

FC20 Series

Hardware Design

Wi-Fi Module Series

Rev. FC20_Series_Hardware_Design_V2.1

Date: 2018-07-06

Status: Released



Our aim is to provide customers with timely and comprehensive service. For any assistance, please contact our company headquarters:

Quectel Wireless Solutions Co., Ltd.

7th Floor, Hongye Building, No.1801 Hongmei Road, Xuhui District, Shanghai 200233, China

Tel: +86 21 5108 6236

Email: info@quectel.com

Or our local office. For more information, please visit:

<http://quectel.com/support/sales.htm>

For technical support, or to report documentation errors, please visit:

<http://quectel.com/support/technical.htm>

Or email to: support@quectel.com

GENERAL NOTES

QUECTEL OFFERS THE INFORMATION AS A SERVICE TO ITS CUSTOMERS. THE INFORMATION PROVIDED IS BASED UPON CUSTOMERS' REQUIREMENTS. QUECTEL MAKES EVERY EFFORT TO ENSURE THE QUALITY OF THE INFORMATION IT MAKES AVAILABLE. QUECTEL DOES NOT MAKE ANY WARRANTY AS TO THE INFORMATION CONTAINED HEREIN, AND DOES NOT ACCEPT ANY LIABILITY FOR ANY INJURY, LOSS OR DAMAGE OF ANY KIND INCURRED BY USE OF OR RELIANCE UPON THE INFORMATION. ALL INFORMATION SUPPLIED HEREIN IS SUBJECT TO CHANGE WITHOUT PRIOR NOTICE.

COPYRIGHT

THE INFORMATION CONTAINED HERE IS PROPRIETARY TECHNICAL INFORMATION OF QUECTEL WIRELESS SOLUTIONS CO., LTD. TRANSMITTING, REPRODUCTION, DISSEMINATION AND EDITING OF THIS DOCUMENT AS WELL AS UTILIZATION OF THE CONTENT ARE FORBIDDEN WITHOUT PERMISSION. OFFENDERS WILL BE HELD LIABLE FOR PAYMENT OF DAMAGES. ALL RIGHTS ARE RESERVED IN THE EVENT OF A PATENT GRANT OR REGISTRATION OF A UTILITY MODEL OR DESIGN.

Copyright © Quectel Wireless Solutions Co., Ltd. 2018. All rights reserved.

About the Document

History

Revision	Date	Author	Description
1.0	2016-11-02	Power JIN	Initial
1.1	2017-12-14	Power JIN/ Kane ZHU	<ol style="list-style-type: none"> 1. Updated the chip model into QCA1023. 2. Added LTE coexistence function for FC20-N. 3. Updated current consumption values in Table 23. 4. Updated RF output power values in Table 24 and Table 25. 5. Updated RF receiving sensitivity in Table 26 and Table 27. 6. Added EC20 R2.1 in the modules that can use in combination with FC20 series module.
2.0	2018-05-17	Power JIN/ Kane ZHU	<ol style="list-style-type: none"> 1. Removed all descriptions relating to BT function. 2. Removed UART, PCM and BT_EN from Figure 1. 3. Changed pins 7, 8, 10, 13~18 into reserved ones. 4. Updated bottom dimensions, recommended footprint and recommended stencil. 5. Updated the peak reflow temperature and recommended reflow soldering thermal profile in Chapter 6.2.
2.1	2018-07-06	Power JIN/ Kane ZHU	<ol style="list-style-type: none"> 1. Added a reference design for RF antenna interface in Chapter 3.8.3. 2. Updated the recommended thermal profile parameters in Chapter 6.2. 3. Updated the frequency range of the modules.

Contents

About the Document	2
Contents	3
Table Index	5
Figure Index	6
1 Introduction	7
1.1. Safety Information	8
2 Product Concept	9
2.1. General Description	9
2.2. Key Features	9
2.3. Functional Diagram	11
2.4. Evaluation Board	12
3 Application Interfaces	13
3.1. General Description	13
3.2. Pin Assignment	14
3.3. Pin Description	15
3.4. Power Supply	17
3.5. WLAN Interface	19
3.5.1. WAKE_ON_WIRELESS *	19
3.5.2. WLAN_EN	20
3.5.3. SDIO Interface	20
3.6. Coexistence Interface	21
3.7. Other Interfaces	22
3.7.1. DBG_TXD Interface	22
3.7.2. 32KHz_IN Interface	22
3.8. Antenna Interface	23
3.8.1. Pin Definition of RF Antenna Interface	23
3.8.2. Operating Frequency	23
3.8.3. Reference Designs	24
3.8.4. Antenna Requirements	25
3.8.5. Recommended RF Connector for Antenna Installation	26
4 Electrical, Reliability and Radio Characteristics	28
4.1. General Description	28
4.2. Electrical Characteristics	28
4.3. I/O Interface Characteristics	29
4.4. Current Consumption	29
4.5. RF Performance	31
4.6. Electrostatic Discharge	33
5 Mechanical Dimensions	34
5.1. Mechanical Dimensions of the Module	34

5.2.	Recommended Footprint and Stencil Design	36
5.3.	Top and Bottom View of the Module	38
6	Storage, Manufacturing and Packaging	39
6.1.	Storage	39
6.2.	Manufacturing and Soldering.....	40
6.3.	Packaging	41
6.3.1.	Tape and Reel Packaging	41
7	Appendix A References.....	44

Table Index

TABLE 1: FC20 SERIES PRODUCTS	7
TABLE 2: KEY FEATURES	9
TABLE 3: I/O PARAMETERS DEFINITION.....	15
TABLE 4: PIN DESCRIPTION OF FC20 SERIES MODULE	15
TABLE 5: POWER SUPPLY PINS AND GND PINS.....	18
TABLE 6: PIN DEFINITION OF WAKE_ON_WIRELESS	20
TABLE 7: PIN DEFINITION OF WLAN_EN.....	20
TABLE 8: PIN DEFINITION OF SDIO INTERFACE	20
TABLE 9: PIN DEFINITION OF COEXISTENCE INTERFACE.....	22
TABLE 10: PIN DEFINITION OF DBG_TXD INTERFACE.....	22
TABLE 11: PIN DEFINITION OF 32KHZ_IN INTERFACE	23
TABLE 12: PIN DEFINITION OF RF ANTENNA INTERFACE	23
TABLE 13: OPERATING FREQUENCY OF FC20-N	23
TABLE 14: OPERATING FREQUENCY OF FC20	24
TABLE 15: ANTENNA CABLE REQUIREMENTS.....	25
TABLE 16: ANTENNA REQUIREMENTS.....	25
TABLE 17: ABSOLUTE MAXIMUM RATINGS	28
TABLE 18: RECOMMENDED OPERATING CONDITIONS.....	29
TABLE 19: GENERAL DC ELECTRICAL CHARACTERISTICS.....	29
TABLE 20: CURRENT CONSUMPTION OF THE MODULE IN LOW POWER MODE.....	29
TABLE 21: CURRENT CONSUMPTION OF THE MODULE	30
TABLE 22: CONDUCTED RF OUTPUT POWER AT 2.4GHZ	31
TABLE 23: CONDUCTED RF OUTPUT POWER AT 5GHZ	32
TABLE 24: CONDUCTED RF RECEIVING SENSITIVITY AT 2.4GHZ.....	32
TABLE 25: CONDUCTED RF RECEIVING SENSITIVITY AT 5GHZ.....	33
TABLE 26: RECOMMENDED THERMAL PROFILE PARAMETERS	40
TABLE 27: REEL PACKAGING	43
TABLE 28: RELATED DOCUMENTS.....	44
TABLE 29: TERMS AND ABBREVIATIONS	44

Figure Index

FIGURE 1: FUNCTIONAL DIAGRAM OF FC20 SERIES MODULE.....	11
FIGURE 2: PIN ASSIGNMENT OF FC20 SERIES MODULE	14
FIGURE 3: REFERENCE CIRCUIT FOR VDD_3V3	18
FIGURE 4: POWER ON/OFF TIMING OF FC20 SERIES MODULE	19
FIGURE 5: WLAN INTERFACE CONNECTION	19
FIGURE 6: SDIO INTERFACE CONNECTION.....	21
FIGURE 7: COEXISTENCE INTERFACE CONNECTION.....	22
FIGURE 8: REFERENCE CIRCUIT FOR RF ANTENNA INTERFACE	24
FIGURE 9: DIMENSIONS OF THE U.FL-R-SMT CONNECTOR (UNIT: MM).....	26
FIGURE 10: MECHANICALS OF U.FL-LP CONNECTORS	26
FIGURE 11: SPACE FACTOR OF MATED CONNECTOR (UNIT: MM).....	27
FIGURE 12: TOP AND SIDE DIMENSIONS	34
FIGURE 13: BOTTOM DIMENSIONS	35
FIGURE 14: RECOMMENDED FOOTPRINT	36
FIGURE 15: RECOMMENDED STENCIL DESIGN	37
FIGURE 16: TOP VIEW OF THE MODULE	38
FIGURE 17: BOTTOM VIEW OF THE MODULE	38
FIGURE 18: RECOMMENDED REFLOW SOLDERING THERMAL PROFILE.....	40
FIGURE 19: TAPE DIMENSIONS	42
FIGURE 20: REEL DIMENSIONS	42

1 Introduction

This document defines the FC20 series module and describes its air interface and hardware interface which are connected with the customers' applications.

The document can help customers quickly understand module interface specifications, electrical and mechanical details, as well as other related information of the module. Through using in combination with Quectel EC2x¹⁾ modules, customers can use FC20 series module to design and set up LTE+Wi-Fi applications easily.

FC20 series module contains two variants: FC20 and FC20-N. Customers can choose a dedicated type based on their requirements. The following table shows the entire models of FC20 series.

Table 1: FC20 Series Products

Module	Wi-Fi
FC20	2.4GHz and 5GHz
FC20-N	2.4GHz

NOTE

¹⁾ EC2x refers to Quectel EC21, EC25 and EC20 R2.1 modules in this document.

1.1. Safety Information

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 FC20 series module. Manufacturers of the cellular terminal should send the following safety information to users and operating personnel, and incorporate these guidelines into all manuals supplied with the product. If not so, Quectel assumes no liability for customers' failure to comply with these precautions.



Full attention must be given 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 the device offers an Airplane Mode, then it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on boarding the 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 signals and cellular network cannot be guaranteed to connect in all possible conditions (for example, with unpaid bills or with an invalid (U)SIM card). When emergent help is needed in such conditions, please remember using emergency call. 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.



The cellular terminal or mobile contains a transmitter and receiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV set, radio, computer or other electric equipment.



In locations with potentially explosive atmospheres, obey all posted signs to turn off wireless devices such as your phone or other cellular terminals. Areas with potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles such as grain, dust or metal powders, etc.

2 Product Concept

2.1. General Description

FC20 series is a range of low-power cost-effective Wi-Fi module based on QCA1023, and incorporates two variants (FC20 and FC20-N) as illustrated below.

FC20

- Supports 1x1 IEEE 802.11 a/b/g/n/ac WLAN standards
- Provides a low-power SDIO 3.0 interface for WLAN and also supports LTE/WLAN coexistence

FC20-N

- Supports 1x1 IEEE 802.11 b/g/n WLAN standards
- Provides a low-power SDIO 3.0 interface for WLAN, and also supports LTE-WLAN coexistence

2.2. Key Features

The following table describes the detailed features of FC20 series module.

Table 2: Key Features

Features	Description
Power Supply	Main supply voltage: 3.3V I/O supply voltage: 1.8V
Data Rate	FC20: <ul style="list-style-type: none">● 802.11b: 1Mbps, 2Mbps, 5.5Mbps, 11Mbps● 802.11g: 6Mbps, 9Mbps, 12Mbps, 18Mbps, 24Mbps, 36Mbps, 48Mbps, 54Mbps● 802.11n: 6.5Mbps, 13Mbps, 19.5Mbps, 26Mbps, 39Mbps, 52Mbps, 58.5Mbps, 65Mbps● 802.11a: 6Mbps, 9Mbps, 12Mbps, 18Mbps, 24Mbps, 36Mbps, 48Mbps, 54Mbps

	<ul style="list-style-type: none"> 802.11ac: VHT20 (MCS0-7), VHT40 (MCS0-9), VHT80 (MCS0-9) FC20-N: <ul style="list-style-type: none"> 802.11b: 1Mbps, 2Mbps, 5.5Mbps, 11Mbps 802.11g: 6Mbps, 9Mbps, 12Mbps, 18Mbps, 24Mbps, 36Mbps, 48Mbps, 54Mbps 802.11n: 6.5Mbps, 13Mbps, 19.5Mbps, 26Mbps, 39Mbps, 52Mbps, 58.5Mbps, 65Mbps
Transmitting Power	FC20: <ul style="list-style-type: none"> 802.11b/11Mbps: 17dBm 802.11g/54Mbps: 15dBm 802.11n/HT20 MCS7: 14.5dBm 802.11a/54Mbps: 12.5dBm 802.11ac/VHT20 MCS0: 13.5dBm FC20-N: <ul style="list-style-type: none"> 802.11b/11Mbps: 17dBm 802.11g/54Mbps: 15dBm 802.11n/HT20 MCS7: 14.5dBm
WLAN Protocol Features	FC20: <ul style="list-style-type: none"> IEEE 802.11a/b/g/n/ac FC20-N: <ul style="list-style-type: none"> IEEE 802.11b/g/n
Operator Mode	AP STA*
Modulation	FC20: <ul style="list-style-type: none"> BPSK, QPSK, CCK, 16QAM, 64QAM, 256QAM FC20-N: <ul style="list-style-type: none"> BPSK, QPSK, CCK, 16QAM, 64QAM
WLAN Interface	SDIO 3.0
Antenna Interface	Wi-Fi antenna interface, 50Ω
Physical Characteristics	Size: (16.6±0.15)mm × (13.0±0.15)mm × (2.1±0.2)mm Package: LCC Weight: approx. 0.81g
Temperature Range	Operating temperature range: -35°C ~ +75°C ¹⁾ Extended temperature range : -40°C ~ +85°C ²⁾ Storage temperature range: -40°C ~ +90°C
RoHS	All hardware components are fully compliant with EU RoHS directive

NOTES

- ¹⁾ Within operation temperature range, the module is IEEE compliant.
- ²⁾ Within extended temperature range, the module remains the ability for data transmission. There is

no unrecoverable malfunction. There are also no effects on radio spectrum and no harm to radio network. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to the normal operating temperature levels, the module will meet IEEE specifications again.

3. “*” means under development.

2.3. Functional Diagram

The following figure shows a block diagram of FC20 series module and illustrates the major functional parts.

- Power supply
- SDIO interface
- Coexistence interface
- RF antenna

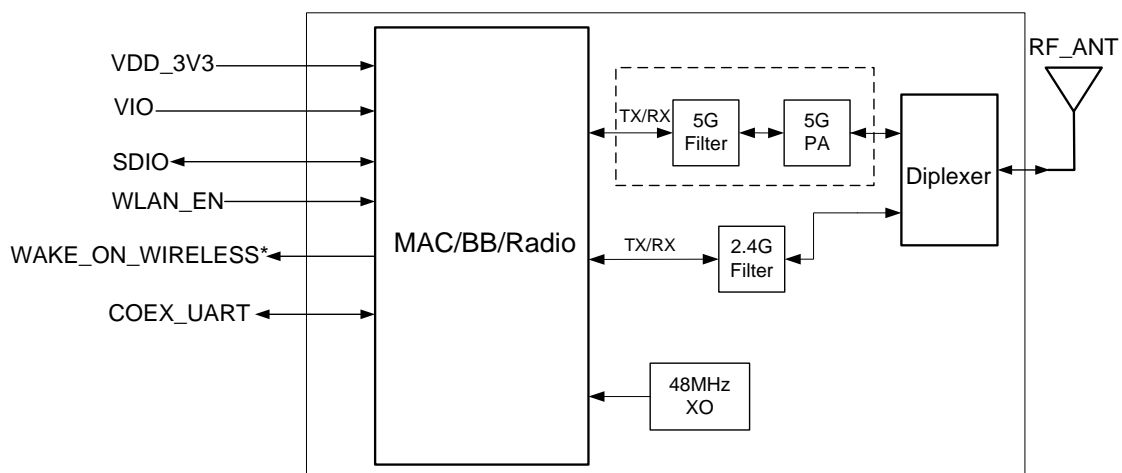


Figure 1: Functional Diagram of FC20 Series Module

NOTE

“*” means under development.

2.4. Evaluation Board

In order to help customers to develop applications with FC20 series module, Quectel supplies an evaluation board (EVB), a RS-232 to USB cable, a USB data cable, a power adapter, 4 antennas and other peripherals to control or test the module. For details, please refer to **document [1]**.

3 Application Interfaces

3.1. General Description

FC20 series module is equipped with 38 LCC pads and 14 LGA pads that can be connected to the cellular application platform. Sub-interfaces included in these pads are described in details in following chapters:

- Power supply
- WLAN interface
- Coexistence interface
- Antenna interface

3.2. Pin Assignment

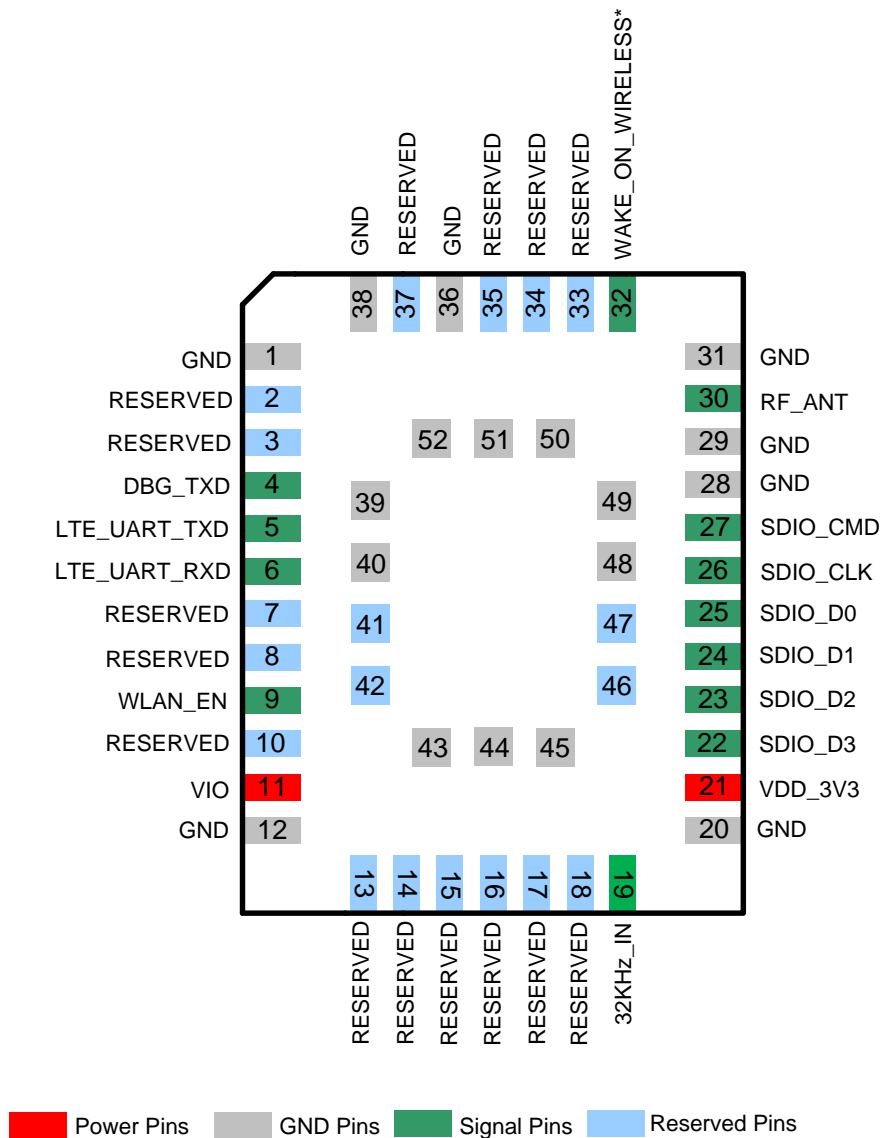


Figure 2: Pin Assignment of FC20 Series Module

NOTES

1. Please keep all RESERVED pins open.
2. "*" means under development.

3.3. Pin Description

The following tables show the pin definition of FC20 series module.

Table 3: I/O Parameters Definition

Type	Description
IO	Bidirectional
DI	Digital input
DO	Digital output
PI	Power input

Table 4: Pin Description of FC20 Series Module

Power Supply					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
VDD_3V3	21	PI	Main power supply for the module	V _{max} =3.46V V _{min} =3.14V V _{norm} =3.3V	It must be able to provide sufficient current up to 0.9A.
VIO	11	PI	Power supply for the module's I/O pins	V _{max} =1.89V V _{min} =1.71V V _{norm} =1.8V	It is powered by EC2x module.
GND	1, 12, 20, 28, 29, 31, 36, 38~40, 43~45, 48~52		Ground		
WLAN Interface					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
WAKE_ON_WIRELESS*	32	DO	Wake up the host	V _{OL} max=0.18V V _{OH} min=1.62V	1.8V power domain. Active low. If unused, keep this pin open.
WLAN_EN	9	DI	WLAN enable control	V _{IL} min=-0.3V V _{IL} max=0.54V	1.8V power domain. Active high.

				$V_{IHmin}=1.26V$ $V_{IHmax}=2.0V$	
SDIO_D3	22	IO	SDIO data pin bit 3	$V_{OLmax}=0.18V$ $V_{OHmin}=1.62V$ $V_{ILmin}=-0.3V$ $V_{ILmax}=0.54V$ $V_{IHmin}=1.26V$ $V_{IHmax}=2.0V$	1.8V power domain
SDIO_D2	23	IO	SDIO data pin bit 2	$V_{OLmax}=0.18V$ $V_{OHmin}=1.62V$ $V_{ILmin}=-0.3V$ $V_{ILmax}=0.54V$ $V_{IHmin}=1.26V$ $V_{IHmax}=2.0V$	1.8V power domain. Require external pull-up to 1.8V.
SDIO_D1	24	IO	SDIO data pin bit 1	$V_{OLmax}=0.18V$ $V_{OHmin}=1.62V$ $V_{ILmin}=-0.3V$ $V_{ILmax}=0.54V$ $V_{IHmin}=1.26V$ $V_{IHmax}=2.0V$	1.8V power domain
SDIO_D0	25	IO	SDIO data pin bit 0	$V_{OLmax}=0.18V$ $V_{OHmin}=1.62V$ $V_{ILmin}=-0.3V$ $V_{ILmax}=0.54V$ $V_{IHmin}=1.26V$ $V_{IHmax}=2.0V$	1.8V power domain
SDIO_CLK	26	DI	SDIO clock	$V_{ILmin}=-0.3V$ $V_{ILmax}=0.54V$ $V_{IHmin}=1.26V$ $V_{IHmax}=2.0V$	1.8V power domain
SDIO_CMD	27	IO	SDIO command	$V_{OLmax}=0.18V$ $V_{OHmin}=1.62V$ $V_{ILmin}=-0.3V$ $V_{ILmax}=0.54V$ $V_{IHmin}=1.26V$ $V_{IHmax}=2.0V$	1.8V power domain

Coexistence Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
LTE_UART_TXD	5	DO	LTE/WLAN coexistence signal	$V_{OLmax}=0.18V$ $V_{OHmin}=1.62V$	1.8V power domain. If unused, keep this pin open.

LTE_UART_RXD	6	DI	LTE/WLAN coexistence signal	$V_{ILmin}=-0.3V$ $V_{ILmax}=0.54V$ $V_{IHmin}=1.26V$ $V_{IHmax}=2.0V$	1.8V power domain. If unused, keep this pin open.
RF Interface					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
RF_ANT	30	IO	Wi-Fi antenna interface		50Ω impedance.
Other Pins					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
DBG_TXD	4	DO	Used for software debugging	$V_{OLmax}=0.18V$ $V_{OHmin}=1.62V$	1.8V power domain. If unused, keep this pin open.
32KHz_IN	19	DI	Low power. External 32.768KHz clock input is required in sleep mode.	$V_{ILmin}=-0.3V$ $V_{ILmax}=0.54V$ $V_{IHmin}=1.26V$ $V_{IHmax}=2.0V$	1.8V power domain. If unused, keep this pin open.
RESERVED Pins					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
RESERVED	2, 3, 7, 8, 10, 13~18, 33~35, 37, 41, 42, 46, 47		Reserved		Keep these pins unconnected.

NOTE

“(★)” means under development.

3.4. Power Supply

The following table shows the power supply pins and the ground pins of FC20 series. The VIO pin is powered by EC2x.

Table 5: Power Supply Pins and GND Pins

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VDD_3V3	21	Main power supply for the module	3.14	3.3	3.46	V
VIO	11	Power supply for the module's I/O pins	1.71	1.8	1.89	V
GND	1, 12, 20, 28, 29, 31, 36, 38~40, 43~45, 48~52	Ground				

FC20 series is powered by VDD_3V3, and it is recommended to use a power supply chip with maximum output current more than 0.9A.

The following figure shows a reference design for VDD_3V3. Pulling PM_ENABLE to a high voltage level will enable VDD_3V3 power output. And this pin should be connected to pin 127 of EC2x. For more details, please refer to **document [2], [3], or [4]**.

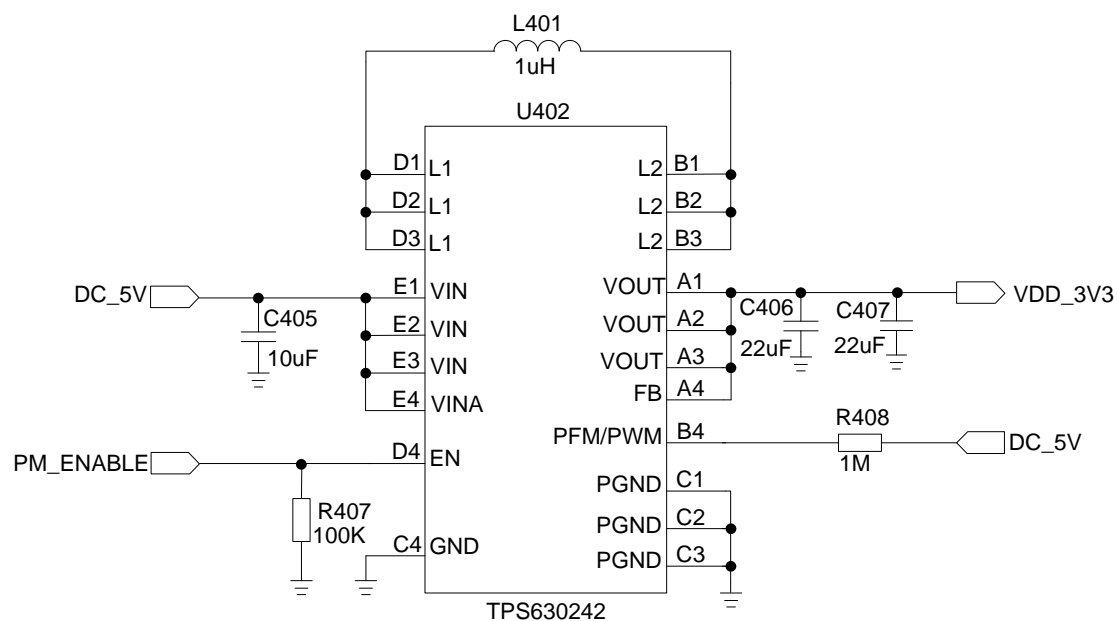


Figure 3: Reference Circuit for VDD_3V3

The following figure shows the recommended power on/off sequences for FC20 series.

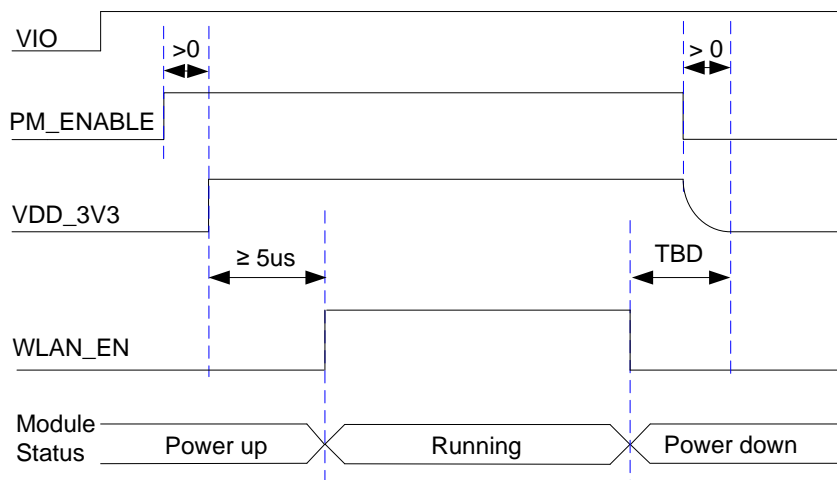


Figure 4: Power ON/OFF Timing of FC20 Series Module

3.5. WLAN Interface

The following figure shows the WLAN interface connection between FC20 series and EC2x.

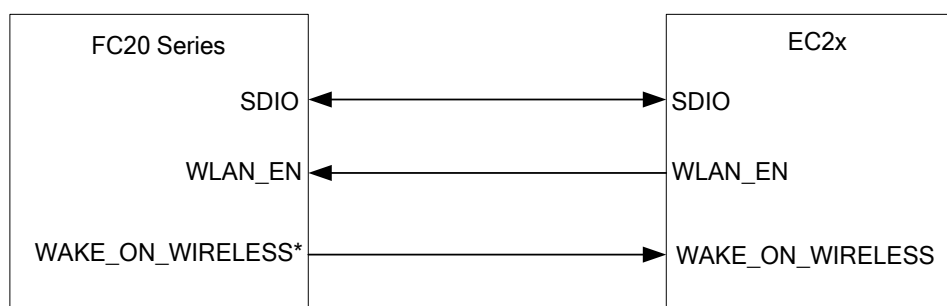


Figure 5: WLAN Interface Connection

NOTE

“*” means under development.

3.5.1. WAKE_ON_WIRELESS *

WAKE_ON_WIRELESS* is used to wake up the EC2x module. When the pin is pulled down, EC2x can be woken up.

Table 6: Pin Definition of WAKE_ON_WIRELESS

Pin Name	Pin No.	I/O	Description	Comment
WAKE_ON_WIRELESS*	32	DO	Wake up the host	Active low. If unused, keep this pin open.

NOTE

“*” means under development.

3.5.2. WLAN_EN

WLAN_EN is used to control the WLAN function of FC20 series. When WLAN_EN is at high level voltage, WLAN function will be enabled.

Table 7: Pin Definition of WLAN_EN

Pin Name	Pin No.	I/O	Description	Comment
WLAN_EN	9	DI	WLAN enable control	Active high.

NOTE

WLAN_EN is a sensitive signal, and thus should be ground shielded and routed as close as possible to FC20 series module.

3.5.3. SDIO Interface

The following table shows the pin definition of SDIO interface.

Table 8: Pin Definition of SDIO Interface

Pin Name	Pin No.	I/O	Description	Comment
SDIO_D3	22	IO	SDIO data pin bit 3	1.8V power domain
SDIO_D2	23	IO	SDIO data pin bit 2	1.8V power domain. Require external pull-up to 1.8V.
SDIO_D1	24	IO	SDIO data pin bit 1	1.8V power domain

SDIO_D0	25	IO	SDIO data pin bit 0	1.8V power domain
SDIO_CLK	26	DI	SDIO clock	1.8V power domain
SDIO_CMD	27	IO	SDIO command	1.8V power domain

The following figure shows the SDIO interface connection between FC20 series and EC2x.

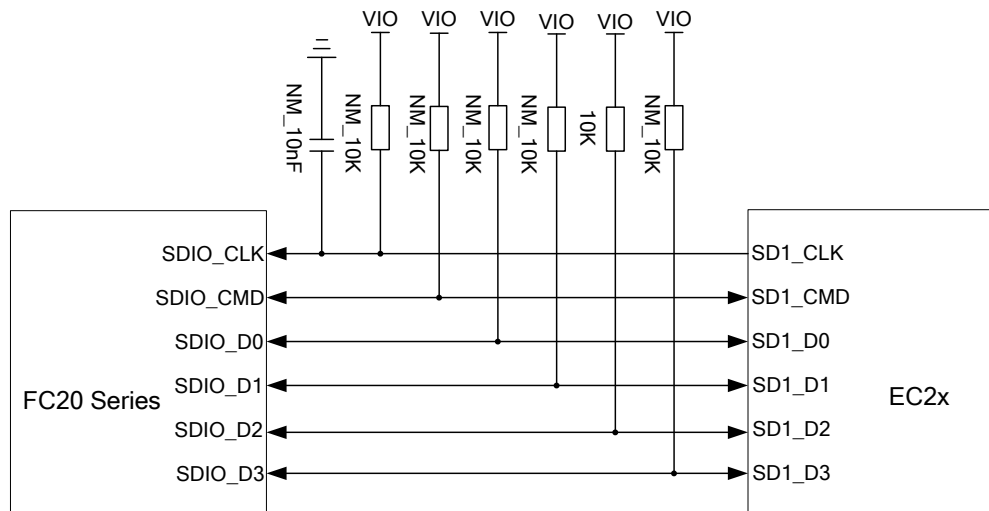


Figure 6: SDIO Interface Connection

In order to ensure the performance of SDIO, please comply with the following principles:

- SDIO signals are very high-speed signals. Please prevent crosstalk among them and other sensitive signals.
- Keep SDIO traces as parallel as possible in the same layer. Make sure SDIO lines are guarded by ground vias and not crossed.
- Do not route SDIO signal traces under crystals, oscillators, magnetic devices and RF signal traces.
- The pull-up resistor on SDIO_D2 line must be mounted.
- Keep SDIO traces as short as possible with equal length, and impedance control as 50Ω.
- The spacing to all other signals is greater than 2 times of the trace width.

3.6. Coexistence Interface

The following table shows the pin definition of coexistence interface.

Table 9: Pin Definition of Coexistence Interface

Pin Name	Pin No.	I/O	Description	Comment
LTE_UART_TXD	5	DO	LTE/WLAN coexistence signal	If unused, keep this pin open.
LTE_UART_RXD	6	DI	LTE/WLAN coexistence signal	If unused, keep this pin open.

The following figure shows the coexistence interface connection between FC20 series and EC2x.

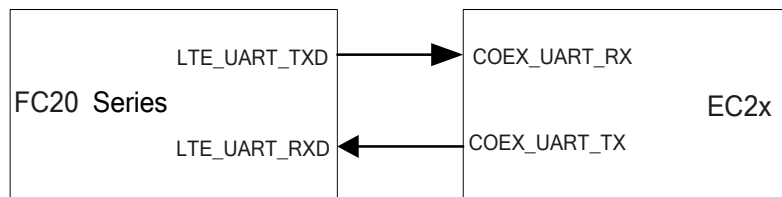


Figure 7: Coexistence Interface Connection

NOTE

“(★)” means under development.

3.7. Other Interfaces

3.7.1. DBG_TXD Interface

DBG_TXD interface can be used for log output.

Table 10: Pin Definition of DBG_TXD Interface

Pin Name	Pin No.	I/O	Description	Comment
DBG_TXD	4	DO	Used for software debugging	If unused, keep this pin open.

3.7.2. 32KHz_IN Interface

The 32KHz clock is used in low power mode such as IEEE power saving mode and sleep mode. It serves as a timer to determine when to wake up FC20 series module to receive beacons in various power saving schemes, and to maintain basic logic operations when in sleep mode. The sleep clock signal is

transferred from EC2x module.

Table 11: Pin Definition of 32KHz_IN Interface

Pin Name	Pin No.	I/O	Description	Comment
32KHz_IN	19	DI	Low power. External 32.768KHz clock input is required in sleep mode.	If unused, keep this pin open.

3.8. Antenna Interface

The pin 30 is the RF antenna pad. And the RF port has an impedance of 50Ω.

3.8.1. Pin Definition of RF Antenna Interface

Table 12: Pin Definition of RF Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
GND	28		Ground	
GND	29		Ground	
RF_ANT	30	IO	Wi-Fi antenna pad	50Ω impedance
GND	31		Ground	

3.8.2. Operating Frequency

Table 13: Operating Frequency of FC20-N

Feature	Frequency	Unit
2.4GHz WLAN	2.412~2.472	GHz

Table 14: Operating Frequency of FC20

Feature	Frequency	Unit
2.4GHz WLAN	2.412~2.472	GHz
5GHz WLAN	5.180~5.825	GHz

3.8.3. Reference Designs

FC20 series module provides an RF antenna pad for Wi-Fi antenna connection. The RF trace in host PCB connected to the module's RF antenna pad should be microstrip line or other types of RF trace, with characteristic impedance close to 50Ω. FC20 series module comes with grounding pads which are next to the antenna pad in order to give a better grounding.

A reference circuit for the RF antenna interface is shown below. It is recommended to reserve a π -type matching circuit for better RF performance. The capacitors are not mounted by default.

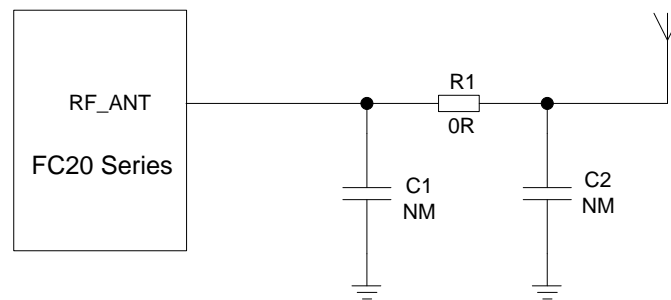


Figure 8: Reference Circuit for RF Antenna Interface

Another type of reference circuit for the RF antenna interface is shown below. It is designed for vehicle applications. It is recommended to reserve two notch filter circuits and a π -type matching circuit for better RF performance. C2/L1 and L3/C3 comprise two notch filter circuits for filtering out interference caused by a particular frequency. When L3/C2/L1/C3 is NC, C1/L2/ C4 comprise a π -type matching circuit. Capacitors C1/C2/C3/C4 and inductors L1/L3 are not mounted by default, and L2 is 0R by default.

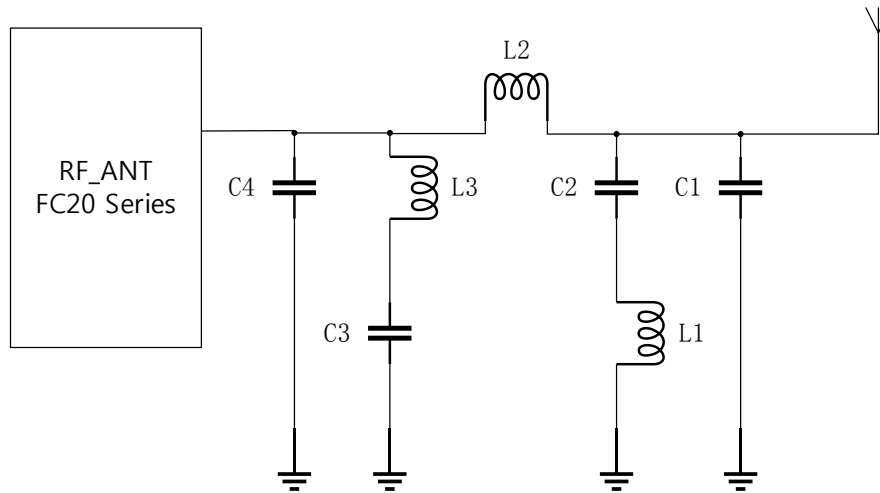


Figure 9: Reference Circuit for RF Antenna Interface (Vehicle Applications)

3.8.4. Antenna Requirements

The following table shows the requirements on RF antenna.

Table 15: Antenna Cable Requirements

Type	Requirements
2.412GHz~2.472GHz	Cable insertion loss <1dB
5.180GHz~5.825GHz	Cable insertion loss <1dB

Table 16: Antenna Requirements

Type	Requirements
Frequency Range	2.412GHz~2.472GHz 5.180GHz~5.825GHz
VSWR	< 2:1 recommended
Gain (dBi)	1 typical
Max Input Power (W)	50
Input Impedance (Ω)	50
Polarization Type	Vertical

3.8.5. Recommended RF Connector for Antenna Installation

If RF connector is used for antenna connection, it is recommended to use the U.FL-R-SMT connector provided by HIROSE.

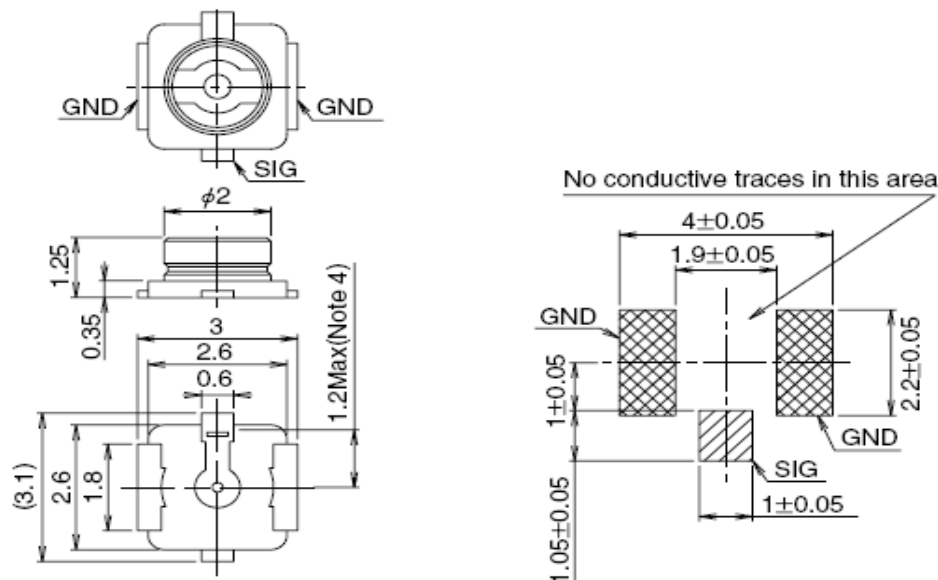


Figure 9: Dimensions of the U.FL-R-SMT Connector (Unit: mm)

U.FL-LP serial connectors listed in the following figure can be used to match the U.FL-R-SMT.

	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
Part No.					
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 10: Mechanicals of U.FL-LP Connectors

The following figure describes the space factor of mated connector

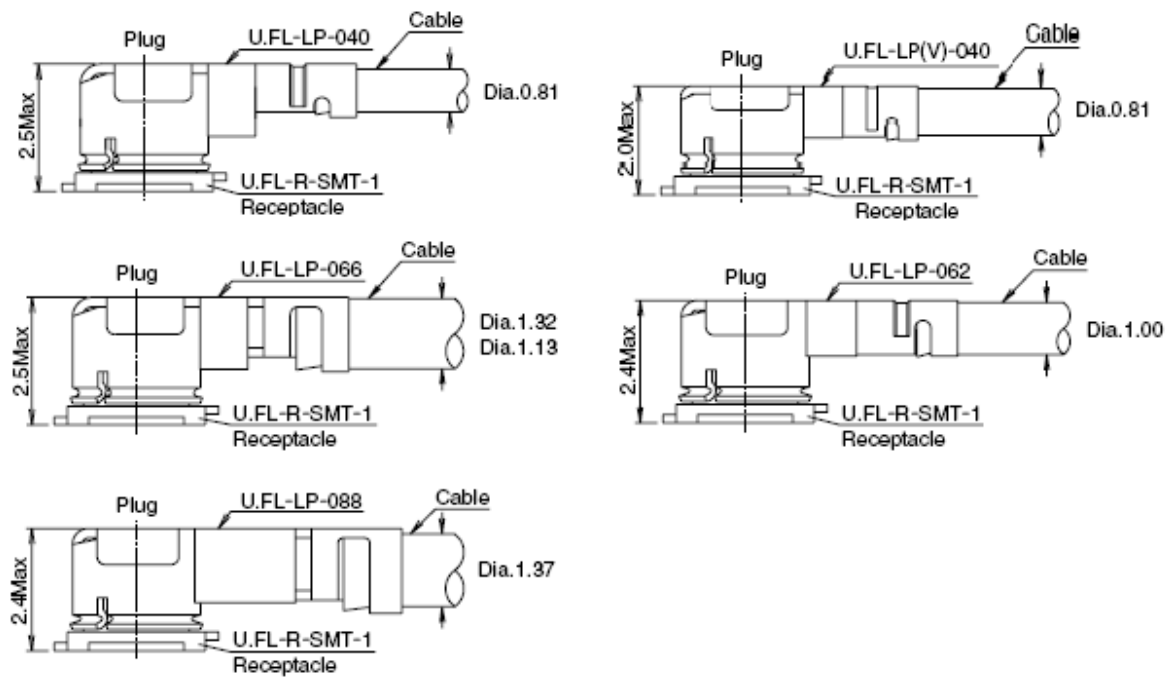


Figure 11: Space Factor of Mated Connector (Unit: mm)

For more details, please visit <http://www.hirose.com>.

4 Electrical, Reliability and Radio Characteristics

4.1. General Description

This chapter mainly introduces the electrical and the radio frequency characteristics of FC20 series module, which are listed in detail in the following chapters:

- Electrical characteristics
- I/O interface characteristics
- Current consumption
- RF performance
- Electrostatic discharge

4.2. Electrical Characteristics

The following table shows the absolute maximum ratings.

Table 17: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VDD_3V3	-0.3	3.46	V
VIO	-0.3	1.89	V
Digital I/O input voltage	-0.3	VIO+0.2	V

The following table shows the recommended operating conditions for FC20 series module.

Table 18: Recommended Operating Conditions

Parameter	Min.	Typ.	Max.	Unit
VDD_3V3	3.14	3.3	3.46	V
VIO	1.71	1.8	1.89	V

4.3. I/O Interface Characteristics

The following table shows the general DC electrical characteristics over recommended operating conditions (unless otherwise specified).

Table 19: General DC Electrical Characteristics

Symbol	Parameter	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	uA

4.4. Current Consumption

Table 20: Current Consumption of the Module in Low Power Mode

Description	Conditions	I _{WLAN_3V3}	I _{VIO}	Unit
OFF State ¹⁾	AT+QWIFI=0	0	554	uA
Idle ²⁾	AT+QWIFI=1	66	6.5	mA

NOTES

- ¹⁾ OFF state: Executing **AT+QWIFI=0** command will make the module enter into this state. Under the state, the sleep clock is disabled and no data is saved.
- ²⁾ Idle state: Wi-Fi function enabled via **AT+QWIFI=1**, but without any device connected to the AP.

Table 21: Current Consumption of the Module

Standard	Data Rate	I _{WLAN_3V3}	Unit
802.11b	TX 1Mbps @17.5dBm	370	mA
	TX 11Mbps @17.2dBm	357	mA
	RX 1Mbps	48	mA
	RX 11Mbps	49	mA
802.11g	TX 6Mbps @16dBm	328	mA
	TX 54Mbps @14.8dBm	245	mA
	RX 6Mbps	49	mA
	RX 54Mbps	50	mA
802.11n	TX HT20-MCS0 @15.8dBm	322	mA
	TX HT20-MCS7 @13.5dBm	234	mA
	TX HT40-MCS0 @14.5dBm	291	mA
	TX HT40-MCS7 @12.5dBm	194	mA
	RX HT20-MCS0	49	mA
	RX HT20-MCS7	50	mA
	RX HT40-MCS0	54	mA
	RX HT40-MCS7	52	mA
802.11a	TX HT20 MCS0	395	mA
	TX HT20 MCS7	307	mA
	RX HT20 MCS0	78	mA

802.11ac	RX HT20 MCS7	78	mA
	TX VHT20 MCS0 @13.2dBm	378	mA
	TX VHT20 MCS8 @12.5dBm	289	mA
	TX VHT40 MCS0 @13.5dBm	372	mA
	TX VHT40 MCS9 @10.5dBm	244	mA
	TX VHT80 MCS0 @13dBm	355	mA
	TX VHT80 MCS9 @10dBm	220	mA
	RX VHT20 MCS0	78	mA
	RX VHT20 MCS8	78	mA
	RX VHT40 MCS0	85	mA
	RX VHT40 MCS9	84	mA
	RX VHT80 MCS8	92	mA
	RX VHT80 MCS9	91	mA

4.5. RF Performance

The following tables summarize the transmitter and receiver characteristics of FC20 series.

Table 22: Conducted RF Output Power at 2.4GHz

Standard	Data Rate	Typ.	Unit
802.11b	1Mbps	17.5±2.5	dBm
802.11b	11Mbps	17.0±2.5	dBm
802.11g	6Mbps	16.5±2.5	dBm
802.11g	54Mbps	15.0±2.5	dBm
802.11n, HT20	MCS0	15.5±2.5	dBm
802.11n, HT20	MCS7	14.5±2.5	dBm

802.11n, HT40	MCS0	15.0±2.5	dBm
802.11n, HT40	MCS7	13.0±2.5	dBm

Table 23: Conducted RF Output Power at 5GHz

Standard	Data Rate	Typ.	Unit
802.11a	6Mbps	14.5±2.5	dBm
802.11a	54Mbps	12.5±2.5	dBm
802.11ac, VHT20	MCS0	13.5±2.5	dBm
802.11ac, VHT20	MCS7	11.5±2.5	dBm
802.11ac, VHT40	MCS0	12.0±2.5	dBm
802.11ac, VHT40	MCS9	10.5±2.5	dBm
802.11ac, VHT80	MCS0	11.5±2.5	dBm
802.11ac, VHT80	MCS9	10.5±2.5	dBm

Table 24: Conducted RF Receiving Sensitivity at 2.4GHz

Standard	Data Rate	Typ.	Unit
802.11b	1Mbps	-92	dBm
802.11b	11Mbps	-85	dBm
802.11g	6Mbps	-88	dBm
802.11g	54Mbps	-72	dBm
802.11n, HT20	MCS0	-88.5	dBm
802.11n, HT20	MCS7	-70	dBm
802.11n, HT40	MCS0	-85	dBm
802.11n, HT40	MCS7	-67	dBm

Table 25: Conducted RF Receiving Sensitivity at 5GHz

Standard	Data Rate	Typ.	Unit
802.11a	6Mbps	-90	dBm
802.11a	54Mbps	-74	dBm
802.11ac,VHT20	MCS0	-90	dBm
802.11ac,VHT20	MCS7	-67	dBm
802.11ac, VHT40	MCS0	-87	dBm
802.11ac, VHT40	MCS9	-62	dBm
802.11ac, VHT80	MCS0	-84	dBm
802.11ac, VHT80	MCS9	-59	dBm

4.6. Electrostatic Discharge

The module is not protected against Electrostatic 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.

5 Mechanical Dimensions

This chapter describes the mechanical dimensions of FC20 series module. All dimensions are measured in mm. The tolerances for dimensions without tolerance values are $\pm 0.05\text{mm}$.

5.1. Mechanical Dimensions of the Module

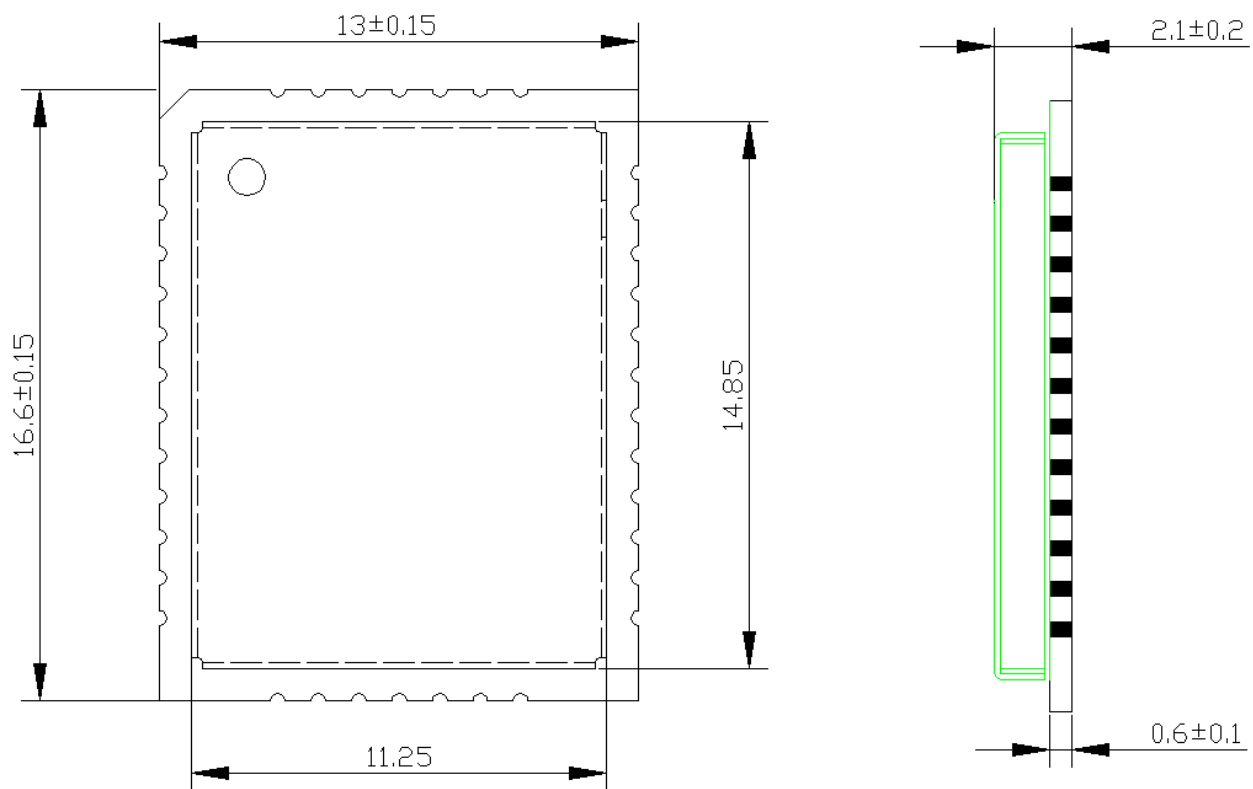


Figure 12: Top and Side Dimensions



The recommended stencil design for FC20 series is shown as below. To ensure the module soldering quality, the thickness of stencil for the module is recommended to be 0.18mm.

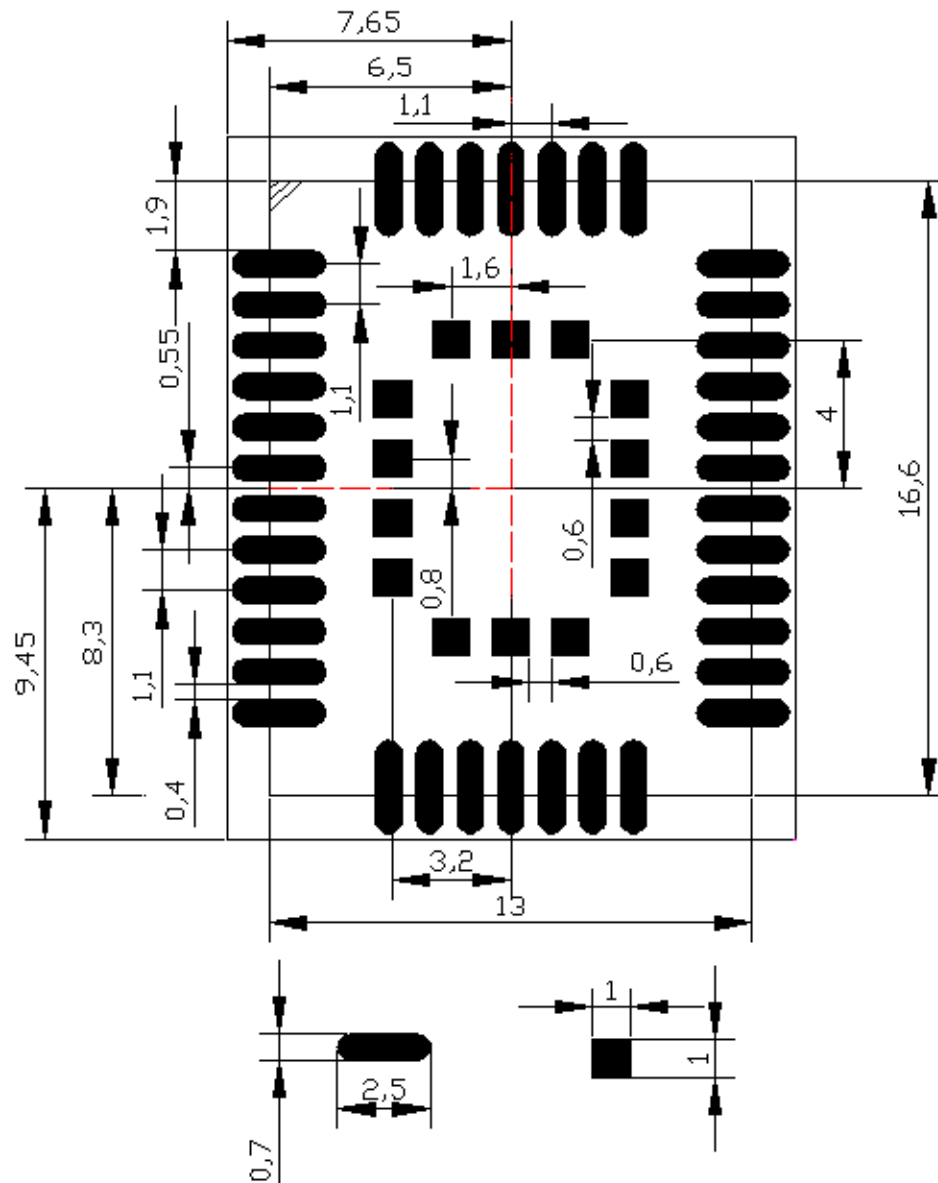


Figure 15: Recommended Stencil Design

NOTES

1. For easy maintenance of the module, please keep about 3mm between the module and other components on host PCB.
2. Keep the RESERVED pins unconnected.

5.3. Top and Bottom View of the Module



Figure 16: Top View of the Module

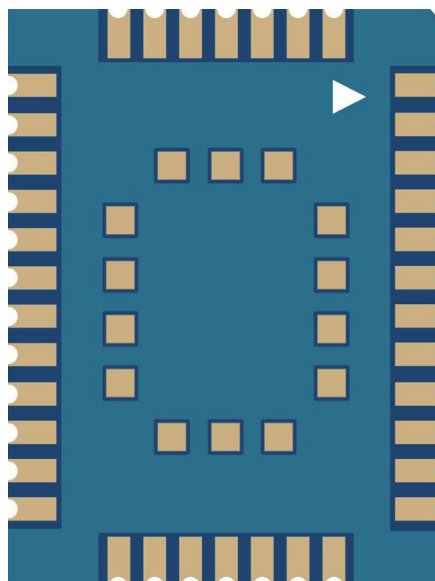


Figure 17: Bottom View of the Module

NOTE

These are design effect drawings of FC20 series module. For more accurate pictures, please refer to the module that you get from Quectel.

6 Storage, Manufacturing and Packaging

6.1. Storage

FC20 series module is stored in a vacuum-sealed bag. It is rated at MSL 3, and its storage restrictions are shown as below.

1. Shelf life in the vacuum-sealed bag: 12 months at $<40^{\circ}\text{C}$ and $<90\%\text{RH}$.
2. After the vacuum-sealed bag is opened, devices that need to be mounted directly must be:
 - Mounted within 168 hours at the factory environment of $\leq 30^{\circ}\text{C}$ and $<60\%\text{RH}$.
 - Stored at $<10\%\text{RH}$.
3. Devices require baking before mounting, if any circumstance below occurs.
 - When the ambient temperature is $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and the humidity indication card shows the humidity is $>10\%$ before opening the vacuum-sealed bag.
 - Device mounting cannot be finished within 168 hours when the ambient temperature is $<30^{\circ}\text{C}$ and the humidity is $<60\%$.
4. If baking is required, devices should be baked for 8 hours at $120^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

NOTE

As the plastic package cannot be subjected to high temperature, it should be removed from devices before high temperature (120°C) baking. If shorter baking time is desired, please refer to *IPC/JEDECJ-STD-033* for baking procedure.

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. The force on the squeegee should be adjusted properly so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil for the module is recommended to be 0.15mm~0.18mm. For more details, please refer to **document [5]**.

It is suggested that the peak reflow temperature is 240~245°C, and the absolute maximum reflow temperature is 245°C. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted 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.

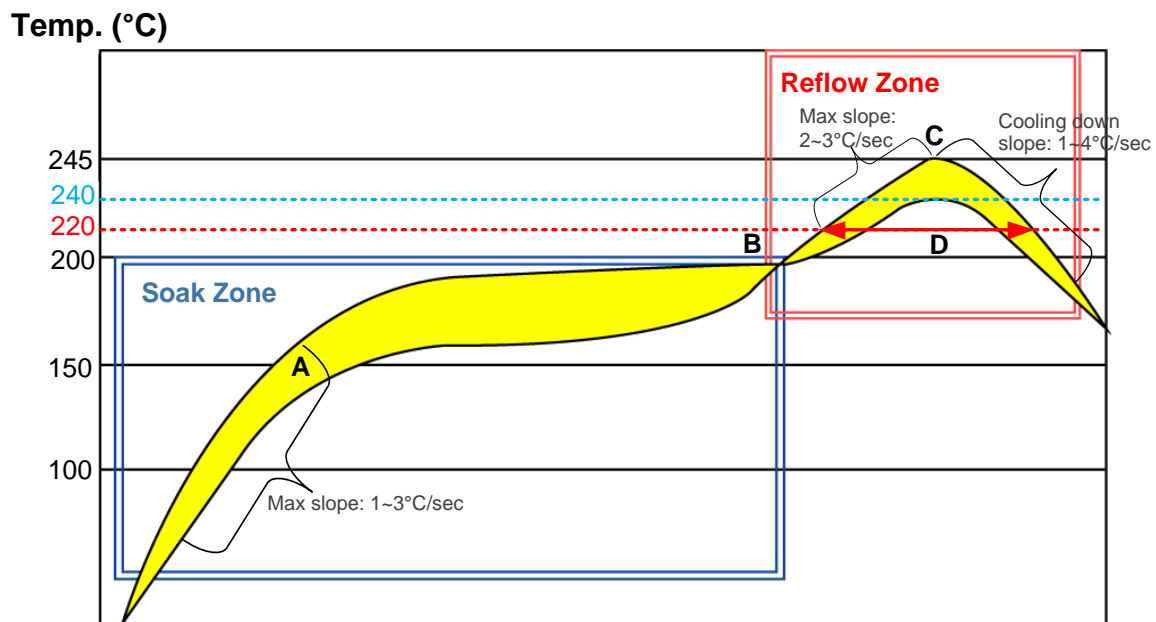


Figure 18: Recommended Reflow Soldering Thermal Profile

Table 26: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1 to 3°C/sec
Soak time (between A and B: 150°C and 200°C)	60 to 120 sec

Reflow Zone

Max slope	2 to 3°C/sec
Reflow time (D: over 220°C)	40 to 60 sec
Max temperature	240°C ~ 245°C
Cooling down slope	1 to 4°C/sec

Reflow Cycle

Max reflow cycle	1
------------------	---

NOTE

During manufacturing and soldering, or any other processes that may contact the module directly, NEVER wipe the module label with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the label information may become unclear.

6.3. Packaging

FC20 series module is packaged in a vacuum-sealed bag which is ESD protected. The bag should not be opened until the devices are ready to be soldered onto the application.

6.3.1. Tape and Reel Packaging

FC20 series module is packaged in tape and reel carriers. The figures below show the packaging details, measured in mm.

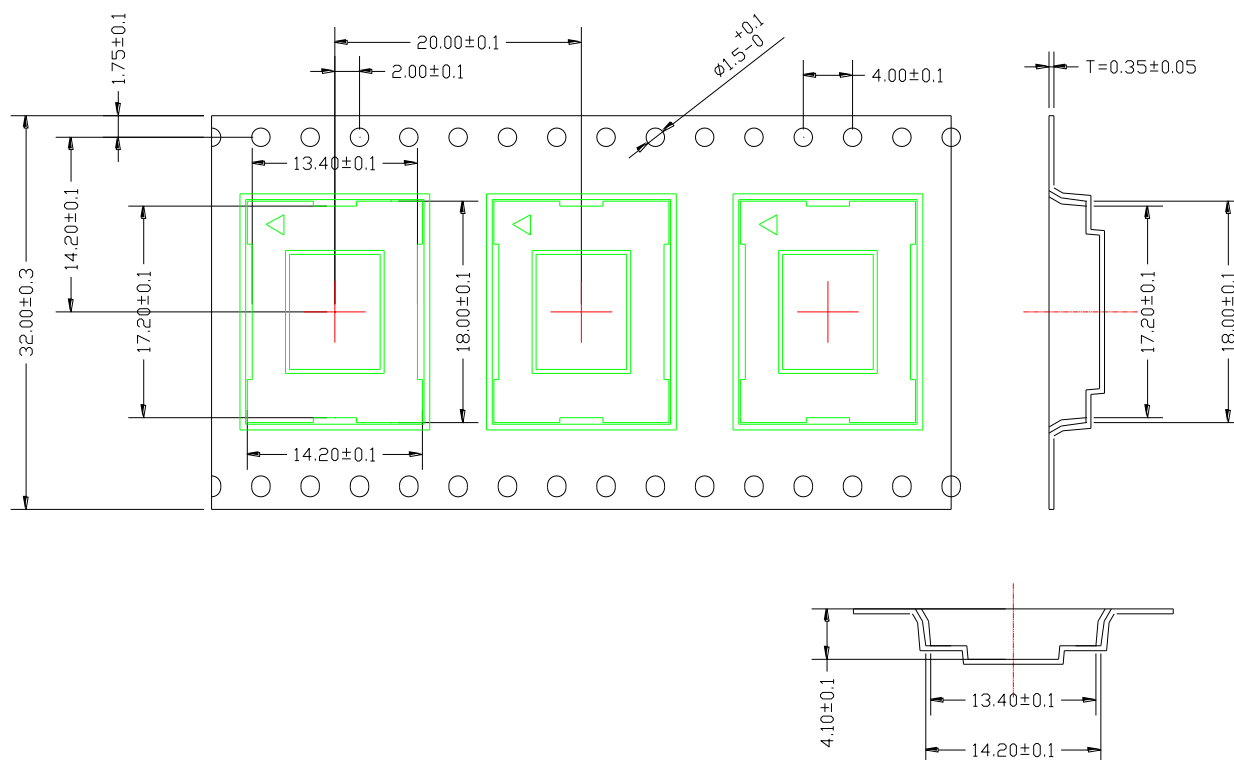


Figure 19: Tape Dimensions

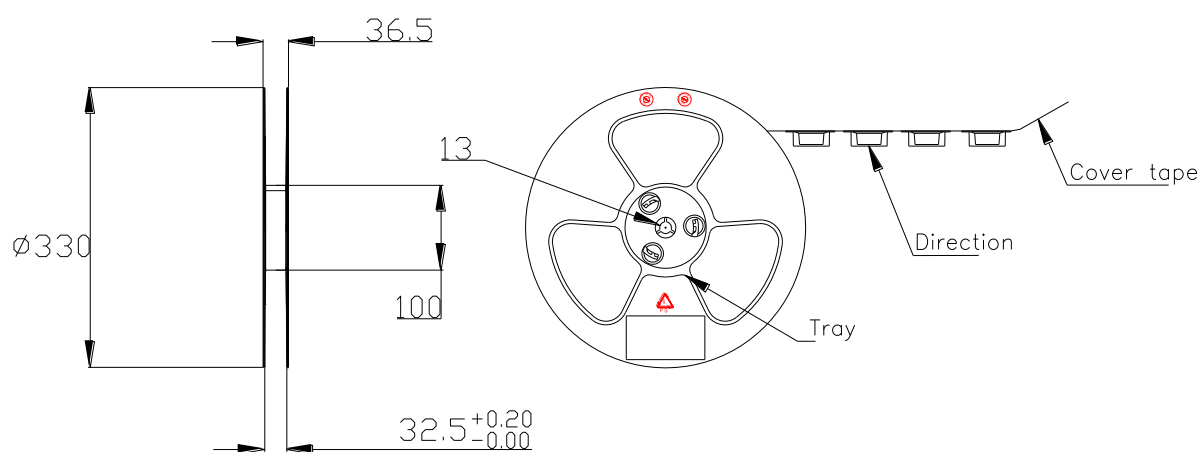


Figure 20: Reel Dimensions

Table 27: Reel Packaging

Model Name	MOQ for MP	Minimum Package: 250pcs	Minimum Package × 4=1000pcs
FC20/FC20-N	250pcs	Size: 370mm × 350mm × 56mm N.W: 0.203kg G.W: 0.945kg	Size: 380mm × 250mm × 365mm N.W: 0.81kg G.W: 4.33kg

7 Appendix A References

Table 28: Related Documents

SN	Document Name	Remark
[1]	Quectel_UMTS<E_EVB_User_Guide	EVB user guide for Quectel UMTS, LTE and FC20 series modules
[2]	Quectel_EC25_Reference_Design	EC25 reference design
[3]	Quectel_EC21_Reference_Design	EC21 reference design
[4]	Quectel_EC20_R2.1_Reference_Design	EC20 R2.1 reference design
[5]	Quectel_Module_Secondary_SMT_User_Guide	Module secondary SMT user guide

Table 29: Terms and Abbreviations

Abbreviation	Description
AP	Access Point
BPSK	Binary Phase Shift Keying
CCK	Complementary Code Keying
CTS	Clear To Send
ESD	Electrostatic Discharge
GND	Ground
HT	High Throughput
IEEE	Institute of Electrical and Electronics Engineers
I_{IL}	Input Leakage Current
I/O	Input/Output
LTE	Long Term Evolution

Mbps	Million Bits Per Second
MCS	Modulation and Coding Scheme
MOQ	Minimum Order Quantity
MP	Manufacture Product
PCB	Printed Circuit Board
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RH	Relative Humidity
RoHS	Restriction of Hazardous Substances
RX	Receive Direction
SDIO	Secure Digital Input and Output Card
TBD	To Be Determined
TX	Transmitting Direction
USB	Universal Serial Bus
VDD	Voltage Power for Digital Device
VHT	Very High Throughput
V_{IHmax}	Maximum Input High Level Voltage Value
V_{IHmin}	Minimum Input High Level Voltage Value
V_{ILmax}	Maximum Input Low Level Voltage Value
V_{ILmin}	Minimum Input Low Level Voltage Value
VIO	Voltage for Input/Output Port
V_{OLmax}	Maximum Output Low Level Voltage Value
V_{OHmin}	Minimum Output High Level Voltage Value
VSWR	Voltage Standing Wave Ratio

Wi-Fi	Wireless-Fidelity
WLAN	Wireless Local Area Networks
