21, S12 (f=10MHz to 3GHz)



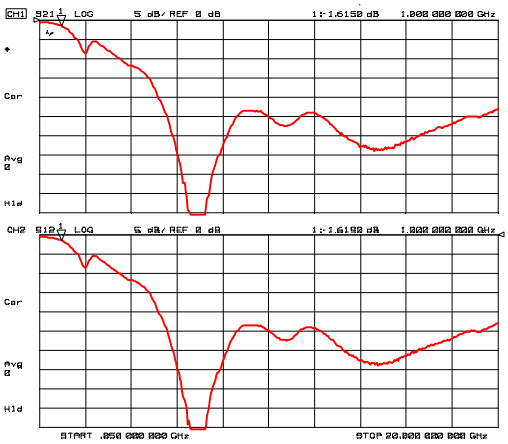
VSWRi, VSWRo (f=10MHz to 3GHz)



Zin, Zout (f=10MHz to 3GHz)



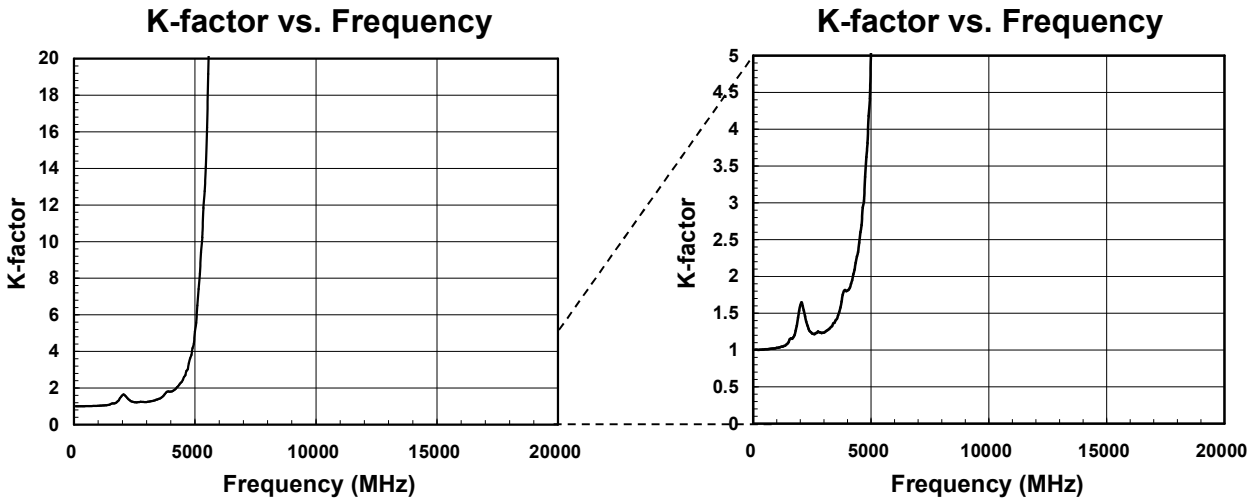
S11, S22 (f=50MHz to 20GHz)



S21, S11 (f=50MHz to 20GHz)

■ **ELECTRICAL CHARACTERISTICS** (Bypass mode, 50Ω)

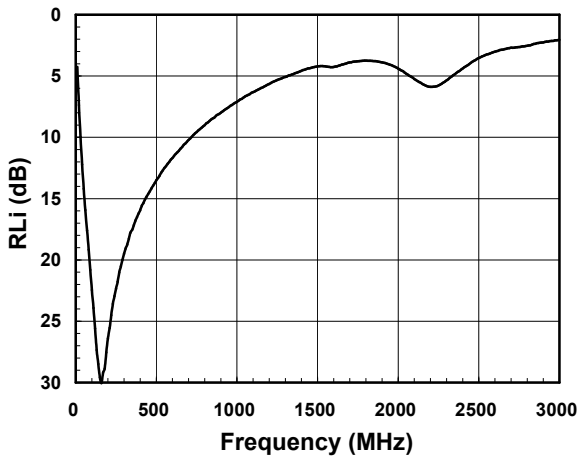
Conditions: V_{DD}=3.3V, V_{CTL}=0V, Ta=25°C, Zs=Zl=50Ω, with application circuit



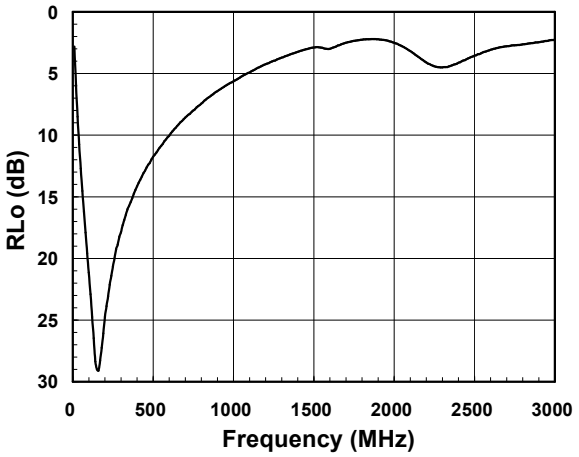
■ **ELECTRICAL CHARACTERISTICS** (Bypass mode, 75Ω)

Conditions: V_{DD}=3.3V, V_{CTL}=0V, Ta=25°C, Zs=Zl=75Ω, with application circuit

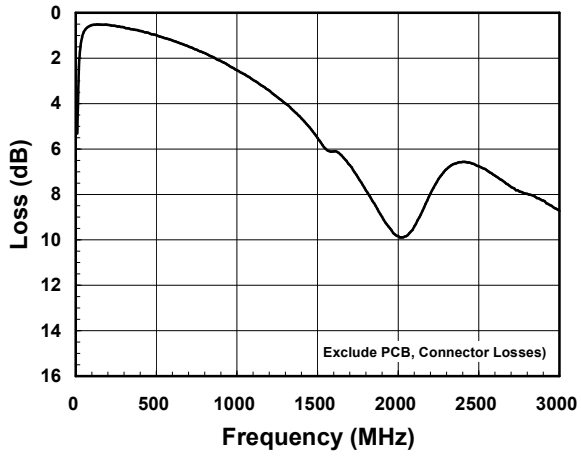
RFIN Port Return Loss vs. Frequency



RFOUT Port Return Loss vs. Frequency

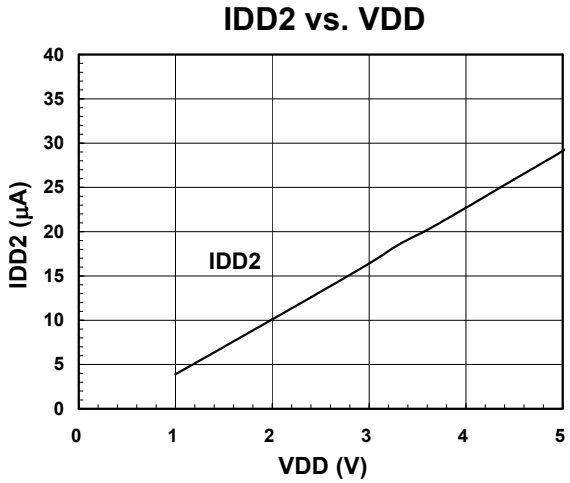


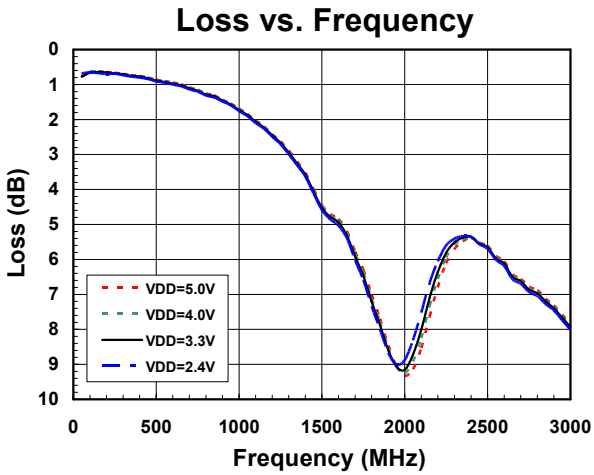
Loss vs. Frequency

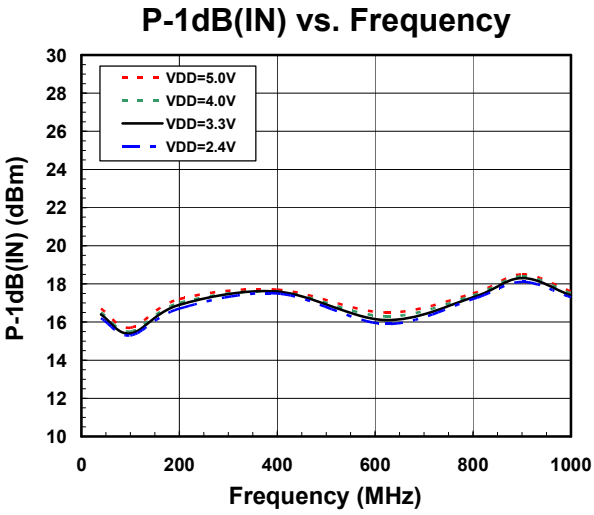


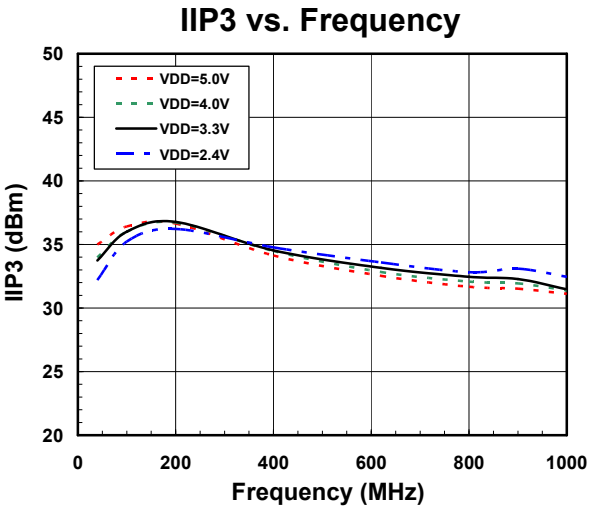
■ ELECTRICAL CHARACTERISTICS (Bypass mode, 50Ω)

Conditions: V_{CTL}=0V, Ta=25°C, Zs=Zl=50Ω, with application circuit





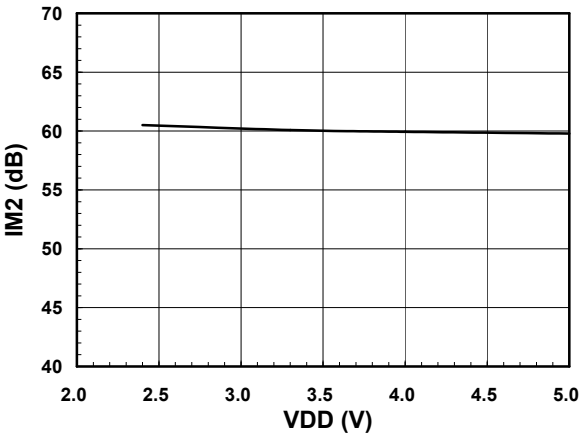




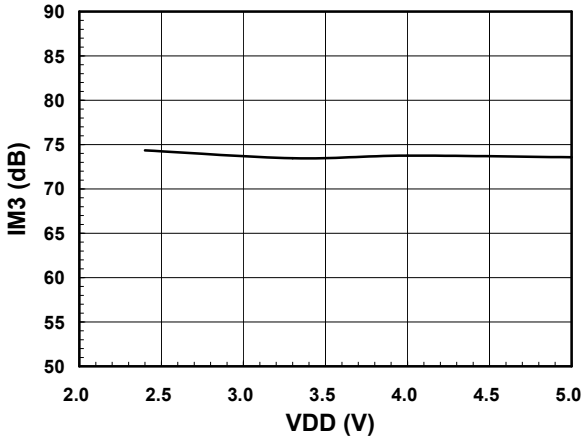
■ ELECTRICAL CHARACTERISTICS (Bypass mode, 50Ω)

Conditions: V_{CTL}=0V, Ta=25°C, Zs=Zl=50Ω, with application circuit

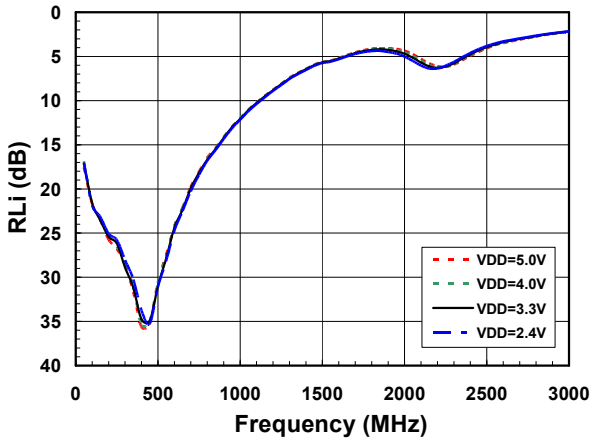
IM2 vs. VDD



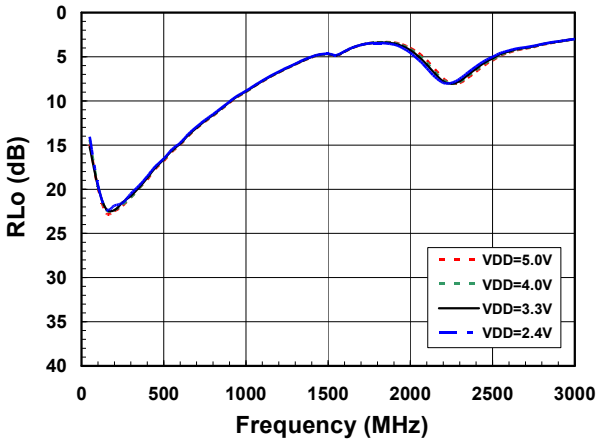
IM3 vs. VDD



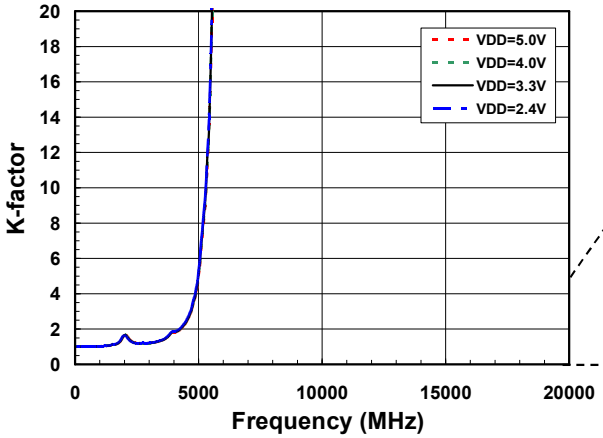
RFIN Port Return Loss vs. Frequency



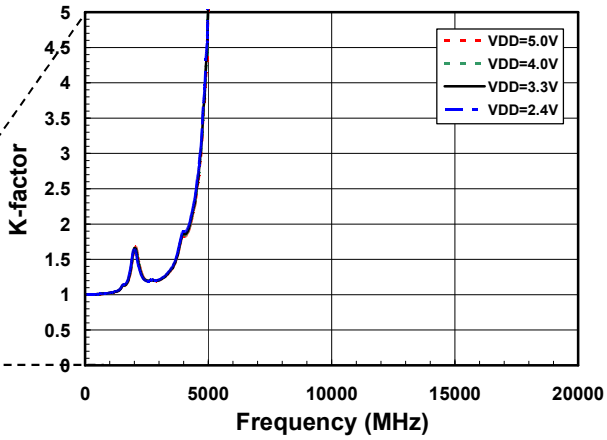
RFOUT Port Return Loss vs. Frequency



K-factor vs. Frequency

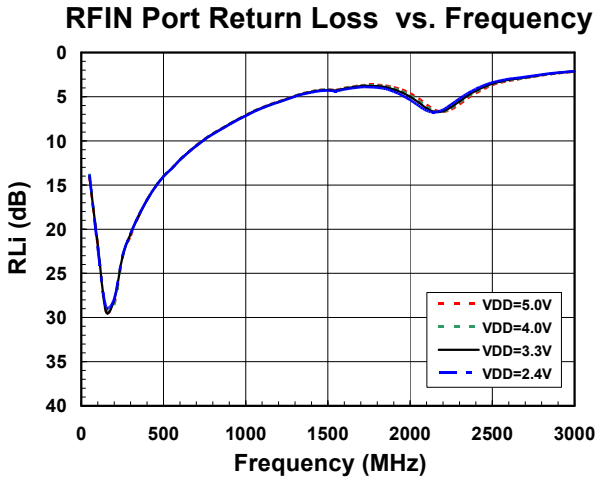


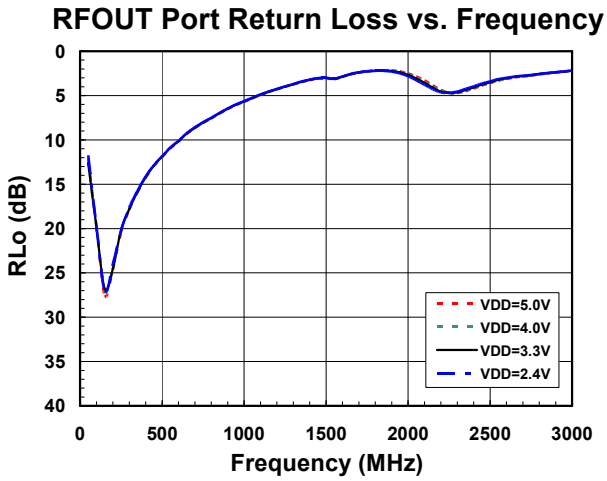
K-factor vs. Frequency

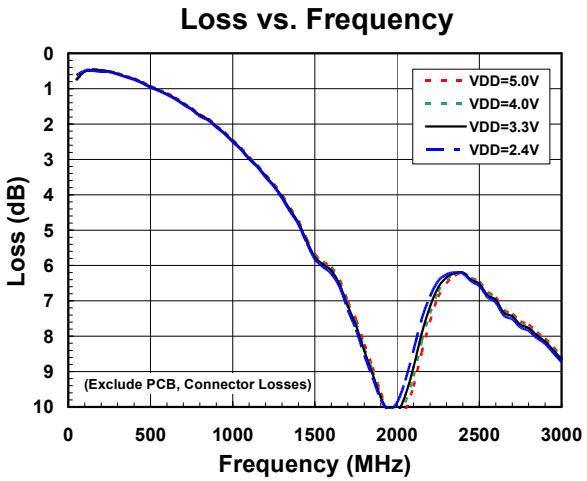


■ ELECTRICAL CHARACTERISTICS (Bypass mode, 75Ω)

Conditions: V_{CTL}=0V, Ta=25°C, Zs=Zl=75Ω, with application circuit



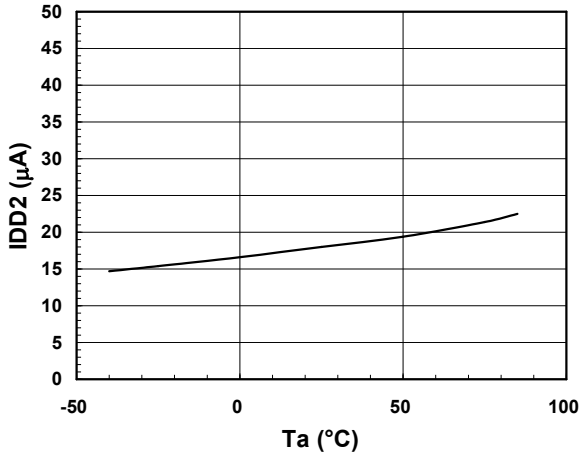




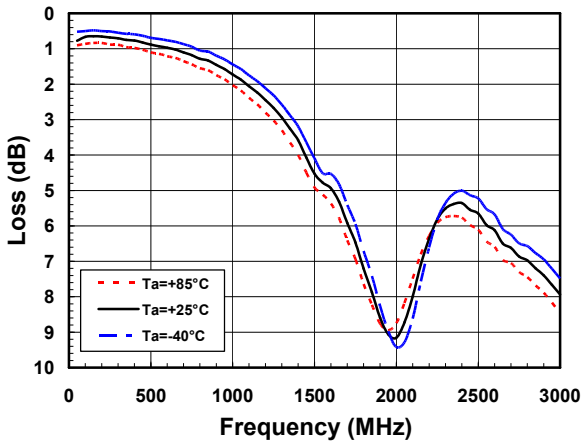
■ ELECTRICAL CHARACTERISTICS (Bypass mode, 50Ω)

Conditions: V_{DD}=3.3V, V_{CTL}=0V, Zs=Zl=50Ω, with application circuit

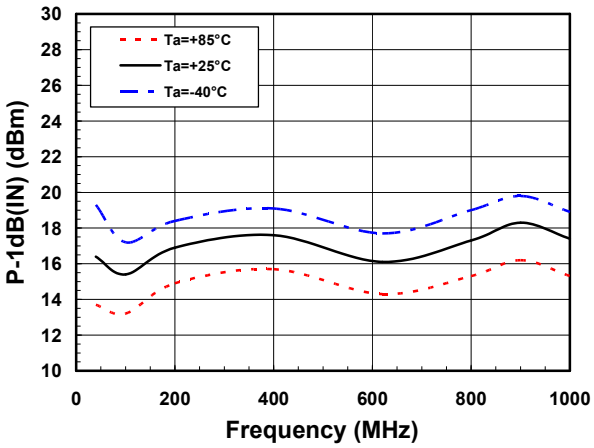
IDD2 vs. Ta



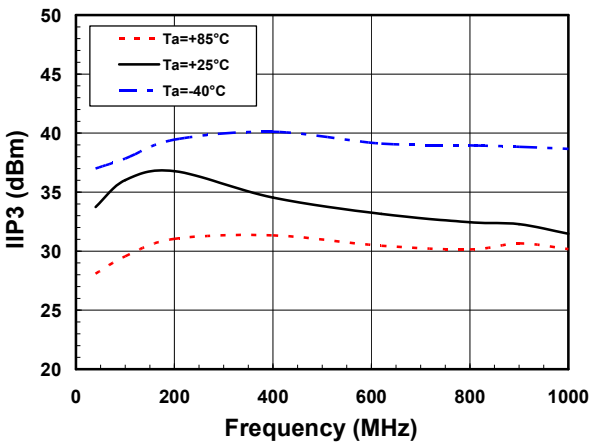
Loss vs. Frequency



P-1dB(IN) vs. Frequency



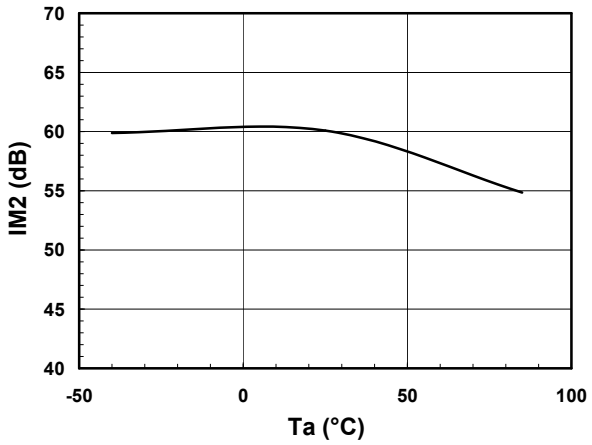
IIP3 vs. Frequency



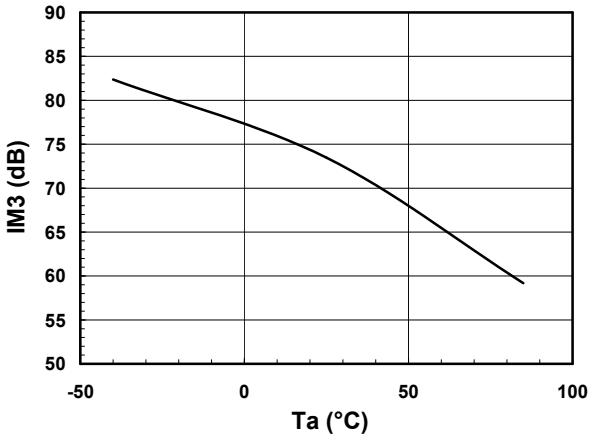
■ ELECTRICAL CHARACTERISTICS (Bypass mode, 50Ω)

Conditions: V_{DD}=3.3V, V_{CTL}=0V, Zs=Zl=50Ω, with application circuit

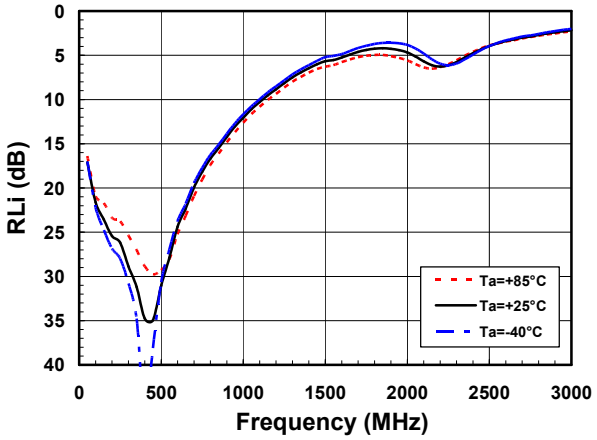
IM2 vs. Ta



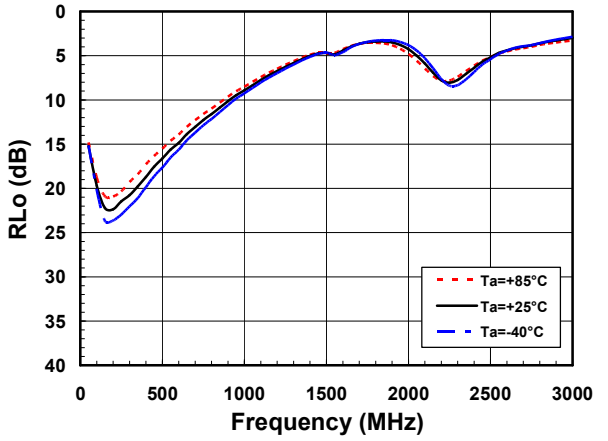
IM3 vs. Ta



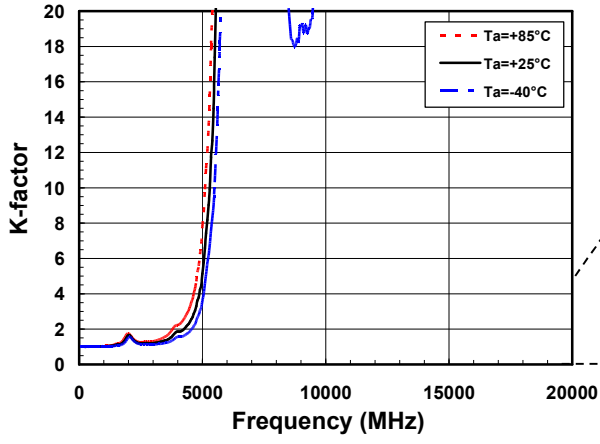
RFIN Port Return Loss vs. Frequency



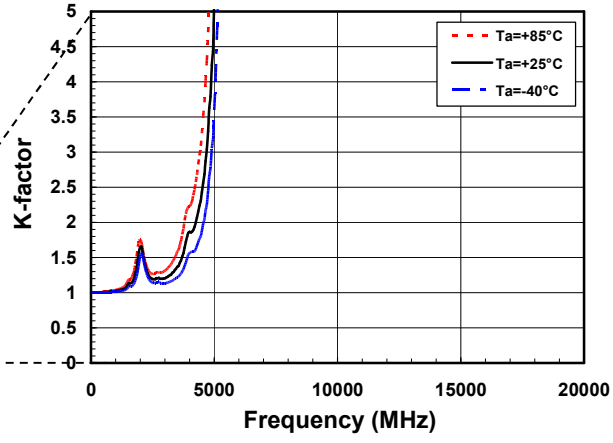
RFOUT Port Return Loss vs. Frequency



K-factor vs. Frequency



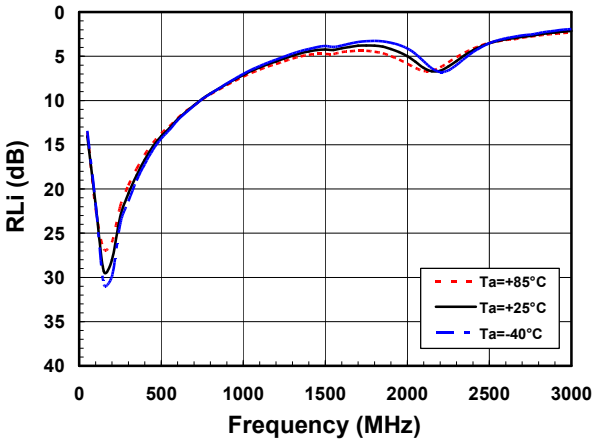
K-factor vs. Frequency



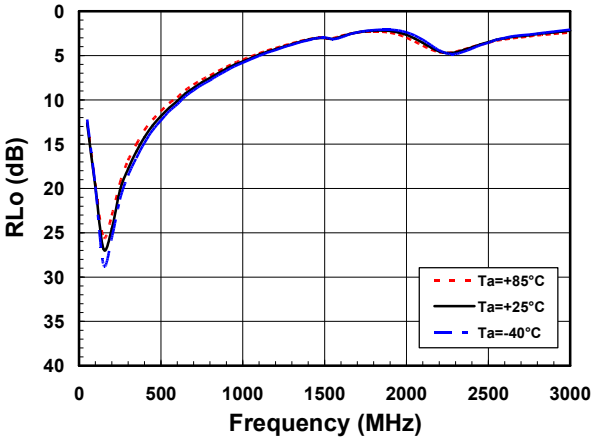
■ ELECTRICAL CHARACTERISTICS (Bypass mode, 75Ω)

Conditions: V_{DD}=3.3V, V_{CTL}=0V, Zs=Zl=75Ω, with application circuit

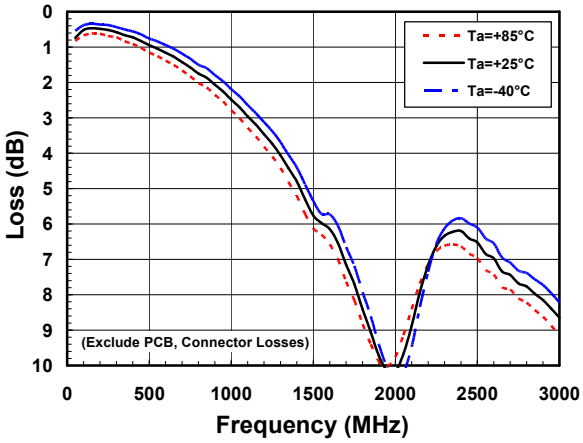
RFIN Port Return Loss vs. Frequency



RFOUT Port Return Loss vs. Frequency

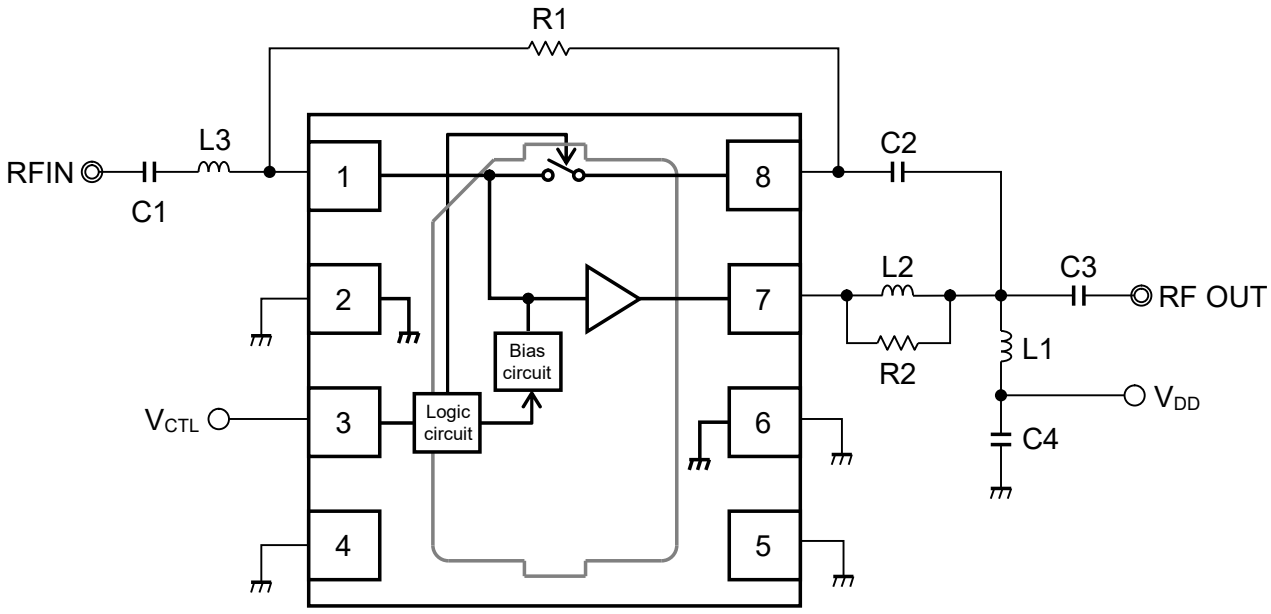


Loss vs. Frequency



■ APPLICATION CIRCUIT

(TOP VIEW)



■ PARTS LIST

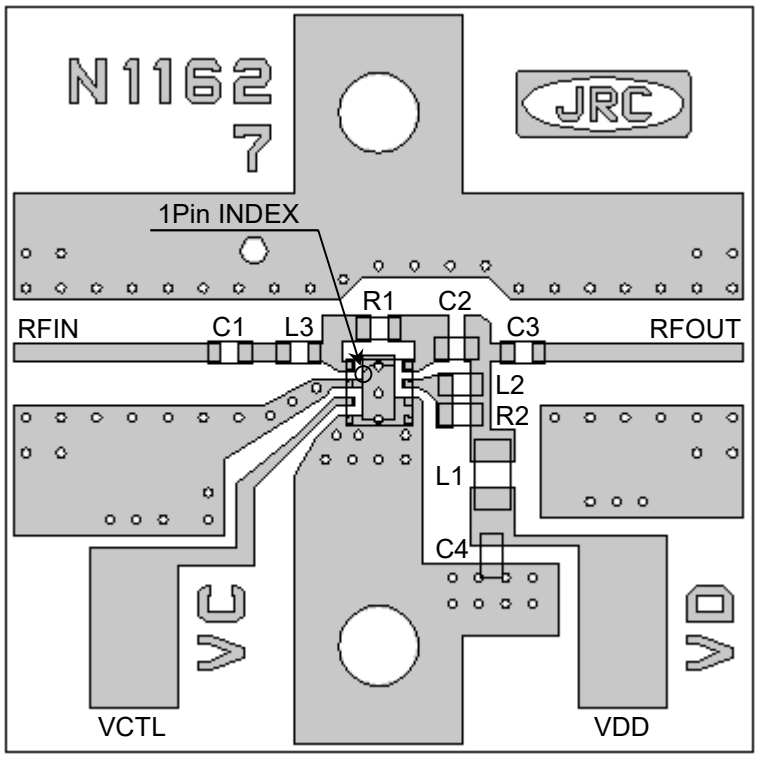
Parts ID	Value	Notes
L1	470nH	TAIYO-YUDEN HK1608 Series
L2, L3	4.7nH	TAIYO-YUDEN HK1005 Series
C1 to C4	0.01μF	MURATA GRM15 Series
R1, R2	680Ω	KOA RK73 Series

PRECAUTIONS

- C1 to C3 are DC-Blocking capacitors, and C4 is a bypass capacitor.
- L1 is RF choke inductor. (DC feed inductor)
- R1 is the feedback resistance.
- R2 is the resistance for stability.
- L2 and L3 are the inductor to adjust the impedance matching.
- All external parts, please be placed as close to the IC.
- In order not to couple with terminal RFIN and RFOUT, please layout ground pattern under the IC.

■ RECOMMENDED PCB DESIGN

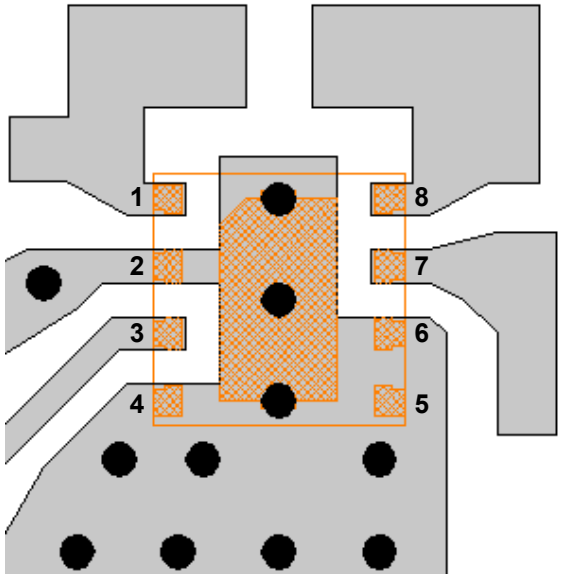
(TOP VIEW)



PCB (FR-4): t=0.2mm
Microstrip line width: 0.38mm
PCB size: 16.8 x 16.8mm
GND via hole diameter: ϕ=0.2mm

■ PCB LAYOUT GUIDELINE

(TOP VIEW)

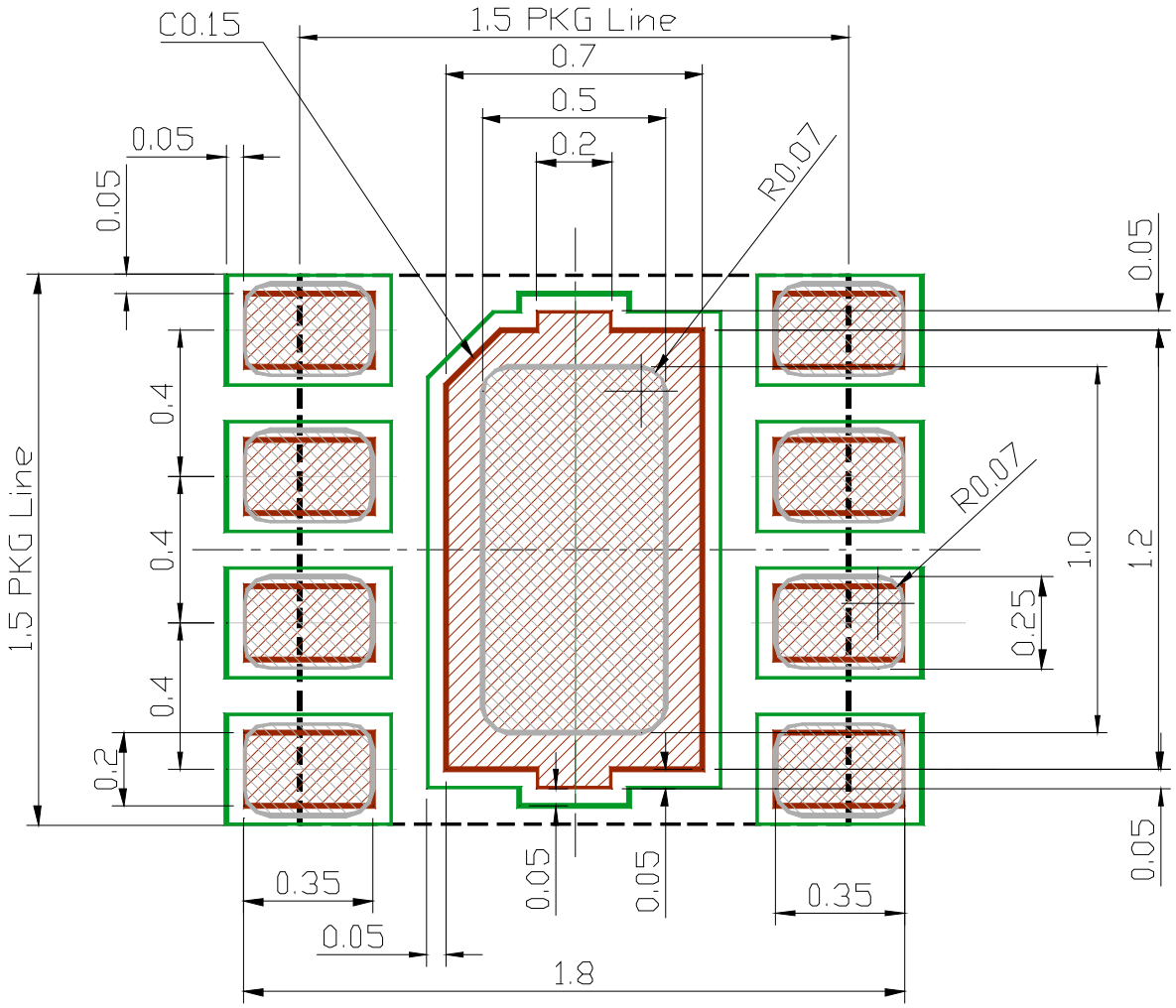


: PCB Pattern
: Package Terminal
: Package Outline
: GND Via Hole
Diameter: ϕ=0.2mm

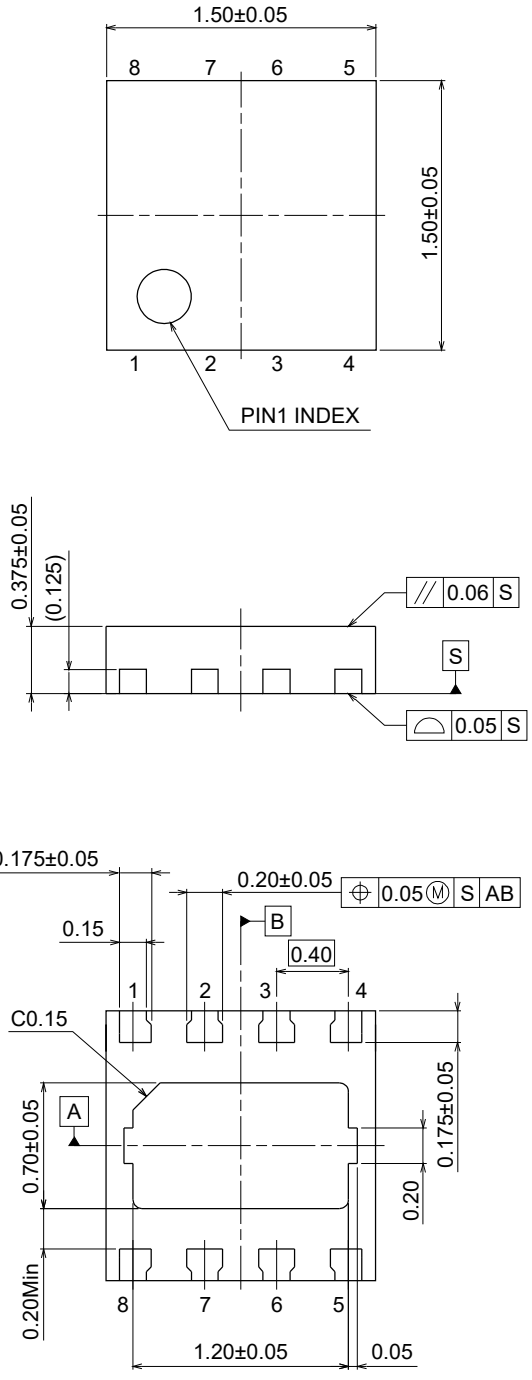
■ RECOMMENDED FOOTPRINT PATTERN (8pin DFN Package 1.5x1.5mm) <Reference>

Package: 1.5mm x 1.5mm
Pin pitch: 0.4mm

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



■ PACKAGE OUTLINE (DFN8-64)



Unit	: mm
Board	: Copper
Terminal Treat	: Ni/Pd/Au plating
Molding Material	: Epoxy resin
Weight	: 2.8mg

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.

[CAUTION]
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    - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
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    - Fire Alarms / Intruder Detectors
    - Vehicle Control Equipment (automotive, airplane, railroad, ship, etc.)
    - Various Safety Devices
    - Traffic control system
    - Combustion equipment

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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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