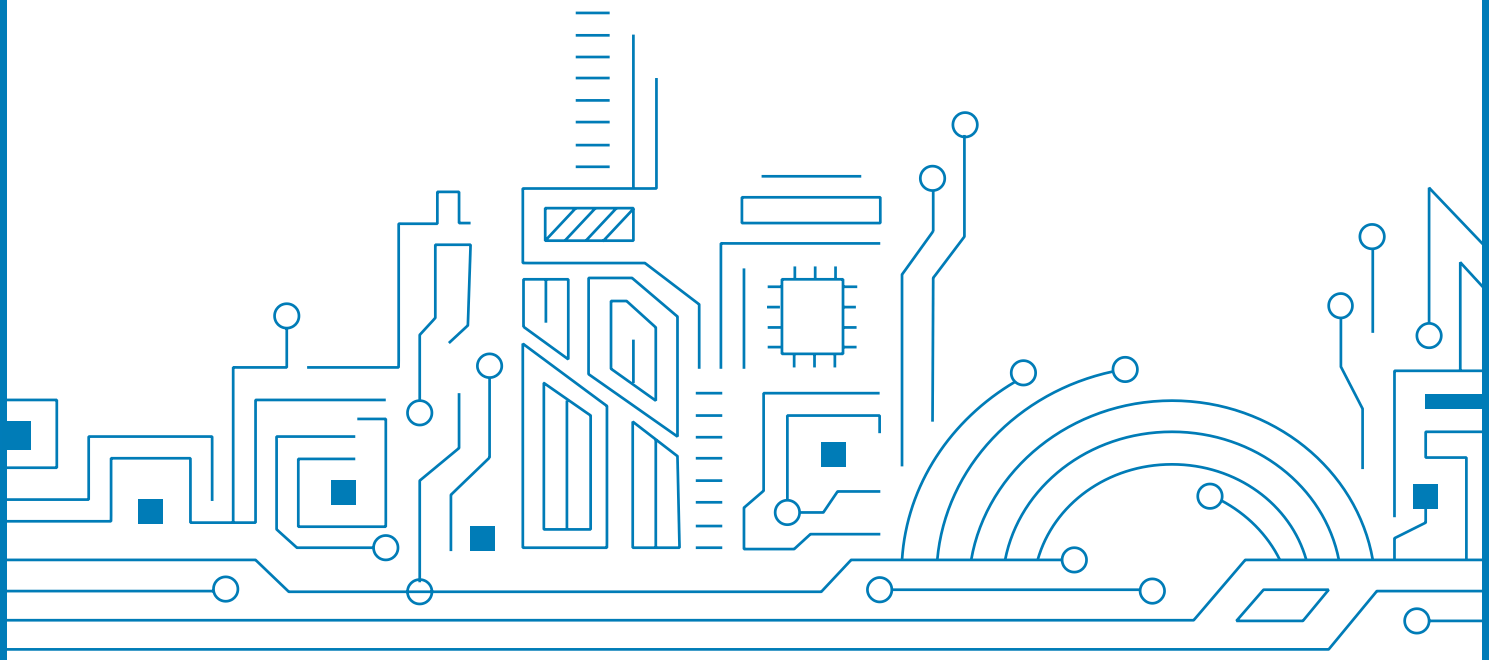
GNSS Positioning Module

TAU1111

Datasheet V1.3



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About the Document

■ Basic info

Document applies to	TAU1111
Document type	Datasheet
Revision and date	V1.3/2021-07
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

TAU1111 is a GNSS positioning module, which is based on the state of the art CYNOSURE III architecture. It supports GPS, BeiDou, GLONASS, Galileo, and QZSS. TAU1111 integrates efficient power management architecture, while providing 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

- Concurrent reception of 5 systems (GPS, BDS, GLONASS, Galileo, and QZSS) to maximize satellites visibility in L1 band
- Provides greater accuracy with more available measurements
- High sensitivity design and low power management
- Smart jammer detection and suppression
- Highly integrated SMD module with cost-effective antenna (L1 only) design

Table 1 TAU1111

Product	GNSS						Features					Interface				Accuracy			Grade		
	Band (S/D/T)	GPS	BDS	GLONASS	Galileo	IRNSS	Built-in LNA	Programmable (flash)	Data logging	D-GNSS	Oscillator	UART	I2C	USB	SPI	Meter	Sub-meter	Centimeter	Standard	Professional	Automotive
TAU1111-1216A00	S	●	●	●	●		●	●	●	●	T	●	○	○	○	●			●		

T= TCXO ○=Supported upon request with special FW

1.3 Module Photo

Figure 1 TAU1111 module photo

1.4 Block Diagram

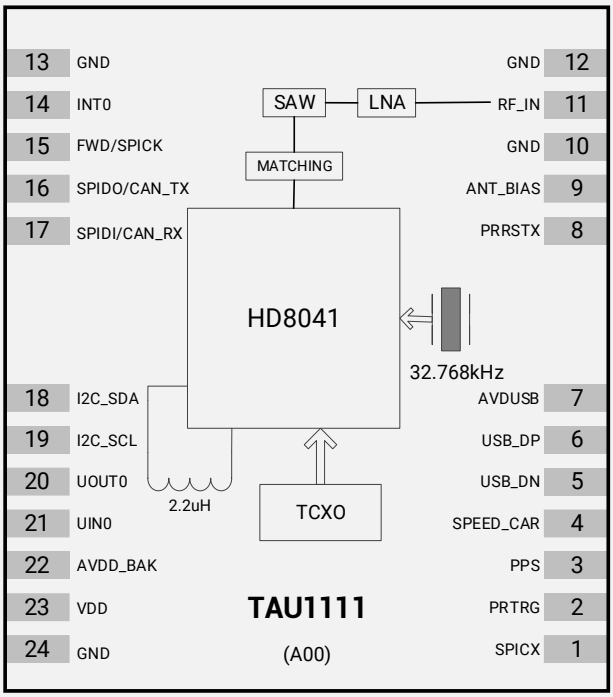


Figure 2 Block diagram

1.5 Specifications

Table 2 Specifications

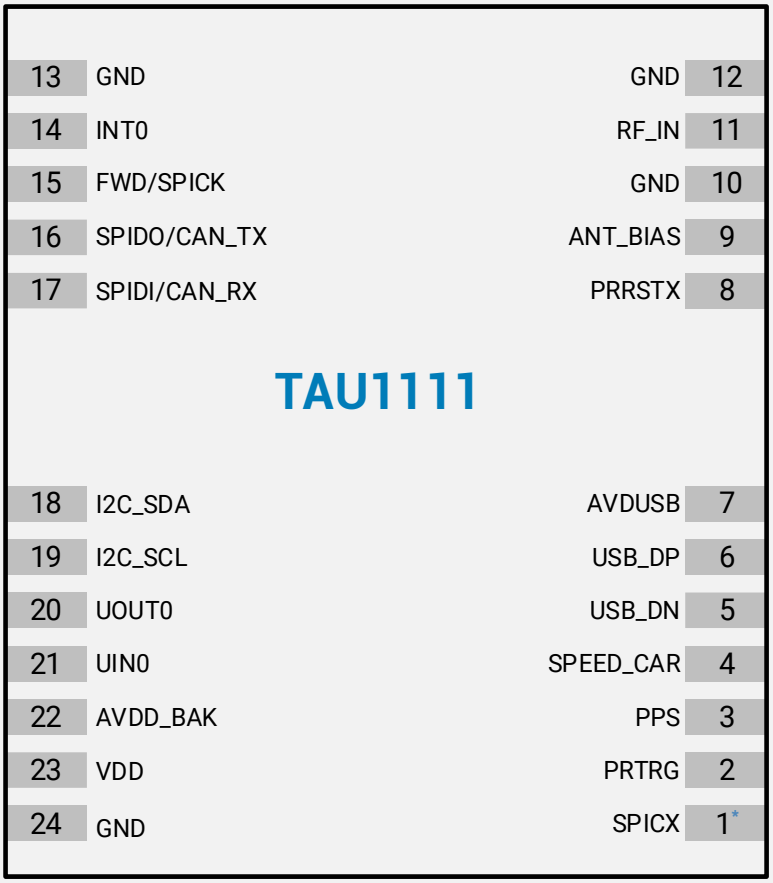
Parameter	Specification	
GNSS tracking channels	40	
GNSS reception	GPS/QZSS: L1C/A	
	BDS: B1I	
	GLONASS: L1OF	
	Galileo: E1	
Update rate	10Hz Maximum	
Position accuracy [1]	GNSS	2.5m CEP
Velocity & Time accuracy	GNSS	0.1m/s CEP
	1PPS	20ns
Time to First Fix(TTFF)	Hot start	1 sec
	Cold start	28 secs
Sensitivity	Cold start	-148dBm
	Hot start	-155dBm
	Reacquisition	-158dBm
	Tracking & navigation	-162dBm
Operating limit	Velocity	515 m/s
	Altitude	18,000 m
Safety supervision	Antenna open circuit detection and short circuit protection	

Parameter	Specification	
Serial interface	UART	1
	I2C[2]	1
	USB[2]	1
	SPI[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	2.0~ 3.6V
	Digital I/O voltage	1.8 ~ 3.6V
	Backup voltage	1.8 ~ 3.6V
Power consumption	GPS+QZSS	25mA@3.3V
	GNSS	35mA@3.3V
	Standby	12uA
Operating temperature	-40 °C ~ +85 °C	
Storage temperature	-40 °C ~ +85 °C	
Package	12.2mm x 16.0mm x 2.4mm 24-pin stamp hole	
Certification	RoHS & REACH	

* *[1] Open sky, demonstrated with a good external LNA*
* *[2] Supported upon request with special FW.*
* *[3] RTCM 2.3/2.4x are supported upon request with special FW.*

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 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 3.0-3.6V.
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. The current is limited below 35mA.
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.
	I2C_SCL	19	I/O	I^2C clock.
System	PRTRG	2	I	Mode selection, or the trigger input in deep sleep mode to wake up the system
	PRRSTX	8	I	External reset, low level active
	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 input. Leave it floating if not used. Default GPIO.

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

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
AVDUSB	USB supply voltage	-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
ESD sensitivity	HBM	-	2000	V

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	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 supply voltage	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

3.3.2 Power Consumption

Table 9 Power consumption

Symbol	Parameter	Measure Pin	Typ.	Unit
I_{CCRX1}	Average tracking current (GPS+QZSS)	VDD [1]	25	mA
I_{CCRX2}	Average tracking current (GNSS)	VDD [1]	35	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

TAU1111 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 less than 50m Vpp. It is recommended to use the LDO above 200mA current.

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 or leave it floating.*

4.2 Power on/off Sequence

TAU1111 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.

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 5ms after both backup supply and main supply reach the minimum operating voltage. Initial system power on sequence is illustrated in Figure 4.

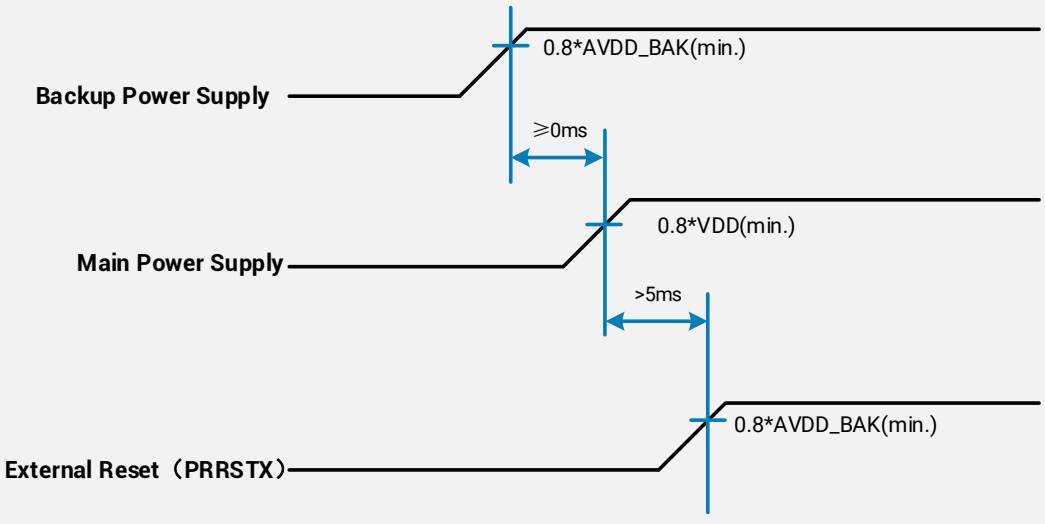


Figure 4 Initial system power on sequence

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 5ms after main power supply resumes to minimum operating voltage. Main power on sequence in application is illustrated in Figure 5.

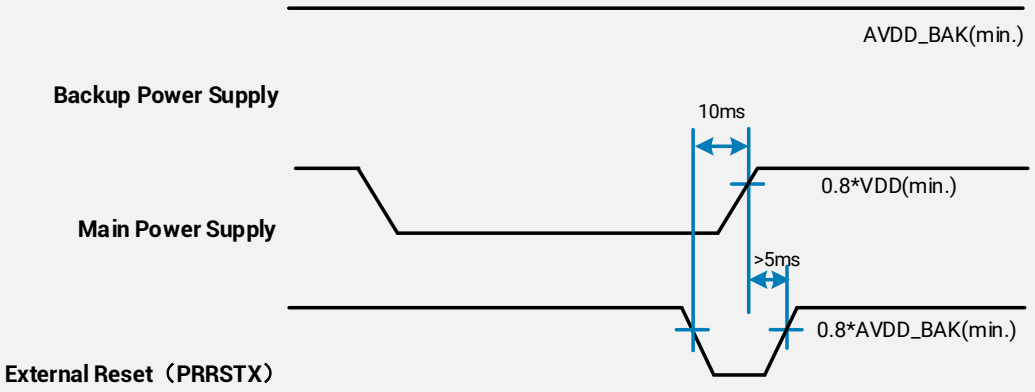


Figure 5 Main power on sequence

4.3 Antenna Design

There is built-in LNA and SAW in the GNSS module. It is recommended to use an active antenna with gain less than 36dB and the noise figure less than 1.5dB.

The module has built-in short circuit detection and open circuit detection functions, 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 ≤ 1mA
Regular circuit or open circuit	OK or OPEN	1mA< ANT_BIAS ≤ 2mA
Regular circuit	OK	2mA< ANT_BIAS ≤ 40±5mA[1]
Short circuit	SHORT	40±5mA[1] < ANT_BIAS < 55mA

* *[1] ±5mA are differences between product batches.*

TIPs:

1. Pulse width of the minimum detectable overshoot current should be more than 10uS.
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, leave PRRSTX and PRTRG pins floating if there is no upgrading or reset demands, or others.

- 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.

4.5 Default Serial Interfaces

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 following protocols without need of explicit configuration: HD binary sentence, NMEA, RTCM The GNSS receiver supports interleaved HD binary and NMEA messages.
Timepluse (1Hz Nav)	1 pulse per second, synchronized at rising edge, pulse length 100ms

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

When the module is applied to the specific application, users can shut off the main power in order to further reduce the power consumption. To avoid the high level in serial interface influencing the normal operation, it is highly suggested to cut off the serial port when shut off the main power. Otherwise, please set the serial port to input mode or high impedance state with pull-down resistor.

5 MECHANICAL SPECIFICATION

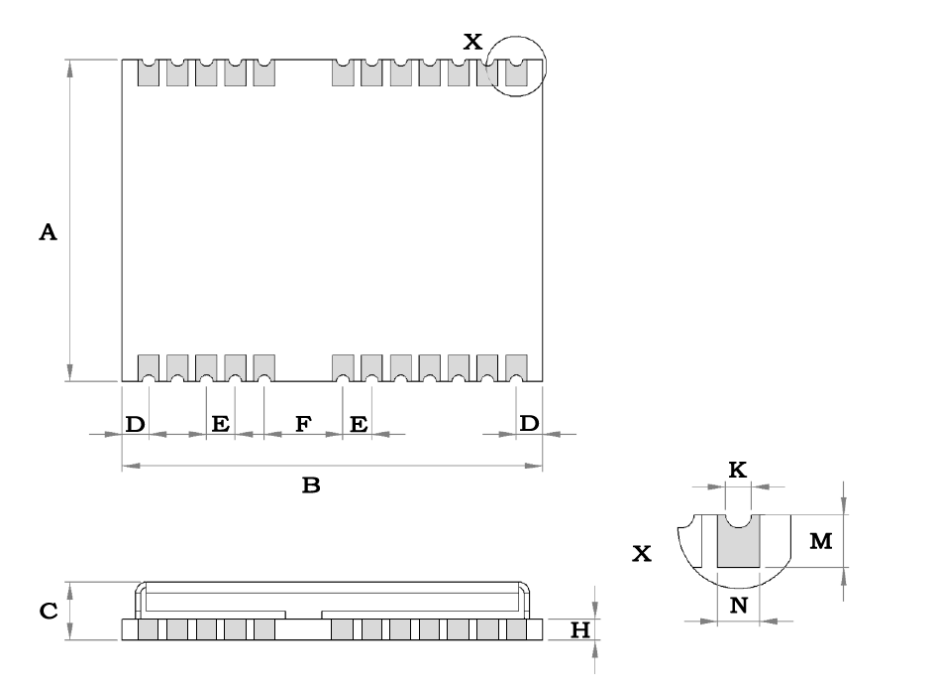


Figure 6 Dimensions

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

6 REFERENCE DESIGN

6.1 Minimal Design

This is a minimal design for a TAU1111 GNSS module. The 82nH 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.

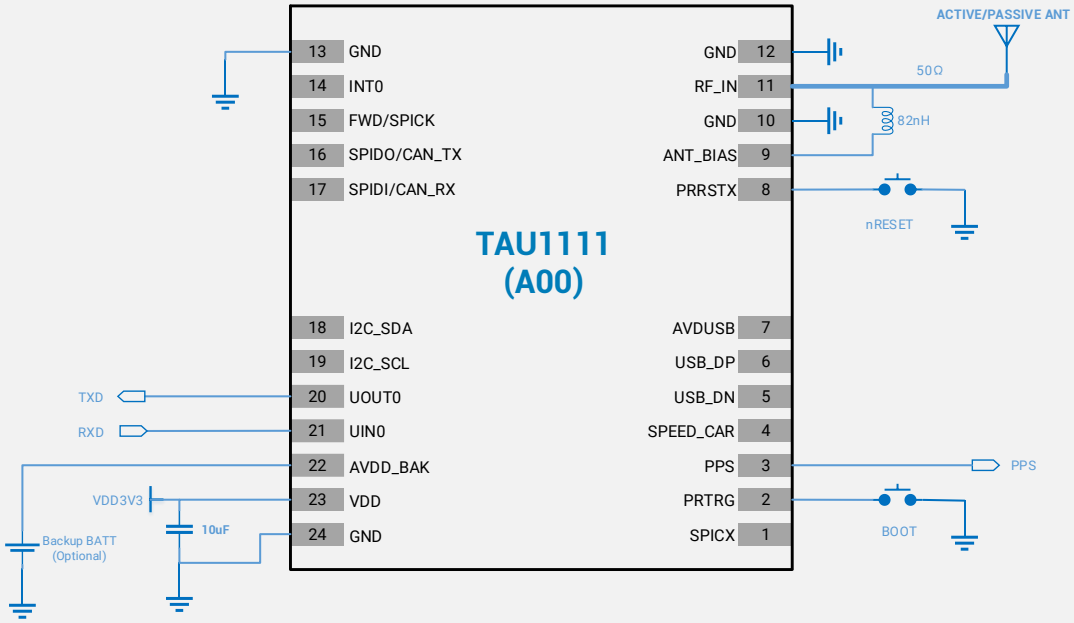


Figure 7 Minimal application diagram

6.2 PCB Footprint Reference

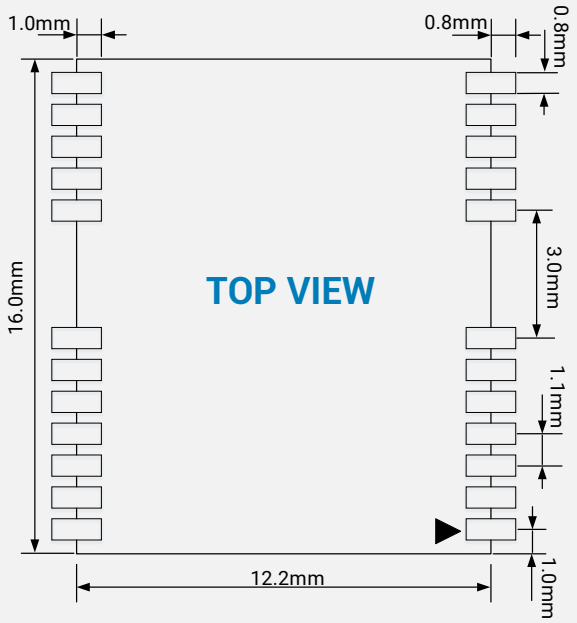


Figure 8 PCB Footprint Reference

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 0.5mm.
(2) The width of RF routing between RF port to antenna interface should be wider than 0.2mm. 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 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})	60-120s
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	60-150s
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.*

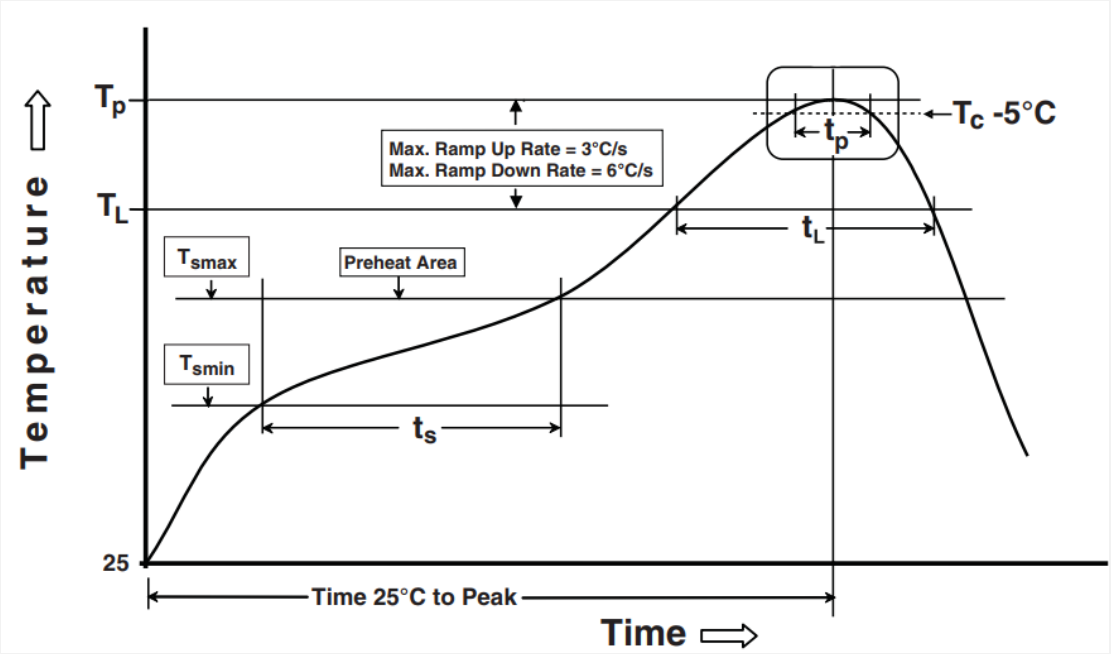


Figure 9 Reflow soldering profile (Refer to IPC/JEDEC J-STD-020E)

8 PRODUCT PACKAGING AND HANDLING

8.1 Packaging

TAU1111 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
			

8.1.1 Tape and Reel

TAU1111 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.

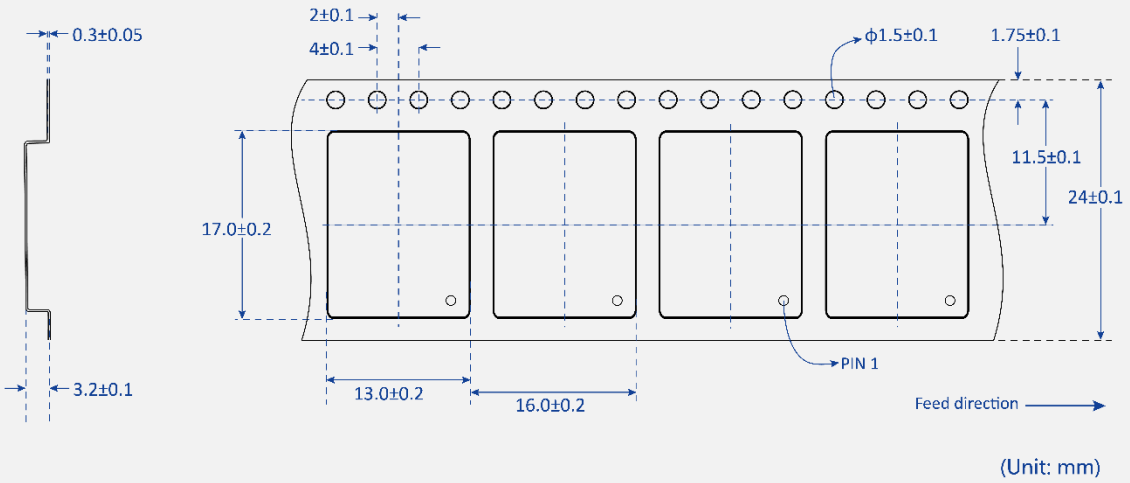


Figure 10 Tape dimensions

TAU1111 is deliverable in quantities of 1000pcs on a reel. The figure below shows the dimensions of the reel.

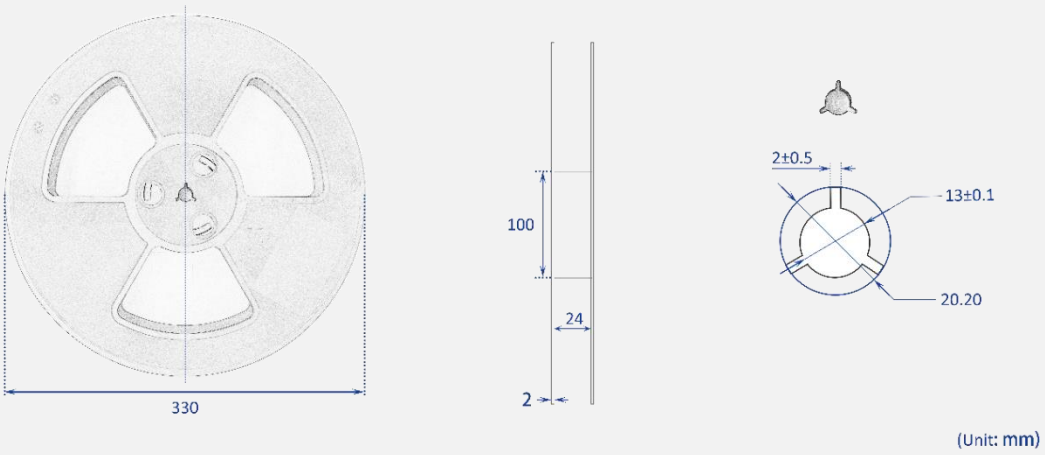


Figure 11 Reel dimensions

8.1.2 Shipment Packaging

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

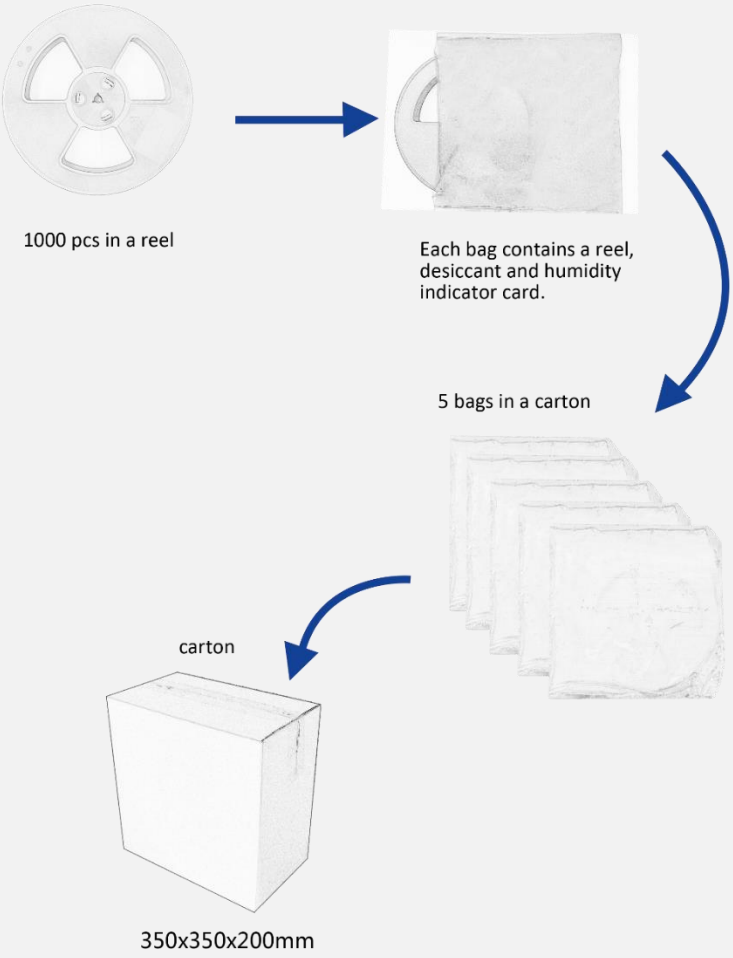


Figure 12 Packaging

8.2 Storage

In order to prevent moisture intake and protect against electrostatic discharge, TAU1111 is packaged together with a humidity indicator card and desiccant to absorb humidity.

8.3 ESD Handling

8.3.1 ESD Handling Precautions

TAU1111 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).

8.3.2 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.

8.3.3 Moisture Sensitivity Level

The Moisture Sensitivity Level (MSL) of the GNSS module is MSL4.

9 LABELING AND ORDERING INFORMATION

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

9.1 Labeling

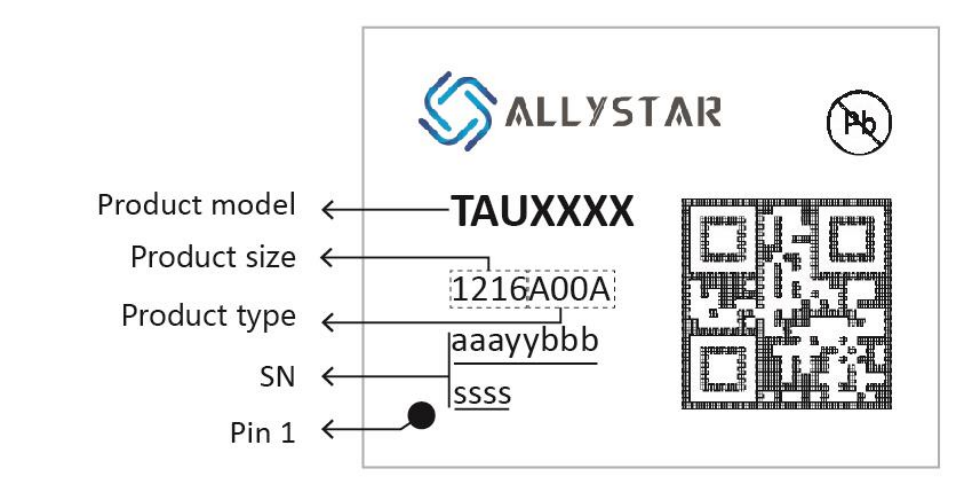


Table 15 Labeling content

Symbol	Explanation	Instance
TAUXXXX	Product model	TAU1111
1216A00A	1216 represents the product size.	1216A00
	A00 means the product type.	
	Second A refers to sales area code. Different code for different sales area.	E (for Europe market)
aaayybbbssss	Serial number	351190010001

9.2 Ordering info

Table 16 Ordering codes

Ordering No.	Product
TAU1111-1216A00E	Concurrent GNSS LCC Module, TCXO, ROM, 12.2*16mm, 1000 pieces/reel, Europe market.
TAU1111-1216A00H	Concurrent GNSS LCC Module, TCXO, ROM, 12.2*16mm, 1000 pieces/reel, India market.
TAU1111-1216A00R	Concurrent GNSS LCC Module, TCXO, ROM, 12.2*16mm, 1000 pieces/reel, Russia market.

10 RELATED DOCUMENTS

[1] Satrack User Manual
[2] Allystar Common Commands
[3] GNSS_Protocol_Specification

11 REVISION HISTORY

Revision	Date	Reviser	Status / Comments
V1.0	2019-10-24	Vita Wu	First released.
V1.1	2020-06	Vita Wu	Updates Section 6.3 Layout note Adds built-in choke design (C00); Updates reference design; Simplifies Pin description;
V1.2	2020-12	Vita Wu	Updates MSL. Deletes SBAS support. Fixes I/O type of INT0 to be *I*. Clarifies power on/off sequence. Updates AVDD_BAK connectivity description in Section 4.1. Improves mechanical specification. Localization. Improves wordings. Improves layout notes in Section 6.3. Deletes 1K resistor in the minimal design diagram. Updates description about short circuit protection.
V1.3	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.

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