TAI-SAW TECHNOLOGY CO., LTD.
No. 3, Industrial 2nd Rd., Ping-Chen Industrial District,
Taoyuan, 324, Taiwan, R.O.C.
TEL: 886-3-4690038 FAX: 886-3-4697532
E-mail: tstsales@mail.taisaw.com Web: www.taisaw.com

Product Specifications Approval Sheet

Product Description: Low noise amplifier for GNSS 1.1mm x 0.7mm

TST Parts No.: TN0117A

Customer Parts No.:_____

Customer signature required

Company:_____

Division:_____

Approved by :_____

Date:_____

Checked by:_____Kazuma Lee_____

Approval by:_____Andy Yu_____

Date:_____04 / 12 / 2017_____

1. Customer signed back is required before TST can proceed with sample build and receive orders.
2. Orders received without customer signed back will be regarded as agreement on the specifications.
3. Any specifications changes must be approved upon by both parties and a new revision of specifications shall be released to reflect the changes.

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Low noise amplifier GaAs MMIC designed for GNSS (Global Navigation Satellite Systems)

MODEL NO.: TN0117A REV. NO.1

RoHS Compliant
Lead free
Lead-free soldering

Electrostatic **S**ensitive **D**evice

A. GENERAL DESCRIPTION:

1. The TN0117A is a low noise amplifier GaAs MMIC designed for GNSS (Global Navigation Satellite Systems).
2. The TN0117A is featured low noise figure, and operates from 1.5V to 3.3V single voltage.
3. The TN0117A has stand-by mode to save the supply current, has the on-chip ESD protection devices.
4. The TN0117A achieves ultra small mounting area by only two external components and ultra small package that is lead-free and halogen-free 6-pin.

B. APPLICATIONS:

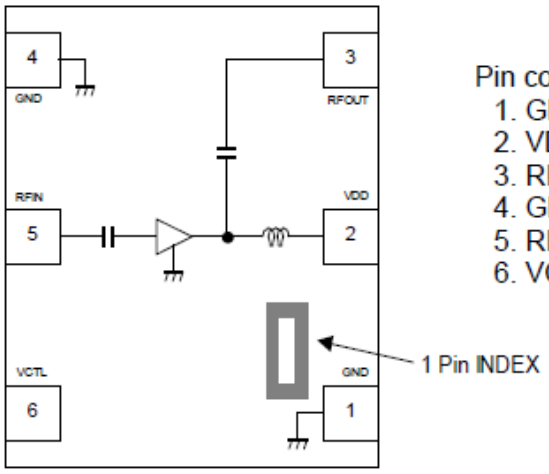
GNSS applications, like GPS, Galileo, GLONASS and COMPASS.

C. FEATURES:

1. Operating frequencies
   1550 to 1615MHz
2. Low supply voltage
   2.8 / 1.8V typ.
3. Low current consumption
   3.5 / 3.1mA typ. @VDD=2.8 / 1.8V, VCTL=1.8V
   0.1μA typ. @VDD=2.8 / 1.8V, VCTL=0V (Stand-by mode)
4. High gain
   19.0 / 18.5dB typ. @VDD=2.8 / 1.8V, VCTL=1.8V
5. Low noise figure
   0.75dB typ. @VDD=2.8 / 1.8V, VCTL=1.8V
6. Ultra small package
   EPFFP6-X2 (Package size: 1.1mm x 0.7mm x 0.37mm typ.)
7. Low external component count
   2pcs.
8. RoHS compliant and Halogen Free
9. MSL1

C. PIN CONFIGURATION:

(Top View)



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

■ TRUTH TABLE

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

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

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

D. ABSOLUTE MAXIMUM RATINGS:

General conditions: T_a=+25°C, Z_s=Z_l=50Ω

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

E. ELECTRICAL CHARACTERISTICS 1 (DC):

General conditions: T_a=+25°C, Z_s=Z_l=50Ω

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

F. ELECTRICAL CHARACTERISTICS 2 (RF, VDD=2.8V):

General conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=1550 to1615MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small Signal Gain1	Gain1	Exclude PCB and connector losses (0.18dB)	16.5	19.0	21.0	dB
Noise Figure1	NF1	Exclude PCB and connector losses (0.08dB)	-	0.75	1.0	dB
Isolation1	ISL1		25.0	35.0	-	dB
Input Power at 1dB Gain Compression Point1	$P_{-1dB\ (IN)1}$		-17.0	-12.5	-	dBm
Input 3rd Order Intercept Point1	IIP3_1	f1=f_{RF}, f2=f1+/-1MHz, Pin=-30dBm	-5.0	-1.5	-	dBm
Out of Band Input 3rd Order Intercept Point1	IIP3_OB1	f_1=1712.7MHz, Pin=-20dBm, f_2=1850MHz, Pin=-20dBm, f_{meas}=1575.4MHz	-4.0	0.0	-	dBm
RFIN Port Return Loss1	RLi1		6.0	10.0	-	dB
RFOUT Port Return Loss1	RLo1		8.0	12.0	-	dB

G. ELECTRICAL CHARACTERISTICS 3 (RF, VDD=1.8V):

General conditions: V_{DD}=1.8V, V_{CTL}=1.8V, f_{RF}=1550 to1615MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

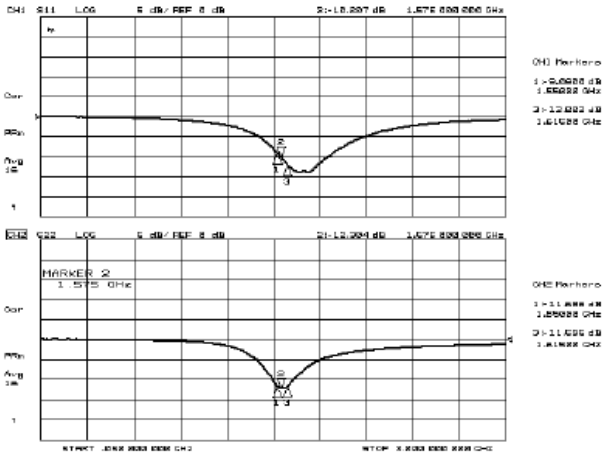
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small Signal Gain2	Gain2	Exclude PCB and connector losses (0.18dB)	15.0	18.5	21.0	dB
Noise Figure2	NF2	Exclude PCB and connector losses (0.08dB)	-	0.75	1.1	dB
Isolation2	ISL2		25.0	35.0	-	dB
Input Power at 1dB Gain Compression Point2	P_{-1dB} (IN)2		-20.0	-16.0	-	dBm
Input 3rd Order Intercept Point2	IIP3_2	f1=f_{RF}, f2=f1+/-1MHz, Pin=-30dBm	-10.0	-5.0	-	dBm
Out of Band Input 3rd Order Intercept Point2	IIP3_OB2	f_1=1712.7MHz, Pin=-20dBm, f_2=1850MHz, Pin=-20dBm, f_{meas}=1575.4MHz	-7.0	-3.0	-	dBm
RF IN Port Return Loss2	RLi2		6.0	10.0	-	dB
RF OUT Port Return Loss2	RLo2		7.0	12.0	-	dB

H. TERMINAL INFORMATION:

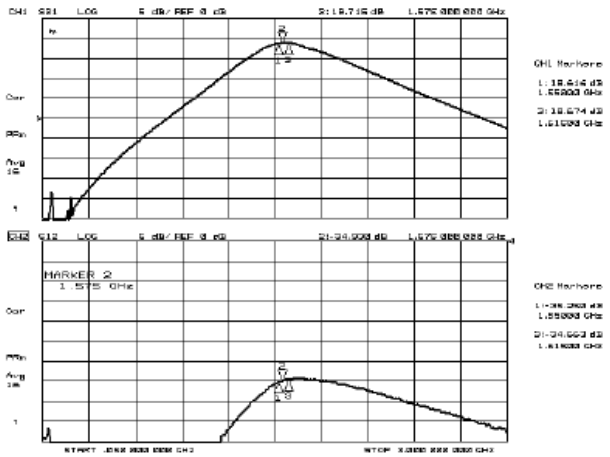
No.	SYMBOL	DESCRIPTION
1	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
2	VDD	Supply voltage terminal. Please connect bypass capacitor C1 with ground as close as possible.
3	RFOUT	RF output terminal. This terminal requires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

I. ELECTRICAL CHARACTERISTICS:

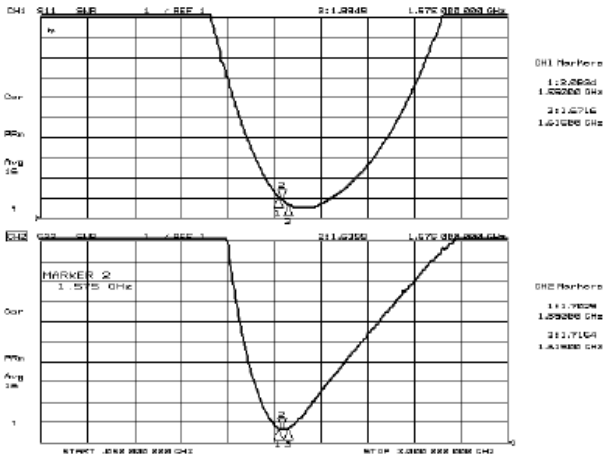
Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, Ta=25°C, Z_s=Z_l=50Ω



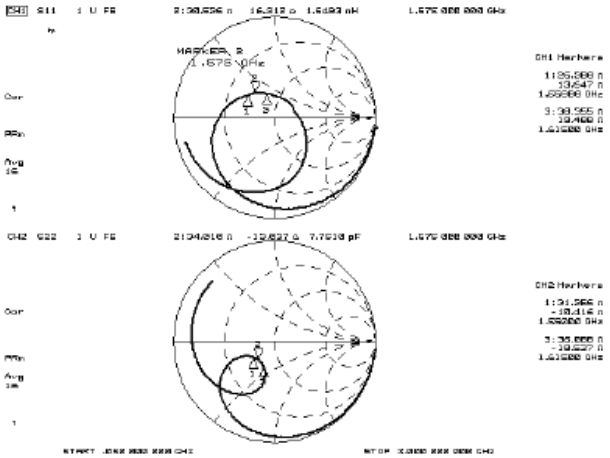
S11, S22



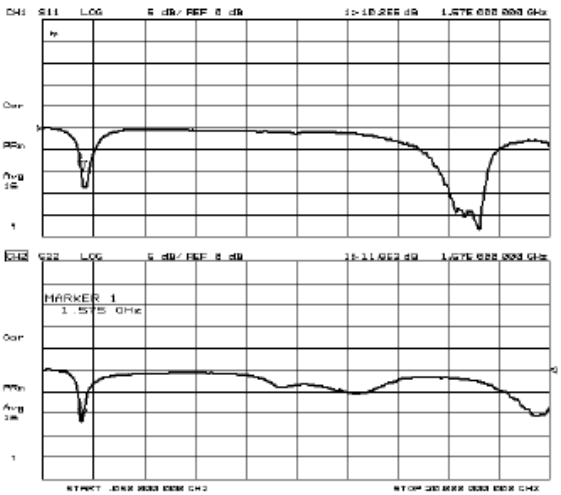
S21, S12



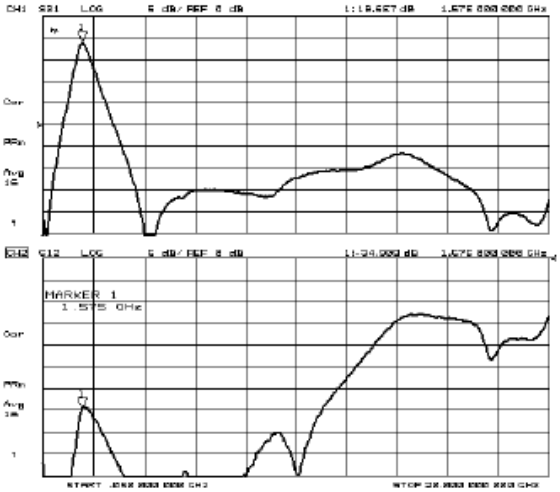
VSWR



Zin, Zout



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

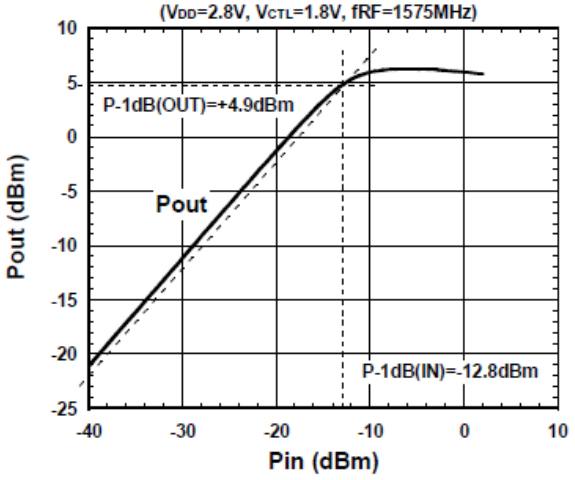


S21, S12 (f=50M to 20GHz)

Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, Ta=25°C, Z_s=Z_l=50Ω

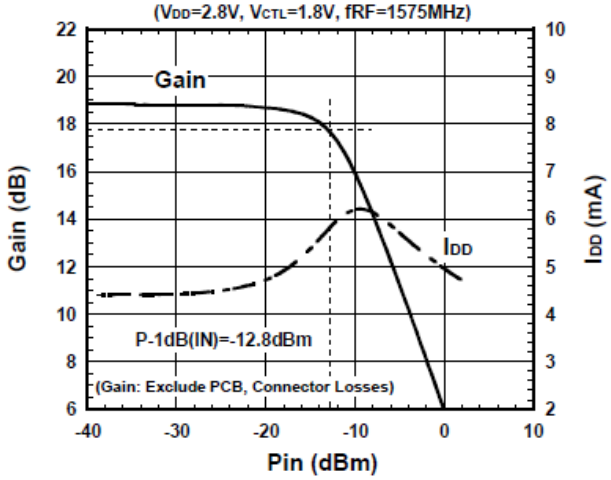
Pout vs. Pin

(VDD=2.8V, VCTL=1.8V, fRF=1575MHz)



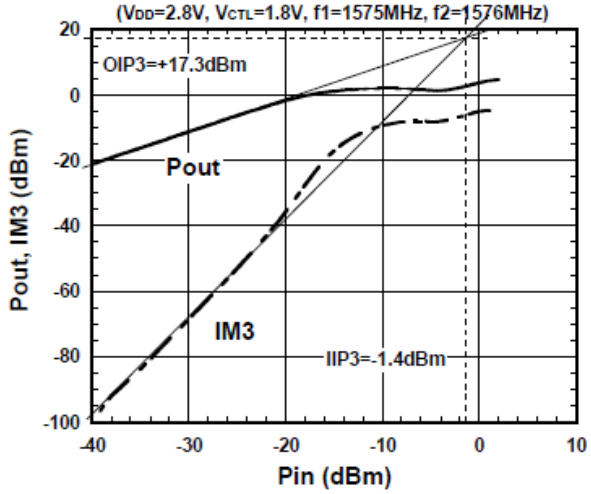
Gain, IDD vs. Pin

(VDD=2.8V, VCTL=1.8V, fRF=1575MHz)



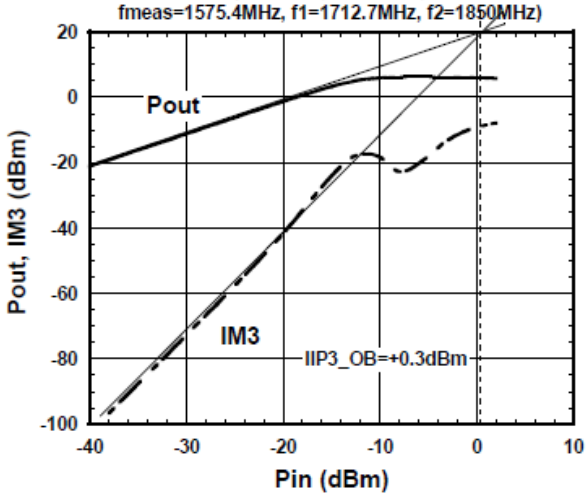
Pout, IM3 vs. Pin

(VDD=2.8V, VCTL=1.8V, f1=1575MHz, f2=1576MHz)



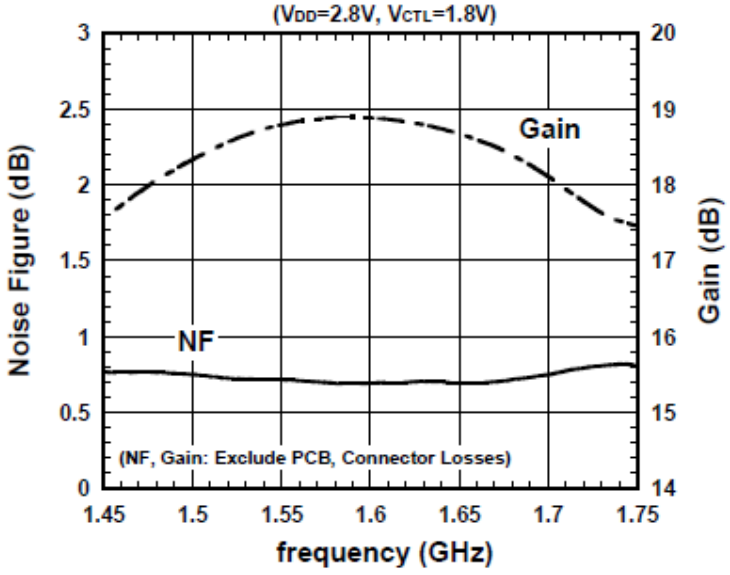
OUT-of-band IIP3

(VDD=2.8V, VCTL=1.8V,
fmeas=1575.4MHz, f1=1712.7MHz, f2=1850MHz)



NF, Gain vs. frequency

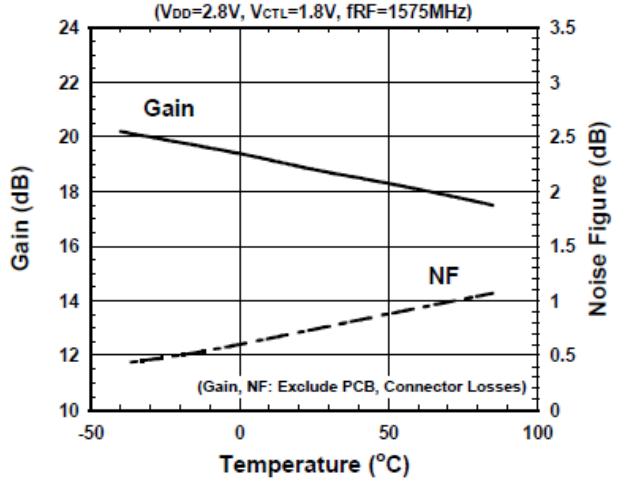
(VDD=2.8V, VCTL=1.8V)



Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=1575MHz, Z_s=Z_l=50Ω

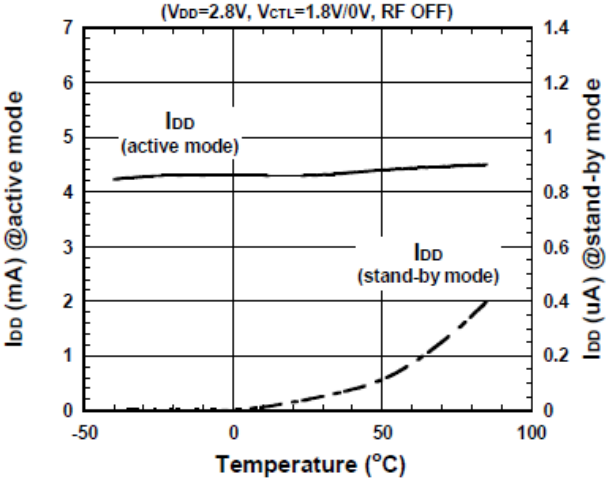
Gain, NF vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, fRF=1575MHz)



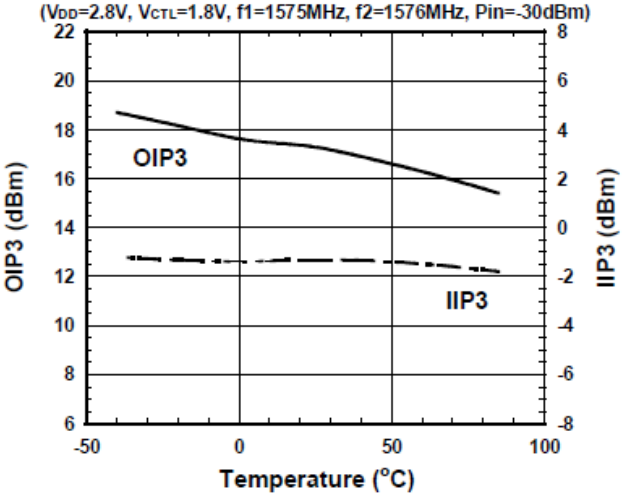
I_{DD} vs. Temperature

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



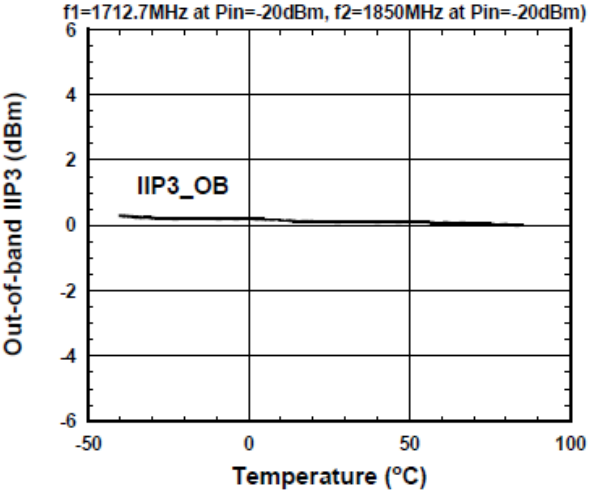
OIP3, IIP3 vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, f1=1575MHz, f2=1576MHz, Pin=-30dBm)



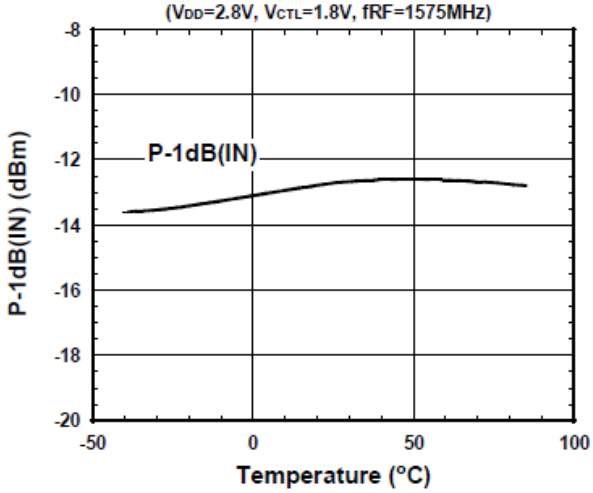
Out-of-band IIP3 vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, fmeas=1575.4MHz,
f1=1712.7MHz at Pin=-20dBm, f2=1850MHz at Pin=-20dBm)



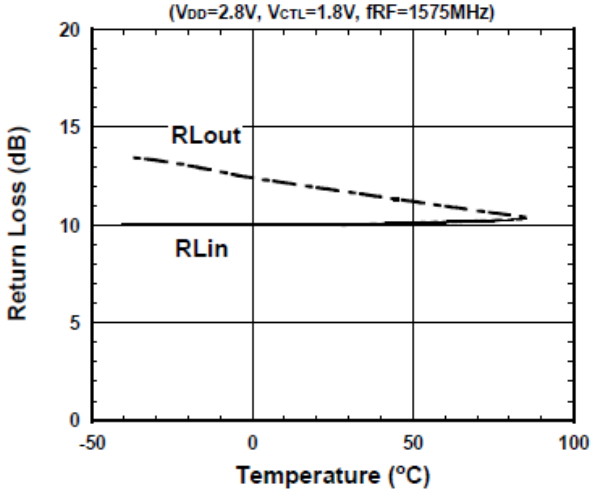
P-1dB(IN) vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, fRF=1575MHz)

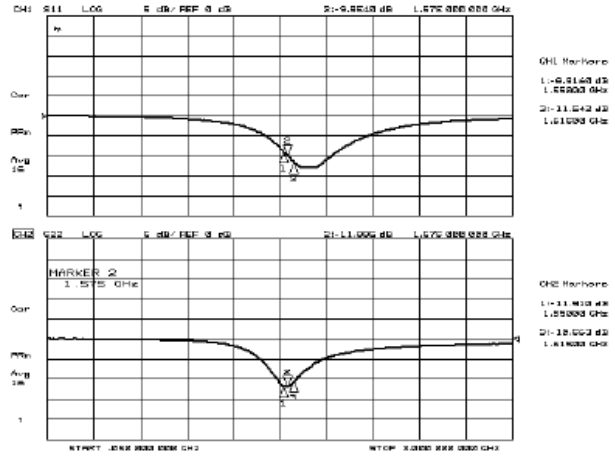


Return Loss vs. Temperature

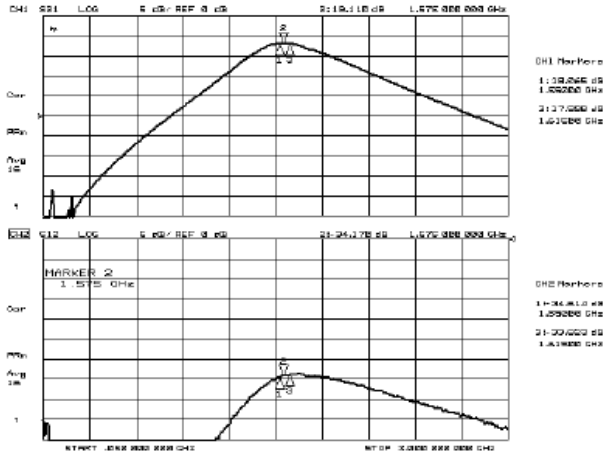
(V_{DD}=2.8V, V_{CTL}=1.8V, fRF=1575MHz)



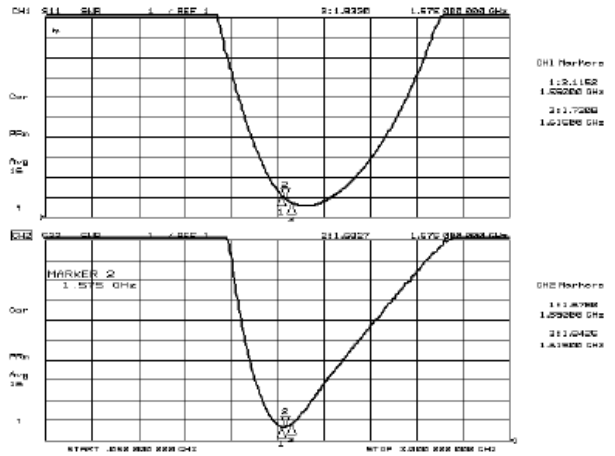
Conditions: V_{DD}=1.8V, V_{CTL}=1.8V, Ta=25°C, Z_s=Z_l=50Ω



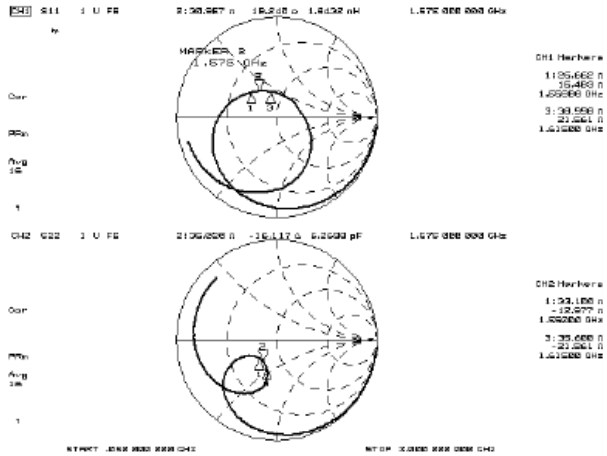
S11, S22



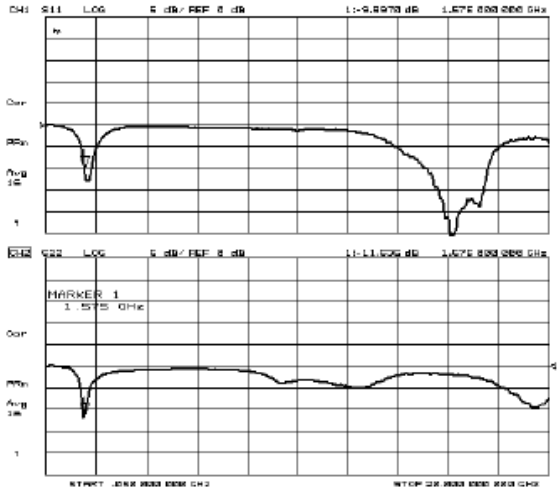
S21, S12



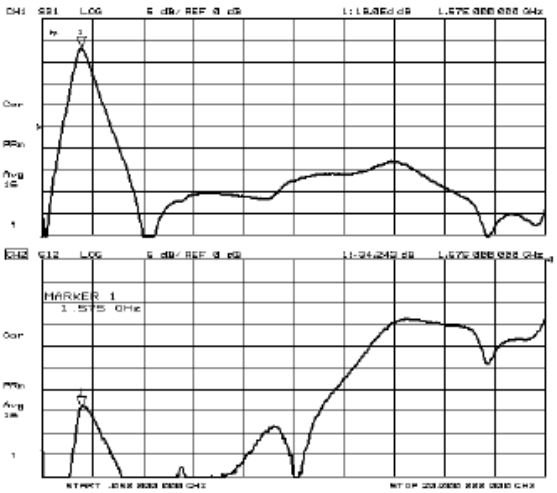
VSWR



Zin, Zout



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

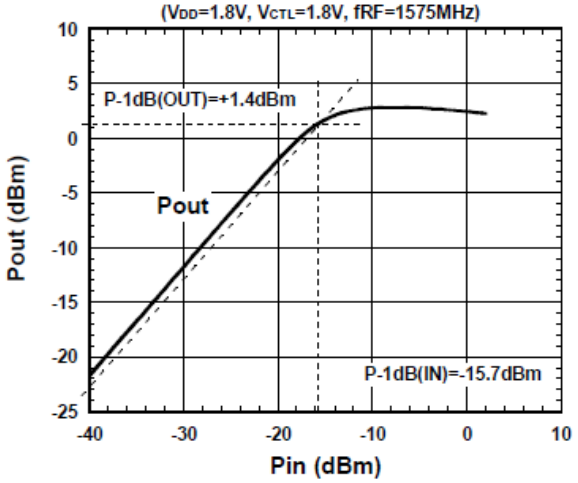


S21, S12 (f=50M to 20GHz)

Conditions: V_{DD}=1.8V, V_{CTL}=1.8V, Ta=25°C, Z_s=Z_l=50Ω

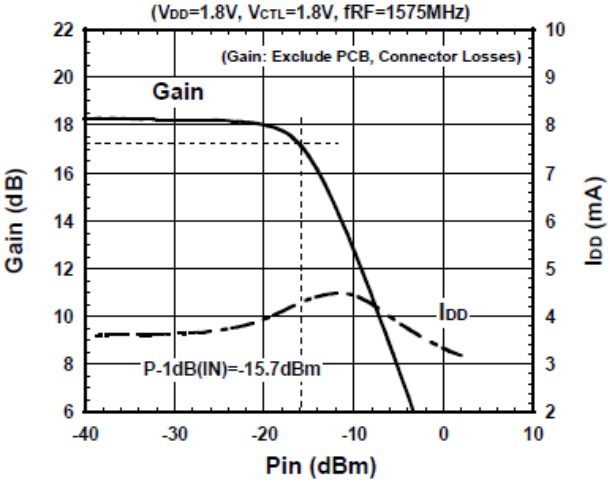
Pout vs. Pin

(V_{DD}=1.8V, V_{CTL}=1.8V, fRF=1575MHz)



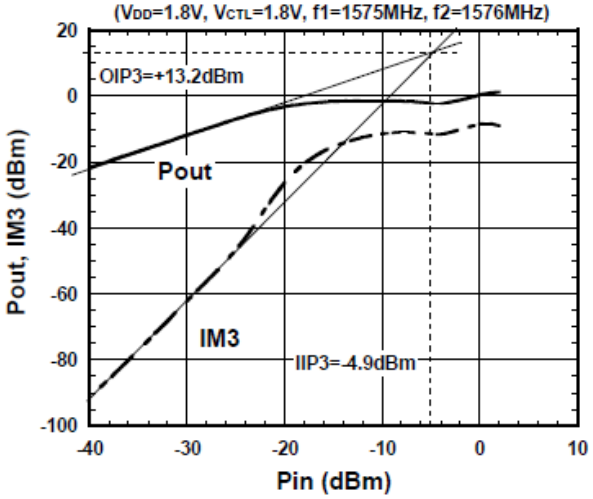
Gain, I_{DD} vs. Pin

(V_{DD}=1.8V, V_{CTL}=1.8V, fRF=1575MHz)



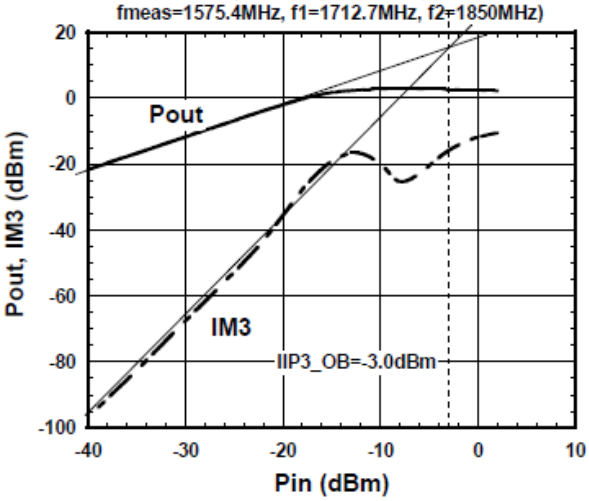
Pout, IM3 vs. Pin

(V_{DD}=1.8V, V_{CTL}=1.8V, f1=1575MHz, f2=1576MHz)



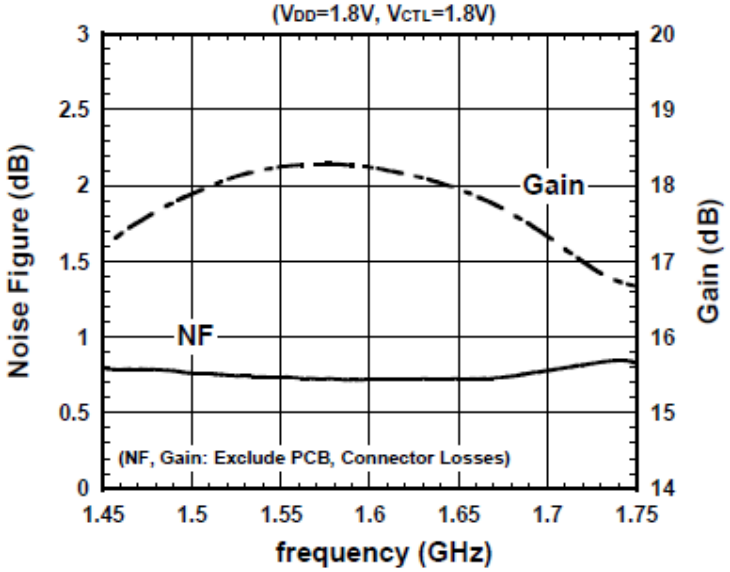
OUT-of-band IIP3

(V_{DD}=1.8V, V_{CTL}=1.8V, fmeas=1575.4MHz, f1=1712.7MHz, f2=1850MHz)



NF, Gain vs. frequency

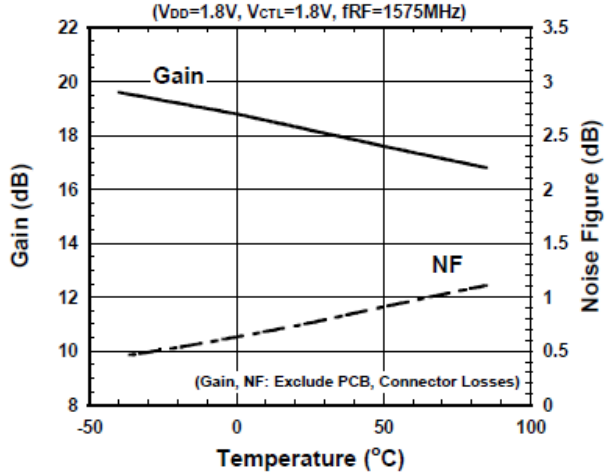
(V_{DD}=1.8V, V_{CTL}=1.8V)



Conditions: V_{DD}=1.8V, V_{CTL}=1.8V, f_{RF}=1575MHz, Z_s=Z_l=50Ω

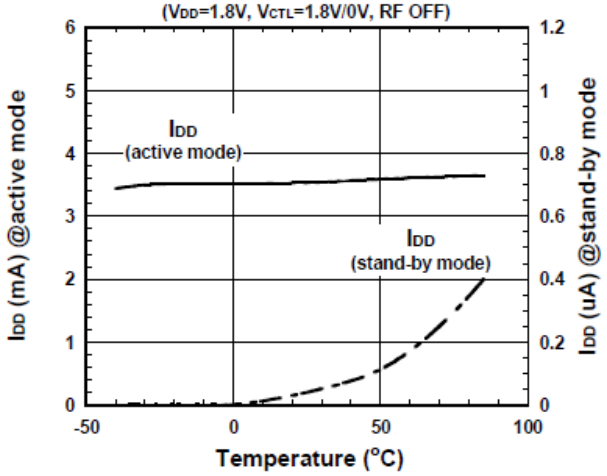
Gain, NF vs. Temperature

(VDD=1.8V, VCTL=1.8V, fRF=1575MHz)



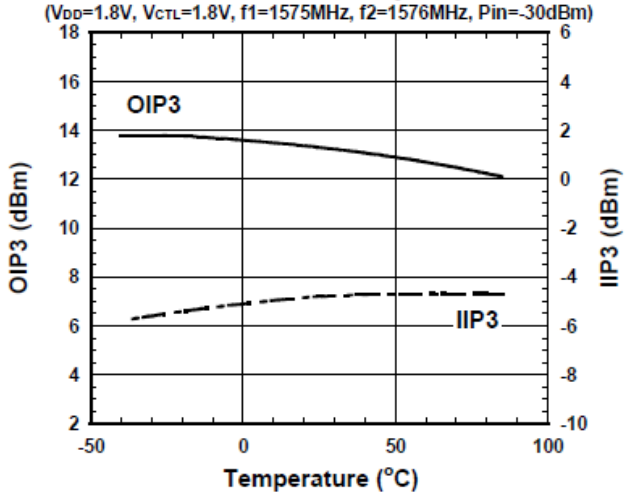
IDD vs. Temperature

(VDD=1.8V, VCTL=1.8V/0V, RF OFF)



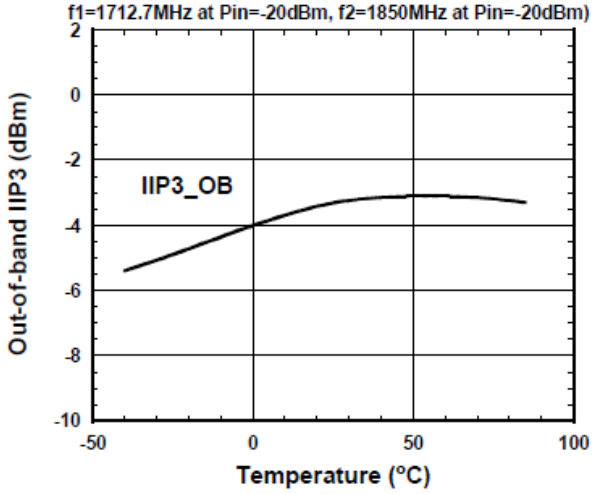
OIP3, IIP3 vs. Temperature

(VDD=1.8V, VCTL=1.8V, f1=1575MHz, f2=1576MHz, Pin=-30dBm)



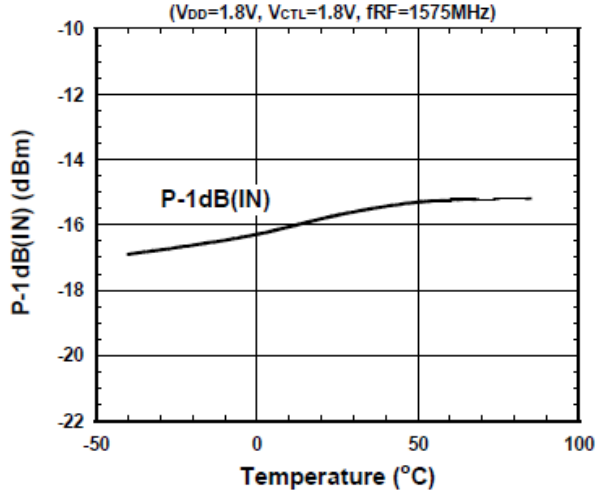
Out-of-band IIP3 vs. Temperature

(VDD=1.8V, VCTL=1.8V, fmeas=1575.4MHz,
f1=1712.7MHz at Pin=-20dBm, f2=1850MHz at Pin=-20dBm)



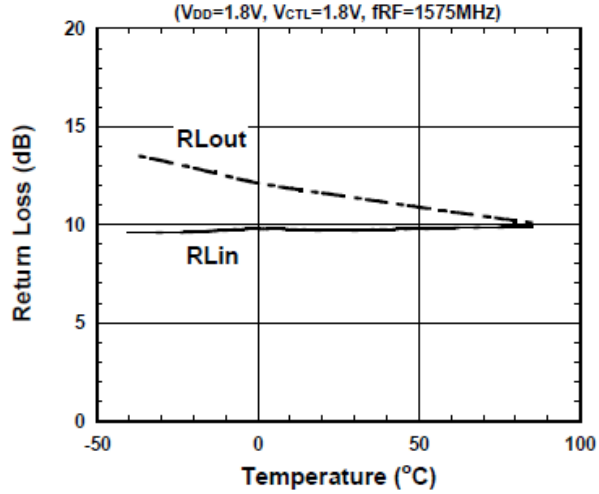
P-1dB(IN) vs. Temperature

(VDD=1.8V, VCTL=1.8V, fRF=1575MHz)



Return Loss vs. Temperature

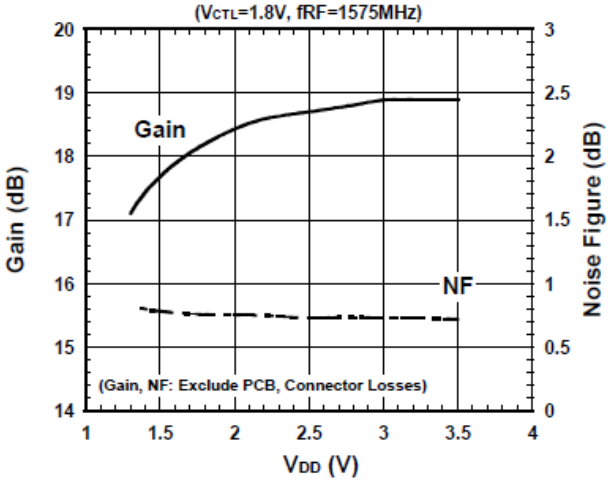
(VDD=1.8V, VCTL=1.8V, fRF=1575MHz)



Conditions: V_{CTL}=1.8V, f_{RF}=1575MHz, Ta=25°C, Z_s=Z_l=50Ω

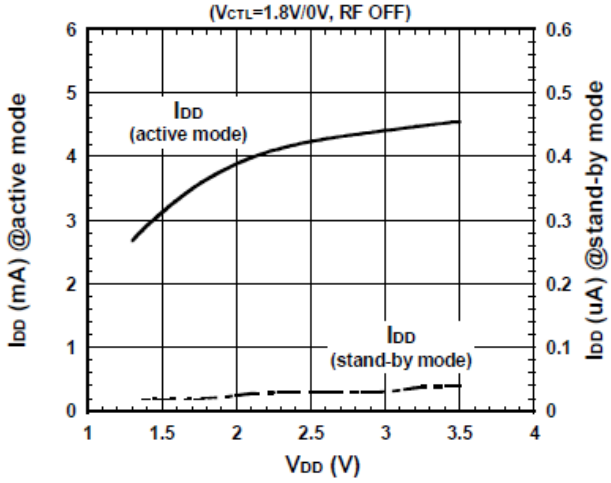
Gain, NF vs. VDD

(VCTL=1.8V, fRF=1575MHz)



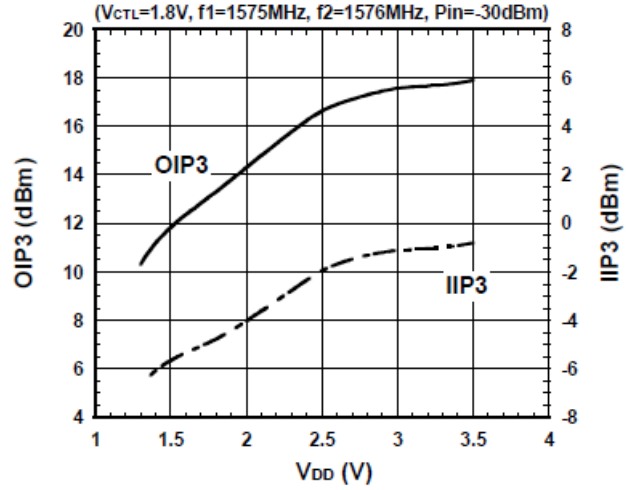
IDD vs. VDD

(VCTL=1.8V/0V, RF OFF)



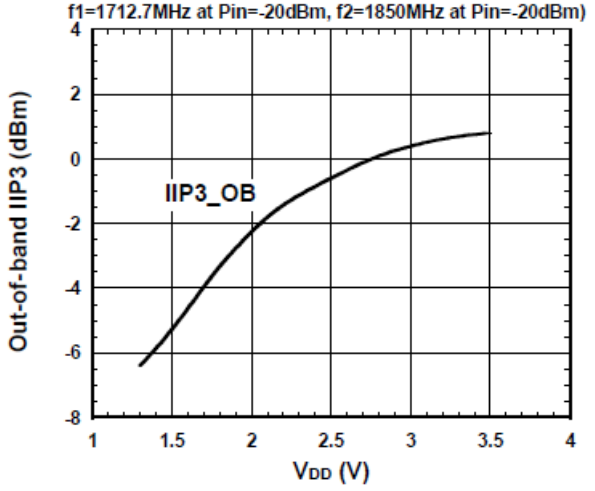
OIP3, IIP3 vs. VDD

(VCTL=1.8V, f1=1575MHz, f2=1576MHz, Pin=-30dBm)



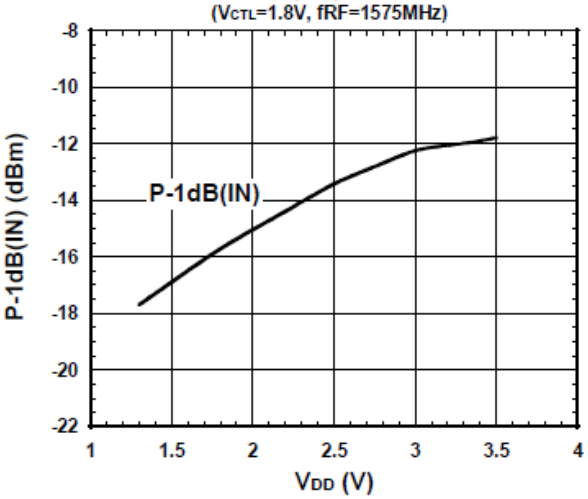
Out-of-band IIP3 vs. VDD

(VCTL=1.8V, fmeas=1575.4MHz,
f1=1712.7MHz at Pin=-20dBm, f2=1850MHz at Pin=-20dBm)



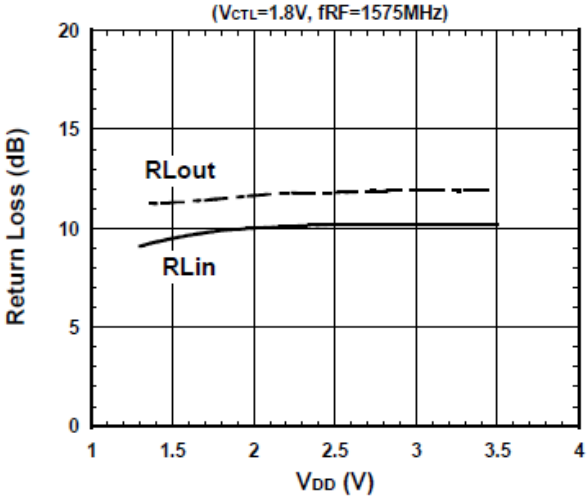
P-1dB(IN) vs. VDD

(VCTL=1.8V, fRF=1575MHz)

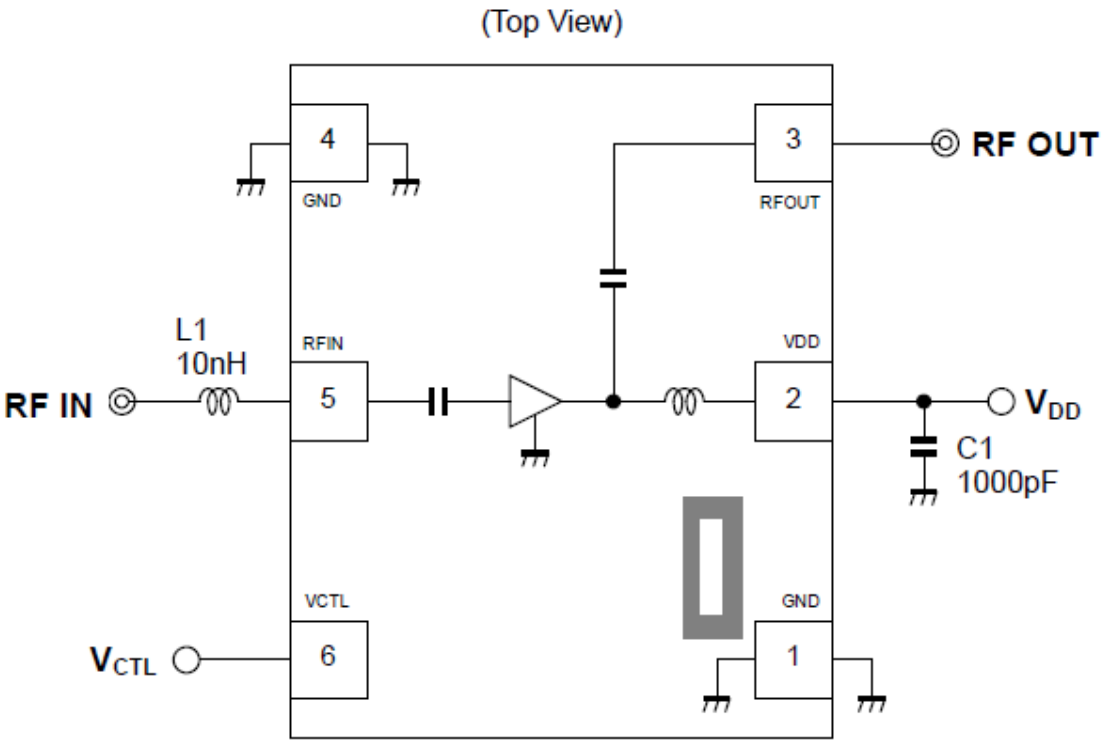


Return Loss vs. VDD

(VCTL=1.8V, fRF=1575MHz)



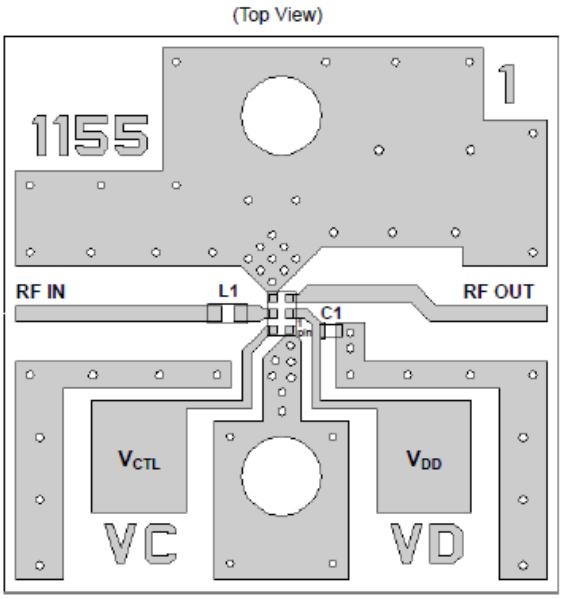
J. APPLICATION CIRCUIT:



Parts list

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

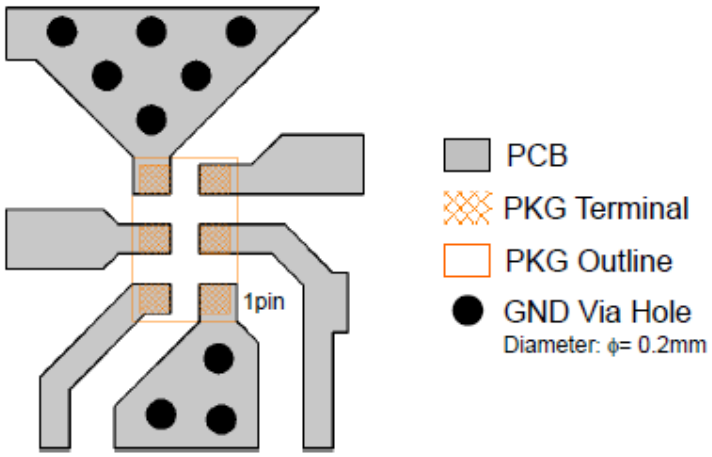
K. EVALUATION BOARD:



PCB Information

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

<PCB LAYOUT GUIDELINE>



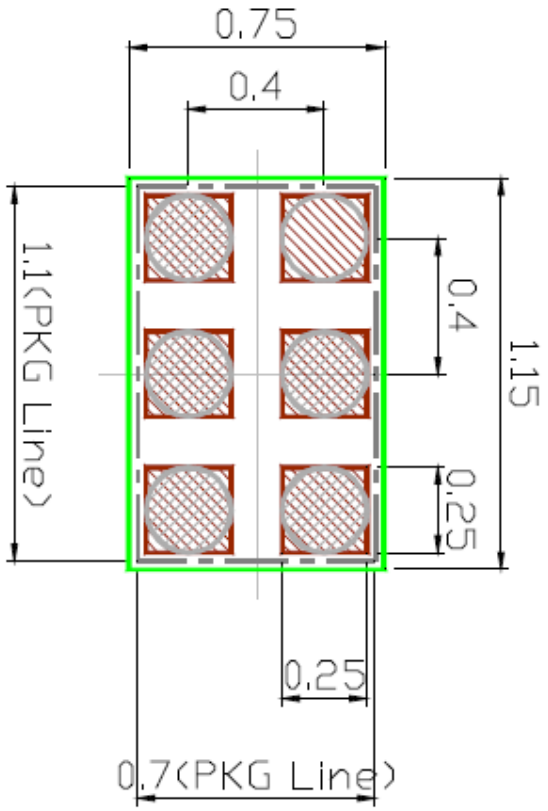
PRECAUTIONS

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

L. RECOMMENDED FOOTPRINT PATTERN:

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

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



M. APPLICATION NOTE FOR ULTRA LOW NOISE FIGURE

(Using LQW15A Series high-Q inductor)

This application note shows an example in order to achieve ultra low noise figure (NF).
LQW15A (MURATA) Series inductor is used for this application.
The example of electrical characteristics are shown as follows:

1. ELECTRICAL CHARACTERISTICS (DC)

General conditions: T_a=+25°C, Z_s=Z_l=50Ω

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

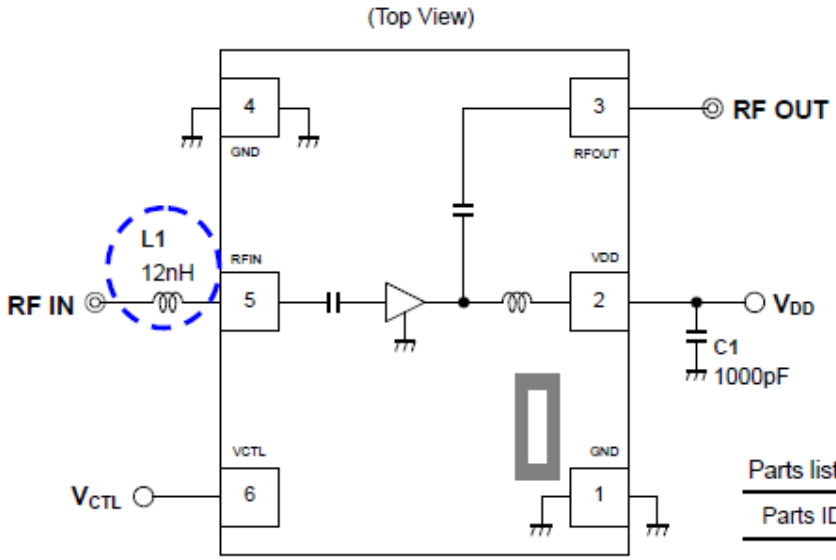
General conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=1550 to1615MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

PARAMETER	SYMBOL	CONDITIONS	MEASURED DATA	UNITS
Small Signal Gain	Gain	Exclude PCB and connector losses (0.18dB)	19.0 to 19.1	dB
Noise Figure	NF	Exclude PCB and connector losses (0.08dB)	0.56 to 0.59	dB
Input Power at 1dB Gain Compression Point	$P_{-1dB(IN)}$		-13.6 to -13.2	dBm
Input 3rd Order Intercept Point	IIP3	f1=f_{RF}, f2=f1+/-1MHz, Pin=-30dBm	-2.1	dBm
Out of Band Input 3rd Order Intercept Point	IIP3_OB	f_1=1712.7MHz, Pin=-20dBm, f_2=1850MHz, Pin=-20dBm, f_{meas}=1575.4MHz	-0.4	dBm
RF IN Port Return Loss	RLi		8.8 to 10.3	dB
RF OUT Port Return Loss	RLo		11.1 to 11.8	dB

General conditions: V_{DD}=1.8V, V_{CTL}=1.8V, f_{RF}=1550 to1615MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit

PARAMETER	SYMBOL	CONDITIONS	MEASURED DATA	UNITS
Small Signal Gain	Gain	Exclude PCB and connector losses (0.18dB)	18.3 to 18.5	dB
Noise Figure	NF	Exclude PCB and connector losses (0.08dB)	0.59 to 0.62	dB
Input Power at 1dB Gain Compression Point	P_{-1dB} (IN)		-16.5 to -16.1	dBm
Input 3rd Order Intercept Point	IIP3	f1=f_{RF}, f2=f1+/-1MHz, Pin=-30dBm	-5.3	dBm
Out of Band Input 3rd Order Intercept Point	IIP3_OB	f_1=1712.7MHz, Pin=-20dBm, f_2=1850MHz, Pin=-20dBm, f_{meas}=1575.4MHz	-3.6	dBm
RF IN Port Return Loss	RLi		8.4 to 9.8	dB
RF OUT Port Return Loss	RLo		10.3 to 11.5	dB

2. APPLICATION CIRCUIT (Using LQW15A Series high-Q inductor)

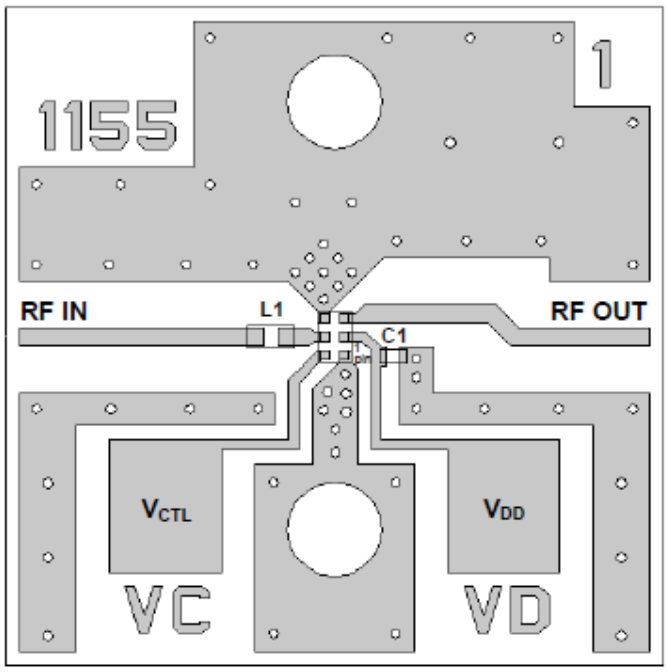


Parts list

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

3. EVALUATION BOARD (Using LQW15A Series high-Q inductor)

(Top View)



PCB Information

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

4. NOISE FIGURE MEASUREMENT BLOCK DIAGRAM

Measuring instruments

NF Analyzer: Agilent N8973A

Noise Source: Agilent 346A

Setting the NF analyzer

Measurement mode form

Device under test: Amplifier

System downconverter: off

Mode setup form

Sideband: LSB

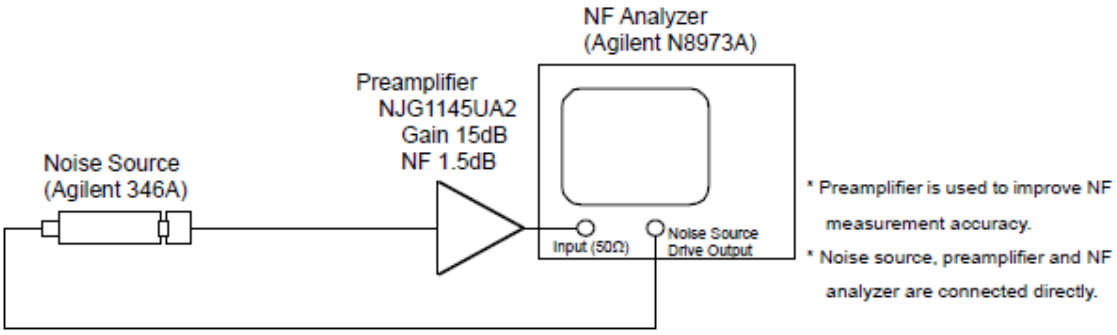
Averages: 16

Average mode: Point

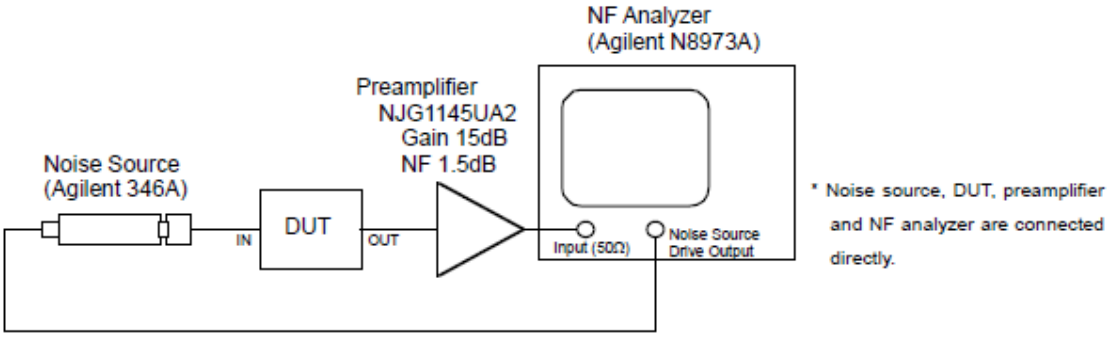
Bandwidth: 4MHz

Loss comp: off

Tcold: setting the temperature of noise source (303.15K)



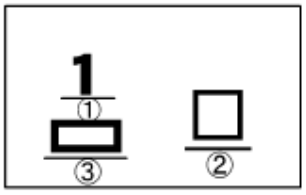
Calibration setup



Measurement Setup

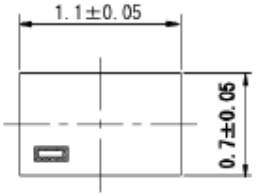
4. PACKAGE OUTLINE

MARK SPECIFICATION

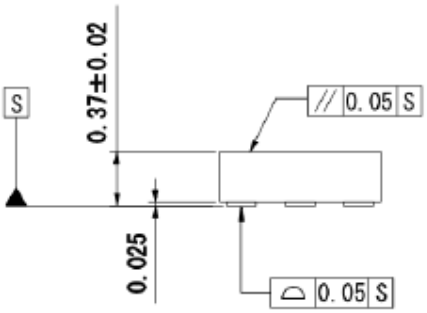


① Device No. 1
② Lot No.
③ Index Mark

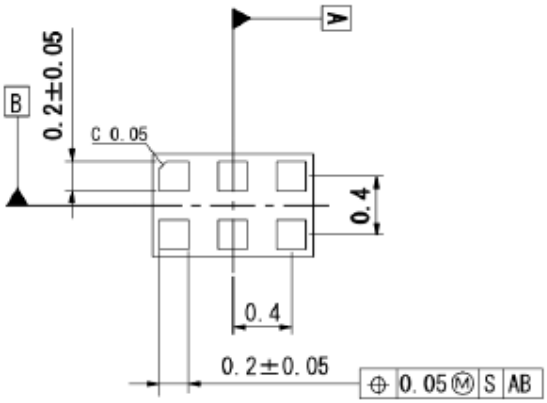
TOP VIEW



SIDE VIEW

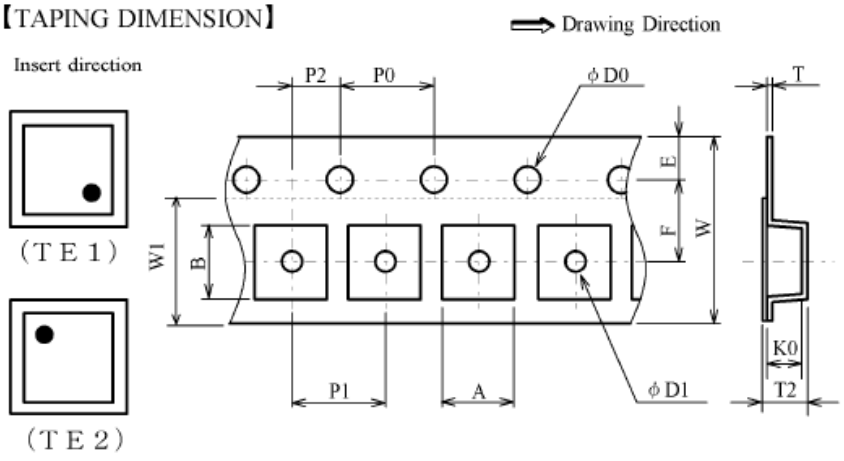


BOTTOM VIEW



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

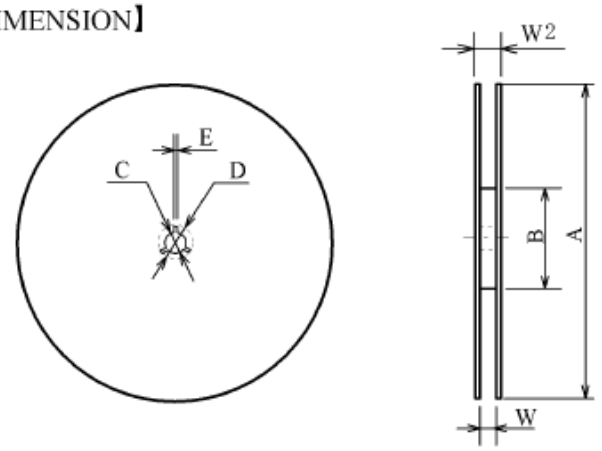
【TAPING DIMENSION】



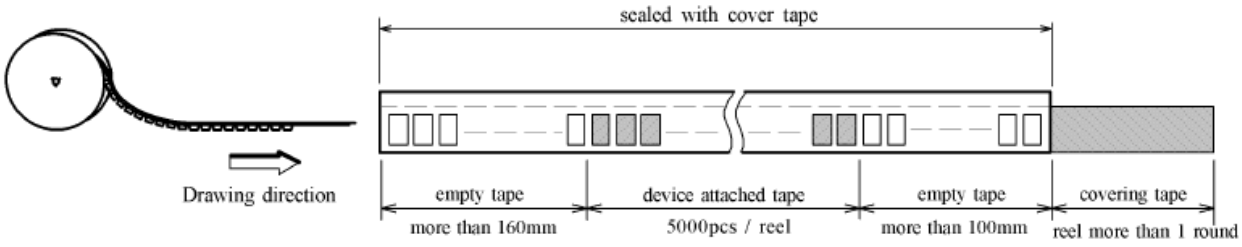
SYMBOL	DIMENSION	REMARKS
A	0.85±0.03	BOTTOM DIMENSION
B	1.25±0.03	BOTTOM DIMENSION
D0	$1.5^{+0.1}_{-0}$	
D1	0.35±0.05	
E	1.75±0.1	
F	3.5±0.05	
P0	4.0±0.1	
P1	4.0±0.1	
P2	2.0±0.05	
T	0.2±0.05	
T2	0.75	
K0	0.45±0.05	
W	$8.0^{+0.3}_{-0.1}$	
W1	5.5	THICKNESS 0.1MAX

*Carrier tape material: PS carbon
Cover tape material: PET

【REEL DIMENSION】



SYMBOL	DIMENSION
A	ϕ $180^{+0}_{-1.5}$
B	ϕ 60^{+1}_{-0}
C	ϕ 13±0.2
D	ϕ 21±0.8
E	2±0.5
W	$9^{+0.3}_{-0}$
W2	11.4±0.1

※MATERIAL : PS carbon

【TAPING STATE】