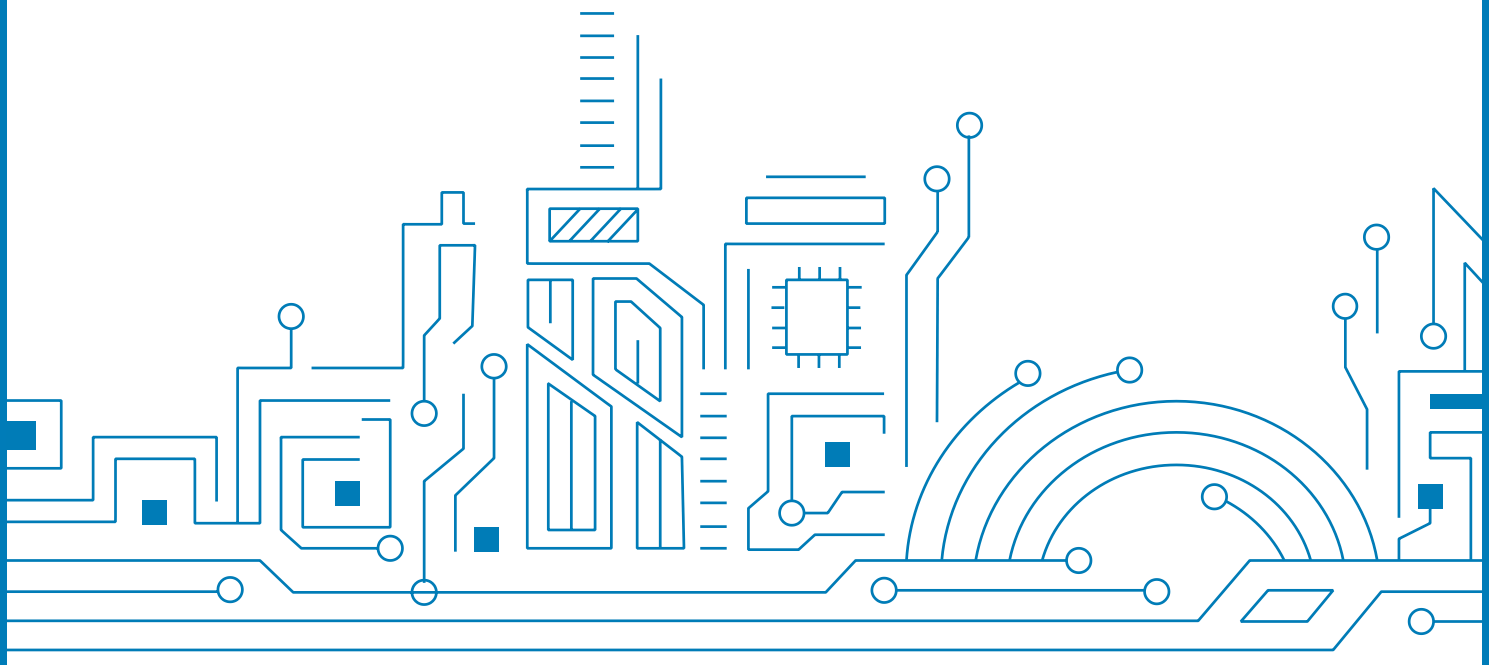
Multi-band Standard Precision GNSS Positioning Module

TAU1201

Datasheet V1.7



www.allystar.com

Notice, Statement and Copyright

ALLYSTAR Technology offers this document as a service to its customers, to support application and engineering efforts that use the products designed by ALLYSTAR Technology. Products and specifications discussed herein are for reference purposes only. Performance characteristics listed in this document do not constitute a warranty or guarantee of product performance.

ALLYSTAR Technology assumes no liability or responsibility for any claims or damages arising out of the use of this document, or from the use of integrated circuits based on this document, including, but not limited to claims or damages based on infringement of patents, copyrights or other intellectual property rights.

This document contains proprietary technical information which is the property of ALLYSTAR Technology, copying of this document and giving it to others and using or communication of the contents thereof, are forbidden without express authority. Offenders are liable to the payment of damages. ALLYSTAR Technology reserves the right to make changes in its products, specifications and other information at any time without notice.

For more documents, please visit www.allystar.com.

About the Document

■ Basic info

Document applies to	TAU1201
Document type	Datasheet
Revision and date	V1.7/2022-10
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.

TABLE OF CONTENT

1 SYSTEM OVERVIEW

1.1 Overview

TAU1201 is a high-performance dual-frequency GNSS positioning module, which is based on the state of the art CYNOSURE III architecture. It supports GPS, BeiDou, Galileo, GLONASS, NavIC, QZSS and SBAS (WAAS, EGNOS, GAGAN and MSAS).

TAU1201 integrates efficient power management architecture, while providing high precision, high sensitivity and low power consumption GNSS solutions which make it suitable for navigation applications on automotive and consumer electronics, as well as fleet management.

1.2 Features

- Supports all civil GNSS systems
- Supports BDS-3 signal: B2a
- Concurrent reception of L1 and L5 band signals
- Sub-meter position accuracy; superior in multi-path mitigation and lower noise in city valley
- Smart jammer detection and suppression
- Highly integrated module, the best cost-effective high precision solution
- Supports single NavIC mode

Table 1 TAU1201

Product	GNSS									Feature					Interface				Accuracy			Grade	
	GNSS system mode	Band (S/D/T)	GPS	BDS	GLONASS	Galileo	NavIC	QZSS	SBAS	Built-in LNA	Programmable (flash)	Data logging	D-GNSS	Oscillator	UART	I2C	USB	SPI	Meter	Sub-meter	Centimeter	Industrial	Automotive
TAU1201-1216A00E	01	D	●	●	●	●		●	●	●	●	●	●	T	●	○	○	○		●		●	
	02	D	●	●		●	●	●	●	●	●	●	●	T	●	○	○	○		●		●	

T = TCXO ○ = Supported upon request with special firmware

1.3 Module Photo

Figure 1 TAU1201

1.4 Block Diagram

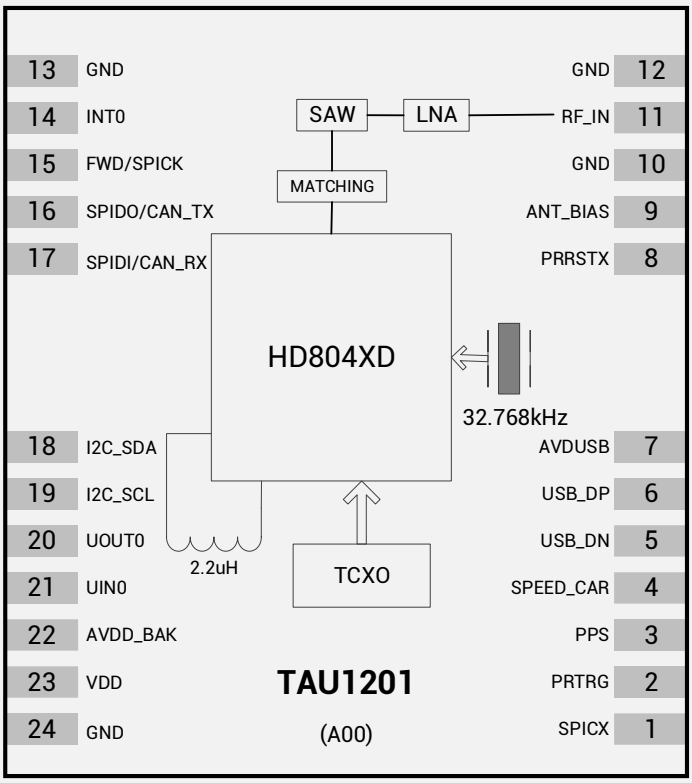


Figure 2 TAU1201 block diagram

1.5 Performance Specifications

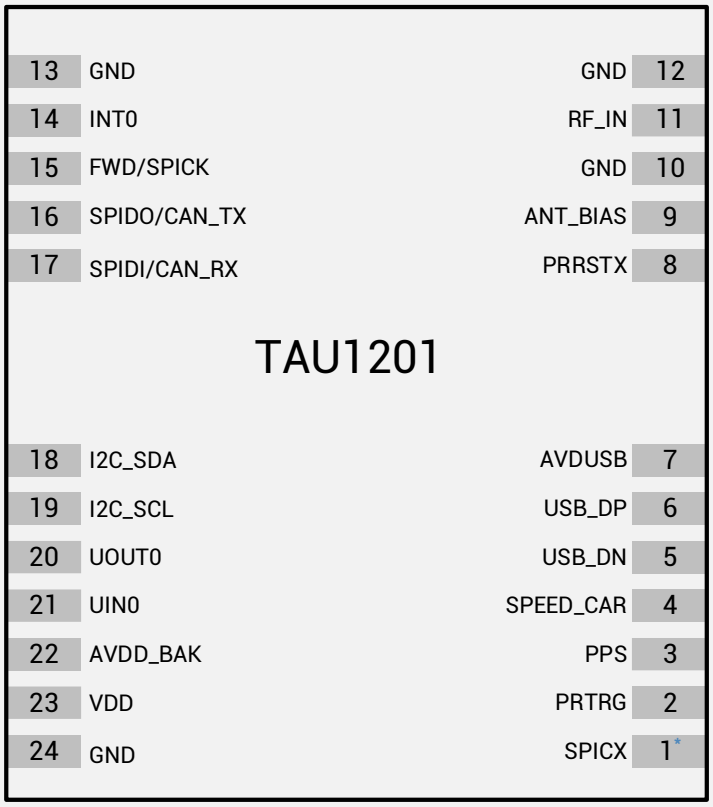
Table 2 Performance specifications

Parameter	Specifications	
GNSS Tracking Channels	40	
GNSS Reception	GPS/QZSS: L1C/A, L5C	
	BDS: B1I, B2a	
	GLONASS: G1	
	Galileo: E1, E5a	
	NavIC: L5	
	SBAS: L1 (WAAS, EGNOS, GAGAN, MSAS)	
Update Rate	Maximum 5 Hz	
Position accuracy[1]	GNSS	1m CEP
Velocity & Time accuracy	GNSS	0.1 m/s CEP
	1PPS	20 ns
Time to First Fix (TTFF)	Hot start	1s
	Cold start	32s
Sensitivity	Cold start	-148 dBm

	Hot start	-155 dBm
	Reacquisition	-158 dBm
	Tracking	-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
	USB[2]	1
	SPI[2]	1
	I2C[2]	1
Protocol	NMEA 0183 Protocol Ver. 4.0/4.1 RTCM 3.0/3.2/2.3/2.4x[3] Cynosure GNSS Receiver Protocol	
Operating condition	Main voltage	2.0-3.6 V
	Digital I/O voltage	1.8-3.6 V
	Backup voltage	1.8-3.6 V
Power consumption	Operating mode	GPS/QZSS, L1 band: 22 mA @ 3.3V
		GNSS, L1+L5 band: 41 mA @ 3.3V
	Standby mode	12 uA
Operating temperature	-40°C to +85°C	
Storage temperature	-40°C to +85°C	
Package	12.2*16.0*2.4 mm 24-pin stamp hole	
Certification	RoHS, REACH, FCC, CE-RED	

* *[1] Open sky, dual band, 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.*

2 PIN DESCRIPTION



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

Figure 3 Pin assignment (top view)

Table 3 Detailed pin descriptions

Function	Symbol	No.	I/O	Description
Power	VDD	23	Power	Main supply input.
	GND	10, 12, 13, 24	VSS	Ground
	AVDD_BAK	22	Power	Backup supply input.
	AVDUSB	7	Power	USB power input. To use the USB interface, connect this pin to 3.0-3.6 V.
Antenna	RF_IN	11	I	RF signal input. 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. Used to power the 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. Leave it floating if not used.
	FWD/SPICK	15	O	SPI clock. Leave it floating if not used.
	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 4 Absolute rating

Symbol	Parameter	Min.	Max.	Unit
VDD	Power input for the main power domain	-0.5	3.63	V
AVDUSB	USB supply voltage	-0.5	3.63	V
AVDD_BAK	Power input for the backup power domain	-0.5	3.63	V
VI_{max}	Voltage input of I/O pin	-0.5	3.63	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 5 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	kΩ

3.2.2 USB I/O

Table 6 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	kΩ
$R_{PUACTIVE}$	Pull-up resistance, active state	--	1.425	--	3.09	kΩ

3.2.3 Others

Table 7 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	kΩ

3.3 DC Characteristics

3.3.1 Operating Conditions

Table 8 Operating conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
VDD	Main voltage	2.0	3.3	3.6	V
AVDUSB	USB supply voltage	3.0	3.3	3.6	V
AVDD_BAK	Power input for the backup power domain	1.8	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

3.3.2 Power Consumption

Table 9 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]	41	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

TAU1201 positioning module has two power supply pins: VDD and AVDD_BAK. The main power is supplied through the VDD pin, and the backup power is supplied through the AVDD_BAK pin. In order to ensure the positioning performance, please control the ripple of the module power supply. It is recommended to use the LDO above 200 mA.

If the power for VDD pin is off, the real-time clock (RTC) and battery backed RAM (BBR) will be 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 will perform a cold start at every power-up if no 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

TAU1201 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.

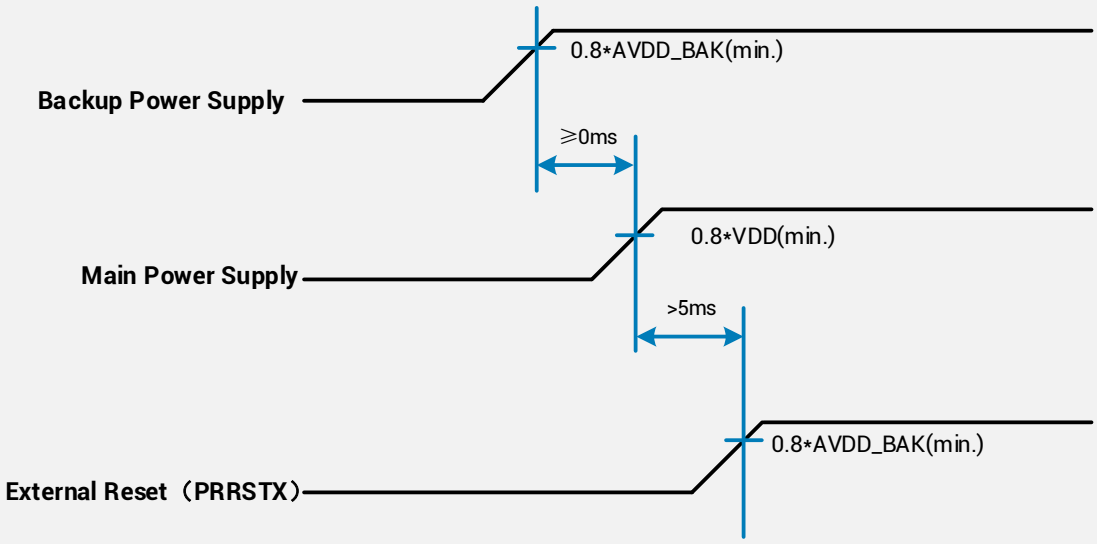


Figure 4 Initial system power on sequence

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.

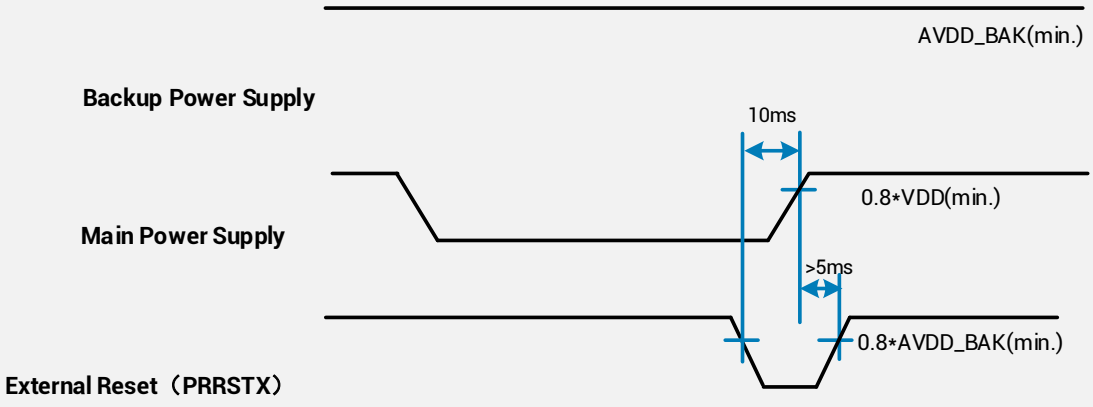


Figure 5 Main power on sequence

4.3 Antenna Design

There is a built-in LNA and SAW in the GNSS module. It is recommended to use an active antenna with gain less than 36 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 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 10 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 11 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.
Timepluse (1 Hz 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

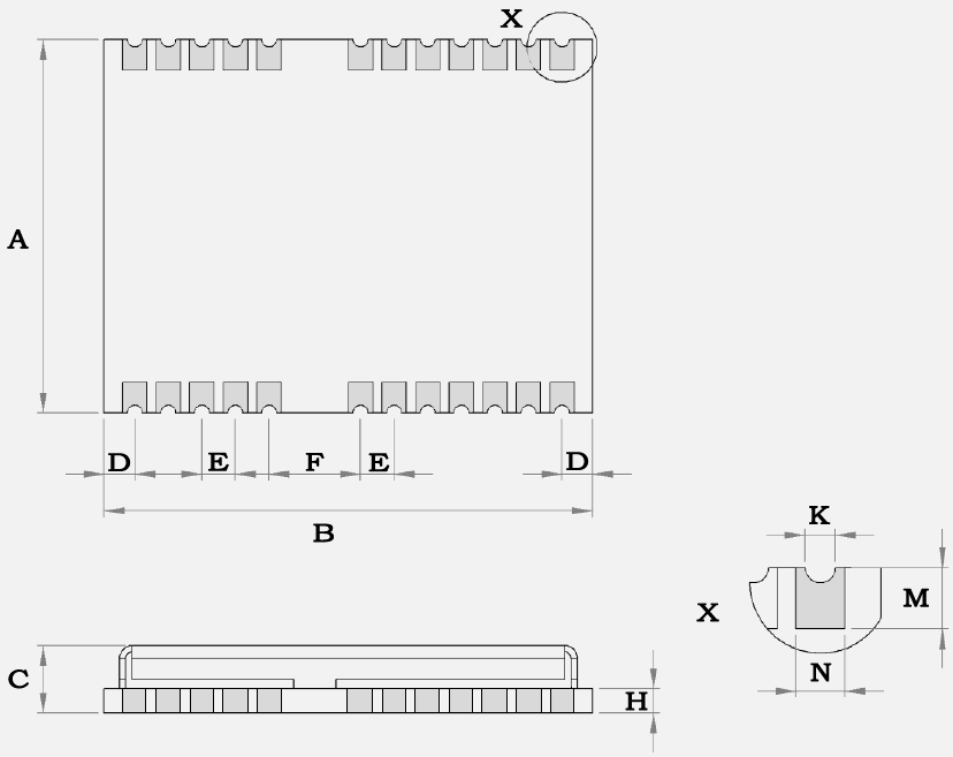


Figure 6 Dimensions

Table 12 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 a minimal design for TAU1201 GNSS module shown as below. 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.

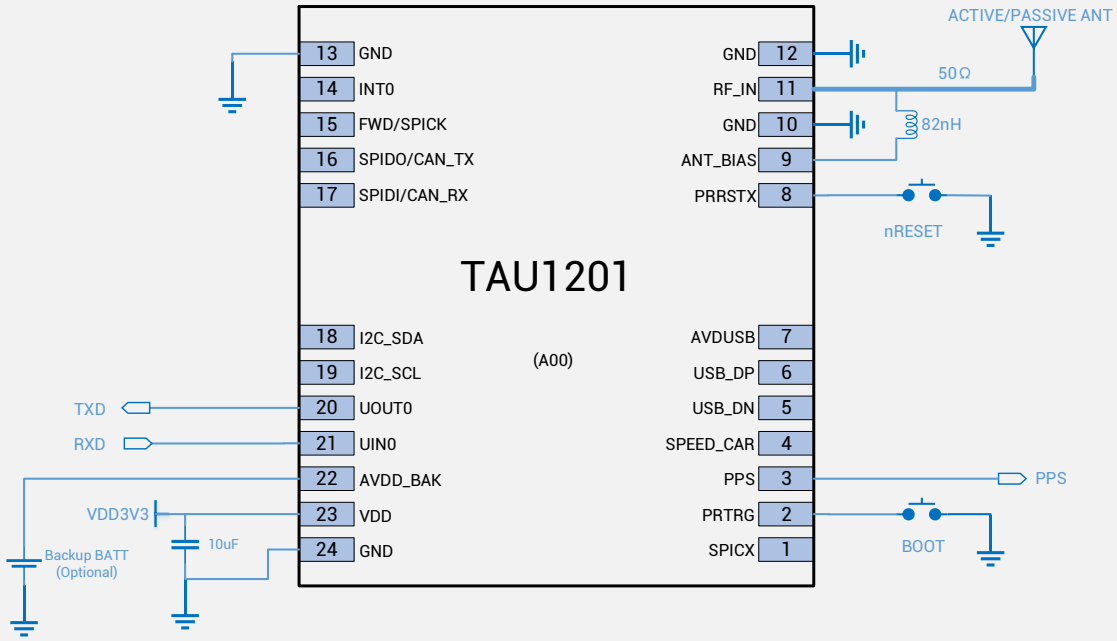


Figure 7 Minimal application diagram

7.2 PCB Footprint Reference

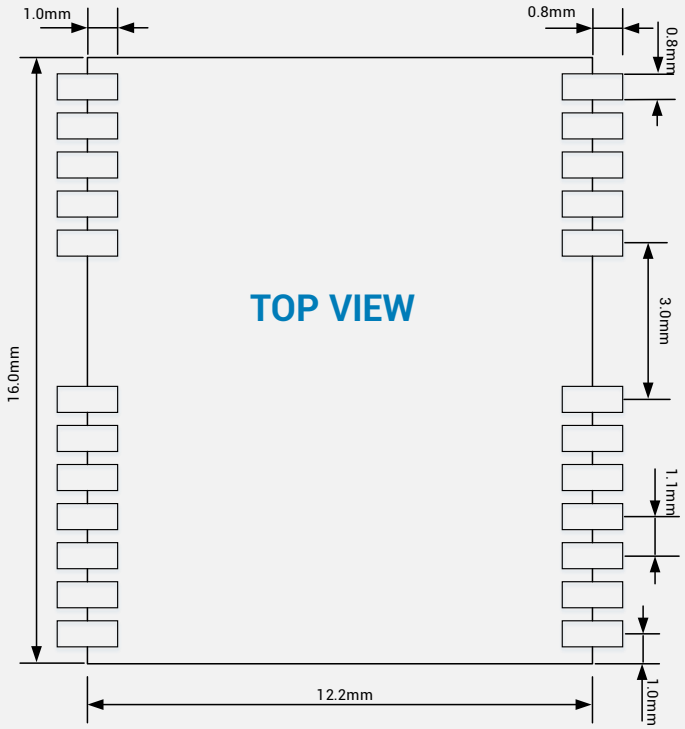


Figure 8 PCB Footprint Reference

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 REFLOW SOLDERING

Table 13 Reflow profile features

Profile Feature	Pb-Free Assembly
Preheat/Soak	
Temperature Min (T_{smin})	150°C
Temperature Max (T_{smax})	200°C
Time (t_s) from (T_{smin} to T_{smax})	60-120 s
Ramp-up rate (T_L to T_p)	3°C/second max.
Liquidous temperature (T_L)	217°C
Time (t_L) maintained above T_L	60-150 s
Peak package body temperature (T_p)	must not exceed the Classification temp T_c[1]
Time (t_p)* within 5°C of the specified classification temperature (T_c)	30* seconds[2]
Ramp-down rate (T_p to T_L)	6°C/second max.
Time 25°C to peak temperature	8 minutes max.

* *[1] T_c = 260°C.*

* *[2] The time above 255°C must not exceed 30 seconds.*

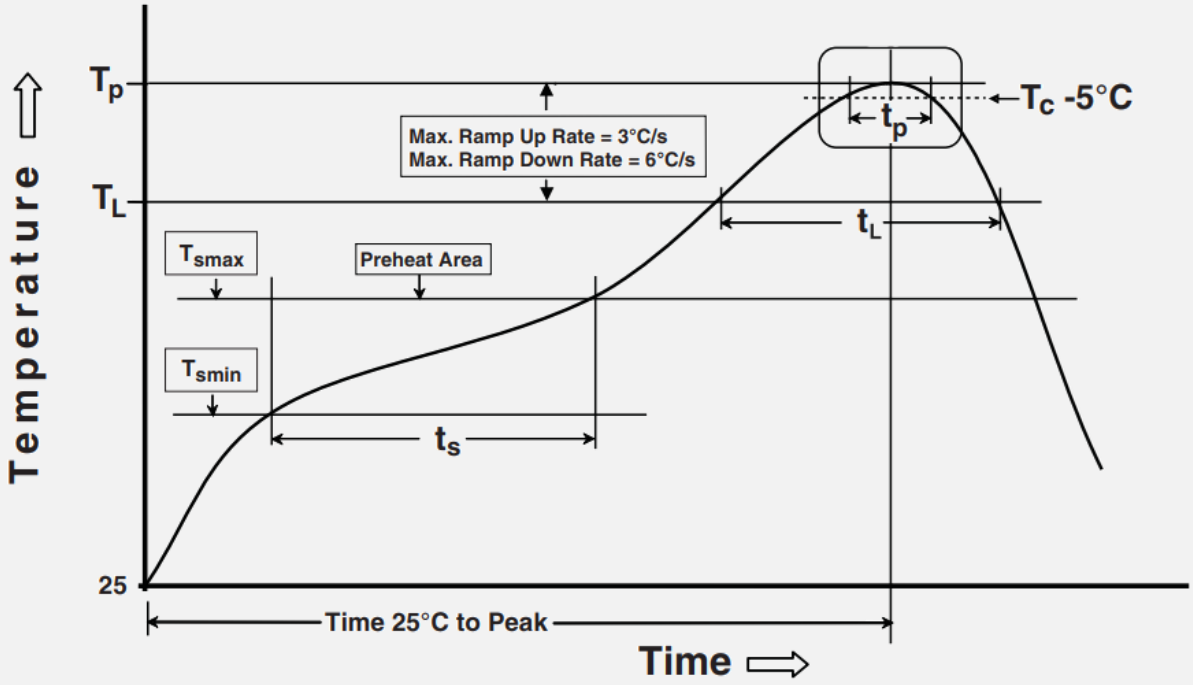


Figure 9 Reflow soldering profile (Refer to IPC/JEDEC J-STD-020E)

9 PRODUCT PACKAGING AND HANDLING

9.1 Packaging

9.1.1 Packaging Notes

TAU1201 GNSS module 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
			

9.1.2 Tape and Reel

The TAU1201 modules are 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.

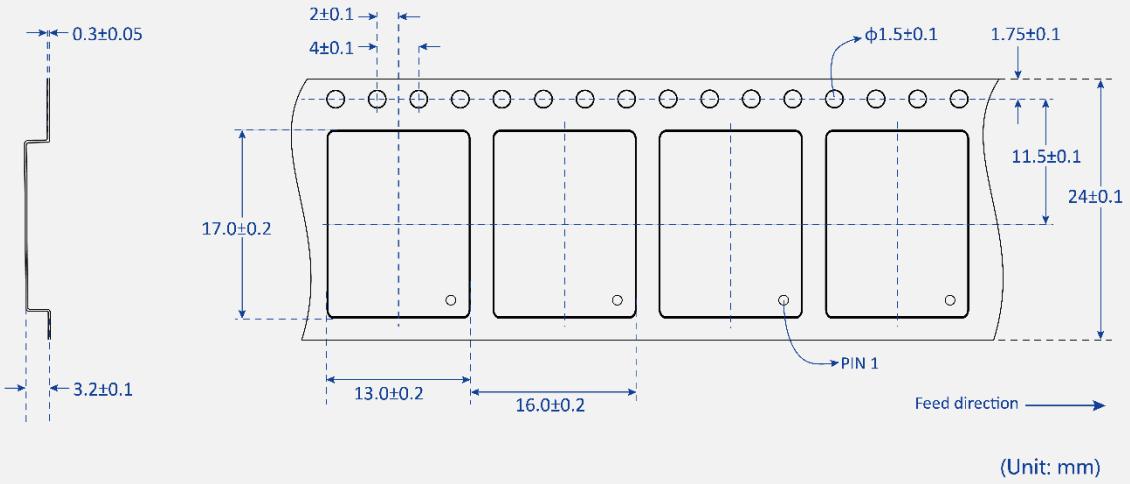


Figure 10 Tape dimensions

TAU1201 are deliverable in quantities of 1000 pcs on a reel. The figure below shows the dimensions of reel for TAU1201.

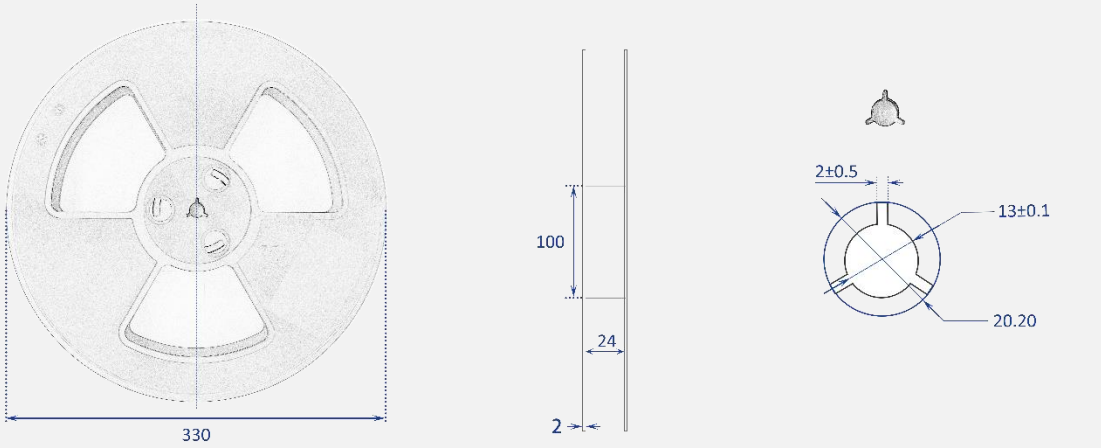


Figure 11 Reel dimensions

9.1.3 Shipment Packaging

The reels of TAU1201 modules 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.

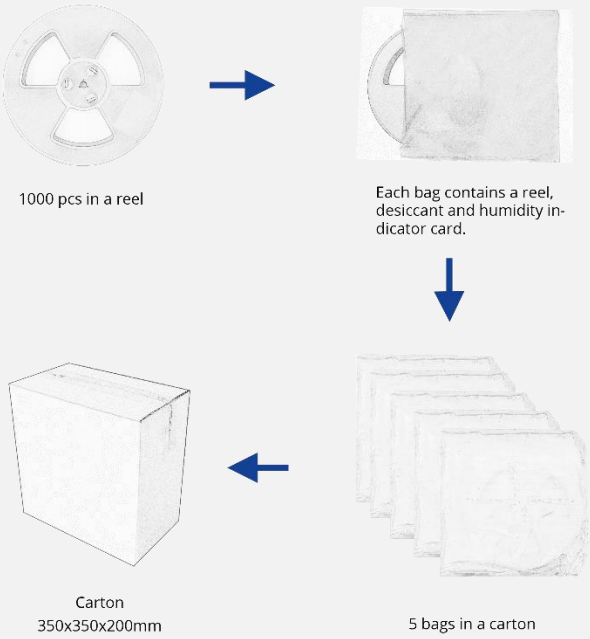


Figure 12 Packaging

9.2 Storage

In order to prevent moisture intake and protect against electrostatic discharge, TAU1201 is packaged together with a humidity indicator card and desiccant to absorb humidity.

9.3 ESD Handling

9.3.1 ESD Handling Precautions

TAU1201 module which contains highly sensitive electronic circuitry is an Electrostatic-sensitive Device (ESD). Observe precautions for handling! Failure to observe these precautions may result in severe damage to the GNSS module!

- 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).

9.3.2 ESD Protection Measures

The GNSS positioning module is sensitive to static electricity. Whenever handling the module, 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.

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

9.3.3 Moisture Sensitivity Level

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

10 LABELING AND ORDERING INFORMATION

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

10.1 Labeling

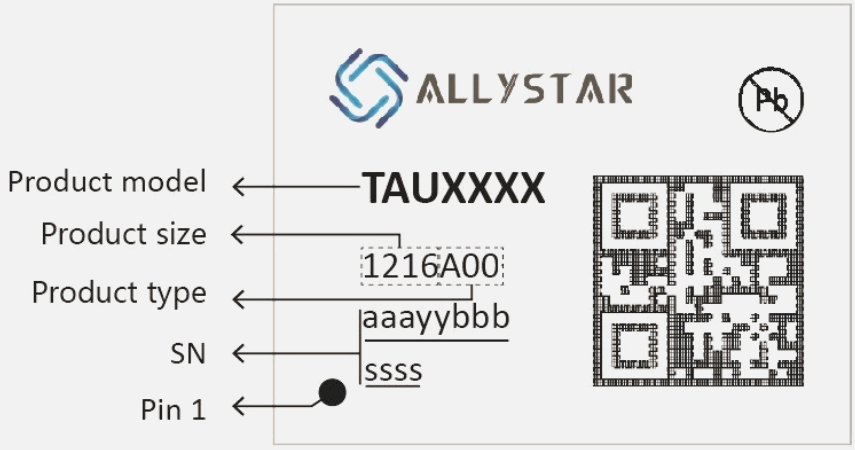


Table 15 Labeling content

Symbol	Explanation	Instance
TAUXXXX	Product model	TAU1201
1216A00	1216 represents the product size.	1216A00
	A00 means the product type.	
aaayybbbssss	Serial number	385190010001

10.2 Ordering info

Table 16 Ordering codes

Ordering No.	Product
TAU1201-1216A00E	Concurrent GNSS LCC Module, TCXO, Flash, GLONASS, 12.2*16 mm, 1000 pieces/reel.
TAU1201-1216A00E	Concurrent GNSS LCC Module, TCXO, Flash, NavIC, 12.2*16 mm, 1000 pieces/reel.

11 RELATED DOCUMENTS

[1] Satrack User Manual

[2] Allystar Common Commands

[3] GNSS_Protocol_Specification

12 REVISION HISTORY

Revision	Date	Author	Status/Comments
V1.0	2019.08	Vita Wu	First released
V1.1	2019.12	Vita Wu	Updates the packaging info; Update Section 6; Adds PCB packaging; Updates LNA built-in; Updates power consumption; Updates antenna gain in Section 4.2;
V1.2	2020.07	Vita Wu	Adds GNSS raw data output support. Adds ANT_BIAS parameters. Updates C00 design. Contents update
V1.3	2020.12	Vita Wu	Deletes SBAS support. Clarifies power on/off sequence. Improves AVDD_BAK pin connection description in Section 4.1. Improves mechanical specification. Updates layout notes in Section 6.3. Deletes 1K resistor in the minimal design diagram. Updates MSL. Localization. Updates description about short circuit protection
V1.4	2021-07	Vita Wu	Adds labeling and ordering info. Details default settings. Adds related document list. Adds document info section. Removes C00 design. Updates main voltage range to be 2.0V~3.6V.
V1.5	2021-11	Cao Min	Content upgrade
V1.6	2021-11	Cao Min	Adds a new supporting system: SBAS (WAAS, EGNOS, GAGAN, MSAS)
V1.7	2022-10	Cao Min	Optimizes the product model Modifies the product grade classification Changes the update rate and GNSS position accuracy, and adds FCC and CE-RED certification in Table 2 Modifies the MSL to MSL3 Updates the product ordering number Optimizes the antenna bias current range 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