



# 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](mailto:tstsales@mail.taisaw.com) Web: [www.taisaw.com](http://www.taisaw.com)

## Product Specifications Approval Sheet

Product Name: GPS, GLONASS, Beidou and Galileo Front-End Module

TST Parts No.: TN0089A

Customer Parts No.: \_\_\_\_\_

Company: _____
Division: _____
Approved by : _____
Date: _____

Checked by: \_\_\_\_\_ Jacky Huang *Jacky Huang*

Approval by: \_\_\_\_\_ Jacky Huang *Jacky Huang*

Date: \_\_\_\_\_ 2014/5/28

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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## GPS, GLONASS , Beidou and Galileo Front-End Module

MODEL NO.: TN0089A

REV. NO.:1

### ■ GENERAL DESCRIPTION

The TN0089A is a front-end module (FEM) designed for GNSS including GPS, GLONASS, BeiDou, and Galileo applications. The TN0089A offers low noise figure, high linearity, and high out-band rejection characteristics brought by included high performance pre- SAW filter and low noise amplifier (LNA). The TN0089A can be operated from 1.5V to 3.3V single voltage.

The TN0089A offers very small mounting area by included one SAW filter, only two external components, and very small package that is 1.5x1.1mm.

### ■ Features

- Low supply voltage 1.8/ 2.8V typ.
- Low current consumption 2.8/3.6mA typ. @VDD=1.8/ 2.8V, VCTL=1.8V  
0.1µA typ. @VDD=1.8/ 2.8V, VCTL=0V (Stand-by mode)
- High gain 15.0/15.5dB typ. @VDD=1.8/ 2.8V, VCTL=1.8V,  
f=1575MHz, 1597~1606MHz
- Low noise figure 1.55/1.50dB typ. @VDD=1.8/ 2.8V, VCTL=1.8V, f=1575MHz  
1.75/1.70dB typ. @VDD=1.8/ 2.8V, VCTL=1.8V, f=1597~1606MHz  
1.95/1.90dB typ. @VDD=1.8/ 2.8V, VCTL=1.8V, f=1559~1591MHz
- High out band rejection @VDD=1.8/ 2.8V, VCTL=1.8V,  
52dBc typ. f=704~915MHz, relative to 1575MHz  
43dBc typ. f=1710~1980MHz, relative to 1575MHz  
52dBc typ. f=2400~2500MHz, relative to 1575MHz
- Small package size : 1.5 x 1.1 x 0.5 mm<sup>3</sup>
- RoHS compliant and Halogen Free, MSL1
- RF input internally pre-matched to 50Ω, RF output internally matched to 50Ω
- Only 2 external SMD parts

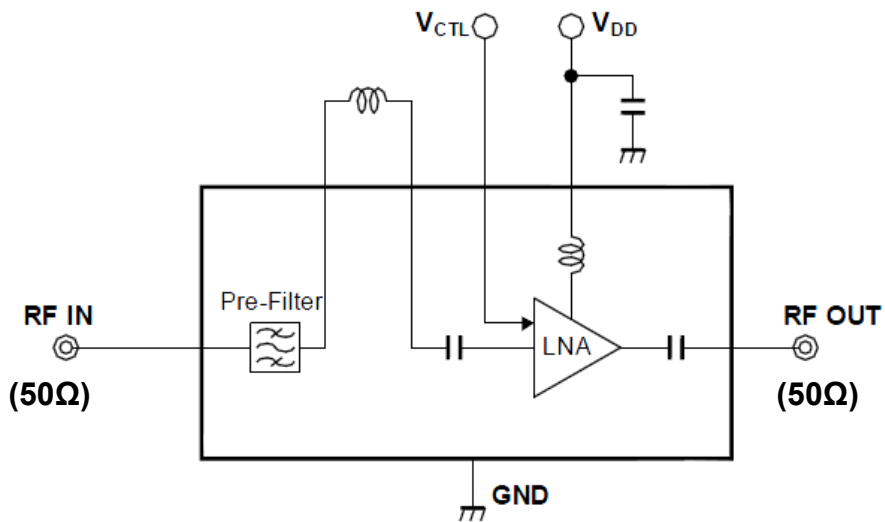


Figure 1 Functional Block diagram

■ Pin configuration

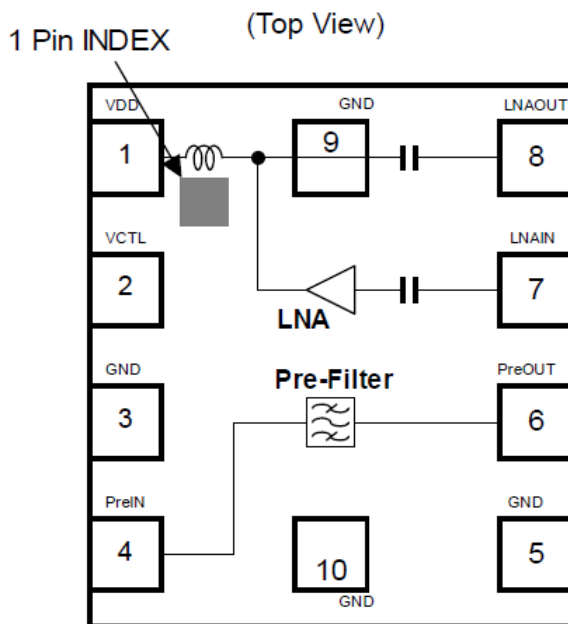


Table 1 Pin Definition and Function

Pin No.	Symbol	Function
1	VDD	Power Supply
2	VCTL	Power On/Off
3	GND	Ground
4	PreIN	RF Input
5	GND	Ground
6	PreOUT	Pre-Filter Output
7	LNAIN	LNA Input
8	LNAOUT	RF Output
9	GND	Ground
10	GND	Ground

■ Truth table

$V_{CTL}$	LNA Mode
L	Standby Mode
H	Active Mode

“L” =  $V_{CTL}(L)$   
 “H” =  $V_{CTL}(H)$

## ■ ELECTRICAL CHARACTERISTICS 1 (DC)

Ta=+25°C, Zs=ZI=50G

Parameter	Condition	Symbol	Measurement data	Units
Supply Voltage		V <sub>DD</sub>	1.8/2.8	V
Control Voltage (High)		V <sub>CTL(H)</sub>	1.8	V
Control Voltage (Low)		V <sub>CTL(L)</sub>	0	V
Operating Current (Active mode)	RF OFF, V <sub>DD</sub> =2.8V, V <sub>CTL</sub> =1.8V	I <sub>DD1</sub>	3.62	mA
	RF OFF, V <sub>DD</sub> =1.8V, V <sub>CTL</sub> =1.8V	I <sub>DD2</sub>	2.85	mA
Operating Current (Standby mode)	RF OFF, V <sub>DD</sub> =2.8V, V <sub>CTL</sub> =0V	I <sub>DD3</sub>	0.0	uA
	RF OFF, V <sub>DD</sub> =1.8V, V <sub>CTL</sub> =0V	I <sub>DD4</sub>	0.0	uA
Control Current	RF OFF, V <sub>CTL</sub> =1.8V	I <sub>CTL</sub>	6.1	uA

## ELECTRICAL CHARACTERISTICS 2 (RF)

$V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $f_{RF}=1575, 1597\sim1606, 1559\sim1591MHz$ ,  $T_a=25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$

Parameter	Condition	Symbol	Measurement data	Units
Small Signal Gain	f=1575MHz (GPS), Exclude PCB, Connector Losses	GainGPS1	16.4	dB
	f=1597~1606MHz (GLONASS), Exclude PCB, Connector Losses	GainGLN1	16.2 ~ 16.6	dB
	f=1559~1591MHz (BeiDou, Galileo), Exclude PCB, Connector Losses	GainBG1	15.8 ~ 16.5	dB
Noise Figure	f=1575MHz (GPS), Exclude PCB, Connector Losses	NFGPS1	1.52	dB
	f=1597~1606MHz (GLONASS), Exclude PCB, Connector Losses	NFGLN1	1.54 ~ 1.71	dB
	f=1559~1591MHz (BeiDou, Galileo), Exclude PCB, Connector Losses	NFBG1	1.44 ~ 1.91	dB
Input Power 1dB Compression	f=1575, 1597~1606, 1559~1591MHz	P-1dB(IN)1	-10.8 ~ -10.0	dBm
Input 3rd Order Intercept Point	f1=1575, 1597~1606, 1559~1591MHz, f2=f1+/- 1MHz, Pin=-30dBm	IIP3_1	-1.8 ~ -0.5	dBm
Out-of-Band Input Power 1dB Compression	fjam=900MHz, fmeas=1575MHz at Pin=-40dBm	P-1dB(IN)_ OB1-1	> +26.0	dBm
	fjam=1710MHz, fmeas=1575MHz at Pin=-40dBm	P-1dB(IN)_ OB2-1	> +26.0	dBm
Out-of-Band Input 2nd Order Intercept Point	f1=824.6MHz at +15dBm, f2=2400MHz at +15dBm, fmeas=1575.4MHz	IIP2_OB1	+86.8	dBm
Out-of-Band Input 3rd Order Intercept Point	f1=1712.7MHz at +15dBm, f2=1850MHz at +15dBm, fmeas=1575.4MHz	IIP3_OB1	+57.7	dBm
700MHz Harmonics	fin=787.76MHz, Pin=+15dBm, fmeas=1575.52MHz	2fo1	-36.2	dBm
Low Band Rejection	f=704~915MHz, relative to 1575MHz	BR_L1	52.7 ~ 58.2	dBc
High Band Rejection	f=1710~1980MHz, relative to 1575MHz	BR_H1	34.9 ~ 52.8	dBc
WLAN Band Rejection	f=2400~2500MHz, relative to 1575MHz	BR_W1	51.8 ~ 54.1	dBc
RF Input Port Return Loss	f=1575MHz (GPS)	RLiGPS1	14.5	dB
	f=1597~1606MHz (GLONASS)	RLiGLN1	11.4 ~ 16.2	dB
	f=1559~1591MHz (BeiDou, Galileo)	RLiBG1	8.6 ~ 20.0	dB
RF Output Port Return Loss	f=1575MHz (GPS)	RLoGPS1	14.5	dB
	f=1597~1606MHz (GLONASS)	RLoGLN1	18.5 ~ 19.2	dB
	f=1559~1591MHz (BeiDou, Galileo)	RLoBG1	12.8 ~ 17.3	dB
Group Delay Time Deviation	f=1597~1606MHz (GLONASS)	GDTGLN1	3.1	ns
	f=1559~1563.2MHz (BeiDou)	GDTB1	2.6	ns
	f=1559~1591MHz (Galileo)	GDTG1	8.2	ns

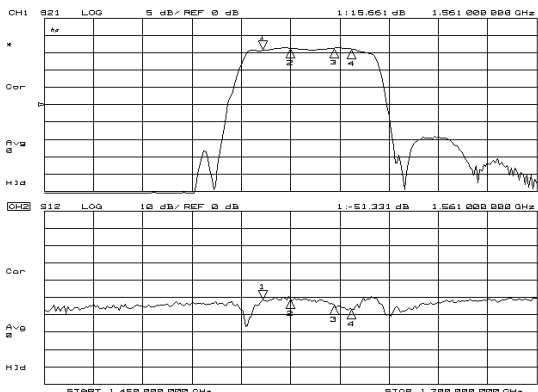
### ■ ELECTRICAL CHARACTERISTICS 3 (RF):

$V_{DD}=1.8V$ ,  $V_{CTL}=1.8V$ ,  $f_{rf}=1575, 1597\sim1606, 1559\sim1591MHz$ ,  $MHz$ ,  $T_a=25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$

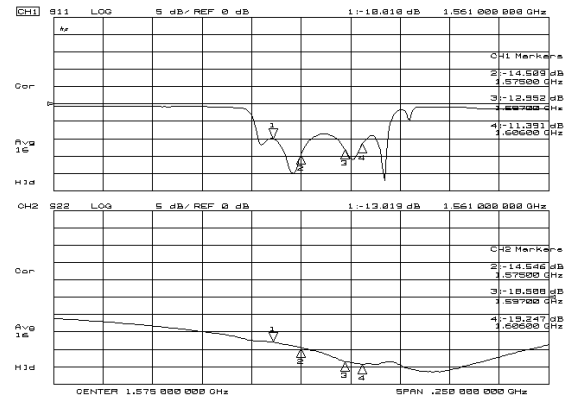
Parameter	Condition	Symbol	Measurement data	Units
Small Signal Gain	f=1575MHz (GPS), Exclude PCB, Connector Losses	Gain1	15.8	dB
	f=1597~1606MHz (GLONASS), Exclude PCB, Connector Losses	Gain2	15.4 ~ 16.0	dB
	f=1559~1591MHz (BeiDou, Galileo), Exclude PCB, Connector Losses	Gain3	15.3 ~ 16.0	dB
Noise Figure	f=1575MHz (GPS), Exclude PCB, Connector Losses	NF1	1.54	dB
	f=1597~1606MHz (GLONASS), Exclude PCB, Connector Losses	NF2	1.57 ~ 1.75	dB
	f=1559~1591MHz (BeiDou, Galileo), Exclude PCB, Connector Losses	NF3	1.47 ~ 1.93	dB
Input Power 1dB Compression	f=1575, 1597~1606, 1559~1591MHz	P-1dB(IN)	-13.5 ~ -12.8	dBm
Input 3rd Order Intercept Point	f1=1575, 1597~1606, 1559~1591MHz, f2=f1+/- 1MHz, Pin=-30dBm	IIP3	-4.3 ~ -3.6	dBm
Out-of-Band Input Power 1dB Compression	fjam=900MHz, fmeas=1575MHz at Pin=-40dBm	P-1dB(IN)_OB1	> +26.0	dBm
	fjam=1710MHz, fmeas=1575MHz at Pin=-40dBm	P-1dB(IN)_OB2	+25.3	dBm
Out-of-Band Input 2nd Order Intercept Point	f1=824.6MHz at +15dBm, f2=2400MHz at +15dBm, fmeas=1575.4MHz	IIP2_OB	+85.2	dBm
Out-of-Band Input 3rd Order Intercept Point	f1=1712.7MHz at +15dBm, f2=1850MHz at +15dBm, fmeas=1575.4MHz	IIP3_OB	+55.8	dBm
700MHz Harmonics	fin=787.76MHz, Pin=+15dBm, fmeas=1575.52MHz	2fo	-35.1	dBm
Low Band Rejection	f=704~915MHz, relative to 1575MHz	BR_L	52.7 ~ 58.2	dBc
High Band Rejection	f=1710~1980MHz, relative to 1575MHz	BR_H	35.3 ~ 52.8	dBc
WLAN Band Rejection	f=2400~2500MHz, relative to 1575MHz	BR_W	52.3 ~ 54.5	dBc
RF Input Port Return Loss	f=1575MHz (GPS)	RLi1	14.5	dB
	f=1597~1606MHz (GLONASS)	RLi2	11.0 ~ 16.5	dB
	f=1559~1591MHz (BeiDou, Galileo)	RLi3	9.2 ~ 24.9	dB
RF Output Port Return Loss	f=1575MHz (GPS)	RLo1	16.5	dB
	f=1597~1606MHz (GLONASS)	RLo2	18.3 ~ 19.4	dB
	f=1559~1591MHz (BeiDou, Galileo)	RLo3	14.8 ~ 19.1	dB
Group Delay Time Deviation	f=1597~1606MHz (GLONASS)	GDT1	2.8	ns
	f=1559~1563.2MHz (BeiDou)	GDT2	2.8	ns
	f=1559~1591MHz (Galileo)	GDT3	8.6	ns

# Typical characteristics

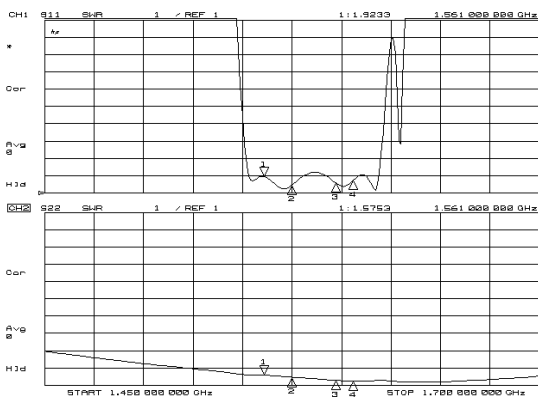
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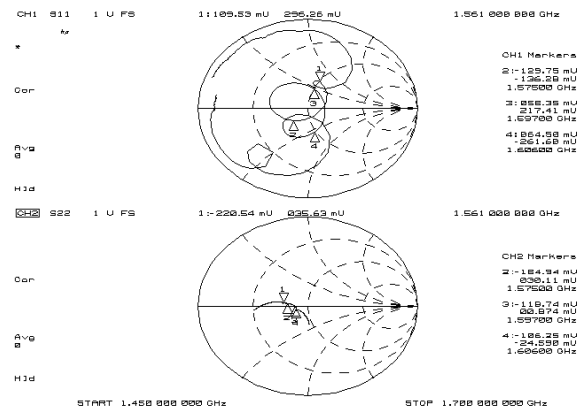
S21, S12 (f=1450~1700MHz)



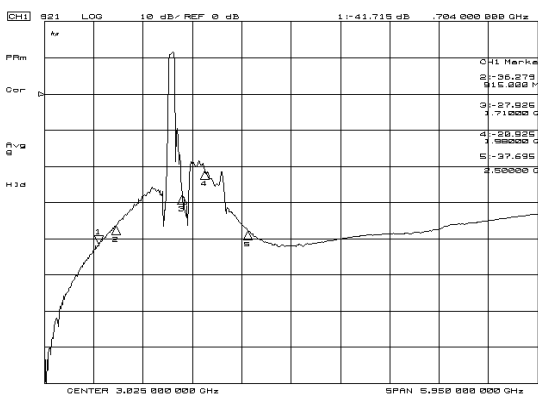
S11, S22 (f=1450~1700MHz)



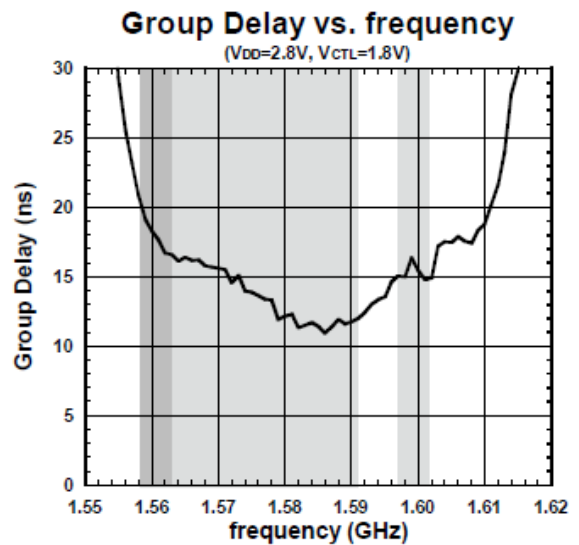
VSWR (f=1450~1700MHz)



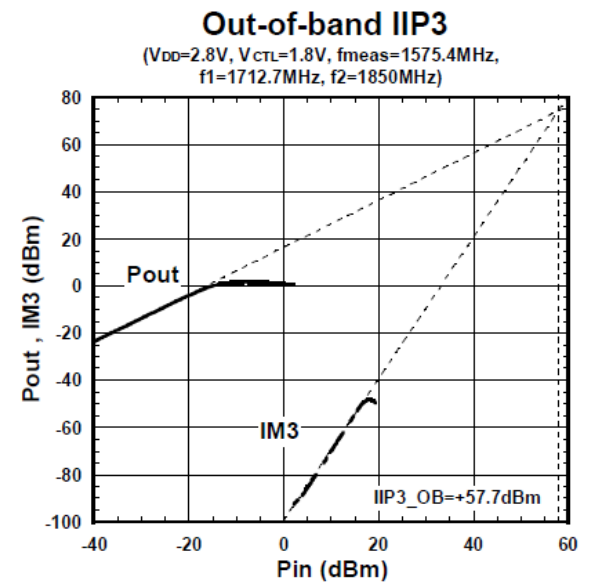
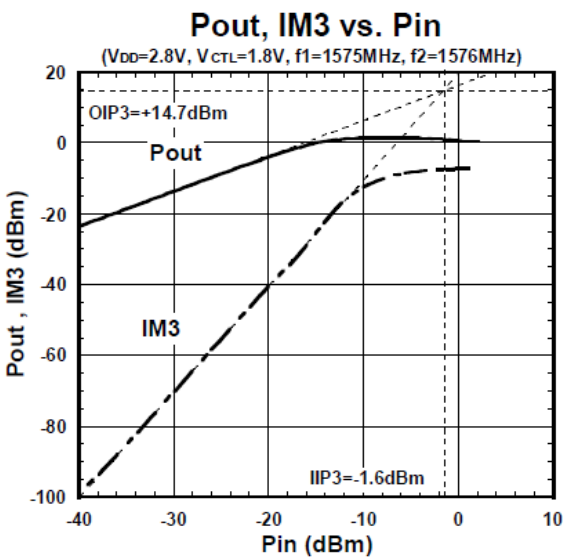
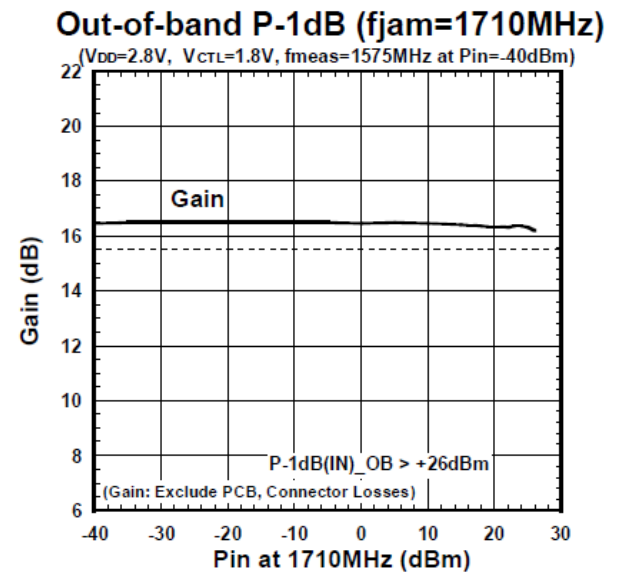
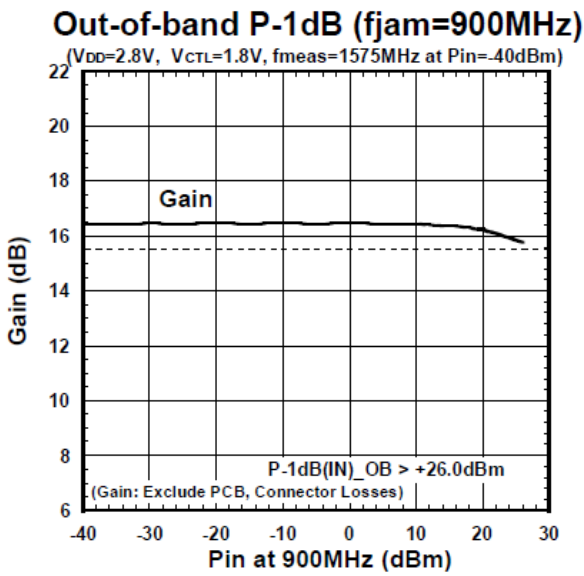
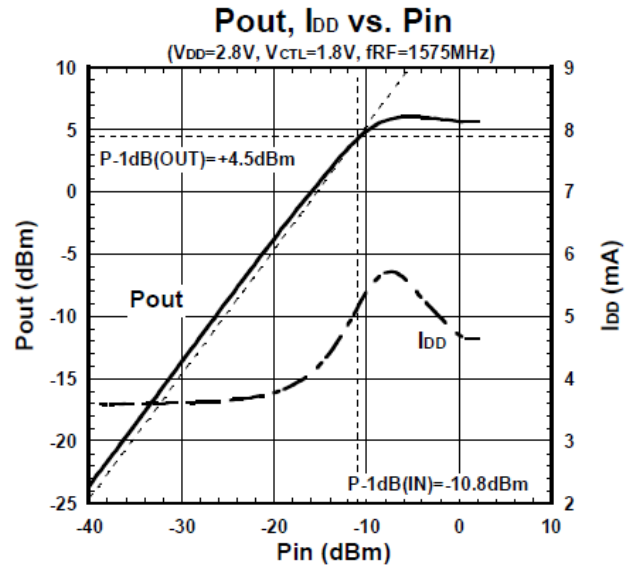
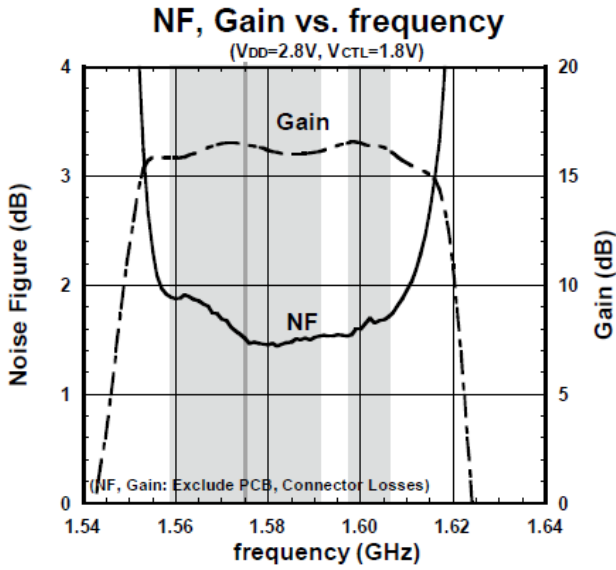
Zin, Zout (f=1450~1700MHz)



Out-of-band attenuation (f=50M~6GHz)



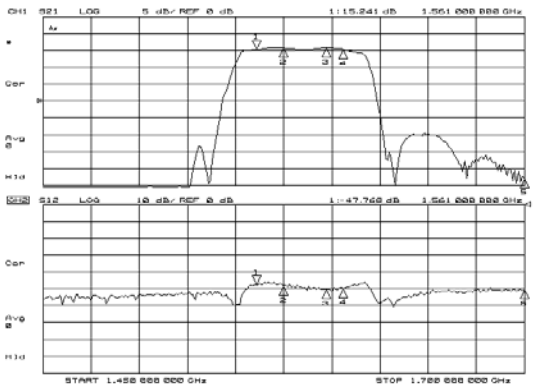
## ■ Typical characteristics



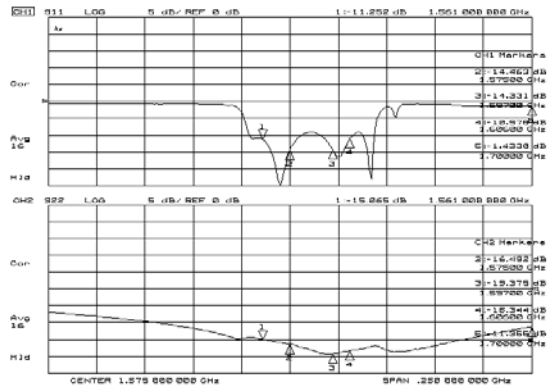


# Typical characteristics

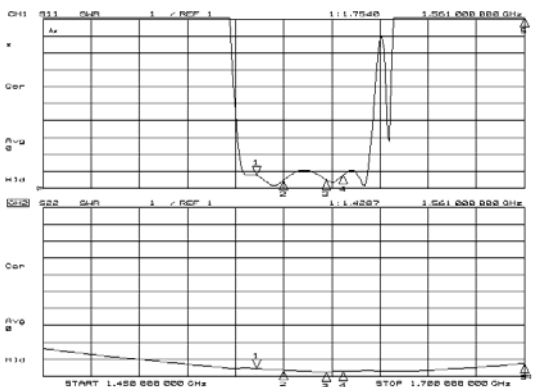
Condition: VDD=1.8V, VCTL=1.8V, Ta=+25°C, Zs=Zl=50Ω



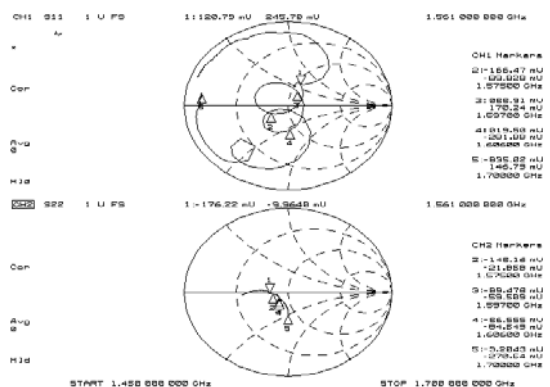
S21, S12 (f=1450~1700MHz)



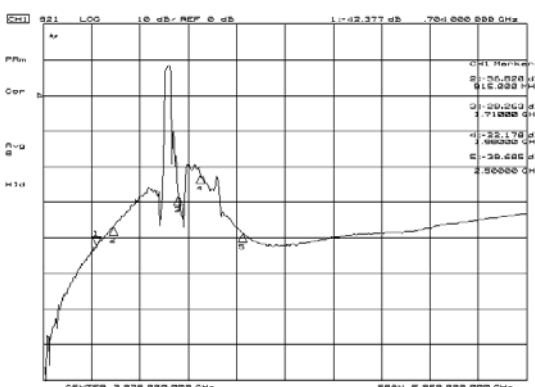
S11, S22 (f=1450~1700MHz)



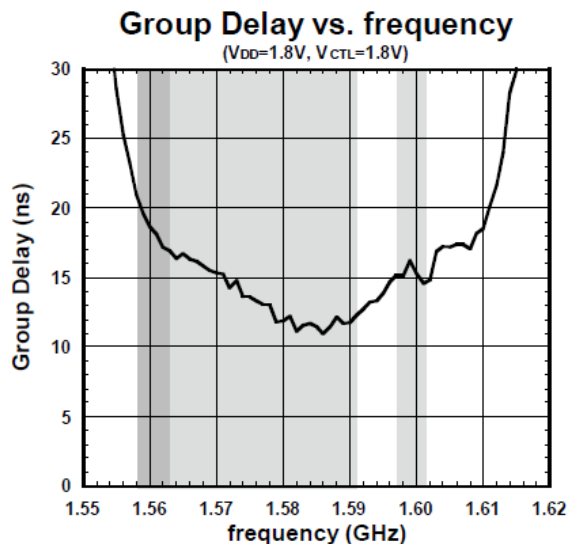
VSWR (f=1450~1700MHz)



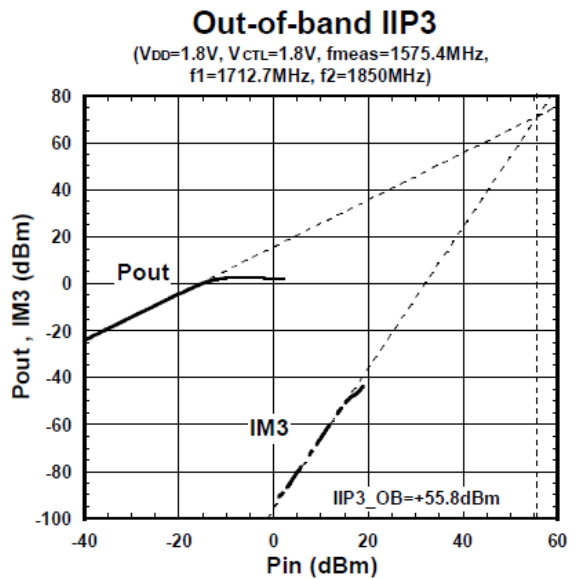
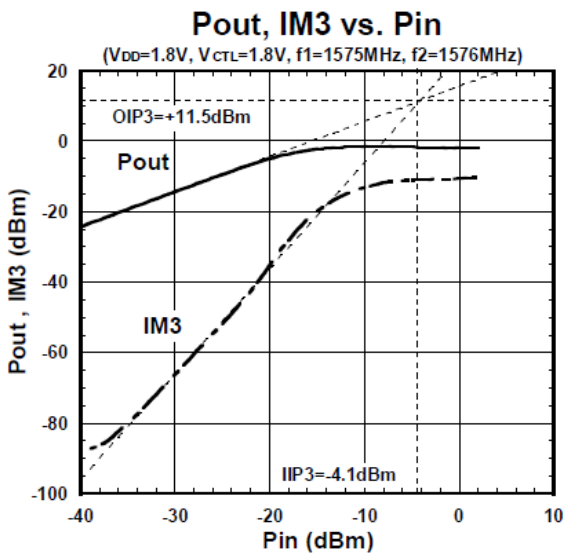
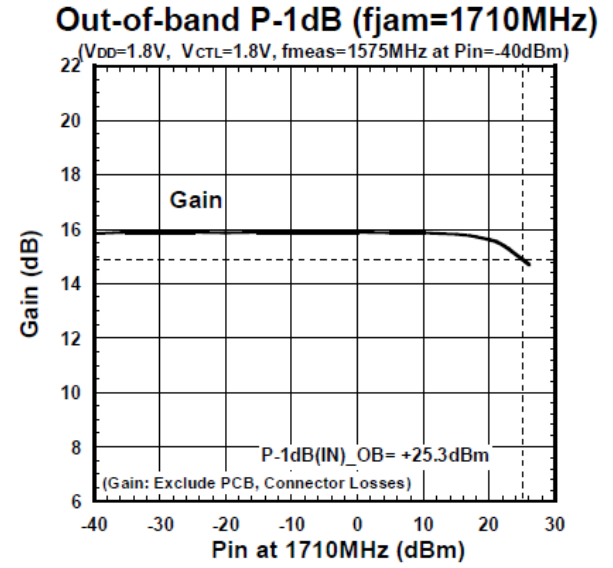
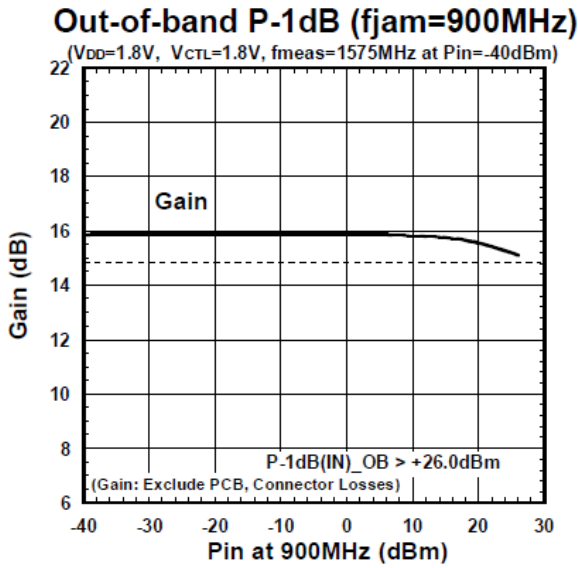
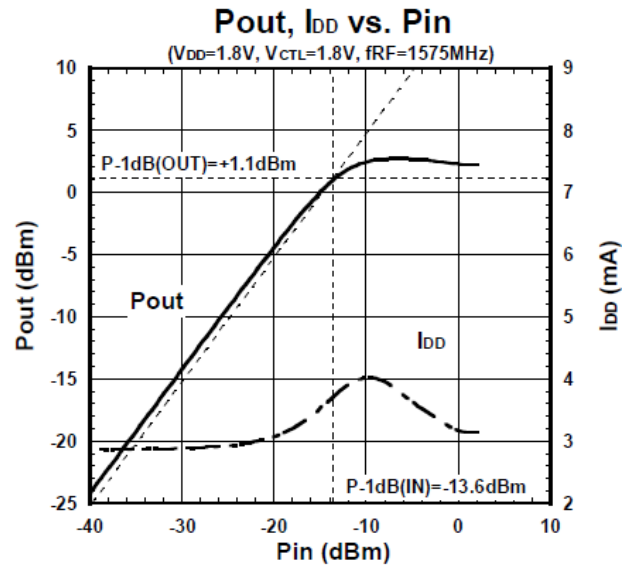
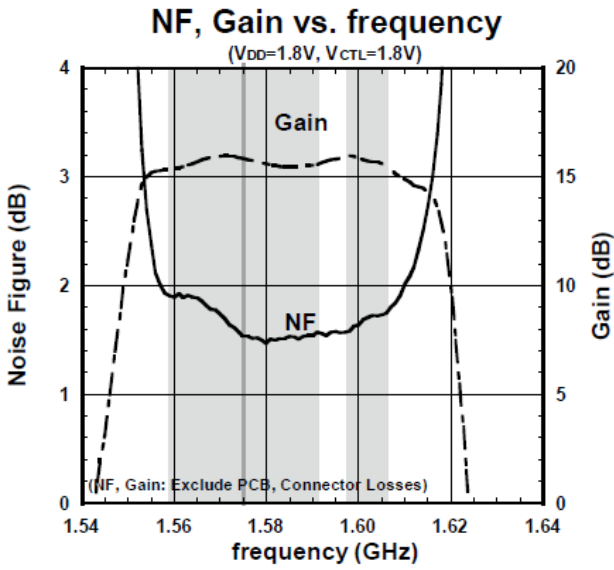
Zin, Zout (f=1450~1700MHz)



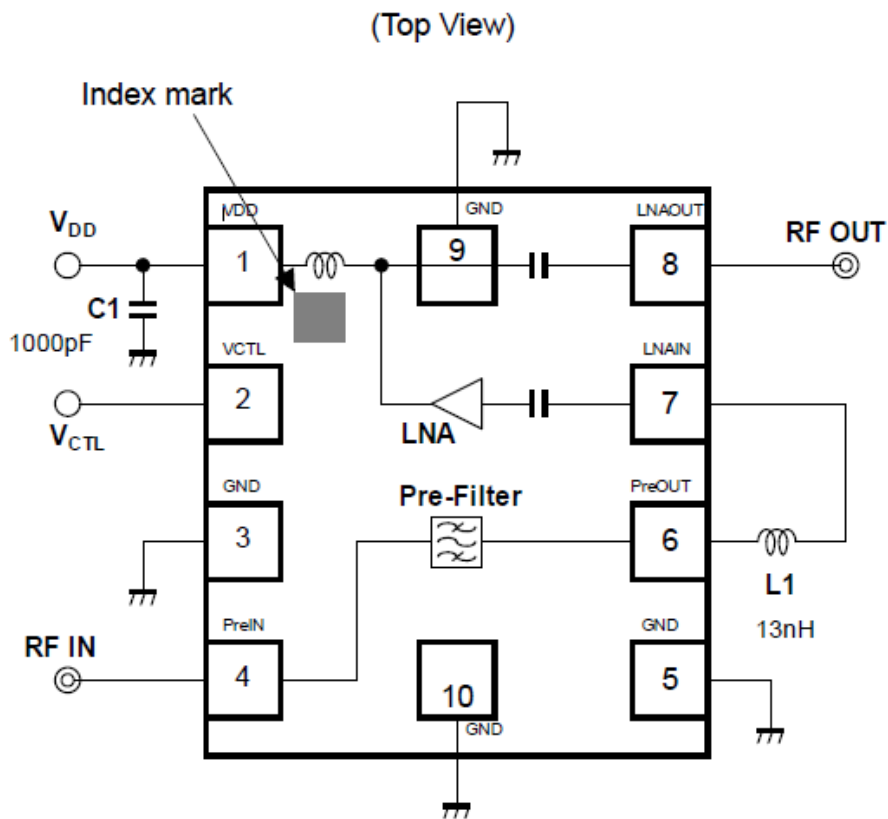
Out-of-band attenuation (f=50M~6GHz)



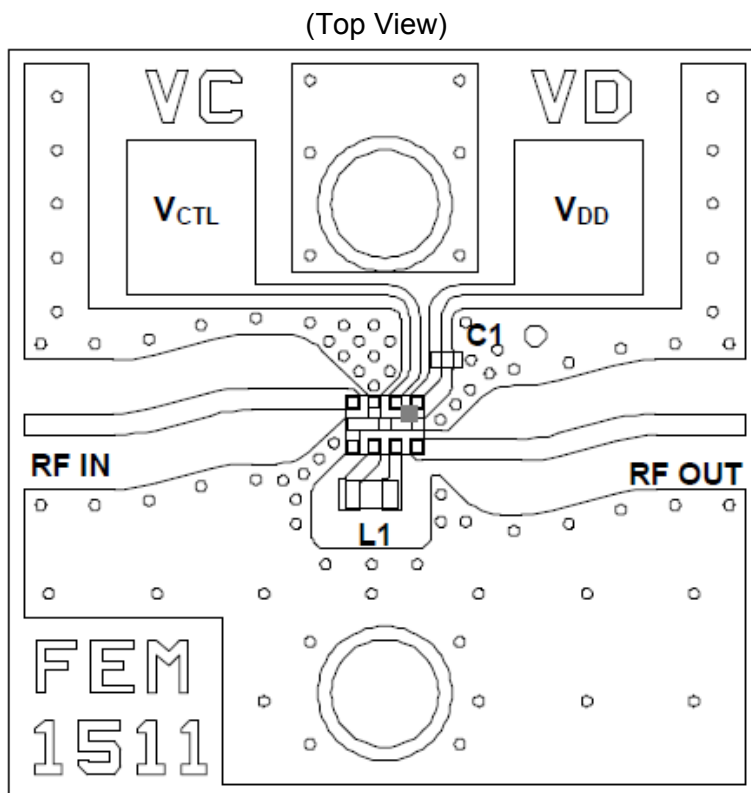
■ Typical characteristics



## Application circuit



## Evaluation board



### Parts list

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

### PCB

Substrate: FR-4

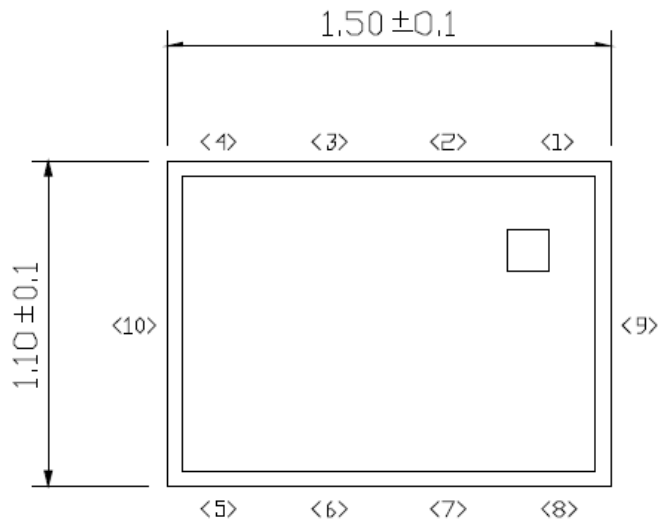
Thickness: 0.2mm

Microstrip line width: 0.4mm  
( $Z_0=50\ \Omega$ )

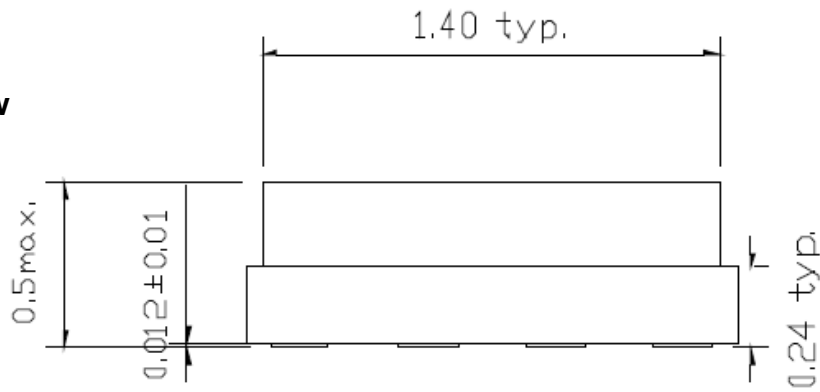
Size: 14.0mm x 14.0mm

■ **OUTLINE DRAWING**

**Top View**



**Side View**



**Bottom View**

