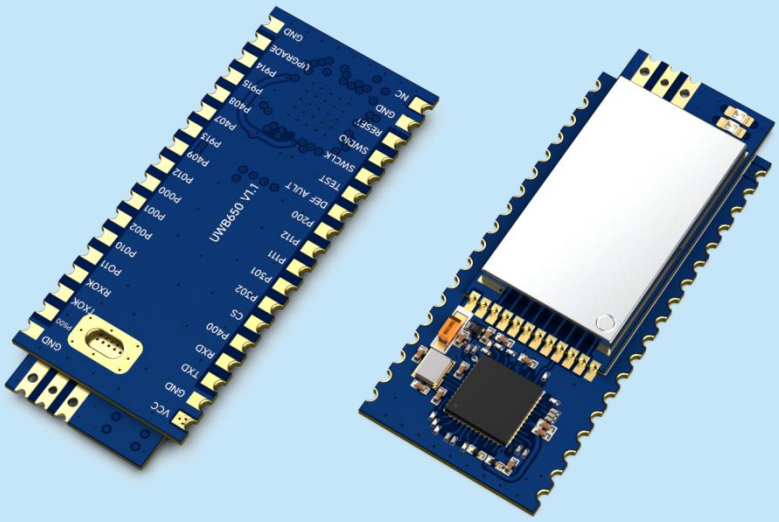
- UWB to TTL wireless module, easy to use
- Air data rate up to 6.8 Mbps
- High-precision ranging & indoor positioning
- Transmission distance over 1KM in open area
- AES128 encryption

Product Specification



Catalogue

Note: Revision History

Revision	Date	Comment
V1.0	2024-6	First release
V1.1	2024-6	Revise Product Description

1. Production Description

UWB650 module, launched by NiceRF, is a wireless communication module based on Ultra Wide Band (UWB) technology and compliant with the IEEE 802.15.4-2020 Standard protocol. Developed from the UWB3000F27, the UWB650 module features a high-power 0.5W amplifier chip. Users do not need to design any circuits, as the UWB650 module includes the wireless communication module and related circuits, integrated with ESD protection devices to provide effective ESD static protection. The UWB650 module combines data communication, two-way ranging (DS-TWR), and three-point planar positioning functions of UWB technology into one module. Users can easily utilize these functions through the UART interface on the module without the need for additional design and development.

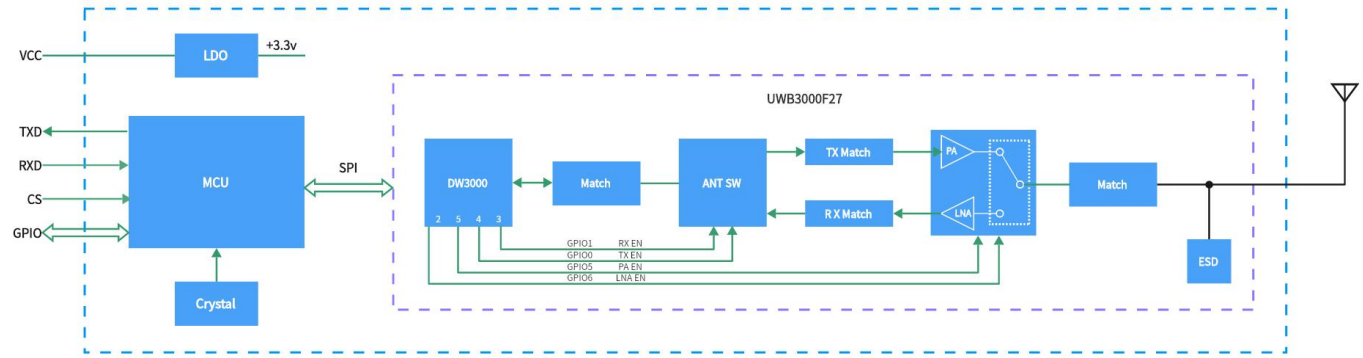
2. Feature

- Comply with IEEE 802.15.4-2020 Standard UWB and communication protocol
- Supports UWB Channel 5 (6489.6 MHz)
- Supports 6.8 Mbps and 850 Kbps RF Rate
- Supports preambles 3/4/9/10/11/12, with modules unable to communicate between different preamble configurations
- Supports multiple transmission power levels, with a maximum transmission power of 0.5W
- Ultra-long distance data communication
- Adopts double-sided two-way ranging (DS-TWR)
- Adopts three-point planar positioning method for precise positioning calculation
- Electrostatic Protection (ESD)

3. Applications

- Personnel positioning in large-scale industrial production
- Various indoor positioning scenarios
- Underground coal mine positioning
- Hospital staff positioning

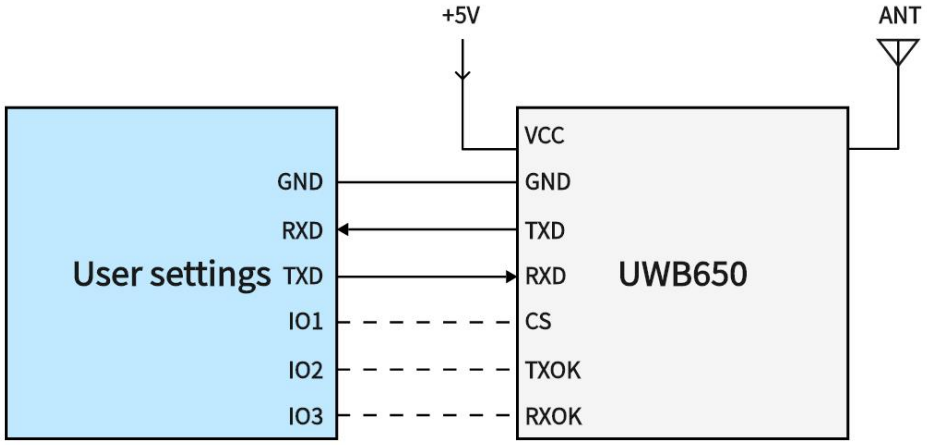
4. Block Diagram



5. Parameters

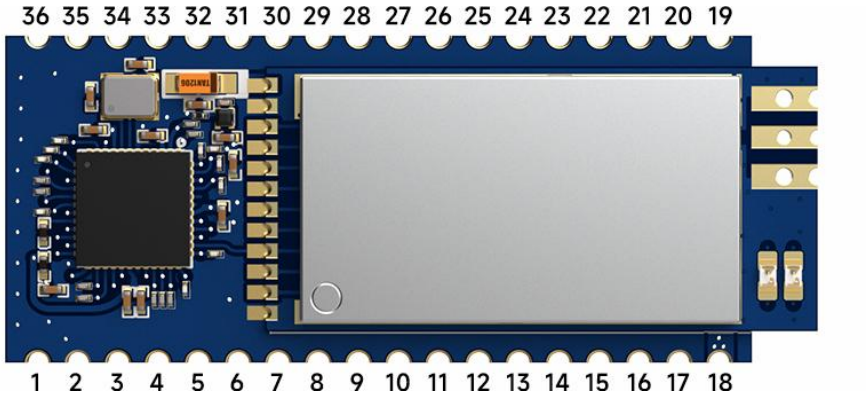
Parameter	Condition	Min.	Typ.	Max.	Unit
Supply Voltage		3.0	4.2	5.5	V
Operating Temperature Range		-20	25	60	℃
Frequency Range	CH5		6489.6		MHz
RF Data Rate		850k		6.8M	bps
Current Consumption					
Sleep current			< 2.2		mA
During data transmission RX current			64~72		mA
During ranging RX current			36		mA
During data transmission TX current			<100		mA
During ranging TX current			36		mA
RF parameter					
Tx Power	@VCC=5.0V	-5		27	dBm
Tx Bandwidth（BW)			499.2		MHz
Receive parameters					
Rx Sensitivity	@850Kbps		-100		dBm
	@6.8Mbps		-94		dBm

6. Typical Application Circuit



Note: The TXOK and RXOK pins of the module are only functional in data transmission mode.

7. Pin Assignment



Pin No.	Pin definition	I/O	Voltage	Description
1	NC			
2, 17, 19, 3	GND	-	0-3.3V	Connect to the power supply ground
3	RESET	I	0-3.3V	Module reset pin, normal high level, pull low to reset
4	Reserved			Leave open
5	Reserved			Leave Open
6	TEST	I	0-3.3V	Reserve
7	DEFAULT	I	0-3.3V	In the working state, continuous pulling down for about 10 seconds with internal pull-up forces a restart and restores factory settings

8	P200	I/O	0-3.3V	Internal MCU IO, expandable applications
9	P112	I/O	0-3.3V	Internal MCU IO, expandable applications
10	P111	I/O	0-3.3V	Internal MCU IO, expandable applications
11	P301	I/O	0-3.3V	Internal MCU IO, expandable applications
12	P302	I/O	0-3.3V	Internal MCU IO, expandable applications
13	CS	I	0-3.3V	Sleep pin, internally pulled up, enters sleep mode when externally driven low
14	P400	I/O	0-3.3V	Internal MCU IO, expandable applications
15	RXD	I	0-3.3V	Serial data input pin, connected to the TXD pin of an external device
16	TXD	O	0-3.3V	Serial data input pin, connected to the RXD pin of an external device
18	VCC	-	3.0-5.5V	External power supply positive pole
20	P500	I/O	0-3.3V	Internal MCU IO, expandable applications
21	TXOK	O	0-3.3V	In data transmission mode only, defaults to low level. Outputs high level after data transmission completion
22	RXOK	O	0-3.3V	In data transmission mode only, defaults to low level. The module outputs high level continuously during the period from receiving data to completing serial output
23	P011	I/O	0-3.3V	Internal MCU IO, expandable applications
24	P010	I/O	0-3.3V	Internal MCU IO, expandable applications
25	P002	I/O	0-3.3V	Internal MCU IO, expandable applications
26	P001	I/O	0-3.3V	Internal MCU IO, expandable applications
27	P000	I/O	0-3.3V	Internal MCU IO, expandable applications
28	P012	I/O	0-3.3V	Internal MCU IO, expandable applications
29	P409	I/O	0-3.3V	Internal MCU IO, expandable applications
30	P913	I/O	0-3.3V	Internal MCU IO, expandable applications
31	P407	I/O	0-3.3V	Internal MCU IO, expandable applications
32	P408	I/O	0-3.3V	Internal MCU IO, expandable applications

33	P915	I/O	0-3.3V	Internal MCU IO, expandable applications
34	P914	I/O	0-3.3V	Internal MCU IO, expandable applications
35	UPGRADE	I	0-3.3V	Internal pull-up. Module resets and enters serial upgrade mode upon receiving a low-level input externally

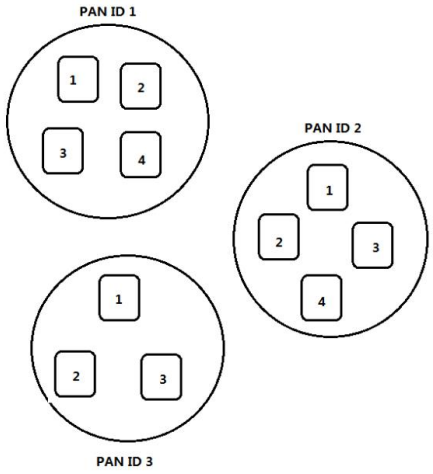
8. Function Description

8. 1 Overview

The module complies with the IEEE 802.15.4-2020 Standard and follows the following wireless communication protocols:

PHY Payload								
MAC Header (MHR)							MAC Payload	MAC Footer (MFR)
Frame Control	Sequence Number	Destination PAN Identifier	Destination Address	Source PAN Identifier	Source Address	Aux Security Header	Frame Payload	FCS
2 octets	1 octet	0 or 2 octets	0, 2 or 8 octets	0 or 2 octets	0, 2 or 8 octets	0, 5, 6 10 or 14 octets	Variable number of octets	2 octets

The PAN Identifier (hereinafter referred to as PAN ID) and Address are important attributes of the UWB device, and their relationship is shown in the following diagram



Among them, PAN Identification (hereinafter referred to as PAN ID) and Address

Whereas the PAN ID serves as a group identifier within UWB modules, under conditions where UWB device wireless configurations are identical and frame filtering is enabled, only UWB devices with the same PAN ID value can communicate with each other.

The Address functions as the unique identifier for a UWB module within the current PAN ID, ensuring that wireless data is correctly transmitted to the intended device.

Additionally, to maintain stability and accuracy in wireless data transmission, modules must have matching preamble codes, air data rates, and AES key configurations; any differences will prevent mutual communication.

8.2 Data transmission function

After receiving data from the serial port, the module encapsulates the data before transmitting it. Users can input up to 1010 bytes of single packet data, which is considered as the MAC Payload in the communication protocol. Users do not need to be concerned with the MHR and MFR sections during usage.

When the module receives data from other modules, it parses the data packet and outputs the MAC Payload part through the serial port. module supports AES-128 (Advanced Encryption Standard) encryption and decryption. Only modules with the same AES configuration can communicate with each other.

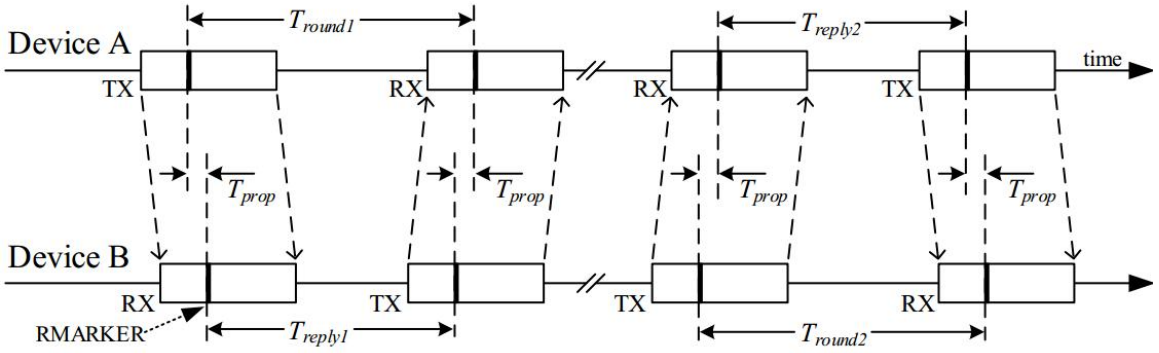
8.3 Distance Measurement Function

The ranging function is divided into Initiator and Responder roles. A module cannot simultaneously function as both an Initiator and a Responder. Moreover, at any given time, a Responder can only engage in ranging with one Initiator.

When the module enters the ranging function, it defaults to the Responder role. The module can automatically respond to the Initiator ranging signals and initiate the ranging process without user intervention.

When the module switches to the initiator role, it can perform ranging in a polling manner with up to five responder modules.

The ranging process is as follows:



Upon completion of each ranging process, both the initiator and the responder obtain a unique distance value, which is independently calculated by each (the ranging values of the initiator and responder are each derived from their own calculations).

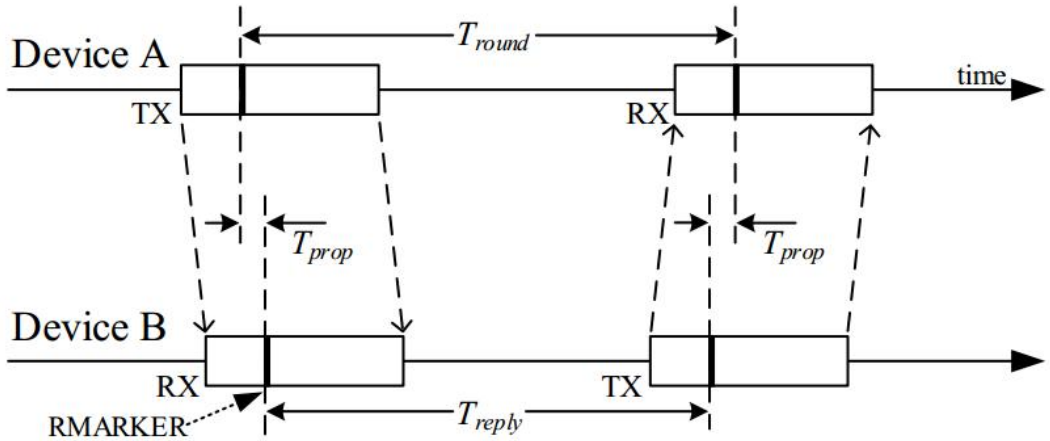
8.4 Positioning function

The positioning function is divided into two roles: Tag and Station. At the same time, a base station can only locate with one tag.

When the module enters the positioning function, it defaults to the Station role. The module can automatically respond to the ranging signal from a Tag and begin the ranging process without user intervention.

When the module switches to the Tag function, users can specify through configuration commands which three Stations the module should initiate ranging with to obtain positioning. If not set, the module will randomly acquire the information of three nearby Stations to initiate ranging and obtain positioning.

The ranging process is as follows:



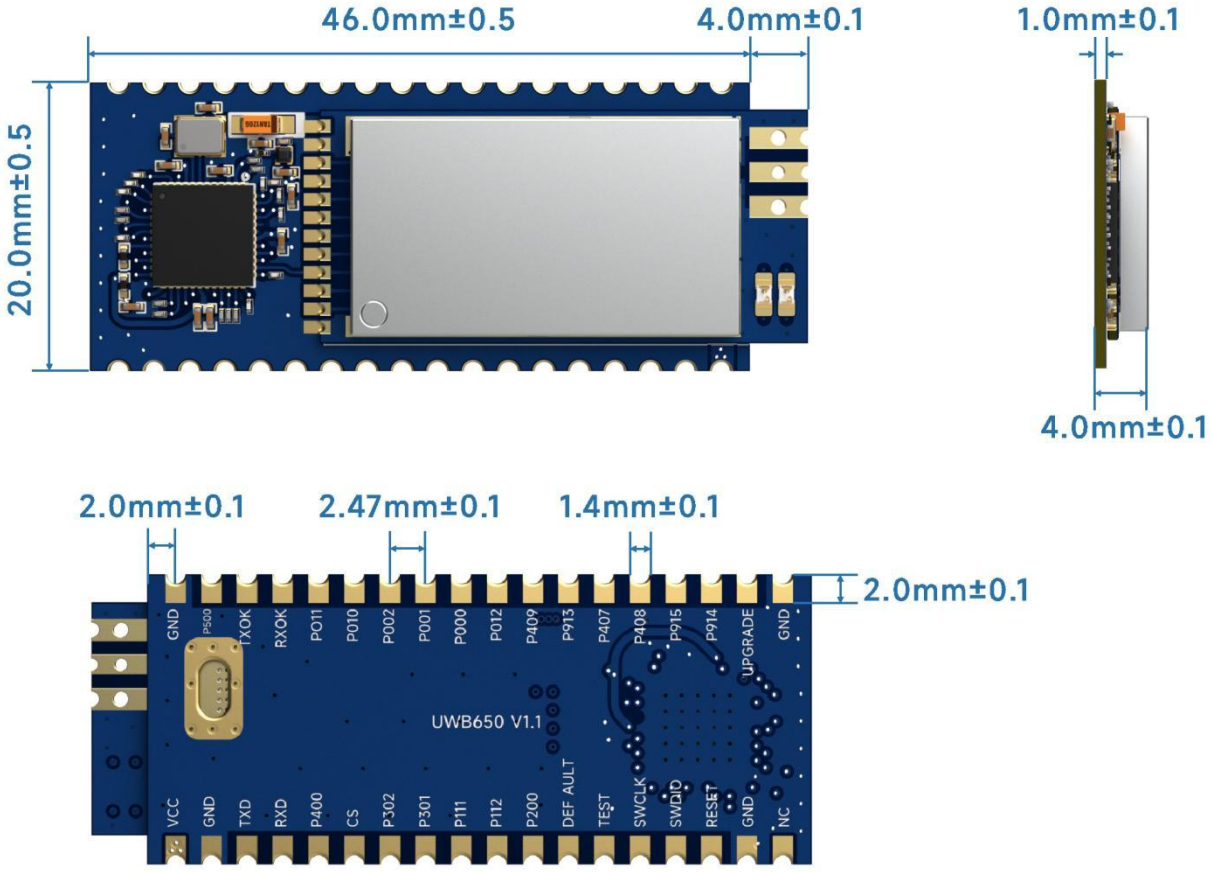
After the module, functioning as a Tag, acquires the distances to the three surrounding Stations, it can determine its own relative position using a positioning algorithm.

8.5 Sleep mode

During normal operation, the CS pin of the module is in an input state with internal pull-up. When an external low-level signal is applied to the CS pin, the module enters sleep mode. During this period, the internal MCU, UWB chip, and power amplifier chip will stop working, maintaining a low current consumption.

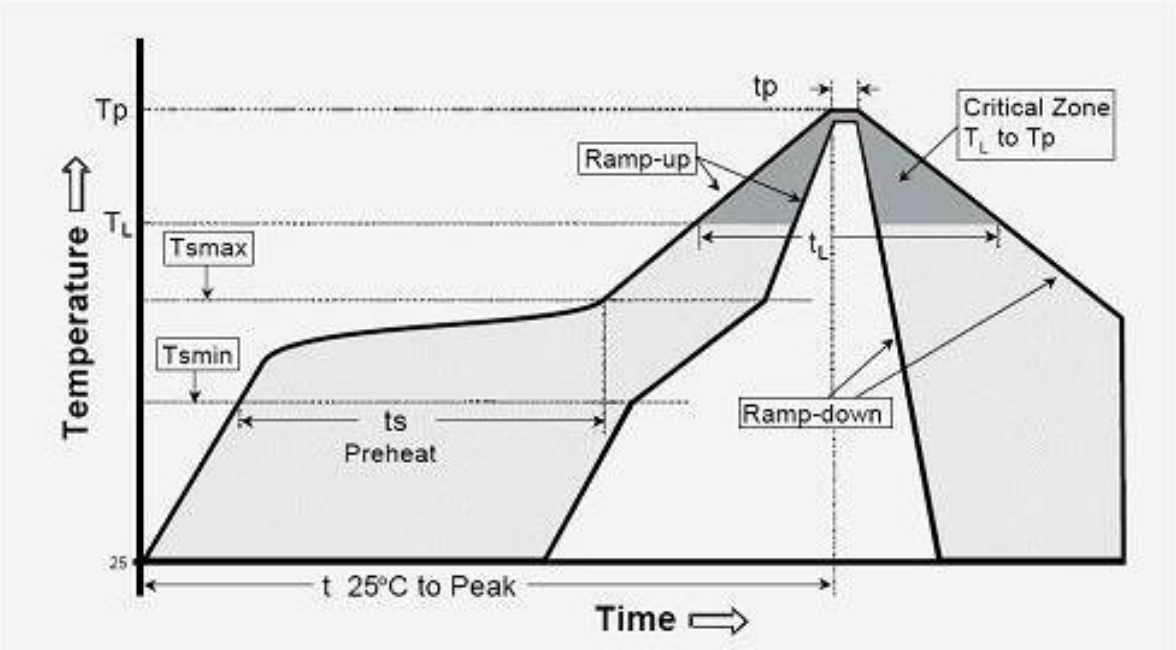
When the CS pin is externally set to a high level, the module wakes up from sleep mode. During this process, the MCU wakes up the internal UWB chip and gradually restores all parameters of the UWB chip.

9. Dimension (Unit：mm)



Appendix：Reflow Chart for SMT Technology

We recommend you should obey the IPC related standards in setting the reflow profile:



IPC/JEDEC J-STD-020B the condition for lead-free reflow soldering	big size components (thickness >=2.5mm)
The ramp-up rate (Tl to Tp)	3℃/s (max.)
preheat temperature - Temperature minimum (Tsmin) - Temperature maximum (Tsmax) - preheat time (ts)	 150℃ 200℃ 60~180s
Average ramp-up rate(Tsmax to Tp)	3℃/s (Max.)
- Liquidous temperature(TL)	217℃
- Time at liquidous(tL)	60~150 second
peak temperature(Tp)	245+/-5℃