Ultra-Low Noise Amplifier for Global Navigation Satellite Systems (GNSS)

Features

- Reduce RF environment Interference with patented Smart-Linearity-Technology (SLT);
- Ultra low noise figure(NF)=0.6dB;
- High power gain=18dB;
- High linearity IIP3oob=0dBm;
- High input 1dB-compression point=-9.5dBm;
- GPS L1 requires only one input matching inductor;
- RF output internally matched to 50 ohm for GPS L1;
- Supply voltage: 1.5V to 3.3V;
- Operating frequencies: 1550~1615MHz; 1164~1300MHz;
- DFN-6L package:1.1mmX0.7mmX0.37mm
- 2000V HBM ESD protection (including RFIN and RFOUT pin)

Applications

- Smart Phones, Feature Phones;
- Tablet PCs;
- Personal Navigation Devices;
- Digital Still Cameras, Digital Video Cameras;
- RF Front End modules;
- Complete GPS chipset modules;
- Theft protection(laptop, ATM);

General Description

- The AW15645DNR is a Low Noise Amplifier designed for Global Navigation Satellite Systems (GNSS) as GPS, GLONASS, Galileo and BDS. With on-chip DC blocking capacitors at RFIN and RFOUT, The AW15645DNR can be close to the antenna, requires only one external input matching inductor, and reduces assembly complexity and the PCB area, enabling a cost-effective solution.
- The AW15645DNR with patented Smart Linearity Technology (SLT) achieves ultra-low noise figure, high linearity, high gain, over a wide range of supply voltages from 1.5V up to 3.3V. All these features make AW15645DNR an excellent choice for GNSS LNA as it improves sensitivity with low noise figure and high gain, provide better immunity against out-of-band jammer signals with high linearity, reduces filtering requirement of preceding stage and hence reduces the overall cost of the GNSS receiver.
- The AW15645DNR is available in a small lead-free, RoHS-Compliant, DFN 1.1 mm x 0.7 mm x 0.37 mm-6L package.

Typical Application Circuit

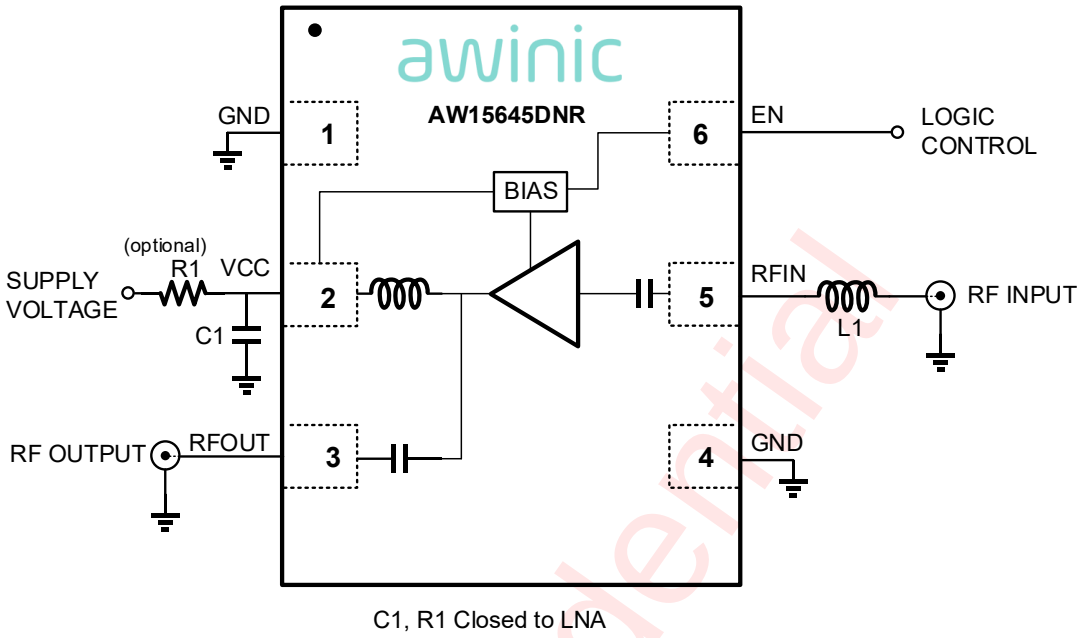


Figure 1(a) Typical Application Circuit of AW15645DNR for GNSS L1

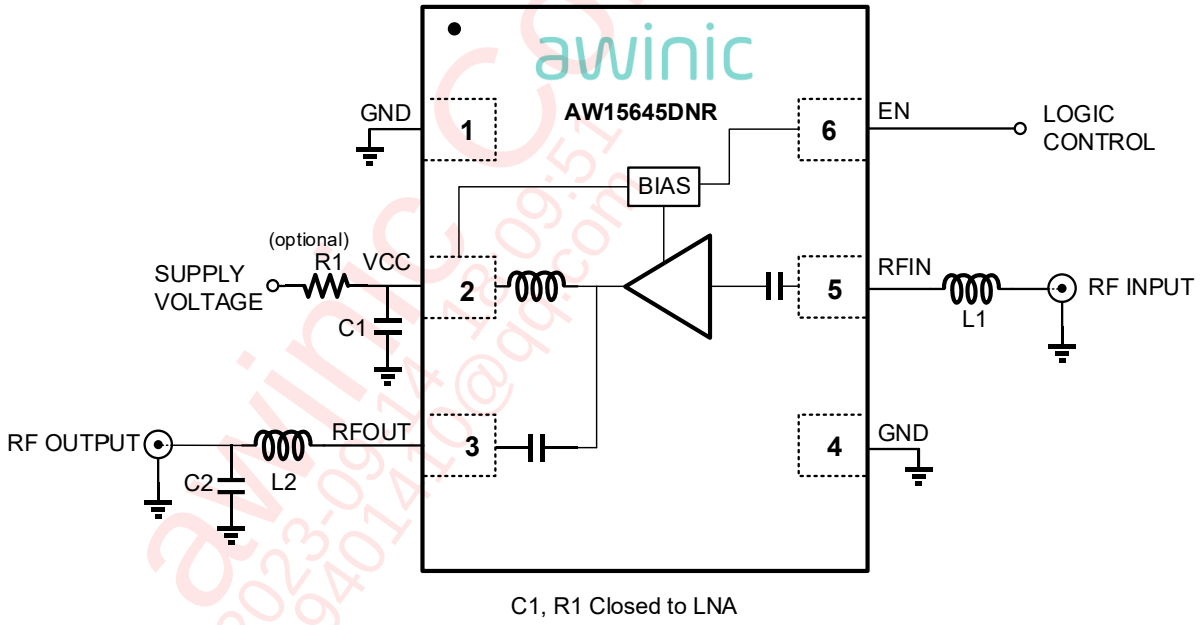


Figure 1(b) Typical Application Circuit of AW15645DNR for GNSS L2/L5

Recommended Components List

Table1: list of components for GNSS L1

Component	Part Number	Inductance (nH)	Q(min)	Q Test Frequency (MHz)	Supplier	Size
L1	LQW15A	10	25	250	Murata	0402
L1	SDWL1005C	10	24	250	Sunlord	0402
Component	Part Number	Capacitance (pF)	Rated Voltage (V)		Supplier	Size
C1	GRM155	1000	50		Murata	0402

Table2: list of components for GNSS L2

Component	Part Number	Inductance (nH)	Q(min)	Q Test Frequency (MHz)	Supplier	Size
L1	LQW15A	16	25	250	Murata	0402
L2	LQW15A	6.8	25	250	Murata	0402
Component	Part Number	Capacitance (pF)	Rated Voltage (V)		Supplier	Size
C1	GRM155	1000	50		Murata	0402
C2	GRM155	3	50		Murata	0402

Table3: list of components for GNSS L5

Component	Part Number	Inductance (nH)	Q(min)	Q Test Frequency (MHz)	Supplier	Size
L1	LQW15A	16	25	250	Murata	0402
L2	LQW15A	8.7	25	250	Murata	0402
Component	Part Number	Capacitance (pF)	Rated Voltage (V)		Supplier	Size
C1	GRM155	1000	50		Murata	0402
C2	GRM155	3	50		Murata	0402

Pin Configuration And Top Mark

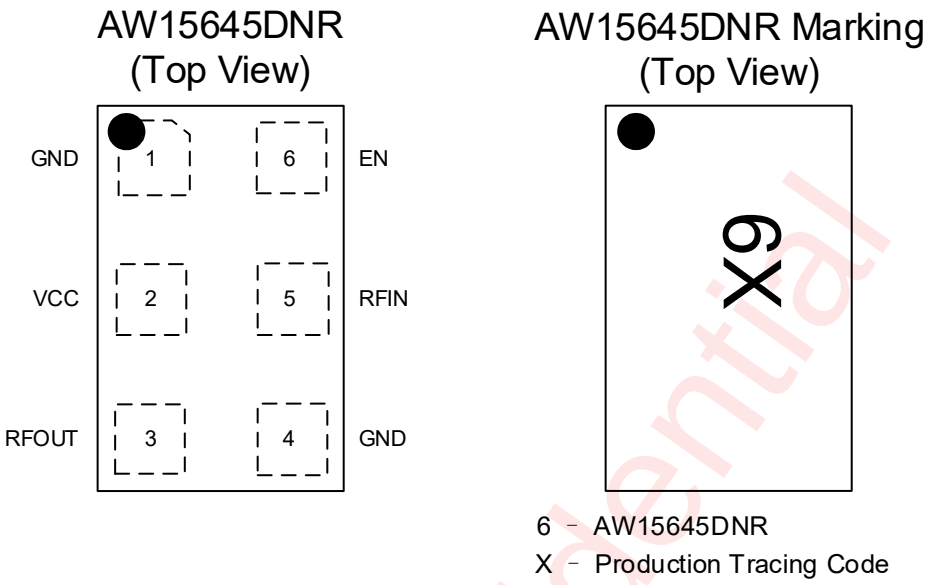


Figure 2 Pin Configuration and Top Mark

Pin Definition

No.	NAME	DESCRIPTION
1	GND	Ground
2	VCC	DC Supply
3	RFOUT	LNA output
4	GND	Ground
5	RFIN	LNA input
6	EN	Logic control

Functional Block Diagram

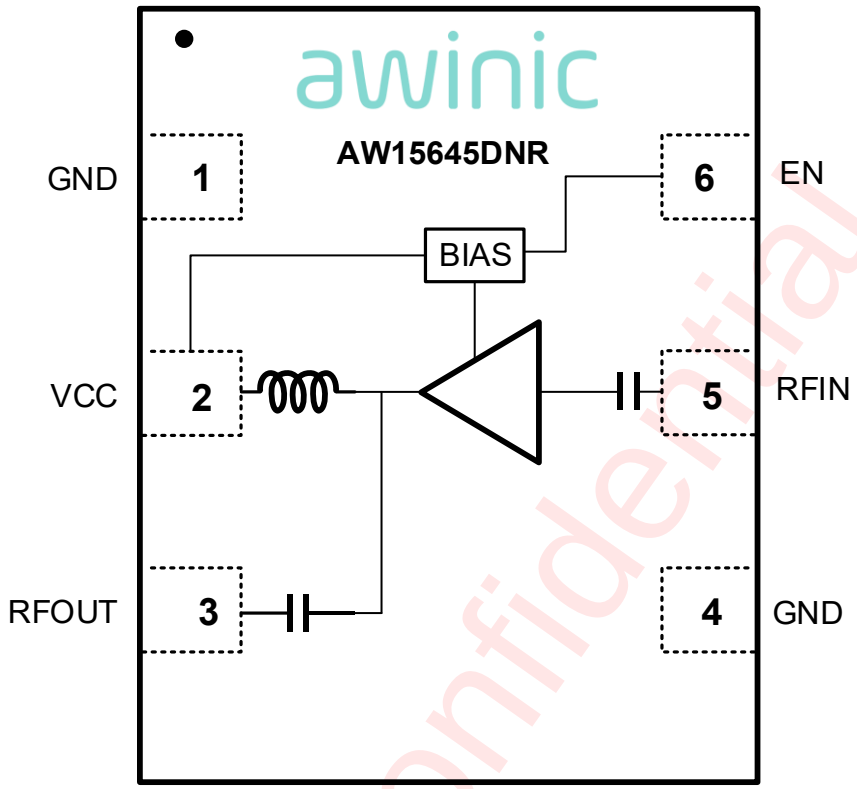


Figure 3 Functional Block Diagram

Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW15645DNR	-40°C ~ 85°C	DFN 1.1mmx0.7mmx0.37mm-6L	6	MSL1	ROHS+HF	9000 units/ Tape and Reel

Absolute Maximum Ratings[1]

PARAMETERS	Symbol	Values			
		Min.	Typ.	Max.	
Supply Voltage at pin VCC	V_{CC}	-0.3	-	3.6	V
Voltage at pin EN [2]	V_{EN}	-0.3	-	3.6	V
Current into pin VCC	I_{CC}	-	-	30	mA
RF input power [3]	P_{IN}	-	-	25	dBm
Package thermal resistance	θ_{JA}	-	148	-	℃/W
Junction temperature	T_J	-	-	150	℃
Storage temperature range	T_{STG}	-65	-	150	℃
Ambient temperature range	T_{amb}	-40	-	85	℃
Solder temperature(10s)		-	260	-	℃
ESD range					
HBM [4]		±2000			V
CDM [4]		±1000			V
Latch-up					
Standard: JESD78E		+IT: +400 -IT: -400			mA mA

***Note1**: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device.*

These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

***Note2:** Warning: due to internal ESD diode protection, the applied DC voltage should not exceed 5.0V in order to avoid excess current.*

***Note3**: The RF input and RF output are AC coupled through internal DC blocking capacitor.*

***Note4**: HBM standard: ESDA/JEDEC JS-001-2017. CDM standard: ESDA/JEDEC JS-002-2018.*

Electrical Characteristics

(AW15645DNR EVB[1]; Typical values are at VCC=2.8V and TA=+25°C, f=1550-1615MHz, unless otherwise noted)

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
DC ELECTRICAL CHARACTERISTICS						
V_{CC}	Supply Voltage		1.5	-	3.3	V
I_{SD}	Shut-Down Current	EN=Low			1	μA
I_{CC}	Supply Current	EN=High		5.8	8	mA
V_{EN}	Digital Input-Logic High		0.8		3.3	V
V_{EN}	Digital Input-Logic Low				0.45	V
I_{EN}	Digital Input-Logic High				10	μA
AC ELECTRICAL CHARACTERISTICS						
Gp	Power Gain		16	18	20	dB
RL_{in}	Input Return Loss		6	10		dB
RL_{out}	Output Return Loss		8	18		dB
ISL	Reverse Isolation		20	30		dB
NF	Noise Figure[2]	Zs=50 ohm; No jammer		0.6	1	dB
Kf	Stability factor	f=20MHz…10GHz	1			
IP1dB	Inband input 1dB-compression point	f=1575.42MHz	-13	-7		dBm

$IIP3_{ib}$	Inband input
	3^{rd}-order intercept point
		f1=1575.42MHz;
		f2=1576.42MHz;
		Pin=-30dBm;
			-5	0		dBm

$IIP3_{oob}$	Out-of-band input 3^{rd}-order intercept point[3]	f1=1712.7MHz; f2=1850MHz;	-5	1		dBm
H2-input referred	LTE band-13 2^{nd} Harmonic	f=787.76MHz Pin=-25dBm		-50		dBm
t_{on}	turn-on time	time from V_{EN} ON to 90% of the final gain		2	3	μs
t_{off}	turn-off time	time from V_{EN} OFF to 10% of the gain		0.4	3	μs

***Note1**: input matched to 50 ohm using a high quality-factor 10nH inductor.*

***Note2**: 0.08dB PCB losses are subtracted.*

***Note3**: Input power = -20 dBm at f1 and -65 dBm at f2.*

(AW15645DNR EVB[1]; Typical values are at VCC=1.8V and TA=+25°C, f=1550-1615MHz, unless otherwise noted)

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
DC ELECTRICAL CHARACTERISTICS						
V_{CC}	Supply Voltage		1.5	-	3.3	V
I_{SD}	Shut-Down Current	EN=Low			1	μA
I_{CC}	Supply Current	EN=High		5.6	8	mA
V_{EN}	Digital Input-Logic High		0.8		3.3	V
V_{EN}	Digital Input-Logic Low				0.45	V
I_{EN}	Digital Input-Logic High				10	μA
AC ELECTRICAL CHARACTERISTICS						
Gp	Power Gain		16	18	20	dB
RL_{in}	Input Return Loss		6	10		dB
RL_{out}	Output Return Loss		8	15		dB
ISL	Reverse Isolation		20	30		dB
NF	Noise Figure[2]	Zs=50 ohm; No jammer		0.6	1	dB
Kf	Stability factor	f=20MHz…10GHz	1			
IP1dB	Inband input 1dB-compression point	f=1575.42MHz	-13	-9.5		dBm

$IIP3_{ib}$	Inband input
	3rd-order intercept point
		f1=1575.42MHz;
		f2=1576.42MHz;
		Pin=-30dBm;
			-7	-2		dBm

$IIP3_{oob}$	Out-of-band input 3rd-order intercept point[3]	f1=1712.7MHz; f2=1850MHz;	-5	0		dBm
H2-input referred	LTE band-13 2nd Harmonic	f=787.76MHz Pin=-25dBm		-50		dBm
t_{on}	turn-on time	time from V_{EN} ON to 90% of the final gain		2.1	3	μs
t_{off}	turn-off time	time from V_{EN} OFF to 10% of the gain		0.4	3	μs

***Note1**: input matched to 50 ohm using a high quality-factor 10nH inductor.*

***Note2**: 0.08dB PCB losses are subtracted.*

***Note3**: Input power = -20 dBm at f1 and -65 dBm at f2.*

(AW15645DNR EVB[1]; Typical values are at VCC=2.8V and TA=+25°C, f=1164-1215MHz, unless otherwise noted)

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
DC ELECTRICAL CHARACTERISTICS						
V_{CC}	Supply Voltage		1.5	-	3.3	V
I_{SD}	Shut-Down Current	EN=Low			1	μA
I_{CC}	Supply Current	EN=High		5.8	8	mA
V_{EN}	Digital Input-Logic High		0.8		3.3	V
V_{EN}	Digital Input-Logic Low				0.45	V
I_{EN}	Digital Input-Logic High				10	μA
AC ELECTRICAL CHARACTERISTICS						
Gp	Power Gain		16	18	20	dB
RL_{in}	Input Return Loss		6	8		dB
RL_{out}	Output Return Loss		8	18		dB
ISL	Reverse Isolation		20	30		dB
NF	Noise Figure[2]	Zs=50 ohm; No jammer		0.6	1	dB
Kf	Stability factor	f=20MHz…10GHz	1			
IP1dB	Inband input 1dB-compression point	f=1176.45MHz	-15	-9		dBm

$IIP3_{ib}$	Inband input
	3rd-order intercept point
		f1=1176.45MHz;
		f2=1177.45MHz;
		Pin=-30dBm;
			-6	-4		dBm

$IIP3_{oob}$	Out-of-band input
	3rd-order intercept point
		f1=1800MHz;
		f2=2400MHz;
		Pin=-20dBm;
			-3	12		dBm

t_{on}	turn-on time	time from V_{EN} ON to 90% of the final gain		2	3	μs
t_{off}	turn-off time	time from V_{EN} OFF to 10% of the gain		0.4	3	μs

***Note1**: input matched to 50 ohm using a high quality-factor 16nH inductor. Output matching using 8.7nH inductor and 3pF capacitor.*

***Note2**: 0.08dB PCB losses are subtracted.*

(AW15645DNR EVB[1]; Typical values are at VCC=1.8V and TA=+25°C, f=1164-1215MHz, unless otherwise noted)

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
DC ELECTRICAL CHARACTERISTICS						
V_{CC}	Supply Voltage		1.5	-	3.3	V
I_{SD}	Shut-Down Current	EN=Low			1	μA
I_{CC}	Supply Current	EN=High		5.6	8	mA
V_{EN}	Digital Input-Logic High		0.8		3.3	V
V_{EN}	Digital Input-Logic Low				0.45	V
I_{EN}	Digital Input-Logic High				10	μA
AC ELECTRICAL CHARACTERISTICS						
Gp	Power Gain		16	18	20	dB
RL_{in}	Input Return Loss		6	8		dB
RL_{out}	Output Return Loss		8	18		dB
ISL	Reverse Isolation		20	30		dB
NF	Noise Figure[2]	Zs=50 ohm; No jammer		0.6	1	dB
Kf	Stability factor	f=20MHz…10GHz	1			
IP1dB	Inband input 1dB-compression point	f=1176.45MHz	-17	-12		dBm

$IIP3_{ib}$	Inband input
	3rd-order intercept point
		f1=1176.45MHz;
		f2=1177.45MHz;
		Pin=-30dBm;
			-10	-5		dBm

$IIP3_{oob}$	Out-of-band input
	3rd-order intercept point
		f1=1800MHz;
		f2=2400MHz;
		Pin=-20dBm;
			-3	12		dBm

t_{on}	turn-on time	time from V_{EN} ON to 90% of the final gain		2.1	3	μs
t_{off}	turn-off time	time from V_{EN} OFF to 10% of the gain		0.4	3	μs

***Note1**: input matched to 50 ohm using a high quality-factor 16nH inductor. Output matching using 8.7nH inductor and 3pF capacitor.*

***Note2**: 0.08dB PCB losses are subtracted.*

(AW15645DNR EVB[1]; Typical values are at VCC=2.8V and TA=+25°C, f=1215-1300MHz, unless otherwise noted)

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
DC ELECTRICAL CHARACTERISTICS						
V_{CC}	Supply Voltage		1.5	-	3.3	V
I_{SD}	Shut-Down Current	EN=Low			1	μA
I_{CC}	Supply Current	EN=High		5.8	8	mA
V_{EN}	Digital Input-Logic High		0.8		3.3	V
V_{EN}	Digital Input-Logic Low				0.45	V
I_{EN}	Digital Input-Logic High				10	μA
AC ELECTRICAL CHARACTERISTICS						
Gp	Power Gain		16	18	20	dB
RL_{in}	Input Return Loss		6	8		dB
RL_{out}	Output Return Loss		6	14		dB
ISL	Reverse Isolation		20	30		dB
NF	Noise Figure[2]	Zs=50 ohm; No jammer		0.6	1	dB
Kf	Stability factor	f=20MHz…10GHz	1			
IP1dB	Inband input 1dB-compression point	f=1227.6MHz	-15	-9		dBm

$IIP3_{ib}$	Inband input
	3rd-order intercept point
		f1=1227.6MHz;
		f2=1228.6MHz;
		Pin=-30dBm;
			-6	-4		dBm

$IIP3_{oob}$	Out-of-band input
	3rd-order intercept point
		f1=1850MHz;
		f2=2485MHz;
		Pin=-25dBm;
			-3	13.5		dBm

t_{on}	turn-on time	time from V_{EN} ON to 90% of the final gain		2	3	μs
t_{off}	turn-off time	time from V_{EN} OFF to 10% of the gain		0.4	3	μs

***Note1**: input matched to 50 ohm using a high quality-factor 16nH inductor. Output matching using 6.8nH inductor and 3pF capacitor.*

***Note2**: 0.08dB PCB losses are subtracted.*

(AW15645DNR EVB[1]; Typical values are at VCC=1.8V and TA=+25°C, f=1215-1300MHz, unless otherwise noted)

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
DC ELECTRICAL CHARACTERISTICS						
V_{CC}	Supply Voltage		1.5	-	3.3	V
I_{SD}	Shut-Down Current	EN=Low			1	μA
I_{CC}	Supply Current	EN=High		5.6	8	mA
V_{EN}	Digital Input-Logic High		0.8		3.3	V
V_{EN}	Digital Input-Logic Low				0.45	V
I_{EN}	Digital Input-Logic High				10	μA
AC ELECTRICAL CHARACTERISTICS						
Gp	Power Gain		16	18	20	dB
RL_{in}	Input Return Loss		6	8		dB
RL_{out}	Output Return Loss		8	14		dB
ISL	Reverse Isolation		20	30		dB
NF	Noise Figure[2]	Zs=50 ohm; No jammer		0.6	1	dB
Kf	Stability factor	f=20MHz…10GHz	1			
IP1dB	Inband input 1dB-compression point	f=1227.6MHz	-17	-12		dBm

$IIP3_{ib}$	Inband input
	3rd-order intercept point
		f1=1227.6MHz;
		f2=1228.6MHz;
		Pin=-30dBm;
			-10	-5		dBm

$IIP3_{oob}$	Out-of-band input
	3rd-order intercept point
		f1=1850MHz;
		f2=2485MHz;
		Pin=-25dBm;
			-3	13		dBm

t_{on}	turn-on time	time from V_{EN} ON to 90% of the final gain		2.1	3	μs
t_{off}	turn-off time	time from V_{EN} OFF to 10% of the gain		0.4	3	μs

***Note1**: input matched to 50 ohm using a high quality-factor 16nH inductor. Output matching using 6.8nH inductor and 3pF capacitor.*

***Note2**: 0.08dB PCB losses are subtracted.*

Package Description

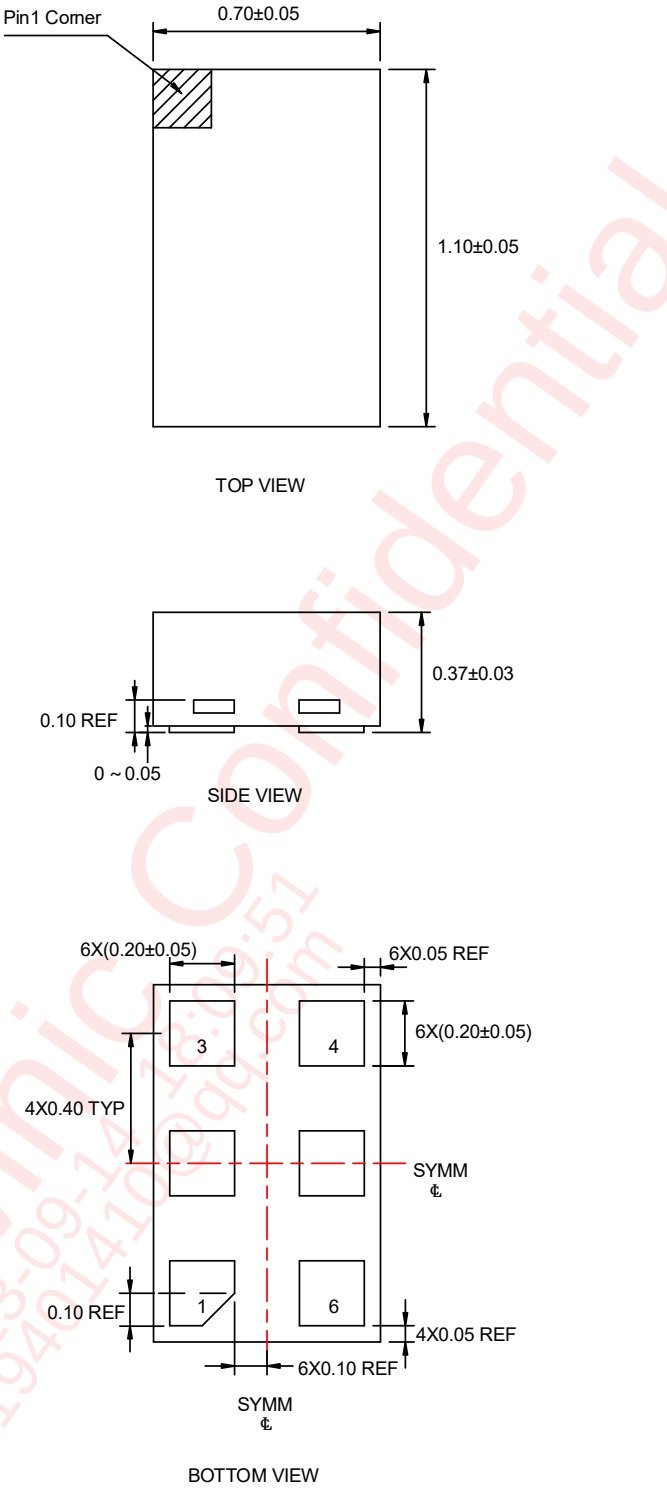
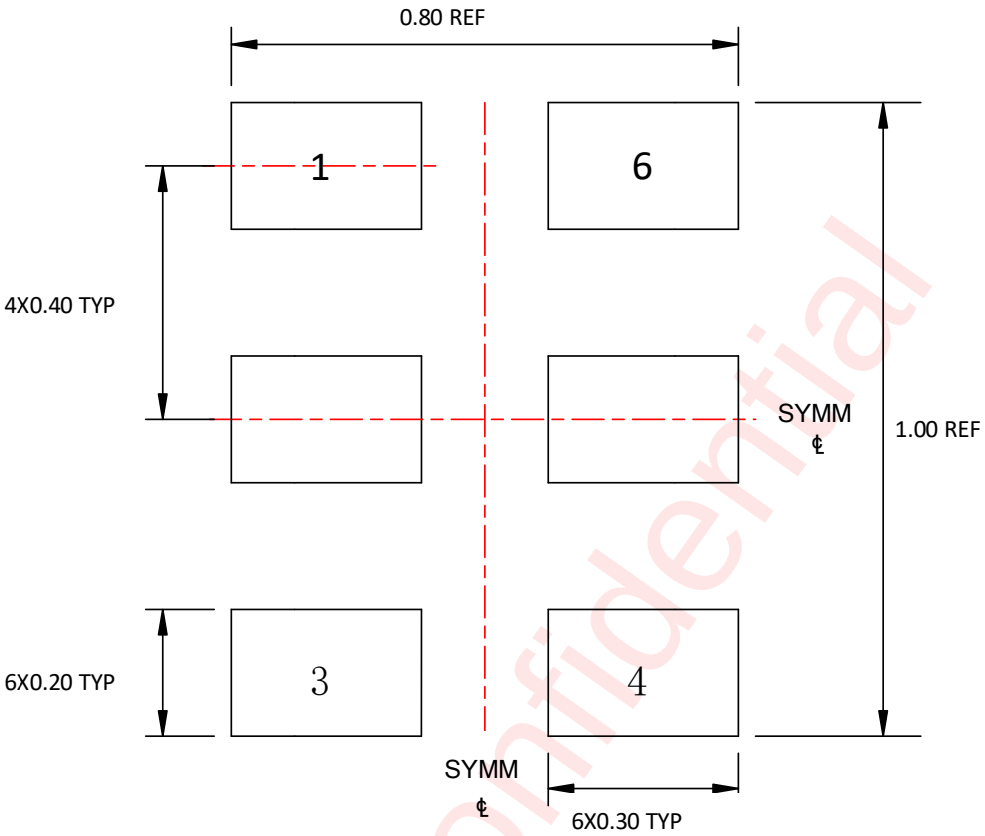
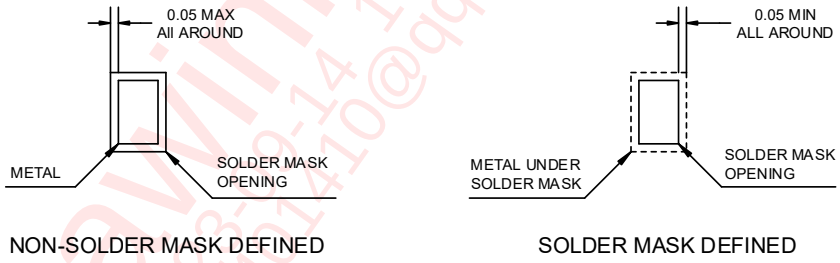


Figure 8 Package Outline

Land Pattern



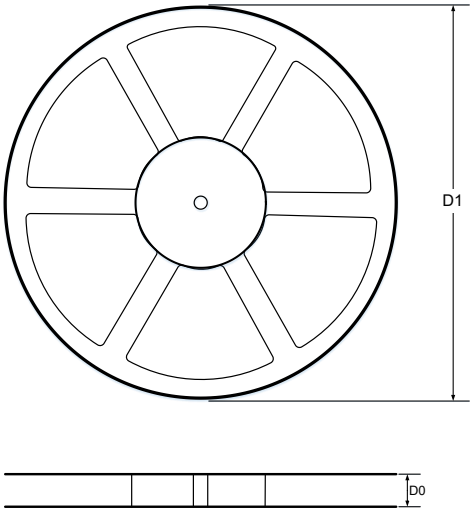


Unit: mm

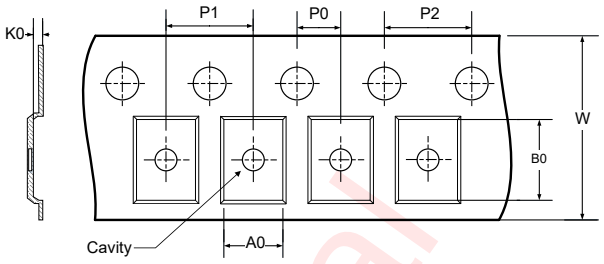
Figure 9 Land Pattern

Tape & Reel Description

REEL DIMENSIONS

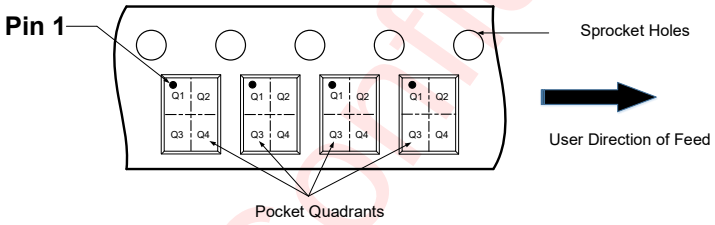


TAPE DIMENSIONS



A0：Dimension designed to accommodate the component width
B0：Dimension designed to accommodate the component length
K0：Dimension designed to accommodate the component thickness
W：Overall width of the carrier tape
P0：Pitch between successive cavity centers and sprocket hole
P1：Pitch between successive cavity centers
P2：Pitch between sprocket hole
D1：Reel Diameter
D0：Reel Width

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



Note：The above picture is for reference only. Please refer to the value in the table below for the actual size

DIMENSIONS AND PIN1 ORIENTATION

D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
178	8.4	0.82	1.22	0.46	2	2	4	8	Q1

All dimensions are nominal

Figure 10 Tape & Reel Description

Revision History

Version	Date	Change Record
V1.0	Feb. 2022	Officially Released
V1.1	Aug. 2022	Update format
V1.2	Aug. 2022	Add the electrical characteristics of L2
V1.3	Aug. 2022	Update format
V1.4	Aug. 2022	Update format
V1.5	Feb. 2022	1. Update the electrical characteristics 2. Update the absolute maximum ratings

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