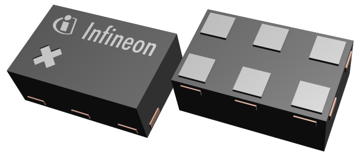
BGA525N6

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 (inluding 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
Green

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:

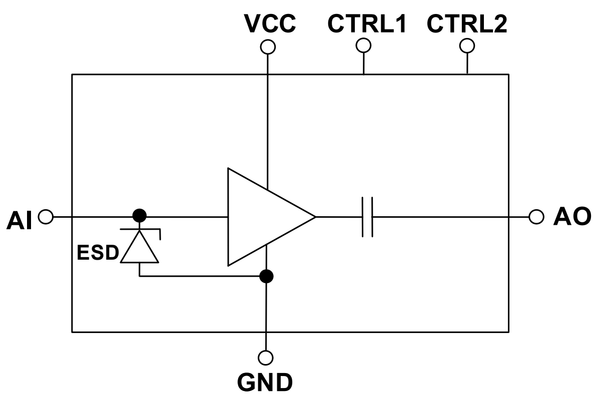
- Low-Power Mode: small battery powered GNSS devices
- Standard Mode: best balance between power consumption and performance
- High-Gain Mode: lowest Noise Figure and fastest Time-To-First-Fix

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

Table of Contents

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.

[1] All voltages refer to GND-Nodes unless otherwise noted
[2] No external DC Voltage allowed
[3] Human Body Model ANSI/ESDA/JEDEC JS-001 (R = 1.5 kΩ, C = 100 pF)
[4] Field-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.

2 Electrical Characteristics

Table 2: Operation ranges at T_A = 25 °C, f = 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 * VCC	–	VCC	V	logic H
	V_{IL}	0	–	0.3 * VCC	V	logic L
Stability	k	>1	–	–		f=20 MHz–10 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

[1] Based on application described in chapter 4

Table 3: Electrical Characteristics at T_A = 25 °C, Low Power Mode, f = 1164– 1300 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 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 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 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 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 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 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_{3OOB}	-7	-4.5	–	dBm	VCC=1.2V, f_1 = 1785 MHz, f_2 = 2401 MHz, P_1=P_2=−20 dBm
		-7.5	-5	–	dBm	VCC=1.8V, f_1 = 1785 MHz, f_2 = 2401 MHz, P_1=P_2=−20 dBm
		-8	-5.5	–	dBm	VCC=2.8V, f_1 = 1785 MHz, f_2 = 2401 MHz, P_1=P_2=−20 dBm

[1] Based on application described in chapter 4
[2] PCB losses are substrated
[3] Verification based on AQL; not 100% tested in production

Table 4: Electrical Characteristics at T_A = 25 °C, Standard Mode, f = 1164– 1300 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 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 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 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 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 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 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_{3OOB}	-2	0.5	–	dBm	VCC=1.2V, f_1 = 1785 MHz, f_2 = 2401 MHz, P_1=P_2=—20 dBm
		-5	-2.5	–	dBm	VCC=1.8V, f_1 = 1785 MHz, f_2 = 2401 MHz, P_1=P_2=—20 dBm
		-5	-2.5	–	dBm	VCC=2.8V, f_1 = 1785 MHz, f_2 = 2401 MHz, P_1=P_2=—20 dBm

[1]Based on application described in chapter 4
[2]PCB losses are substrated
[3]Verification based on AQL; not 100% tested in production

Table 5: Electrical Characteristics at T_A = 25 °C, High Gain Mode, f = 1164– 1300 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 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 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 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 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 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 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_{3OOB}	-1.5	1	–	dBm	VCC=1.2V, f_1 = 1785 MHz, f_2 = 2401 MHz, P_1=P_2=−20 dBm
		-1.5	1	–	dBm	VCC=1.8V, f_1 = 1785 MHz, f_2 = 2401 MHz, P_1=P_2=−20 dBm
		-3	-0.5	–	dBm	VCC=2.8V, f_1 = 1785 MHz, f_2 = 2401 MHz, P_1=P_2=−20 dBm

[1] Based on application described in chapter 4
[2] PCB losses are substrated
[3] Verification based on AQL; not 100% tested in production

Table 6: Electrical Characteristics at T_A = 25 °C, Low Power Mode, f = 1550– 1615 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 MHz	$\lvert S_{21}\rvert^2$	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 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 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 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 MHz	$1/\lvert S_{12}\rvert^2$	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 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_{3OOB}	-7.5	-5	–	dBm	VCC=1.2V, f_1 = 1713 MHz, f_2 = 1850 MHz, P_1=P_2=−20 dBm
		-10	-7.5	–	dBm	VCC=1.8V, f_1 = 1713 MHz, f_2 = 1850 MHz, P_1=P_2=−20 dBm
		-11	-8.5	–	dBm	VCC=2.8V, f_1 = 1713 MHz, f_2 = 1850 MHz, P_1=P_2=−20 dBm

[1]Based on application described in chapter 4
[2]PCB losses are substrated
[3]Verification based on AQL; not 100% tested in production

Table 7: Electrical Characteristics at T_A = 25 °C, Standard Mode, f = 1550– 1615 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 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 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 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 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 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 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_{3OOB}	-7.5	-5	–	dBm	VCC=1.2V, f_1 = 1713 MHz, f_2 = 1850 MHz, P_1=P_2=−20 dBm
		-5.5	-3	–	dBm	VCC=1.8V, f_1 = 1713 MHz, f_2 = 1850 MHz, P_1=P_2=−20 dBm
		-7.5	-5	–	dBm	VCC=2.8V, f_1 = 1713 MHz, f_2 = 1850 MHz, P_1=P_2=−20 dBm

[1] Based on application described in chapter 4
[2] PCB losses are substrated
[3] Verification based on AQL; not 100% tested in production

Table 8: Electrical Characteristics at T_A = 25 °C, High Gain Mode, f = 1550– 1615 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 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 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 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 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 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 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_{3OOB}	-9.5	-7	–	dBm	VCC=1.2V, f_1 = 1713 MHz, f_2 = 1850 MHz, P_1=P_2=−20 dBm
		-7.5	-5	–	dBm	VCC=1.8V, f_1 = 1713 MHz, f_2 = 1850 MHz, P_1=P_2=−20 dBm
		-3.5	-1	–	dBm	VCC=2.8V, f_1 = 1713 MHz, f_2 = 1850 MHz, P_1=P_2=−20 dBm

[1] Based on application described in chapter 4
[2] PCB losses are substrated
[3] Verification based on AQL; not 100% tested in production

3 Application Information

Pin Configuration and Function

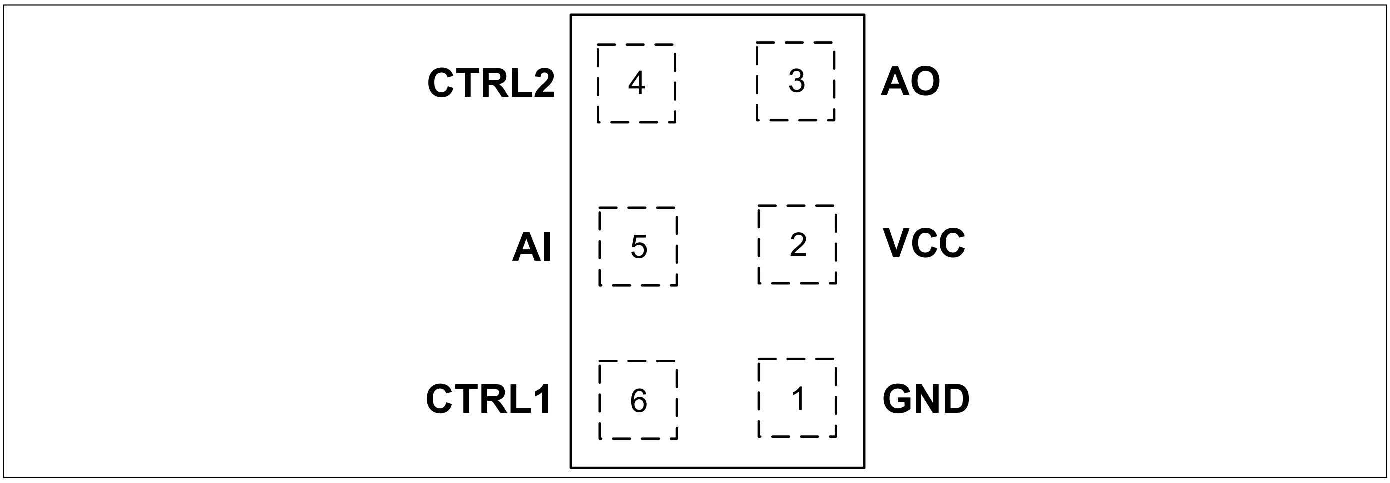


Figure 1: BGA525N6 Pin Configuration (top view)

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

Application Board Configuration

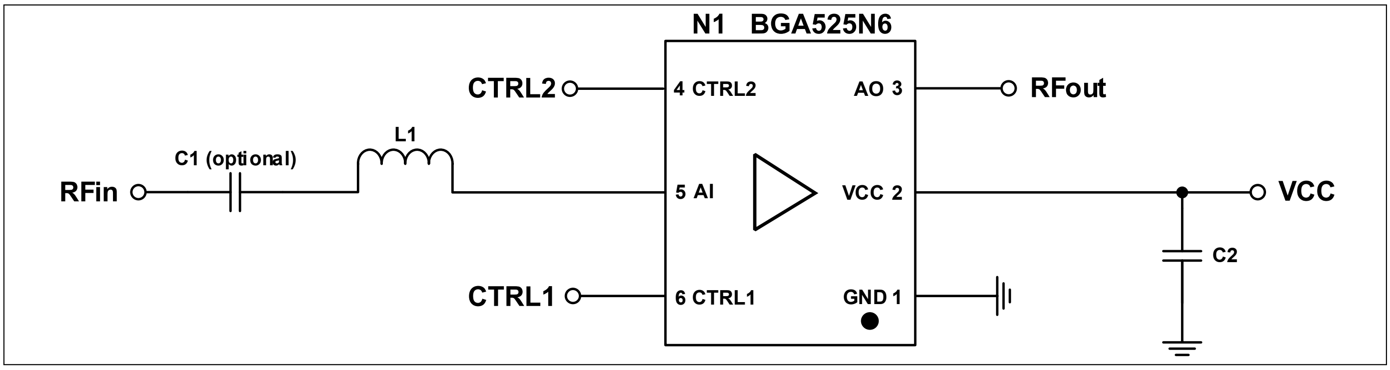


Figure 2: BGA525N6 Application Schematic for L1/L2/L5

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

4 Package Information

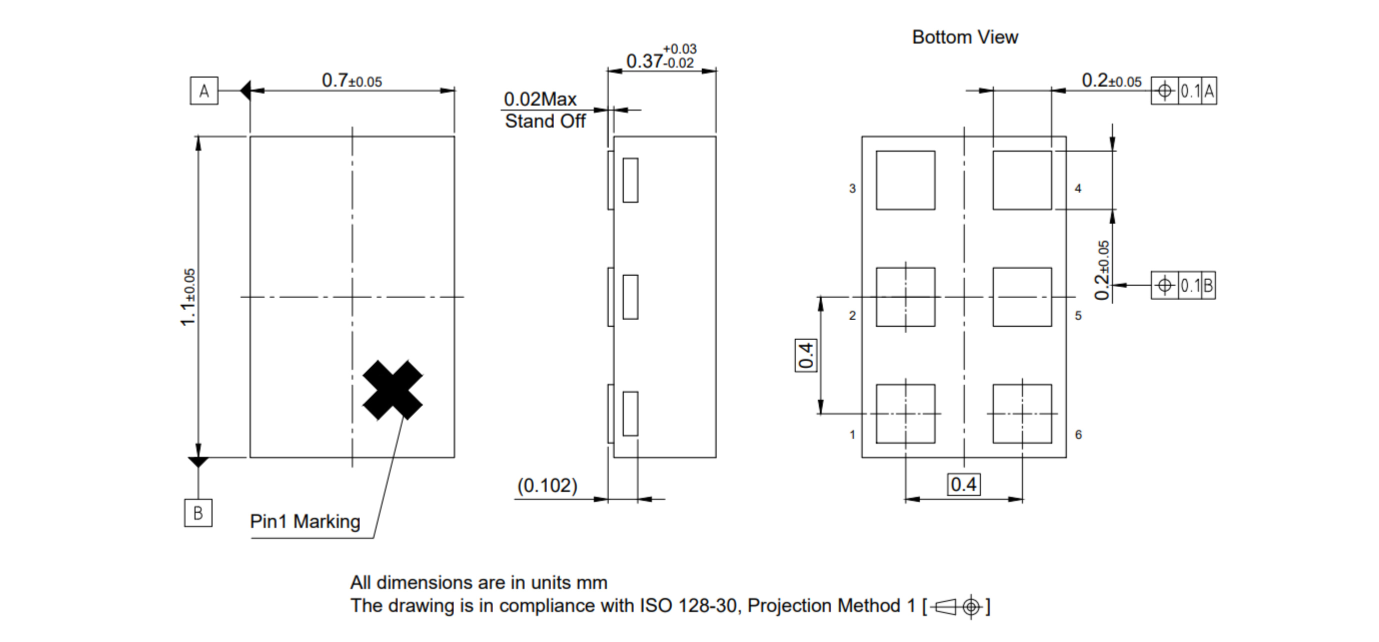


Figure 3: PG-TSNP-6-10 Package Outline (0.7mm x 1.1mm x 0.37mm)

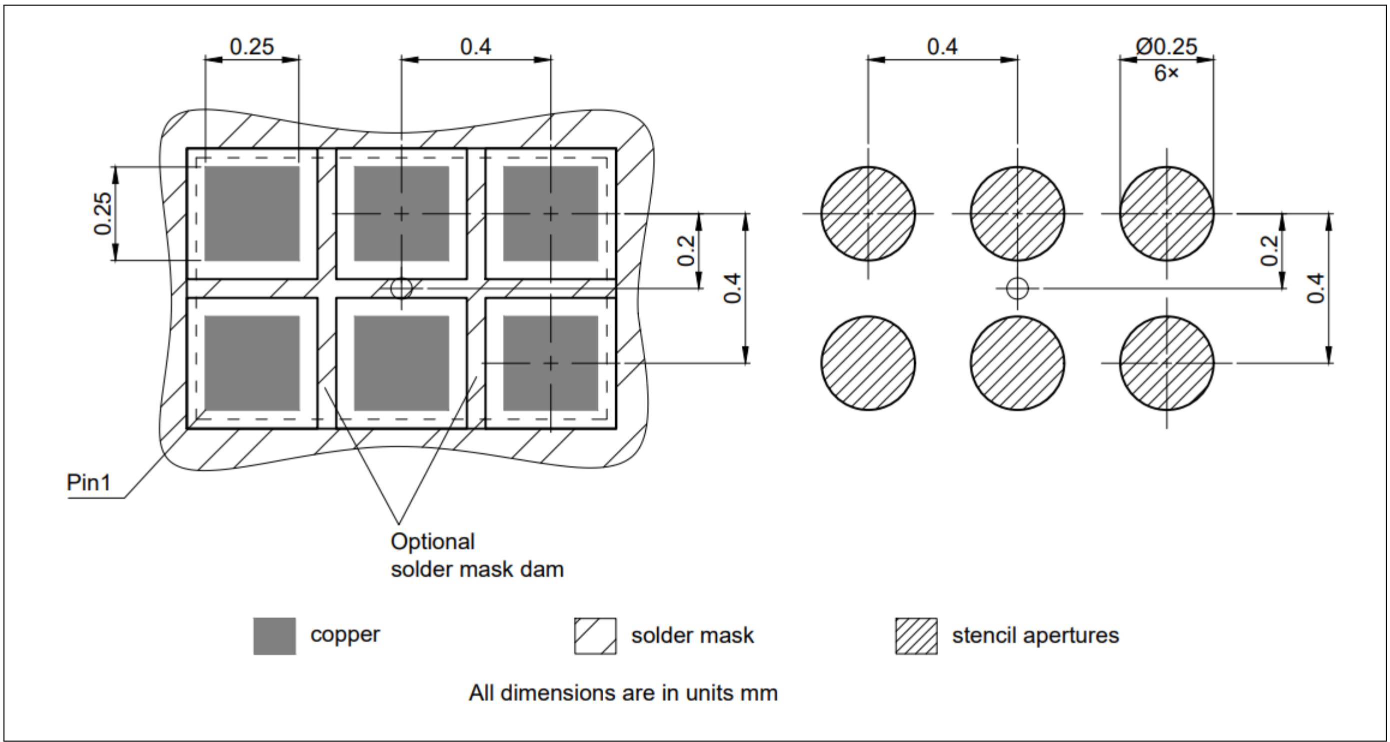


Figure 4: Footprint Recommendation

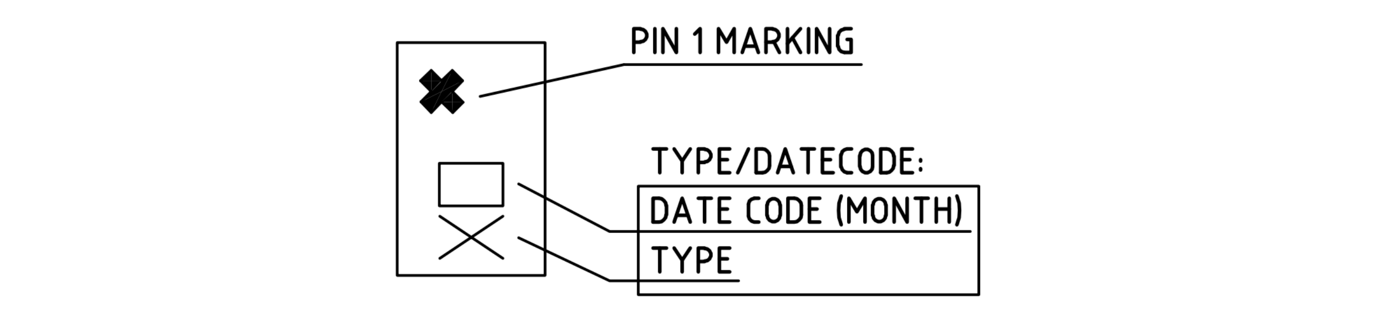


Figure 5: Marking Specification (top view)

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

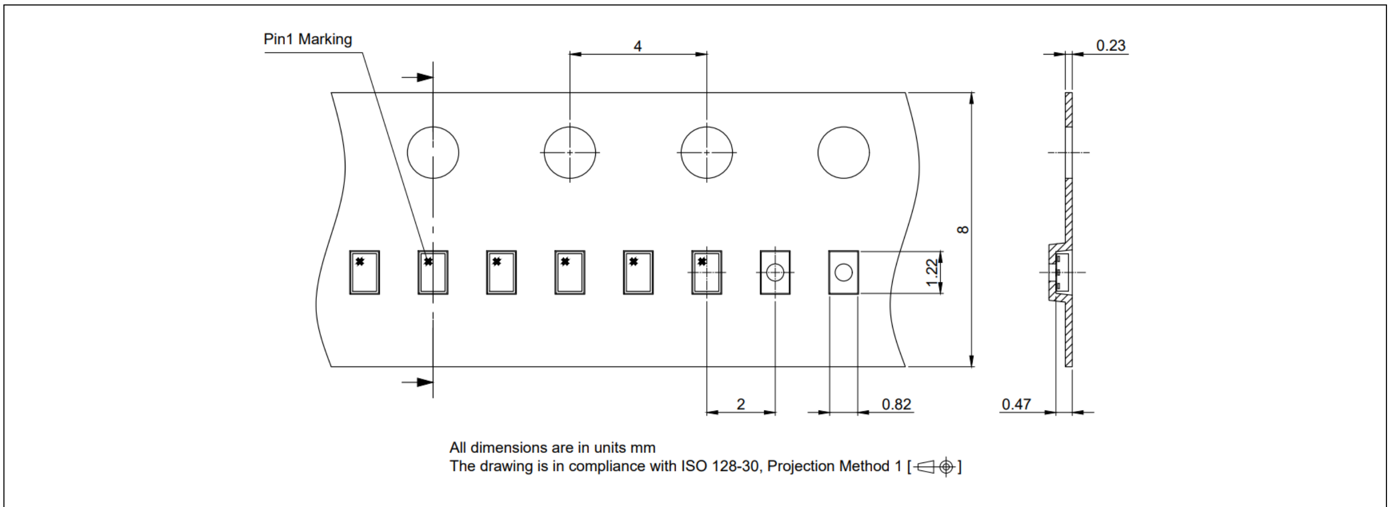


Figure 6: PG-TSNP-6-10 Carrier Tape

Revision History	
–	
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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