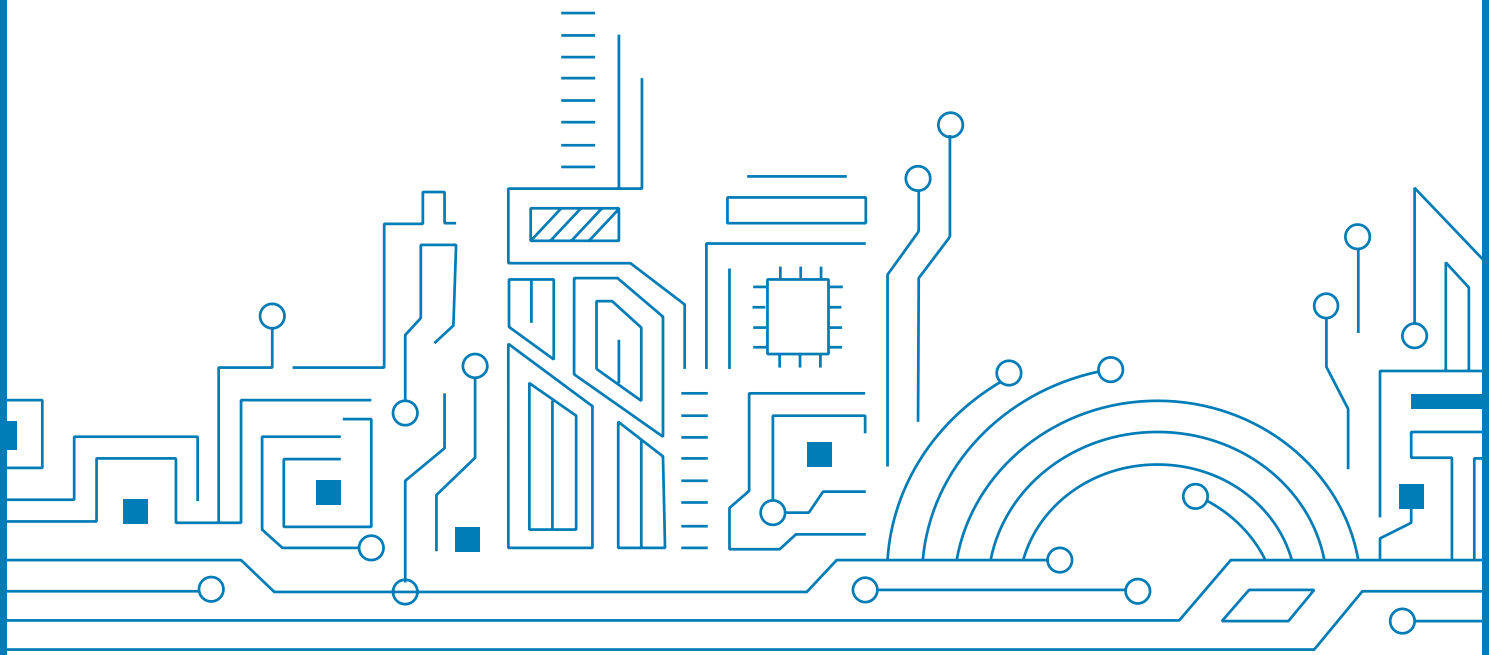
# GNSS Module with Dead Reckoning

# TAU2202

Datasheet

V1.1



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# About the Document

## ■ Basic info

| | |
|---|---|
| **Document applies to** | TAU2202 |
| **Document type** | Datasheet |
| **Revision and date** | V1.1/2023-04 |
| **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. |

| Product model | Ordering No. | Frequency |
|---|---|---|
| TAU2202 | TAU2202-1216A00 | L1+L5 |
| | TAU2202-1216AFX | L1 |

# TABLE OF CONTENT

# 1 SYSTEM OVERVIEW

## 1.1 Overview

TAU2202 is a GNSS module with dead reckoning, which is based on the Allystar CYNOSURE III SoC chips. It supports GPS, BDS, and QZSS satellite signals. Combining GNSS positioning and inertial navigation technology makes TAU2202 output positioning data in the environments where GNSS signal quality is poor or even lost (such as tunnels, underground parking, etc.), and provide continuous and accurate positioning for navigation applications.

TAU2202 integrates a 3-axis accelerometer and a 3-axis gyroscope, while supporting other sensor access for multi-source information fusion to achieve higher positioning accuracy. Thanks to its excellent positioning performance in a harsh environment, TAU2202 is friendly to applications such as vehicle inertial navigation, drones, and e-bikes.

## 1.2 Product photo


Figure 1 TAU2202

## 1.3 Features

- Supports GNSS and INS navigation technology
- Supports BDS-3 signals
- Built-in 6D IMU, 3-axis gyroscope and 3-axis accelerometer
- Supports other sensors access for multi-source information fusion
- Supports A-GNSS
- Supports free-installation

**Table 1 TAU2202**

| Product | Type | GNSS | | | | | | | Feature | | | | | | | Interface | | | | Accuracy | | | Grade | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DR Module | Bands (S/D/T) | GPS | BDS | GLONASS | Galileo | NavIC | QZSS | Built-in SAW | Built-in LNA | Data logging | D-GNSS | Oscillator | Built-in inductor | Raw data | UART | CAN | USB | SPI | Meter | Sub-meter | Centimeter | Industrial | Automotive |
| TAU2202-1216A00 | ● | D | ● | ● | | | | ● | ● | ● | | ● | T | | | ● | ○ | | ○ | | ● | | ● | |
| TAU2202-1216AFX | ● | S | ● | ● | | | | ● | ● | ● | | ● | T | | | ● | ○ | | ○ | ● | | | ● | |

○ = Supported upon request with special firmware T = TCXO

## 1.4 Block Diagram

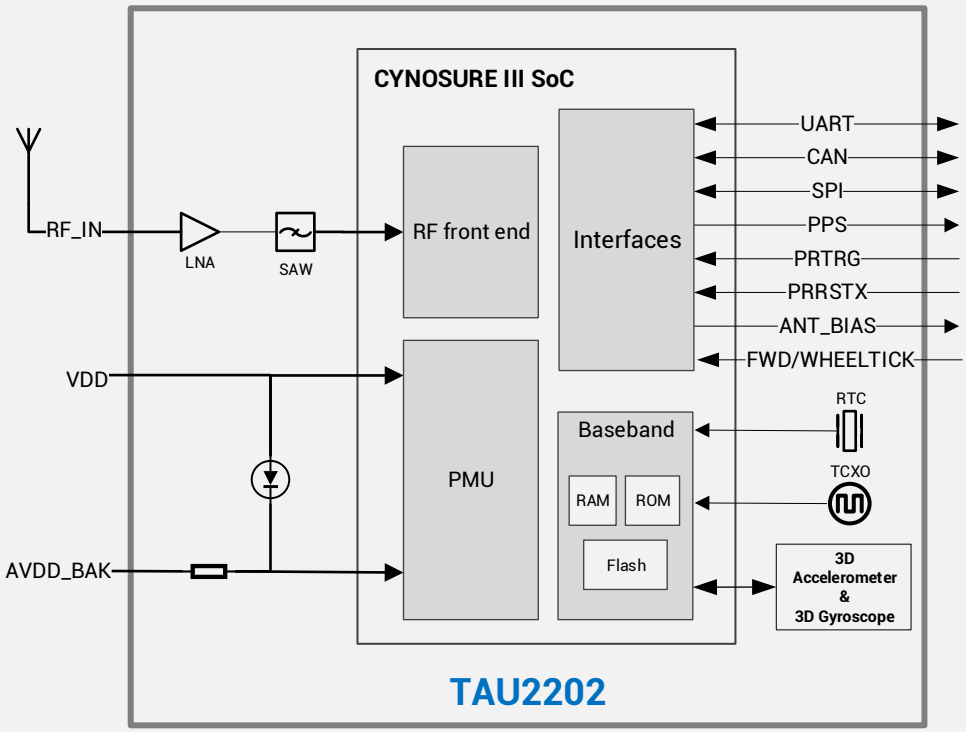


Figure 2 Block diagram

## 1.5 Specifications

**Table 2 Specifications**

| Parameter | Specification | |
|---|---|---|
| GNSS reception | TAU2202-1216AFX | GPS/QZSS: L1<br>BDS: B1I, B1C[1] |
| | TAU2202-1216A00 | GPS/QZSS: L1, L5<br>BDS: B1I, B1C[1], B2a |
| Update rate | Position update: 1 Hz | |
| | Sensor output: 50 Hz | |
| Position accuracy | GNSS | 1.0m CEP |
| Velocity & Time accuracy | GNSS | 0.1 m/s CEP |
| | 1PPS | 20 ns |
| Time to First Fix (TTFF) | Hot start | 1s |
| | Cold start | 30s |
| Sensitivity[2] | Cold start | -148 dBm |
| | Hot start | -155 dBm |
| | Reacquisition | -158 dBm |
| | Tracking & navigation | -160 dBm |
| Operating condition | Main voltage | 3.0-3.6 V |
| | Digital I/O voltage | 3.0-3.6 V |

| Parameter | Specification | |
|---|---|---|
| | Backup voltage | 1.8-3.6 V |
| Power consumption | TAU2202-1216AFX (L1) | Acquisition: 40 mA @ 3.3V |
| | | Tracking & navigation: 38 mA @ 3.3V |
| | TAU2202-1216A00 (L1+L5) | Acquisition: 54 mA @ 3.3V |
| | | Tracking & navigation: 50 mA @ 3.3V |
| | Standby | 12 uA |
| Serial interface | UART | 1 |
| | CAN[1] | 1 |
| | SPI[1] | 1 |
| Position error[3] | UDR: 5% mileage | |
| | ADR: 3% mileage | |
| Protocol | NMEA 0183 protocol 4.00/4.10 | Default: 115200 bps, 8 data bit, 1 stop bit, no parity<br>Default output message: GGA, GSA, GSV, RMC, ZDA, TXT-ANT |
| | ALLYSTAR RTCM IMU Raw data | Acc, Gyro Raw data |
| Operating limit | Velocity | 515 m/s |
| | Altitude | 18,000m |
| Operating temperature | -40°C to +85°C | |
| Storage temperature | -40°C to +90°C | |
| Package | 24-pin LCC | |
| Size | 12.2*16.0*2.4 mm | |
| Certification | RoHS, REACH | |

* *[1] Supported upon request with special firmware. CAN is alternative to SPI*
* *[2] Demonstrated with a good external LNA*
* *[3] GNSS signals lost 120s*

# 2 PIN DESCRIPTION

## 2.1 Pin Assignment

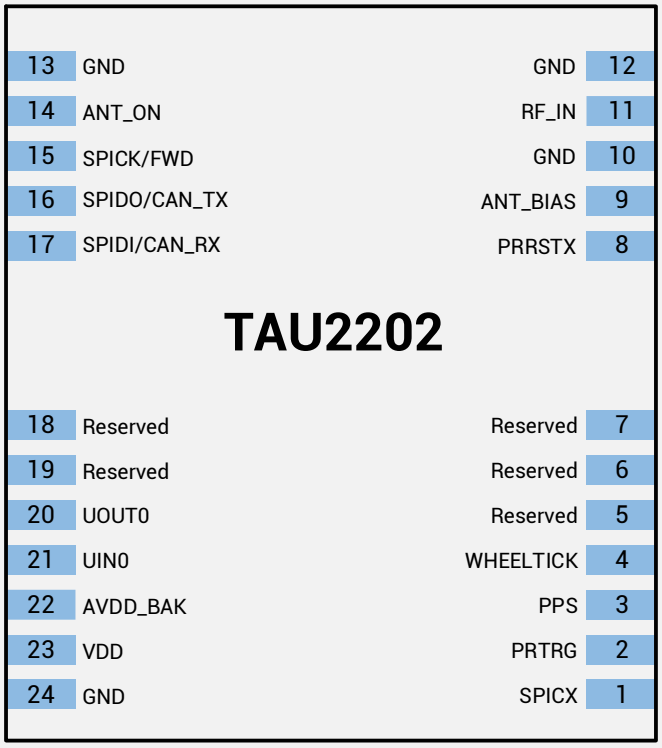


Figure 3 Pin assignment (top view)

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

## 2.2 Detailed Pin Descriptions

**Table 3 Detailed pin descriptions**

| Function | Symbol | No. | I/O | Description |
|---|---|---|---|---|
| Power | VDD | 23 | Power | Main supply input. |
| | GND | 10, 12, 13, 24 | GND | Ground |
| | AVDD_BAK | 22 | Power | Backup supply input. |
| Antenna | RF_IN | 11 | I | RF signal input. |
| | ANT_BIAS | 9 | O | RF section output voltage. Used to power the external active antenna. |
| UART | UOUT0 | 20 | O | UART serial data output. |
| | UIN0 | 21 | I | UART serial data input. |
| SPI[1] | SPICX | 1 | O | SPI chip select. Leave it floating if not used. |
| | SPICK/FWD | 15 | I/O | Either SPI clock or forward/backward signal input. FWD, by default. High level indicates forward, while low level means backward. Leave it floating if not used. |
| | SPIDO/CAN_TX | 16 | O | Either SPI data or CAN data output. Leave it floating if not used. |
| | SPIDI/CAN_RX | 17 | I | Either SPI data or CAN data input. Leave it floating if not used. |
| Other | PRTRG | 2 | I | Mode selection, or the trigger input to wake up the system. |
| | PRRSTX | 8 | I | External reset, low active. Connect this pin to the Host. |
| | PPS | 3 | O | Time pulse output (PPS). |
| | WHEELTICK | 4 | I | Velocity pulse signal input. Leave it floating if not used. |
| | ANT_ON | 14 | O | External active antenna ON/OFF. |
| | Reserved | 5, 6, 7, 18, 19 | -- | Reserved pin. Leave it floating. |

* *[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 |
| 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 |
| $T_{env}$ | Operation temperature | -40 | 85 | °C |
| $T_{storage}$ | Storage temperature | -40 | 90 | °C |
| $T_{solder}$ | Solder reflow temperature | -- | 260 | °C |

## 3.2 DC Characteristics

**Table 5 DC Characteristics**

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| VDD | Power input for the main power domain | 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 |

## 3.3 ESD

Please add appropriate ESD protection on the module during design to ensure its functionality according to its application field.

**Table 6 ESD protection performance**

| Pin | Contact discharge | Air discharge | Condition |
|---|---|---|---|
| RF_IN | ±2kV | ±4kV | HBM, 45% RH, 25℃ |
| GND | ±2kV | ±4kV | |
| Others | ±2kV | ±4kV | |

# 4 HARDWARE DESCRIPTION

## 4.1 Connecting Power

TAU2202 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 as possible. It is recommended to use the LDO of a current above 200 mA, and PSRR not less than 70 dB for power supply. Add a magnetic bead on VDD pin if the power noise is high.

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 will perform a cold start at every power-up if no aiding data are sent to the module.

**Note:** If no backup supply is available, connect AVDD_BAK pin to VDD.

## 4.2 Power on/off Sequence

A permanent damage may occur with inappropriate power on sequence. So, please follow the rules below during design. To meet the requirement of controlling the power on/off sequence of the module, please connect the external reset pin (PRRSTX) to the Host.

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. The system power on sequence is illustrated in **Figure 4 System power on sequence**.

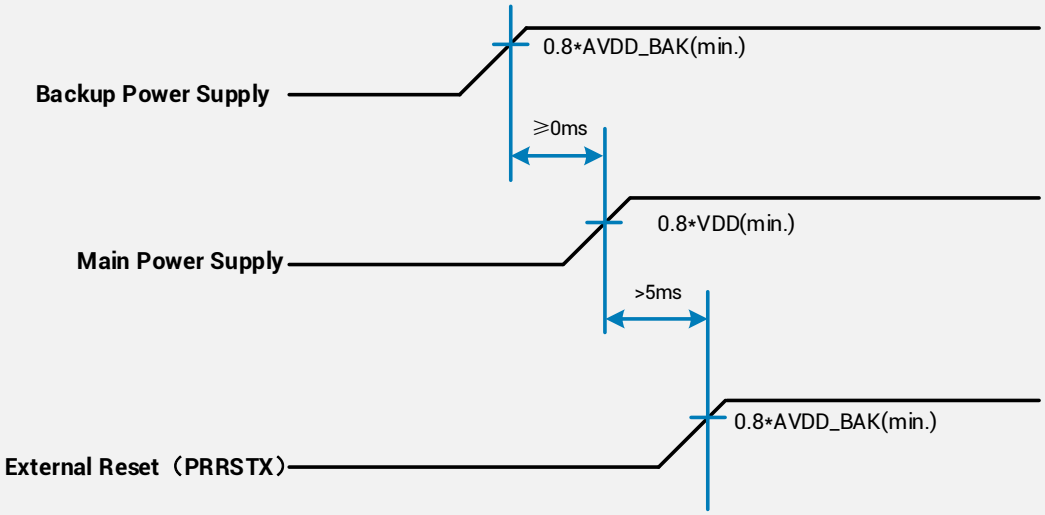


Figure 4 System power on sequence

## 4.3 Antenna Design

There is a built-in LNA and SAW in TAU2202. It is recommended to use an active antenna with gain less than 30 dB and the noise figure less than 1.5 dB.

### 4.3.1 ANT_BIAS

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

**Table 7 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 and PRTRG 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 (see **Figure 6 Reset Timing**). 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**.
- 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.

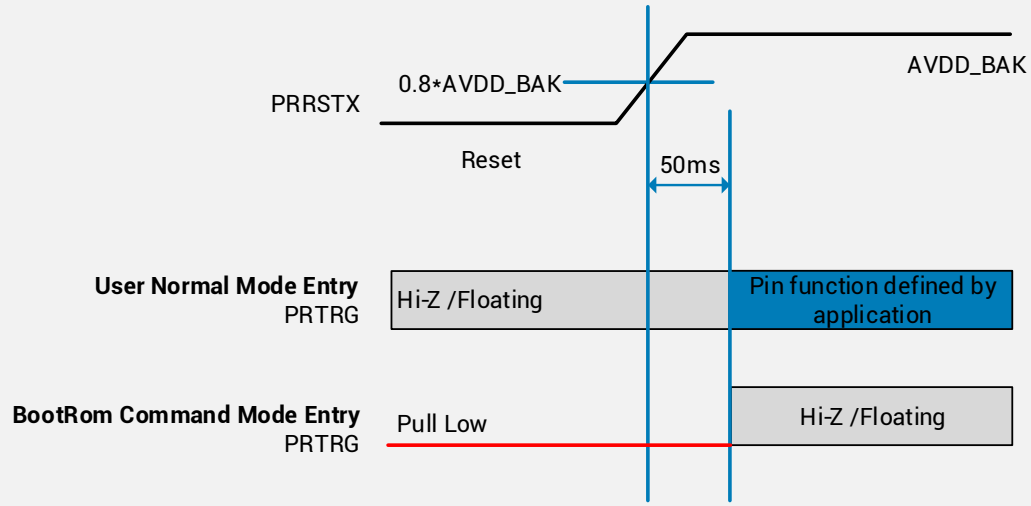


Figure 5 Switching the operation mode

| Parameter | Symbol | Pin | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Reset Timing | $t_{RSTL}$ | PRRSTX | Connected to a stable power source, and TCXO clock remains stable. | 100 | -- | -- | mS |

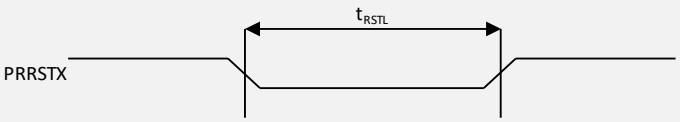


Figure 6 Reset Timing

# 5 MECHANICAL SPECIFICATION

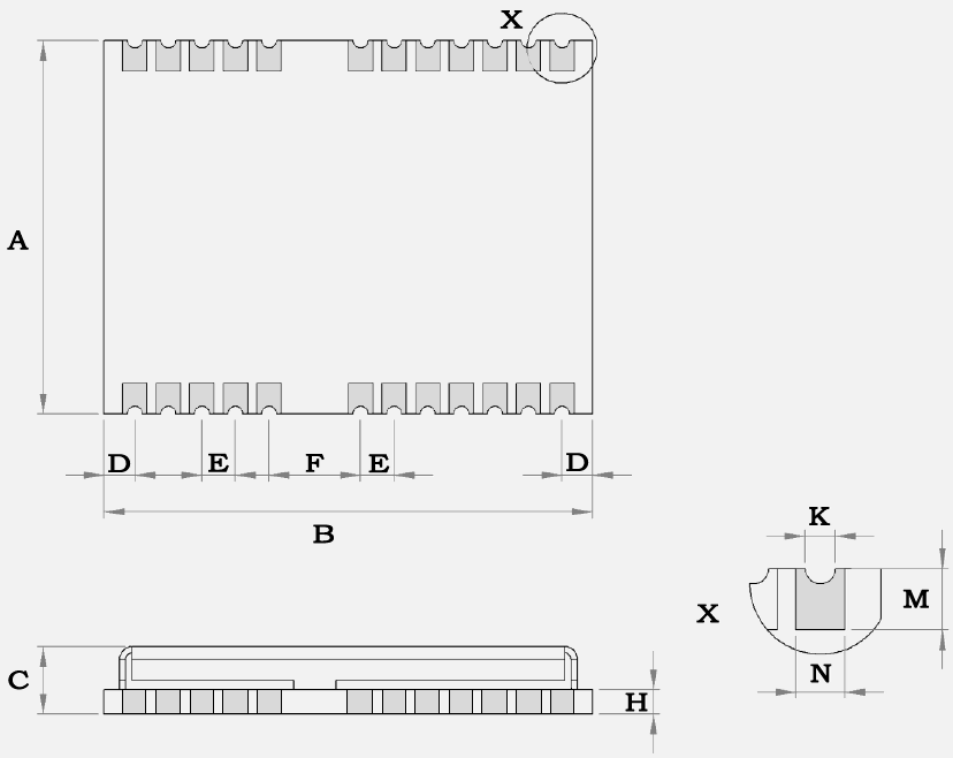


Figure 7 Dimensions

**Table 8 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 |

# 6 REFERENCE DESIGN

## 6.1 Reference Design

This is a minimal design for TAU2202. An 82 nH inductor is used only when an active antenna is connected, and no need for a passive antenna.

A diode is used to connect the AVDD_BAK pin and VDD pin internally, which can charge the external backup battery. See **1.4 Block Diagram** for details.

The characteristic impedance from RF_IN pin to the antenna connector should be 50Ω.

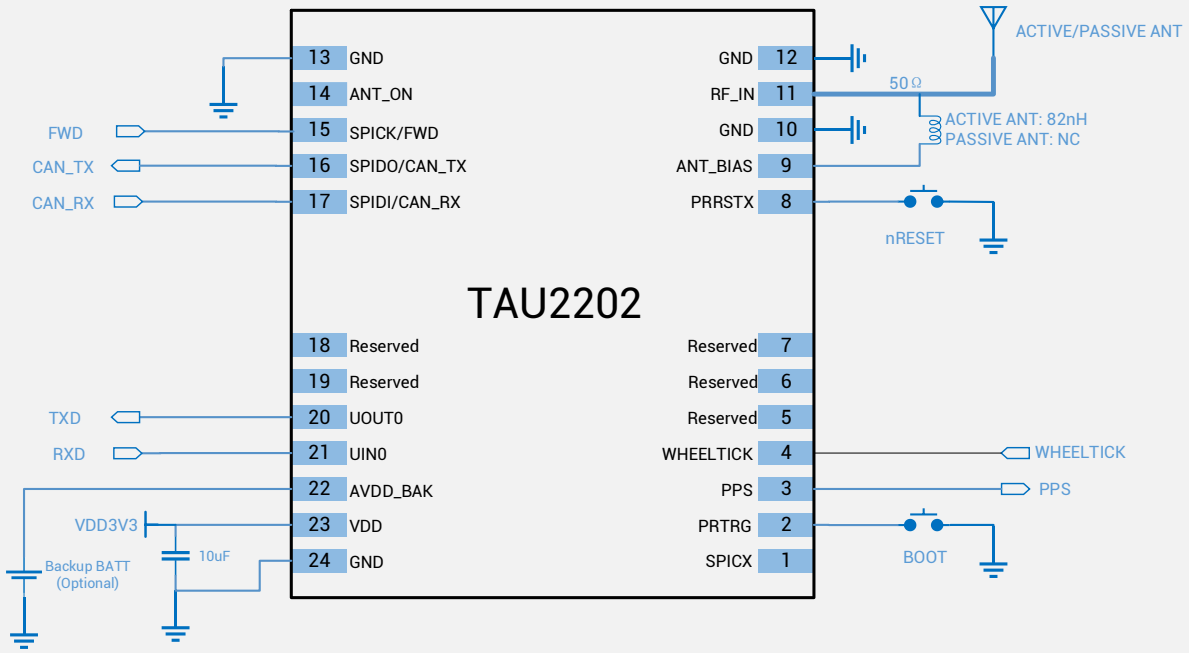


Figure 8 Minimal application diagram

## 6.2 PCB Footprint Reference

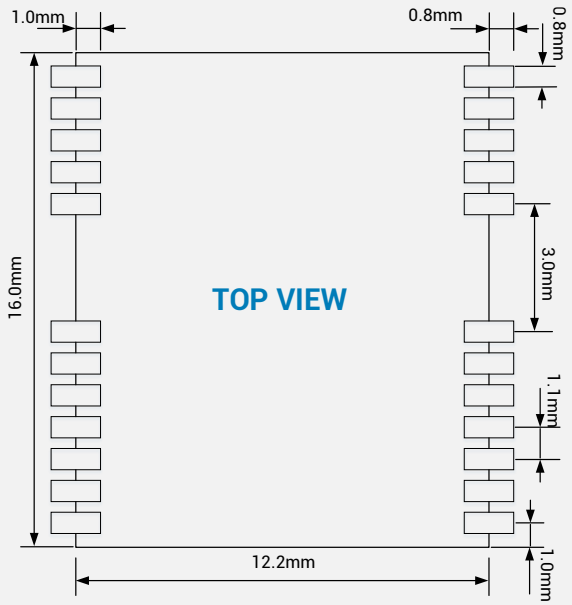


Figure 9 PCB Footprint Reference

## 6.3 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.

# 7 INSTALLATION AND CALIBRATION

## 7.1 Installation Notice

The module must be rigidly connected to the mounting body on a vehicle to ensure that there is no shaking or relative displacement with the mounting body during initialization and driving. Any displacement may lead to an operative error occurred to the module.

## 7.2 Installation

TAU2202 contains a 3-axis gyroscope and a 3-axis accelerometer and is built in a fine self-calibration algorithm, which allows it to be freely installed at any angle relative to the vehicle coordinate system, such as horizontal installation, inclined installation at a certain angle, and installation with bottom up, etc.

## 7.3 Calibration and Status Query

### 7.3.1 Calibration

After installation, a calibration is required to estimate the module installation status and sensor parameters.

**Calibration environment requirements:** an open sky, and a flat road (a driving environment in which 3D positioning can be fixed with pdop lower than 3, and CNR more than 28 dB).

**Steps for calibration:**

1) After the module is installed, it will automatically activate calibration after the vehicle starting on a flat road in an open sky. During the calibration, a good satellite visibility should be guaranteed, which means the calibration environment requirements should be met.

2) After the module position is fixed, keep the vehicle still for more than 20s with power on, then accelerate forward to 40 km/h above in a short time, and drive forward at a speed greater than 20 km/h for at least 10s on open and flat road.

3) Under the normal driving conditions, make a left turn and a right turn of nearly 90° at a normal turning speed.

> **Note:**
>
> 1) After completing above calibration steps, continue to drive normally for more than 15 minutes in an open environment. Driving straight and turning can make the INS converge more accurate, thereby improving the inertial navigation positioning accuracy in complex environments such as garages and tunnels.
>
> 2) When the module is loose, dropped, or removed, etc., it is necessary to clear the calibration parameters and re-calibrate the module according to the calibration steps.

### 7.3.2 Status query

After a calibration, users can check the NMEA message to figure out the INS status of the module.

- NMEA message like *$GNTXT…INS,* ***A****…* with *INS A i*ndicates INS is activated.
- NMEA message like *$GNTXT…INS,* ***V****…* with *INS V i*ndicates INS is NOT activated.
- NMEA message like *$GNTXT…INS,* ***E****…* with *INS E i*ndicates INS is under assessment.
- NMEA message like *$GNTXT…INS,* ***G****…* with *INS G i*ndicates GNSS positioning.

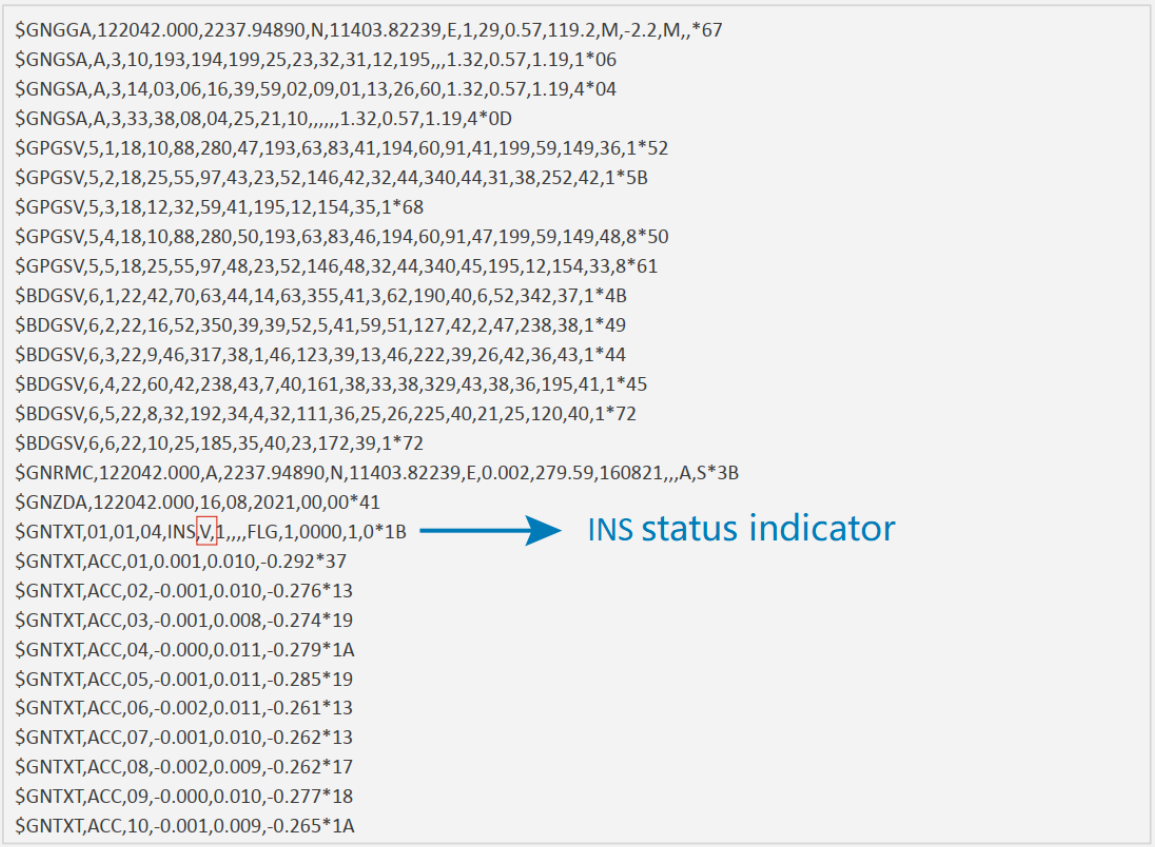


**Figure 10 INS status output**

# 8 DEFAULT MESSAGE

**Table 9 Default message**

| Interface | Settings |
|---|---|
| UART output | Data format: 8 data bits, no parity bit, 1 stop bit<br>Default baud: 115200 bps<br>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 | Data format: 8 data bits, no parity bit, 1 stop bit<br>Default baud: 115200 bps<br>Default protocol: HD binary protocol, RTCM message. |
| PPS | 1 pulse per second, synchronized at rising edge, pulse length 100ms |

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

If the UART is connected well to the MCU when VDD is off, a high UART level may cause residual power on VDD, leading to power on failure. Therefore, when VDD is off, it is advisable to disconnect the UART or set MCU_UART to the input or high resistance state.

# 9 PACKAGING INFORMATION

## 9.1 Packaging

TAU2202 is a Moisture Sensitive Device (MSD) and Electrostatic Sensitive Device (ESD). During 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 10 Packing hierarchy**

| Module | Reel | Sealed bag | Packing box | Shipping carton |
|---|---|---|---|---|
|  |  |  |  |  |

### 9.1.1 Tape and Reel

TAU2202 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.

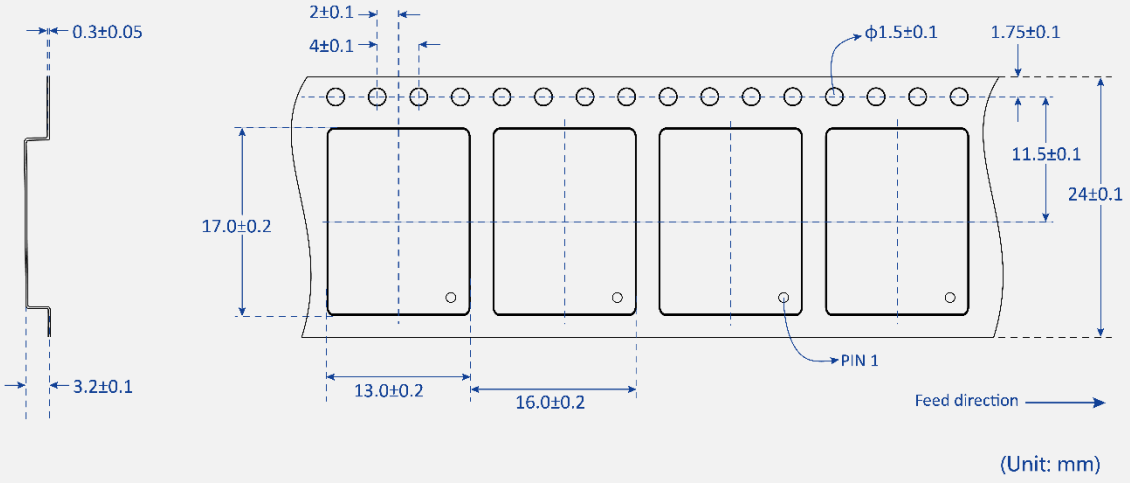


Figure 11 Tape dimensions

TAU2202 is deliverable in quantities of 1000 pcs on a reel. The figure below shows the dimensions of the reel.

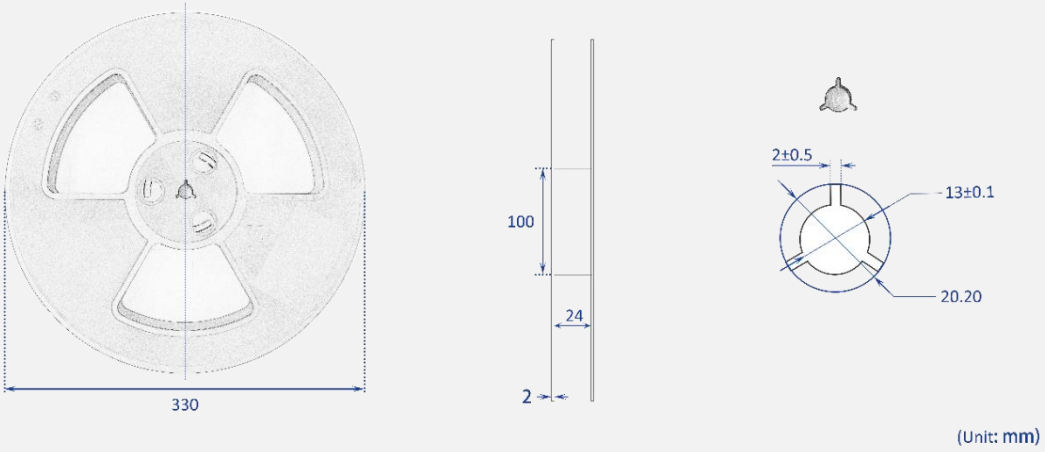


Figure 12 Reel dimensions

### 9.1.2 Shipment Packaging

The reels are packed in the sealed bags in a box and shipped by shipping cartons. Up to five boxes (1000 pcs in total) can be packed in one shipping carton.

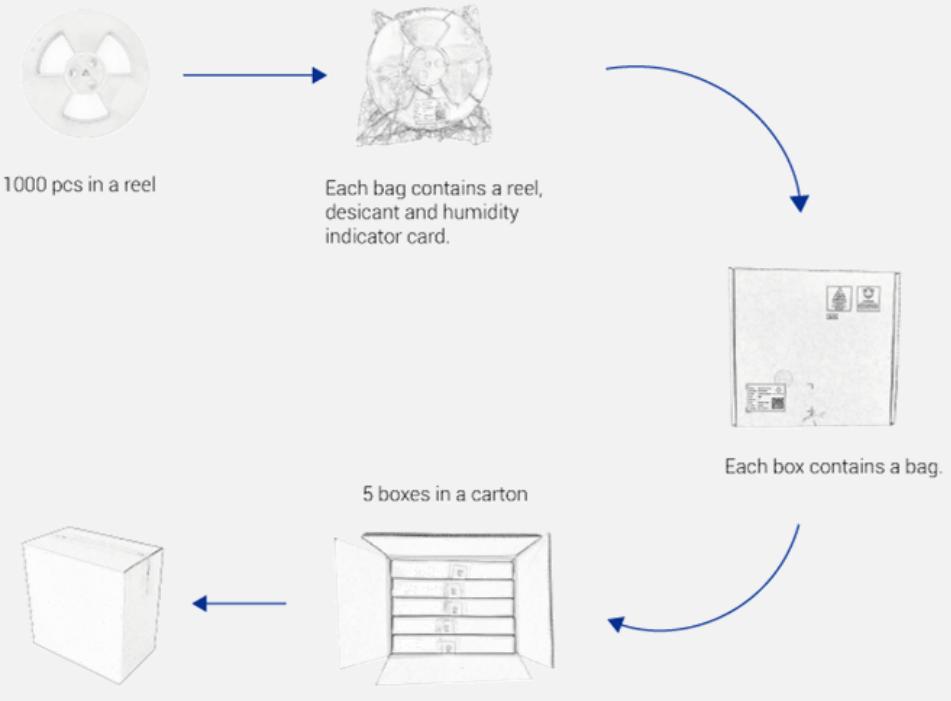


Figure 13 Packaging

## 9.2 Storage

In order to prevent moisture intake and protect against electrostatic discharge, TAU2202 is packaged together with a humidity indicator card and desiccant to absorb humidity.

## 9.3 ESD Handling

### 9.3.1 ESD Handling Precautions

TAU2202 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!

- 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 module's RF pin, make sure to use an ESD safe soldering iron (tip).


### 9.3.2 ESD Protection Measures

The GNSS positioning modules 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

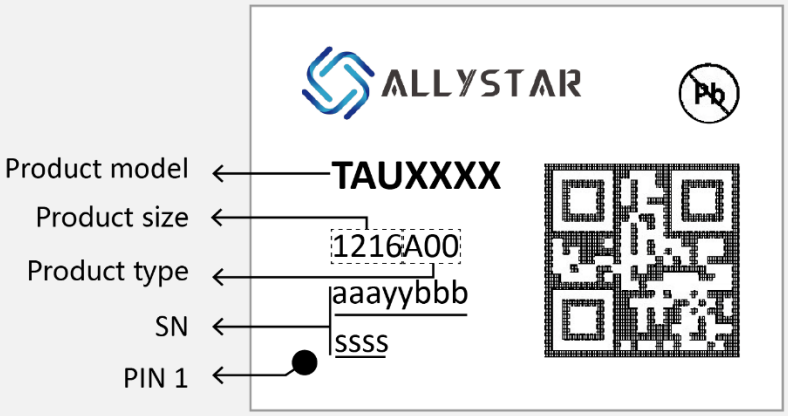


**Table 11 Labeling info**

| Symbol | Explanation |
|---|---|
| TAUXXXX | Product model for market promotion. |
| 1216 | 1216 represents the product size. |
| A00 | A00 means the product type. |
| aaayybbbssss | Serial number |

## 10.2 Ordering info

**Table 12 Ordering codes**

| Ordering No. | Product |
|---|---|
| TAU2202-1216AFX | Concurrent GNSS LCC Module, TCXO, Flash, L1, 12.2*16 mm, 1000 pcs/reel |
| TAU2202-1216A00 | Concurrent GNSS LCC Module, TCXO, Flash, L1+L5, 12.2*16 mm, 1000 pcs/reel |

# 11 REVISION HISTORY

| Revision | Date | Revised by | Status/Comments |
|---|---|---|---|
| V1.0 | 2022-09 | Berry | First release. |
| V1.1 | 2023-04 | Berry | Adds ADR<br>Updates the installation methods and packages<br>Contents optimization |
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