L1 Band, Satellite Navigation, RF Front-end Low-noise Amplifier Chip

PRODUCT DESCRIPTION

The MS2659 is a low-noise amplifier (LNA) with high gain and low noise figure, supporting for multi-mode global satellite positioning in L1 band. The MS2659 can be applied to GNSS navigation receivers like GPS, BD2, GALILEO and GLONASS. The MS2659 is available in SOT23-6 package.

SOT23-6

FEATURES

- Supporting for BD, GPS, GALILEO and GLONASS Satellite Navigation Systems in L1 Frequency Band
- Typical Noise Figure: 0.86dB
- Typical Power Gain: 17.3dB
- Typical Input P1dB: -13dBm
- Operating Frequency: 1550MHz ~ 1615MHz
- Current Consumption: 4.4mA
- Wide Power Supply: 1.5V ~ 3.5V
- ESD(HBM): 2kV
- Integrated 50Ω Output Matching Circuit
- Simple External Circuit
- Operating Temperature Range: -40°C ~ 120°C
- Storage Temperature Range: -40°C ~ 150°C

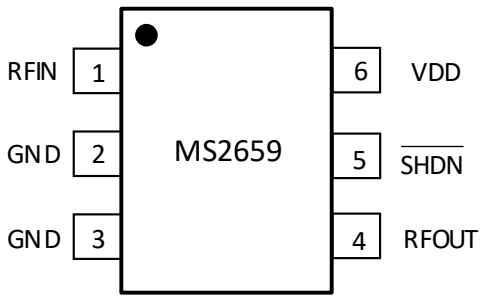
APPLICATIONS

- Automatic Navigation
- Location Mobile Device
- Personal Navigation Device
- Phone with GPS
- Notebook/PAD
- Underwater Navigation
- Aviation Device

PRODUCT SPECIFICATION

Part Number	Package	Marking
MS2659	SOT23-6	2659

PIN CONFIGURATION



PIN DESCRIPTION

Pin	Name	Type	Description
1	RFIN	I	RF Input
2,3	GND	-	Ground
4	RFOUT	O	RF Output
5	$\overline{\text{SHDN}}$	I	Operation (High-level), Sleep (Low-level)
6	VDD	-	Power Supply

ABSOLUTE MAXIMUM RATINGS

Any exceeding absolute maximum rating application causes permanent damage to device. Because long-time absolute operation state affects device reliability. Absolute ratings just conclude from a series of extreme tests. It doesn't represent chip can operate normally in these extreme conditions.

Parameter	Symbol	Ratings	Unit
VDD to GND		-0.3 ~ 5.0	V
RFIN to GND		-0.3 ~ 2.0	V
RFOUT to GND		-0.3 ~ 5.0	V
$\overline{SHDN}$ to GND		-0.3 ~ 5.0	V
RF Input Power	P_{IN}	+20	dBM
Operating Temperature Range	T_{opr}	-40 ~ +120	°C
Lead Temperature(10s)		+260	°C

ELECTRICAL CHARACTERISTICS

DC Electrical Characteristics

At room temperature

Parameter	Condition	Min	Typ	Max	Unit
Power Supply		1.5	2.85	3.6	V
Power Supply Current	$\overline{SHDN}$ =1, VDD=2.85V	3.4	4.3	5.1	mA
	$\overline{SHDN}$ =1, VDD=1.5V	3.3	4.2	5.0	mA
	$\overline{SHDN}$ =1, VDD=3.4V	3.6	4.5	5.4	mA
	$\overline{SHDN}$ =0	0.03	0.54	1	μA
Digital Input Logic High Level		1.2			V
Digital Input Logic Low Level				0.5	V
RFIN DC Bias Voltage	$\overline{SHDN}$ =1	0.80	0.87	0.90	V

Note: Under normal conditions, the chip is in the unconditional stabilization condition from -40°C to +120°C. If there is no additional AC signal, DC operating current does not exceed the maximum operating value. If this happens, it is necessary to check S parameter to ensure whether the module is in unstable state.

AC Electrical Characteristics 1

1575.42MHz center frequency, 2.85V power supply

Parameter	Typ				Unit
Operating Frequency	1575.42				MHz
Input Matching Inductor L1	2.7	3.3	5.6	Transmission Line[3]	nH
Power Gain	17.3	17.5	17.6	17.6	dB
Noise Figure[1]	0.86	0.91	1.08	0.91	dB
Input Return Loss	11.5	13.7	21.1	16.0	dB
Output Return Loss	13.2	14	16.1	20.4	dB
Reverse Isolation	28	28	29	29	dB
Input IP3[2]	-4	-5.5	-5.8	-4.8	dBm
Input P1dB	-13	-14.5	-14.8	-13.7	dBm

Note:

1. Measured value (including PCB, SMA and other board-level access loss).
2. Adopt two signals with -2MHz and 2MHz deviating from center frequency (1575.42MHz) respectively.
3. The specific geometric parameters of the transmission line refer to PCB description.

AC Electrical Characteristics 2

1561.098MHz center frequency, 2.85V power supply

Parameter	Typ				Unit
Operating Frequency	1561.098				MHz
Input Matching Inductor L1	2.7	3.3	5.6	Transmission Line[3]	nH
Power Gain	17.2	17.4	17.5	17.5	dB
Noise Figure[1]	0.88	0.92	1.01	0.92	dB
Input Return Loss	11.5	13.5	21.7	15.8	dB
Output Return Loss	14.0	14.9	17.8	22.7	dB
Reverse Isolation	28	28	29	29	dB
Input IP3[2]	-4.8	-5.6	-6	-4.8	dBm
Input P1dB	-13.8	-14.6	-15.0	-13.8	dBm

Note:

1. Measured value (including PCB, SMA and other board-level access loss).
2. Adopt two signals with -2MHz and 2MHz deviating from center frequency (1561.098MHz) respectively.
3. The specific geometric parameters of the transmission line refer to PCB description.

AC Electrical Characteristics 3

1602MHz center frequency, 2.85V power supply

Parameter	Typ				Unit
Operating Frequency	1602				MHz
Input Matching Inductor L1	2.7	3.3	5.6	Transmission Line[3]	nH
Power Gain	17.4	17.6	17.6	17.7	dB
Noise Figure[1]	0.89	0.94	1.1	0.91	dB
Input Return Loss	11.8	14.3	20.4	16.9	dB
Output Return Loss	11.9	12.4	14.3	16.4	dB
Reverse Isolation	28	28	29	29	dB
Input IP3[2]	-4.8	-5.6	-6	-4.3	dBm
Input P1dB	-13.8	-14.6	-15.0	-13.3	dBm

Note:

1. Measured value (including PCB, SMA and other board-level access loss).
2. Adopt two signals with -2MHz and 2MHz deviating from center frequency (1602MHz) respectively.
3. The specific geometric parameters of the transmission line refer to PCB description.

S Parameter, Stability Factor k and Mensuration b

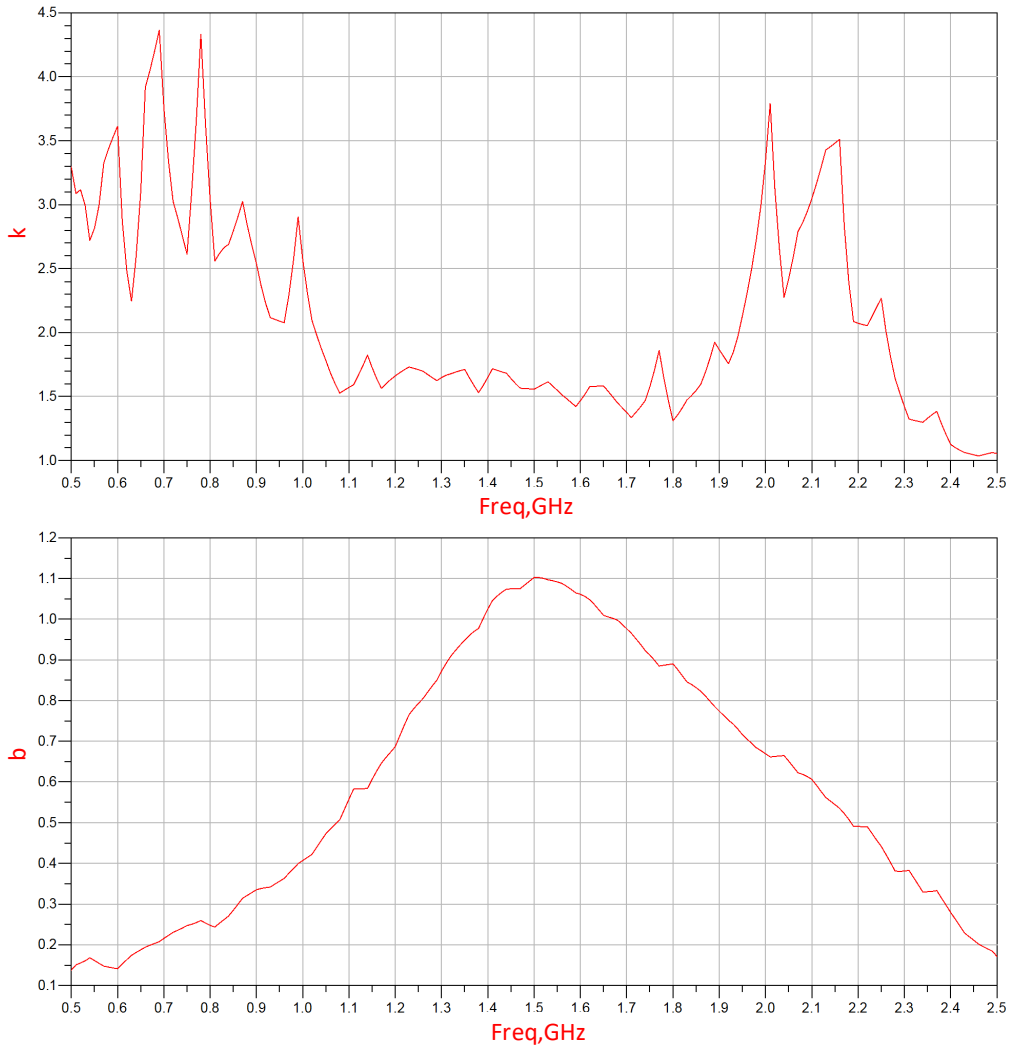
Sufficient conditions for the amplifier to stabilize: k>1; b>0

In L1 band and three navigation modes, the amplifier satisfies unconditional stabilization conditions.

The following table shows the stability factor k and mensuration b according to the measured S parameter and ADS software when the operating frequency is between 500MHz and 2500MHz and there is no match.

Frequency	k	b	Frequency	k	b
500.0 MHz	3.293	0.138	1.580 GHz	1.453	1.073
600.0 MHz	3.612	0.141	1.590 GHz	1.422	1.064
700.0 MHz	3.762	0.216	1.600 GHz	1.468	1.061
800.0 MHz	3.042	0.248	1.610 GHz	1.519	1.055
900.0 MHz	2.54	0.335	1.620 GHz	1.577	1.048
1.000 GHz	2.573	0.407	1.630 GHz	1.579	1.036
1.100 GHz	1.572	0.558	1.640 GHz	1.581	1.023
1.200 GHz	1.661	0.687	1.650 GHz	1.583	1.009
1.300 GHz	1.648	0.872	1.700 GHz	1.375	0.976
1.400 GHz	1.65	1.025	1.800 GHz	1.31	0.89
1.500 GHz	1.557	1.102	1.900 GHz	1.866	0.774
1.510 GHz	1.577	1.102	2.000 GHz	3.341	0.669
1.520 GHz	1.596	1.1	2.100 GHz	3.046	0.607
1.530 GHz	1.615	1.097	2.200 GHz	2.072	0.49
1.540 GHz	1.582	1.094	2.300 GHz	1.422	0.381
1.550 GHz	1.548	1.091	2.400 GHz	1.126	0.28
1.560 GHz	1.514	1.088	2.500 GHz	1.054	0.171
1.570 GHz	1.484	1.081			

The following figure shows the stability factor k and mensuration b according to the measured S parameter and ADS software when the operating frequency is between 500MHz and 2500MHz and there is no match,



TYPICAL CHARACTERISTICS CURVE

Typical operating conditions: evaluation board test, 25°C temperature, 3V power supply, input center frequency signal, unless otherwise noted.

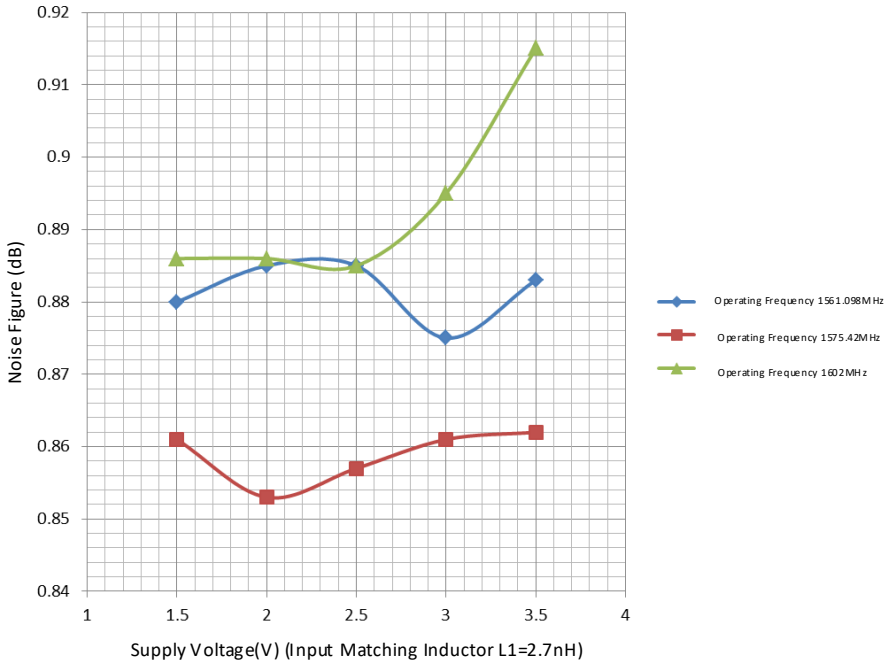


Figure 1. Noise Figure VS. Power Supply

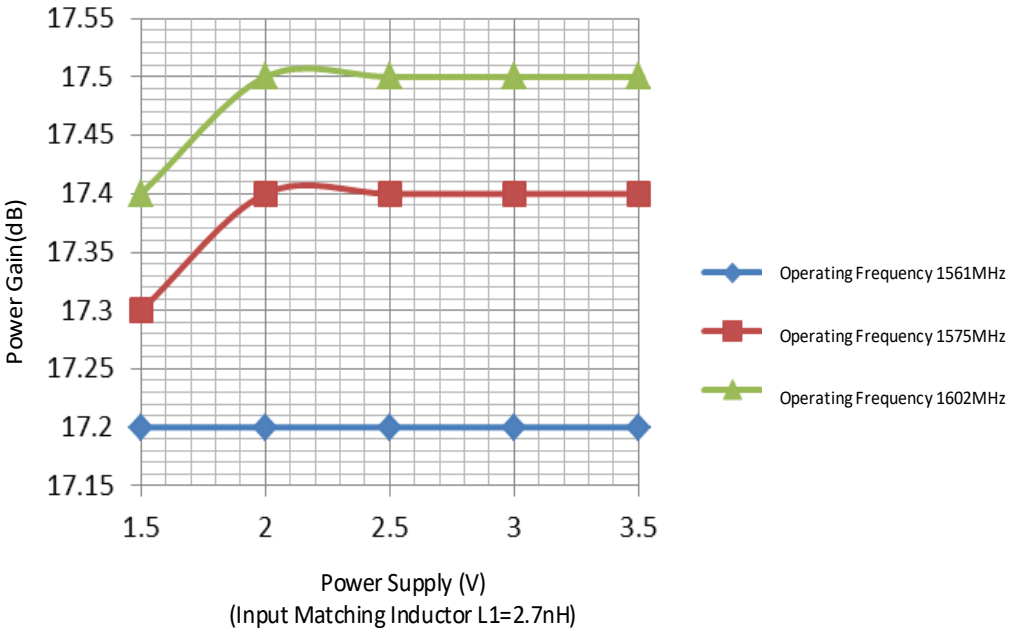


Figure 2. Power Gain VS. Power Supply

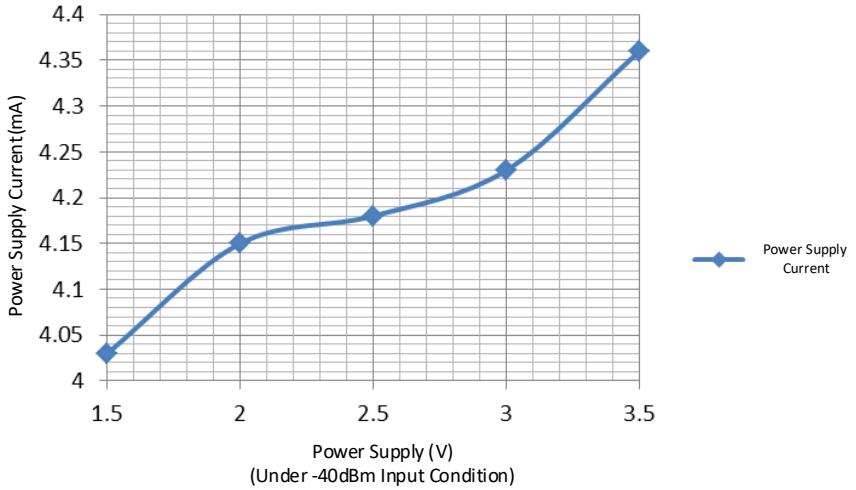


Figure 3. Supply Current VS. Supply Voltage

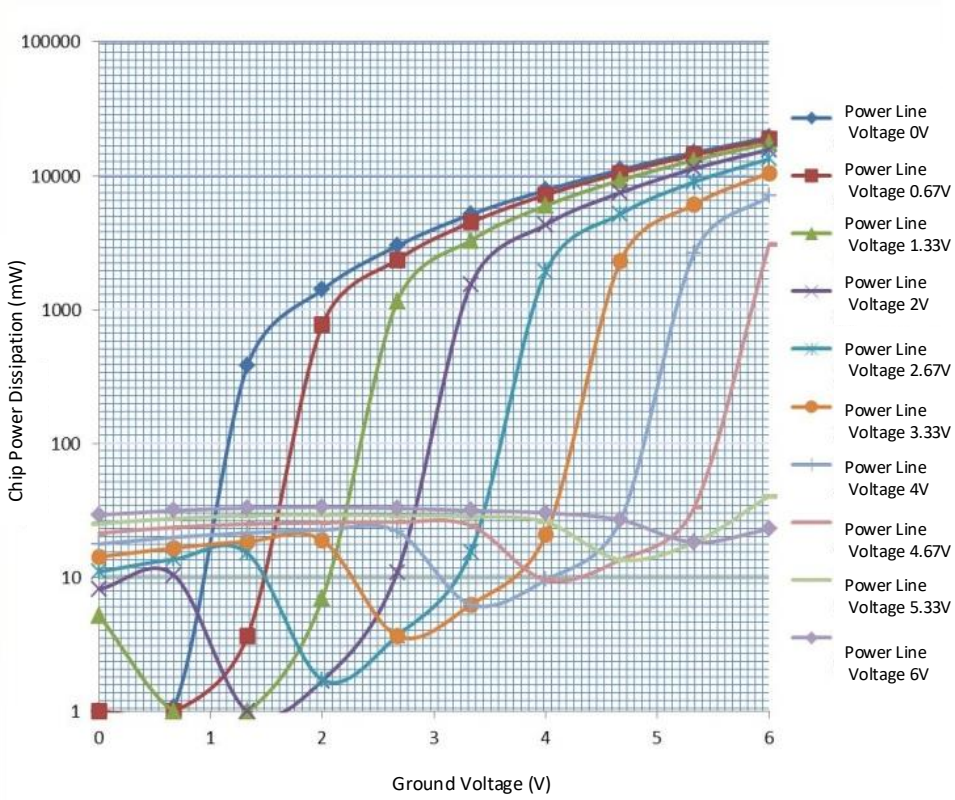


Figure 4. The Curve of Relationship between Chip Power Dissipation, Ground Voltage and Power Line Voltage (It can be seen that the ground connection needs to be good)

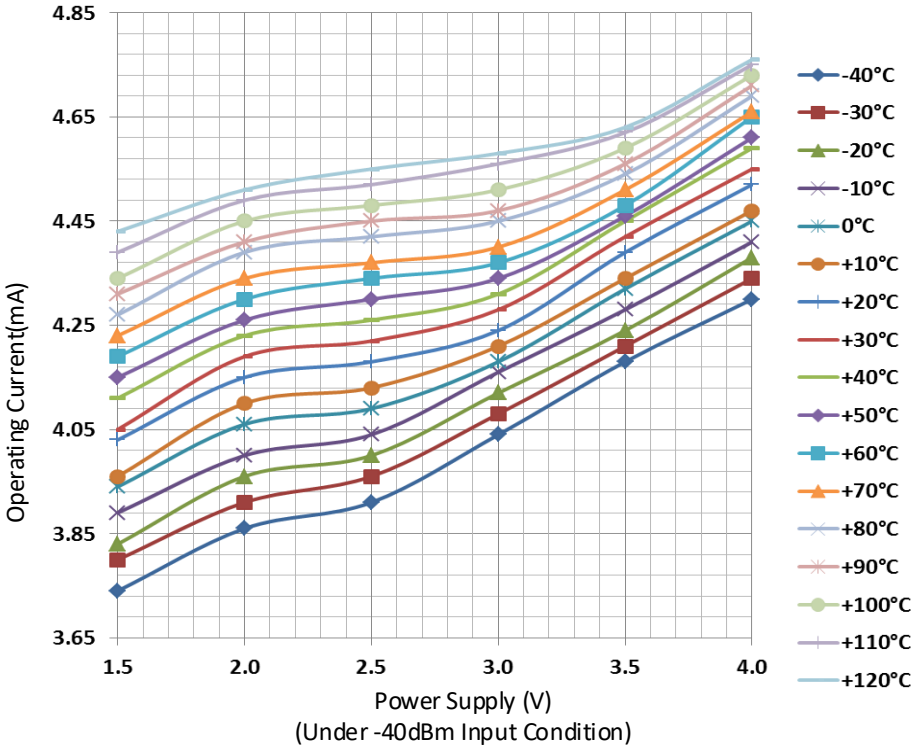


Figure 5.Operating Current VS. Power Supply at Different Ambient Temperatures

Input Matching Inductance: 5.6nH, Operating Frequency: 1561.098MHz, BD2 mode

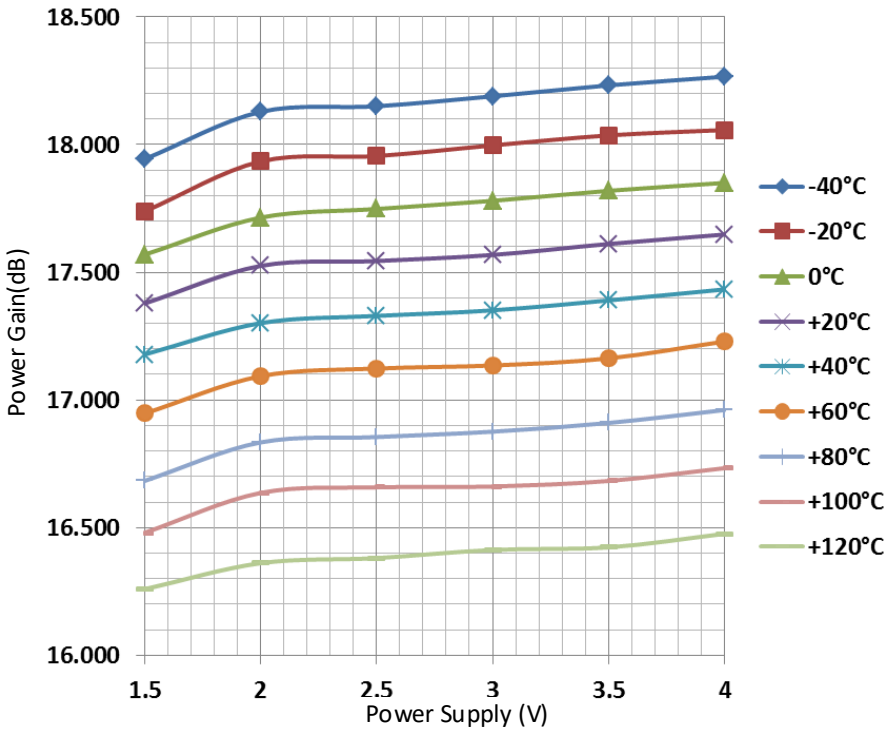


Figure 6. The Curve of Relationship between Power Gain, Power Supply and Temperatures (BD Mode)

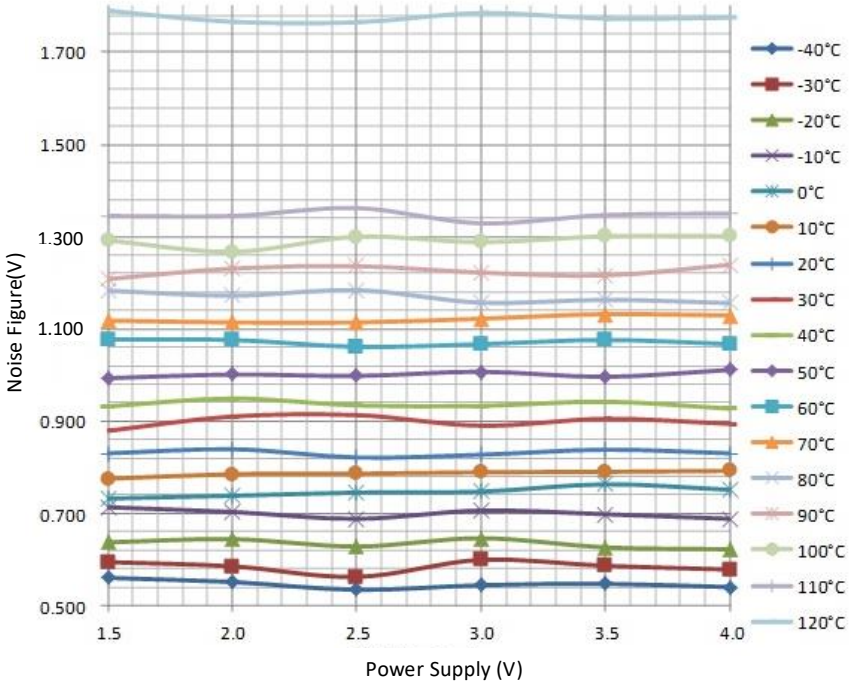


Figure 7. The Curve of Relationship between Noise Figure, Power Supply and Temperatures (BD Mode)

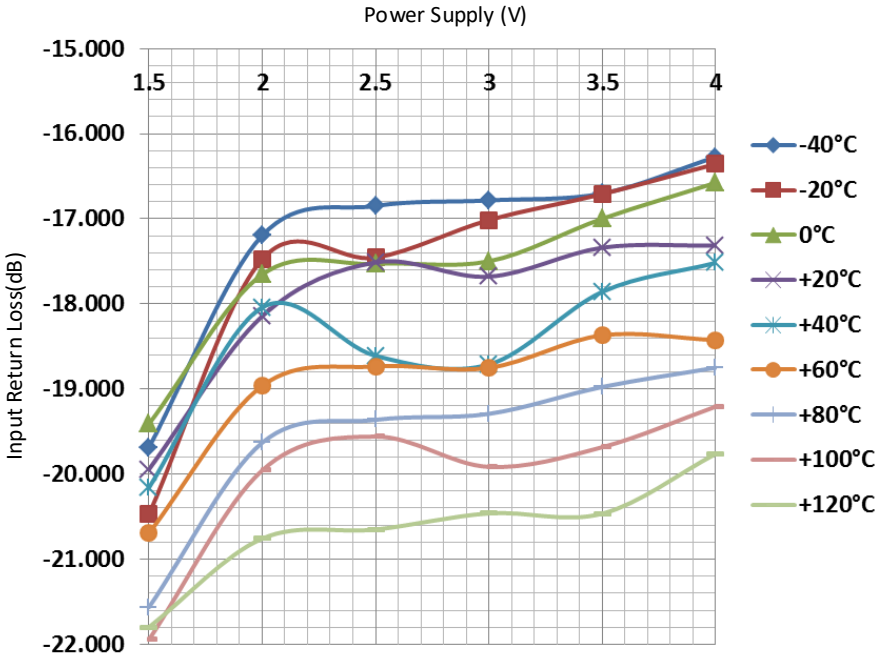


Figure 8. The Curve of Relationship between Input Return Loss, Power Supply and Temperatures (BD Mode)

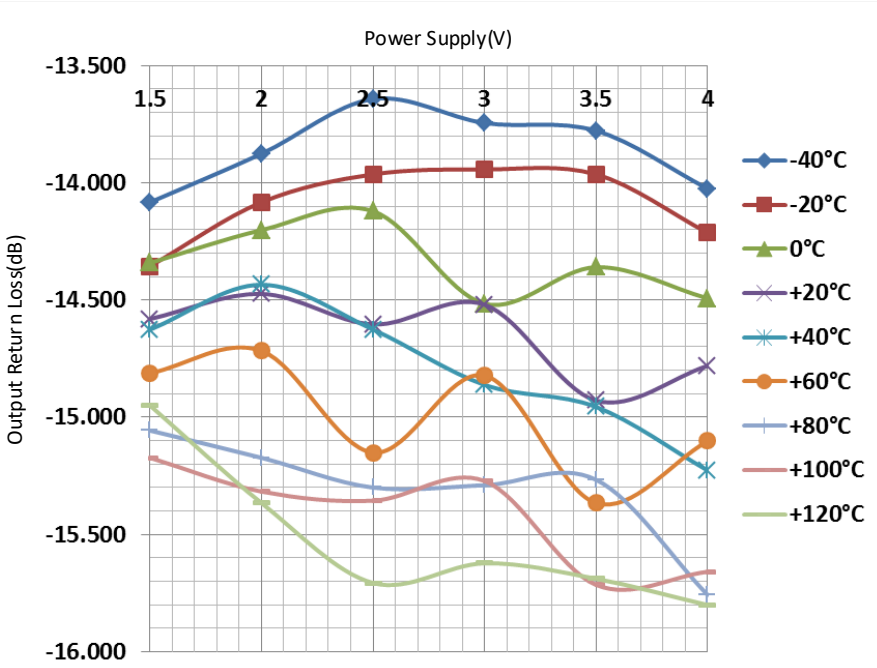


Figure 9. The Curve of Relationship between Output Return Loss, Power Supply and Temperatures (BD Mode)

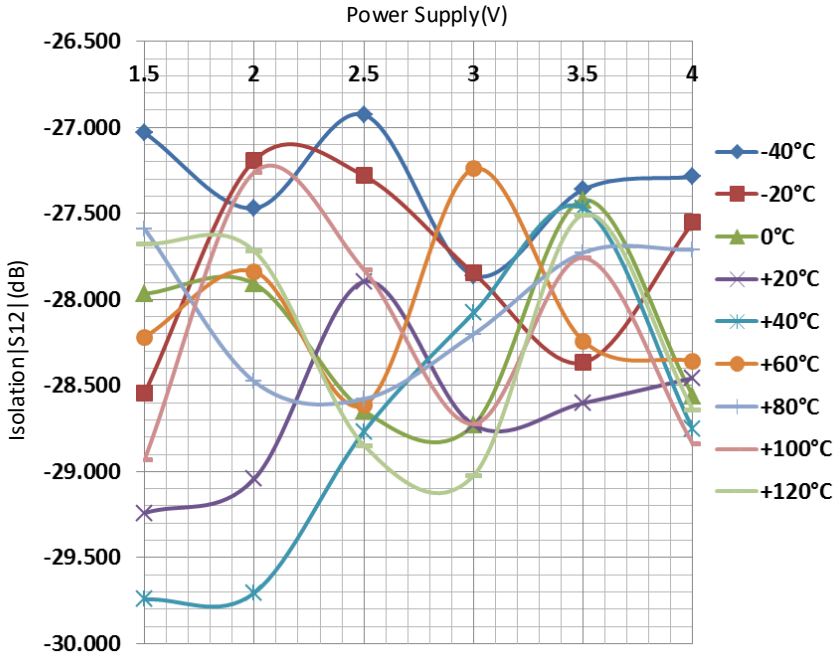


Figure 10. The Curve of Relationship between Isolation|S12|, Power Supply and Temperatures (BD Mode)

Operating Frequency: 1575.42MHz, GPS Mode

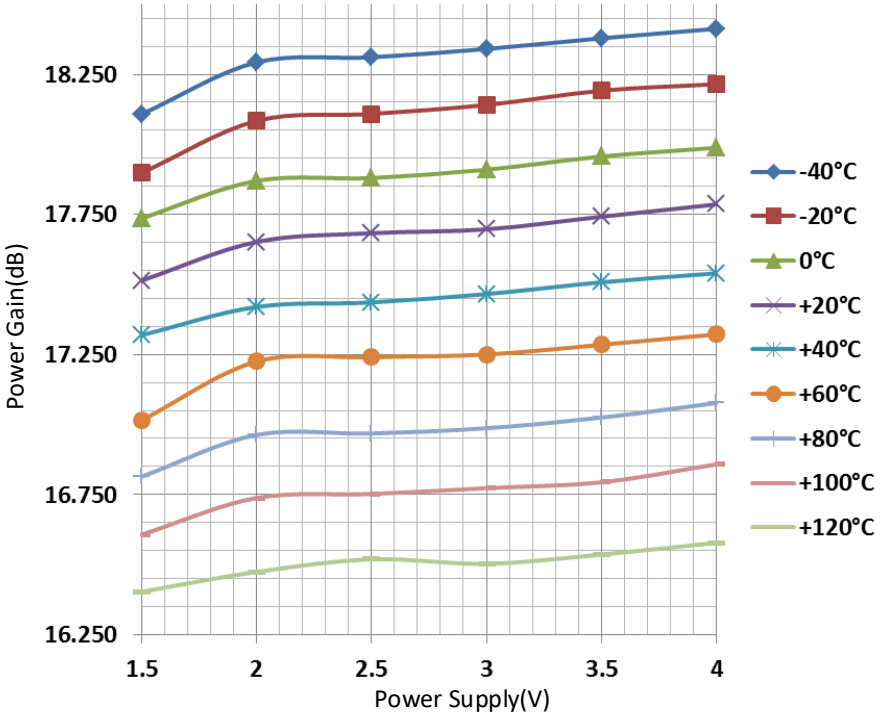


Figure 11. The Curve of Relationship between Power Gain, Power Supply and Temperatures (GPS Mode)

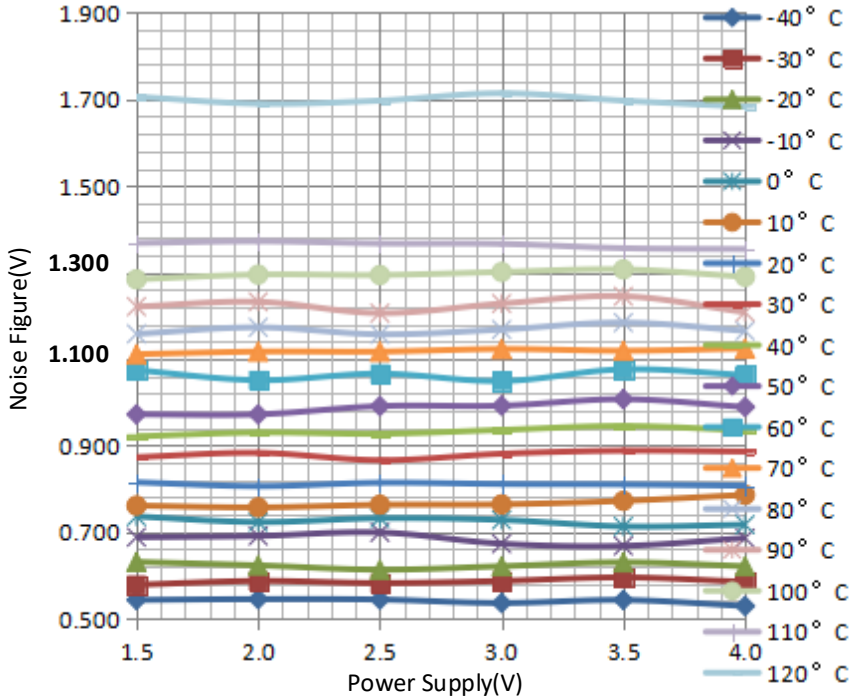


Figure 12. The Curve of Relationship between Noise Figure, Power Supply and Temperatures (GPS Mode)

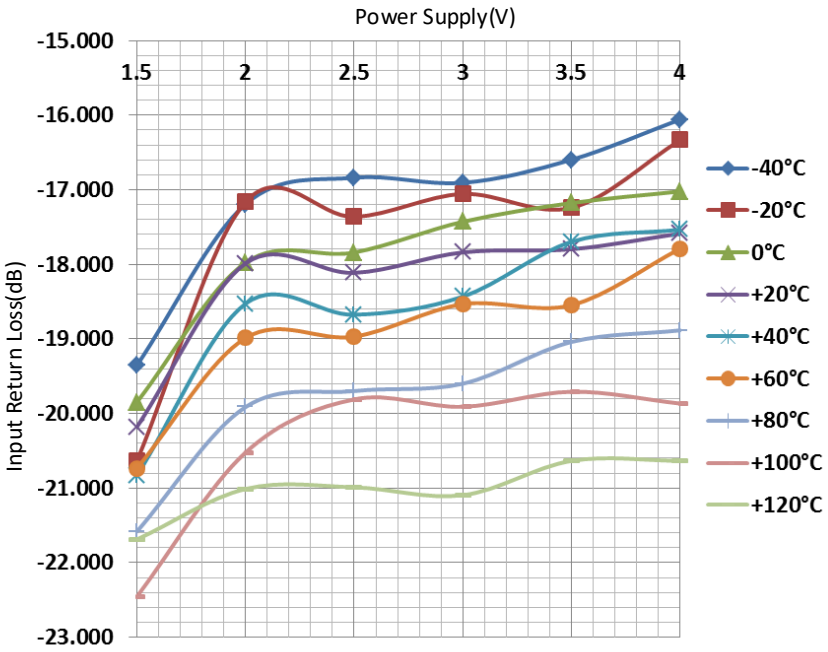


Figure 13. The Curve of Relationship between Input Return Loss, Power Supply and Temperatures (GPS Mode)

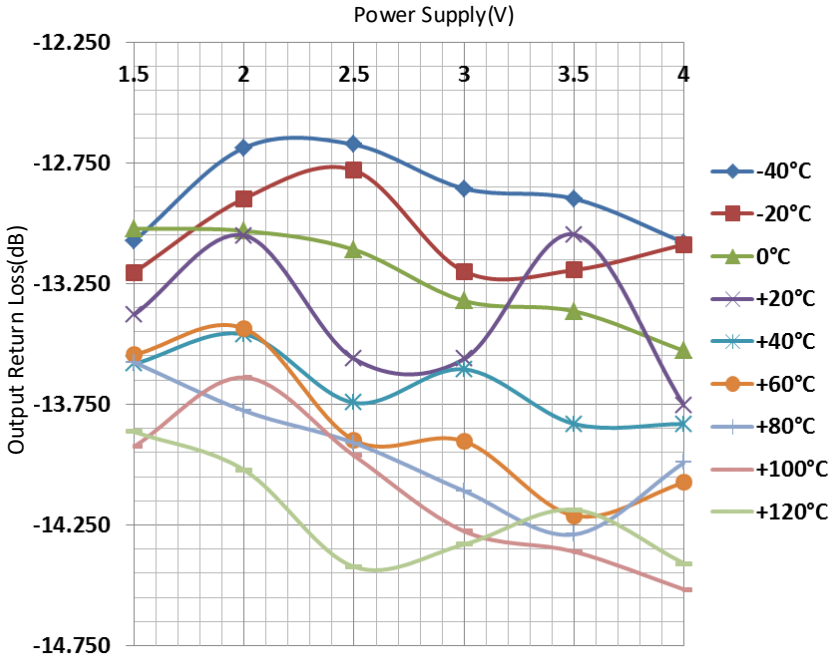


Figure 14. The Curve of Relationship between Output Return Loss, Power Supply and Temperatures (GPS Mode)

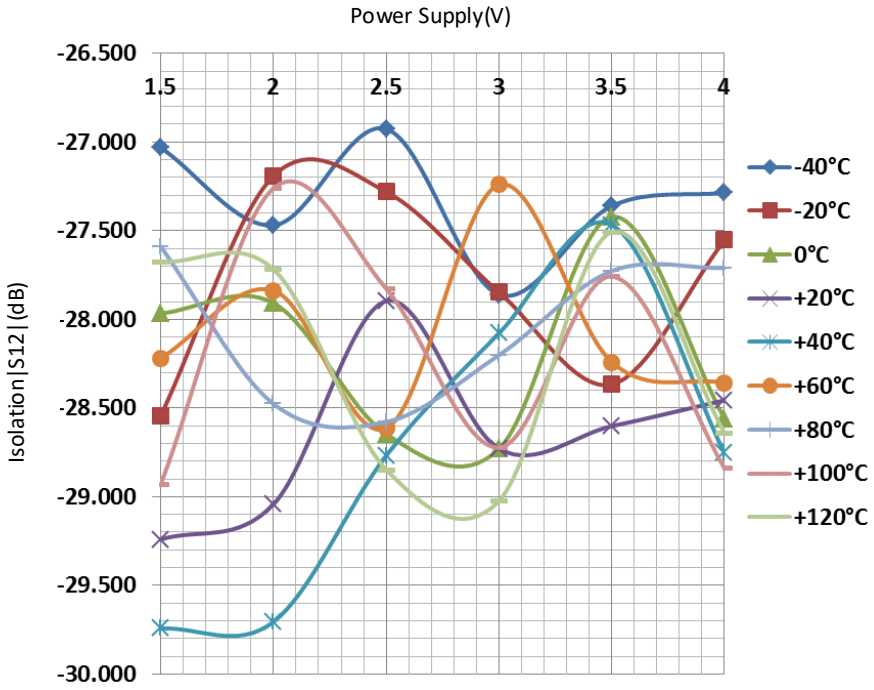


Figure 15. The Curve of Relationship between Isolation|S12|, Power Supply and Temperatures (GPS Mode)

Operating Frequency: 1602MHz, Glonass Mode

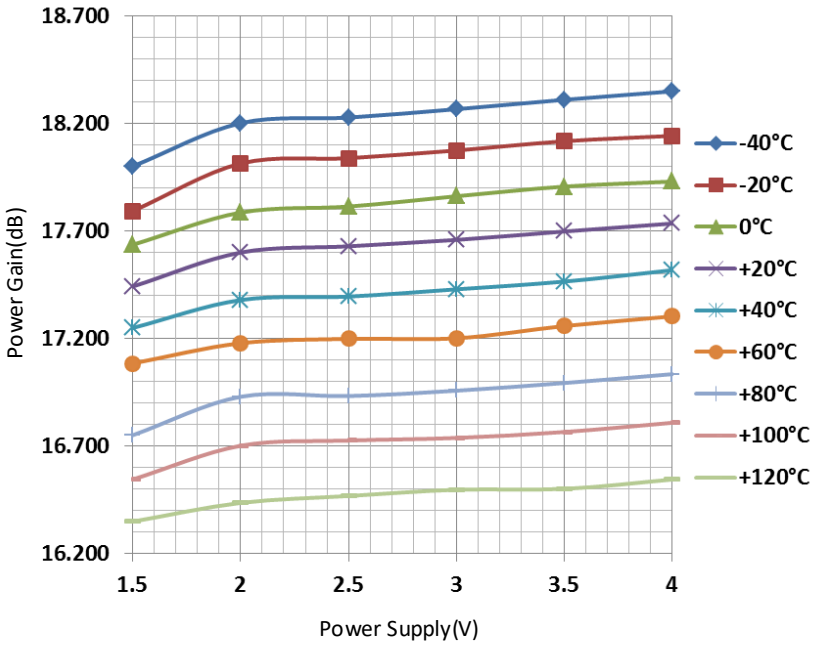


Figure 16. The Curve of Relationship between Power Gain, Power Supply and Temperatures (Glonass Mode)

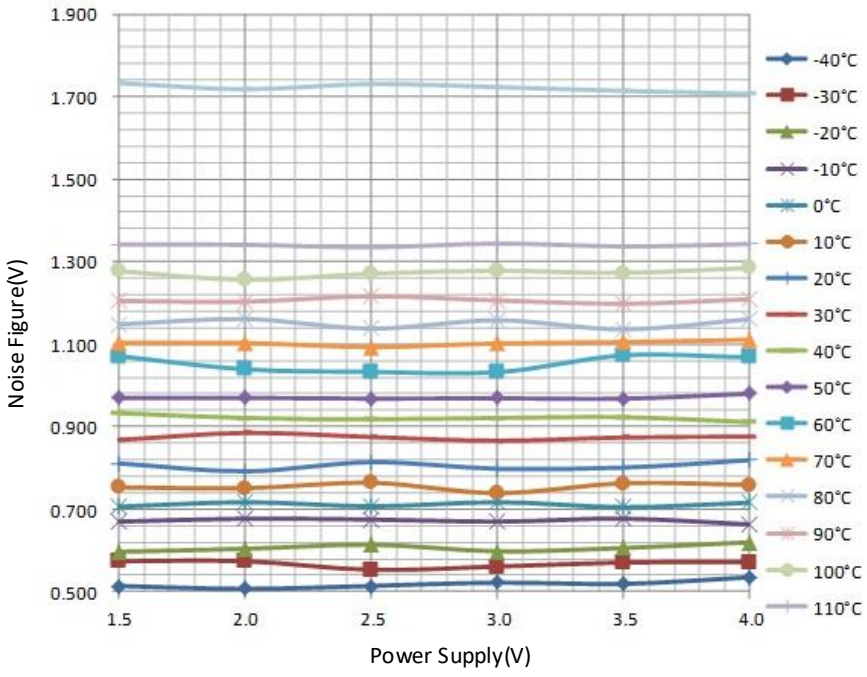


Figure 17. The Curve of Relationship between Noise Figure, Power Supply and Temperatures (Glonass Mode)

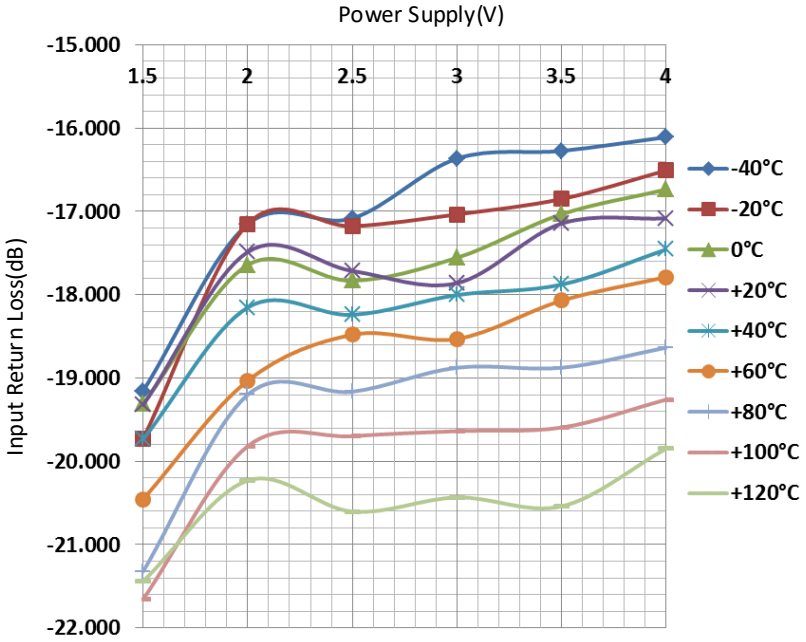


Figure 18. The Curve of Relationship between Input Return Loss, Power Supply and Temperatures (Glonass Mode)

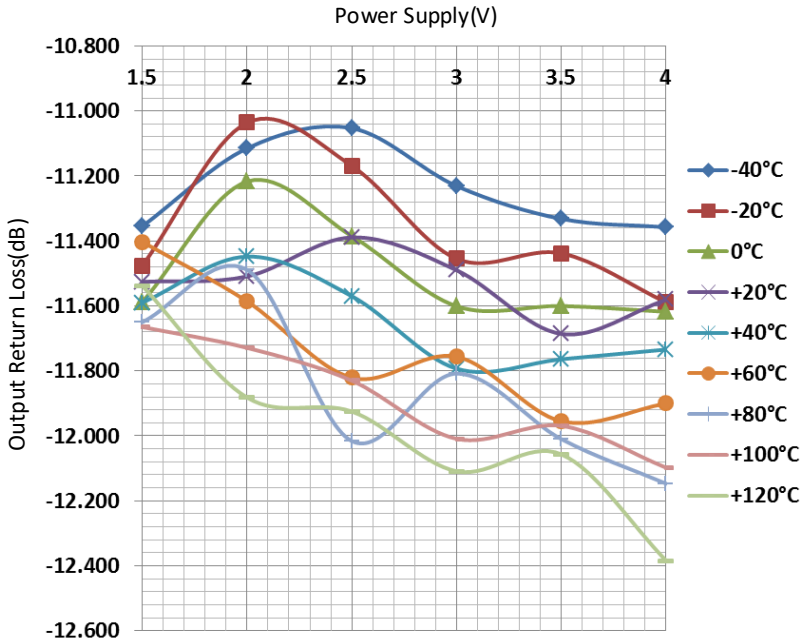


Figure 19. The Curve of Relationship between Output Return Loss, Power Supply and Temperatures (Glonass Mode)

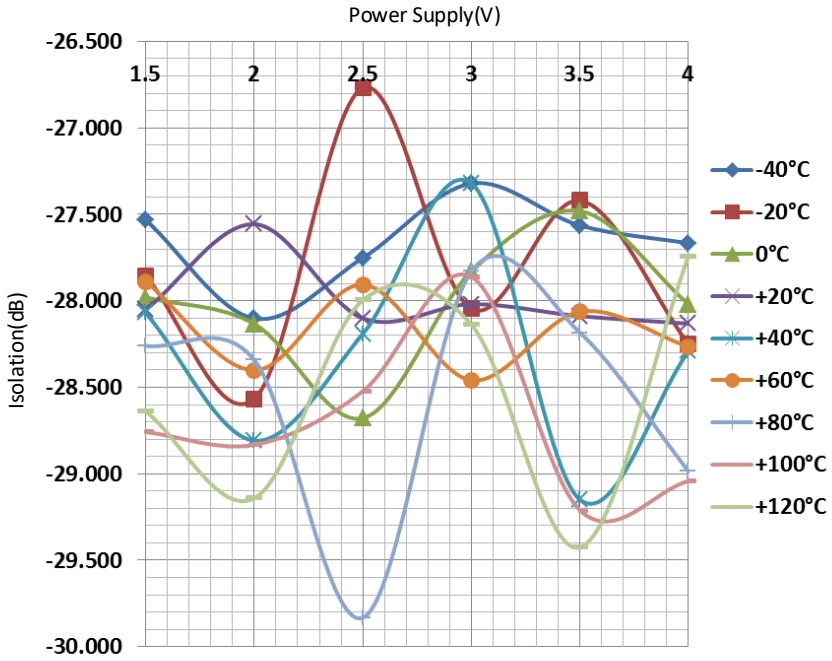
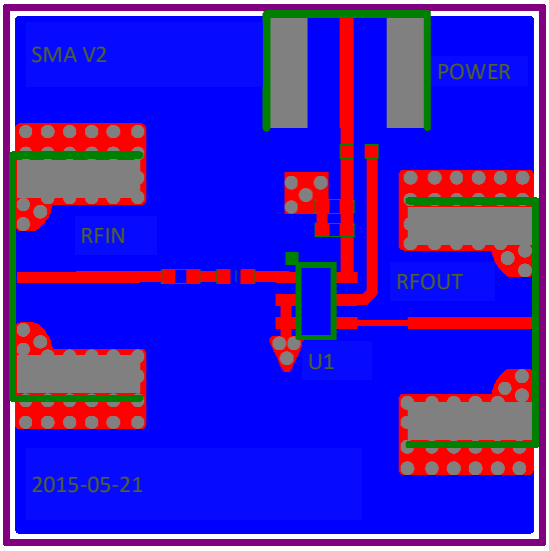


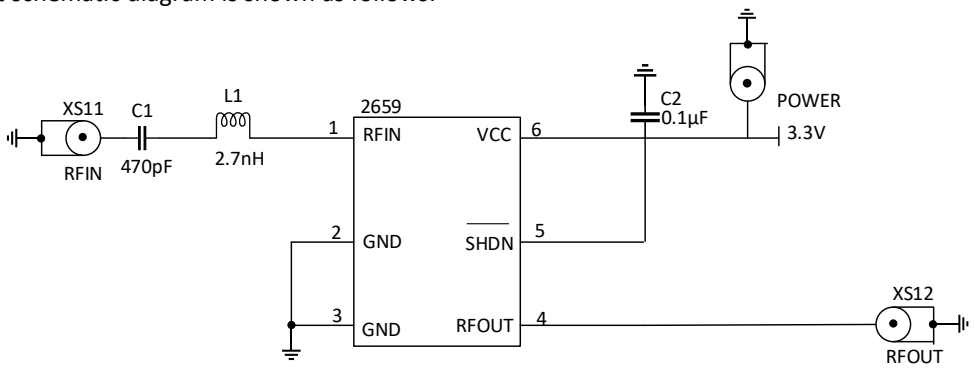
Figure 20. The Curve of Relationship between Isolation|S12|, Power Supply and Temperatures (Glonass Mode)

EVALUATION TEST BOARD PCBA DESCRIPTION

The evaluation test board of the MS2659 adopts two-layer board made of FR4 material. The thickness is 0.8mm, the average thickness of copper surface of circuit board is 30μm and the area is 22×22mm^2. As shown in the figure below, U1 is the test chip MS2659, C1 is the input DC blocking capacitor, L1 is the input matching inductor and C2, C3 are power bypass capacitors (optional). Input terminal RFIN and output terminal RFOUT are accessed with SMA.



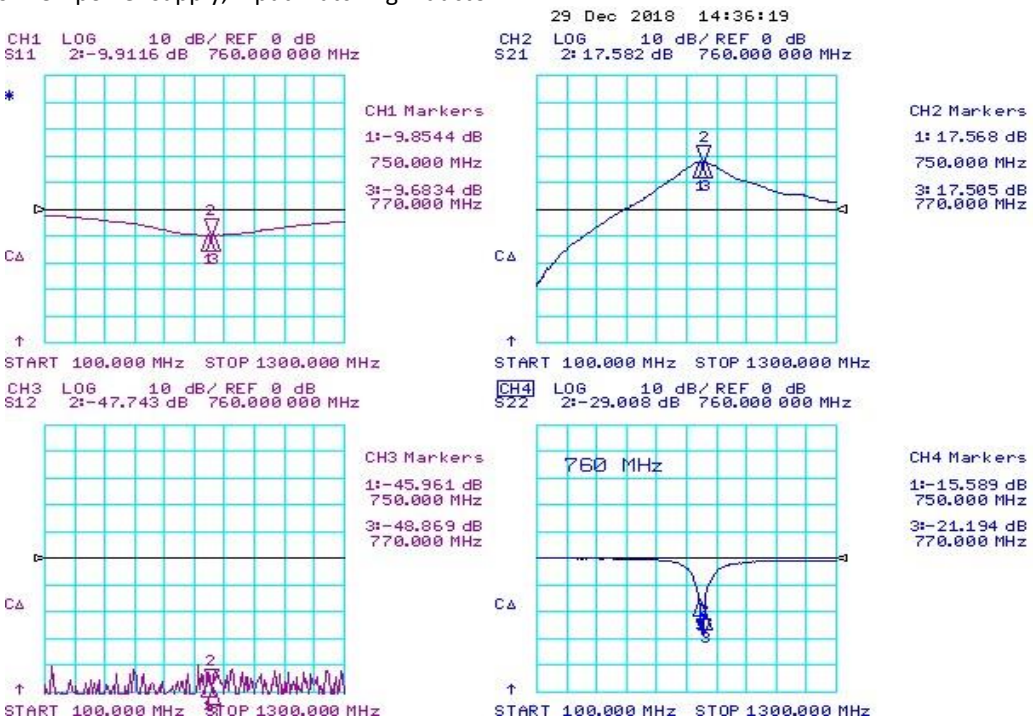
The circuit schematic diagram is shown as follows:



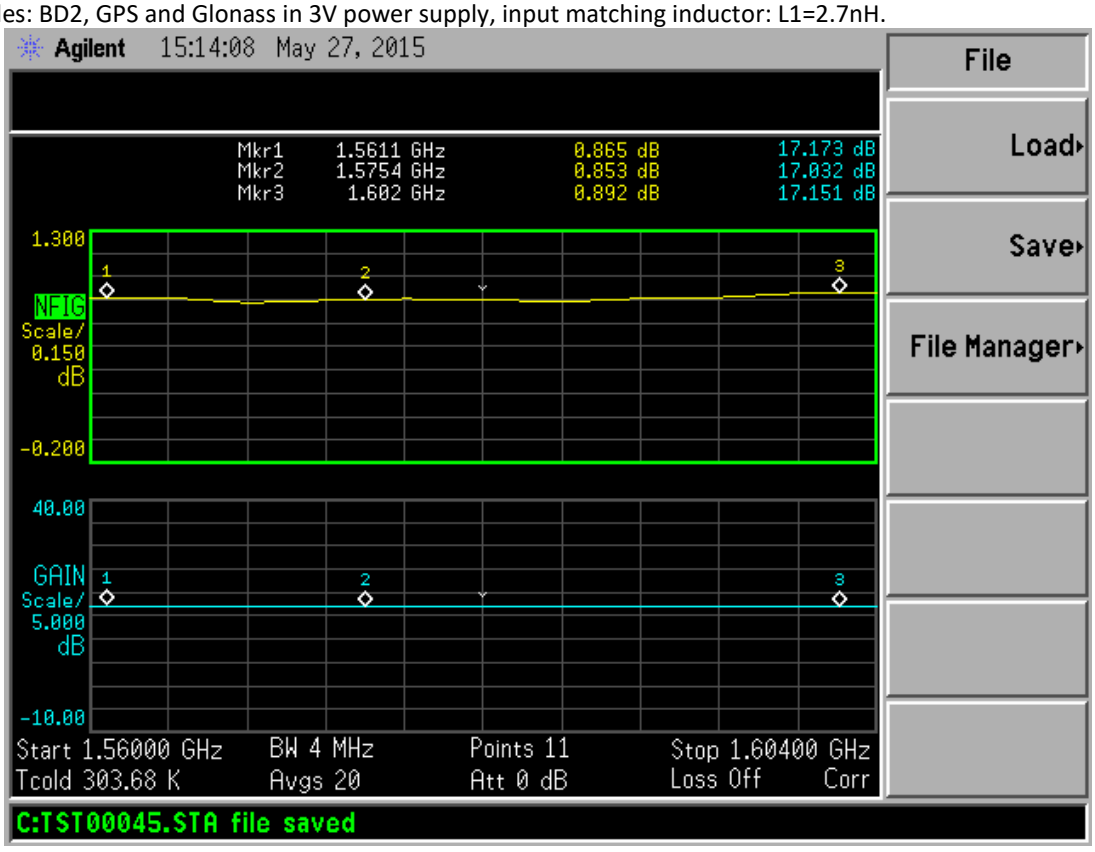
Peripheral Components Description

Symbol	Description
C1	Input DC Blocking Capacitor Murata GRM155R71H471KA01D C0402; 470pF ± 10% 50V X7R
L1	Input Matching Inductor Murata LQG15HS2N7S02D L0402 Lamination; 2.7nH ± 0.3nH
C2	Power Bypass Capacitor Murata GRM155R71C104KA88D C0402;100nF ± 10%;16V X7R

The following figures show the measured value of S parameter for three navigation modes: BD2, GPS and Glonass in 3V power supply, input matching inductor: L1=2.7nH.

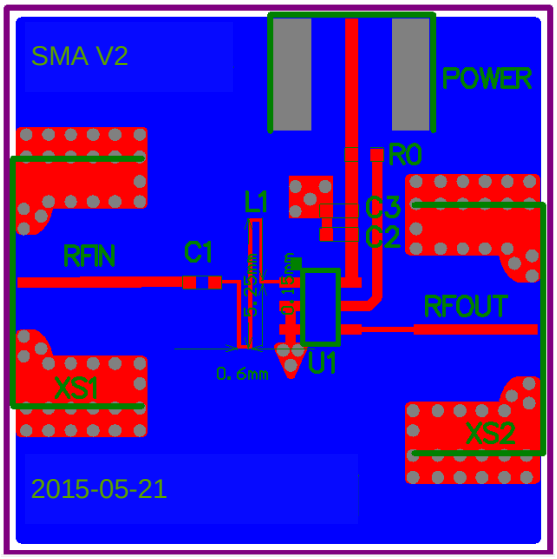


The following figure shows the noise figure and the measured value of relevant gain for three navigation modes: BD2, GPS and Glonass in 3V power supply, input matching inductor: L1=2.7nH.

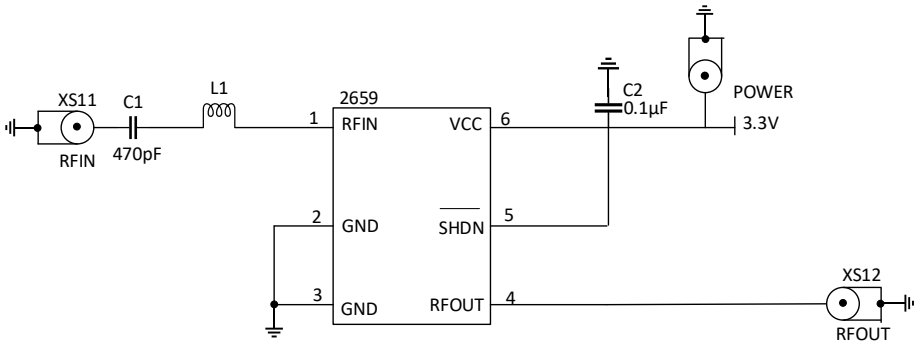


Transmission Line Matching Chip Evaluation Test Board PCBA Description

The evaluation test board of the MS2659 adopts two-layer board made of FR4 material. The thickness is 0.8mm, the average thickness of copper surface of circuit board is 30μm and the area is 22×22mm^2. As shown in the figure below, U1 is the test chip MS2659, C1 is the input DC blocking capacitor, L1 is the transmission line (The geometric parameters are indicated in the figure, three values are 0.6mm, 5.25mm and line width is 0.15mm), C2, C3 are power bypass capacitors (optional). R0 is the resistor connecting $\overline{\text{SHDN}}$ with power (weld 0Ω resistance). Input terminal RFIN, output terminal RFOUT and power POWER are accessed with SMA. Three SMA terminals are accessed with shielded wires.



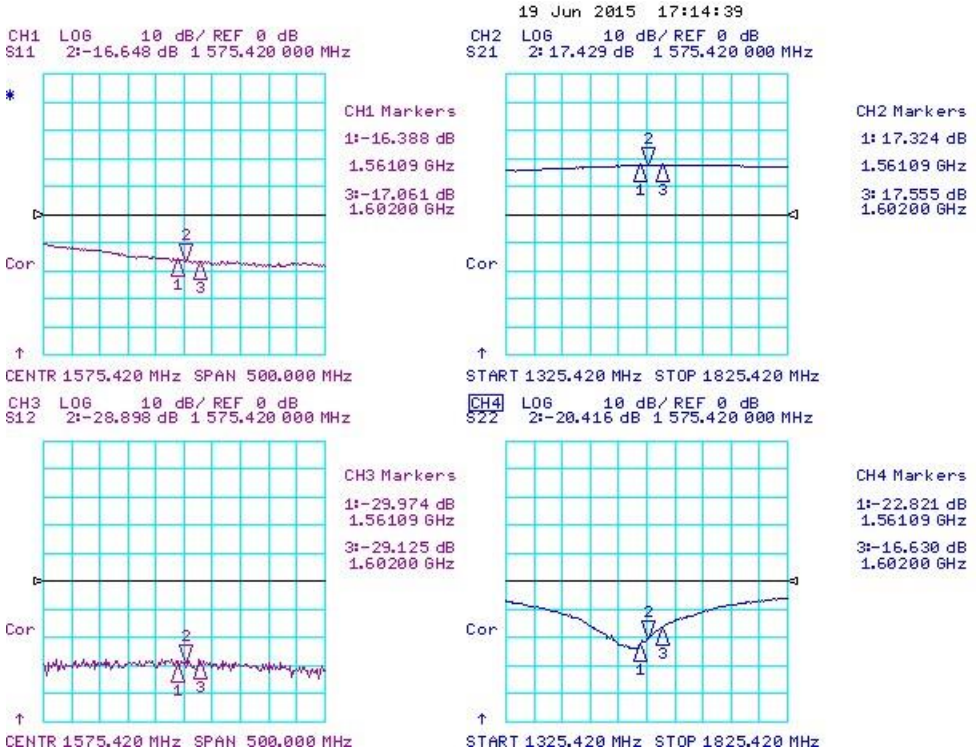
The circuit schematic diagram is shown as follows:



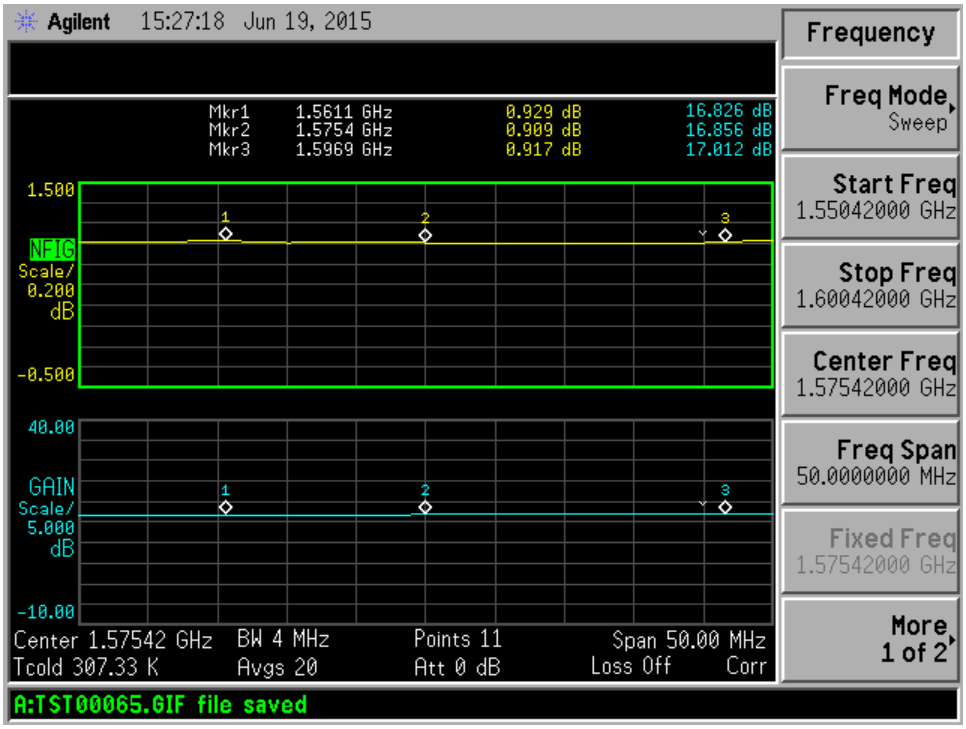
Peripheral Components Description

Symbol	Description
C1	Input DC Blocking Capacitor Murata GRM155R71H471KA01D C0402; 470pF ± 10% 50V X7R
L1	As the transmission line of matching inductor, the geometric parameters are described in PCB.
C2	Power Bypass Capacitor Murata GRM155R71C104KA88D C0402;100nF ± 10%; 16V X7R

The following figures show the measured value of S parameter for three navigation modes: BD2, GPS and Glonass in 3V power supply

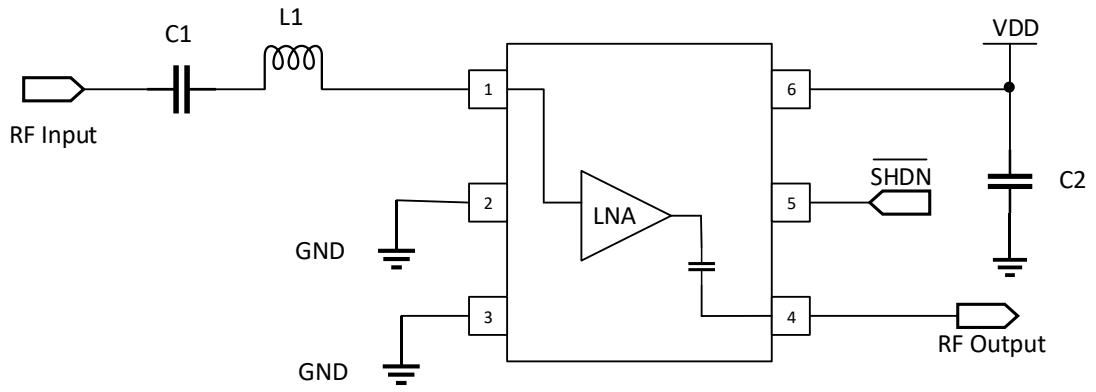


The following figure shows the noise figure and the measured value of relevant gain for three navigation modes: BD2, GPS and Glonass in 3V power supply .

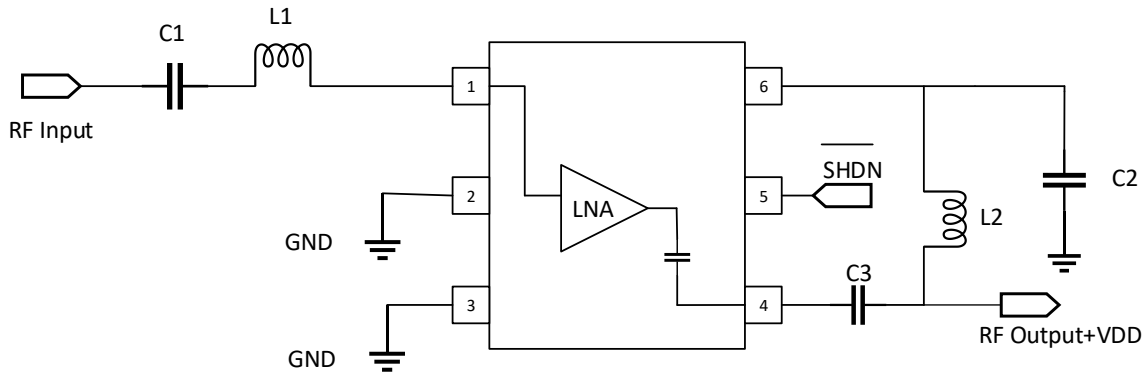


TYPICAL APPLICATION

Typical Application 1 (Navigation Positioning Receiver Receiving Front-end Circuit)



Typical Application 2 (Navigation Positioning Active Antenna Circuit)

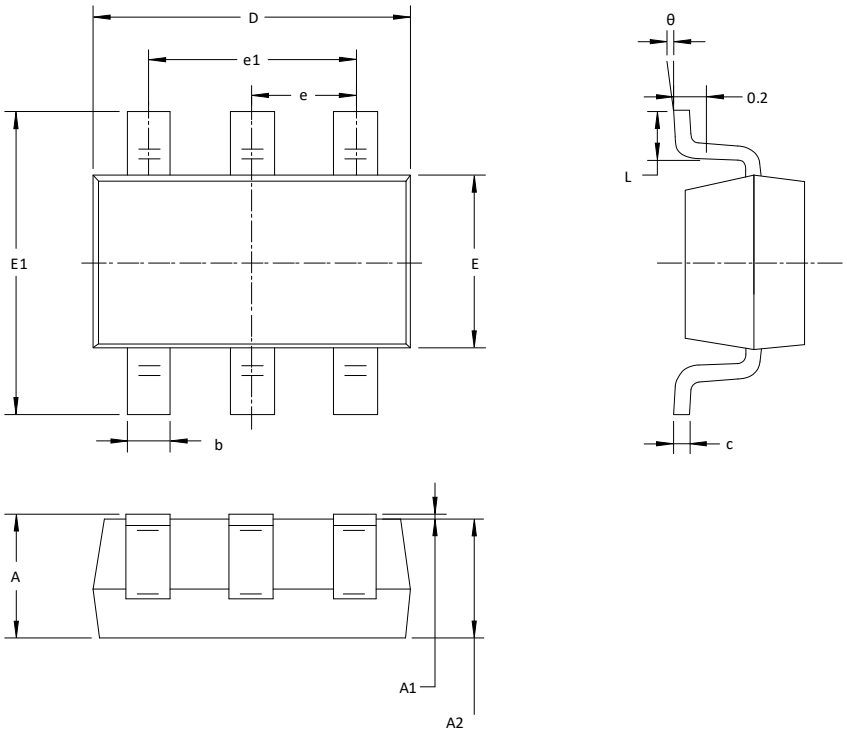


Peripheral Components Description

Symbol	Description
C1,C3	Input DC Blocking Capacitors Murata GRM155R71H471KA01D C0402; 470pF±10%; 50V X7R;
L1	Input Matching Inductor According to S parameter and noise figure, 2.7nH, 3.3nH, 5.6nH and transmission line inductor can be chosen as inductance values. Murata LQG15HS2N7S02D L0402 Lamination; 2.7nH±0.3nH Murata LQG15HS3N3S02D L0402 Lamination; 3.3nH±0.3nH Murata LQG15HS5N6S02D L0402 Lamination; 5.6nH±0.3nH
L2	RF Isolation Inductor; 33nH±5%(0402) Murata LQG15HS33NJ02D
C2	Power Bypass Capacitor Murata GRM155R71C104KA88D C0402; 100nF±10%; 16V X7R;

PACKAGE OUTLINE DIMENSIONS

SOT23-6



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.900(BSC)		0.075(BSC)	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

MARKING and PACKAGING SPECIFICATION

1. Marking Drawing Description

Product Name: 2659

Product Code: XXXX

2. Marking Drawing Demand

Laser printing, contents in the middle, font type Arial.

3. Packaging Specification

Device	Package	Piece/Reel	Reel/Box	Piece/Box	Box/Carton	Piece/Carton
MS2659	SOT23-6	3000	10	30000	4	120000

STATEMENT

- All Revision Rights of Datasheets Reserved for Ruimeng. Don't release additional notice.

  Customer should get latest version information and verify the integrity before placing order.
- When using Ruimeng products to design and produce, purchaser has the responsibility to observe safety standard and adopt corresponding precautions, in order to avoid personal injury and property loss caused by potential failure risk.
- The process of improving product is endless. And our company would sincerely provide more excellent product for customer.

MOS CIRCUIT OPERATION PRECAUTIONS

Static electricity can be generated in many places. The following precautions can be taken to effectively prevent the damage of MOS circuit caused by electrostatic discharge:

1. The operator shall ground through the anti-static wristband.
2. The equipment shell must be grounded.
3. The tools used in the assembly process must be grounded.
4. Must use conductor packaging or anti-static materials packaging or transportation.

+86-571-89966911

Rm701, No.9 Building, No. 1 WeiYe Road, Puyan Street, Binjiang District, Hangzhou, Zhejiang

http:// www.relmon.com