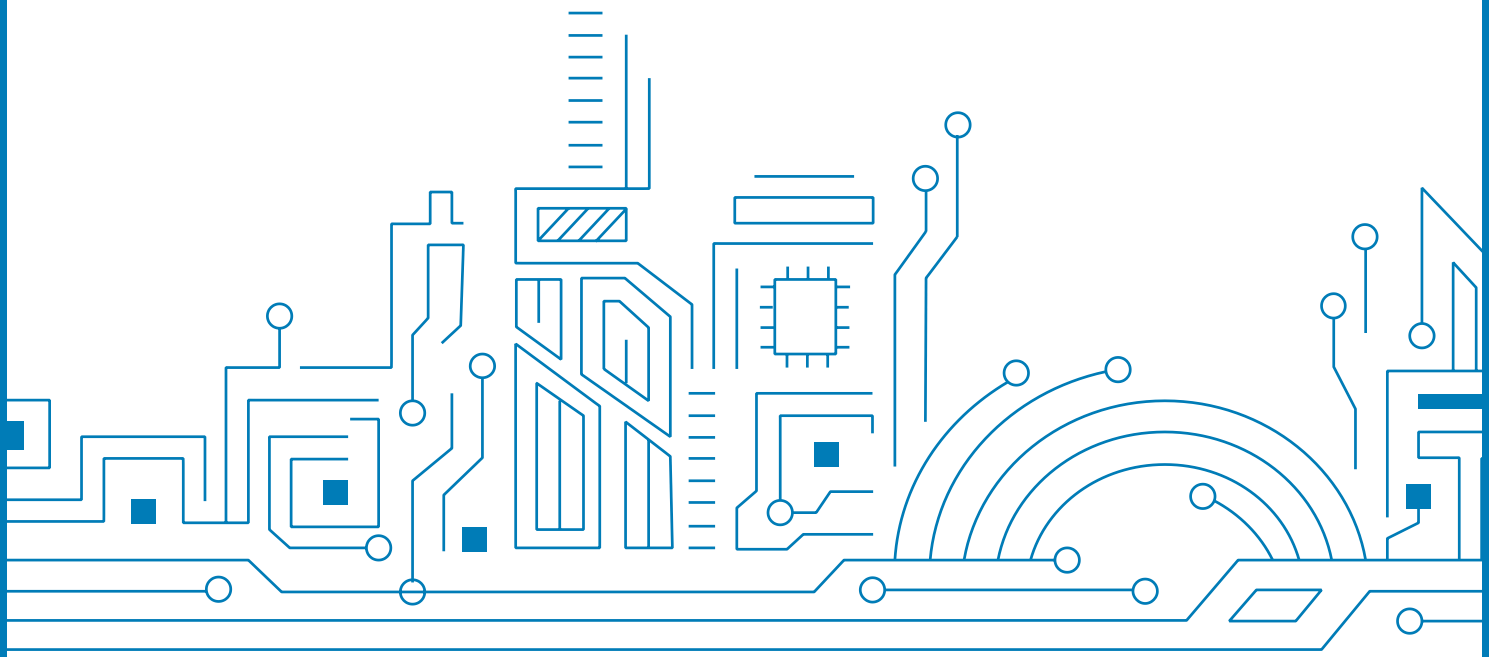
Multi-Band GNSS RTK Module

TAU1312

Datasheet V1.4



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About the Document

■ Basic info

Document applies to	TAU1312
Document type	Datasheet
Revision and date	V1.4/2022-10
Product status	Mass production

■ Product status description

In development	Objective specification. Revision may be released in later status.
Engineering sample	Product specifications tested on early. Revision may be released in later status.
Preliminary	Product specifications come from small production. Revision may be released in later status.
Mass production	Final product specification to mass market.

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1 SYSTEM OVERVIEW

1.1 Overview

TAU1312 is a high-performance dual-band RTK positioning module, which is based on the state of the art CYNOSURE III SoC architecture. It supports GPS, BeiDou, GLONASS, Galileo, and QZSS. TAU1312 integrates efficient power management architecture, while providing high precision, high sensitivity and low power GNSS solutions which make it suitable for navigation applications on automotive and consumer electronics, as well as fleet management.

1.2 Features

- Supports GPS, BDS, GLONASS, Galileo, and QZSS
- Compact size for high precision industry
- Integrated Real Time Kinematics (RTK)
- State-of-art low power consumption design
- Supports multi-band multi-system high-precision raw data output, easy for 3rd party integration
- Highly integrated module, the best cost-effective high precision GNSS solution

Table 1 TAU1312

Product	GNSS						Feature							Interface				Accuracy			Grade	
	Band (S/D/T)	GPS	BDS	GLONASS	Galileo	NavIC	Built-in LNA	Programmable (flash)	Data logging	D-GNSS	Oscillator	Raw Data	RTK	UART	I2C	USB	SPI	Meter	Sub-meter	Centimeter	Industrial	Automotive
TAU1312-1216A00E	D	●	●	●	●			●	●	●	T	●	●	●	○	○	○			●	●	

T = TCXO ○ = Supported upon request with special firmware

1.3 Module photo

Figure 1 TAU1312 module photo

1.4 Block diagram

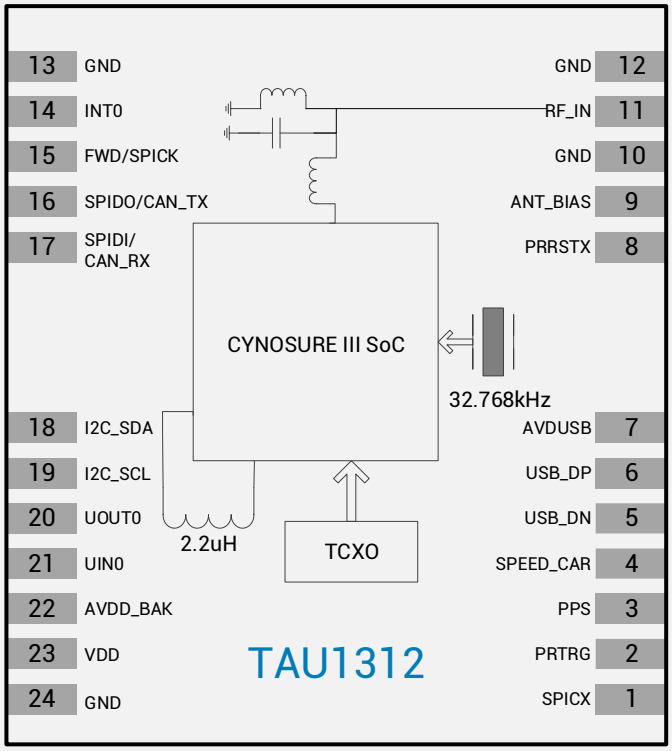


Figure 2 Block diagram

1.5 Specifications

Table 2 Specifications

Parameter	Specification	
GNSS tracking channels	40	
GNSS reception	GPS/QZSS: L1C/A, L2C, L5	
	BDS: B1I, B2I, B2a	
	GLONASS: G1, G2	
	Galileo: E1, E5a	
Update rate	PVT	5 Hz Max.
	RTK	5 Hz Max.
Position accuracy[1]	GNSS	1m CEP
	D-GNSS	<1.0m CEP
	RTK	1.0 cm+1 ppm(H)
		3.0 cm+1 ppm(V)
Velocity & Time accuracy	GNSS	0.1 m/s CEP
	1PPS	20 ns
Time to First Fix (TTFF)	Hot start	2 secs
	Cold start	24 secs
	RTK convergence	<10s
Sensitivity	Cold start	-148 dBm

	Hot start	-158 dBm
	Reacquisition	-160 dBm
	Tracking & navigation	-162 dBm
Operating limit	Velocity	515 m/s
	Altitude	18,000m
Antenna supervision	Antenna short circuit protection and open circuit detection.	
Serial interface	UART	1
	SPI[2]	1
	USB[2]	1
	I2C[2]	1
	CAN[2]	1
Protocol	NMEA 0183 Protocol Ver. 4.00/4.10 RTCM 3.0/3.2/2.3/2.4x[3] Cynosure GNSS Receiver Protocol	
Operating condition	Main voltage	2.0V - 3.6V
	Digital I/O voltage	1.8V - 3.6V
	Backup voltage	1.8V - 3.6V
Power consumption	GPS/QZSS, L1 band	22 mA[4]
	GNSS, L1+L5 band	34 mA[5]
	GNSS, L1+L2 band	34 mA[6]
	Standby	12 uA[7]
Operating temperature	-40°C to +85°C	
Storage temperature	-40°C to +85°C	
Package	12.2x16.0x2.4 mm 24-pin stamp hole	
Certification	RoHS, REACH, FCC, CE-RED	

* *[1] Demonstrated with a good external LNA*
* *[2] Supported upon request with special firmware*
* *[3] RTCM 2.3/2.4x are supported upon request with special firmware.*
* *[4] Open sky conditions, GPS/QZSS, L1 band, 16 tracked Satellites*
* *[5] Open sky conditions, GPS/QZSS+BDS+Galileo, L1+L5 band, 32 tracked Satellites*
* *[6] Open sky conditions, GPS/QZSS+BDS+Galileo, L1+L2 band, 32 tracked Satellites*
* *[7] Standby under RTC mode, wake up by PRTRG and RTC time-out*

1.6 GNSS Reception

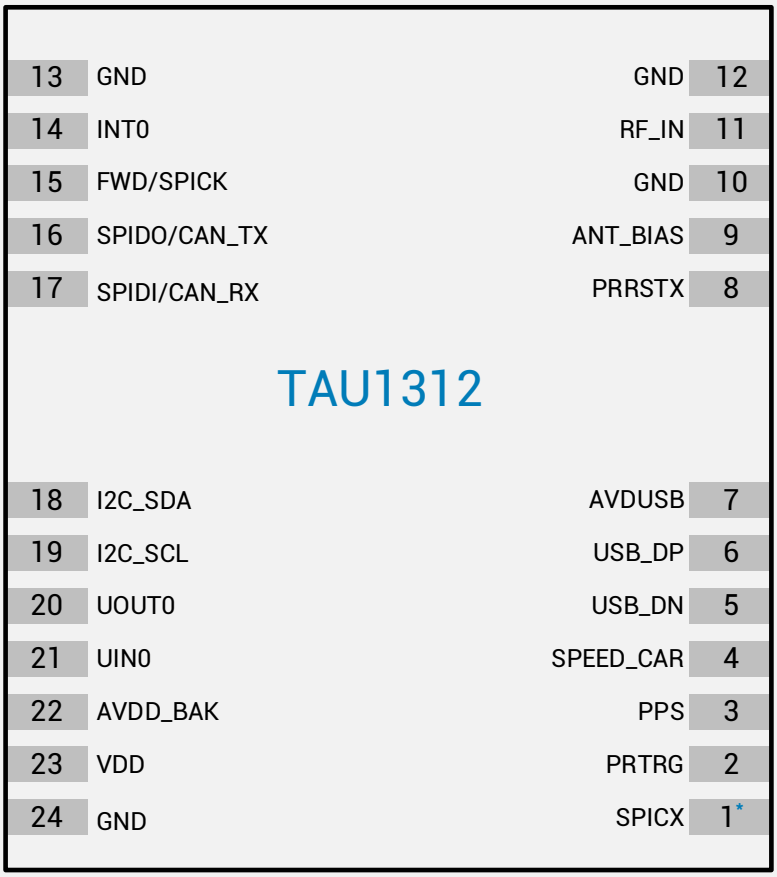
Table 3 GNSS reception table

P/N	GNSS mode	GPS/QZSS					BDS					GLONASS		Galileo			NavIC
		L1C/A	L1C	L2C	L5	L6	B1I	B1C	B2I	B2a	B3I	G1	G2	E1	E5	E6	L5
TAU1312-1216A00E	A (L1+ L5)	•	-	-	•	-	•	-	-	•	-	•	-	•	•[1]	-	-
	B (L1+ L2)	•	-	•[2]	-	-	•	-	•	-	-	•	•	•	-	-	-

* *[1] Supports E5a and Pilot channel only*
* *[2] Supports L2CM*

2 PIN DESCRIPTION

2.1 Pin assignment



* *Pin 1 aligns to the circular hole on module cover.*

Figure 3 Pin assignment (top view)

2.2 Detailed pin descriptions

Table 4 Detailed pin descriptions

Function	Symbol	No.	I/O	Description
Power	VDD	23	Power	Main voltage supply.
	GND	10, 12, 13, 24	VSS	Assure a good GND connection to all GND pins of the module, preferably with a large ground plane.
	AVDD_BAK	22	Power	Backup voltage supply.
	AVDUSB	7	Power	USB voltage supply. To use the USB interface, connect this pin to 3.0V - 3.6V.
Antenna	RF_IN	11	I	Use a controlled impedance of 50Ω for the routing from RF_IN pin to the antenna or the antenna connector.
	ANT_BIAS	9	O	RF section output voltage. The ANT_BIAS pin can be used to supply powers to an external active antenna.
UART	UOUT0	20	O	UART0 serial data output.
	UIN0	21	I	UART0 serial data input.
USB[1]	USB_DN	5	I/O	USB I/O line. USB bidirectional communication pin. Leave it floating if not used.
	USB_DP	6	I/O	
SPI[1]	SPICX	1	O	SPI chip select
	FWD/SPICK	15	O	SPI clock
	SPIDO/CAN_TX	16	O	SPI data or CAN data output. Leave it floating if not used.
	SPIDI/CAN_RX	17	I	SPI data or CAN data input. Leave it floating if not used.
I2C[1]	I2C_SDA	18	I/O	I^2C data. Leave it floating if not used.
	I2C_SCL	19	I/O	I^2C clock. Leave it floating if not used.
System	PRTRG	2	I	Mode selection, or the trigger input in deep sleep mode to wake up the system
	PRRSTX	8	I	Low active Connect this pin to the Host
	PPS	3	O	Time pulse output (PPS)
	SPEED_CAR[1]	4	I	Speed pulse. Leave it floating if not used. Default GPIO.
	INT0	14	I	External interrupt. Leave it floating if not used. Default GPIO.

* *[1] Supported upon request with special firmware.*

3 ELECTRICAL CHARACTERISTICS

3.1 Absolute Maximum Rating

Table 5 Absolute rating

Symbol	Parameter	Min.	Max.	Unit
VDD	Power input for the main power domain	-0.5	3.63	V
AVDD_BAK	Power input for the backup power domain	-0.5	3.63	V
AVDUSB	USB supply voltage	-0.5	3.6	V
$T_{storage}$	Storage temperature	-40	85	°C
T_{solder}	Solder reflow temperature	--	260	°C

3.2 IO Characteristics

3.2.1 PRRSTX and PRTRG

Table 6 PRRSTX and PRTRG

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I_{IZ}	Input leakage current	--	--	--	+/-1	uA
V_{IH}	Input high voltage	--	AVDD_BAK*0.7	--	AVDD_BAK	V
V_{IL}	Input low voltage	--	0	--	AVDD_BAK*0.3	V
C_i	Input capacitance	--	--	--	10	pF
R_{PU}	Pull-up resistance	--	18	--	84	kOhm

3.2.2 USB I/O

Table 7 USB signal

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I_{IZ}	Input leakage current	--	--	--	+/-10	uA
V_{IH}	Input high voltage	--	AVDUSB*0.9	--	AVDUSB	V
V_{IL}	Input low voltage	--	0	--	AVDUSB*0.1	V
V_{OH}	Output high voltage	I_{OH} = 10 mA, AVDUSB = 3.3V	2.35	--	--	V
V_{OL}	Output low voltage	I_{OL} = 10 mA, AVDUSB = 3.3V	--	--	0.5	V
R_{PUIDEL}	Pull-up resistance, idle state	--	0.9	--	1.575	kOhm
$R_{PUACTIVE}$	Pull-up resistance, active state	--	1.425	--	3.09	kOhm

3.2.3 Others

Table 8 Others

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I_{IZ}	Input leakage current	--	--	--	+/-1	uA
V_{IH}	Input high voltage	--	VDD*0.7	--	VDD	V
V_{IL}	Input low voltage	--	0	--	VDD*0.3	V
V_{OH}	Output high voltage	I_{OH} = 11.9 mA, VDD = 3.3V	2.64	--	--	V
V_{OL}	Output low voltage	I_{OL} = 7.9 mA, VDD = 3.3V	--	--	0.4	V
C_i	Input capacitance	--	--	--	11	pF
R_{PU}	Pull-up resistance	--	35	--	84	kOhm

3.3 DC Characteristics

3.3.1 Operating Conditions

Table 9 Operating conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
VDD	Power input for the main power domain	2.0	3.3	3.6	V
AVDD_BAK	Power input for the backup power domain	1.8	3.3	3.6	V
AVDUSB	USB power input	3.0	3.3	3.6	V
I_{ANT_BIAS}	ANT_BIAS output current	--	--	35	mA
V_{ANT_BIAS}	ANT_BIAS output voltage	--	VDD-0.2	--	V
ICC_{max}	Maximum operating current @ VDD	--	--	200	mA
T_{env}	Operating temperature	-40	--	85	°C
$T_{storage}$	Storage temperature	-40	--	85	°C

3.3.2 Power Consumption

Table 10 Power consumption

Symbol	Parameter	Measure Pin	Typ.	Unit
I_{CCRX1}	Average tracking current (GPS/QZSS, L1 only)	VDD[1]	22	mA
I_{CCRX2}	Average tracking current (GNSS, L1+L5)	VDD[1]	34	mA
I_{CCDBM}	Standby mode	AVDD_BAK[2]	12	uA

* *[1] Condition: VDD = 3.3V @ Room Temperature; All Pins Open.*
* *[2] Condition: AVDD_BAK = 3.3V @ Room Temperature; All Pins Open.*

4 HARDWARE DESCRIPTION

4.1 Connecting power

TAU1312 positioning module has two power supply pins: VDD and AVDD_BAK. The VDD pin provides the main supply voltage, and the AVDD_BAK pin provides the backup supply voltage. In order to ensure the positioning performance, please control the ripple of the module power supply. It is recommended to use the LDO above 100 mA.

If the power for VDD pin is off, the real-time clock (RTC) and battery backed RAM (BBR) are supplied through the AVDD_BAK pin. Thus, orbit information and time can be maintained and will allow a Hot or Warm start. If no backup battery is connected, the module performs a cold start at every power up if not aiding data are sent to the receiver.

Note: *If no backup supply is available, connect the AVDD_BAK pin to VDD or leave it floating.*

4.2 Power on/off Sequence

The module has two independent power domains (backup and main domain). In data backup mode, main power supply can be completely shut down for further power reduction for ultra-low power application.

To meet the requirement of controlling the power on/off sequence of the module, please connect the external reset pin (PRRSTX) to the Host.

4.2.1 Initial system power on

When both backup and main supply power on from their off state, external reset (PRRSTX) must be active and hold more than 5 ms after both backup supply and main supply reach the minimum operating voltage. Initial system power on sequence is illustrated in Figure 4.

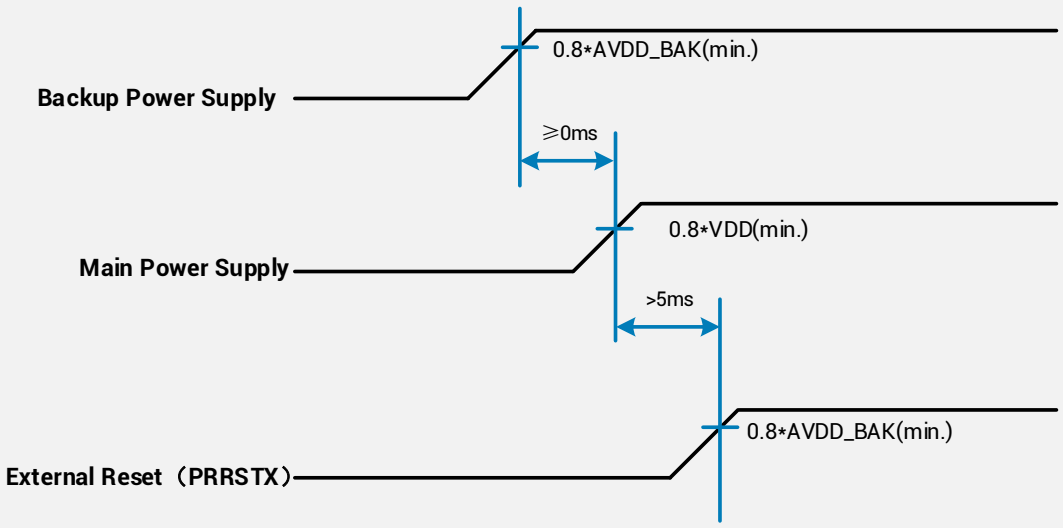


Figure 4 Initial system power on sequence

4.2.2 Main power supply off/on in application

If application intends to shut down main power supply (VDD) while keep backup power supply (AVDD_BAK) alive to save backup data, the following rules should be applied:

External reset (PRRSTX) must be active when main power supply is under power off. In this case, external reset must be hold active more than 5 ms after main power supply resumes to minimum operating voltage. Main power on sequence in application is illustrated in Figure 5.

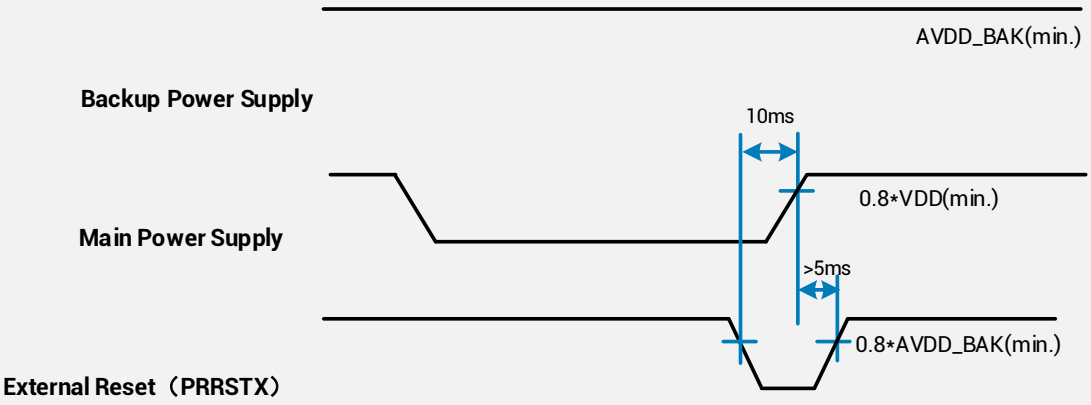


Figure 5 Main power on sequence

4.3 Antenna design

There is no built-in LNA and SAW in the GNSS module. It is recommended to use an active antenna with gain less than 50 dB and the noise figure less than 1.5 dB. The module has built-in short circuit detection and open circuit detection function, which can detect the status of normal connection, and send out antenna status prompt message in NMEA data.

- **Short circuit protection**
  - The module includes internal short circuit antenna detection. Once an overcurrent is detected at the ANT_BIAS port, the module will restrict the current output automatically to protect from damages.
- **Open circuit detection**
  - The module can detect an open circuit in the antenna. Users can judge it from antenna status messages.

Table 11 ANT_BIAS current range and antenna status

Antenna status	Status output	ANT_BIAS current range
Open circuit	OPEN	0 < ANT_BIAS ≤ 1 mA
Regular circuit or open circuit	OK or OPEN	1 mA < ANT_BIAS ≤ 2 mA
Regular circuit	OK	2 mA < ANT_BIAS ≤ 40 mA
Short circuit	SHORT	ANT_BIAS > 40 mA

TIPs:

1. Pulse width of the minimum detectable overshoot current should be more than 10 uS.
2. NMEA message of antenna status output:

- OPEN: $GNTXT,01,01,01,**ANT_OPEN***40
- OK: $GNTXT,01,01,01,**ANT_OK***50
- SHORT: $GNTXT,01,01,01,**ANT_SHORT***06

4.4 Reset and mode control

The operation mode of GNSS module is controlled by PRRSTX (nRESET) and PRTRG (BOOT) pin. While the module works in normal operation, keep PRRSTX and PRTRG pins at high level. The module will enter reset state when PRRSTX being low level. Operate PRTRG and PRRSTX pins as the following instructions to enter **BootROM Command Mode** to update firmware.

- Keep PRTRG pin floating during system power-up or the external reset (PRRSTX from low to high), and the module will enter **User Normal Mode**.
- When the module powers up or PRRSTX from low to high, the module will execute an **external reset**. (If the power for AVDD_BAK is always on, the external reset will not affect the ephemeris data in the backup domain)
- Drive PRTRG pin to low or connect PRTRG to GND directly (not by pull-down resistance) during system power-up or the external reset (PRRSTX from low to high), and the system enters **BootROM Command Mode** at PRTRG pin being released from low to floating state, and ready for firmware upgrading command.
- When connecting PRRSTX and PRTRG to any host IO, DO NOT use the pull-up or pull-down resistance.

5 DEFAULT MESSAGE

Table 12 Default message

Interface	Settings
UART output	115200 baud, 8 data bits, no parity bit, 1 stop bit Configured to transmit both NMEA and HD Binary protocols, but only the following NMEA (and no HD Binary sentence) messages have been activated at start-up: GGA, GSA, GSV, RMC, ZDA, TXT-ANT
UART input	115200 baud, 8 data bits, no parity bit, 1 stop bit, autobauding disabled Automatically accepts the following protocols without need of explicit configuration: HD binary sentence, NMEA, RTCM The GNSS receiver supports interleaved HD binary and NMEA messages.
Timepulse (1Hz Nav)	1 pulse per second, synchronized at rising edge, pulse length 100 ms

* *Refer to GNSS_Protocol_Specification for information about other settings.*

When the module is applied to the specific application where the main supply needs to be cut, in this case, it is recommended to cut the serial interface connection at the same time or set the serial port to input mode or high impedance state.

6 MECHANICAL SPECIFICATION

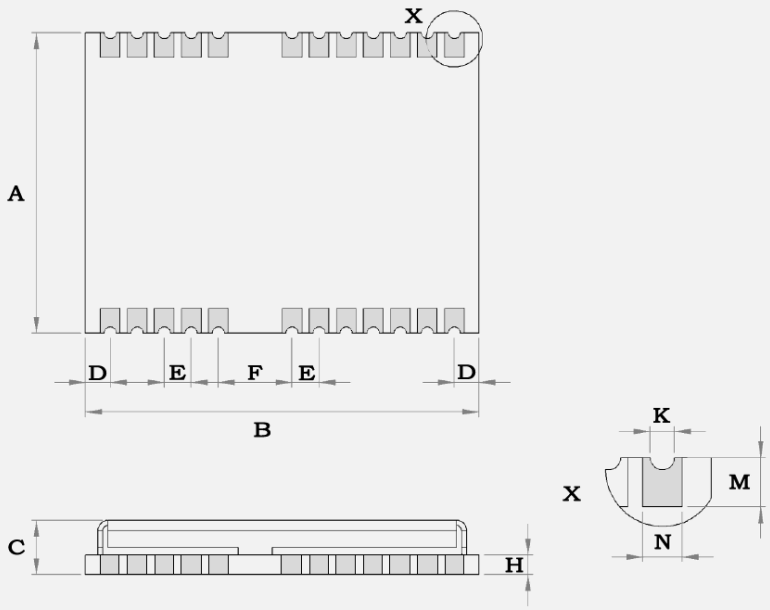


Figure 6 Dimensions

Table 13 Dimensions

Symbol	Min.(mm)	Typ.(mm)	Max.(mm)
A	12.0	12.2	12.4
B	15.8	16.0	16.2
C	2.2	2.4	2.6
D	0.9	1.0	1.3
E	1.0	1.1	1.2
F	2.9	3.0	3.1
H	--	0.8	--
K	0.4	0.5	0.6
M	0.8	0.9	1.0
N	0.7	0.8	0.9

7 REFERENCE DESIGN

7.1 Minimal design

This is the minimal design for TAU1312 GNSS module. The 82 nH inductor is used only when an active antenna is connected, and no need with a passive antenna. The characteristic impedance from RF_IN pin to the antenna connector should be 50Ω.

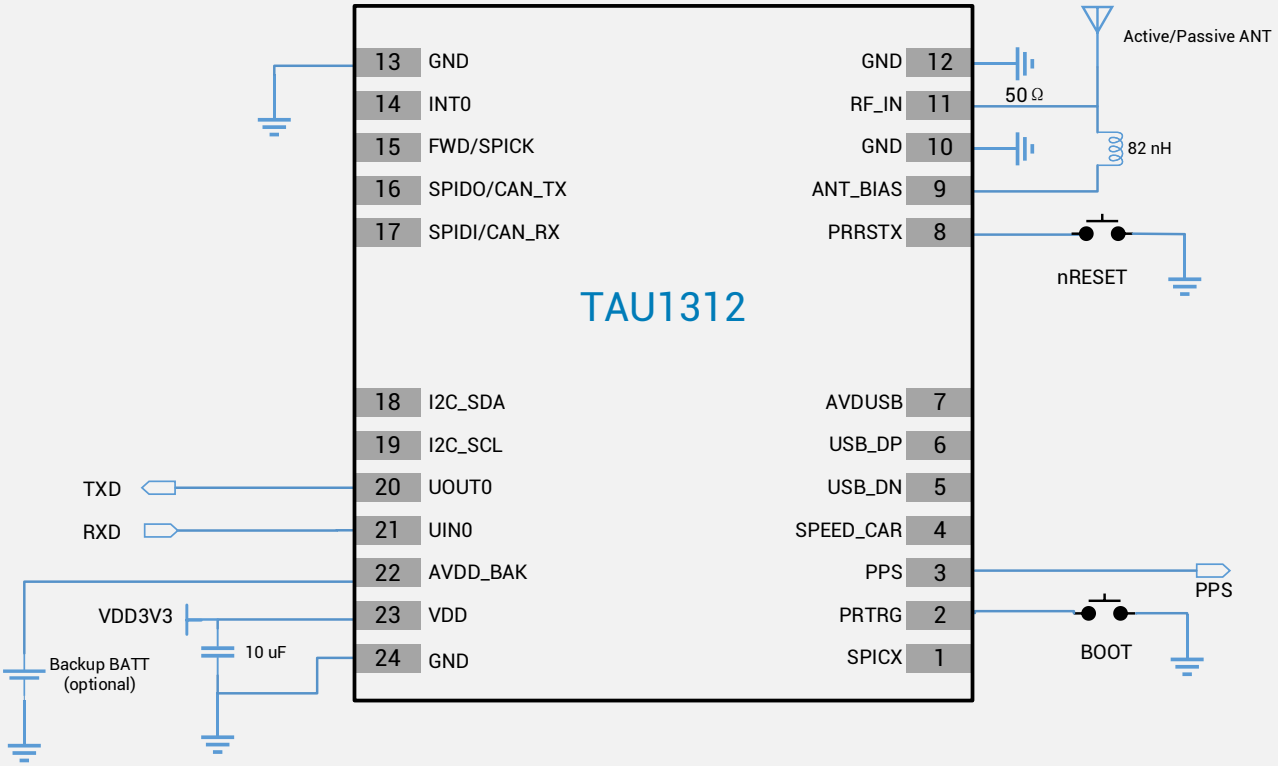


Figure 7 Minimal application diagram

7.2 PCB Footprint Reference

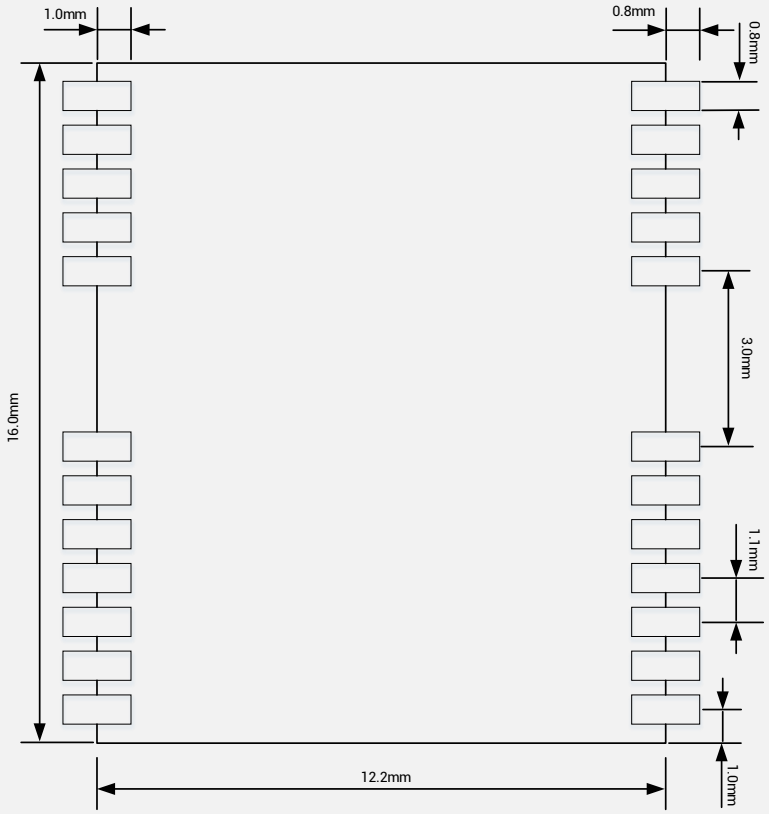


Figure 8 PCB Footprint Reference

7.3 Layout Notes

(1) A decoupling capacitor should be placed close to VDD pin of the module, and the width of power routing should be more than 0.5 mm.
(2) The width of RF routing between RF port to antenna interface should be wider than 0.2 mm. The characteristic impedance of RF routing between RF port to antenna interface should be controlled to 50Ω.
(3) It is recommended that the routing from RF port to antenna interface refers to the second layer, and no routing are recommended on the layer.
(4) Do not place the module close to any EMI source, like antenna, RF routing, DC/DC or power conductor, clock signal or other high-frequency switching signal, etc.

8 PRODUCT PACKAGING AND HANDLING

8.1 Packaging

8.1.1 Packaging Notes

TAU1312 is a Moisture Sensitive Device (MSD) and Electrostatic Sensitive Device (ESD). During the packing and shipping, it is strictly required to take appropriate MSD handling instructions and precautions. The table below shows the general packing hierarchy for the standard shipment.

Table 14 Packing hierarchy

Module	Reel	Sealed bag	Shipping carton
			

8.1.2 Tape and Reel

TAU1312 is delivered as hermetically sealed, reeled tapes in order to enable efficient production, production lot set-up and tear-down. The figure below shows the tape dimensions.

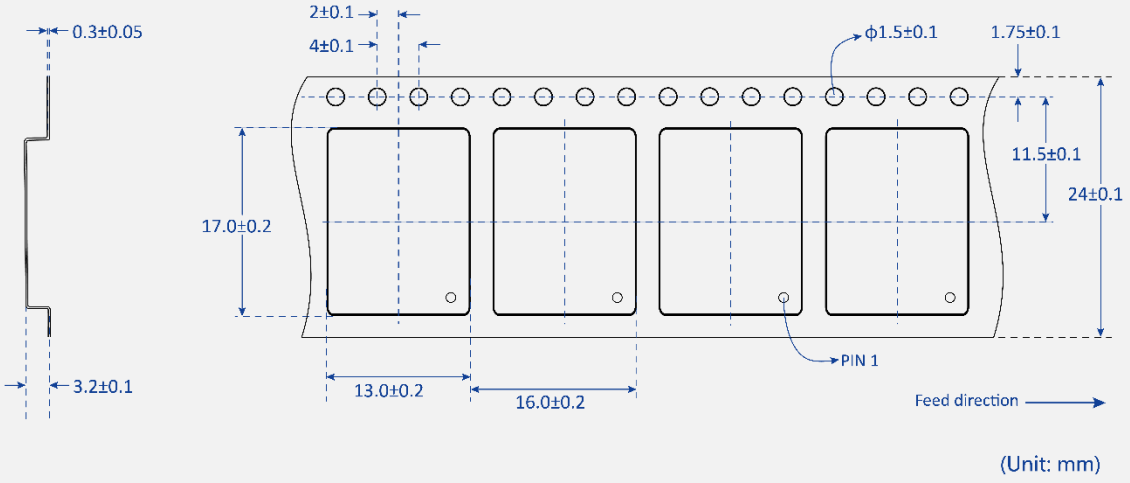


Figure 9 Tape dimensions

TAU1312 is deliverable in quantities of 1000 pcs on a reel. The figure below shows the dimensions of reel for TAU1312.

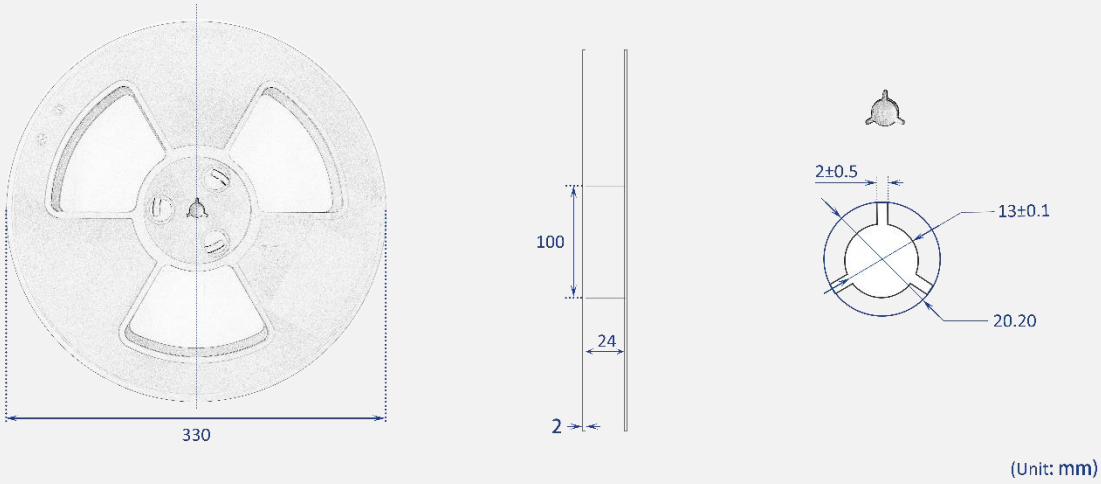


Figure 10 Reel dimensions

8.1.3 Shipment Packaging

The reels of TAU1312 are packed in the sealed bags and shipped by shipping cartons. Up to five sealed bags (5000 pcs in total) can be packed in one shipping carton.

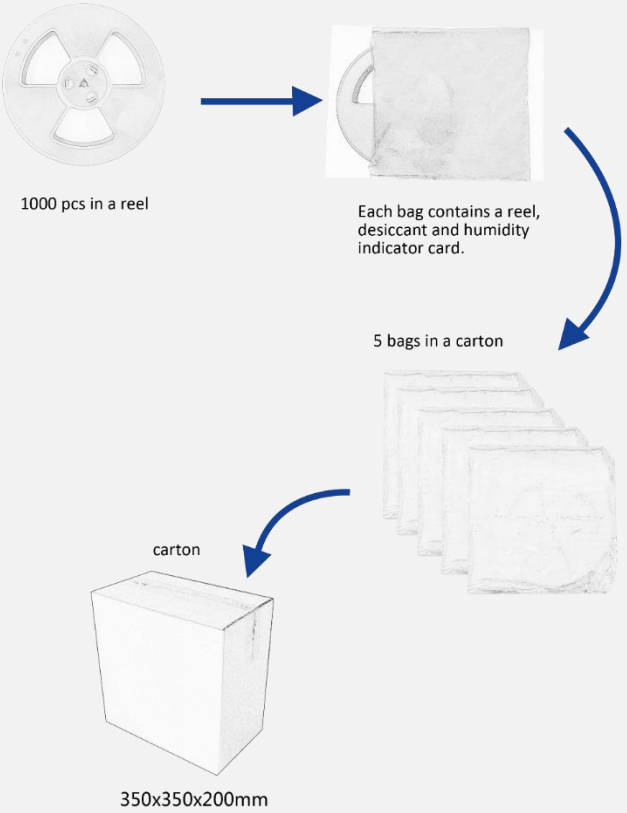


Figure 11 Packaging

8.2 Storage

In order to prevent moisture intake and protect against electrostatic discharge, TAU1312 is packaged together with a humidity indicator card and desiccant to absorb humidity.

8.3 ESD Handling Precautions

TAU1312 module which contains highly sensitive electronic circuitry is an Electrostatic-sensitive Device (ESD). Observe precautions for handling! Failure to observe these precautions can result in severe damage to the GNSS module!

- Unless there is a galvanic coupling between the local GND (i.e. the workbench) and the PCB GND, then the first point of contact when handling the PCB must always be between the local GND and PCB GND.
- Before mounting an antenna patch, connect ground of the device.
- When handling the RF pin, do not come into contact with any charged capacitors and be careful when contacting materials that can develop charges (e.g. patch antenna ~10 pF, coax cable ~50 - 80 pF/m, soldering iron, …)
- To prevent electrostatic discharge through the RF input, do not touch any exposed antenna area. If there is any risk that such exposed antenna area is touched in non ESD protected work area, implement proper ESD protection measures in the design.
- When soldering RF connectors and patch antennas to the receiver's RF pin, make sure to use an ESD safe soldering iron (tip).

8.4 ESD protection measures

TAU1312 GNSS positioning module is sensitive to static electricity. Whenever handling it, particular care must be exercised to reduce the risk of electrostatic charges. In addition to standard ESD safety practices, the following measures should be taken into account.

- Add ESD Diodes to the RF input part to prevent electrostatics discharge.
- Do not touch any exposed antenna area.
- Add ESD Diodes to the UART interface.

8.5 Moisture sensitivity level

The Moisture Sensitivity Level (MSL) of the GNSS module is MSL3.

9 LABELING AND ORDERING INFORMATION

Labeling and ordering information help customers get more about Allystar products.

9.1 Labeling

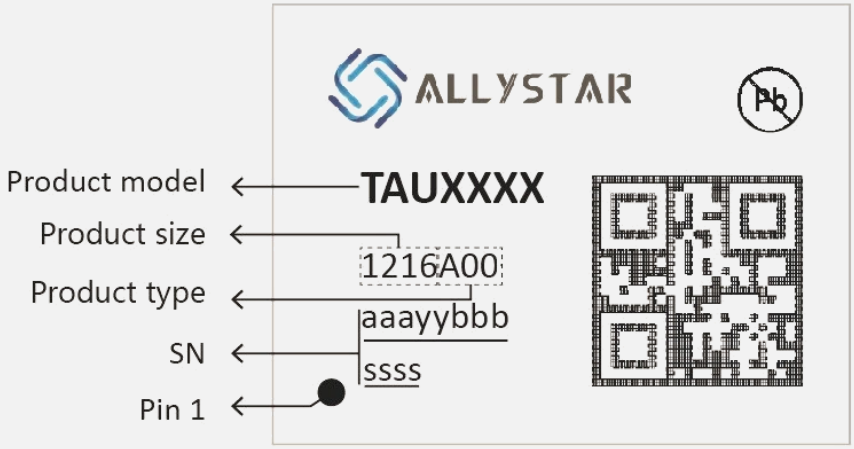


Table 15 Labeling content

Symbol	Explanation	Instance
TAUXXXX	Product model	TAU1312
1216A00	1216 represents the product size.	1216A00
	A00 means the product type.	
aaayybbbssss	Serial number	375190010001

9.2 Ordering info

Table 16 Ordering codes

Ordering No.	Product information
TAU1312-1216A00E	Concurrent GNSS LCC Module, TCXO, Flash, 12.2*16 mm, 1000 pieces/reel.

10 RELATED DOCUMENTS

[1] Satrack User Manual

[2] Allystar Common Commands

[3] Recommended Reflow Profile

[4] GNSS_Protocol_Specification

11 REVISION HISTORY

Revision	Date	Reviser	Status/Comments
V1.0	2020-06	Vita Wu	First release
V1.1	2020-12	Vita Wu	1) Updates MSL. 2) Fixes I/O type of I2C pin to be *I/O*. 3) Fixes I/O type of INT0 pin to be *I*. 4) Deletes SBAS support. 5) Updates the AVDD_BAK pin connectivity description in Section 4.1. 6) Clarifies power on/off sequence in Section 4.2. 7) Updates inductor value to be 82nH in minimal design. 8) Deletes 1K resistor in the minimal design diagram. 9) Deletes L6 band support. 10) Improves mechanical specification. 11) Updates description about short circuit protection. 12) Improves wording. 13) Localization.
V1.2	2021-07	Vita Wu	Adds labeling and ordering info. Details default settings. Adds related document list. Adds document info section. Adds packaging info. Updates operative VDD to 2.0V~3.6V. Adds ANT_BIAS values.
V1.3	2021-11	Vita Wu	Fixed RTK accuracy in Table 2. Updated headquarters' address.
V1.4	2022-10	Cao Min	Optimizes the chip name the module based on Updates the product grade classification in Table 1 Modifies update rate and GNSS position accuracy, and adds FCC and CE-RED certification in Table 2 Modifies MSL to MSL3 Updates the product ordering number Adds Table 11 ANT_BIAS current range and antenna

			status in Section 4.3 Contents optimization

www.allystar.com

info.gnss@allystar.com

Headquarters

Allystar Technology (Shenzhen) Co., Ltd.
Address: 201-2, 2F, Tower F, Xinghe World, No.1, Yabao Road, LongGang District, Shenzhen City, Guangdong Province, China.

Calgary Office

Allystar Technology (Canada) Ltd.
Address: Unit 288, 3553 31 Street NW Calgary, Alberta, Canada T2L 2K7