

BGA525N6

Broadband Low Power LNA for L1/L2/L5 GNSS Applications

Features

- Operation frequencies 1164 to 1615 MHz
- Multiple-Operating Modes for different applications
- Current consumption down to 1.5 mA
- Wide supply voltage range 1.1 V to 3.3 V
- High insertion power gain up to 19 dB
- Low noise figure down to 0.7 dB
- 2 kV HBM ESD protection (including AI pin)
- Broadband design ensures the functionality of all GNSS signals within 1164 to 1615 MHz with the same matching



- RoHS
- Halogen-Free
- Lead-Free
- Greener

Potential Application

The BGA525N6 enhances GNSS signal sensitivity for band L1/L2/L5 especially in wearables and mobile cellular IoT applications. It offers 3 different GPIO controlled modes:

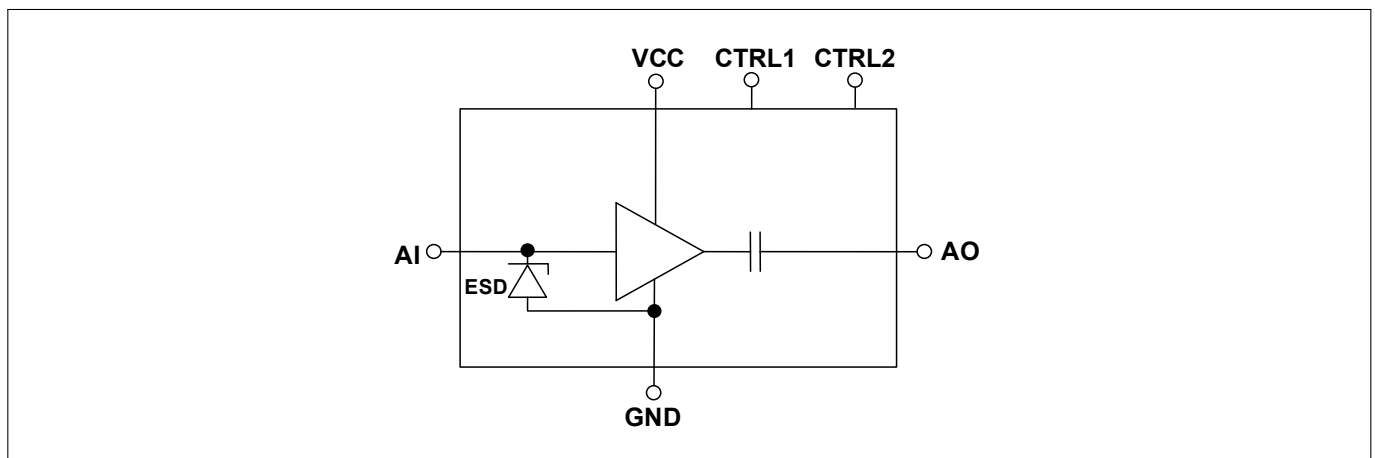
- Low-Power Mode: small battery powered GNSS devices
- Standard Mode: best balance between power consumption and performance
- High-Gain Mode: lowest Noise Figure and fastest Time-To-First-Fix

The broadband design ensures the functionality of all GNSS signals within 1164 to 1615 MHz with the same matching. Simplified dual-band GNSS system designs with one RF-Path are enabled by BGA525N6.

Product Validation

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22.

Block Diagram



Product Name	Marking	Package	Ordering Information
BGA525N6	8	PG-TSNP-6-10	BGA525N6 E6327

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Absolute Maximum Ratings**1 Absolute Maximum Ratings****Table 1: Absolute Maximum Ratings**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Voltage at pin VCC	V_{CC}	-0.3	–	3.6	V	¹
Voltage at pin AI	V_{AI}	–	–	–	V	²
Voltage at pin AO	V_{AO}	-0.3	–	$V_{CC} + 0.3$	V	$V_{CC} + 0.3$ must not exceed 3.6 V
Voltage at pin CTRL1/CTRL2	V_{CTRL}	-0.3	–	$V_{CC} + 0.3$	V	–
Current into pin VCC	I_{CC}	–	–	10	mA	–
Junction temperature	T_J	–	–	150	°C	–
Ambient temperature range	T_A	-40	–	85	°C	–
Storage temperature range	T_{STG}	-55	–	150	°C	–
ESD capability, HBM	V_{ESD_HBM}	-2000	–	+2000	V	³
ESD capability, CDM	V_{ESD_CDM}	-1000	–	+1000	V	⁴
RF input power	P_{IN}	–	–	+25	dBm	CW signal, VSWR 10:1, (refer to 50 Ohm), device level, VCC/VCTRL type, 25°C, for 30s and all modes.

¹All voltages refer to GND-Nodes unless otherwise noted²No external DC Voltage allowed³Human Body Model ANSI/ESDA/JEDEC JS-001 ($R = 1.5\text{ k}\Omega$, $C = 100\text{ pF}$)⁴Field-Induced Charged-Device Model ANSI/ESDA/JEDEC JS-002. Simulates charging/discharging events that occur in production equipment and processes. Potential for CDM ESD events occurs whenever there is metal-to-metal contact in manufacturing.

Warning: Stresses above the max. values listed here may cause permanent damage to the device. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit. Exposure to conditions at or below absolute maximum rating but above the specified maximum operation conditions may affect device reliability and life time. Functionality of the device might not be given under these conditions.

Electrical Characteristics

2 Electrical Characteristics**Table 2: Operation ranges at $T_A = 25\text{ °C}$, $f = \text{L1/L2/L5}$**

Parameter ¹	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply Voltage	V_{CC}	1.1	–	3.3	V	–
Control Input Voltage	V_{IH}	$0.7 * V_{CC}$	–	VCC	V	logic H
	V_{IL}	0	–	$0.3 * V_{CC}$	V	logic L
Stability	k	>1	–	–		$f=20\text{ MHz}–10\text{ GHz}$ (all Modes)
Transient time	t_s	–	30	32	ns	Low Power Mode to OFF Mode Standard Mode to OFF Mode High Gain Mode to OFF Mode
		–	21.7	23.5	μs	C1=1nF OFF to LOW Power Mode OFF to Standard Mode OFF to High Gain Mode
		–	733	847	ns	C1=10pF OFF to LOW Power Mode OFF to Standard Mode OFF to High Gain Mode

¹Based on application described in chapter 4

Electrical Characteristics**Table 3: Electrical Characteristics at $T_A = 25\text{ }^\circ\text{C}$, Low Power Mode, $f = 1164\text{--}1300\text{ MHz}$**

Parameter ¹	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply Current	I_{CC}	-	1.5	1.8	mA	Low Power Mode, VCC=1.8V
		-	-	1	μA	OFF Mode
Insertion Power Gain ¹ $f = 1176\text{ MHz}$	$ S_{21} ^2$	14.5	15.5	16.5	dB	VCC=1.2V
		14.5	15.5	16.5	dB	VCC=1.8V
		14.5	15.5	16.5	dB	VCC=2.8V
Noise Figure ² $f = 1176\text{ MHz}$	NF	-	0.9	1.2	dB	VCC=1.2V
		-	0.9	1.2	dB	VCC=1.8V
		-	0.9	1.2	dB	VCC=2.8V
Input return loss ³ $f = 1176\text{ MHz}$	RL_{IN}	8	9.5	-	dB	VCC=1.2V
		7.5	9	-	dB	VCC=1.8V
		7.5	9	-	dB	VCC=2.8V
Output return loss ³ $f = 1176\text{ MHz}$	RL_{OUT}	9	11	-	dB	VCC=1.2V
		9	11	-	dB	VCC=1.8V
		9	11	-	dB	VCC=2.8V
Reverse isolation ³ $f = 1176\text{ MHz}$	$1/ S_{12} ^2$	30	33	-	dB	VCC=1.2V
		30	34	-	dB	VCC=1.8V
		30	34	-	dB	VCC=2.8V
Inband input 1dB-compression point ³ $f = 1176\text{ MHz}$	IP_{1dB}	-17	-14	-	dBm	VCC=1.2V
		-13	-10	-	dBm	VCC=1.8V
		-9	-6	-	dBm	VCC=2.8V
Out of band input 3rd-order intercept point	IIP_{300B}	-7	-4.5	-	dBm	VCC=1.2V, $f_1 = 1785\text{ MHz}, f_2 = 2401\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$
		-7.5	-5	-	dBm	VCC=1.8V, $f_1 = 1785\text{ MHz}, f_2 = 2401\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$
		-8	-5.5	-	dBm	VCC=2.8V, $f_1 = 1785\text{ MHz}, f_2 = 2401\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$

¹Based on application described in chapter 4²PCB losses are substrated³Verification based on AQL; not 100% tested in production

Electrical Characteristics**Table 4: Electrical Characteristics at $T_A = 25\text{ °C}$, Standard Mode, $f = 1164\text{--}1300\text{ MHz}$**

Parameter ¹	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply Current	I_{CC}	-	2.3	2.4	mA	Standard Mode, VCC=1.8V
		-	-	1	μA	OFF Mode
Insertion Power Gain ¹ $f = 1176\text{ MHz}$	$ S_{21} ^2$	16.8	17.8	18.8	dB	VCC=1.2V
		16.8	17.9	18.8	dB	VCC=1.8V
		16.8	17.8	18.8	dB	VCC=2.8V
Noise Figure ² $f = 1176\text{ MHz}$	NF	-	0.8	1.1	dB	VCC=1.2V
		-	0.8	1.1	dB	VCC=1.8V
		-	0.8	1.1	dB	VCC=2.8V
Input return loss ³ $f = 1176\text{ MHz}$	RL_{IN}	8	11	-	dB	VCC=1.2V
		7.5	10.5	-	dB	VCC=1.8V
		7.5	10.5	-	dB	VCC=2.8V
Output return loss ³ $f = 1176\text{ MHz}$	RL_{OUT}	9	11	-	dB	VCC=1.2V
		9	11	-	dB	VCC=1.8V
		9	11	-	dB	VCC=2.8V
Reverse isolation ³ $f = 1176\text{ MHz}$	$1/ S_{12} ^2$	30	34	-	dB	VCC=1.2V
		30	34	-	dB	VCC=1.8V
		30	34	-	dB	VCC=2.8V
Inband input 1dB-compression point ³ $f = 1176\text{ MHz}$	IP_{1dB}	-19	-16.5	-	dBm	VCC=1.2V
		-15	-12	-	dBm	VCC=1.8V
		-11	-8.5	-	dBm	VCC=2.8V
Out of band input 3rd-order intercept point	IIP_{300B}	-2	0.5	-	dBm	VCC=1.2V, $f_1 = 1785\text{ MHz}, f_2 = 2401\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$
		-5	-2.5	-	dBm	VCC=1.8V, $f_1 = 1785\text{ MHz}, f_2 = 2401\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$
		-5	-2.5	-	dBm	VCC=2.8V, $f_1 = 1785\text{ MHz}, f_2 = 2401\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$

¹Based on application described in chapter 4²PCB losses are substrated³Verification based on AQL; not 100% tested in production

Electrical Characteristics**Table 5: Electrical Characteristics at $T_A = 25\text{ }^\circ\text{C}$, High Gain Mode, $f = 1164\text{--}1300\text{ MHz}$**

Parameter ¹	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply Current	I_{CC}	-	3.4	3.6	mA	High Gain Mode, VCC=1.8V
		-	-	1	μA	OFF Mode
Insertion Power Gain ¹ $f = 1176\text{ MHz}$	$ S_{21} ^2$	18	19	20	dB	VCC=1.2V
		18	19	20	dB	VCC=1.8V
		18	19	20	dB	VCC=2.8V
Noise Figure ² $f = 1176\text{ MHz}$	NF	-	0.7	1	dB	VCC=1.2V
		-	0.7	1	dB	VCC=1.8V
		-	0.7	1	dB	VCC=2.8V
Input return loss ³ $f = 1176\text{ MHz}$	RL_{IN}	9.5	11.5	-	dB	VCC=1.2V
		8.5	10.5	-	dB	VCC=1.8V
		8	10	-	dB	VCC=2.8V
Output return loss ³ $f = 1176\text{ MHz}$	RL_{OUT}	8.5	10.5	-	dB	VCC=1.2V
		8.5	10.5	-	dB	VCC=1.8V
		8	10	-	dB	VCC=2.8V
Reverse isolation ³ $f = 1176\text{ MHz}$	$1/ S_{12} ^2$	30	34	-	dB	VCC=1.2V
		30	34	-	dB	VCC=1.8V
		30	34	-	dB	VCC=2.8V
Inband input 1dB-compression point ³ $f = 1176\text{ MHz}$	IP_{1dB}	-20	-18	-	dBm	VCC=1.2V
		-16	-14	-	dBm	VCC=1.8V
		-12	-10	-	dBm	VCC=2.8V
Out of band input 3rd-order intercept point	IIP_{300B}	-1.5	1	-	dBm	VCC=1.2V, $f_1 = 1785\text{ MHz}, f_2 = 2401\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$
		-1.5	1	-	dBm	VCC=1.8V, $f_1 = 1785\text{ MHz}, f_2 = 2401\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$
		-3	-0.5	-	dBm	VCC=2.8V, $f_1 = 1785\text{ MHz}, f_2 = 2401\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$

¹Based on application described in chapter 4²PCB losses are substrated³Verification based on AQL; not 100% tested in production

Electrical Characteristics**Table 6: Electrical Characteristics at $T_A = 25\text{ °C}$, Low Power Mode, $f = 1550\text{--}1615\text{ MHz}$**

Parameter ¹	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply Current	I_{CC}	-	1.5	1.8	mA	Standard Mode, VCC=1.8V
		-	-	1	μA	OFF Mode
Insertion Power Gain ¹ $f = 1575\text{ MHz}$	$ S_{21} ^2$	13	14	15	dB	VCC=1.2V
		13.5	14.5	15.5	dB	VCC=1.8V
		14	15	16	dB	VCC=2.8V
Noise Figure ² $f = 1575\text{ MHz}$	NF	-	1	1.3	dB	VCC=1.2V
		-	1	1.3	dB	VCC=1.8V
		-	1	1.3	dB	VCC=2.8V
Input return loss ³ $f = 1575\text{ MHz}$	RL_{IN}	8.5	11.5	-	dB	VCC=1.2V
		10.5	13.7	-	dB	VCC=1.8V
		11	14	-	dB	VCC=2.8V
Output return loss ³ $f = 1575\text{ MHz}$	RL_{OUT}	11	13	-	dB	VCC=1.2V
		11.5	13.5	-	dB	VCC=1.8V
		12	14	-	dB	VCC=2.8V
Reverse isolation ³ $f = 1575\text{ MHz}$	$1/ S_{12} ^2$	30	36	-	dB	VCC=1.2V
		30	36	-	dB	VCC=1.8V
		30	36	-	dB	VCC=2.8V
Inband input 1dB-compression point ³ $f = 1575\text{ MHz}$	IP_{1dB}	-14	-12	-	dBm	VCC=1.2V
		-10.5	-8.5	-	dBm	VCC=1.8V
		-6.5	-4.5	-	dBm	VCC=2.8V
Out of band input 3rd-order intercept point	IIP_{300B}	-7.5	-5	-	dBm	VCC=1.2V, $f_1 = 1713\text{ MHz}, f_2 = 1850\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$
		-10	-7.5	-	dBm	VCC=1.8V, $f_1 = 1713\text{ MHz}, f_2 = 1850\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$
		-11	-8.5	-	dBm	VCC=2.8V, $f_1 = 1713\text{ MHz}, f_2 = 1850\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$

¹Based on application described in chapter 4²PCB losses are substrated³Verification based on AQL; not 100% tested in production

Electrical Characteristics**Table 7: Electrical Characteristics at $T_A = 25\text{ °C}$, Standard Mode, $f = 1550\text{--}1615\text{ MHz}$**

Parameter ¹	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply Current	I_{CC}	-	2.3	2.4	mA	Standard Mode, VCC=1.8V
		-	-	1	μA	OFF Mode
Insertion Power Gain ¹ $f = 1575\text{ MHz}$	$ S_{21} ^2$	15.5	16.5	17.5	dB	VCC=1.2V
		16	17	18	dB	VCC=1.8V
		16	17	18	dB	VCC=2.8V
Noise Figure ² $f = 1575\text{ MHz}$	NF	-	0.85	1.15	dB	VCC=1.2V
		-	0.85	1.15	dB	VCC=1.8V
		-	0.85	1.15	dB	VCC=2.8V
Input return loss ³ $f = 1575\text{ MHz}$	RL_{IN}	15.5	18.5	-	dB	VCC=1.2V
		16.5	19	-	dB	VCC=1.8V
		16.5	19	-	dB	VCC=2.8V
Output return loss ³ $f = 1575\text{ MHz}$	RL_{OUT}	11	13	-	dB	VCC=1.2V
		11.5	13.5	-	dB	VCC=1.8V
		12	14	-	dB	VCC=2.8V
Reverse isolation ³ $f = 1575\text{ MHz}$	$1/ S_{12} ^2$	30	35	-	dB	VCC=1.2V
		30	35	-	dB	VCC=1.8V
		30	35	-	dB	VCC=2.8V
Inband input 1dB-compression point ³ $f = 1575\text{ MHz}$	IP_{1dB}	-17	-15	-	dBm	VCC=1.2V
		-13	-11	-	dBm	VCC=1.8V
		-9	-6.7	-	dBm	VCC=2.8V
Out of band input 3rd-order intercept point	IIP_{300B}	-7.5	-5	-	dBm	VCC=1.2V, $f_1 = 1713\text{ MHz}, f_2 = 1850\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$
		-5.5	-3	-	dBm	VCC=1.8V, $f_1 = 1713\text{ MHz}, f_2 = 1850\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$
		-7.5	-5	-	dBm	VCC=2.8V, $f_1 = 1713\text{ MHz}, f_2 = 1850\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$

¹Based on application described in chapter 4²PCB losses are substrated³Verification based on AQL; not 100% tested in production

Electrical Characteristics**Table 8: Electrical Characteristics at $T_A = 25\text{ °C}$, High Gain Mode, $f = 1550\text{--}1615\text{ MHz}$**

Parameter ¹	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply Current	I_{CC}	-	3.4	3.6	mA	High Gain Mode, VCC=1.8V
		-	-	1	μA	OFF Mode
Insertion Power Gain ¹ $f = 1575\text{ MHz}$	$ S_{21} ^2$	17	18	19	dB	VCC=1.2V
		17	18	19	dB	VCC=1.8V
		17.5	18.5	19.5	dB	VCC=2.8V
Noise Figure ² $f = 1575\text{ MHz}$	NF	-	0.75	1.05	dB	VCC=1.2V
		-	0.75	1.05	dB	VCC=1.8V
		-	0.75	1.05	dB	VCC=2.8V
Input return loss ³ $f = 1575\text{ MHz}$	RL_{IN}	12	14	-	dB	VCC=1.2V
		10.5	12.5	-	dB	VCC=1.8V
		10	12	-	dB	VCC=2.8V
Output return loss ³ $f = 1575\text{ MHz}$	RL_{OUT}	11	13	-	dB	VCC=1.2V
		11.5	13.5	-	dB	VCC=1.8V
		12	14	-	dB	VCC=2.8V
Reverse isolation ³ $f = 1575\text{ MHz}$	$1/ S_{12} ^2$	30	35	-	dB	VCC=1.2V
		30	35	-	dB	VCC=1.8V
		30	35	-	dB	VCC=2.8V
Inband input 1dB-compression point ³ $f = 1575\text{ MHz}$	IP_{1dB}	-18	-16.5	-	dBm	VCC=1.2V
		-16	-14	-	dBm	VCC=1.8V
		-11	-9	-	dBm	VCC=2.8V
Out of band input 3rd-order intercept point	IIP_{300B}	-9.5	-7	-	dBm	VCC=1.2V, $f_1 = 1713\text{ MHz}, f_2 = 1850\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$
		-7.5	-5	-	dBm	VCC=1.8V, $f_1 = 1713\text{ MHz}, f_2 = 1850\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$
		-3.5	-1	-	dBm	VCC=2.8V, $f_1 = 1713\text{ MHz}, f_2 = 1850\text{ MHz},$ $P_1=P_2=-20\text{ dBm}$

¹Based on application described in chapter 4²PCB losses are substrated³Verification based on AQL; not 100% tested in production

3 Application Information

Pin Configuration and Function

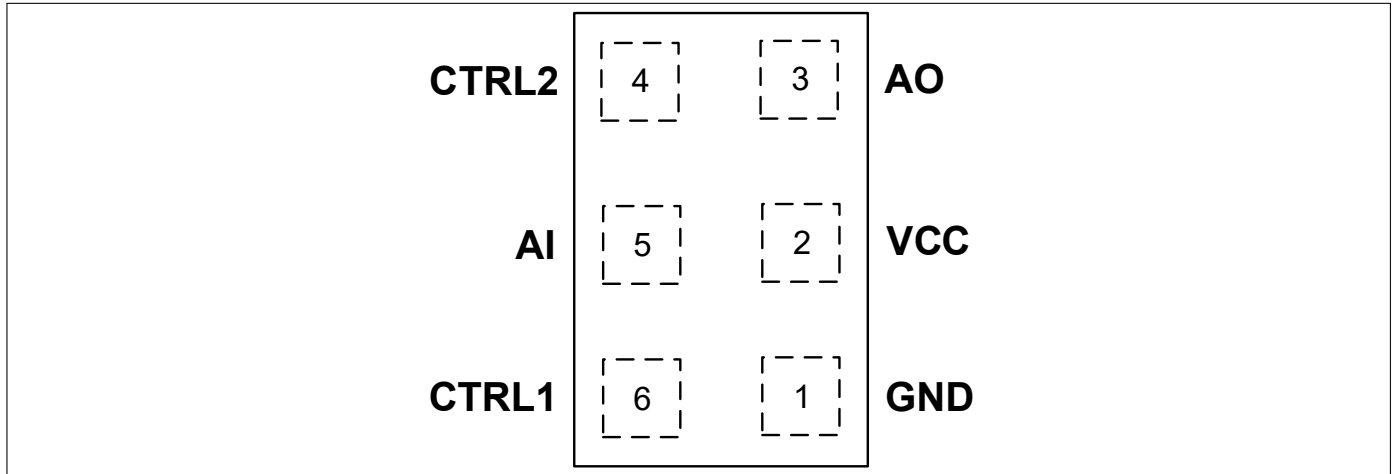


Figure 1: BGA525N6 Pin Configuration (top view)

Table 9: Pin Definition and Function

Pin No.	Name	Function
1	GND	Ground
2	VCC	DC Supply
3	AO	LNA Output
4	CTRL2	Control Pin 2
5	AI	LNA Input
6	CTRL1	Control Pin 1

Table 10: Gain Mode Selection Truth Table

Control Voltage V_{CTRL1}	Control Voltage V_{CTRL2}	Gain Mode
Low	High	High Gain Mode
High	Low	Standard Mode
High	High	Low Power Mode
Low	Low	OFF Mode

BGA525N6

Broadband Low Power LNA for L1/L2/L5 GNSS Applications

Application Information

Application Board Configuration

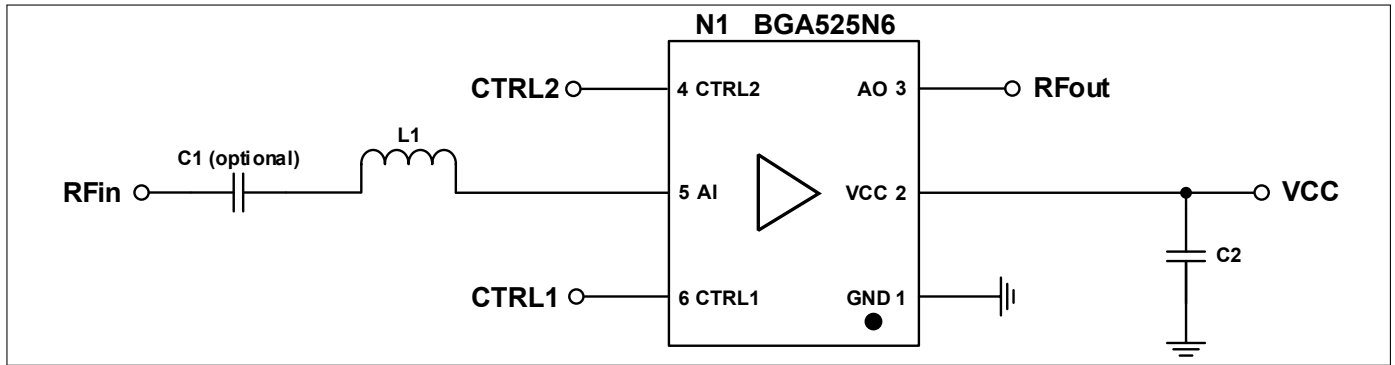


Figure 2: BGA525N6 Application Schematic for L1/L2/L5

Table 11: Bill of Materials Table

Name	Value	Package	Manufacturer	Function
C1	1nF	0402	Various	DC Block
C2	68pF	0402	Various	bypass ¹
L1	see Matching Table	0402	Murata LQW15 type	Input matching
N1	BGA525N6	PG-TSNP-6-10	Infineon	GNSS LNA

Table 12: Matching Table

Band	Operation Mode	Matching Inductor
L1 & L2/L5	Low Power - 1.5mA	12 nH
	Standard - 2.3mA	11 nH
	High Power - 3.6mA	10 nH

BGA525N6

Broadband Low Power LNA for L1/L2/L5 GNSS Applications

Package Information

4 Package Information

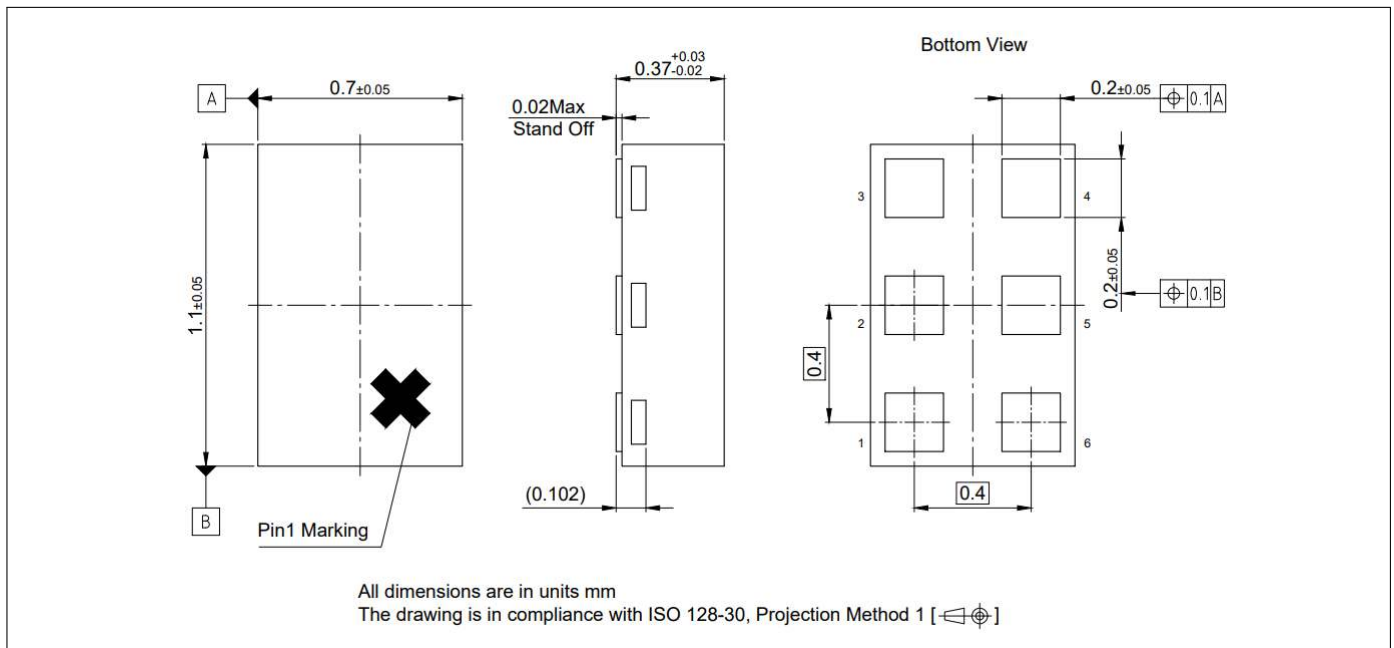


Figure 3: PG-TSNP-6-10 Package Outline (0.7mm x 1.1mm x 0.37mm)

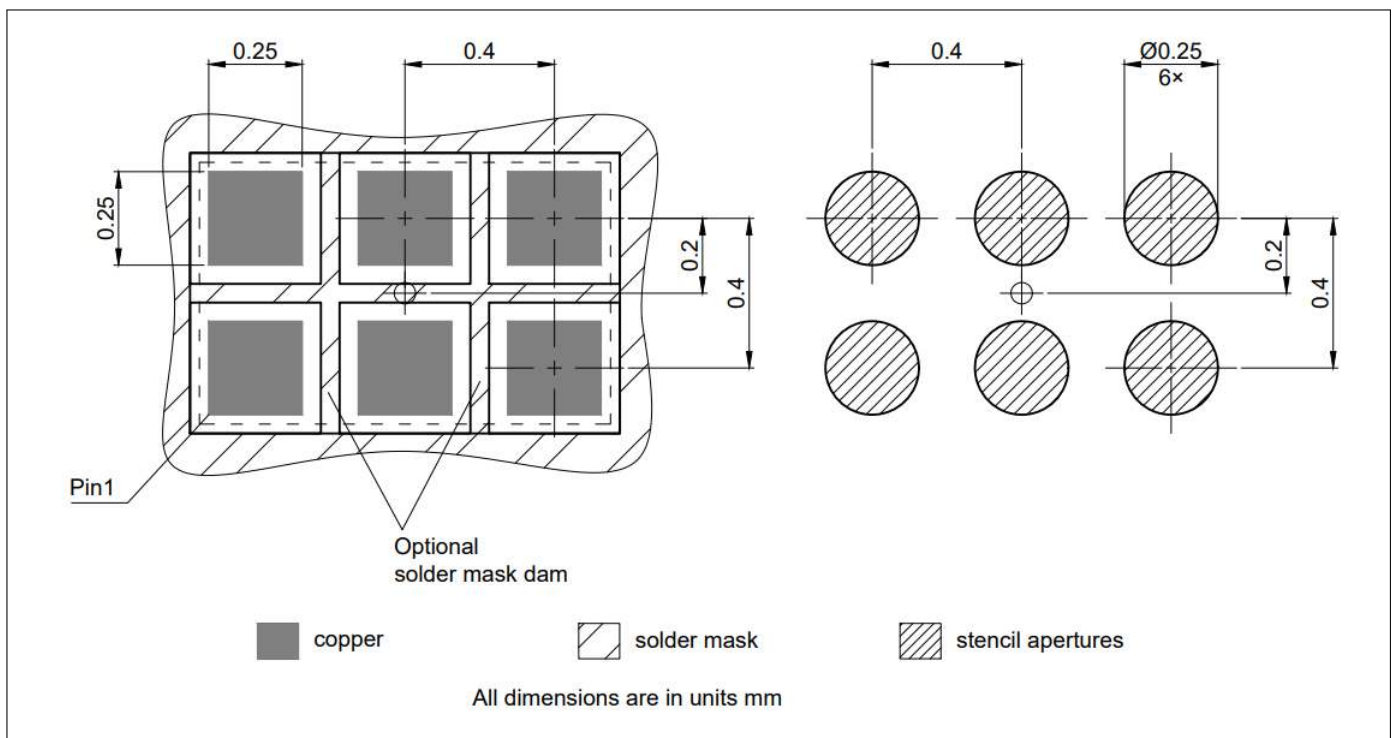


Figure 4: Footprint Recommendation

Package Information

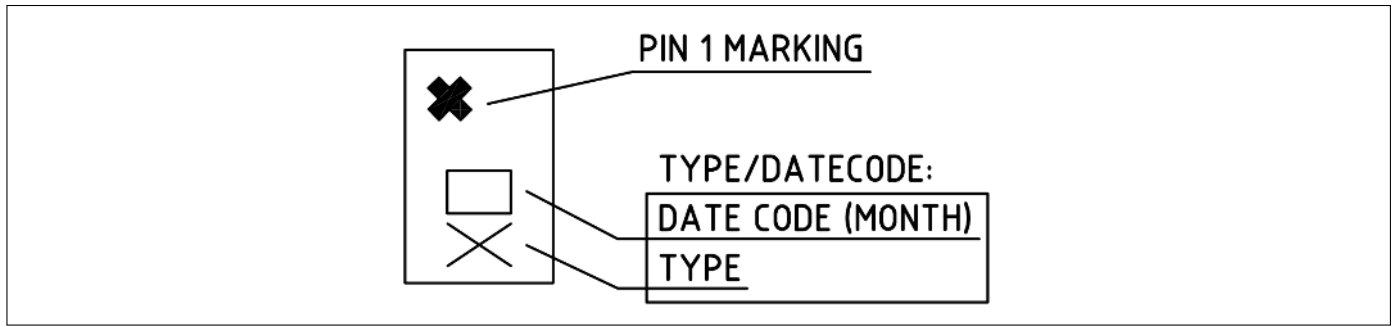


Figure 5: Marking Specification (top view)

Table 13: Monthly Date Code Marking

Month	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
1	a	p	A	P	a	p	A	P	a	p	A	P
2	b	q	B	Q	b	q	B	Q	b	q	B	Q
3	c	r	C	R	c	r	C	R	c	r	C	R
4	d	s	D	S	d	s	D	S	d	s	D	S
5	e	t	E	T	e	t	E	T	e	t	E	T
6	f	u	F	U	f	u	F	U	f	u	F	U
7	g	v	G	V	g	v	G	V	g	v	G	V
8	h	x	H	X	h	x	H	X	h	x	H	X
9	j	y	J	Y	j	y	J	Y	j	y	J	Y
10	k	z	K	Z	k	z	K	Z	k	z	K	Z
11	l	2	L	4	l	2	L	4	l	2	L	4
12	n	3	N	5	n	3	N	5	n	3	N	5

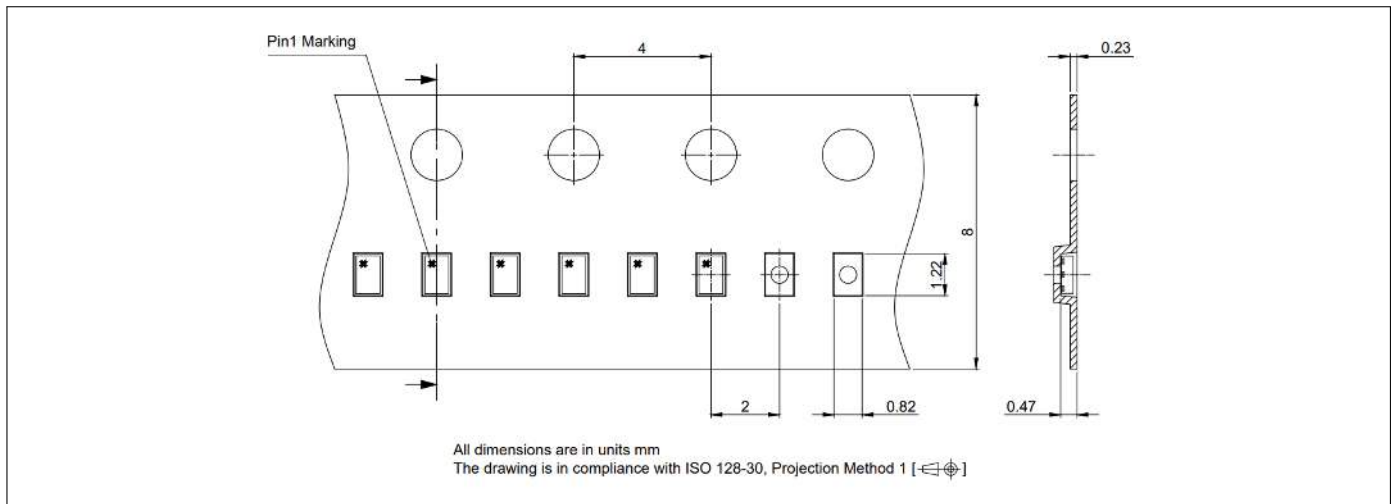


Figure 6: PG-TSNP-6-10 Carrier Tape



Revision History

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Page or Item	Subjects (major changes since previous revision)
Revision 1.0, 2023-05-12	

Revision History

	Final Data Sheet Creation

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Edition 2023-05-12
Published by
Infineon Technologies AG
81726 Munich, Germany

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