FC41D

Hardware Design

Wi-Fi&Bluetooth Module Series

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The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any cellular terminal or mobile incorporating the module. Manufacturers of the cellular terminal should notify users and operating personnel of the following safety information by incorporating these guidelines into all manuals of the product. Otherwise, Quectel assumes no liability for customers' failure to comply with these precautions.

	Full attention must be paid to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) causes distraction and can lead to an accident. Please comply with laws and regulations restricting the use of wireless devices while driving.
	Switch off the cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If there is an Airplane Mode, it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on an aircraft.
	Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.
	Cellular terminals or mobiles operating over radio signal and cellular network cannot be guaranteed to connect in certain conditions, such as when the mobile bill is unpaid or the (U)SIM card is invalid. When emergent help is needed in such conditions, use emergency call if the device supports it. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength. In an emergency, the device with emergency call function cannot be used as the only contact method considering network connection cannot be guaranteed under all circumstances.
	The cellular terminal or mobile contains a transceiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.
	In locations with explosive or potentially explosive atmospheres, obey all posted signs and turn off wireless devices such as mobile phone or other cellular terminals. Areas with explosive or potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, and areas where the air contains chemicals or particles such as grain, dust or metal powders.

About the Document

Revision History

Version	Date	Author	Description
-	2021-02-19	Soni RAO/ Michael DU	Creation of the document
1.0.0	2021-03-13	Soni RAO/ Michael DU	Preliminary
1.0.1	2021-06-23	Soni RAO/ Michael DU	Preliminary: 1. Updated the module pin assignment 2. Sheet 23-27: updated test data 3. Sheet 2, 24-26: updated the RF parameters 4. Sheet 17: updated PCB antenna parameters 5. Updated the mechanical dimensions picture of the module

Contents

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1 Introduction

This document defines the FC41D module and describes its air interface and hardware interfaces which are connected with your application.

With this document, you can quickly understand module interface specifications, electrical and mechanical details, as well as other related information of the module. The document, coupled with application notes and user guides, makes it easy to design and set up mobile applications with the module.

1.1. Special Mark

Table 1: Special Mark

Mark	Definition
*	When an asterisk (*) is used after a function, feature, interface, pin name, AT command, or argument, it indicates that the function, feature, interface, pin name, AT command, or argument is under development and currently not supported, unless otherwise specified.

2 Product Concept

2.1. General Description

FC41D is a low-power, cost-effective Bluetooth 5.2 and Wi-Fi 802.11b/g/n module, which integrates the hardware and software resources required for Wi-Fi and Bluetooth applications. It can support AP and STA of Wi-Fi connection, and low-power Bluetooth connection. It is very suitable for low flow control and data acquisition applications such as home intelligent terminal, industrial application and so on.

FC41D module has a built-in Wi-Fi and bluetooth ultra-high integration microcontroller, which provides the necessary ability to calculate and stable Wi-Fi and Bluetooth connectivity for IoT data terminals. It includes:

- 120 MHz ARM kernel
- 256K Byte RAM
- 2M Byte Flash
- A controller that complies with IEEE 802.11 b/g/n and Bluetooth 5.2 standards

With a compact profile of 18.0 mm × 20.0 mm × 2.2 mm, FC41D is powered by a single 3.3 V power supply. It has a total of 27 LCC pins.

2.2. Key Features

The following table describes the key features of FC41D module.

Table 2: Key Features

Features	Details
Power Supply	● **VBAT Power Supply:** Supply voltage range: 3.0–3.6 V Typical supply voltage: 3.3 V
Operating Frequency	● 2.4 GHz: 2.412–2.484 GHz ● Bluetooth: 2.402–2.480 GHz

Wi-Fi Transmission Data Rates	● 802.11b: 1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps ● 802.11g: 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps ● 802.11n: HT20 (MCS0–MCS7)
Wi-Fi Transmitting Power	● 2.4 GHz ● 802.11 b/11 Mbps: 17 dBm ● 802.11 g/54 Mbps: 15 dBm ● 802.11 n/HT20 MCS7: 14 dBm
Wi-Fi Protocol Features	● IEEE 802.11 b/g/n
Wi-Fi Modulation	● CCK, BPSK, QPSK,16QAM, 64QAM
Wi-Fi Operation Mode	● AP ● STA
Bluetooth Protocol Feature	● GATT
Bluetooth Operation Mode	● BLE
Bluetooth Modulation	● GFSK
Wireless Application Interfaces	● UART/SPI
Antenna Interface	● Wi-Fi/Bluetooth antenna interface, 50 Ω impedance ● ANT_WIFI/BT, IPEX antenna and PCB antenna are optional
Physical Characteristics	● Size: (18.0 ±0.15) mm × (20.0 ±0.15) mm × (2.2 ±0.2) mm (without shielding cover) (18.0 ±0.15) mm × (20.0 ±0.15) mm × (2.6 ±0.2) mm (with shielding cover) ● Package: LCC ● Weight: 1.05 g (without shielding cover) ● Weight: 1.51 g (with shielding cover)
Temperature Range	● Operating temperature range: -40 °C to +85 °C ● Storage temperature range: -45 °C to +95 °C
RoHS	● All hardware components are fully compliant with EU RoHS directive

2.3. Functional Diagram

The following figure shows a block diagram of FC41D module.

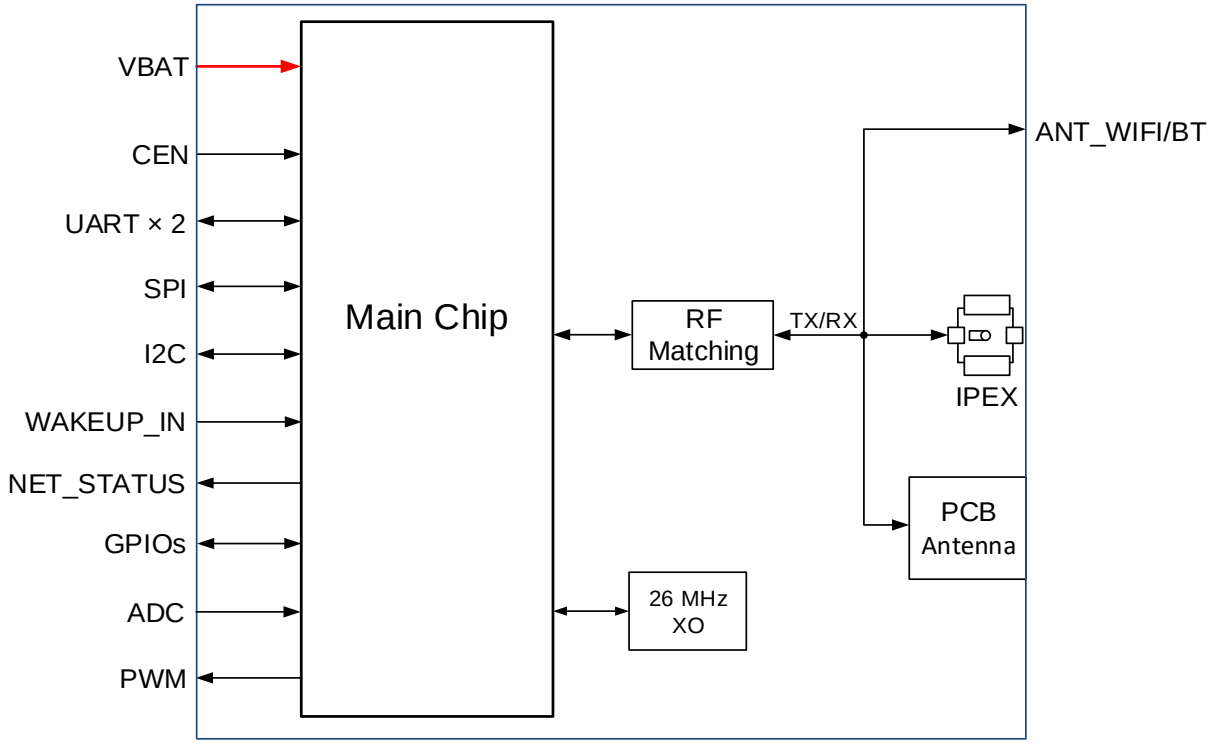


Figure 1: Functional Diagram

NOTE

According to different order codes, FC41D has three kinds antennas: PCB antenna, IPEX connector and ANT_WIFI/BT pin external antenna, you can choose one of them according to your needs.

2.4. Evaluation Board

To help customers develop applications with FC41D module conveniently, Quectel supplies the evaluation board (EVB). The evaluation board tool includes an EVB board (FC41D-TE-B), a USB 2.0 data cable, an antenna and other external equipment used for control and test modules. For more details, see ***document 45[1]***.

3 Application Interfaces

3.1. General Description

The FC41D module has 27 LCC pins. The following interfaces are described in detail in subsequent chapters:

- Power supply
- Module reset
- Wireless connectivity interfaces
  -UART
  -SPI
- I2C interface
- PWM interface*
- WAKEUP interface
- Network status indication
- GPIO interfaces
- ADC interface*
- RF antenna interface

3.2. Pin Assignment

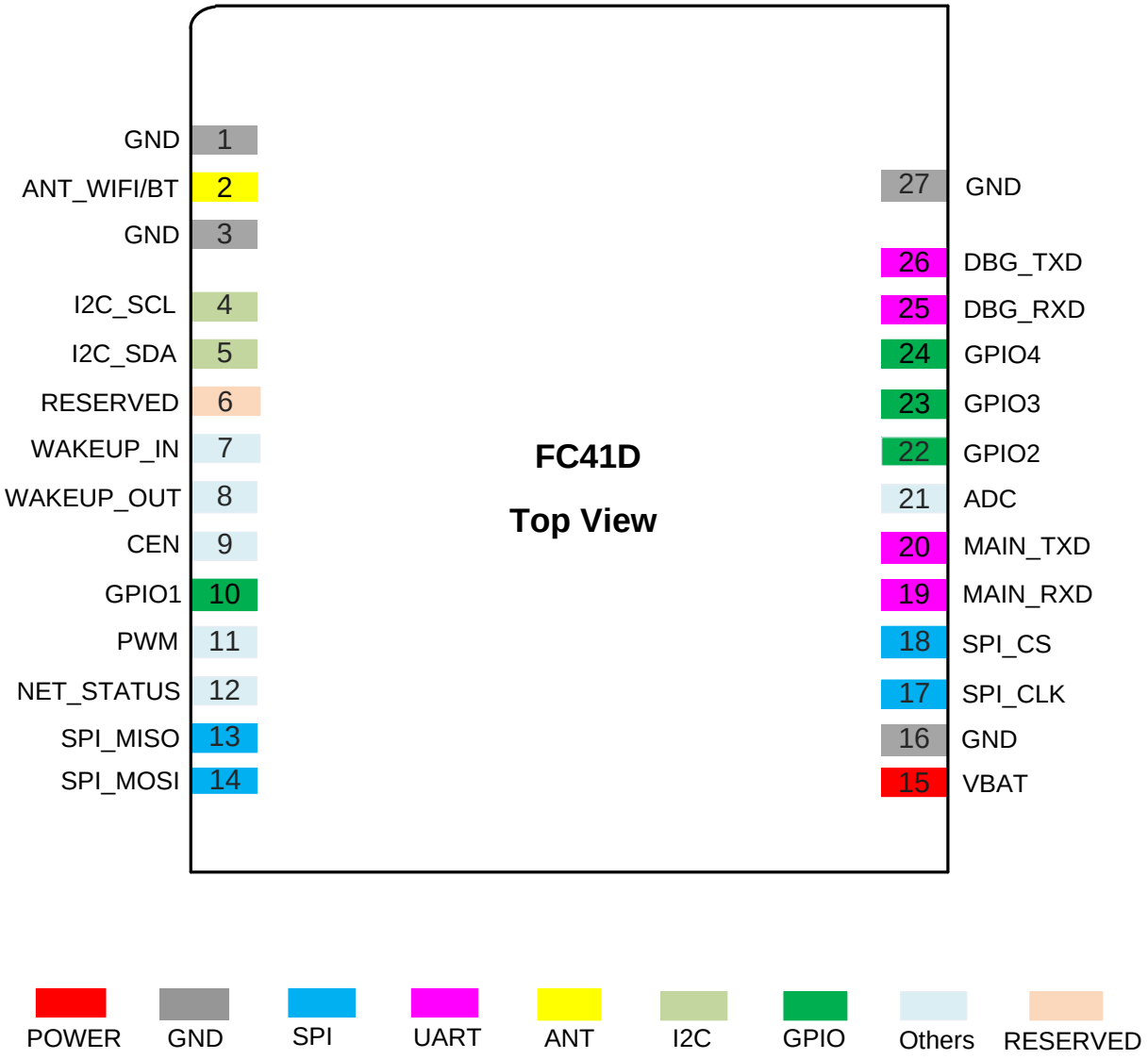


Figure 2: Pin Assignment (Top View)

NOTE

Please keep all RESERVED pins open.

3.3. Pin Description

The following tables show the pin description of module:

Table 3: I/O Parameters Description

Type	Description
AI	Analog Input
AIO	Analog Input/Output
DI	Digital Input
DIO	Digital Input/Output
DO	Digital Output
OD	Open Drain
PI	Power Input

Table 4: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT	15	PI	Power supply for the module	Vmax = 3.6 V Vmin = 3.0 V Vnom = 3.3 V	It must be provided with sufficient current up to 0.3 A.
GND	1, 3, 16, 27				
Turn On/Off					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
CEN	9	DI	Turn on/off and reset the module	Vmax = 3.6 V Vmin = 3.0 V Vnom = 3.3 V	Pulled up to 3.3 V internally.
UART Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
MAIN_TXD	20	DO	Main UART	3.3 V power domain	

			transmit		
MAIN_RXD	19	DI	Main UART receive		
DBG_TXD	26	DO	Debug UART transmit		
DBG_RXD	25	DI	Debug UART receive		
SPI Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SPI_MISO	13	DIO	SPI master-in salve-out	3.3 V power domain	
SPI_MOSI	14	DIO	SPI master-out slave-in		
SPI_CLK	17	DIO	SPI clock		
SPI_CS	18	DIO	SPI chip selection		
I2C Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
I2C_SCL	4	OD	I2C serial clock	3.3 V power domain	
I2C_SDA	5	OD	I2C serial data		
WAKEUP Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
WAKEUP_IN	7	DI	Wake up the module from deep sleep	3.3 V power domain	
WAKEUP_OUT*	8	DO	Wake up output		
Indication Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
NET_STATUS	12	DO	Indicate the module's network activity status	3.3 V power domain	Output high level when Wi-Fi is connected in STA mode; Can be reused as

					PMW interface.
PWM Interface*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PWM	11	DO	Pulse width modulation output channel	3.3 V power domain	
GPIO Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GPIO1	10	DIO	General-purpose input/output	3.3 V power domain	
GPIO2	22	DIO	General-purpose input/output		Can be reused as PMW interface.
GPIO3	23	DIO	General-purpose input/output		
GPIO4	24	DIO	General-purpose input/output		
ADC Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC	21	AI	General-purpose ADC interface	Voltage Range: 0–2.4 V	Can be reused as PMW interface.
RF Antenna Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANT_WIFI/BT	2	AIO	Wi-Fi/Bluetooth antenna interface		50 Ω Impedence
RESERVED					
Pin Name	**Pin No.**				
RESERVED	6				

NOTE

Please keep all RESERVED and unused pins open.

3.4. Power Supply Design

3.4.1. Pin Description

The following table shows the power supply pin and ground pin of FC41D module.

Table 5: Definition of Power Supply and GND Pins

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VBAT	15	Power supply	3.0	3.3	3.6	V
GND	1, 3, 16, 27					

FC41D module is powered by VBAT, and it is recommended to use a power supply chip with sufficient current of at least 0.3 A. In order to achieve better power supply performance, it is recommended to parallel 22 µF decoupling capacitor and 1 µF,100 nF filter capacitor near the module's VBAT pin. At the same time, it is suggested to add a TVS near the VBAT to improve the surge voltage bearing capacity of the module. In principle, the longer the VBAT line is, the wider it should be.

VBAT reference circuit is shown as below:

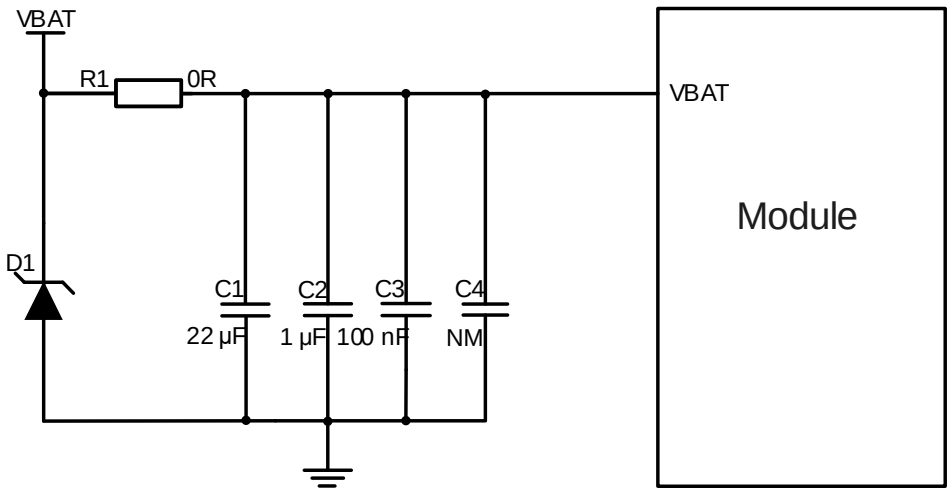


Figure 3: VBAT Reference Circuit

3.5. Reset the module

Drive CEN low for at least 100 ms and then release to reset the module.

Table 6: Definition of Power Supply and GND Pins

Pin Name	Pin No.	Description	Comment
CEN	9	Reset the module	Pulled up to 3.3 V internally (≥ 100 ms).

The reference designs for resetting the module are shown below. An open drain/collector driving circuit or a button can be used to control the CEN pin.

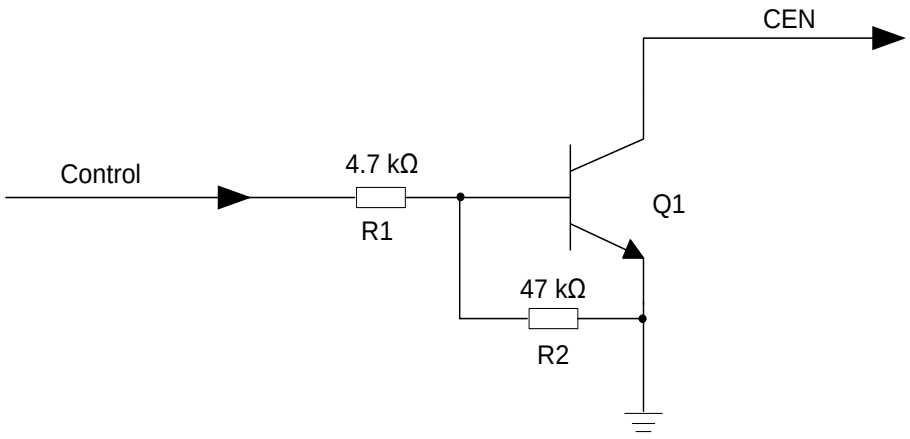


Figure 4: Reference Circuit of CEN by Using Driving Circuit

Another way to control the CEN is directly through a button switch. A TVS should be placed near the button for ESD protection. The reference circuit is as follows:

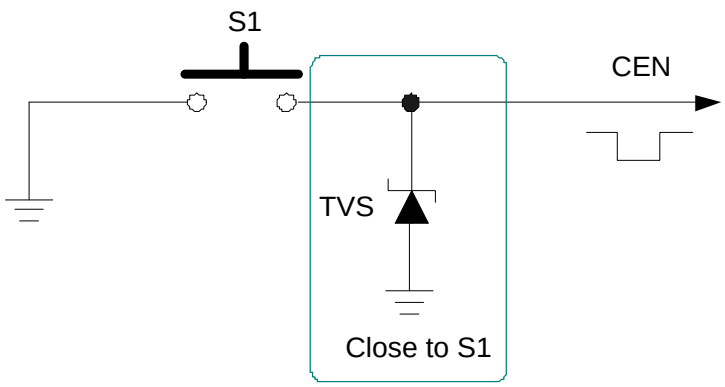


Figure 5: Reference Circuit of CEN by Using Button

The reset timing is illustrated in the following figure.

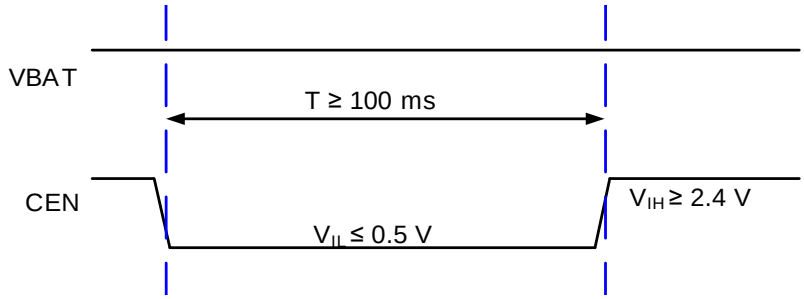


Figure 6: Timing of Resetting Module

3.6. Wireless Connection Interfaces

3.6.1. UART

The module has two serial interfaces: the main UART and the debug UART. The module is used as DCE (Data Communication Equipment), and is connected in the traditional DCE-DTE (Data Terminal Equipment) mode.

Table 7: UART Pin Definition

Interface	Pin Name	Pin No.	Description
Main UART	MAIN_TXD	20	Main UART transmit
	MAIN_RXD	19	Main UART receive
Debug UART	DBG_TXD	26	Debug UART transmit
	DBG_RXD	25	Debug UART receive

The main UART can be used for AT command transmission and data transmission. The default baud rate is 115200 bps, and the maximum baud rate can reach 6 Mbps.

The main UART is available for firmware upgrade and supports a default baud rate of 921600 bps.

The following diagram shows a schematic diagram of the main UART interface connection between DCE and DTE.

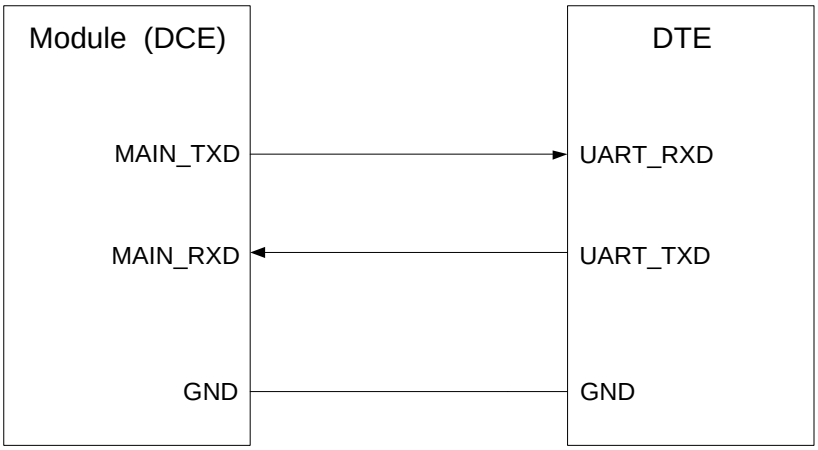


Figure 7: Main UART Connection Diagram

Through debug tools, the debug UART can be used to output logs for firmware debugging. Its baud rate is 115200 bps by default.

The following is a reference design of debug UART.

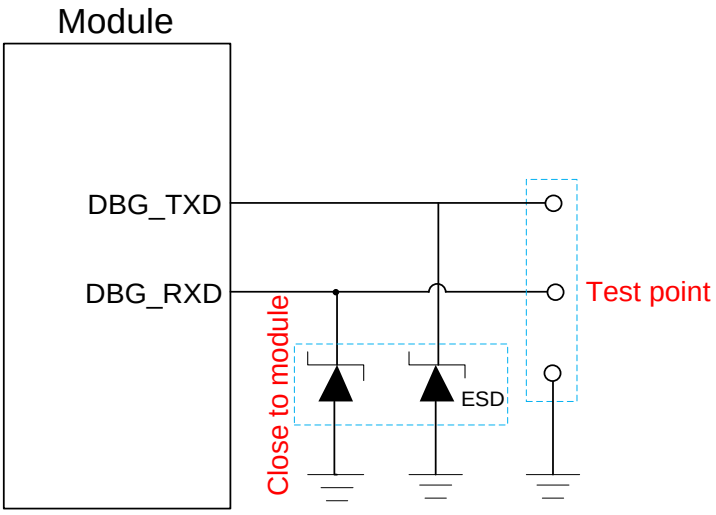


Figure 8: Debug UART Reference Crcuit

3.6.2. SPI

FC41D module provides a SPI interface that supports both master and slave modes. The maximum clock frequency of the interface can reach 50 MHz in slave mode, and the clock frequency is 8 MHz in the master mode.

The pin description of SPI interface is shown in the below table:

Tabel 8: SPI Pin Definition

Interface	Pin Name	Pin No.	Description
SPI	SPI_MISO	13	SPI master input slave output
	SPI_MOSI	14	SPI master output slave input
	SPI_CLK	17	SPI clock
	SPI_CS	18	SPI chip selection

The timing of SPI interface is shown in the figure below, and the timing parameters are shown in the table below:

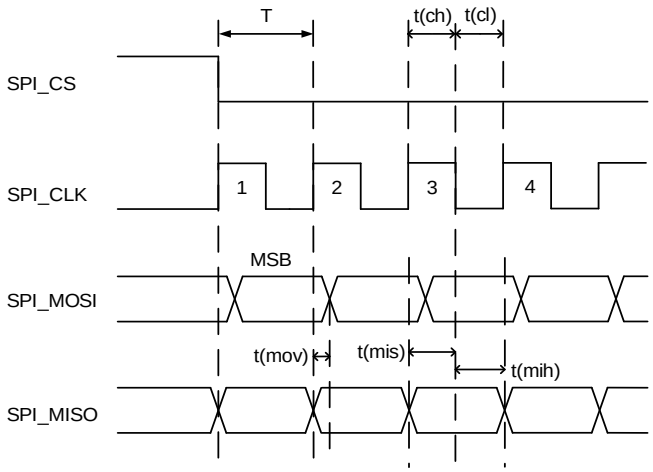


Figure 9: SPI Timing

Table 9: SPI Timing Parameters

Parameter	Description	Min.	Typ.	Max.	Unit
T	SPI clock cycle	20.0	-	-	ns
t(ch)	SPI clock high level time	9.0	-	-	ns
t(cl)	SPI clock low time	9.0	-	-	ns
t(mov)	SPI valid time of master mode data output	-5.0	-	5.0	ns
t(mis)	SPI setup time of master mode data input	5.0	-	-	ns
t(mih)	SPI hold time of master mode data input	1.0	-	-	ns

3.7. I2C Interface

FC41D module provides an I2C interface that support support master mode only with maximum clock frequency of 400 kHz and 7-bit addressing. It can be used to connect peripherals such as EEPROM.

Table 10: I2C Pin Definition

Pin Name	Pin No.	I/O	Description	Function
I2C_SCL	4	OD	I2C serial clock	Require external pull-up to 3.3 V
I2C_SDA	5	OD	I2C serial data	

3.8. PWM Interface*

FC41D module provides 1 PWM channel by default, and can supports up to 6 PWM interfaces through multiplexing from other interfaces. Each PWM channel has three modes: Timer mode, PWM mode, Capture mode, and each mode of each channel is multiplexed 32-bit count. The period and duty cycle are configurable on PWM mode.

The following table show the pin description of PWM interfaces.

Table 11: PWM Pin Definition

Pin Name	Pin No.	I/O	Function	
			Default Function	Alternate Function
GPIO2	22	DO	GPIO2	PWM1
GPIO3	23	DO	GPIO3	PWM2
GPIO4	24	DO	GPIO4	PWM3
PWM	11	DO	PWM4	
NET_STATUS	12	DO	NET_STATUS	PWM5
ADC	21	DO	ADC	PWM6

3.9. WAKEUP Interface

FC41D supports waking up host with WAKEUP_OUT*, and it can also be woken up from deep sleep by WAKEUP_IN.

Table 12: Pin Definition of WAKEUP Interfaces

Pin Name	Pin No.	I/O	Description	Comment
WAKEUP_IN	7	DI	Wake up the module from deep sleep	High level wakeup
WAKEUP_OUT*	8	DO	Wake up output	

3.10. Network Status Indication

FC41D provides one network indication pin: NET_STATUS. The pin is used to drive a network status indication LED.

The following tables describe the pin definition and logic level changes of NET_STATUS in different network status.

Tabel 13: NET_STATUS Pin Definition

Pin Name	Pin No.	I/O	Description	Note
NET_STATUS	12	DO	Indicate the module's network activity status	Output high level when Wi-Fi is connected in STA mode

A reference circuit is shown in the following figure.

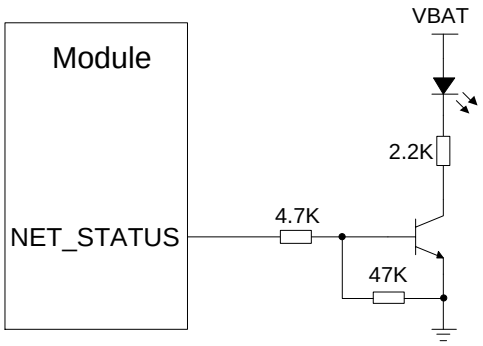


Figure 10: Reference Circuit of the Network Status Indicator

3.11. GPIO Interfaces

FC41D module provides 4 GPIOs by default. Any GPIO can be configured as interrupt to wake the module from low power mode.

The following table show the pin description of GPIO Interfaces.

Tabel 14: GPIO Pin Definition

Pin Name	Pin No.	I/O	Description	Note
GPIO1	10	DIO	General-purpose input/output	Wake-up interrupt; 3.3 V voltage domain.
GPIO2	22			
GPIO3	23			
GPIO4	24			

3.12. ADC Interface*

The module provides one ADC interface by default, and the voltage range is 0–2.4 V. The AT command can be used to read the voltage value of the ADC. In order to ensure the accuracy of the ADC voltage measurement, the ADC traces should be surrounded with ground.

Table 15: ADC Pin Definition

Pin Name	Pin No.	Description
ADC	21	General-purpose ADC interface

Table 16: ADC Features

Parameter	Min.	Typ.	Max.	Unit
ADC Voltage Range	0	-	2.4	V
ADC Resolution Rate	-	TBD	-	bits
ADC Sample Rate	-	TBD	-	MHz

3.13. RF Antenna Interface

FC41D module provides PCB antenna, IPEX connector or ANT_WIFI/BT pin (stamp hole) in three order codes. The IPEX connector is not mounted on the module when using PCB antenna or ANT_WIFI/BT pin.

3.13.1. Operating Frequency

The operating frequency of FC41D module is shown in the table below:

Table 17: FC41D Operating Frequency

Mode	Frequency	Unit
2.4 GHz Wi-Fi	2.412–2.484	GHz
Bluetooth 5.2	2.402–2.480	GHz

3.13.2. RF Antenna Pin Description

RF Antenna pin description is as below:

Table 18: Antenna Pin Definition

Pin Name	Pin No.	I/O	Description	Note
ANT_WIFI/BT	2	AIO	Wi-Fi/Bluetooth antenna interface	50 Ω impedance

3.13.3. On Board PCB Antenna

Table 19: On Board PCB Antenna Characteristics*

Characters	Min.	Typ.	Max.	Unit
Frequency	2400	-	2500	MHz
Impedance	-	50	-	Ω
VSWR	-	-	2	-
Gain	-	2	-	dBi
Efficiency	-	35%	-	-

3.13.4. IPEX Connector

The mechanic size of the IPEX connector provided by the FC41D module are as follows.

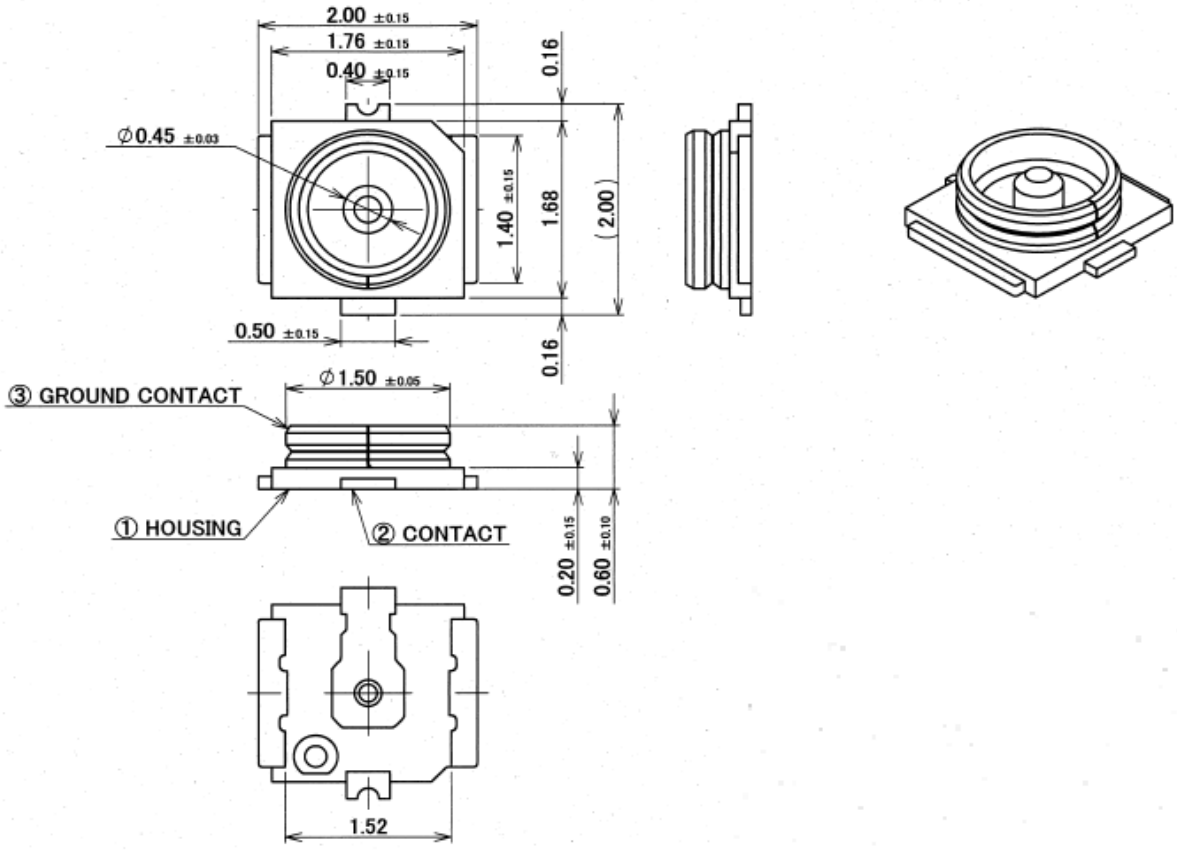


Figure 11: IPEX Connector Size

3.13.5. RF Antenna Reference Design

FC41D module is equipped with RF antenna pad for connecting Wi-Fi/Bluetooth antennas. The RF trace between main PCB and the module RF antenna pin must be the microstrip line or other types of RF trace, and the characteristic impedance should be close to 50 Ω. The GND pin of FC41D series module is close to the antenna solder pad for better grounding effect.

The circuit of RF antenna interface is shown below. In order to achieve better RF performance, it is necessary to reserve LC and π matching circuit. Matching components such as R1, L1, C1, C2, C3 should be placed as close to the antenna as possible, L1, C1, C2, C3 is not mounted by default.

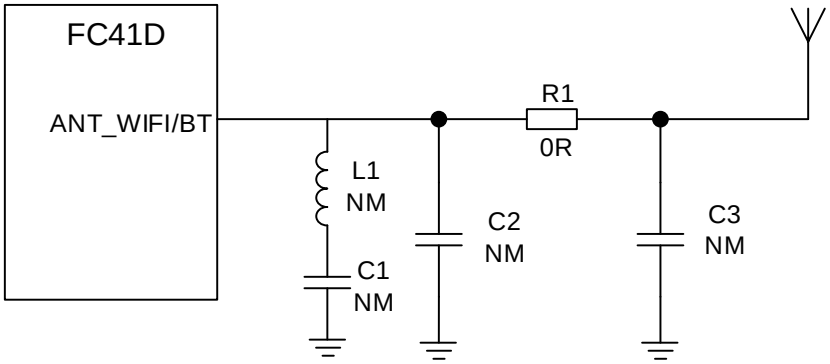


Figure 12: RF Antenna Reference Design

When using the PCB antenna on the module, the module should be placed at the side of the motherboard PCB board as far as possible, and the distance between the motherboard PCB and other metal devices, connectors, PCB through holes, wiring and copper cladding should be at least 16 mm. All layers in the PCB of the motherboard under the PCB antenna should be designed as keepout areas.

3.13.6. Reference Design of RF Layout

The characteristic impedance of all RF traces on your PCB should be controlled at 50 Ω. The impedance of the RF traces is usually determined by the trace width (W), the material's dielectric constant, the height from the reference ground to the signal layer (H), and the spacing between RF traces and grounds (S). The microstrip or coplanar waveguide is typically used in RF layout to control characteristic impedance. The following are reference designs for microstrip or coplanar waveguide transmission lines with different PCB structures.

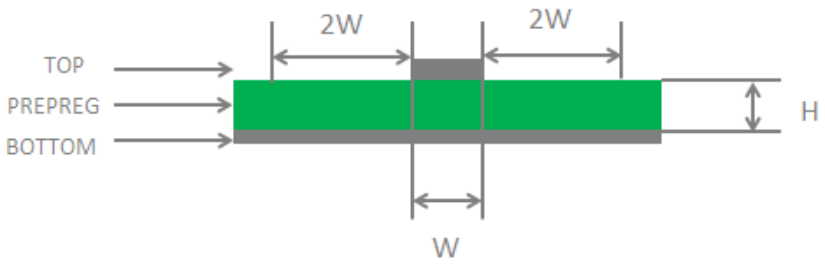


Figure 13: Microstrip Design on a 2-layer PCB

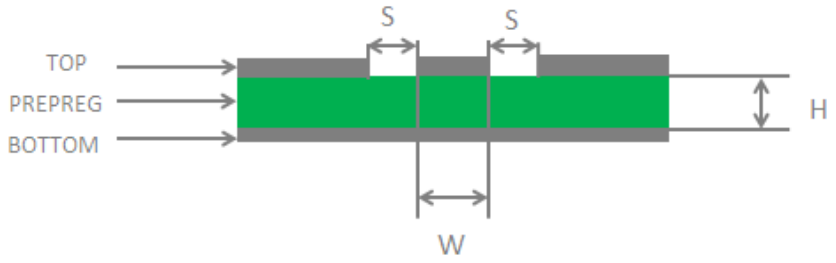


Figure 14: Coplanar Waveguide Design on a 2-layer PCB

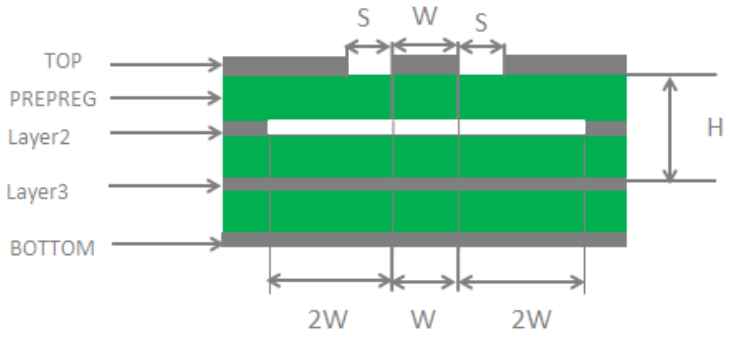


Figure 15: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

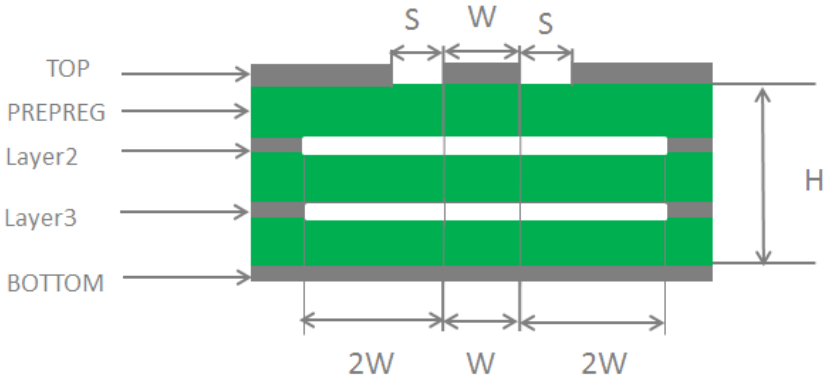


Figure 16: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

To ensure RF performance and reliability, the following principles should be complied with in RF layout design:

- Use an impedance simulation tool to accurately control the characteristic impedance of RF traces to 50 Ω.
- The GND pins adjacent to RF pins should not be designed as thermal relief pads, and should be fully connected to ground.
- The distance between the RF pins and the RF connector should be as short as possible and all the right-angle traces should be changed to curved ones. The recommended trace angle is 135°.
- There should be clearance under the signal pin of the antenna connector or solder joint.
- The reference ground of RF traces should be complete. Meanwhile, adding some ground vias around RF traces and the reference ground could help to improve RF performance. The distance between the ground vias and RF traces should be no less than two times the width of RF signal traces (2 × W).
- Keep RF traces away from interference sources, and avoid intersection and paralleling between traces on adjacent layers.

For more details, see ***document [2]***.

3.13.7. Antenna Cable and Antenna Requirements

To minimize the loss on RF trace and RF cable, pay attention to the antenna design. The following tables show the requirements on Wi-Fi and Bluetooth antenna.

Table 20: Antenna Cable Requirement

Frequence	Requirement
2.412–2.484 GHz	Insertion loss <1 dB

Table 21: Antenna Requirement

Type	Requirement
Frequence	2.412–2.484 GHz
VSWR	< 2
Gain (dBi)	Typical 1
Max input power (W)	50
Input impedance (Ω)	50

Polarization type	Vertical

3.14. Recommended RF Connector for Antenna Installation

If RF connector is used for antenna connection, it is recommended to use Hirose's U. FL-R-SMT connector.

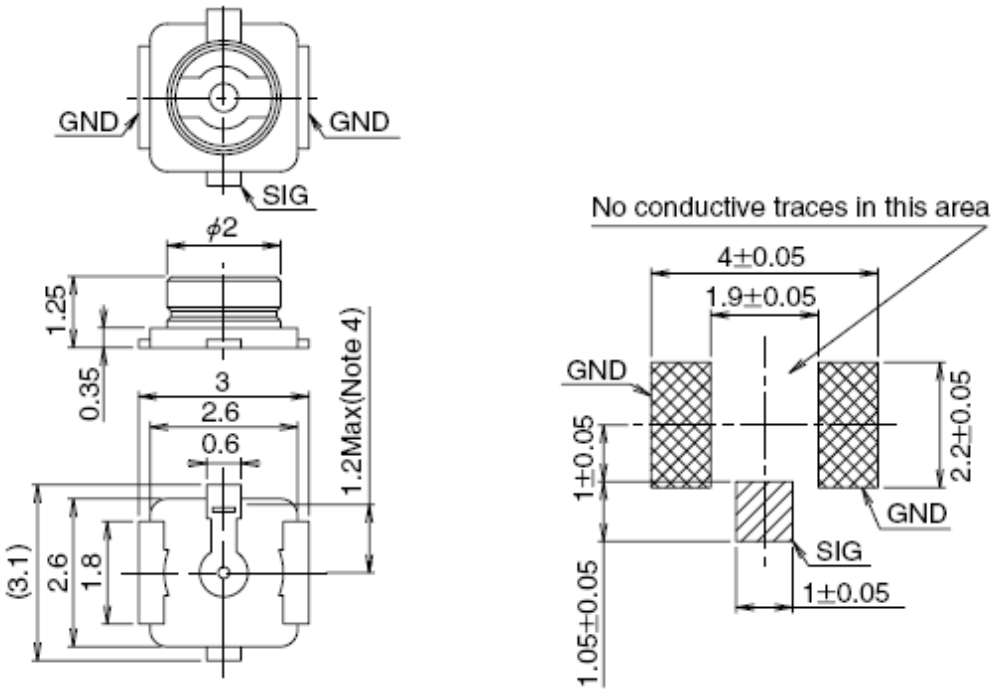


Figure 17: U.FL-R-SMT Connector (Unit: mm)

U. FL-LP series connectors can be selected to match U.FL-R-SMT.

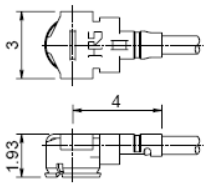
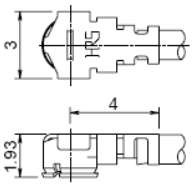
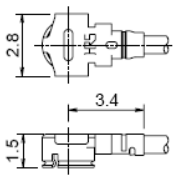
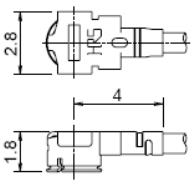
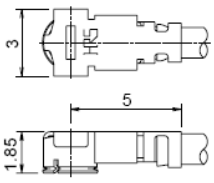
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 0.81mm Coaxial cable	Dia. 1mm Coaxial cable	Dia. 1.37mm Coaxial cable
Weight (mg)	53.7	59.1	34.8	45.5	71.7
RoHS	YES				

Figure 18: U. FL-LP Series Connectors

The following diagram shows the connector and the assembled dimensions of the connector:

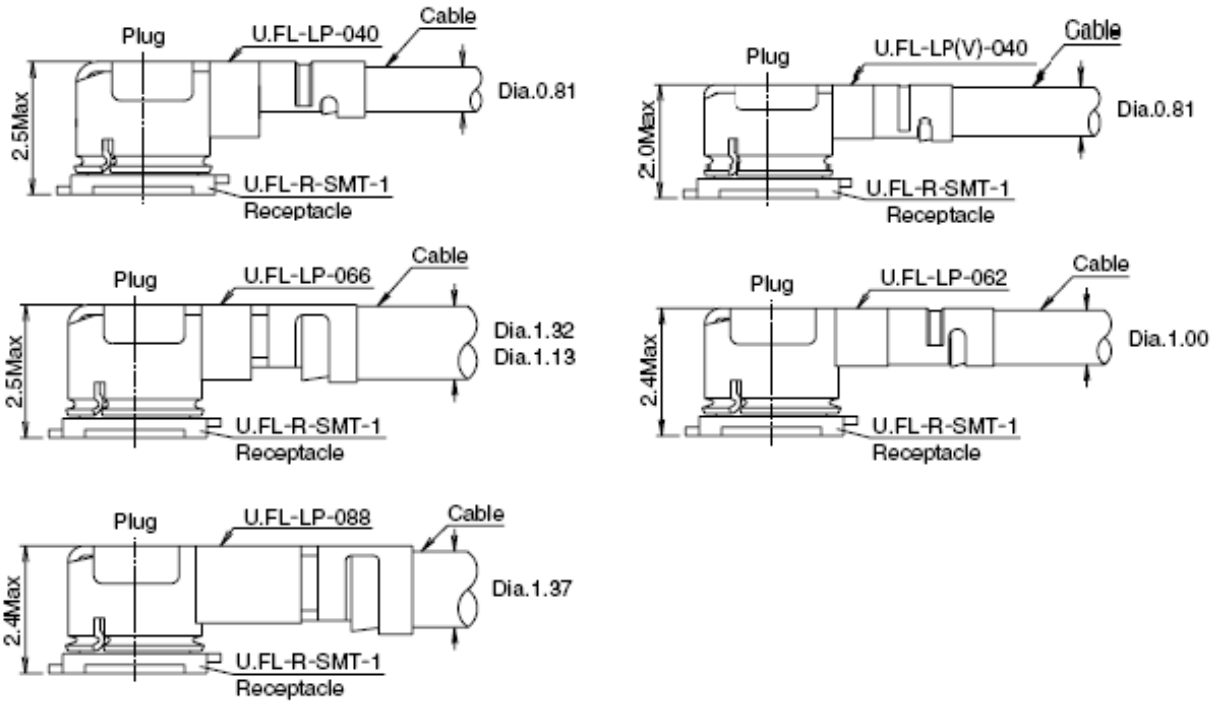


Figure 19: Connectors and Connector Combinations (Unit: mm)

For more information, please visit http://www.hirose.com.

4 Reliability, Radio and Electrical Characteristics

4.1. General Description

This chapter mainly introduces the electrical characteristics and RF characteristics of the module. The specific contents are as follows:

- Electrical Characteristics
- I/O Characteristics
- Power Consumption
- RF Characteristics
- ESD Performance

4.2. Electrical Characteristics

Absolute maximum ratings and recommended operating condition for power supply and voltage on digital and analog pins of the module are listed in the following table.

Table 22: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT	-0.3	3.9	V
I/O input voltage	-0.3	3.9	V

Table 23: Recommended Operating Conditions

Parameter	Min.	Typ.	Max.	Unit
VBAT	3.0	3.3	3.6	V

4.3. I/O Characteristics

The following table lists the general DC electrical characteristics of the module.

Table 24: General DC Electrical Characteristics

Parameter	Description	Min.	Max.	Unit
V_{IH}	High Level Input Voltage	0.7 × VIO	VIO + 0.2	V
V_{IL}	Low Level Input Voltage	-0.3	0.3 × VIO	V
V_{OH}	High Level Output Voltage	0.9 × VIO	VIO	V
V_{OL}	Low Level Output Voltage	0	0.1 × VIO	V
I_{iL}	Input leakage current	-5	5	μA

4.4. Current Consumption

Table 25: Current Consumption of the Module

Parameter	Condition	Typical	Unit
Deep sleep current	AT+QDEEPSLEEP	8.6	μA
Low voltage standby current		TBD	μA
Normal standby current		TBD	μA
802.11b	TX (2.4 GHz) HT20 1 Mbps	91	mA
	TX (2.4 GHz) HT20 11 Mbps	92	mA

802.11g	TX (2.4 GHz) HT20 6 Mbps	90	mA
	TX (2.4 GHz) HT20 54 Mbps	88	mA
802.11n	TX (2.4 GHz) HT20 MCS0	89	mA
	TX (2.4 GHz) HT20 MCS7	88	mA

4.5. RF Performances

4.5.1. Wi-Fi Performances

Table 26: 2.4 GHz Conducted Output Power

Operating Mode / Rate	Min.	Typ.	Unit
802.11b @ 1 Mbps	15	17	dBm
802.11b @ 11 Mbps	15	17	dBm
802.11g @ 6 Mbps	14	16	dBm
802.11g @ 54 Mbps	13	15	dBm
802.11n, HT20 @ MCS0	13	15	dBm
802.11n, HT20 @ MCS7	12	14	dBm

Table 27: 2.4 GHz Conducted Receive Sensitivity

Operating Mode / Rate	Typ. (dBm)
802.11b @ 1 Mbps	-96
802.11b @ 11 Mbps	-87
802.11g @ 6 Mbps	-89
802.11g @ 54 Mbps	-72
802.11n, HT20 @ MCS0	-89

802.11n, HT20 @ MCS7	-70

4.5.2. BLE Performances

Table 28: BLE Conducted Mode Output Power / Receive Sensitivity

Operating Mode	Output Power (Typical)	Receive Sensitivity (Typical)	Unit
BLE (1 MHz)	6	-95	dBm

4.6. ESD Performances

The module is not protected against electrostatics discharge (ESD) in general. Consequently, it is subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates the module.

The following table shows the module electrostatic discharge characteristics.

Table 29: ESD Characteristics (Temperature: 25 ºC, Humidity: 45 %)

Tested Interfaces	Contact Discharge	Air Discharge	Unit
VBAT, GND	±7	±10	kV
ANT_WIFI/BT	±8	±10	kV
Other Interfaces	±0.5	±1	kV

5 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ±0.2 mm unless otherwise specified.

5.1. Mechanical Dimensions of the Module

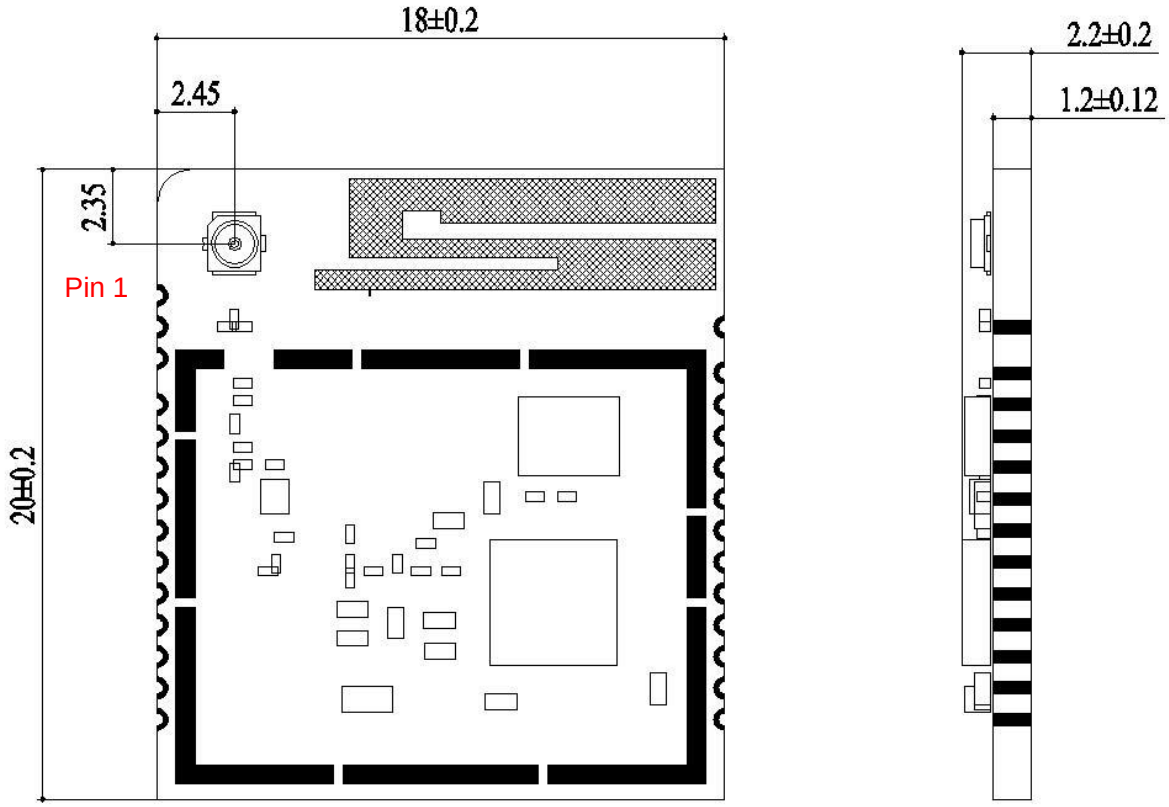


Figure 20: Module Top and Side Dimensions

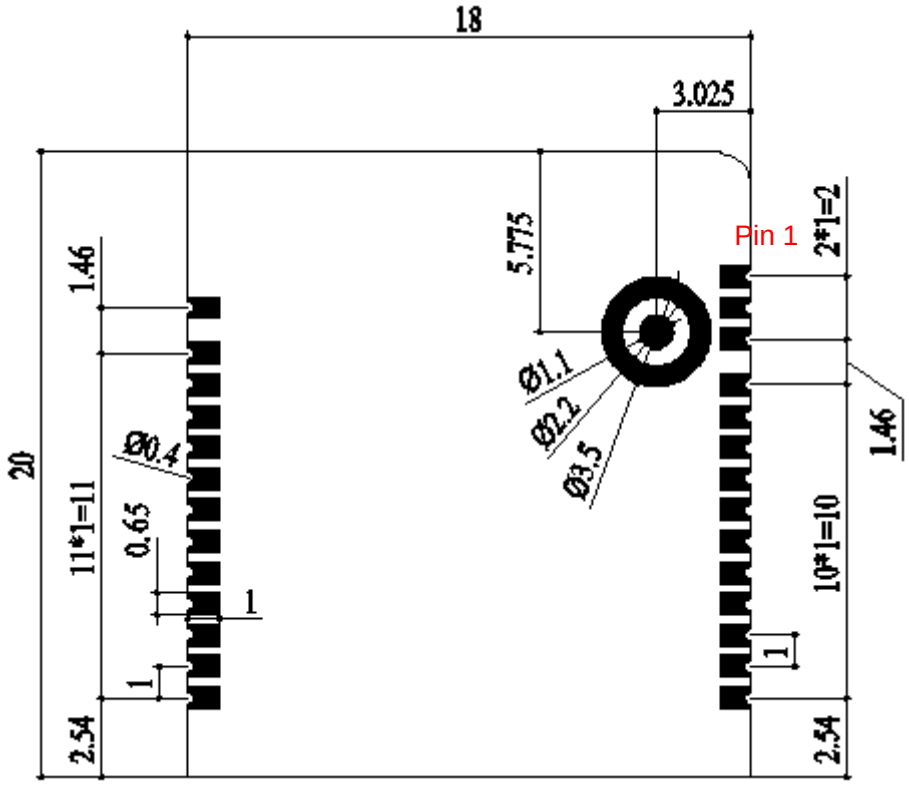


Figure 21: Module Dimension (Bottom View)

NOTE

The package warpage level of the module conforms to the *JEITA ED-7306* standard.

5.2. Recommended Footprint

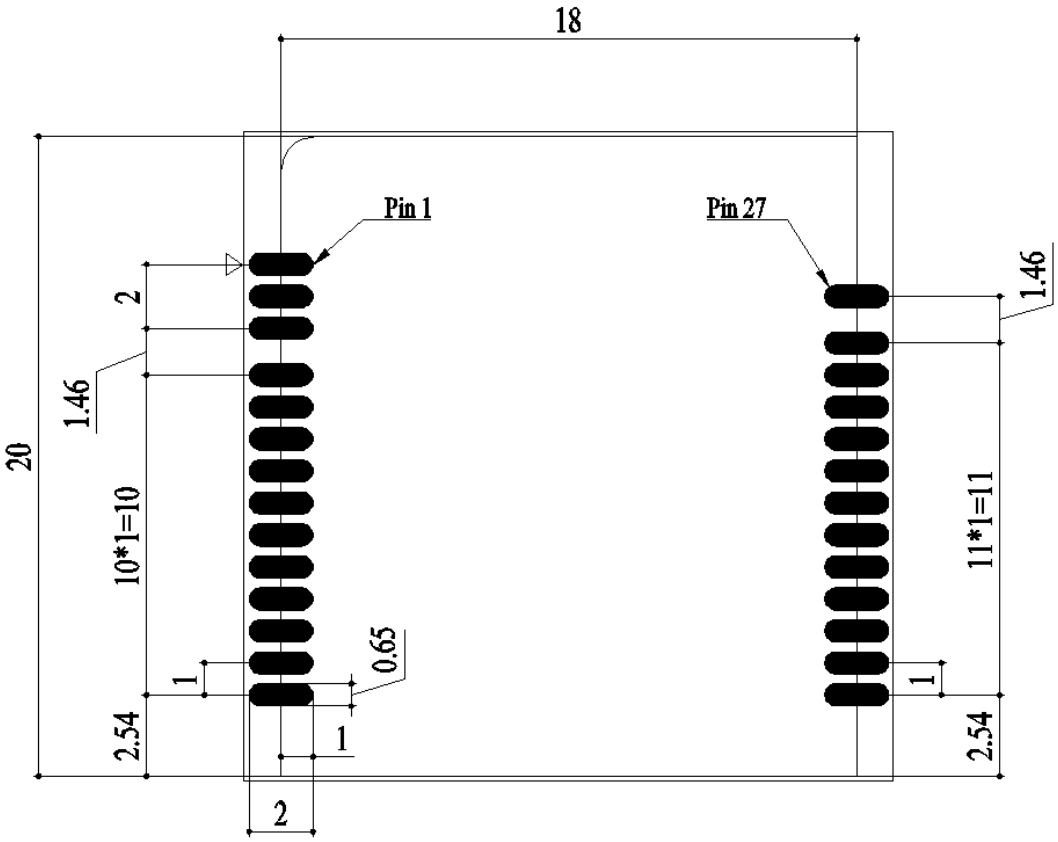


Figure 22: Recommeded Footprint (Top View)

NOTE

For easy maintenance of the module, keep about 3 mm between the module and other components on the motherboard.

6 Storage, Manufacturing and Packaging

6.1. Storage

The module is provided with vacuum-sealed packaging. MSL of the module is rated as 3. The storage requirements are shown below.

1. Recommended Storage Condition: The temperature should be 23 ±5 °C and the relative humidity should be 35–60 %.

2. The storage life (in vacuum-sealed packaging) is 12 months in Recommended Storage Condition.

3. The floor life of the module is 168 hours [1] in a plant where the temperature is 23 ±5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g. a drying cabinet).

4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:
   - The module is not stored in Recommended Storage Condition;
   - Violation of the third requirement above occurs;
   - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
   - Before module repairing.

5. If needed, the pre-baking should follow the requirements below:
   - The module should be baked for 8 hours at 120 ±5 °C;
   - All modules must be soldered to PCB within 24 hours after the baking, otherwise they should be put in a dry environment such as in a drying oven.

[1] This floor life is only applicable when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours after the package is removed if the temperature and moisture do not conform to, or are not sure to conform to *IPC/JEDEC J-STD-033*. And do not remove the packages of tremendous modules if they are not ready for soldering.

NOTE

1. To avoid blistering, layer separation and other soldering issues, extended exposure of the module to the air is forbidden.
2. Take out the module from the package and put it on high-temperature-resistant fixtures before baking. All modules must be soldered to PCB within 24 hours after the baking, otherwise put them in the drying oven. If shorter baking time is desired, see *IPC/JEDEC J-STD-033* for the baking procedure.
3. Pay attention to ESD protection, such as wearing anti-static gloves, when touching the modules.

6.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. To guarantee module soldering quality, the thickness of stencil for the module is recommended to be 0.15–0.18 mm. For more details, see ***document [3]***.

The peak reflow temperature should be 238–246 ºC, with 246 ºC as the absolute maximum reflow temperature. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted only after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below.

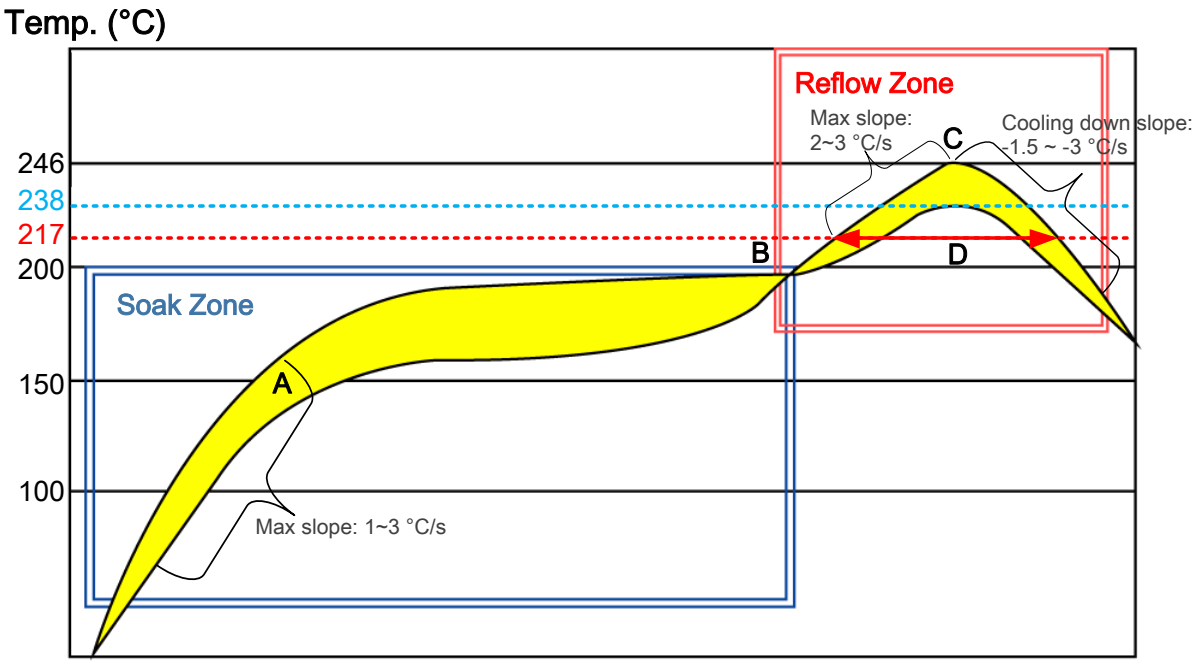


Figure 23: Recommended Reflow Soldering Thermal Profile

Table 30: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1–3 °C/s
Soak time (between A and B: 150 °C and 200 °C)	70–120 s
Reflow Zone	
Max slope	2–3 °C/s
Reflow time (D: over 217 °C)	40–70 s
Max temperature	238 °C to 246 °C
Cooling down slope	-1.5 to -3 °C/s
Reflow Cycle	
Max reflow cycle	1

NOTE

1. During manufacturing and soldering, or any other processes that may contact the module directly, NEVER wipe the module's shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the shielding can may become rusted.
2. The shielding can for the module is made of Cupro-Nickel base material. It is tested that after 12 hours' Neutral Salt Spray test, the laser engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.
3. If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.

6.3. Packaging

FC41D module is packaged with tape and sealed in a vacuum bag. It is recommended to open the vacuum package when it is used in actual production.

Each reel contains 250 FC41D modules with a reel diameter of 330 mm. The figures below show the packaging details, measured in mm.

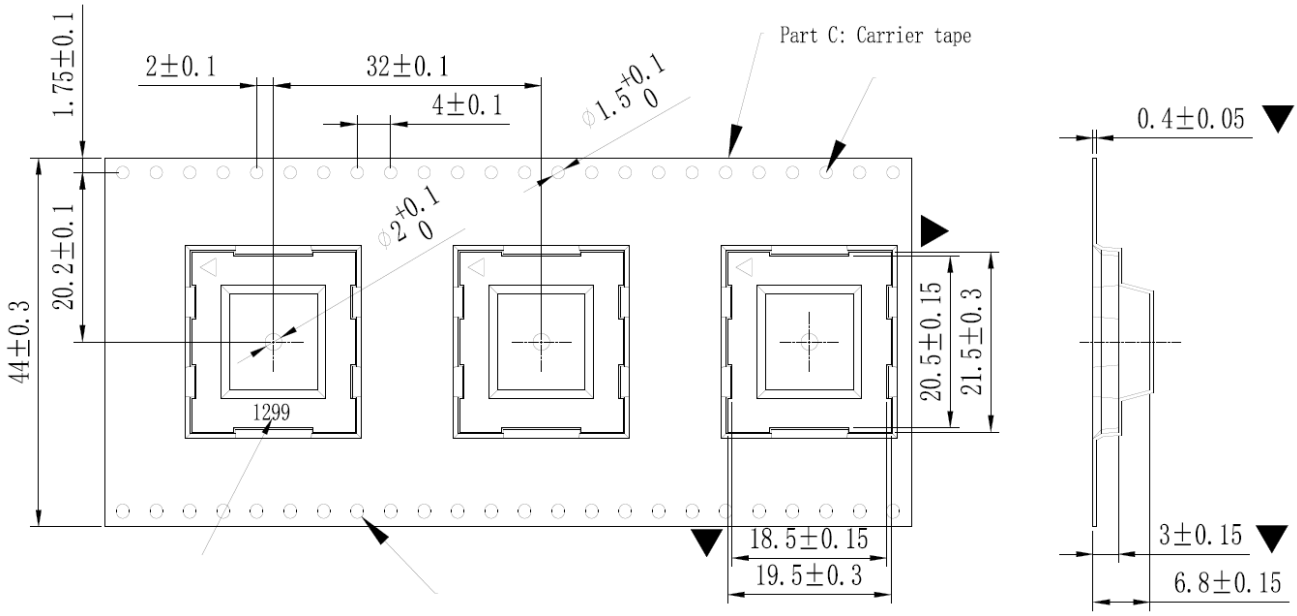


Figure 24: Tap Specification

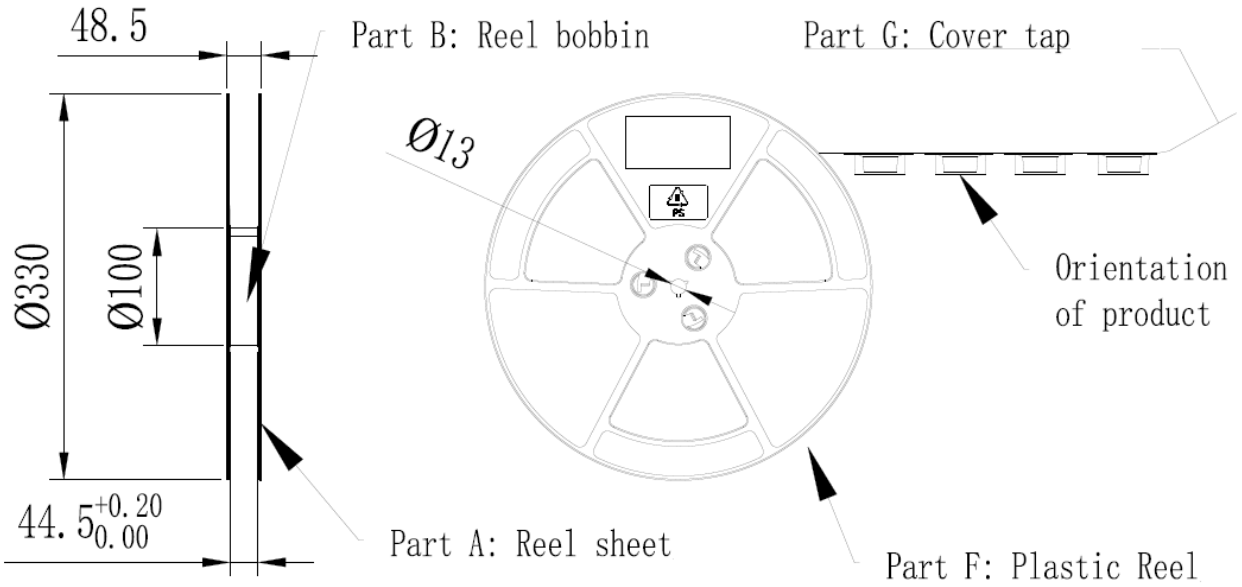


Figure 25: Reel Specification

7 Appendix References

Table 31: Reference Documents

Document Name
[1] Quectel_FC41D-TE-B_User_Guide
[2] Quectel_RF_Layout_Application_Note
[3] Quectel_Module_SMT_Application_Note

Table 32: Terms and Abbreviations

Abbreviation	Description
AP	Access Point
BLE	Bluetooth Low Energy
BPSK	Binary Phase Shift Keying
BT	Bluetooth
CCK	Complementary Code Keying
CTS	Clear To Send
DPSK	Differential Phase Shift Keying
DQPSK	Differential Quadrature Reference Phase Shift Keying
ESD	Electrostatic Discharge
GATT	Generic Attribute Profile
GFSK	Gauss frequency Shift Keying
GND	Ground

HT	High Throughput
IEEE	Institute of Electrical and Electronics Engineers
I/O	Input/Output
Mbps	Million Bits Per Second
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RH	Relative Humidity
RoHS	Restriction of Hazardous Substances
STA	Spike-triggered average
RTS	Request to Send
RXD	Receive Data
SDIO	Secure Digital Input and Output Card
TBD	To Be Determined
TXD	Transmit Data
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
VHT	Very High Throughput
Vnom	Normal Voltage Value
VSWR	Voltage Standing Wave Ratio
Wi-Fi	Wireless Fidelity