eM300-8a

Hardware Design

eLTE-IoT Module Series

Rev. eM300-8a_Hardware_Design_V1.0

Date: 2017-03-17

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About the Document

History

Revision	Date	Author	Description
1.0	2017-03-17	Bryant CHEN/ Mark ZHANG	Initial

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1 Introduction

This document defines the eM300-8a module and describes its hardware interface which are connected with your application and the air interface.

This document can help you quickly understand module interface specifications, electrical and mechanical details. Associated with application note and user guide, you can use eM300-8a module to design and set up mobile applications easily.

1.1. Safety Information

The following safety precautions must be observed during all phases of the operation, such as usage, service or repair of any cellular terminal or mobile incorporating eM300-8a 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 the customer's 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. You must comply with laws and regulations restricting the use of wireless devices while driving.
	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it is switched off. The operation of wireless appliances in an aircraft is forbidden, so as to prevent interference with communication systems. Consult the airline staff about the use of wireless devices on boarding the aircraft, if your device offers an Airplane Mode which must be enabled prior to boarding an aircraft.
	Switch off your wireless device when in hospitals, clinics or other health care facilities. These requests are desinged to prevent possible interference with sensitive medical equipment.
	Cellular terminals or mobiles operating over radio frequency signal and cellular network cannot be guaranteed to connect in all conditions, for example no mobile fee or with an invalid USIM/SIM card. While you are in this condition and need emergent help, please remember using emergency call. In order to make or receive a call, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength.
	Your cellular terminal or mobile contains a transmitter and receiver. When it is ON, it receives and transmits radio frequency energy. 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.

1.2. FCC statement

1.2.1. FCC Regulations:

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

This device has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiated radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-Reorient or relocate the receiving antenna.
-Increase the separation between the equipment and receiver.
-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-Consult the dealer or an experienced radio/TV technician for help.

Caution: Changes or modifications not expressly approved by the party responsible for compliance could void the user‘s authority to operate the equipment.

1.2.2. RF Exposure Information

This device complies with FCC radiation exposure limits set forth for an uncontrolled environment. In order to avoid the possibility of exceeding the FCC radio frequency exposure limits, human proximity to the antenna shall not be less than 20cm (8 inches) during normal operation.

1.2.3. IMPORTANT NOTE:

This module is intended for OEM integrator. The OEM integrator is still responsible for the FCC compliance requirement of the end product, which integrates this module. 20cm minimum distance has to be able to be maintained between the antenna and the users for the host this module is integrated into. Under such configuration, the FCC radiation exposure limits set forth for an population/uncontrolled environment can be satisfied.

Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

1.2.4. USERS MANUAL OF THE END PRODUCT:

In the users manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the FCC radio-frequency exposure guidelines for an uncontrolled environment can be satisfied. The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment. If the

size of the end product is smaller than 8x10cm, then additional FCC part 15.19 statement is required to be available in the users manual: This device complies with Part 15 of FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

1.2.5. LABEL OF THE END PRODUCT:

The final end product must be labeled in a visible area with the following " Contains TX FCC ID: QIS201705EM300". If the size of the end product is larger than 8x10cm, then the following FCC part 15.19 statement has to also be

available on the label: This device complies with Part 15 of FCC rules.

Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

2 Product Concept

2.1. General Description

eM300-8a is designed to communicate with infrastructure equipment. The following table shows the frequency bands of eM300-8a module.

Table 1: Frequency Bands of eM300-8a Module

Mode	eM300-8a
TDD	902~928MHz

The eM300-8a is designed to support a very large number of connected terminal devices (up to 100,000 per cell), and it supports adaptive modulation coding and spreading schemes to enable a trade-off between coverage and bit rate.

With an ultra-compact profile of 19.9mm × 23.6mm × 2.2mm, the module can meet almost all the requirements for IoT applications, including smart metering, security system, industrial PDA, remote maintenance & control, etc.

eM300-8a is an SMD type module with LCC package, which can be easily embedded into applications. It provides abundant hardware interfaces such as ADC and UART interfaces.

Designed with power saving technique, the eM300-8a consumes an ultra-low current in PSM (Power Saving Mode).

The module fully complies with the RoHS directive of the European Union.

2.2. Key Features

The following table describes the detailed features of eM300-8a module.

Table 2: eM300-8a Key Features

Feature	Implementation
Power Supply	VBAT supply voltage: 3.1V ~ 4.2V Typical VBAT supply voltage: 3.6V VDD_EXT supply voltage: 1.7V ~ 3.6V[1)] Typical VDD_EXT supply voltage: 1.8V or 3.0V
Power Saving	Ultra-low sleep current
Temperature Range	● Operation temperature range: -30°C ~ +75°C[2)] ● Extended temperature range: -40°C ~ +85°C[3)]
SWD Interface	SWD port: ● Two lines on SWD port interface: SWD_CLK and SWD_DATA ● SWD port can be used for firmware upgrading
UART Interfaces	Main port: ● Three lines on main port interface ● Used for AT command communication and data transmission, and the baud rate is 9600bps ● Main port can also be used for firmware upgrading, and the baud rate is 115200bps Debug port: ● Two lines on debug port interface: DBG_TXD and DBG_RXD ● Debug port is used for debugging ● Only support 57600bps baud rate
Physical Characteristics	Size: 19.9±0.15 × 23.6±0.15 × 2.2±0.2mm Weight: Approx 1.6g
Firmware Upgrade	Firmware upgrade via SWD port or main port
Antenna Interface	Connected to antenna pad with 50 Ohm impedance control

1. [1)] The supply voltage of VDD_EXT should not be greater than that of VBAT.
2. [2)] Within operation temperature range, the module is 3GPP compliant.
3. [3)] Within extended temperature range, the module remains the ability to establish and maintain an SMS, data transmission, etc. 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 3GPP specifications again.

2.3. Functional Diagram

The following figure shows a block diagram of eM300-8a and illustrates the major functional parts.

- Radio frequency
- Power management
- Peripheral interface

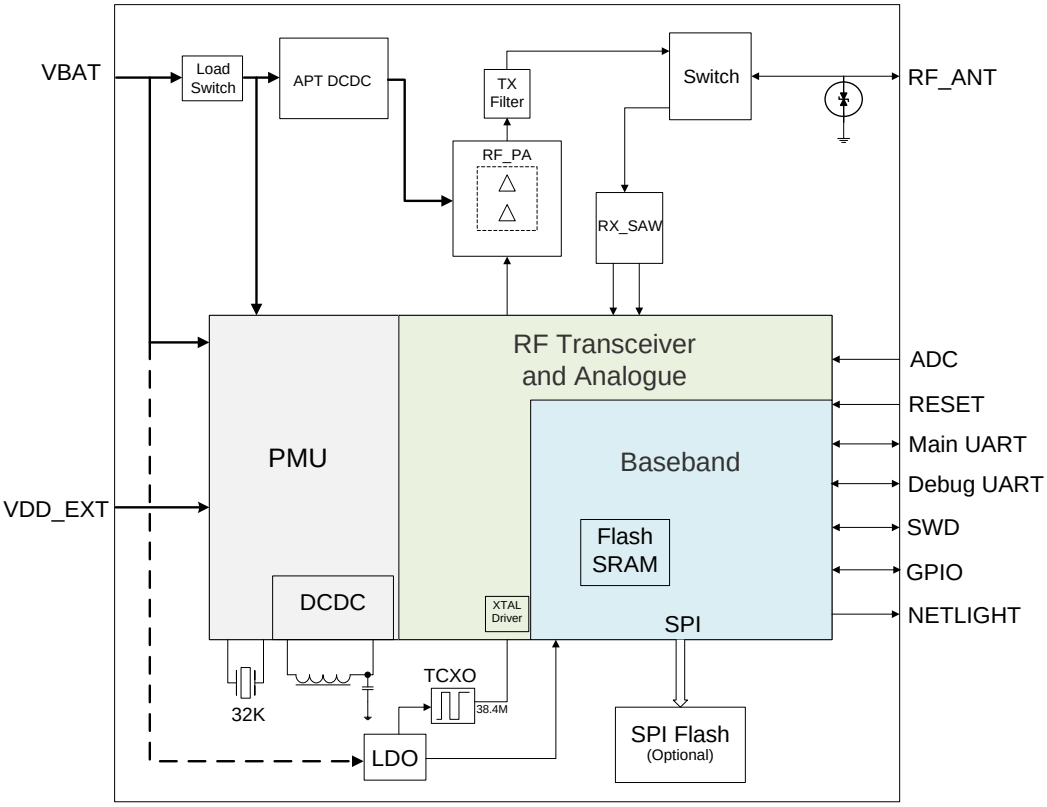

Figure 1: Functional Diagram

2.4. Evaluation Board

In order to help you to develop applications with eM300-8a, Quectel supplies the evaluation board (EVB), RS-232 to USB cable, power adapter, antenna and other peripherals to control or test the module.

3 Application Functions

3.1. General Description

eM300-8a is equipped with 54-pin 1.1mm pitch SMT pads plus 40-pin ground pads and reserved pads. The following chapters provide detailed descriptions of these pins:

- Power supply
- SWD interface
- UART interfaces
- ADC interface
- GPIO interface
- NETLIGHT
- RF interface

3.2. Pin Assignment

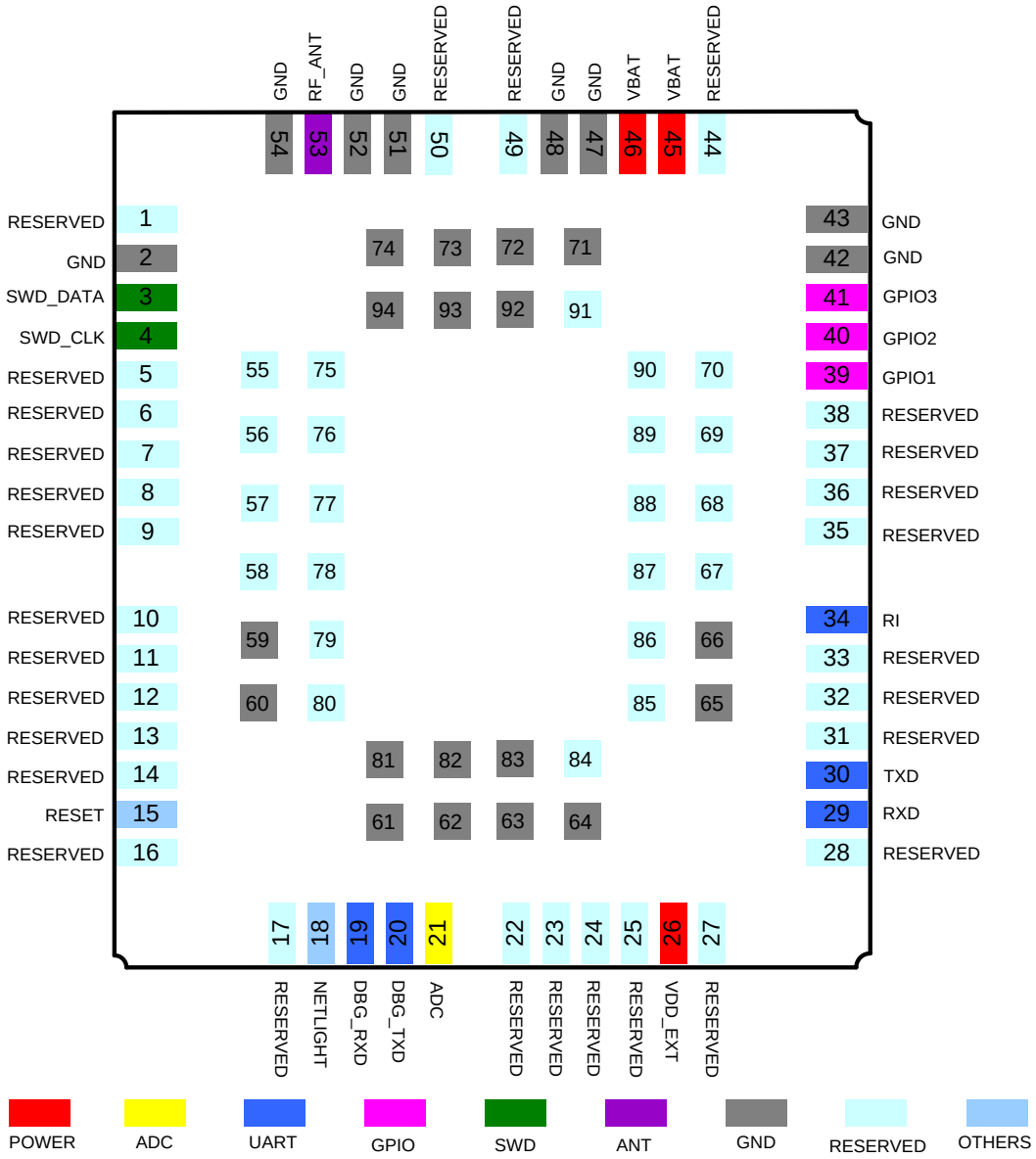

Figure 2: Pin Assignment

3.3. Pin Description

The following tables show the pin definition and description of eM300-8a.

Table 3: I/O Parameters Definition

Type	Description
IO	Bidirectional
DI	Digital input
DO	Digital output
PI	Power input
PO	Power output
AI	Analog input
AO	Analog output
OD	Open drain

Table 4: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT	45, 46	PI	Main power supply of the module: VBAT=3.1V~4.2V	Vmax=4.2V Vmin=3.1V Vnorm=3.6V	
VDD_EXT	26	PI	Power supply for module baseband part	Vmax=3.6V Vmin=1.7V Vnorm=1.8V or 3.0V	Recommend to add a 2.2~4.7uF bypass capacitor when supplying this pin.
GND	2, 42, 43, 47, 48, 51, 52, 54, 59~66, 71~74, 81~83, 92~94		Ground		

SWD Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SWD_DATA	3	IO	Serial wire data signal	V_{OL}max=0.1×VDD_EXT V_{OH}min=0.8×VDD_EXT V_{IL}min=-0.1×VDD_EXT V_{IL}max=0.2×VDD_EXT V_{IH}min=0.7×VDD_EXT V_{IH}max=1.1×VDD_EXT	Used for firmware upgrading.
SWD_CLK	4	DI	Serial wire clock signal	V_{OL}max=0.1×VDD_EXT V_{OH}min=0.8×VDD_EXT	
Reset Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET	15	DI	Reset the module	R_{PU}≈78kΩ V_{IH}max=1.1×VDD_EXT V_{IH}min=0.7×VDD_EXT V_{IL}max=0.2×VDD_EXT	Pull up internally. Active low.
Network Status Indicator					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
NETLIGHT	18	DO	Network status indication	V_{OL}max=0.1×VDD_EXT V_{OH}min=0.8×VDD_EXT	If unused, keep this pin open.
ADC interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC	21	AI	General purpose analog to digital converter	Input voltage range: 0V to VBAT	If unused, keep this pin open.

UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RXD	29	DI	Receive data	V_{IL}max=0.2×VDD_EXT V_{IH}min=0.7×VDD_EXT V_{IH}max=1.1×VDD_EXT	VDD_EXT power domain.
TXD	30	DO	Transmit data	V_{OL}max=0.1×VDD_EXT V_{OH}min=0.8×VDD_EXT	VDD_EXT power domain.
RI	34	DO	Ring indicator	V_{OL}max=0.1×VDD_EXT V_{OH}min=0.8×VDD_EXT	VDD_EXT power domain. If unused, keep this pin open.
Debug Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
DBG_RXD	19	DI	Receive data	V_{IL}max=0.2×VDD_EXT V_{IH}min=0.7×VDD_EXT V_{IH}max=1.1×VDD_EXT	If unused, keep these pins open.
DBG_TXD	20	DO	Transmit data	V_{OL}max=0.1×VDD_EXT V_{OH}min=0.8×VDD_EXT	If unused, keep these pins open.
GPIO Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GPIO1	39	IO	Digital programmable input/output	V_{OL}max=0.1×VDD_EXT V_{OH}min=0.8×VDD_EXT V_{IL}min=-0.1×VDD_EXT V_{IL}max=0.2×VDD_EXT V_{IH}min=0.7×VDD_EXT	If unused, keep these pins open.
GPIO2	40	IO	Digital programmable input/output		
GPIO3	41	IO	Digital programmable input/output		

				V_{IH}max=1.1×VDD_EXT	
RF Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RF_ANT	53	IO	RF antenna pad	Impedance of 50Ω	
RESERVED Pins					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESERVED	1, 5~14, 16, 17, 22, 23, 24, 25, 27, 28, 31~33, 35~38, 44, 49, 50, 55~58, 67~70, 75~80, 84~91		Reserved		Keep these pins unconnected.

3.4. Operating Modes

eM300-8a module has three operating modes, which can determine availability of functions for different levels of power-saving.

Table 5: Overview of Operating Modes

Mode	Function	
Normal Operation	Active	In active mode, all functions of the module are available and all processors are active. Radio transmission and reception can be performed. Transitions to idle mode and PSM can only be initiated in Active mode.
	Idle	In idle mode, all processors are inactive, but all peripherals can be active. The system clock is active and power consumption is reduced via clock gating and power gating. Idle mode is entered

		when all processors are executing a wait-for-interrupt (WFI) instruction.
	PSM	In PSM, only the 32kHz RTC is working, which means the module can be moved to active mode by an RTC interrupt or by an external event through the peripherals that are using the RTC. This mode is entered by all processors setting the “sleep-deep” bit and then executing a WFI instruction.

3.5. Power Supply

3.5.1. Power Supply Pins

eM300-8a provides two VBAT pins and one VDD_EXT pin dedicated for connection with the external power supply. The supply voltage of VDD EXT should not be greater than the VBAT voltage.

The following table shows the VBAT, VDD_EXT and ground pins.

Table 6: VBAT, VDD_EXT and GND Pins

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VBAT	45, 46	Main power supply of the module	3.1	3.6	4.2	V
VDD_EXT	26	Power supply for module baseband part	1.7	1.8/3.0	3.6	V
GND	2, 42, 43, 47, 48, 51, 52, 54, 59~66, 71~74, 81~83, 92~94	Ground	-	0	-	V

3.5.2. Reference Design for Power Supply

The power design for the module is very important, as the performance of the module largely depends on the power source. The VBAT power supply is capable of providing the sufficient current up to 0.5A at least. The VBAT power supply range is from 3.1V to 4.2V and the VDD_EXT supports 1.7V to 3.6V power supply. Make sure that the input voltage of the VBAT will never drop below 3.1V even in burst transmission. If the VBAT power voltage drops below 3.1V, the module will be abnormal.

For better power performance, it is recommended to place a 100uF tantalum capacitor with low ESR (ESR=0.7Ω) and three ceramic capacitors with 100nF, 100pF and 22pF near the VBAT pin. In order to increase the number of external power supply interfaces, it is better to use an LDO regulator to supply

power for VDD_EXT. It is also recommended to place a ceramic capacitor with 4.7uF near VDD_EXT pin. The reference circuit is illustrated in the following figure.

The trace width of VBAT and VDD_EXT should be designed as wide as possible. In principle, the longer the trace is, the wider it will be.

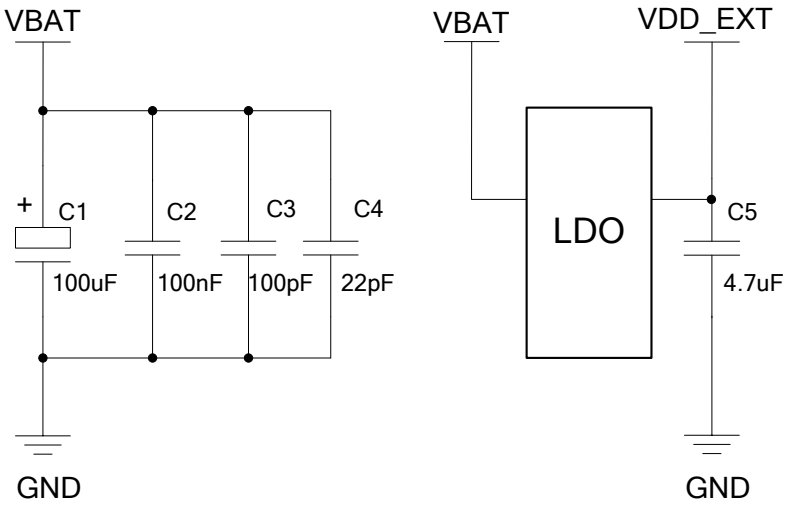

Figure 3: Reference Circuit for the VBAT and VDD_EXT Input

3.6. Power on and down Scenarios

3.6.1. Power on

The module can be automatically turned on by supplying power source to VBAT pins.

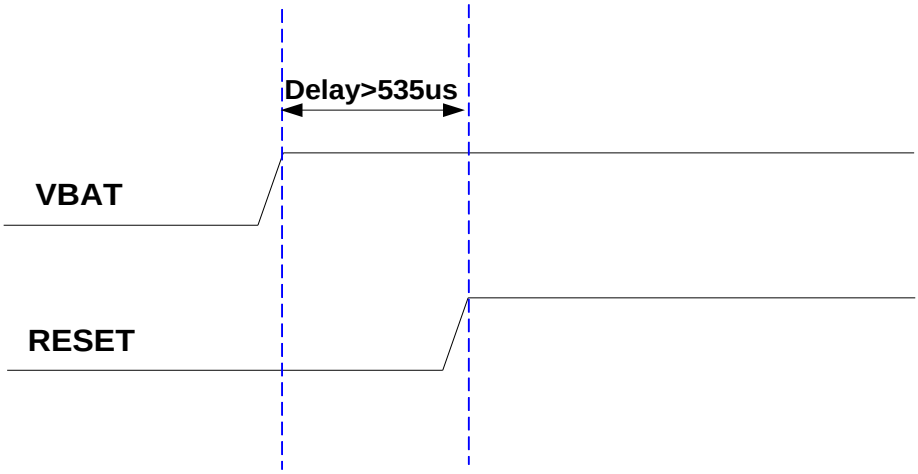

Figure 4: Turn-on Timing

3.6.2. Power down

The module can be turned off by shutting down the VBAT power supply.

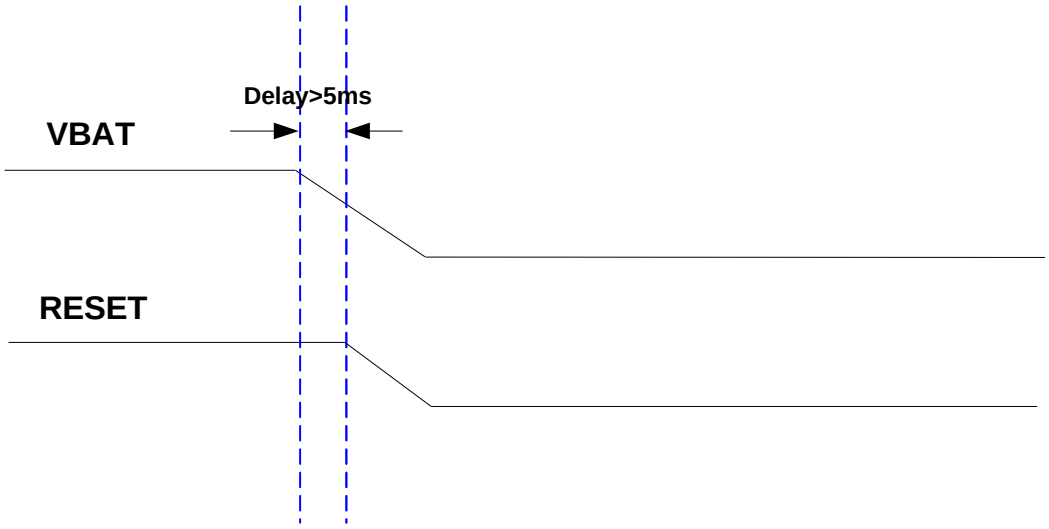

Figure 5: Turn-off Timing

3.6.3. Reset the Module

The module can be reset by driving the reset pin to a low level voltage for a certain time. The reset timing is illustrated as the following table.

Table 7: Reset Characteristics

Pin Name	Pin No.	Description	Reset Time
RESET	15	Reset the module, low active	>100ms

The recommended circuit is shown as below. You can use open drain/collector driver or button to control the RESET.

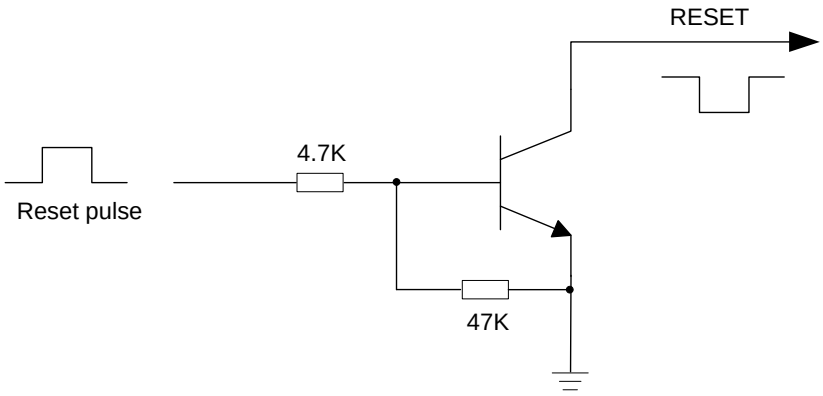

Figure 6: Reference Circuit of RESET by Using Driving Circuit

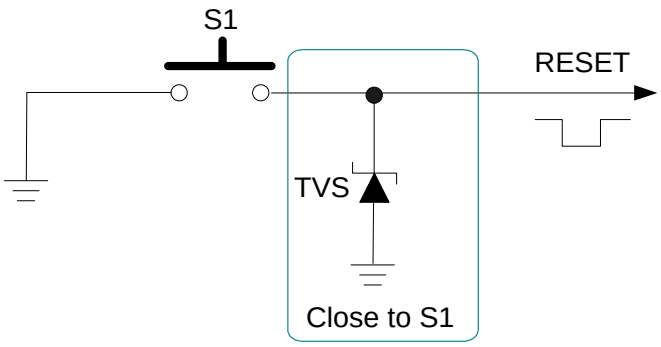

Figure 7: Reference Circuit of RESET by Using Button

3.7. SWD Interface

The module provides one SWD (Serial Wire Debug) interface for firmware upgrading. It is recommended to reserve SWD interface in order to upgrade firmware.

Table 8: Pin Definition of SWD Interfaces

Interfaces	Pin Name	Pin No.	Description
SWD	SWD_DATA	3	Serial wire data signal
SWD	SWD_CLK	4	Serial wire clock signal

The following figure is a reference design for SWD interface.

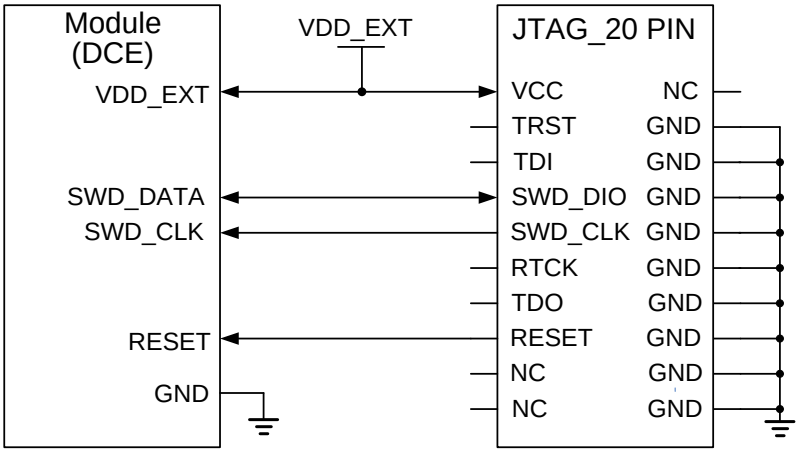

Figure 8: Reference Design for SWD Interface

3.8. UART Interfaces

The module provides two UART ports: main port and debug port. The module is designed as a DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection.

The main port:

- TXD: Send data to RXD of DTE.
- RXD: Receive data from TXD of DTE.
- RI: Ring indicator (when an SMS is received or data is transmitted, the module will output signals to inform DTE).

The debug port:

- DBG_TXD: Send data to the COM port of computer.
- DBG_RXD: Receive data from the COM port of computer.

The logic levels are described in the following table.

Table 9: Pin Definition of the UART Interfaces

Interfaces	Pin No.	Pin Name	Description	Comment
Debug Port	19	DBG_RXD	Receive data	VDD_EXT power domain

	20	DBG_TXD	Transmit data	VDD_EXT power domain
Main Port	29	RXD	Receive data	VDD_EXT power domain
	30	TXD	Transmit data	VDD_EXT power domain
	34	RI	Ring indicator	VDD_EXT power domain

Table 10: Logic Levels of the UART Interfaces

Parameter	Min.	Max.	Unit
V_{IL}	-0.1×VDD_EXT	0.2×VDD_EXT	V
V_{IH}	0.7×VDD_EXT	1.1×VDD_EXT	V
V_{OL}		0.1×VDD_EXT	V
V_{OH}	0.8×VDD_EXT	VDD_EXT	V

3.8.1. Main Port

Main port can be used for AT command communication and data transmission, and the baud rate is 9600bps. It can also be used for firmware upgrading, and the baud rate is 115200bps.

The following figure shows the connection between the DCE and DTE.

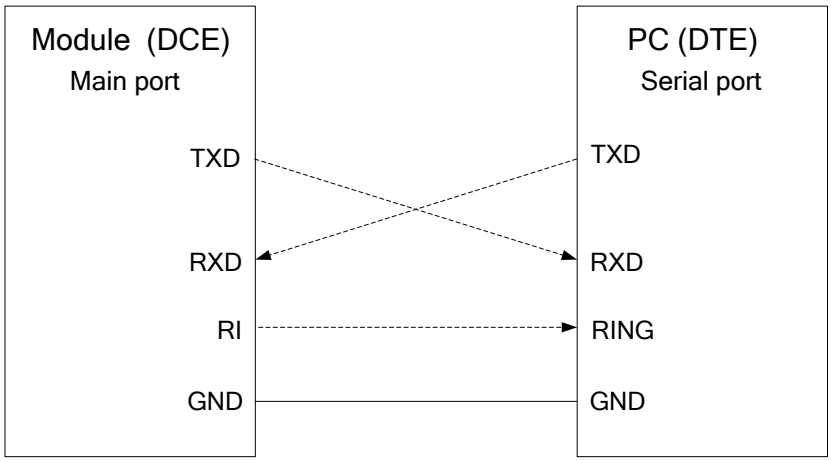

Figure 9: Reference Design for Main Port

3.8.2. Debug Port

Debug port can only be used to view log information with UE Log Viewer tool for debugging. The baud rate is 57600bps.

A reference design for debug port is shown as below.

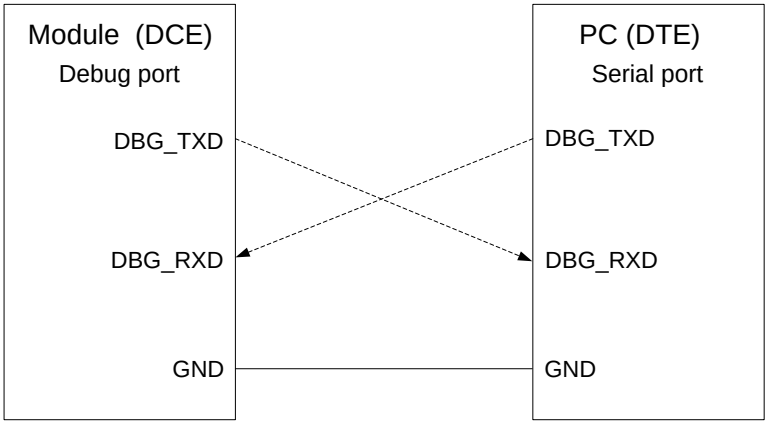

Figure 10: Reference Design for Debug Port

3.8.3. The UART Application

When the supply voltage of VDD_EXT is 3.0V, the reference design of 3.3V level match is shown as below.

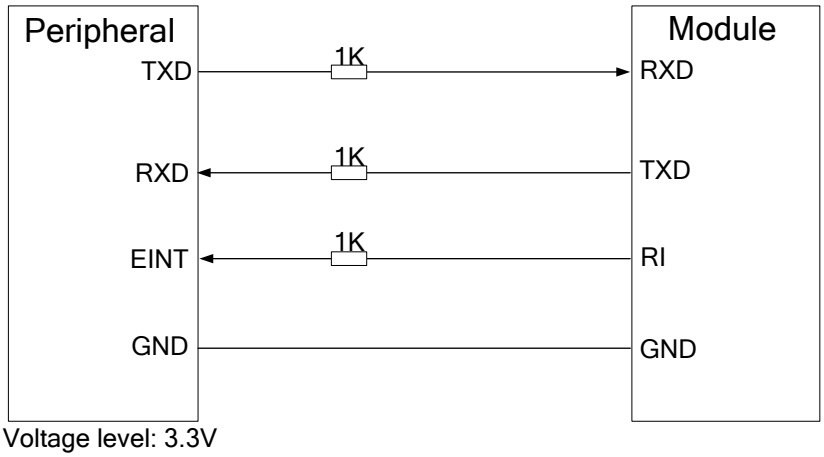

Figure 11: Level Match Design for 3.3V System

In order to reduce the power consumption of the system, it is highly recommended to add a resistor circuit on the UART port signal lines when the host's voltage level is 3.3V. For systems with a higher voltage level, a level shifter IC could be used between the host and the module.

The following circuit shows a reference design for the communication between module and PC. As the electrical level of module is 3.0V, a RS-232 level shifter must be used. Please make sure the I/O voltage of level shifter which connects to module is 3.0V.

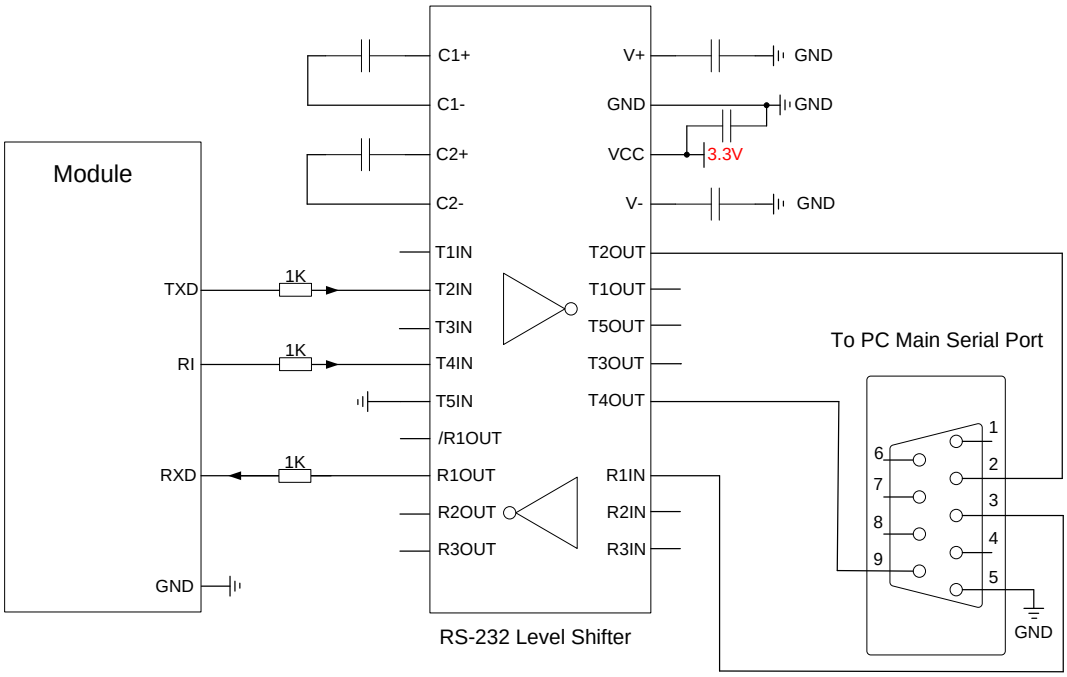

Figure 12: Sketch Map for RS-232 Interface Match

Please visit vendor web site to select the suitable RS-232 level shifter IC, such as: http://www.exar.com/ and http://www.maximintegrated.com.

3.9. ADC Interface*

The module provides a 10-bit ADC input channel to measure the value of voltage. This ADC is available in active mode and idle mode.

Table 11: Pin Definition of the ADC

Name	Pin No.	Description
ADC	21	Analog to digital converter

"*" means under development.

3.10. GPIO Interface

The module contains three GPIO pins which are controlled through software. The GPIO pins are controlled by the VDD_EXT power domain.

Table 12: Pin Definition of the GPIO interface

Name	Pin No.	Description
GPIO1	39	Digital programmable input/output
GPIO2	40	Digital programmable input/output
GPIO3	41	Digital programmable input/output

The GPIO pins are available in active, idle and power saving modes. In active and idle modes, data is sampled and synchronized to the system clock, and interrupts are generated synchronously. In PSM, data is sampled and synchronized to the RTC clock, and interrupts are generated asynchronously. In all the three modes, interrupts can be configured to trigger on rising-edge, falling-edge, high-level or low-level. The GPIO pins can be configured for high drive strength or low drive strength (default) and have optional pull-down resistors.

3.11. Behaviors of the RI*

Table 13: Behaviors of the RI

State	RI Response
Idle	HIGH
SMS*	When an SMS is received, the RI is changed to LOW and kept at low level for about 120ms. Then it is changed to HIGH.
URC	Certain URCs can trigger RI to LOW for 120ms. Then it is changed to HIGH.

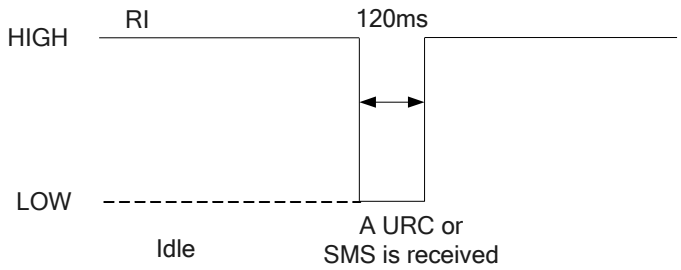

Figure 13: Behaviors of RI When a URC or SMS is Received

"*" means under development.

3.12. Network Status Indication*

The NETLIGHT signal can be used to drive a network status indicator LED. The working state of this pin is listed in the following table.

Table 14: Working State of the NETLIGHT

State	Module Function
Low	The module is not working or not synchronized with network.
High	The module is synchronized with network.

A reference circuit is shown as below.

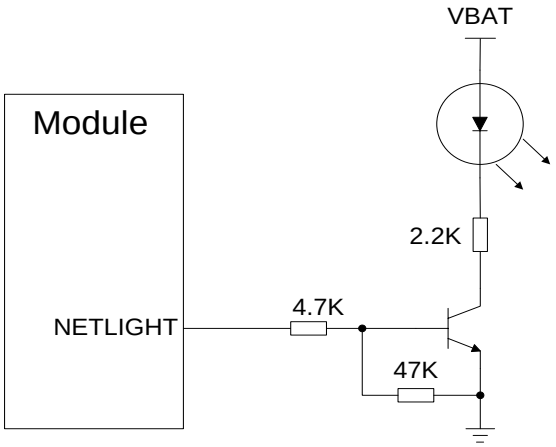

Figure 14: Reference Design for NETLIGHT

"*" means under development.

4 Antenna Interface

The pin 53 is the RF antenna pad. The RF interface has an impedance of 50Ω.

Table 15: Pin Definition of the RF_ANT

Name	Pin	Description
GND	51	Ground
GND	52	Ground
RF_ANT	53	RF antenna pad
GND	54	Ground

4.1. RF Reference Design

A reference design for RF is shown as below.

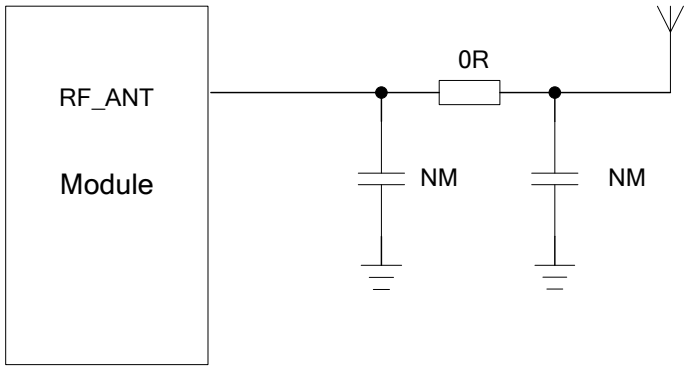

Figure 15: Reference Design for RF

eM300-8a provides an RF antenna pad for antenna connection. There is one grounding pad on both sides of the antenna pad in order to give a better grounding. Besides, a π-type match circuit is suggested to be used to adjust the RF performance, and place the π-type matching components as close to the antenna as possible.

4.2. Reference Design of RF Layout

For user's PCB, the characteristic impedance of all RF traces should be controlled as 50 ohm. The impedance of the RF traces is usually determined by the trace width (W), the materials' dielectric constant, the distance between signal layer and reference ground (H), and the clearance between RF trace and ground (S). Microstrip line or coplanar waveguide line is typically used in RF layout for characteristic impedance control. The following are reference designs of microstrip line or coplanar waveguide line with different PCB structures.

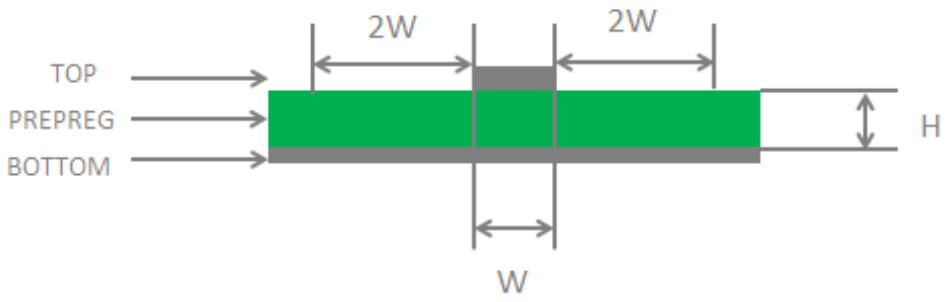

Figure 16: Microstrip Line Design on a 2-layer PCB

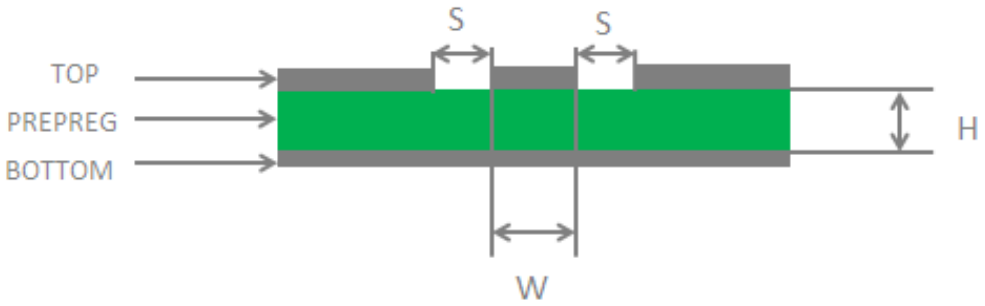

Figure 17: Coplanar Waveguide Line Design on a 2-layer PCB

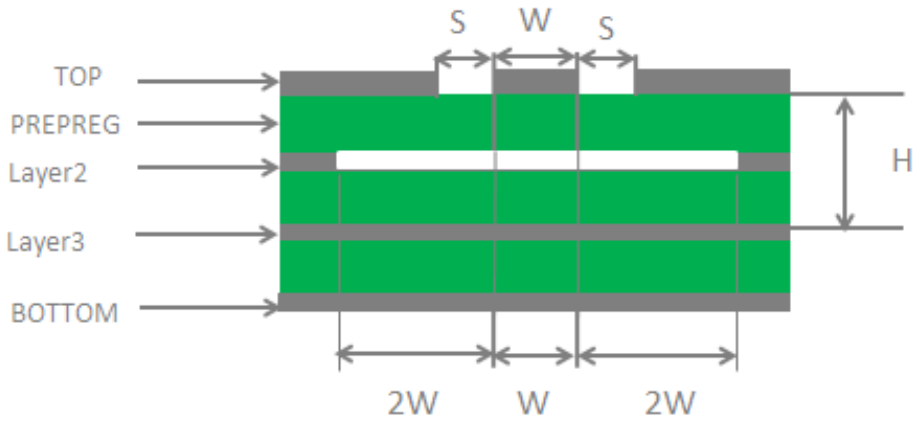

Figure 18: Coplanar Waveguide Line Design on a 4-layer PCB (Layer 3 as Reference Ground)

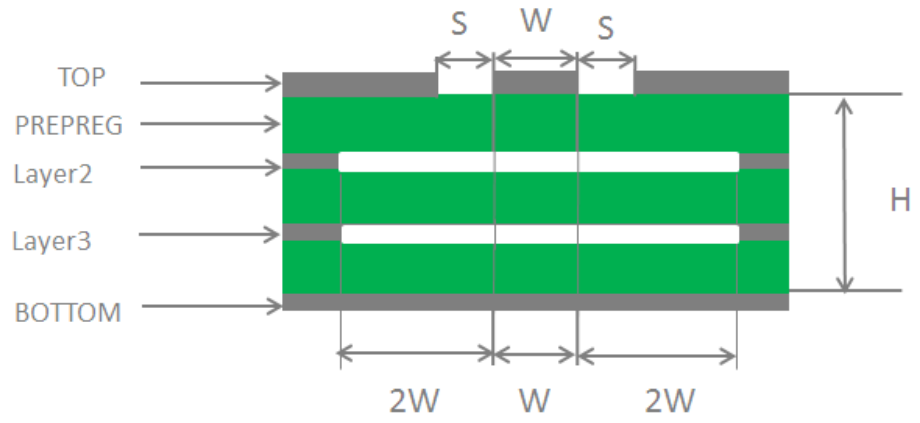

Figure 19: Coplanar Waveguide Line Design on a 4-layer PCB (Layer 4 as Reference Ground)

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

- Use impedance simulation tool to control the characteristic impedance of RF traces as 50 ohm.
- The GND pins adjacent to RF pins should not be hot welded, 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.
- There should be clearance area 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).

For more details about RF layout, please refer to ***document [2]***.

4.3. RF Receiving Sensitivity

Table 16: RF Receiving Sensitivity (MCS-1, BLER <10%)

Frequency	Receive Sensitivity
902~928MHz	-140dBm
863~870MHz	-140dBm

4.4. Antenna Requirement

The following table shows the requirement on eLTE-IoT antenna.

Table 17: Antenna Cable Requirement

Frequency Range	Requirement
863-928MHz	Insertion Loss: <1dB

Table 18: Antenna Requirements

Type	Requirements
Frequency Range	863-928MHz
VSWR	≤2
Gain (dBi)	≤4
Max Input Power (W)	5
Input Impedance (Ω)	50
Polarization Type	linear

4.5. RF Cable Welding

Welding the RF cable to RF pad of module correctly will reduce the loss on the path of RF, please refer to the following example of RF cable welding.

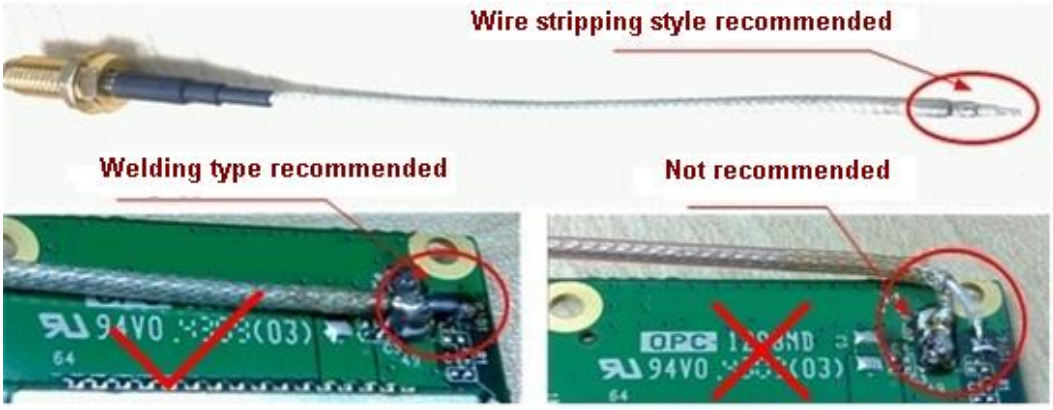

Figure 20: Recommended RF Cable Welding

5 Electrical, Reliability and Radio Characteristics

5.1. Absolute Maximum Ratings

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

Table 19: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT	-0.3	+4.2	V
VDD_EXT	-0.3	+3.6	V
Current of Power Supply	0	0.3	A
Voltage at Digital Pins	-0.3	+3.3	V
Voltage at Analog Pins	-0.3	+4.2	V
Voltage at Digital/Analog Pins in Power Down Mode	-0.25	+0.25	V

5.2. Operating Temperature

The operating temperature is listed in the following table:

Table 20: Operating Temperature

Parameter	Min.	Typ.	Max.	Unit
Operation Temperature Range[1)]	-30	+25	+75	ºC
Extended Operation Range[2)]	-40		+85	ºC

1. [1)] Within operation temperature range, the module is 3GPP compliant.
2. [2)] Within extended temperature range, the module remains the ability to establish and maintain an SMS, data transmission, etc. 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 Pout might reduce in their value and exceed the specified tolerances. When the temperature returns to the normal operating temperature levels, the module will meet 3GPP specifications again.

5.3. Current Consumption

The values of current consumption are shown below.

Table 21: Current Consumption

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
I_{VBAT}	PSM	Deep sleep state	-	-	-	uA
	Idle mode	Standby state		6		mA
	Active mode	Radio transmission (23dBm)		250		mA
		Radio reception		86		mA

6 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module.

6.1. Mechanical Dimensions of the Module

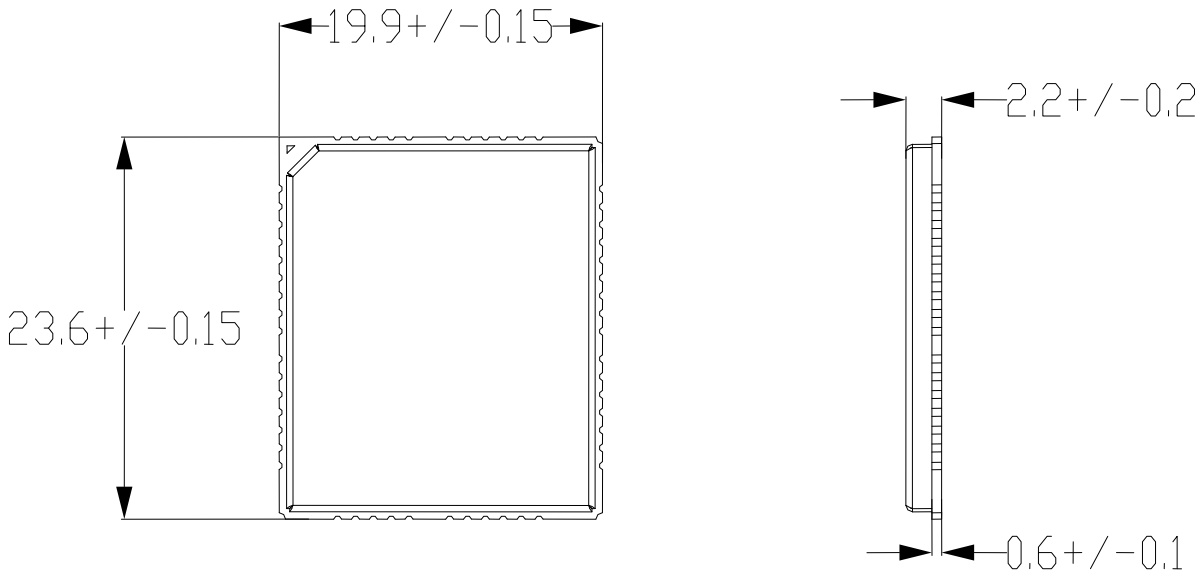

Figure 21: Top and Side Dimensions of eM300-8a Module (Unit: mm)

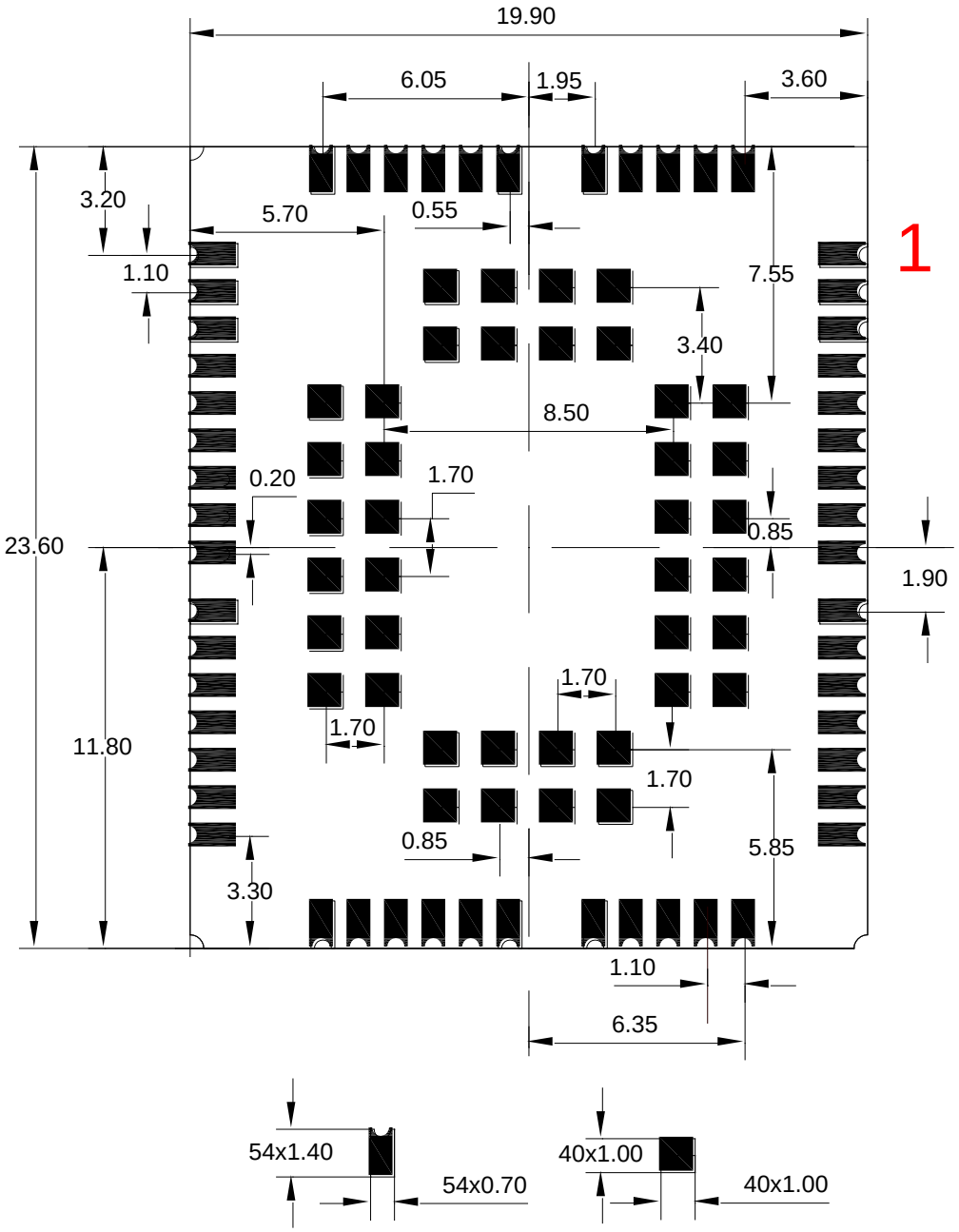

Figure 22: Bottom Dimensions of eM300-8a Module (Unit: mm)

6.2. Recommended Footprint

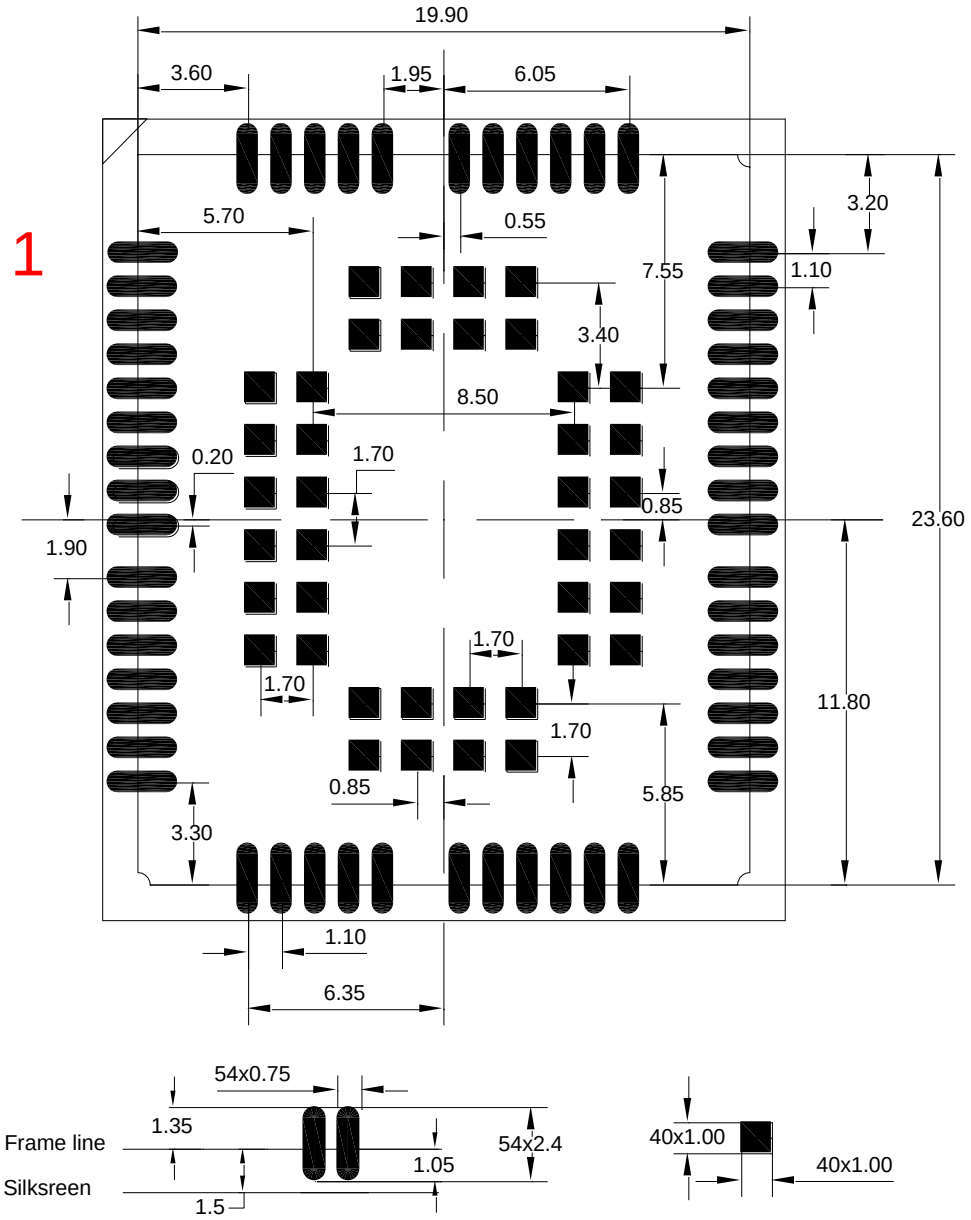

Figure 23: Recommended Footprint (Unit: mm)

1. For easy maintenance of the module, please keep about 3mm between the module and other components in the host PCB.
2. All RESERVED pins must not be connected to GND.
3. All dimensions are in millimeters.

7 Storage, Manufacturing and Packaging

7.1. Storage

eM300-8a module is stored in a vacuum-sealed bag. The storage restrictions are shown as below.

1. Shelf life in the vacuum-sealed bag: 12 months at <40ºC/90%RH.

2. After the vacuum-sealed bag is opened, devices that will be subjected to reflow soldering or other high temperature processes must be:

- Mounted within 72 hours at the factory environment of ≤30ºC/60% RH.
- Stored at <10% RH.

3. Devices require baking before mounting, if any circumstance below occurs:

- When the ambient temperature is 23ºC±5ºC, humidity indication card shows the humidity is >10% before opening the vacuum-sealed bag.
- Device mounting cannot be finished within 72 hours at factory conditions of ≤30ºC/60%

4. If baking is required, devices may be baked for 48 hours at 125ºC±5ºC.

As the plastic container cannot be subjected to high temperature, it should be removed from devices before high temperature (125ºC) baking. If shorter baking time is desired, please refer to the IPC/JEDECJ-STD-033 for baking procedure.

7.2. 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 pads at the bottom of the module should be 0.15mm. For more details, please refer to ***document [1]***.

It is suggested that the peak reflow temperature is 235 ~ 245ºC (for SnAg3.0Cu0.5 alloy). The absolute max reflow temperature is 260ºC. To avoid damage to the module when it is repeatedly heated, it is suggested that the module should be mounted after reflow soldering for the other side of PCB has been completed. Recommended reflow soldering thermal profile is shown below.

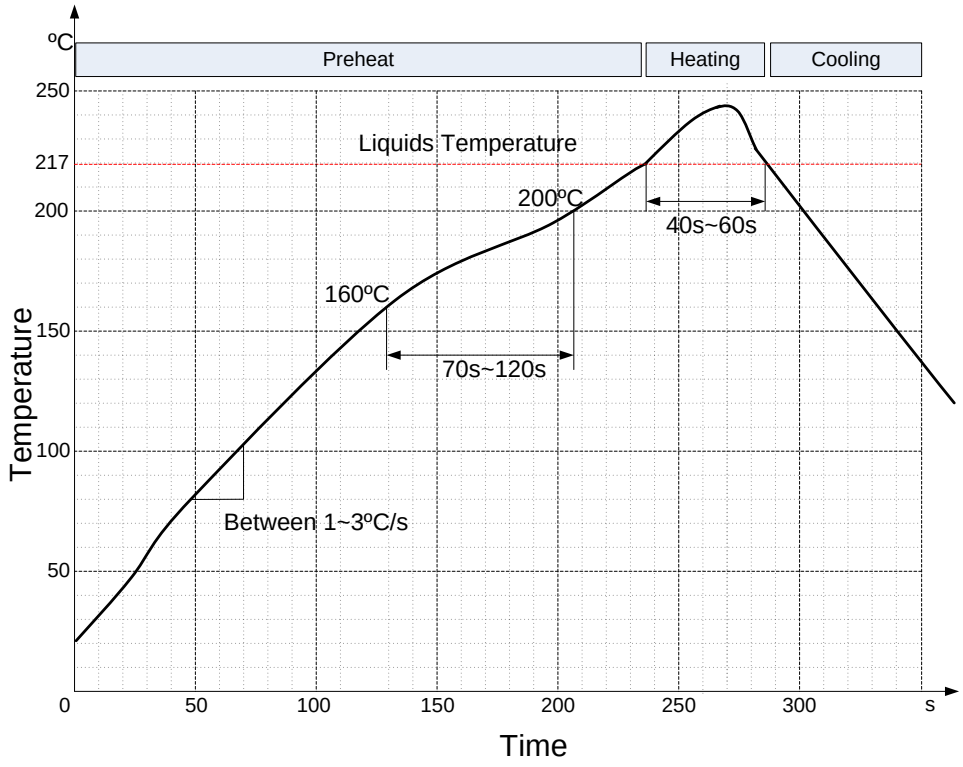

Figure 24: Reflow Soldering Thermal Profile

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.

7.3. Packaging

The modules are stored inside a vacuum-sealed bag which is ESD protected. It should not be opened until the devices are ready to be soldered onto the application.

7.3.1. Tape and Reel Packaging

The reel is 330mm in diameter and each reel contains 250 modules.

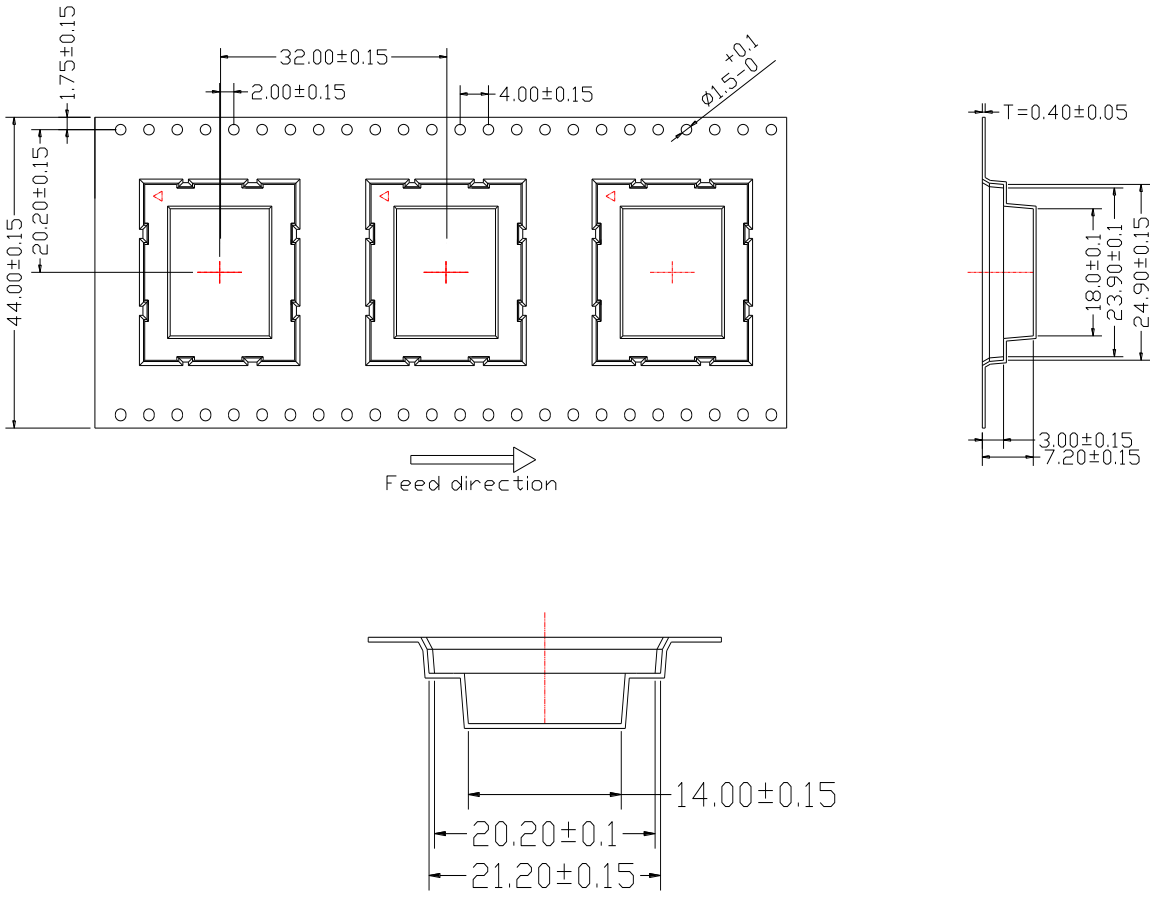

Figure 25: Tape Dimensions

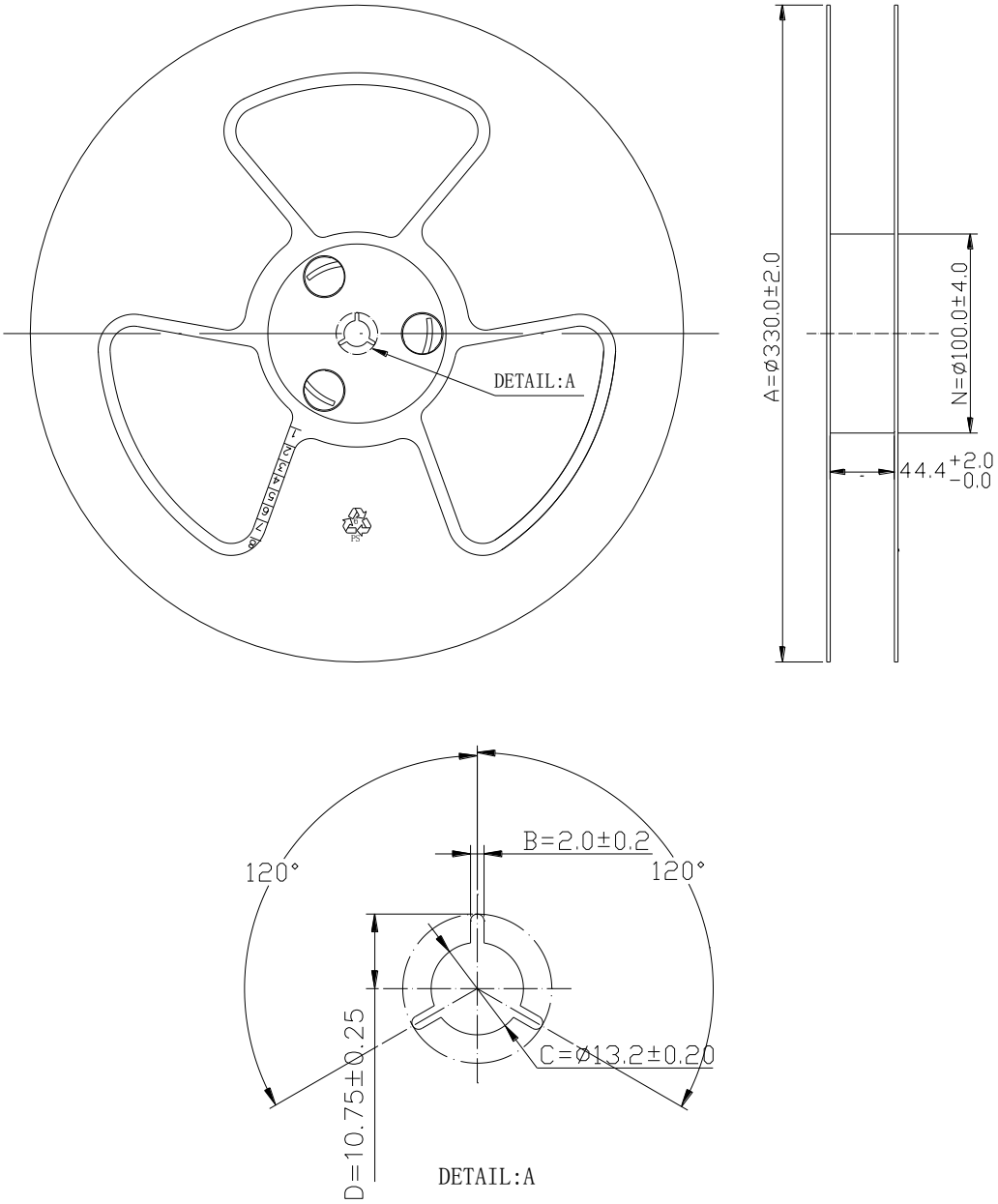

Figure 26: Reel Dimensions

8 Appendix A Reference

Table 22: Related Documents

SN	Document Name	Remark
[1]	Quectel_Module_Secondary_SMT_User_Guide	Module Secondary SMT User Guide
[2]	Quectel_RF_Layout_Application_Note	RF Layout Application Note

Table 23: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
DCE	Data Communications Equipment (typically module)
DTE	Data Terminal Equipment (typically computer, external controller)
eLTE-IoT	Evolved Long Term Evolution Internet of Things
I/O	Input/Output
IC	Integrated Circuit
Imax	Maximum Load Current
Inorm	Normal Current
kbps	Kilo Bits Per Second
LED	Light Emitting Diode
PCB	Printed Circuit Board
PSM	Power Saving Mode
RF	Radio Frequency

RMS	Root Mean Square (value)
RoHS	Restriction of Hazardous Substances
RTC	Real Time Clock
RX	Receive Direction
USIM	Universal Subscriber Identification Module
SMS	Short Message Service
TE	Terminal Equipment
TX	Transmitting Direction
UART	Universal Asynchronous Receiver & Transmitter
URC	Unsolicited Result Code
VSWR	Voltage Standing Wave Ratio
Vmax	Maximum Voltage Value
Vnorm	Normal Voltage Value
Vmin	Minimum Voltage Value
VIHmax	Maximum Input High Level Voltage Value
VIHmin	Minimum Input High Level Voltage Value
VILmax	Maximum Input Low Level Voltage Value
VILmin	Minimum Input Low Level Voltage Value
VImax	Absolute Maximum Input Voltage Value
VImin	Absolute Minimum Input Voltage Value
VOHmax	Maximum Output High Level Voltage Value
VOHmin	Minimum Output High Level Voltage Value
VOLmax	Maximum Output Low Level Voltage Value
VOLmin	Minimum Output Low Level Voltage Value