

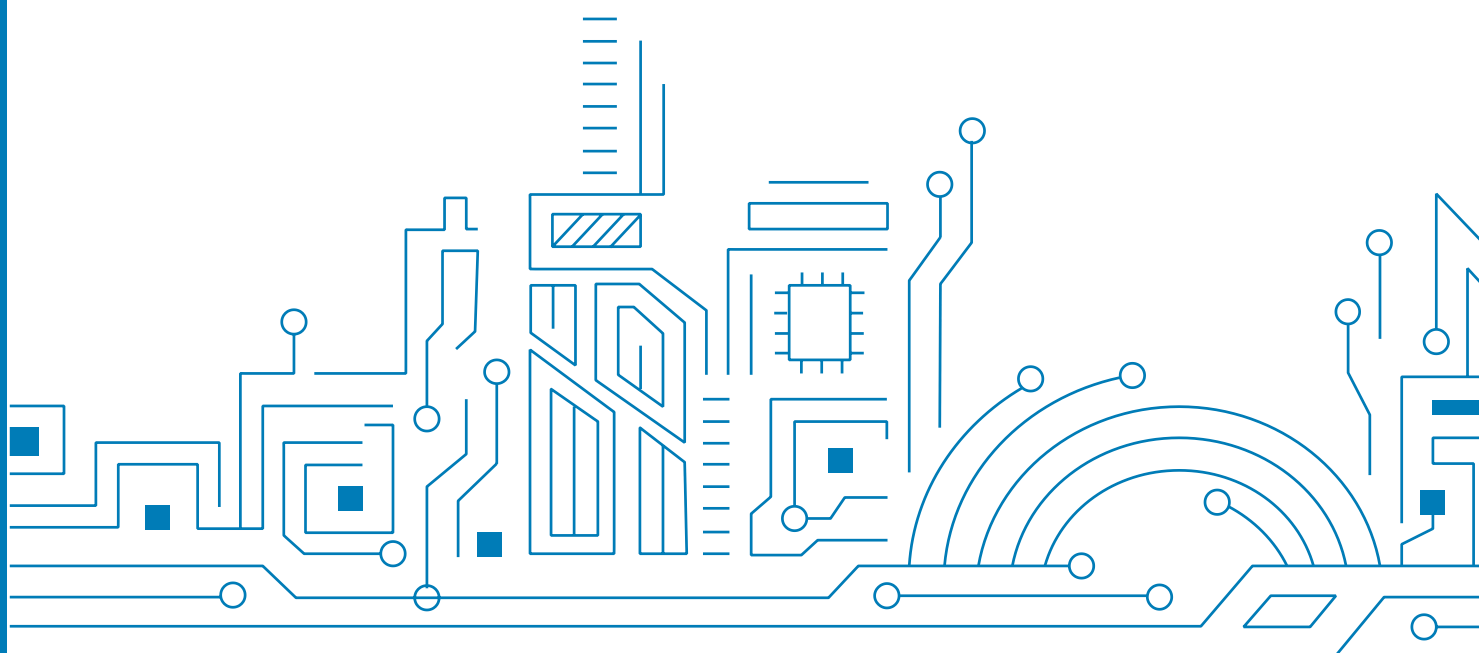


ALLYSTAR

# Multi-System GNSS Positioning Module

## TAU1111

Datasheet V1.1



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## TABLE OF CONTENT

<b>1</b>	<b>SYSTEM OVERVIEW.....</b>	<b>5</b>
1.1	Overview .....	5
1.2	Features .....	5
1.3	Module Photo .....	5
1.4	Block Diagram .....	6
1.5	Specifications .....	6
<b>2</b>	<b>PIN DESCRIPTION.....</b>	<b>8</b>
2.1	Pin Assignment .....	8
2.2	Detailed Pin Descriptions.....	9
<b>3</b>	<b>ELECTRICAL CHARACTERISTICS.....</b>	<b>10</b>
3.1	Absolute Maximum Rating .....	10
3.2	IO Characteristics .....	10
3.2.1	PRRSTX and PRTRG .....	10
3.2.2	USB I/O .....	10
3.2.3	ANT_BIAS .....	11
3.2.4	Others .....	11
3.3	DC Characteristics.....	11
3.3.1	Operating Conditions .....	11
3.3.2	Power Consumption .....	11
<b>4</b>	<b>HARDWARE DESCRIPTION.....</b>	<b>12</b>
4.1	Connecting Power .....	12
4.2	Antenna Design .....	12
4.3	Reset and Mode Control .....	13
4.4	Serial Interfaces.....	13
<b>5</b>	<b>MECHANICAL SPECIFICATION .....</b>	<b>14</b>
<b>6</b>	<b>REFERENCE DESIGN.....</b>	<b>15</b>
6.1	Minimal Design .....	15
6.2	PCB Footprint Reference .....	17
6.3	Layout Notes.....	17
6.3.1	Reflow soldering .....	17
<b>7</b>	<b>PRODUCT PACKAGING AND HANDLING .....</b>	<b>19</b>
7.1	Packaging .....	19
7.1.1	Tape and Reel.....	19
7.1.2	Shipment Packaging.....	20
7.2	Storage .....	21

7.3	ESD Handling .....	21
7.3.1	ESD Handling Precautions .....	21
7.3.2	ESD Protection Measures.....	21
7.3.3	Moisture Sensitivity Level.....	21
<b>8</b>	<b>REVISION HISTORY.....</b>	<b>22</b>

## List of tables

Table 1	Differences between TAU1111-1216A00 and TAU1111-1216C00 .....	5
Table 2	Specifications.....	6
Table 3	Detailed pin descriptions .....	9
Table 4	Absolute rating .....	10
Table 5	PRRSTX and PRTRG.....	10
Table 6	USB signal.....	10
Table 7	ANT_BIAS .....	11
Table 8	Others .....	11
Table 9	Operating conditions.....	11
Table 10	Power consumption.....	11
Table 11	ANT_BIAS current range and antenna status.....	12
Table 12	Dimensions.....	14
Table 13	Reflow profile features .....	17
Table 14	Packing hierarchy.....	19

## List of figures

Figure 1	TAU1111 module photo.....	5
Figure 2	Block diagram .....	6
Figure 3	Pin assignment (top view).....	8
Figure 4	Dimensions .....	14
Figure 5	Minimal application diagram of A00 with internal power for ANT .....	15
Figure 6	Minimal application diagram of C00 with internal power for ANT .....	16
Figure 7	Minimal application diagram with external power for ANT.....	16
Figure 8	PCB Footprint Reference .....	17
Figure 9	Reflow soldering profile (Refer to IPC/JEDEC J-STD-020E) .....	18
Figure 10	Tape dimensions .....	19
Figure 11	Reel dimensions .....	20
Figure 12	Packaging .....	20

# 1 SYSTEM OVERVIEW

## 1.1 Overview

TAU1111 is a multi-system GNSS positioning module, which is based on the state of the art CYNOSURE III architecture. It supports BDS-3 (BeiDou Navigation Satellite System 3). Besides, it is capable of tracking all the global civil navigation systems (BDS, GPS, GLONASS, Galileo, QZSS and SBAS). 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, QZSS and SBAS) 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

## 1.3 Module Photo



Figure 1 TAU1111 module photo

Table 1 Differences between TAU1111-1216A00 and TAU1111-1216C00

PN	Description
TAU1111-1216A00	RF_IN pin does not provide the power for active antenna, so a bias choke from ANT_BIAS to RF_IN pin should be used.
TAU1111-1216C00	A bias choke is built-in between ANT_BIAS and RF_IN pin to power the active antenna. If the active antenna is powered by a supply source other than the module, a capacitor should be used to block the DC from RF_IN.

## 1.4 Block Diagram

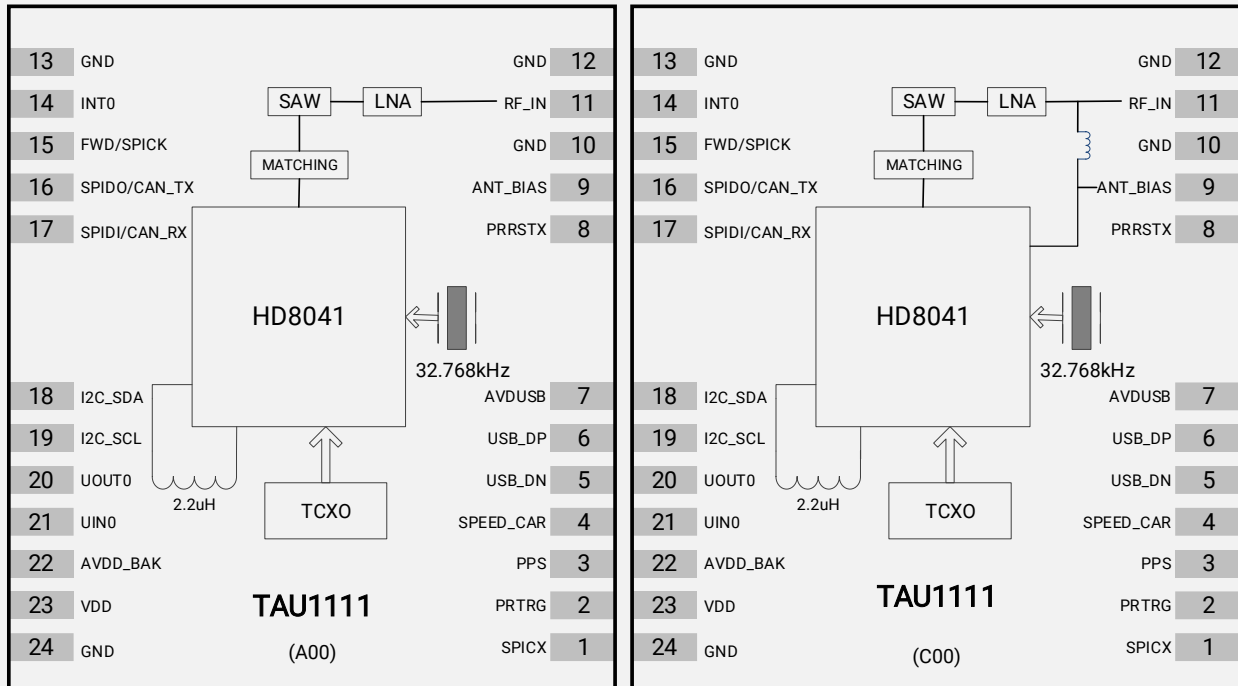


Figure 2 Block diagram

## 1.5 Specifications

Table 2 Specifications

Parameter	Specification	
GNSS Tracking channel	40 channels	
GNSS reception	GPS/QZSS: L1C/A, L1C <sup>[1]</sup>	
	BDS: B1I, B1C <sup>[1]</sup>	
	GLONASS: L10F	
	Galileo: E1	
	SBAS: L1	
Update rate	10Hz Maximum	
Position accuracy <sup>[2]</sup>	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

Parameter	Specification	
Safety supervision	Antenna open circuit detection and short circuit protection	
	Low voltage detection	
Serial interface	UART	1
	I2C	1
	USB	1
	SPI	1
	CAN <sup>[3]</sup>	1
Protocol	NMEA 0183 Protocol Ver. 4.00/4.10, Cynosure GNSS Receiver Protocol	
Operating condition	Main voltage	1.8 ~ 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] Supported by specific firmware upgrade

\* [2] Open sky, demonstrated with a good external LNA

\* [3] Supported by specific firmware upgrade

## 2 PIN DESCRIPTION

### 2.1 Pin Assignment

13	GND	GND	12
14	INT0	RF_IN	11
15	FWD/SPICK	GND	10
16	SPIDO/CAN_TX	ANT_BIAS	9
17	SPIDI/CAN_RX	PRRSTX	8
<b>TAU1111</b>			
18	I2C_SDA	AVDUSB	7
19	I2C_SCL	USB_DP	6
20	UOUT0	USB_DN	5
21	UIN0	SPEED_CAR	4
22	AVDD_BAK	PPS	3
23	VDD	PRTRG	2
24	GND	SPICX	1

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. If no backup power is available, leave this pin floating.
	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	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	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	I2C_SDA	18	I/O	I <sup>2</sup> C data.
	I2C_SCL	19	I/O	I <sup>2</sup> C 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	4	I	Speed pulse. Leave it floating if not used. Default GPIO.
	INT0	14	O	External interrupt. Leave it floating if not used. Default GPIO.

## 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
V <sub>I</sub> max	Voltage input of I/O pin	-0.5	3.63	V
T <sub>storage</sub>	Storage temperature	-40	85	°C
T <sub>solder</sub>	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 <sub>Iz</sub>	Input leakage current	--	--	--	+/-1	uA
V <sub>IH</sub>	Input high voltage	--	AVDD_BAK*0.7	--	AVDD_BAK	V
V <sub>IL</sub>	Input low voltage	--	0	--	AVDD_BAK*0.3	V
C <sub>i</sub>	Input capacitance	--	--	--	10	pF
R <sub>PU</sub>	Pull-up resistance	--	18	--	84	KΩ

#### 3.2.2 USB I/O

Table 6 USB signal

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I <sub>Iz</sub>	Input leakage current	--	--	--	+/-10	uA
V <sub>IH</sub>	Input high voltage	--	AVDUSB*0.9	--	AVDUSB	V
V <sub>IL</sub>	Input low voltage	--	0	--	AVDUSB*0.1	V
V <sub>OH</sub>	Output high voltage	I <sub>OH</sub> =10 mA, AVDUSB=3.3V	2.35	--	--	V
V <sub>OL</sub>	Output low voltage	I <sub>OL</sub> =10 mA, AVDUSB=3.3V	--	--	0.5	V
R <sub>PUIDEL</sub>	Pull-up resistance, idle state	--	0.9	--	1.575	kΩ
R <sub>PUACTIVE</sub>	Pull-up resistance, active state	--	1.425	--	3.09	kΩ

### 3.2.3 ANT\_BIAS

Table 7 ANT\_BIAS

Parameter	Condition	Min.	Typ.	Max.	Unit
RF supply current	--	--	--	35	mA
RF supply voltage	--	1.42	--	3.43	V

### 3.2.4 Others

Table 8 Others

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I <sub>IZ</sub>	Input leakage current	--	--	--	+/-1	uA
V <sub>IH</sub>	Input high voltage	--	VDD*0.7	--	VDD	V
V <sub>IL</sub>	Input low voltage	--	0	--	VDD*0.3	V
V <sub>OH</sub>	Output high voltage	I <sub>OH</sub> =11.9 mA, VDD=3.3V	2.64	--	--	V
		I <sub>OH</sub> =2.8 mA, VDD=1.8V	1.53	--	--	V
V <sub>OL</sub>	Output low voltage	I <sub>OL</sub> =7.9 mA, VDD=3.3V	--	--	0.4	V
		I <sub>OL</sub> =3.9 mA, VDD=1.8V	--	--	0.45	V
C <sub>i</sub>	Input capacitance	--	--	--	11	pF
R <sub>PU</sub>	Pull-up resistance	--	35	--	84	KΩ

## 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	1.8	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
ICC <sub>max</sub>	Maximum operating current @ VDD	--	--	200	mA
T <sub>env</sub>	Operating temperature	-40	--	85	°C

### 3.3.2 Power Consumption

Table 10 Power consumption

Symbol	Parameter	Measure Pin	Typ.	Unit
I <sub>CCRX1</sub> <sup>[1]</sup>	Run Mode (GPS+QZSS)	VDD <sup>[3]</sup>	25	mA
I <sub>CCRX2</sub> <sup>[2]</sup>	Run Mode (All GNSS)	VDD <sup>[3]</sup>	35	mA
I <sub>CCDBM</sub>	Standby mode	AVDD_BAK <sup>[4]</sup>	12	uA

\* [1] Open sky, GPS+QZSS, 16 tracking channels, position fixed

\* [2] Open sky, all GNSS, 32 tracking channels, position fixed

\* [3] Condition: VDD=3.3V@Room Temperature; All Pins Open.

\* [4] 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, leave AVDD\_BAK pin floating.

### 4.2 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 cut off this power supply automatically to prevent permanent 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	$0 < \text{ANT\_BIAS} \leq 1\text{mA}$
Regular circuit or open circuit	OK or OPEN	$1\text{mA} < \text{ANT\_BIAS} \leq 2\text{mA}$
Regular circuit	OK	$2\text{mA} < \text{ANT\_BIAS} \leq 40 \pm 5\text{mA}^{[1]}$
Short circuit	SHORT	$40 \pm 5\text{mA}^{[1]} < \text{ANT\_BIAS} < 55\text{mA}$

\* [1]  $\pm 5\text{mA}$  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

### 4.3 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.

### 4.4 Serial Interfaces

The module provides a TTL Universal Asynchronous Receiver / Transmitter (UART) interface. The data format is: 1 start bit, 8 data bits, 1 stop bit, no checksum, and the default baud rate is 115200 bps. NMEA data outputs while the module is powered on. The upper computer can set the operation mode and baud rate of the module through serial interface.

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

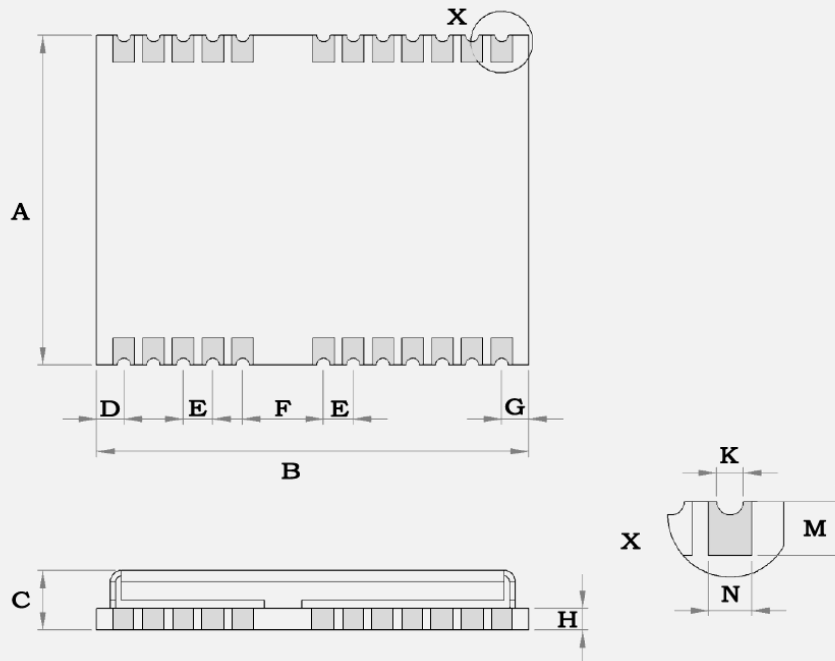


Figure 4 Dimensions

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
G	0.9	1.0	1.3
H	-	0.8	--
K	0.4	0.5	0.6
M	0.8	0.9	1.0
N	0.7	0.8	0.9

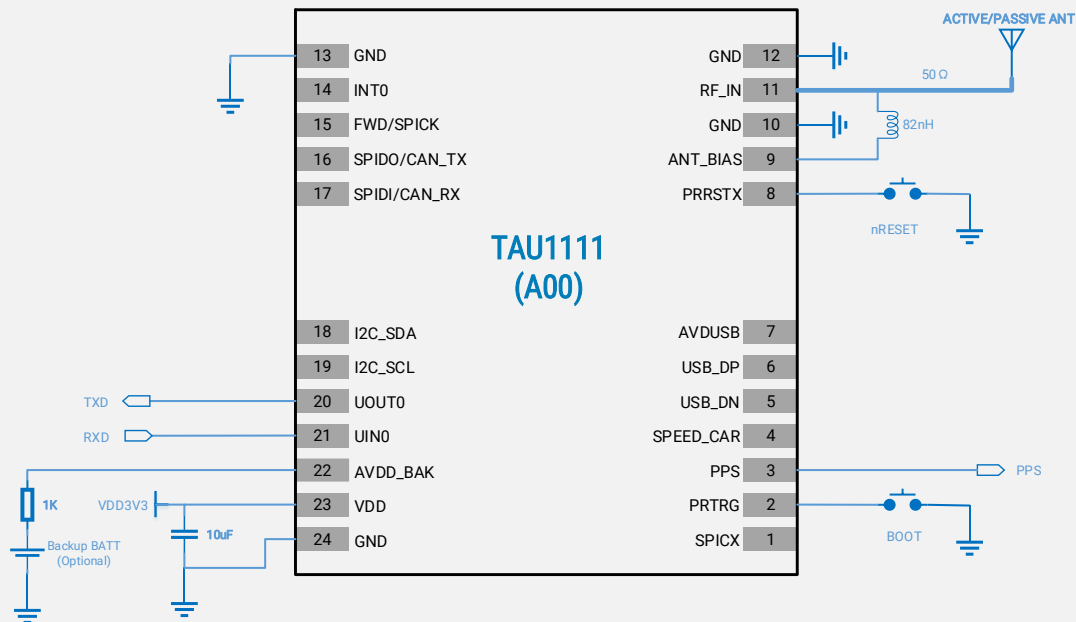
## 6 REFERENCE DESIGN

### 6.1 Minimal Design

TAU1111 includes two designs of TAU1111-1216A00 and TAU1111-1216C00.

- In A00 design, RF\_IN pin does not provide the power for active antenna, so a bias choke of 82nH from ANT\_BIAS to RF\_IN pin should be used. (Refer to **Figure 5**)
- In C00 design, a bias choke is built-in between ANT\_BIAS and RF\_IN pin to power the active antenna. (Refer to **Figure 6**)
- If the active antenna is powered by a supply source other than the module, a capacitor should be used to block the DC from RF\_IN. (Refer to **Figure 7**)

The characteristic impedance from RF\_IN pin to the antenna connector should be 50Ω.



**Figure 5 Minimal application diagram of A00 with internal power for ANT**

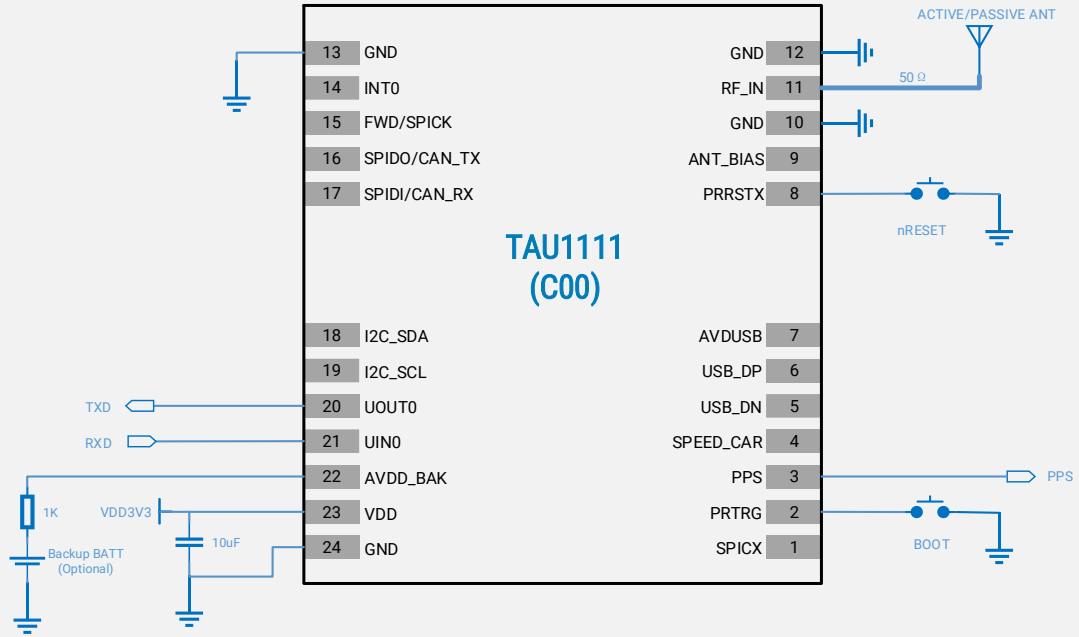


Figure 6 Minimal application diagram of C00 with internal power for ANT

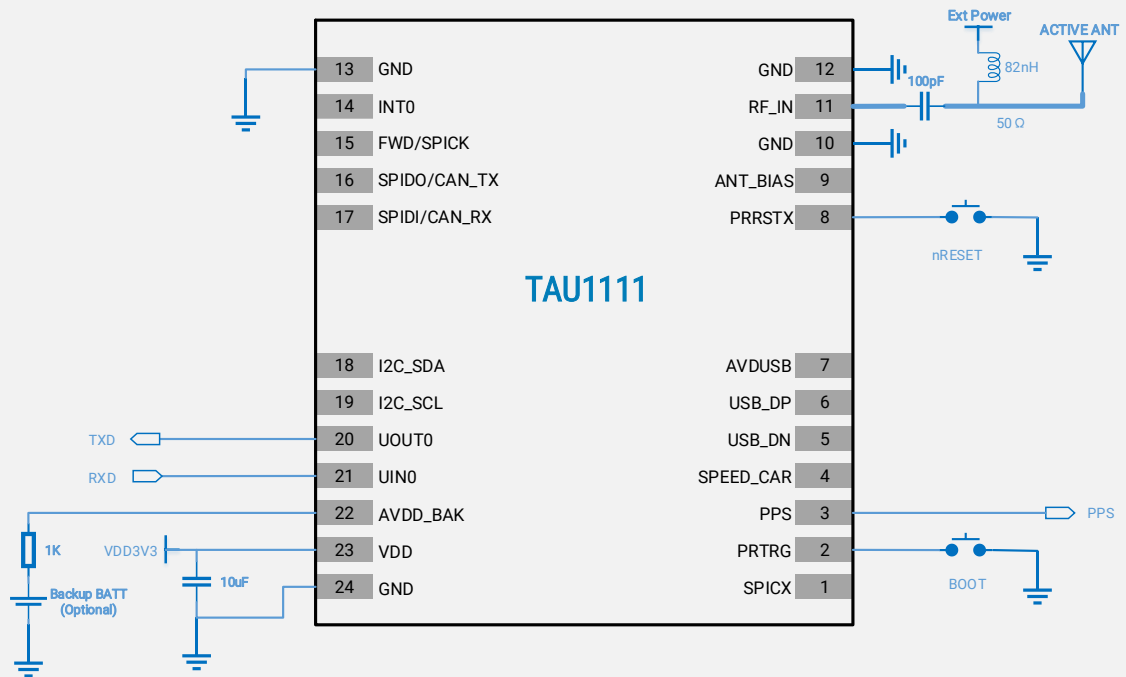


Figure 7 Minimal application diagram with external power for ANT



## 6.2 PCB Footprint Reference

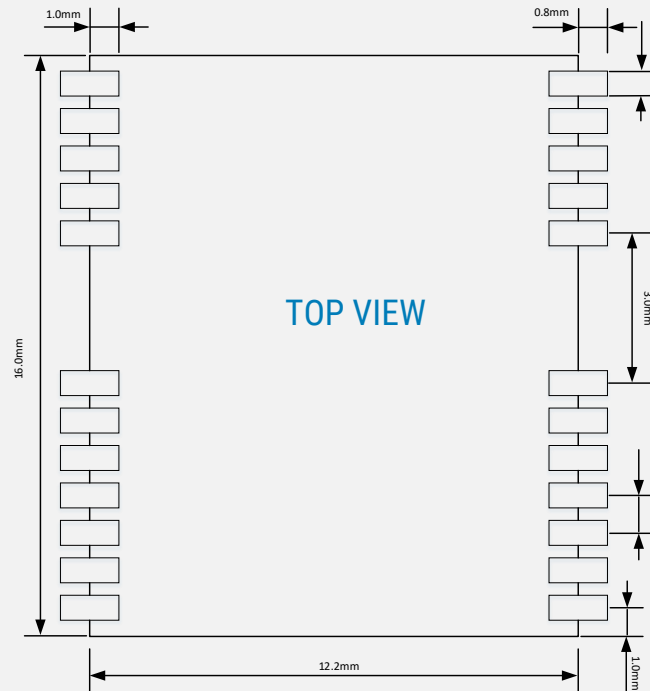


Figure 8 PCB Footprint Reference

## 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 characteristic impedance of RF routing between RF port to antenna should be controlled to 50  $\Omega$ .
- 3) 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.

### 6.3.1 Reflow soldering

Table 13 Reflow profile features

Profile Feature	Pb-Free Assembly
<b>Preheat/Soak</b>	
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]  $T_c=260^{\circ}\text{C}$ .

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

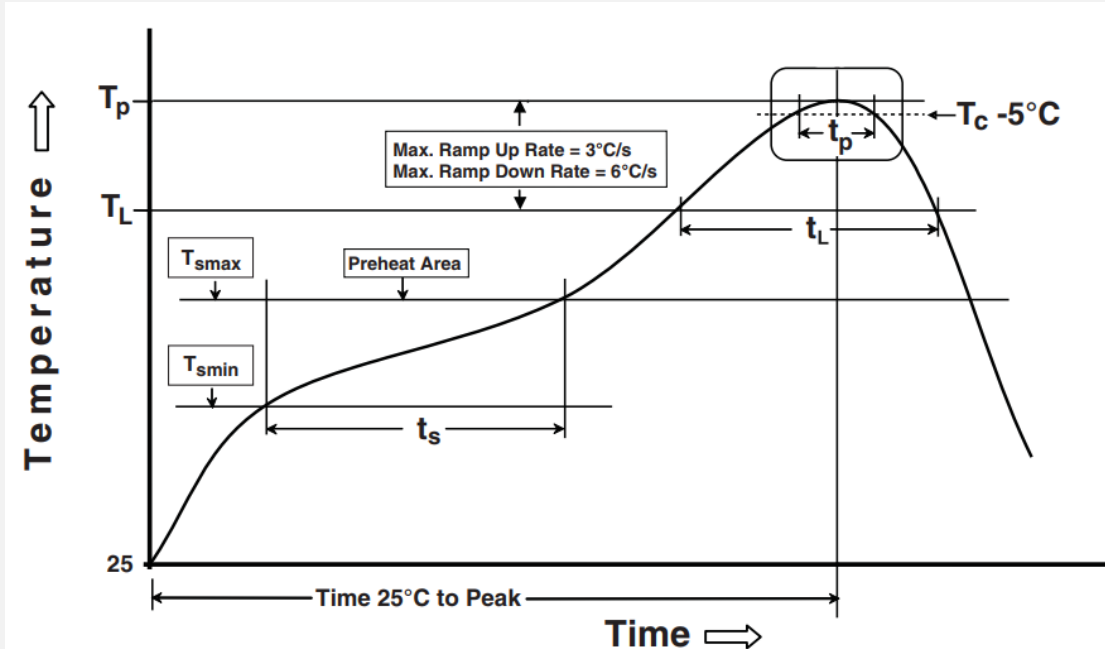






Figure 9 Reflow soldering profile (Refer to IPC/JEDEC J-STD-020E)

## 7 PRODUCT PACKAGING AND HANDLING

### 7.1 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.

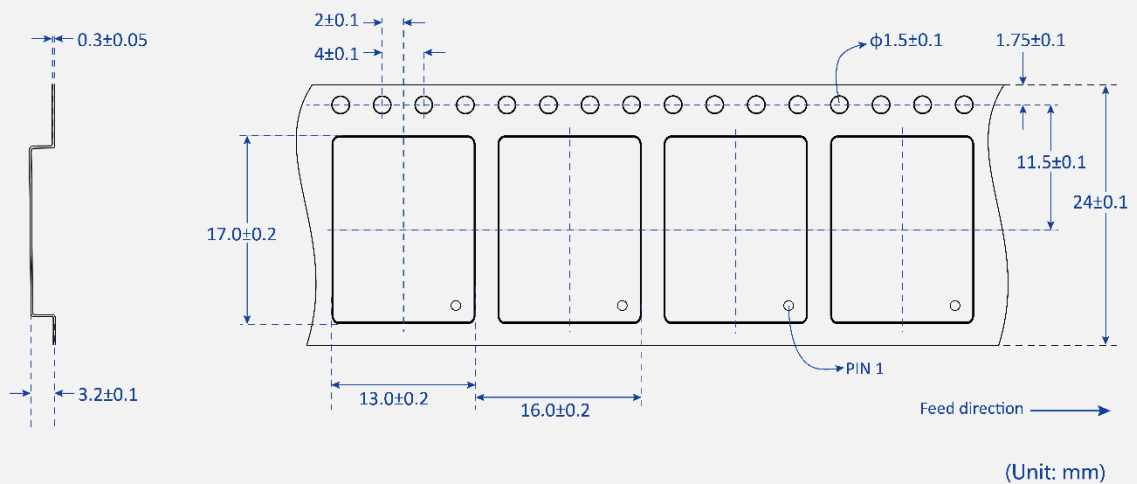
**Table 14 Packing hierarchy**

Module	Reel	Sealed bag	Shipping carton
			

**Note:** Packaging of non-standard quantities is not explained here. Take the reality as a reference.

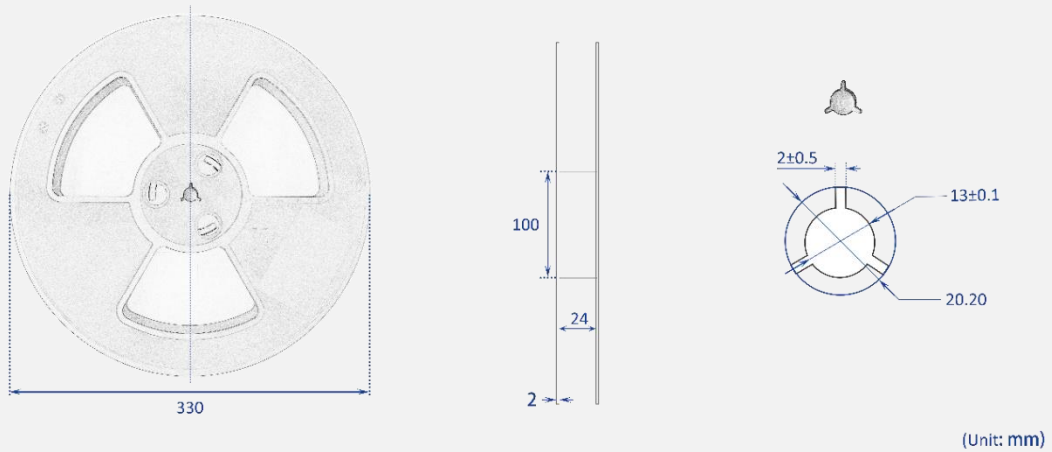
#### 7.1.1 Tape and Reel

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**

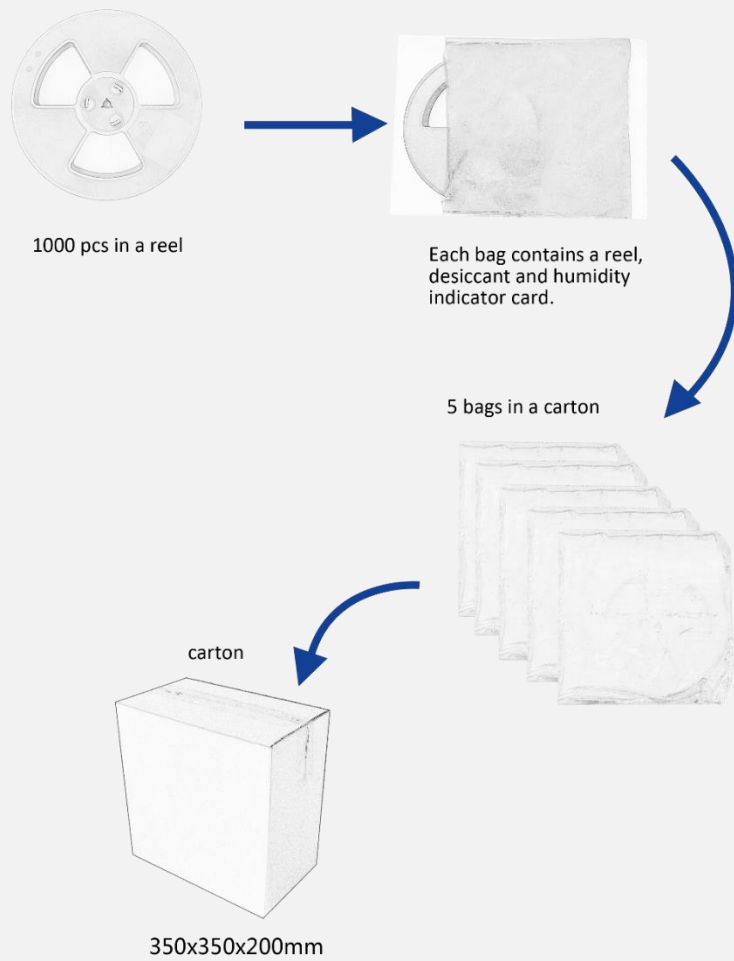
TAU1111 is deliverable in quantities of 1000pcs on a reel. The figure below shows the dimensions of the reel.



**Figure 11 Reel dimensions**

**7.1.2 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**

## 7.2 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.

## 7.3 ESD Handling

### 7.3.1 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).



### 7.3.2 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.

### 7.3.3 Moisture Sensitivity Level

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

## 8 REVISION HISTORY

Revision	Date	Author	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;



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