

UC20 Hardware Design

UMTS/HSPA Module Series

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About the Document

History

Revision	Date	Author	Description
1.0	2013-07-17	Mountain ZHOU	Initial
1.1	2013-08-29	Mountain ZHOU	<ol style="list-style-type: none"> 1. Updated USB driver information. 2. Added GNSS contents in Chapter 4. 3. Added GNSS current consumption. 4. Updated GNSS antenna requirements. 5. Released USIM_PRESENCE function.
1.2	2014-01-21	Mountain ZHOU	<ol style="list-style-type: none"> 1. Added UC20-G information. 2. Added AMR-WB feature. 3. Added USB upgrade test points' diagram. 4. Added reference design of transistor circuit on UART interface. 5. Deleted debug function of Debug UART interface. 6. Released AP_READY, main UART upgrade function and Rx-diversity function. 7. Modified UC20-A frequency bands. 8. Modified W_DISABLE# definition. 9. Modified GNSS sensitivity definition. 10. Modified turning on timing figure. 11. Added power saving methods in Sleep Mode in Chapter 3.5.1. 12. Updated airplane mode in Chapter 3.5.2. 13. Updated I2C pins definition. 14. Updated current consumption.
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			Chapter 3.16.2.
			4. Updated power circuit of Figure 6.
			5. Updated current consumption.
			1. Updated internet protocol features and USB driver.
			2. Updated VBAT input voltage range.
			3. Updated Chapter 3.6.2, and added VBAT drop figure.
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			5. Updated current consumption.
			6. Updated recommended footprint in Chapter 7.2.
			7. Deleted description of UART autobauding.
			8. Deleted Chapter of USIM connector.
			9. Changed TXB0108 chip to TXS0108 chip.

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1 Introduction

This document defines the UC20 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 notes and user guide, you can use UC20 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 UC20 module. Manufacturers of the cellular terminal should send the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. If not so, Quectel does not take on any liability for customer 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) cause 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 switched off. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. Consult the airline staff about the use of wireless devices on boarding the aircraft, if your device offers a Airplane Mode which must be enabled prior to boarding an aircraft.



Switch off your wireless device when in hospitals or clinics or other health care facilities. These requests are desinged to prevent possible interference with sentitive medical equipment.



Cellular terminals or mobiles operate over radio frequency signal and cellular network and cannot be guaranteed to connect in all conditions, for example no mobile fee or an invalid SIM card. While you are in this condition and need emergent help, please remember using emergency call. In order to make or receive 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 exposable atmospheres including 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.

2 Product Concept

2.1. General Description

UC20 is an embedded HSPA+/EDGE engine with Rx-diversity. Its UMTS-based modem provides data connectivity on HSPA+, HSDPA, HSUPA, WCDMA, EDGE, GPRS networks. It can also provide GPS/GLONASS and voice functionality¹⁾ for your specific application. UC20 offers a maximum data rate of 14.4Mbps on downlink and 5.76Mbps on uplink in HSPA+/HSPA mode. UC20 also support GPRS/EDGE multi-slot class 12. GPRS supports the coding schemes CS-1, CS-2, CS-3 and CS-4. EDGE supports CS1-4 and MCS1-9 coding schemes. UC20 contains three variants UC20-A, UC20-E and UC20-G. You can choose the dedicated type based on the wireless network configuration. The following table shows the entire radio band configuration of UC20 series.

Table 1: UC20 Series Frequency Bands

Module	GSM 850	EGSM 900	DCS 1800	PCS 1900	UMTS 800	UMTS 850	UMTS 900	UMTS 1900	UMTS 2100	Rx-diversity	GNSS
UC20-A						✓		✓		✓	✓
UC20-E	✓	✓	✓	✓			✓		✓	✓	✓
UC20-G	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

NOTE

¹⁾ UC20 series (UC20-A/UC20-E/UC20-G) includes **Data-only** and **Telematics** versions. **Data-only** version does not support voice function, **Telematics** version supports it.

More details about GPRS/EDGE multi-slot configuration and coding schemes, please refer to Appendix B, C and D.

With a tiny profile of 32.0mm × 29.0mm × 2.5mm, UC20 can meet almost all requirements for M2M application such as automotive, metering, tracking system, security solutions, routers, wireless POS, mobile computing devices, PDA phone and tablet PC, etc..

UC20 is an SMD type module, which can be embedded in application through its 112-pin pads including 72 LCC signal pads and 40 other pads.

UC20 is integrated with internet service protocols like TCP/UDP and PPP. Extended AT commands have been developed for customer to use these internet service protocols easily.

2.2. Key Features

The following table describes the detailed features of UC20 module.

Table 2: UC20 Key Features

Feature	Details
Power Supply	Supply voltage: 3.3V~4.3V Typical supply voltage: 3.8V
Frequency Bands	UC20-A: UMTS850/1900 UC20-E: GSM850/900/1800/1900, UMTS900/2100 UC20-G: GSM850/900/1800/1900, UMTS800/850/900/1900/2100
Transmission Data	HSPA R6: Max 14.4Mbps (DL)/Max 5.76Mbps (UL) UMTS R99: Max 384kbps (DL)/Max 384kbps (UL) EDGE: Max 236.8kbps (DL)/Max 236.8kbps (UL) GPRS: Max 85.6kbps (DL)/Max 85.6kbps (UL) CSD: 14.4kbps
Transmitting Power	Class 4 (33dBm±2dB) for GSM850 and EGSM900 Class 1 (30dBm±2dB) for DCS1800 and PCS1900 Class E2 (27dBm±3dB) for GSM850 and EGSM900 8-PSK Class E2 (26dBm+3/-4dB) for DCS1800 and PCS1900 8-PSK Class 3 (24dBm+1/-3dB) for UMTS800/850/900/1900/2100
HSPA and UMTS Features	HSPA data rate is corresponded with 3GPP R6. 14.4Mbps on downlink and 5.76Mbps on uplink. WCDMA data rate is corresponded with 3GPP R99/R4. 384kbps on downlink and 384kbps on uplink. Support both 16-QAM and QPSK modulation.
GSM/GPRS/EDGE Data Features	GPRS: Support GPRS multi-slot class 12 (10 by default) Coding scheme: CS-1, CS-2, CS-3 and CS-4 Maximum of four Rx time slots per frame EDGE: Support EDGE multi-slot class 12 (12 by default). Support GMSK and 8-PSK for different MCS (Modulation and Coding

	<p>scheme).</p> <p>Downlink coding schemes: CS 1-4 and MCS 1-9</p> <p>Uplink coding schemes: CS 1-4 and MCS 1-9</p> <p>CSD:</p> <p>CSD transmission rates: 14.4kbps non-transparent</p> <p>Support Unstructured Supplementary Services Data (USSD).</p>
Internet Protocol Features	<p>Support TCP/UDP/PPP/FTP/SMTP/HTTP/FILE/MMS/SSL protocols</p> <p>Support the protocols PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) usually used for PPP connections.</p>
SMS	<p>Text and PDU mode</p> <p>Point to point MO and MT</p> <p>SMS cell broadcast</p> <p>SMS storage: ME by default</p>
USIM Interface	<p>Support USIM/SIM card: 1.8V, 3.0V</p>
Audio Features	<p>Support one digital audio interface: PCM interface</p> <p>GSM: HR/FR/EFR/AMR/AMR-WB</p> <p>WCDMA: AMR/AMR-WB</p> <p>Echo cancellation and noise suppression</p>
PCM Interface	<p>Used for audio function with external codec.</p> <p>Support 8-bit A-law, μ-law and 16-bit linear data formats.</p> <p>Support long frame sync and short frame sync.</p> <p>Support master and slave mode, but must be the master in long frame sync.</p>
UART Interface	<p>Support two UART interfaces: main UART interface and debug UART interface.</p> <p>Main UART interface:</p> <ul style="list-style-type: none"> ● Seven lines on main UART interface ● Support RTS and CTS hardware flow control ● Baud rate can reach up to 921600bps, 115200bps by default ● Used for AT command, data transmission or firmware upgrade ● Support multiplexing function <p>Debug UART interface:</p> <ul style="list-style-type: none"> ● Two lines on debug UART interface: DBG_TXD and DBG_RXD ● Can be used for GNSS NMEA sentences output
USB Interface	<p>Compliant with USB 2.0 specification (slave only), the data transfer rate can reach up to 480Mbps.</p> <p>Used for AT command communication, data transmission, GNSS NMEA output, software debug and firmware upgrade.</p> <p>USB Driver: Windows XP, Windows Vista, Windows 7, Windows 8, Windows CE5.0/6.0/7.0, Linux 2.6/3.0, Android 2.3/4.0/4.2.</p>
Rx-diversity	<p>Support UMTS Rx-diversity</p>

GNSS Features	Gen8 of Qualcomm GNSS engine (GPS and GLONASS) Protocol: NMEA 0183
AT Commands	Compliant with 3GPP TS 27.007, 27.005 and Quectel enhanced AT commands.
Real Time Clock	Implemented
Network Indication	Two pins including NET_MODE and NET_STATUS to indicate network connectivity status.
Antenna Interface	Include main GSM/UMTS antenna, UMTS diversity antenna and GNSS antenna.
Physical Characteristics	Size: 32.0±0.15 × 29.0±0.15 × 2.5±0.2mm Weight: approx. 4.9g
Temperature Range	Normal operation: -35°C ~ +75°C Restricted operation: -40°C ~ -35°C and +75°C ~ +85°C ²⁾ Storage temperature: -45°C ~ +90°C
Firmware Upgrade	USB interface (by default) or main UART interface.
RoHS	All hardware components are fully compliant with EU RoHS directive.

NOTE

²⁾ When the module works within this restricted temperature range, RF performance might degrade. For example, the frequency error or the phase error would increase.

2.3. Functional Diagram

The following figure shows a block diagram of UC20 and illustrates the major functional parts.

- Power management
- Baseband
- DDR+NAND flash
- Radio frequency
- Peripheral interface
 - UART interface
 - USIM card interface
 - USB interface
 - PCM interface
 - ADC interface
 - Status indication
 - Control interface

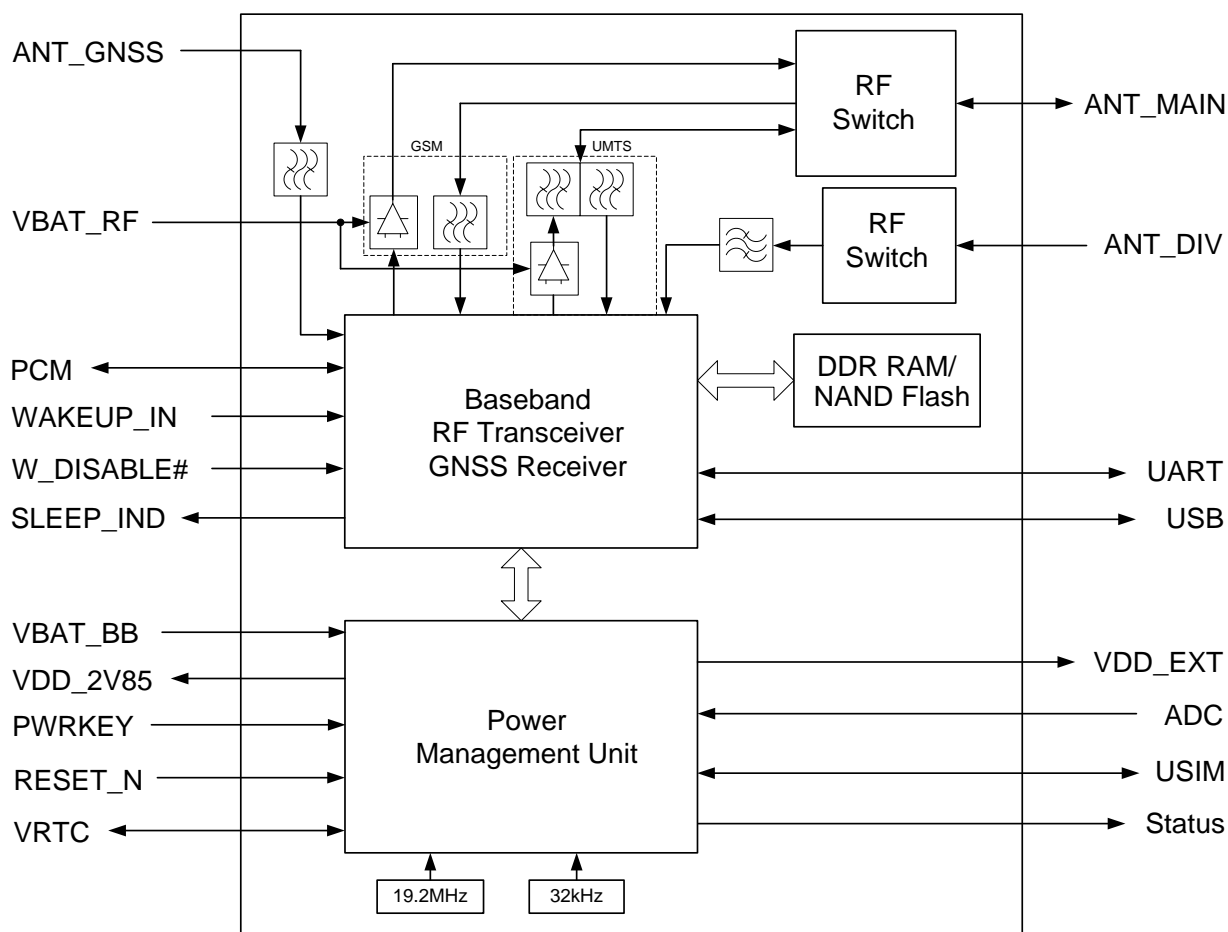


Figure 1: Functional Diagram

2.4. Evaluation Board

In order to help you to develop applications with UC20, Quectel supplies an evaluation board (EVB), RS-232 to USB cable, USB data cable, power adapter, earphone, antenna and other peripherals to control or test the module. For details, please refer to **document [2]**.

3 Application Interface

3.1. General Description

UC20 is equipped with a 72-pin 1.3mm pitch SMT pads plus 40-pin other pads that connect to cellular application platform. Sub-interfaces included in these pads are described in detail in the following chapters:

- Power supply
- UART interface
- USIM interface
- USB interface
- PCM interface
- ADC interface
- Status indication

3.2. Pin Assignment

The following figure shows the pin assignment of the UC20 module.

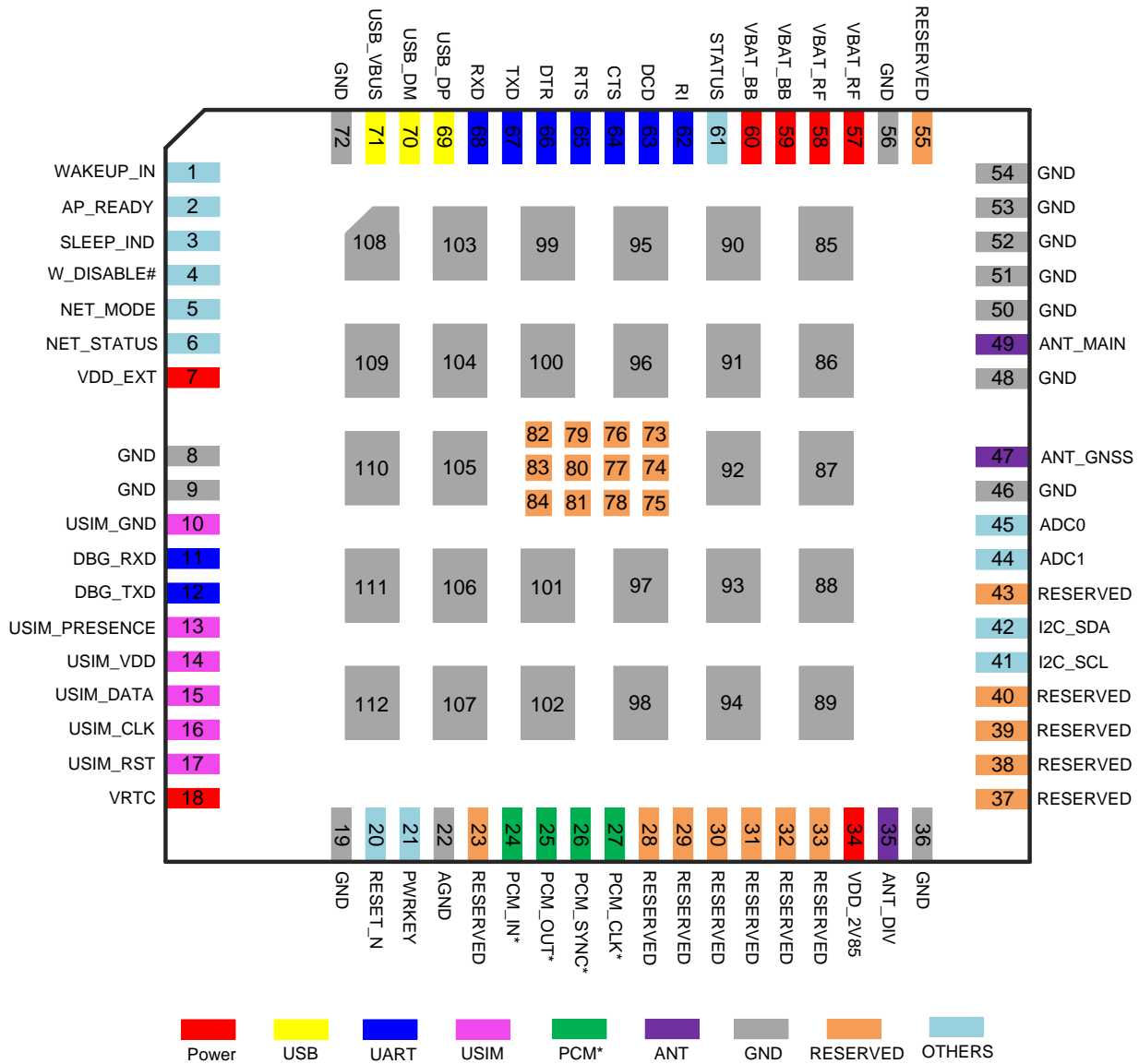


Figure 2: Pin Assignment (Top View)

NOTES

1. Keep all RESERVED pins and unused pins unconnected.
2. GND pads 85~112 should be connected to ground in the design, and RESERVED pads 73~84 should not be designed in schematic and PCB decal.
3. "*" means PCM function is only supported in **Telematics** version.

3.3. Pin Description

The following tables show the UC20's pin definition.

Table 3: IO Parameters Definition

Type	Description
IO	Bidirectional input/output
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_BB	59,60	PI	Power supply for module baseband part.	Vmax = 4.3V Vmin = 3.3V Vnorm = 3.8V	It must be able to provide sufficient current up to 0.8A.
VBAT_RF	57,58	PI	Power supply for module RF part.	Vmax = 4.3V Vmin = 3.3V Vnorm = 3.8V	It must be able to provide sufficient current in a transmitting burst which typically rises to 2.0A.
VRTC	18	IO	Power supply for internal RTC circuit.	V _{Omax} = 3.25V when VBAT ≥ 3.3V. V _I = 1.5V~3.25V at I _{IN} = 3uA when VBAT is not applied.	If unused, keep it open.
VDD_EXT	7	PO	Provide 1.8V for	Vnorm = 1.8V	Power supply for

			external circuit.	$I_{Omax} = 20mA$	external GPIO's pull up circuits.
VDD_2V85	34	PO	Provide 2.85V for external circuit.	$V_{norm} = 2.85V$ $I_{Omax} = 100mA$	Reserved for future application. If unused, keep it open.
GND	8,9,19,36, 46,48,50~ 54,56,72, 85~112		Ground.		

Turn On/Off

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
PWRKEY	21	DI	Turn on/off the module.	$R_{PU} \approx 200k\Omega$ $V_{IHmax} = 2.1V$ $V_{IHmin} = 1.3V$ $V_{ILmax} = 500mV$	Pull-up to 1.8V internally.
RESET_N	20	DI	Reset the module.	$R_{PU} \approx 200k\Omega$ $V_{IHmax} = 2.1V$ $V_{IHmin} = 1.3V$ $V_{ILmax} = 500mV$	Pull-up to 1.8V internally. Active low. If unused, keep it open.

Status Indication

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
STATUS	61	OD	Indicate the module operating status.		Require external pull-up. If unused, keep it open.
NET_MODE	5	DO	Indicate the module network registration mode.	$V_{OHmin} = 1.35V$ $V_{OLmax} = 0.45V$	1.8V power domain. If unused, keep it open.
NET_STATUS	6	DO	Indicate the module network activity status.	$V_{OHmin} = 1.35V$ $V_{OLmax} = 0.45V$	1.8V power domain. If unused, keep it open.
SLEEP_IND	3	DO	Indicate the sleep status.	$V_{OHmin} = 1.35V$ $V_{OLmax} = 0.45V$	1.8V power domain. If unused, keep it open.

USB Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
USB_VBUS	71	PI	USB detection.	$V_{max} = 5.25V$ $V_{min} = 3.0V$ $V_{norm} = 5.0V$	

USB_DP	69	IO	USB differential data bus.	Compliant with USB 2.0 standard specification.	Require differential impedance of 90Ω.
USB_DM	70	IO	USB differential data bus.	Compliant with USB 2.0 standard specification.	Require differential impedance of 90Ω.
USIM Interface					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
USIM_GND	10		Specified ground for USIM card.		
USIM_VDD	14	PO	Power supply for USIM card.	For 1.8V USIM: V _{max} = 1.9V V _{min} = 1.7V For 3.0V USIM: V _{max} = 3.05V V _{min} = 2.7V I _{Omax} = 50mA	Either 1.8V or 3V is supported by the module automatically.
USIM_DATA	15	IO	Data signal of USIM card.	For 1.8V USIM: V _{ILmax} = 0.6V V _{IHmin} = 1.2V V _{OLmax} = 0.45V V _{OHmin} = 1.35V For 3.0V USIM: V _{ILmax} = 1.0V V _{IHmin} = 1.95V V _{OLmax} = 0.45V V _{OHmin} = 2.55V	Pull-up to USIM_VDD with 15k resistor internally.
USIM_CLK	16	DO	Clock signal of USIM card.	For 1.8V USIM: V _{OLmax} = 0.45V V _{OHmin} = 1.35V For 3.0V USIM: V _{OLmax} = 0.45V V _{OHmin} = 2.55V	
USIM_RST	17	DO	Reset signal of USIM card.	For 1.8V USIM: V _{OLmax} = 0.45V V _{OHmin} = 1.35V For 3.0V USIM: V _{OLmax} = 0.45V	

				$V_{OHmin} = 2.55V$	
USIM_PRE SENCE	13	DI	USIM card insertion detection.	$V_{ILmin} = -0.3V$ $V_{ILmax} = 0.6V$ $V_{IHmin} = 1.2V$ $V_{IHmax} = 2.0V$	1.8V power domain. If unused, keep it open.

ADC Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
ADC0	45	AI	General purpose analog to digital converter.	Voltage range: 0.2V to 2.1V	If unused, keep it open.
ADC1	44	AI	General purpose analog to digital converter.	Voltage range: 0.2V to 4.2V	If unused, keep it open.

Main UART Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
RI	62	DO	Ring indicator.	$V_{OLmax} = 0.45V$ $V_{OHmin} = 1.35V$	1.8V power domain. If unused, keep it open.
DCD	63	DO	Data carrier detection.	$V_{OLmax} = 0.45V$ $V_{OHmin} = 1.35V$	1.8V power domain. If unused, keep it open.
CTS	64	DO	Clear to send.	$V_{OLmax} = 0.45V$ $V_{OHmin} = 1.35V$	1.8V power domain. If unused, keep it open.
RTS	65	DI	Request to send.	$V_{ILmin} = -0.3V$ $V_{ILmax} = 0.6V$ $V_{IHmin} = 1.2V$ $V_{IHmax} = 2.0V$	1.8V power domain. If unused, keep it open.
DTR	66	DI	Data terminal ready, sleep mode control.	$V_{ILmin} = -0.3V$ $V_{ILmax} = 0.6V$ $V_{IHmin} = 1.2V$ $V_{IHmax} = 2.0V$	1.8V power domain. Pull-up by default. Low level wakes up the module. If unused, keep it open.
TXD	67	DO	Transmit data.	$V_{OLmax} = 0.45V$ $V_{OHmin} = 1.35V$	1.8V power domain. If unused, keep it open.
RXD	68	DI	Receive data.	$V_{ILmin} = -0.3V$ $V_{ILmax} = 0.6V$ $V_{IHmin} = 1.2V$	1.8V power domain. If unused, keep it open.

$V_{IHmax} = 2.0V$

Debug UART Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
DBG_TXD	12	DO	Transmit data.	$V_{OLmax} = 0.45V$ $V_{OHmin} = 1.35V$	1.8V power domain. If unused, keep it open.
DBG_RXD	11	DI	Receive data.	$V_{ILmin} = -0.3V$ $V_{ILmax} = 0.6V$ $V_{IHmin} = 1.2V$ $V_{IHmax} = 2.0V$	1.8V power domain. If unused, keep it open.

RF Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
ANT_DIV	35	AI	Diversity antenna.	50Ω impedance	If unused, keep it open.
ANT_MAIN	49	IO	Main antenna.	50Ω impedance	
ANT_GNSS	47	AI	GNSS antenna.	50Ω impedance	If unused, keep it open.

PCM Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
PCM_IN	24	DI	PCM data input.	$V_{ILmin} = -0.3V$ $V_{ILmax} = 0.6V$ $V_{IHmin} = 1.2V$ $V_{IHmax} = 2.0V$	1.8V power domain. If unused, keep it open.
PCM_OUT	25	DO	PCM data output.	$V_{OLmax} = 0.45V$ $V_{OHmin} = 1.35V$	1.8V power domain. If unused, keep it open.
PCM_SYNC	26	IO	PCM data frame sync signal.	$V_{OLmax} = 0.45V$ $V_{OHmin} = 1.35V$ $V_{ILmin} = -0.3V$ $V_{ILmax} = 0.6V$ $V_{IHmin} = 1.2V$ $V_{IHmax} = 2.0V$	1.8V power domain. In master mode, it is an output signal. In slave mode, it is an input signal. If unused, keep it open.
PCM_CLK	27	IO	PCM data bit clock.	$V_{OLmax} = 0.45V$ $V_{OHmin} = 1.35V$ $V_{ILmin} = -0.3V$ $V_{ILmax} = 0.6V$ $V_{IHmin} = 1.2V$ $V_{IHmax} = 2.0V$	1.8V power domain. In master mode, it's an output signal. In slave mode, it is an input signal. If unused, keep it open.

AGND	22		Reserved for analog ground.	Ground.	If unused, connect this pin to ground.
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I2C Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
I2C_SCL	41	OD	I2C serial clock.		External pull-up resistor is required. 1.8V only. If unused, keep it open.
I2C_SDA	42	OD	I2C serial data.		External pull-up resistor is required. 1.8V only. If unused, keep it open.

Other Pins

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
WAKEUP_IN	1	DI	Sleep mode control.	$V_{ILmin} = -0.3V$ $V_{ILmax} = 0.6V$ $V_{IHmin} = 1.2V$ $V_{IHmax} = 2.0V$	1.8V power domain. Pull-up by default. Low level wakes up the module. If unused, keep it open.
W_DISABLE#	4	DI	Airplane mode control.	$V_{ILmin} = -0.3V$ $V_{ILmax} = 0.6V$ $V_{IHmin} = 1.2V$ $V_{IHmax} = 2.0V$	1.8V power domain. Pull-up by default. In low level voltage, module can enter into airplane mode. If unused, keep it open.
AP_READY	2	DI	Application processor sleep state detection.	$V_{ILmin} = -0.3V$ $V_{ILmax} = 0.6V$ $V_{IHmin} = 1.2V$ $V_{IHmax} = 2.0V$	1.8V power domain. If unused, keep it open.

RESERVED Pins

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
RESERVED	23,28~33 ,37~40, 43,55,73 ~84		Reserved		Keep these pins unconnected.

3.4. Operating Modes

The table below briefly summarizes the various operating modes referred to in the following chapters.

Table 5: Overview of Operating Modes

Mode	Details
Normal Operation	GSM Idle Software is active. The module has registered to the GSM network and is ready to send and receive data.
	GSM Talk/Data GSM connection is ongoing. In this mode, the power consumption is decided by the configuration of power control level (PCL), dynamic DTX control and the working RF band.
	GPRS Idle The module is ready for GPRS data transfer, but no data transfer is going on. In this case, power consumption depends on network setting and GPRS configuration.
	GPRS Data There is GPRS data in transfer (PPP, TCP or UDP). In this mode, power consumption is decided by the PCL, working RF band and GPRS multi-slot configuration.
	EDGE Idle The module is ready for data transfer in EDGE mode, but no data is currently sent or received. In this case, power consumption depends on network settings and EDGE configuration.
	EDGE Data There is EDGE data in transfer (PPP, TCP or UDP). In this mode, power consumption is decided by the PCL, working RF band and EDGE multi-slot configuration.
	UMTS Idle Software is active. The module has registered to the UMTS network and the module is ready to send and receive data.
	UMTS Talk/Data UMTS connection is ongoing. In this mode, the power consumption is decided by network setting (e.g. TPC pattern) and data transfer rate.
	HSPA Idle Software is active. The module has registered to the HSPA network and the module is ready to send and receive data.
	HSPA Data HSPA data transfer is ongoing. In this mode, the power consumption is decided by network setting (e.g. TPC pattern) and data transfer rate.
Minimum Functionality Mode AT+CFUN command can set the module entering into a minimum functionality mode without removing the power supply. In this case, both RF function and USIM card will be invalid.	
Airplane Mode AT+CFUN command and W_DISABLE# pin can set the module entering into airplane mode. In this case, RF function will be invalid.	

Sleep Mode	In this mode, the current consumption of the module will be reduced to the minimal level. During this mode, the module can still receive paging message, SMS, voice call and TCP/UDP data from the network normally.
Power Down Mode	In this mode, the power management unit shuts down the power supply. Only the power supply for RTC remains. Software is not active. The serial interface is not accessible. Operating voltage (connected to VBAT_RF and VBAT_BB) remains applied.

3.5. Power Saving

3.5.1. Sleep Mode

UC20 is able to reduce its current consumption to a minimum value during the sleep mode. The following section describes UC20's power saving procedure.

3.5.1.1. UART Application

If application processor communicates with module via UART interface, the following preconditions can let the module enter into the sleep mode.

- Execute AT command **AT+QSCLK=1** to enable the sleep mode.
- Drive DTR to high level.

The following figure shows the connection between the module and application processor.

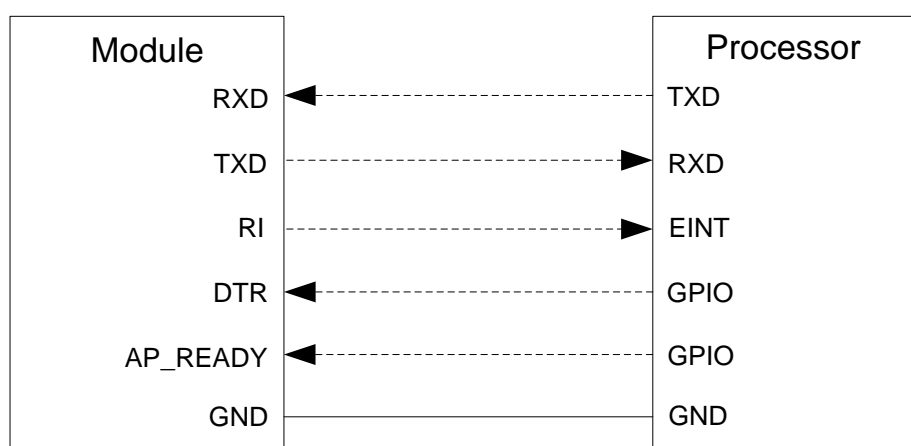


Figure 3: UART Sleep Application

The RI of module is used to wake up the processor, and AP_READY will detect the sleep state of processor (can be configured to high level or low level detection). You should pay attention to the level

match shown in dotted line between module and processor.

Driving DTR to low level will wake up the module.

3.5.1.2. USB Application with Suspend Function

If application processor communicates with module via USB interface, and processor supports USB suspend function, the following preconditions can let the module enter into the sleep mode.

- Execute AT command **AT+QSCLK=1** to enable the sleep mode.
- The processor's USB bus which is connected with the module USB interface enters into suspended state.

The following figure shows the connection between the module and processor.

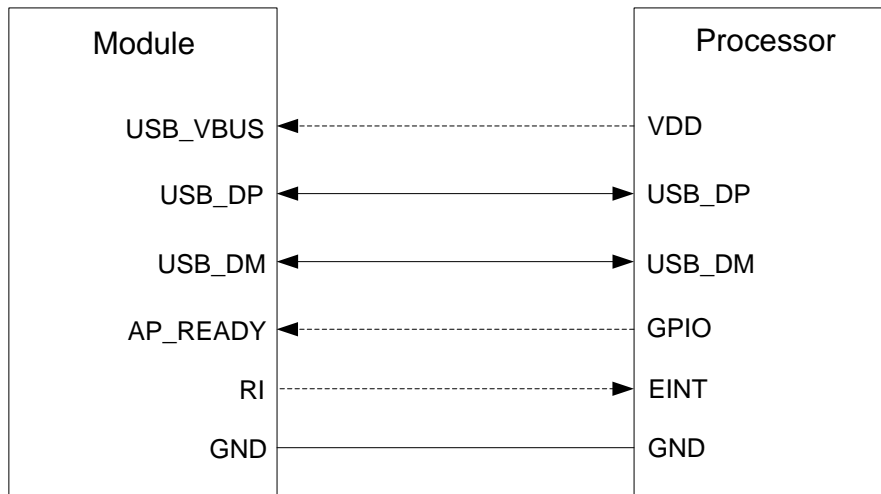


Figure 4: USB Application with Suspend Function

When the processor's USB bus returns to resume state, the module will be woken up.

3.5.1.3. USB Application without Suspend Function

If application processor communicates with module via USB interface, and processor does not support USB suspend function, you should disconnect USB_VBUS with additional control circuit to let the module enter into sleep mode.

- Execute AT command **AT+QSCLK=1** to enable the sleep mode.
- Disconnect USB_VBUS.

The following figure shows the connection between the module and application processor.

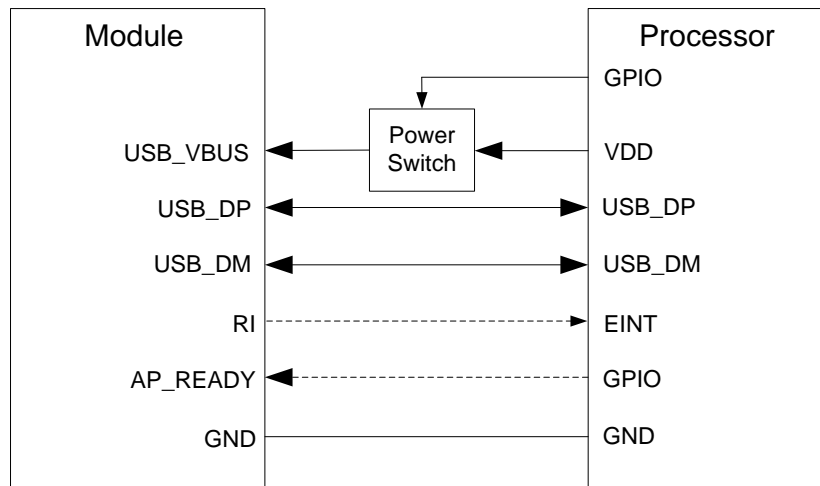


Figure 5: USB Sleep Application without Suspend Function

Supply power to USB_VBUS will wake up the module.

In sleep mode, module can still receive paging, SMS, voice call and TCP/UDP data from network, but the UART port is not accessible. When the module enters into the sleep mode, the SLEEP_IND will output a high logic level.

For more details about power saving mode, please refer to **document [8]**.

3.5.2. Airplane Mode

When module enters into the airplane mode, the RF function does not work, and all AT commands correlative with RF function will be not accessible. This mode can be set with the following way.

Hardware:

The W_DISABLE# pin is pulled up by default, drive it to low level will let the module enter into airplane mode.

Software:

Command **AT+CFUN** provides the choice of the functionality level <fun>=0, 1, 4.

AT+CFUN=0: Minimum functionality mode, both USIM and RF function are disabled.

AT+CFUN=1: Full functionality mode (by default).

AT+CFUN=4: Airplane mode. RF function is disabled.

NOTES

1. The W_DISABLE# control function is disabled in firmware by default. It can be enabled by AT command **AT+QCFG="airplanecontrol"**. Refer to **document [1]**.
2. When the module is in sleep mode, the W_DISABLE# control is invalid. Please be sure to wake the module up first.
3. GNSS function is still available when RF function is disabled.

3.6. Power Supply

3.6.1. Power Supply Pins

UC20 provides four VBAT pins dedicated to connect with the external power supply. There are two separate voltage domains for VBAT.

- VBAT_RF with two pads for module RF part.
- VBAT_BB with two pads for module baseband part.

The following table shows the VBAT pins and ground pins.

Table 6: VBAT and GND Pins

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VBAT_RF	57,58	Power supply for module RF part.	3.3	3.8	4.3	V
VBAT_BB	59,60	Power supply for module baseband part.	3.3	3.8	4.3	V
GND	8,9,19,36,46, 48,50~54,56, 72, 85~112	Ground.	-	0	-	V

3.6.2. Decrease Voltage Drop

The power supply range of the module is 3.3V ~ 4.3V. Make sure the input voltage will never drop below 3.3V. If the voltage drops below 3.3V, the module will turn off automatically. The following figure shows the voltage drop during transmitting burst in 2G network, the voltage drop will be less in 3G network.

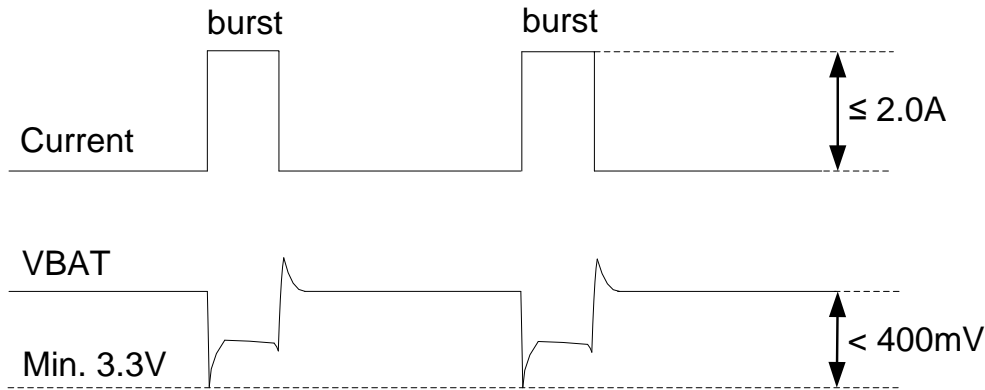


Figure 6: Voltage Drop during Transmitting Burst

To decrease voltage drop, a bypass capacitor of about 100μF with low ESR should be used. Multi-layer ceramic chip (MLCC) capacitor can provide the best combination of low ESR. The main power supply from an external application has to be a single voltage source and expanded to two sub paths with star structure. The width of VBAT_BB trace should be no less than 1mm, and the width of VBAT_RF trace should be no less than 2mm, and the principle of the VBAT trace is the longer, the wider.

Three ceramic capacitors (100nF, 33pF, 10pF) are recommended to be applied to the VBAT pins. The capacitors should be placed close to the UC20's VBAT pins. In addition, in order to get a stable power source, it is suggested to use a zener diode of which reverse zener voltage is 5.1V and dissipation power is more than 0.5W. The following figure shows star structure of the power supply.

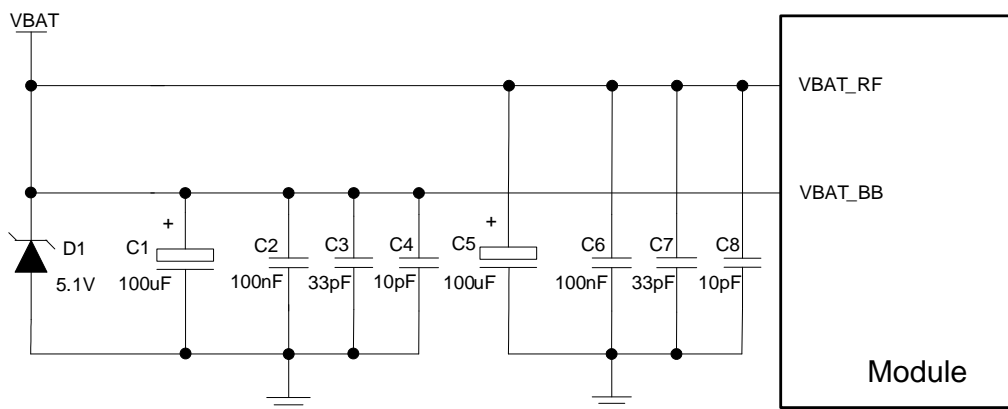


Figure 7: Star Structure of the Power Supply

3.6.3. Reference Design for Power Supply

The power design for the module is very important, since the performance of power supply for the module largely depends on the power source. The power supply is capable of providing the sufficient current up to

2A at least. If the voltage drop between the input and output is not too high, it is suggested to use a LDO to supply power for module. If there is a big voltage difference between the input source and the desired output (VBAT), a buck converter is preferred to be used as a power supply.

The following figure shows a reference design for +5V input power source. The designed output for the power supply is about 3.8V and the maximum load current is 3A.

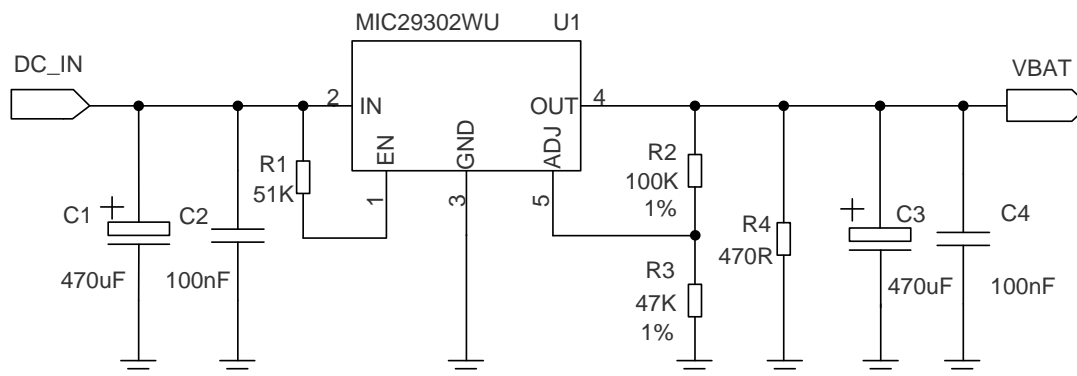


Figure 8: Reference Circuit of Power Supply

3.6.4. Monitor the Power Supply

You can use the **AT+CBC** command to monitor the VBAT_BB voltage value. For more details, please refer to **document [1]**.

3.7. Turn on and off Scenarios

3.7.1. Turn on Module Using the PWRKEY

The following table shows the pin definition of PWRKEY.

Table 7: PWRKEY Pin Description

Pin Name	Pin No.	Description	DC Characteristics	Comment
PWRKEY	21	Turn on/off the module.	$V_{IHmax} = 2.1V$ $V_{IHmin} = 1.3V$ $V_{ILmax} = 500mV$	Pull-up to 1.8V internally with 200kΩ resistor.

When UC20 is in power down mode, it can be turned on to normal mode by driving the PWRKEY pin to a low level at least 100ms. It is recommended to use an open drain/collector driver to control the PWRKEY. After STATUS pin (require external pull-up) outputting a low level, PWRKEY pin can be released. A simple

reference circuit is illustrated in the following figure.

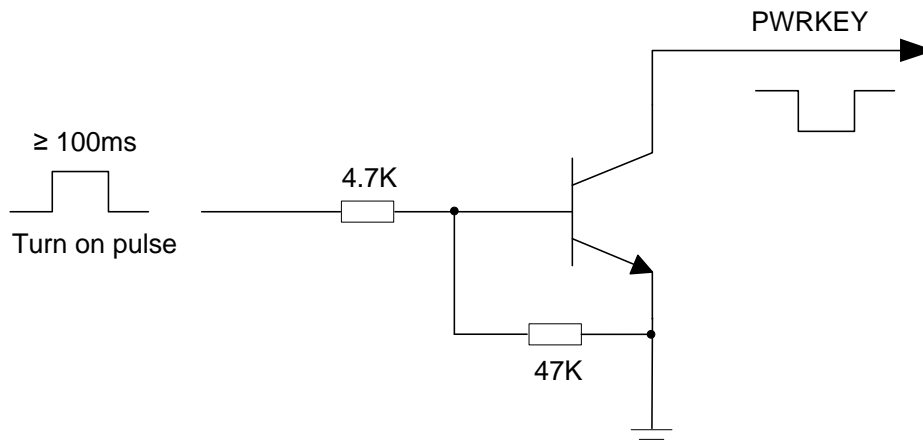


Figure 9: Turn on the Module Using Driving Circuit

The other way to control the PWRKEY is using a button directly. A TVS component is indispensable to be placed nearby the button for ESD protection. When pressing the key, electrostatic strike may generate from finger. A reference circuit is showed in the following figure.

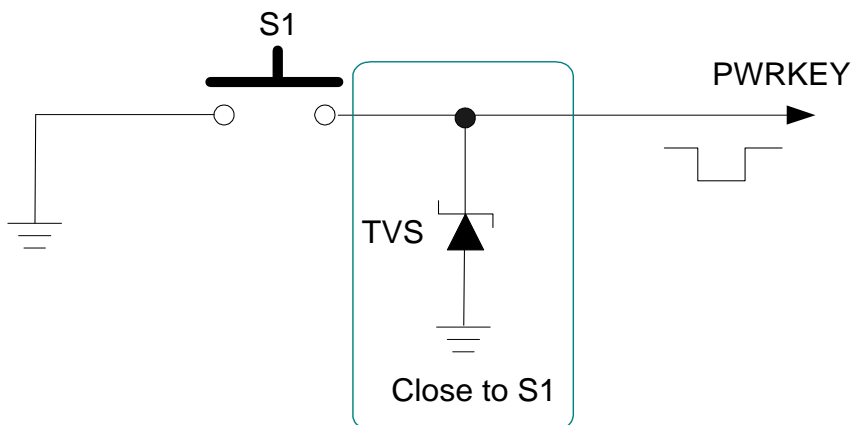


Figure 10: Turn on the Module Using Keystroke

The turn on scenarios is illustrated as the following figure.

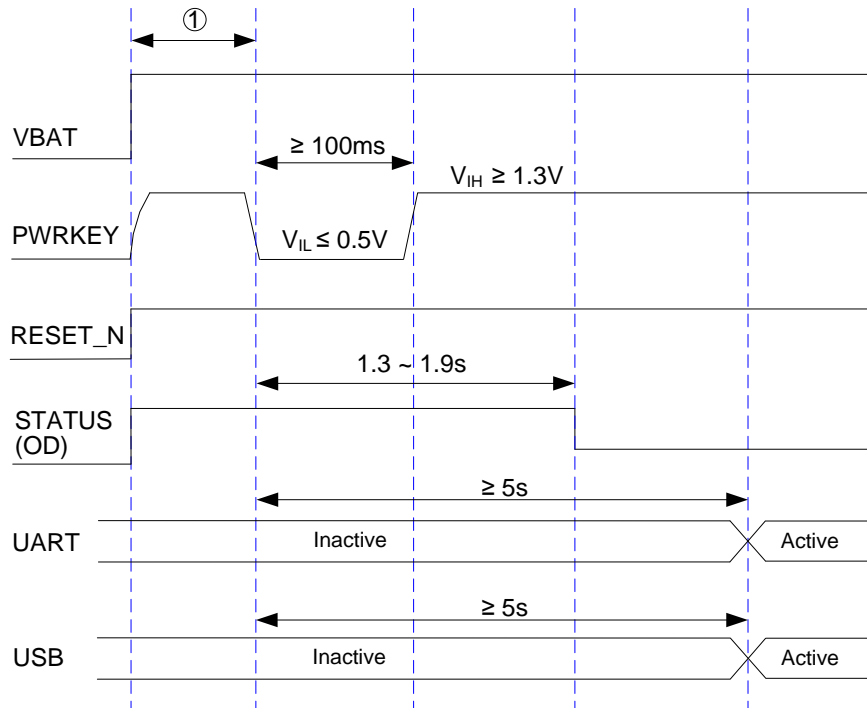


Figure 11: Timing of Turning on Module

NOTE

Make sure that VBAT is stable before pulling down PWRKEY pin. The time between them is recommended to be 30ms.

3.7.2. Turn off Module

The following procedures can be used to turn off the module:

- Normal power down procedure: Turn off the module using the PWRKEY pin.
- Normal power down procedure: Turn off the module using command **AT+QPOWD**.
- Automatic shutdown: Turn off the module automatically if under-voltage or over-voltage is detected.

3.7.2.1. Turn off Module Using the PWRKEY Pin

Driving the PWRKEY to a low level voltage at least 0.6s, the module will execute power-down procedure after PWRKEY is released. The power-down scenario is illustrated as the following figure.

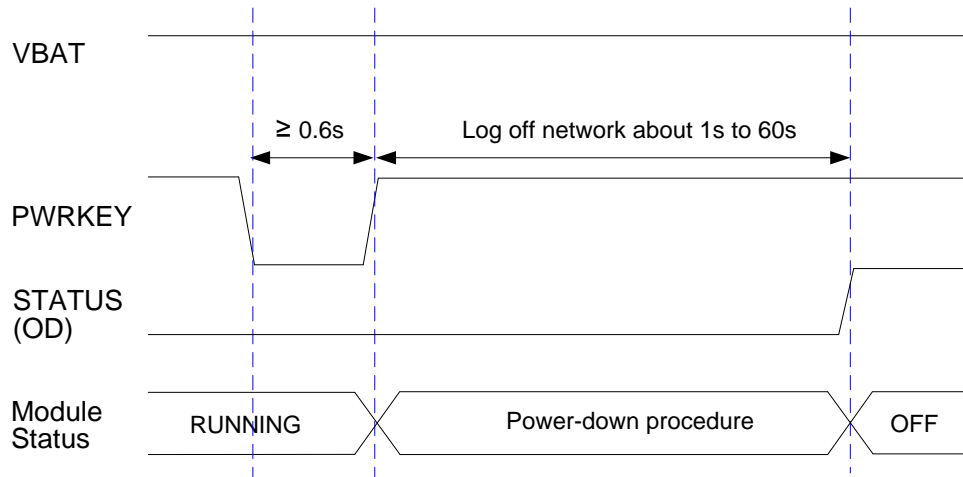


Figure 12: Timing of Turning off Module

During power-down procedure, module will send out URC “NORMAL POWER DOWN” via URC port first, then log off network and save important data. After logging off, module sends out “POWERED DOWN” and shut down the internal power supply. The power on VBAT pins is not allowed to turn off before the URC “POWERED DOWN” is output to avoid data loss. If logging off is not done within 60s, module will shut down internal power supply forcibly.

After that moment, the module enters the power down mode, no other AT commands can be executed and only the RTC is still active.

3.7.2.2. Turn off Module Using AT Command

It is also a safe way to use AT command **AT+QPOWD** to turn off the module, which is similar to turning off the module via PWRKEY Pin.

Please refer to **document [1]** for details about the AT command of **AT+QPOWD**.

3.7.2.3. Automatic Shutdown

The module will constantly monitor the voltage applied on the VBAT, if the voltage $\leq 3.5V$, the following URC will be presented:

+QIND: “vbatt”,-1

If the voltage $\geq 4.21V$, the following URC will be presented:

+QIND: “vbatt”,1

The uncritical voltage is 3.3V to 4.35V, If the voltage > 4.35V or < 3.3V the module would automatically shut down itself.

If the voltage < 3.3V, the following URC will be presented:

+QIND: "vbatt",-2

If the voltage > 4.35V, the following URC will be presented:

+QIND: "vbatt",2

NOTE

The value of voltage threshold can be revised by command **AT+QCFG="vbatt"**, refer to **document [1]** for details.

3.8. Reset the Module

The RESET_N can be used to reset the module.

Table 8: RESET_N Pin Description

Pin Name	Pin No.	Description	DC Characteristics	Comment
RESET_N	20	Reset the module.	V _{IH} max = 2.1V V _{IH} min = 1.3V V _{IL} max = 500mV	Pull-up to 1.8V internally with 200kΩ resistor. Active low.

You can reset the module by driving the RESET_N to a low level voltage for more than 150ms and then releasing.

The recommended circuit is similar to the PWRKEY control circuit. You can use open drain/collector driver or button to control the RESET_N.

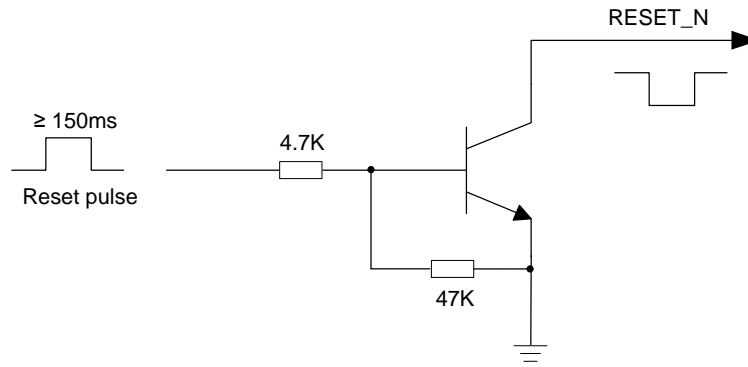


Figure 13: Reference Circuit of RESET_N by Using Driving Circuit

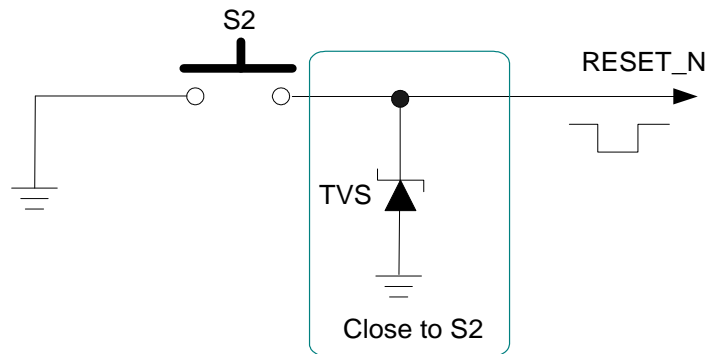


Figure 14: Reference Circuit of RESET_N by Using Button

The reset scenario is illustrated as the following figure.

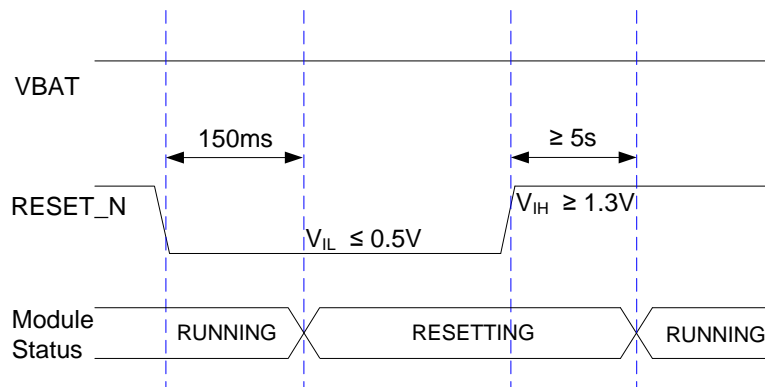


Figure 15: Timing of Resetting Module

NOTE

Use the RESET_N only when turning off the module by the command **AT+QPOWD** and the PWRKEY pin failed.

3.9. RTC Backup

The RTC (Real Time Clock) can be powered by an external power source through the pin VRTC when the module is powered down and there is no power supply for the VBAT. It is also available to charge the battery on the VRTC when module is turned on. You can choose rechargeable battery, capacitor or non-rechargeable battery depending on different applications.

The following figures show the various sample circuits for VRTC backup.

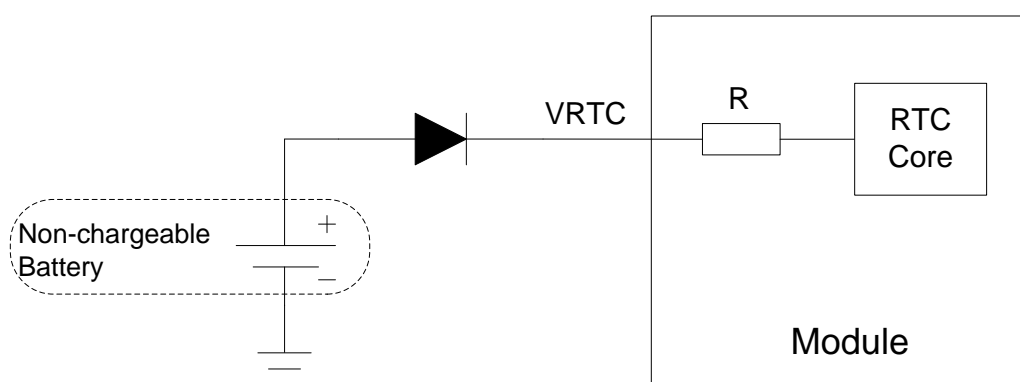


Figure 16: RTC Supply from Non-chargeable Battery

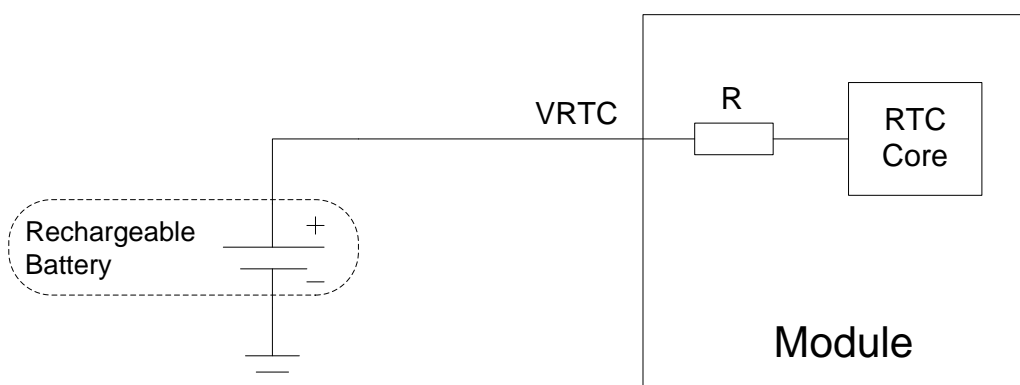


Figure 17: RTC Supply from Rechargeable Battery

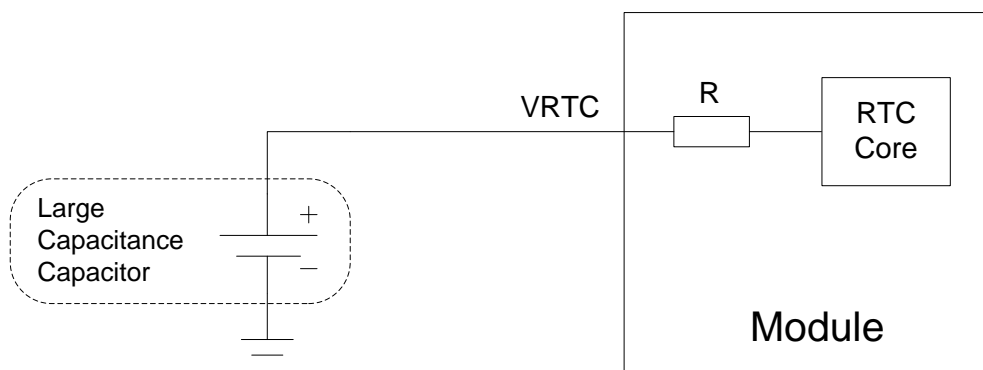


Figure 18: RTC Supply from Capacitor

3.10. UART Interface

The module provides two UART interfaces: main UART interface and debug UART interface. The following shows the different features.

- Main UART interface supports 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600bps baud rate, the default is 115200bps. This interface can be used for data transmission, AT communication or firmware upgrade.
- Debug UART interface supports 115200bps. It can be used for GNSS NMEA sentences output.

NOTE

USB interface supports software debug and firmware upgrade by default.

The module is designed as the DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection. The following tables show the pin definition of these two UART interfaces.

Table 9: Pin Definition of the Main UART Interface

Pin Name	Pin No.	I/O	Description	Comment
RI	62	DO	Ring indicator.	1.8V power domain.
DCD	63	DO	Data carrier detection.	1.8V power domain.
CTS	64	DO	Clear to send.	1.8V power domain.

RTS	65	DI	Request to send.	1.8V power domain.
DTR	66	DI	Data terminal ready.	1.8V power domain.
TXD	67	DO	Transmit data.	1.8V power domain.
RXD	68	DI	Receive data.	1.8V power domain.

Table 10: Pin Definition of the Debug UART Interface

Pin Name	Pin No.	I/O	Description	Comment
DBG_TXD	12	DO	Transmit data.	1.8V power domain.
DBG_RXD	11	DI	Receive data.	1.8V power domain.

The logic levels are described in the following table.

Table 11: Logic Levels of Digital I/O

Parameter	Min	Max	Unit
V_{IL}	-0.3	0.6	V
V_{IH}	1.2	2.0	V
V_{OL}	0	0.45	V
V_{OH}	1.35	1.8	V

UC20 provides 1.8V UART interface. A level translator should be used if your application is equipped with a 3.3V UART interface. A level translator TXS0108PWR provided by **Texas Instrument** is recommended. The following figure shows the reference design.

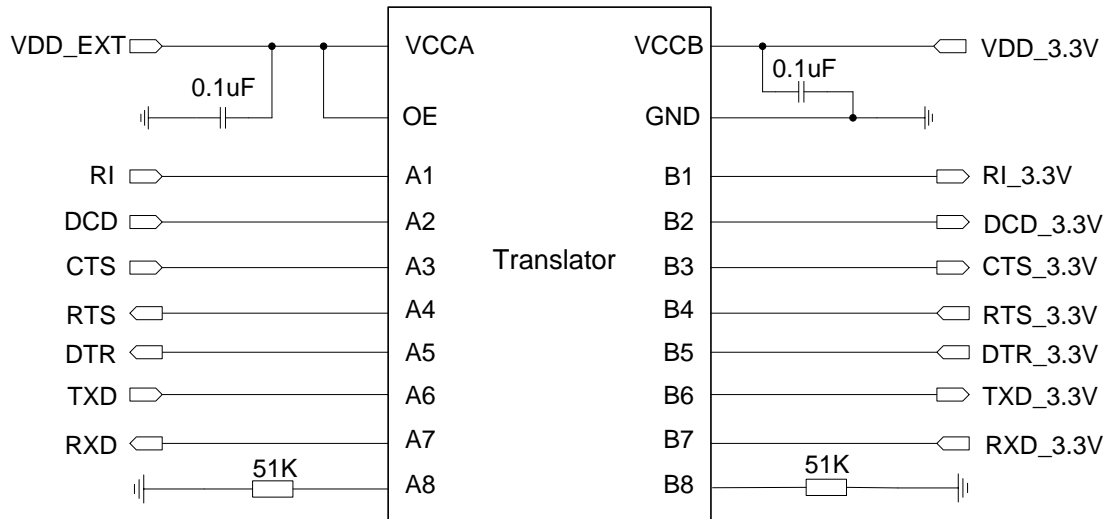


Figure 19: Reference Circuit with Translator Chip

Please visit <http://www.ti.com> for more information.

Another example with transistor translation circuit is shown as below. The construction of dotted line can refer to the construction of solid line. Please pay attention to direction of connection. Input dotted line of module should refer to input solid line of the module. Output dotted line of module should refer to output solid line of the module.

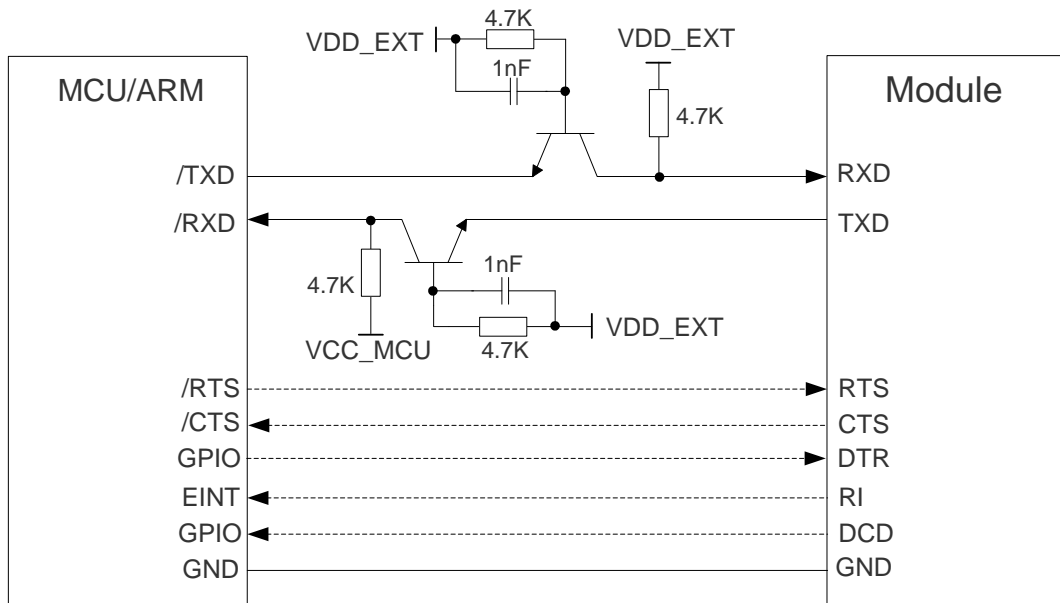


Figure 20: Reference Circuit with Transistor Circuit

The following figure is an example of connection between UC20 and PC. A voltage level translator and a RS-232 level translator chip must be inserted between module and PC, since these two UART interfaces do not support the RS-232 level, while support the 1.8V CMOS level only.

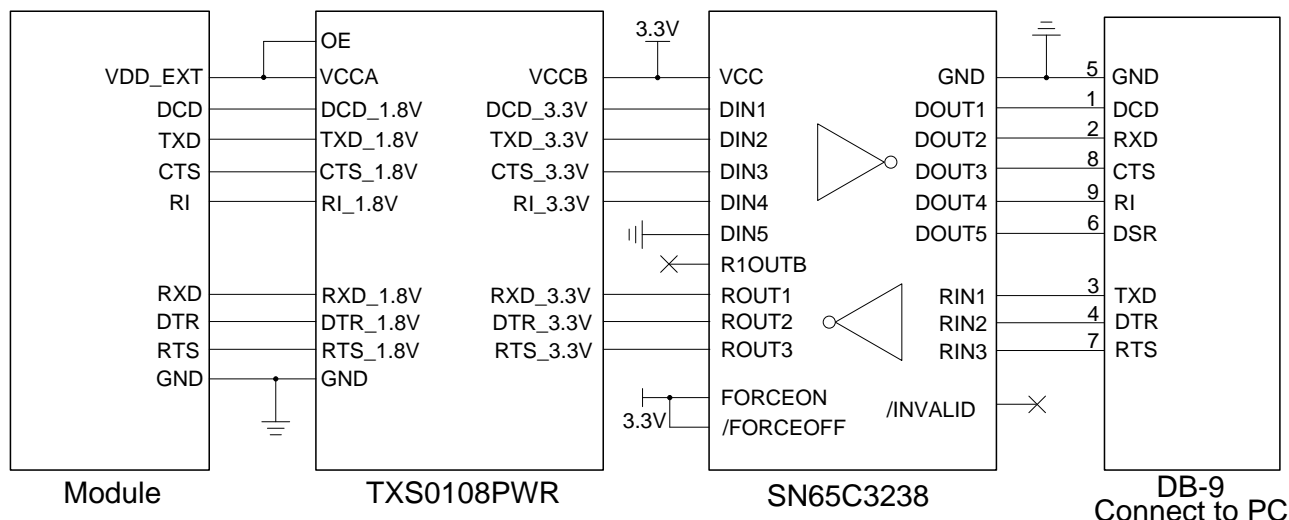


Figure 21: RS232 Level Match Circuit

NOTES

1. The module disables the hardware flow control by default. When hardware flow control is required, RTS and CTS should be connected to the host. AT command **AT+IFC=2,2** is used to enable hardware flow control. AT command **AT+IFC=0,0** is used to disable the hardware flow control. For more details, please refer to **document [1]**.
2. Rising edge on DTR will let the module exit from the data mode by default. It can be disabled by AT commands. Refer to **document [1]** about the command **AT&D** and **AT&V** for details.
3. DCD is used as data mode indication. Refer to **document [1]** about the command **AT&C** and **AT&V** for details.

3.11. USIM Card Interface

The USIM card interface circuitry meets ETSI and IMT-2000 SIM interface requirements. Both 1.8V and 3.0V USIM cards are supported.

Table 12: Pin Definition of the USIM Interface

Pin Name	Pin No.	I/O	Description	Comment
USIM_VDD	14	PO	Power supply for USIM card.	Either 1.8V or 3.0V is supported by the module automatically.
USIM_DATA	15	IO	Data signal of USIM card.	Pull-up to USIM_VDD with 15k resistor internally.

USIM_CLK	16	DO	Clock signal of USIM card.
USIM_RST	17	DO	Reset signal of USIM card.
USIM_PRESENCE	13	DI	USIM card insertion detection. 1.8V power domain.
USIM_GND	10		Specified ground for USIM card.

The following figure shows the reference design of the 8-pin USIM card.

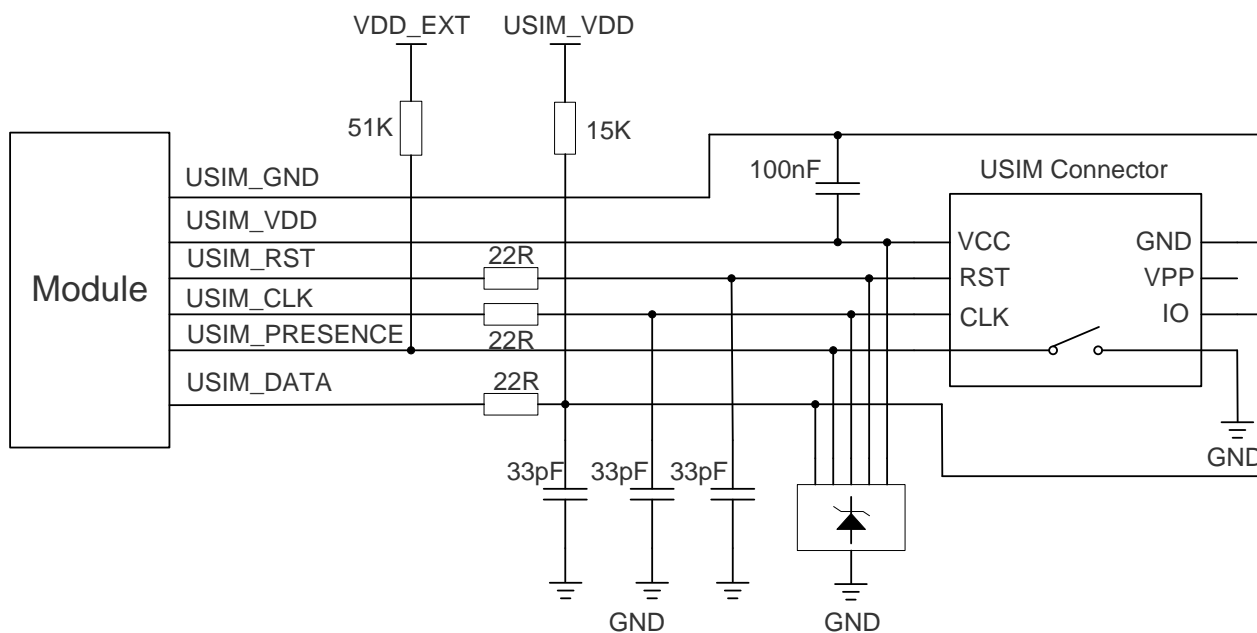


Figure 22: Reference Circuit of the 8 Pin USIM Card

NOTE

Some AT commands are invalid when USIM card is not applied.

UC20 supports USIM card hot-plugging via the USIM_PRESENCE pin. For details, refer to **document [1]** about the command **AT+QSIMDET**. If you do not need the USIM card detection function, keep USIM_PRESENCE unconnected. The reference circuit for using a 6-pin USIM card connector is illustrated as the following figure.

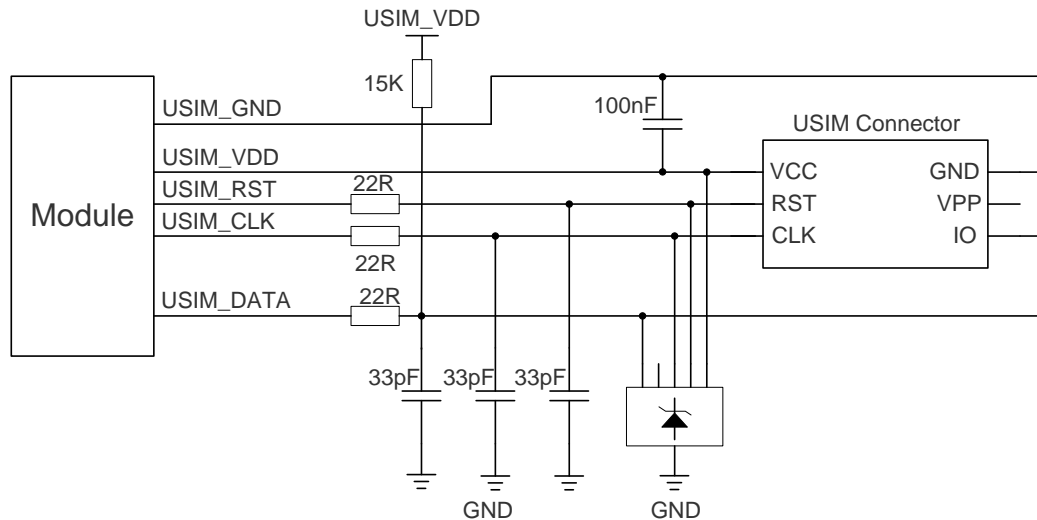


Figure 23: Reference Circuit of the 6 Pin USIM Card

In order to enhance the reliability and availability of the USIM card in your application, please follow the following criterion in the USIM circuit design:

- Keep layout of USIM card as close as possible to the module. Assure the length of the trace is less than 200mm.
- Keep USIM card signal away from RF and VBAT alignment.
- Assure the ground between module and USIM connector short and wide. Keep the width of ground and USIM_VDD no less than 0.5mm to maintain the same electric potential. The decouple capacitor of USIM_VDD should be less than 1uF and must be near to USIM connector.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away with each other and shield them with surrounded ground.
- In order to offer good ESD protection, it is recommended to add TVS. The 22Ω resistors should be added in series between the module and the USIM card so as to suppress the EMI spurious transmission and enhance the ESD protection. The 33pF capacitors are used for filtering interference of EGSM900. Please note that the USIM peripheral circuit should be close to the USIM connector.
- The pull-up resistor on USIM_DATA line can improve anti-jamming capability when long layout trace and sensitive occasion is applied, and should be placed close to the USIM connector.

3.12. USB Interface

UC20 contains one integrated Universal Serial Bus (USB) transceiver which complies with the USB 2.0 specification and supports high speed (480 Mbps), full speed (12 Mbps) and low speed (1.5 Mbps) mode. The USB interface is primarily used for AT command, data transmission, GNSS NMEA sentences output, software debug and firmware upgrade. The following table shows the pin definition of USB interface.

Table 13: USB Pin Description

Pin Name	Pin No.	I/O	Description	Comment
USB_DP	69	IO	USB differential data bus (positive).	Require differential impedance of 90Ω.
USB_DM	70	IO	USB differential data bus (minus).	Require differential impedance of 90Ω.
USB_VBUS	71	PI	Used for detecting the USB interface connected.	3.0~5.25V. Typical 5.0V.
GND	72		Ground.	

More details about the USB 2.0 specifications, please visit <http://www.usb.org/home>.

The following figure shows the reference circuit of USB interface.

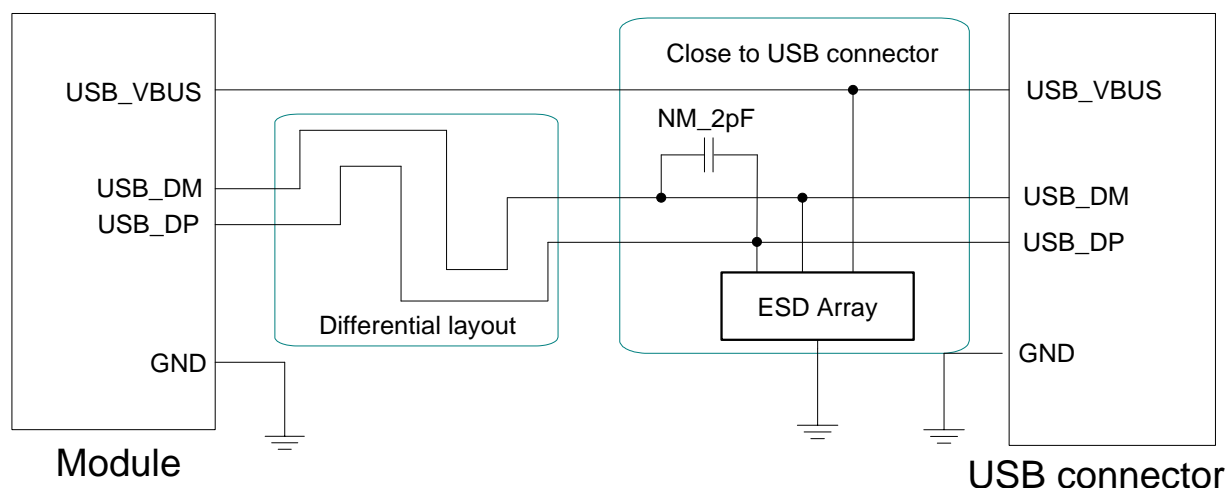


Figure 24: Reference Circuit of USB Application

In order to ensure the USB interface design corresponding with the USB 2.0 specification, please comply with the following principles.

- It is important to route the USB signal traces as differential pairs with total grounding. The impedance of USB differential trace is 90ohm.
- Do not route signal traces under crystals, oscillators, magnetic devices and RF signal traces. It is important to route the USB differential traces in inner-layer with ground shielding not only upper and lower layer but also right and left side.
- Pay attention to the influence of junction capacitance of ESD component on USB data lines. Typically, the capacitance value should be less than 2pF.
- Keep the ESD components as closer to the USB connector as possible.

NOTE

UC20 module can only be used as a slave device.

The USB interface is recommended to be reserved for firmware upgrade in your design. The following figure shows the recommended test points.

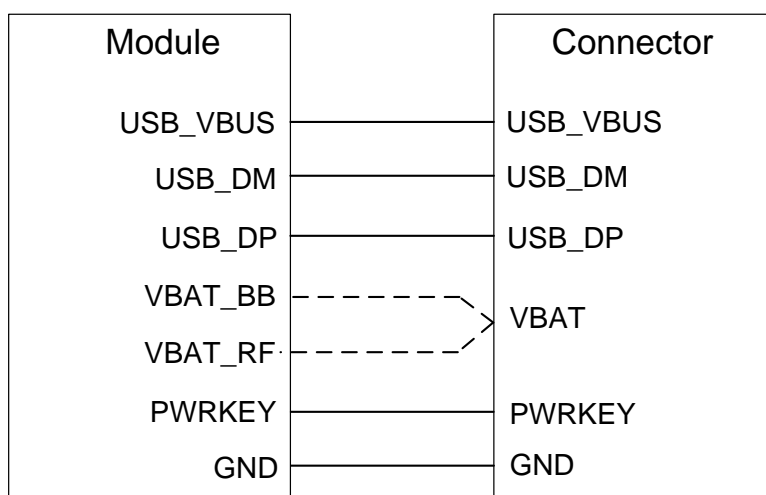


Figure 25: Test Points of Firmware Upgrade

3.13. PCM and I2C Interface

UC20 provides one Pulse Code Modulation (PCM) digital interface for audio design, which supports the following modes:

- Primary mode (short sync, works as both master and slave)
- Auxiliary mode (long sync, works as master only)

In primary mode, the data is sampled on the falling edge of the PCM_CLK and transmitted on the rising edge; the PCM_SYNC falling edge represents the MSB. In this mode, PCM_CLK supports 128, 256, 512, 1024, 2048 and 4096kHz for different speech codec.

In auxiliary mode, the data is sampled on the falling edge of the PCM_CLK and transmitted on the rising edge; while the PCM_SYNC rising edge represents the MSB. In this mode, PCM interface operates with a 128kHz PCM_CLK and an 8kHz, 50% duty cycle PCM_SYNC only.

UC20 supports 8-bit A-law and μ -law, and also 16-bit linear data formats. The following figures show the primary mode's timing relationship with 8kHz PCM_SYNC and 2048kHz PCM_CLK and auxiliary mode's timing relationship with 8kHz PCM_SYNC and 128kHz PCM_CLK.

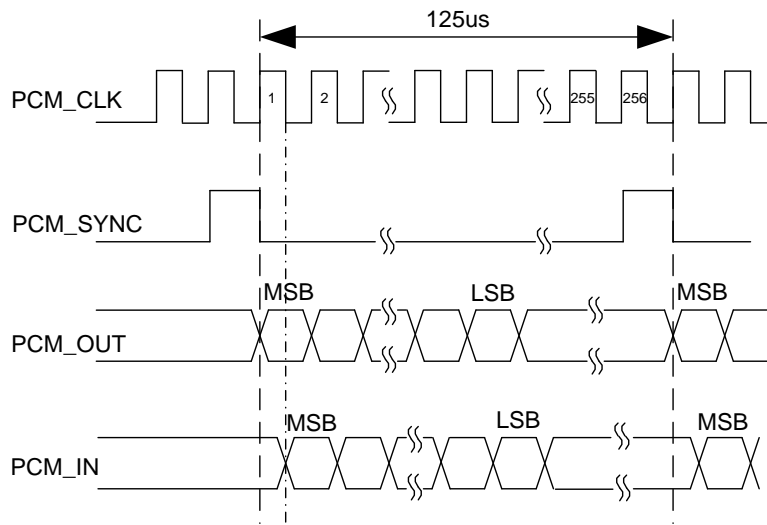


Figure 26: Primary Mode Timing

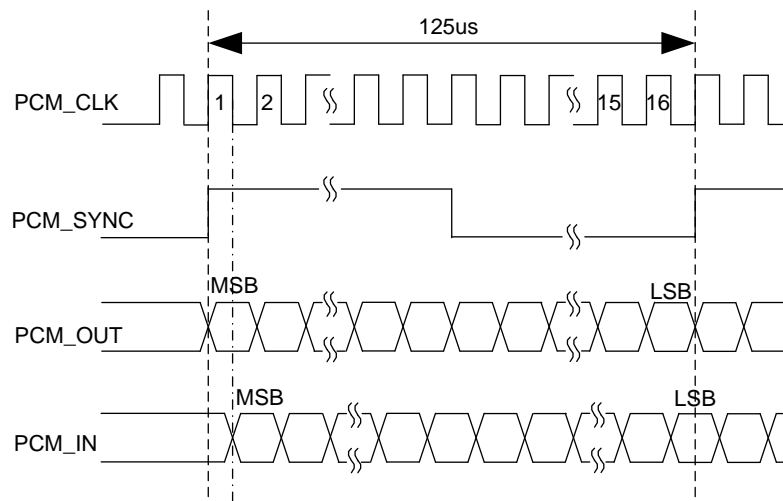


Figure 27: Auxiliary Mode Timing

The following table shows the pin definition of PCM and I2C interface which can be applied on audio codec design.

Table 14: Pin Definition of PCM and I2C Interface

Pin Name	Pin No.	I/O	Description	Comment
PCM_IN	24	DI	PCM data input.	1.8V power domain.
PCM_OUT	25	DO	PCM data output.	1.8V power domain.
PCM_SYNC	26	IO	PCM data frame sync signal.	1.8V power domain.
PCM_CLK	27	IO	PCM data bit clock.	1.8V power domain.
I2C_SCL	41	OD	I2C serial clock.	Require external pull-up resistor. 1.8V only.
I2C_SDA	42	OD	I2C serial data.	Require external pull-up resistor. 1.8V only.

Clock and mode can be configured by AT command, and the default configuration is master mode using short sync data format with 2048kHz PCM_CLK and 8kHz PCM_SYNC. In addition, UC20's firmware has integrated the configuration on NAU8814 application with I2C interface. Refer to **document [1]** about the command **AT+QDAI** for details.

The following figure shows the reference design of PCM interface with external codec IC.

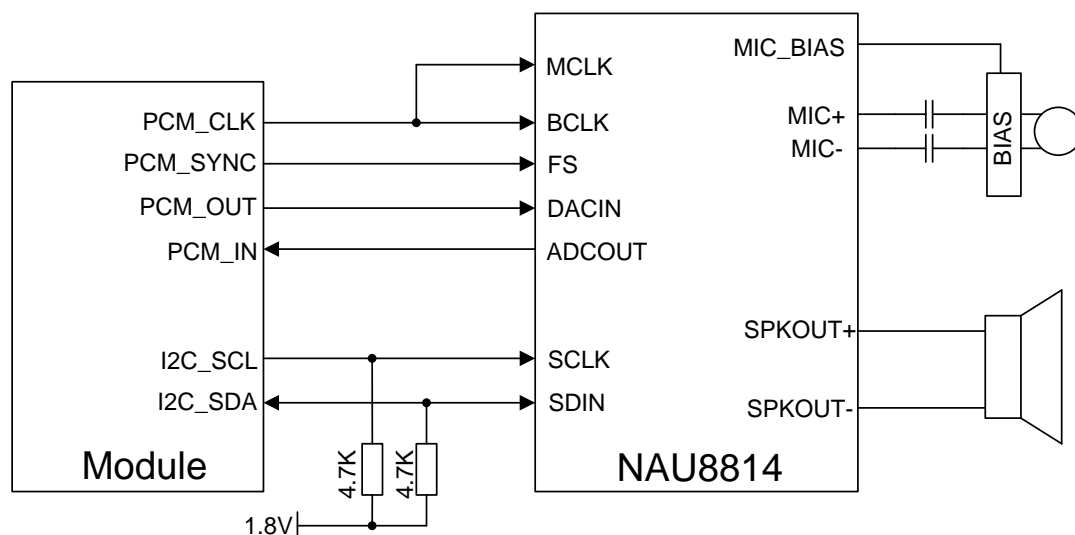


Figure 28: Reference Circuit of PCM Application with Audio Codec

NOTES

1. It is recommended to reserved RC (R=22Ω, C=22pF) circuit on the PCM lines, especially for PCM_CLK.
2. UC20 works as a master device pertaining to I2C interface.

3.14. ADC Function

The module provides two analog-to-digital converters (ADC) to digitize the analog signal to 15-bit digital data such as battery voltage, temperature and so on. Using AT command **AT+QADC=0** can read the voltage value on ADC0 pin. Using AT command **AT+QADC=1** can read the voltage value on ADC1 pin. For more details of these AT commands, please refer to **document [1]**.

In order to improve the accuracy of ADC, the trace of ADC should be surrounded by ground.

Table 15: Pin Definition of the ADC

Pin Name	Pin No.	Description
ADC0	45	General purpose analog to digital converter.
ADC1	44	General purpose analog to digital converter.

The following table describes the characteristic of the ADC function.

Table 16: Characteristic of the ADC

Parameter	Min.	Typ.	Max.	Unit
ADC0 Voltage Range	0.2		2.1	V
ADC1 Voltage Range	0.2		4.2	V
ADC Resolution		15		bits
Offset Error		3.5		%
Gain Error		2.5		%

3.15. Network Status Indication

The network indication pins can be used to drive a network status indicator LED. The module provides two pins which are NET_MODE and NET_STATUS. The following tables describe pin definition and logic level changes in different network status.

Table 17: Pin Definition of Network Indicator

Pin Name	Pin No.	I/O	Description	Comment
NET_MODE	5	DO	Indicate the module network registration mode.	1.8V power domain
NET_STATUS	6	DO	Indicate the module network activity status.	1.8V power domain

Table 18: Working State of the Network Indicator

Pin Name	Status	Description
NET_MODE	Always High	Registered in 3G network
	Always Low	Others
NET_STATUS	Flicker slowly (200ms High/1800ms Low)	Network searching
	Flicker slowly (1800ms High/200ms Low)	Idle
	Flicker quickly (125ms High/125ms Low)	Data transfer is ongoing
	Always High	Voice calling

A reference circuit is shown in the following figure.

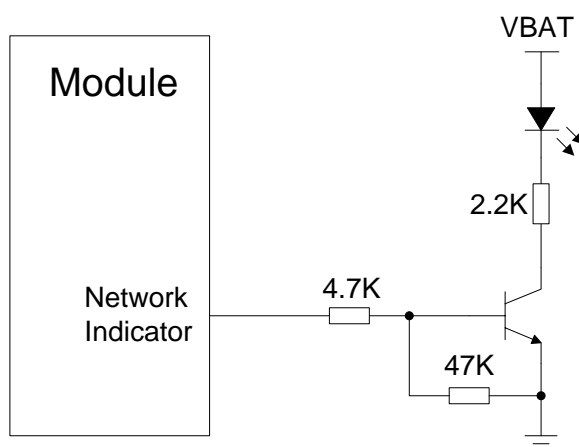


Figure 29: Reference Circuit of the Network Indicator

3.16. Operating Status Indication

3.16.1. STATUS

The STATUS pin is an open drain output for indicating the module operation status. You can connect it to a GPIO of DTE with pulled up, or as LED indication circuit as below. When the module is turned on normally, the STATUS will present the low state. Otherwise, the STATUS will present high-impedance state.

Table 19: Pin Definition of STATUS

Pin Name	Pin No.	I/O	Description	Comment
STATUS	61	OD	Indicate the module operation status.	Require external pull-up.

The following figure shows different design circuit of STATUS, you can choose either one according to your application demands.

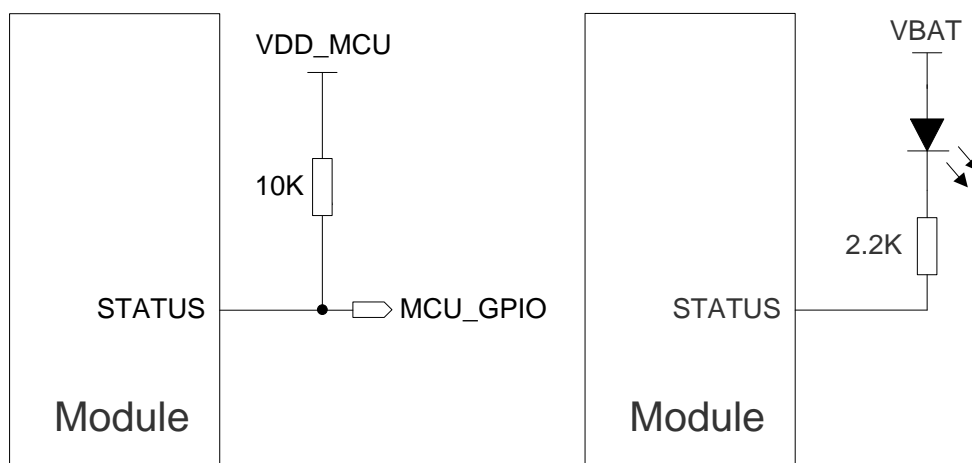


Figure 30: Reference Circuit of the STATUS

3.16.2. SLEEP_IND

The SLEEP_IND is an indicated pin for judging whether the module is in sleep mode or not. When the module enters into the sleep mode, the SLEEP_IND will output a logic high level. So you can use the SLEEP_IND for low current indication. The following table shows the pin definition of SLEEP_IND.

Table 20: Pin Definition of SLEEP_IND

Pin Name	Pin No.	I/O	Description	Comment
SLEEP_IND	3	DO	Indicate the sleep status.	1.8V power domain. Outputs high level when the module is in sleep mode.

A reference circuit is shown in the following figure.

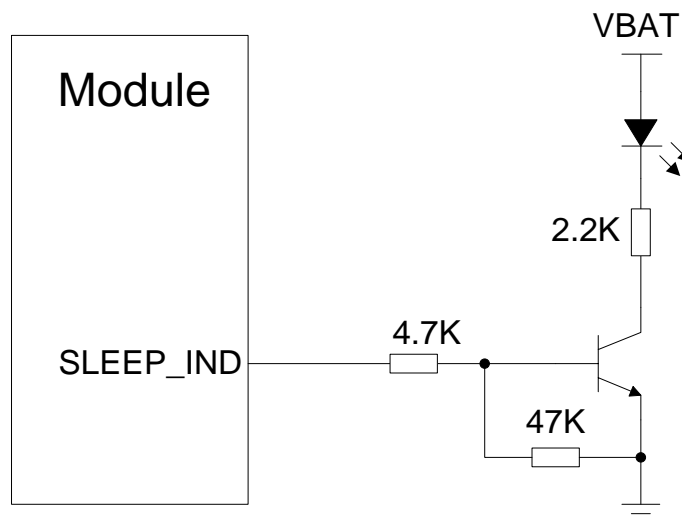


Figure 31: Reference Circuit of the SLEEP_IND

Module still periodically monitors the paging channel of the current base station (paging block reception) during the sleep mode. When the module monitors the paging channel, it wakes up to active mode, to enable the reception of paging block. In between, the module switches to sleep mode.

The following figure shows the paging timing cycle (T) during sleep mode.

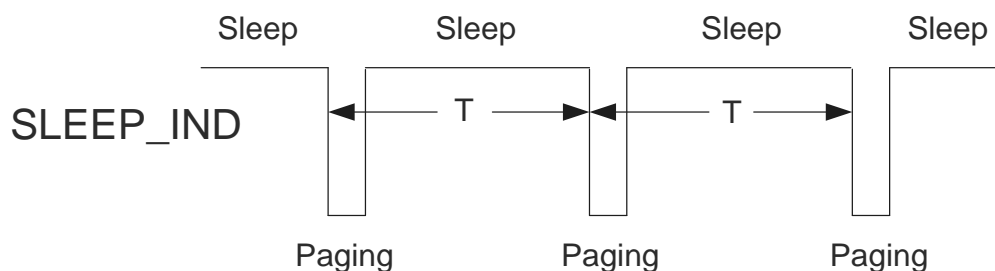


Figure 32: Relationship between Sleep and Network Paging

As to GSM network, the paging period time can be calculated with the following formula.

$$T = 4.615\text{ms} \times 51 \times \text{DRX}$$

As to WCDMA network, the paging period time can be calculated with the following formula.

$$T = 10\text{ms} \times 2^{\text{DRX}}$$

DRX (Discontinuous Reception) is a value from 2 to 9 in GSM network, resulting in paging intervals 470.6ms to 2118.42ms, and a value from 6 to 9 in WCDMA network, resulting in paging intervals from 640ms to 5120ms.

3.17. Behavior of the RI

You can use command **AT+QCFG="risignalttype", "physical"** to configure RI behavior:

No matter which port URC is presented on, URC will trigger the behavior on RI pin.

NOTE

URC can be output from UART port, USB AT port and USB modem port by command **AT+QURCCFG**. The default port is USB AT port.

In additional, RI behavior can be configured flexible. The default behavior of the RI is shown as below.

Table 21: Behavior of the RI

State	Response
Idle	RI keeps high level.
URC	RI outputs 120ms low pulse when new URC returns.

The RI behavior can be changed by command **AT+QCFG="urc/ri/ring"**, refer to *document [1]* for details.

4 GNSS Receiver

4.1. General Description

UC20 includes a fully integrated global navigation satellite system solution that supports the latest generation gpsOne Gen8 of Qualcomm (GPS and GLONASS). Compared with GPS only, dual systems increase usable constellation, reduce coverage gaps and TTFF, and increase positioning accuracy, especially in rough urban environments.

UC20 works in standalone mode, allows device to demodulate GNSS assistance data, calculate position without any assistance from the network, suitable for various application needing lowest-cost, accurate position determination. UC20 supports Qualcomm gpsOneXTRA technology (one kind of A-GNSS), which will download XTRA file from the internet server to enhance the TTFF. XTRA file contains predicted GPS and GLONASS satellites coordinates and clock biases valid for up to 7days. It is the best if XTRA file is downloaded once every 1-2 days. And UC20 also supports SBAS (including WAAS, EGNOS and MSAS), which will improve fix accuracy.

UC20 provides power-saving solution named DPO (Dynamic Power Optimization), which attempts to turn off GNSS RF parts, reduces current consumption by 50% at most without impact on TTFF, thus extends battery life, and maximizes talk and standby time as well.

UC20 supports standard NMEA-0183 protocol, and outputs NMEA sentences with 1Hz via USB interface by default.

By default, UC20 GNSS engine is switched off, it has to be switched on with AT command. For more details about GNSS engine technology and configurations, refer to **document [7]**.

4.2. GNSS Performance

The following table shows UC20 GNSS performance.

Table 22: GNSS Performance

Parameter	Description	Conditions	Typ.	Unit
Sensitivity (GNSS)	Cold start	Autonomous	-144	dBm
		With LNA	-147	dBm
	Reacquisition	Autonomous	-154	dBm
		With LNA	-159	dBm
	Tracking	Autonomous	-155	dBm
		With LNA	-161	dBm
TTFF (GNSS)	Cold start @open sky	Autonomous	32	s
		XTRA enabled	22	s
	Warm start @open sky	Autonomous	29	s
		XTRA enabled	3	s
	Hot start @open sky	Autonomous	2.5	s
		XTRA enabled	2	s
Accuracy (GNSS)	CEP-50	Autonomous @open sky	<1.5	m

NOTES

1. Tracking sensitivity: the lowest GPS signal value at the antenna port for which the module can keep on positioning for 3 minutes.
2. Reacquisition sensitivity: the lowest GPS signal value at the antenna port for which the module can fix position again within 3 minutes after loss of lock.
3. Cold start sensitivity: the lowest GPS signal value at the antenna port for which the module fixes position within 3 minutes after executing cold start command.

4.3. Layout Guideline

The following layout guideline should be taken into account in your design.

- Maximize the distance between the GNSS antenna and the main GSM/UMTS antenna.
- Noisy digital circuits such as the USIM card, USB interface, Camera module, Display connector and SD card should be away from the antenna.
- Use ground vias around the GNSS trace and sensitive analog signal traces to provide coplanar isolation and protection.
- Keep 50 ohm characteristic impedance of the ANT_GNSS trace.

Refer to **Chapter 5** for GNSS reference design and antenna consideration.

5 Antenna Interface

UC20 antenna interface includes a main GSM/UMTS antenna, an optional UMTS Rx-diversity antenna, which is used to improve UMTS's receiving performance, and a GNSS antenna. The antenna interface has an impedance of 50Ω.

5.1. GSM/UMTS Antenna Interface

5.1.1. Pin Definition

The main antenna and UMTS Rx-diversity antenna pins definition are shown below.

Table 23: Pin Definition of the RF Antenna

Pin Name	Pin No.	I/O	Description	Comment
ANT_MAIN	49	IO	Main antenna	50Ω impedance
ANT_DIV	35	AI	Diversity antenna	50Ω impedance

5.1.2. Operating Frequency

Table 24: The Module Operating Frequencies

Band	Receive	Transmit	Unit
GSM850	869 ~ 894	824 ~ 849	MHz
EGSM900	925 ~ 960	880 ~ 915	MHz
DCS1800	1805 ~ 1880	1710 ~ 1785	MHz
PCS1900	1930 ~ 1990	1850 ~ 1910	MHz
UMTS 2100	2110 ~ 2170	1920 ~ 1980	MHz
UMTS 1900	1930 ~ 1990	1850 ~ 1910	MHz

UMTS 900	925 ~ 960	880 ~ 915	MHz
UMTS 850	869 ~ 894	824 ~ 849	MHz
UMTS 800	875 ~ 885	830 ~ 840	MHz

5.1.3. Reference Design

The reference design of main antenna and UMTS Rx-diversity antenna is shown as below. It should reserve a π -type matching circuit for better RF performance. The capacitors are not mounted by default.

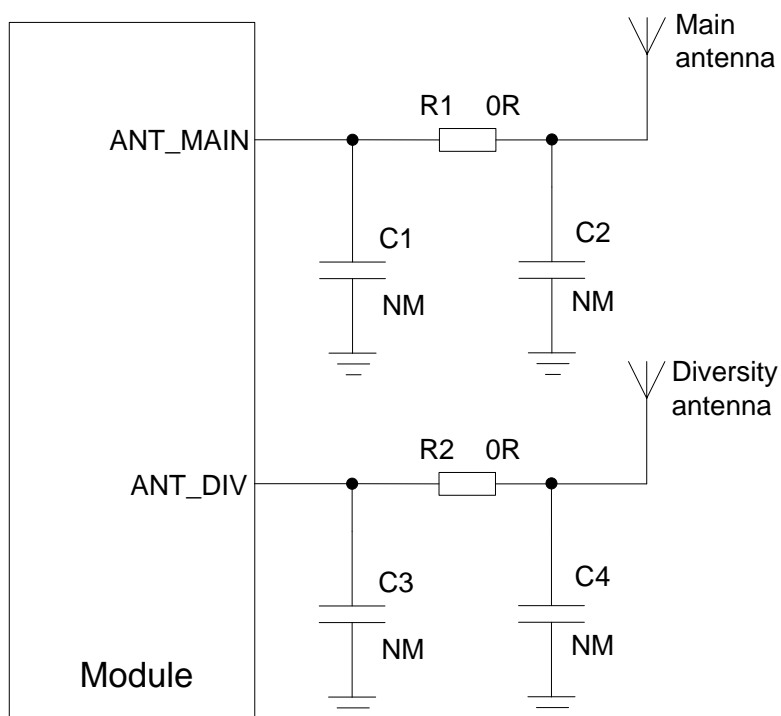


Figure 33: Reference Circuit of Antenna Interface

NOTE

Keep a proper distance between main antenna and diversity antenna to improve the receiving sensitivity.

5.2. GNSS Antenna Interface

The following tables show the GNSS antenna pin definition and frequency specification.

Table 25: Pin Definition of GNSS Antenna

Pin Name	Pin No.	I/O	Description	Comment
ANT_GNSS	47	AI	GNSS antenna	50Ω impedance

Table 26: GNSS Frequency

Type	Frequency	Unit
GPS	1575.42±1.023	MHz
GLONASS	1597.5 ~ 1605.8	MHz

5.2.1. Reference Design for Passive Antenna

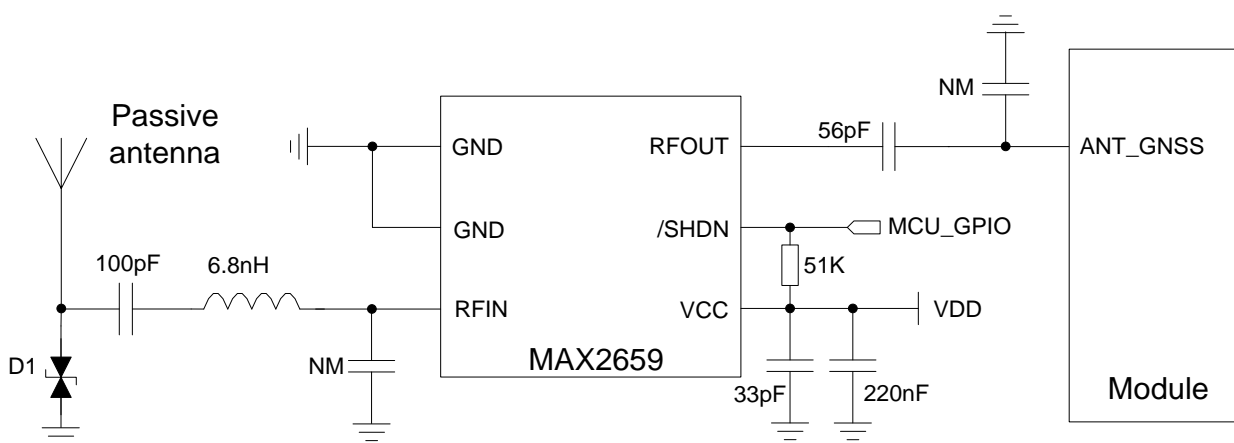


Figure 34: Reference Circuit of GNSS Passive Antenna

5.2.2. Reference Design for Active Antenna

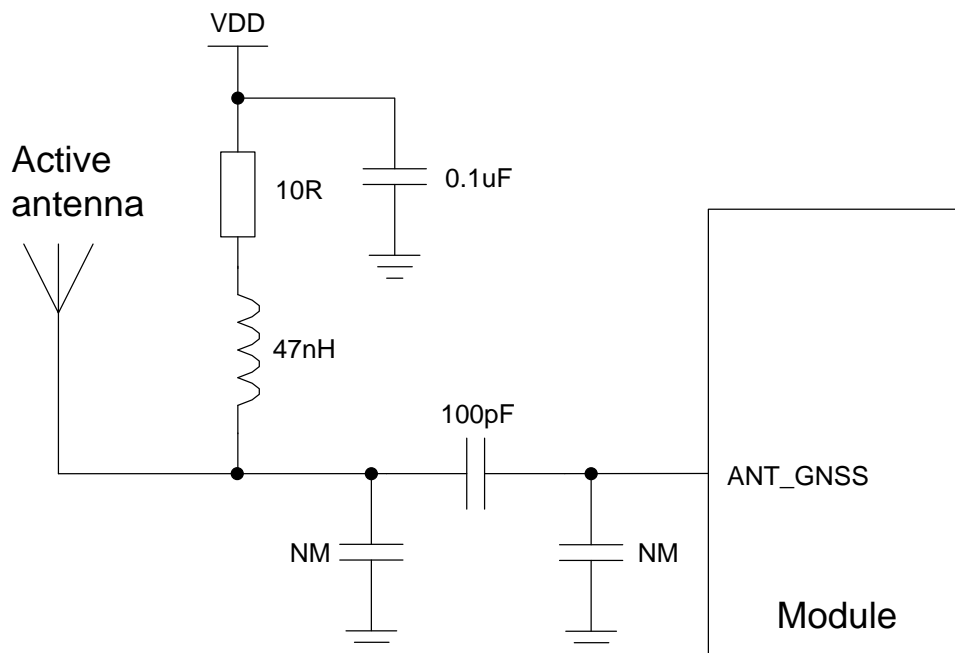


Figure 35: Reference Circuit of GNSS Active Antenna

NOTES

1. You can choose the corresponding reference circuit above according to your demands on antenna circuit design.
2. MAX2659 is the recommended LNA chip. You can disable LNA to save power with one GPIO shown in above figure. Pay attention to this pin's voltage level.
3. VDD supplies power for active antenna. You can choose the right VDD according to the requirements for active antenna. This power circuit is not needed if passive antenna is applied here.
4. All NM capacitors are reserved for adjusting RF performance.
5. The capacitance of ESD component D1 should be less than 1pF.

5.3. Antenna Installation

5.3.1. Antenna Requirement

The following table shows the requirement on GSM/UMTS antenna and GNSS antenna.

Table 27: Antenna Requirements

Type	Requirements
GNSS	Frequency range: 1565~1607 MHz Polarization: RHCP or linear VSWR: < 2 (Typ.) Passive antenna gain: > 0dBi Active antenna noise figure: < 1.5dB Active antenna gain: > -2dBi Active antenna embedded LNA gain: 20dB (Typ.) Active antenna total gain: > 18dBi (Typ.)
GSM/UMTS	VSWR: ≤ 2 Gain (dBi): 1 Max Input Power (W): 50 Input Impedance (ohm): 50 Polarization Type: Vertical Cable Insertion Loss: < 1dB (GSM850/900, UMTS800/850/900) Cable Insertion Loss: < 1.5dB (GSM1800/1900, UMTS1900/2100)

5.3.2. Install the Antenna with RF Connector

The following figure is the antenna installation with RF connector provided by HIROSE. The recommended RF connector is UF.L-R-SMT.

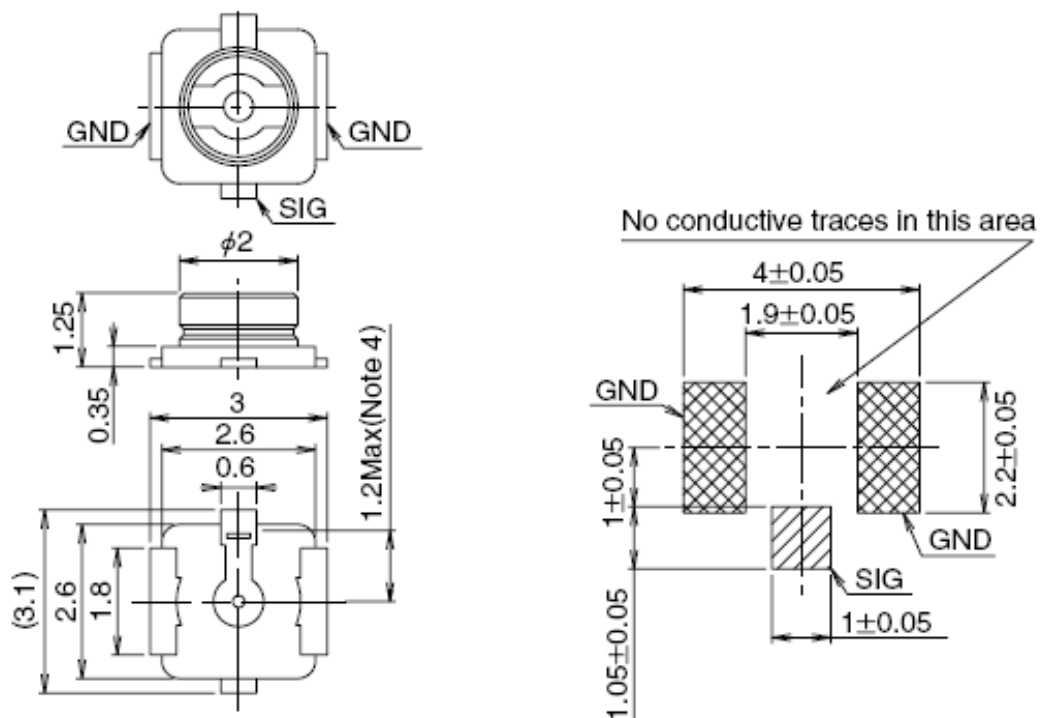


Figure 36: Dimensions of the UF.L-R-SMT Connector (Unit: mm)

You can use U.FL-LP serial connector listed in the following figure to match the UF.L-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 37: Mechanicals of UF.L-LP Connectors

The following figure describes the space factor of mated connector.

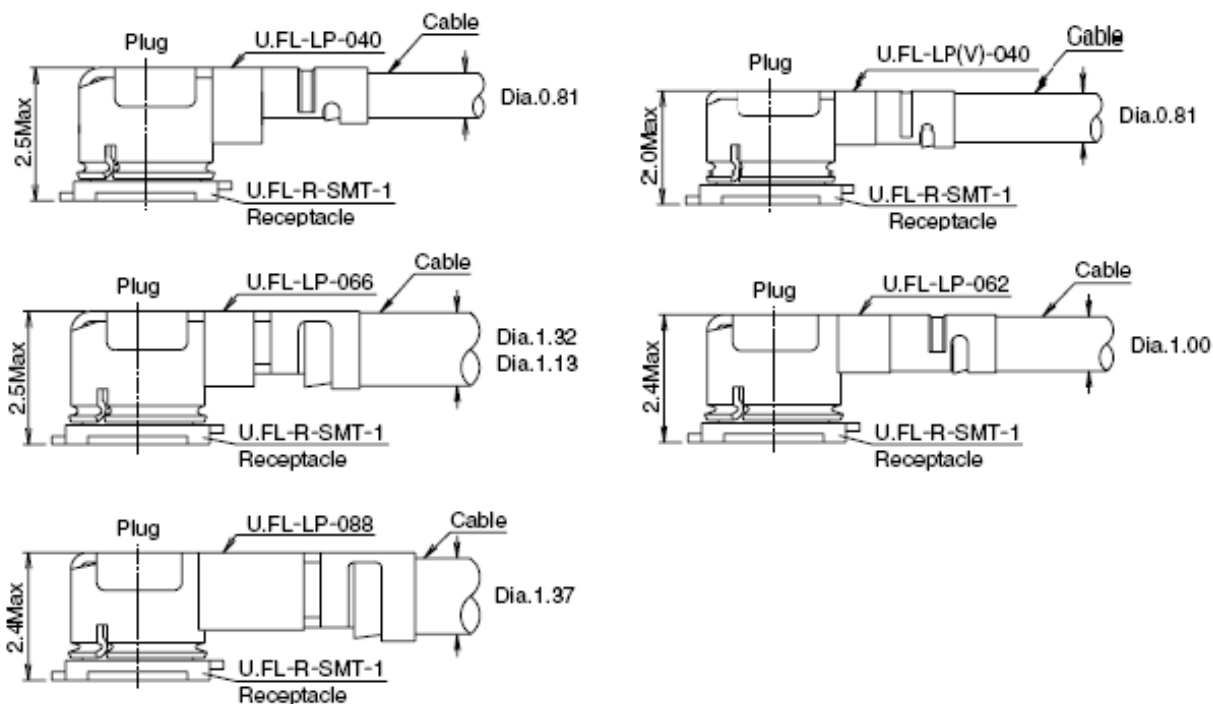


Figure 38: Space Factor of Mated Connector (Unit: mm)

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

6 Electrical, Reliability and Radio Characteristics

6.1. Absolute Maximum Ratings

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

Table 28: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT_RF/VBAT_BB	-0.3	4.7	V
USB_VBUS	-0.3	5.5	V
Peak Current of VBAT_BB	0	0.8	A
Peak Current of VBAT_RF	0	1.8	A
Voltage at Digital Pins	-0.3	2.3	V
Voltage at ADC0	0	2.1	V
Voltage at ADC1	0	4.2	V

6.2. Power Supply Ratings

Table 29: The Module Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VBAT	VBAT_BB and VBAT_RF	Voltage must stay within the min/max values, including voltage	3.3	3.8	4.3	V

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
		drop, ripple and spikes.				
	Voltage drop during transmitting burst	Maximum power control level on GSM850 and EGSM900.			400	mV
I _{VBAT}	Peak supply current (during transmission slot)	Maximum power control level on GSM850 and EGSM900.		1.8	2.0	A
USB_VBUS	USB detection		3.0	5.0	5.25	V

6.3. Operating Temperature

The operating temperature is listed in the following table.

Table 30: Operating Temperature

Parameter	Min.	Typ.	Max.	Unit
Normal Temperature	-35	25	75	°C
Restricted Operation	-40~ -35		75 ~ 85	°C
Storage Temperature	-45		90	°C

NOTE

The maximum surface temperature may be up to 100°C when module works at 85°C ambient temperature.

6.4. Current Consumption

The values of current consumption are shown below.

Table 31: The Module Current Consumption

Parameter	Description	Conditions	Typ.	Unit	
I_{VBAT}	OFF state supply current	Power down	45	uA	
	GSM/GPRS supply current	Sleep (USB disconnected)	3.6 @DRX=2	mA	
			1.5 @DRX=9	mA	
		Sleep (USB suspended)	3.7 @DRX=2	mA	
			1.6 @DRX=9	mA	
		Idle (USB disconnected)	15.0 @DRX=2	mA	
			Idle (USB connected)	32.0 @DRX=2	mA
		WCDMA supply current	Sleep (USB disconnected)	2.9 @DRX=6	mA
				1.1 @DRX=9	mA
			Sleep (USB suspended)	3.0 @DRX=6	mA
				1.2 @DRX=9	mA
	Idle (USB disconnected)		15.0 @DRX=6	mA	
			Idle (USB connected)	34.0 @DRX=6	mA
	GPRS data transfer (GNSS off)	GSM850 1DL/1UL PCL=5	260	mA	
			GSM850 4DL/1UL PCL=5	276	mA
			GSM850 3DL/2UL PCL=5	385	mA
			GSM850 2DL/3UL PCL=5	483	mA
			GSM850 1DL/4UL PCL=5	554	mA
		EGSM900 1DL/1UL PCL=5	275	mA	
			EGSM900 4DL/1UL PCL=5	312	mA
EGSM900 3DL/2UL PCL=5			448	mA	
EGSM900 2DL/3UL PCL=5			540	mA	
EGSM900 1DL/4UL PCL=5			610	mA	
DCS1800 1DL/1UL PCL=0			196	mA	

	DCS1800 4DL/1UL PCL=0	204	mA
	DCS1800 3DL/2UL PCL=0	299	mA
	DCS1800 2DL/3UL PCL=0	368	mA
	DCS1800 1DL/4UL PCL=0	432	mA
	PCS1900 1DL/1UL PCL=0	238	mA
	PCS1900 4DL/1UL PCL=0	247	mA
	PCS1900 3DL/2UL PCL=0	256	mA
	PCS1900 2DL/3UL PCL=0	467	mA
	PCS1900 1DL/4UL PCL=0	572	mA
	GSM850 1DL/1UL PCL=8	190	mA
	GSM850 4DL/1UL PCL=8	210	mA
	GSM850 3DL/2UL PCL=8	306	mA
	GSM850 2DL/3UL PCL=8	400	mA
	GSM850 1DL/4UL PCL=8	494	mA
	EGSM900 1DL/1UL PCL=8	185	mA
	EGSM900 4DL/1UL PCL=8	197	mA
	EGSM900 3DL/2UL PCL=8	293	mA
EDGE data transfer (GNSS off)	EGSM900 2DL/3UL PCL=8	386	mA
	EGSM900 1DL/4UL PCL=8	480	mA
	DCS1800 1DL/1UL PCL=2	162	mA
	DCS1800 4DL/1UL PCL=2	165	mA
	DCS1800 3DL/2UL PCL=2	245	mA
	DCS1800 2DL/3UL PCL=2	322	mA
	DCS1800 1DL/4UL PCL=2	399	mA
	PCS1900 1DL/1UL PCL=2	189	mA
	PCS1900 4DL/1UL PCL=2	189	mA

	PCS1900 3DL/2UL PCL=2	298	mA	
	PCS1900 2DL/3UL PCL=2	401	mA	
	PCS1900 1DL/4UL PCL=2	503	mA	
WCDMA data transfer (GNSS off)	UMTS Band I HSDPA @max power	557	mA	
	UMTS Band I HSUPA @max power	542	mA	
	UMTS Band II HSDPA @max power	549	mA	
	UMTS Band II HSUPA @max power	536	mA	
	UMTS Band V HSDPA @max power	593	mA	
	UMTS Band V HSUPA @max power	576	mA	
	UMTS Band VI HSDPA @max power	530	mA	
	UMTS Band VI HSUPA @max power	493	mA	
	UMTS Band VIII HSDPA @max power	539	mA	
	UMTS Band VIII HSUPA @max power	505	mA	
	GSM voice call	GSM850 @PCL=5	292	mA
		EGSM900 @PCL=5	293	mA
DCS1800 @PCL=0		235	mA	
PCS1900 @PCL=0		288	mA	
WCDMA voice call	UMTS Band I @max power	531	mA	
	UMTS Band II @max power	532	mA	
	UMTS Band V @max power	528	mA	
	UMTS Band VI @max power	470	mA	
	UMTS Band VIII @max power	490	mA	
GNSS off		34.0	mA	
Cold start (Autonomous)		83.8	mA	
Tracking (Autonomous)	Idle, USB active @WCDMA DRX=6	74.6	mA	
Tracking (DPO on)		51.7	mA	

NOTE

GNSS tracking current is tested in the following conditions:

- For Cold Start, 10 minutes after First Fix.
- For Hot Start, 15 seconds after First Fix.

6.5. RF Output Power

The following table shows the RF output power of UC20 module.

Table 32: Conducted RF Output Power

Frequency	Max.	Min.
GSM850	33dBm±2dB	5dBm±5dB
EGSM900	33dBm±2dB	5dBm±5dB
DCS1800	30dBm±2dB	0dBm±5dB
PCS1900	30dBm±2dB	0dBm±5dB
GSM850 (8-PSK)	27dBm±3dB	5dBm±5dB
EGSM900 (8-PSK)	27dBm±3dB	5dBm±5dB
DCS1800 (8-PSK)	26dBm±3dB	0dBm±5dB
PCS1900 (8-PSK)	26dBm±3dB	0dBm±5dB
UMTS 2100	24dBm+1/-3dB	<-50dBm
UMTS 1900	24dBm+1/-3dB	<-50dBm
UMTS 900	24dBm+1/-3dB	<-50dBm
UMTS 850	24dBm+1/-3dB	<-50dBm
UMTS 800	24dBm+1/-3dB	<-50dBm

NOTE

In GPRS 4 slots TX mode, the max output power is reduced by 2.5dB. This design conforms to the GSM specification as described in chapter 13.16 of 3GPP TS 51.010-1.

6.6. RF Receiving Sensitivity

The following table shows the conducted RF receiving sensitivity of UC20 module.

Table 33: Conducted RF Receiving Sensitivity

Frequency	Receive Sensitivity (Typ.)
GSM850	-108.5dBm
EGSM900	-108.5dBm
DCS1800	-108dBm
PCS1900	-108dBm
UMTS 2100	-110dBm
UMTS 1900	-110dBm
UMTS 900	-110dBm
UMTS 850	-110dBm
UMTS 800	-110dBm

6.7. Electrostatic Discharge

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 electrostatics discharge characteristics.

Table 34: Electrostatics Discharge Characteristics

Tested Points	Contact Discharge	Air Discharge	Unit
VBAT, GND	±5	±10	kV
All Antenna Interfaces	±4	±8	kV
Other Interfaces	±0.5	±1	kV

7 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module. All dimensions are measured in mm.

7.1. Mechanical Dimensions of the Module

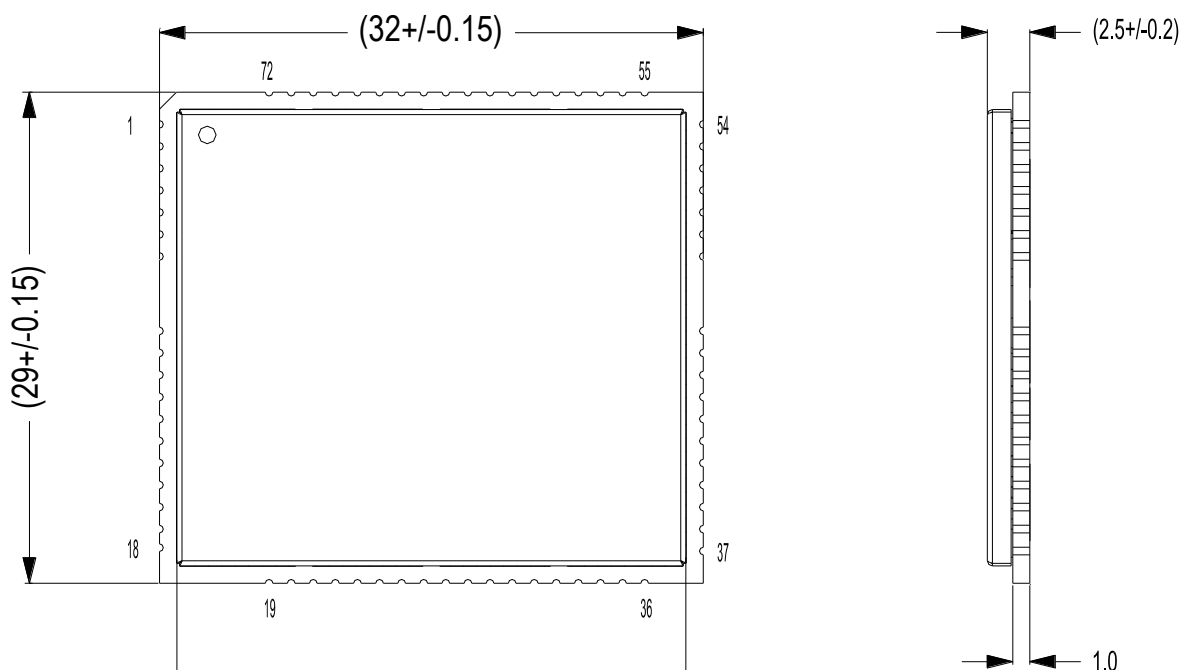


Figure 39: UC20 Top and Side Dimensions

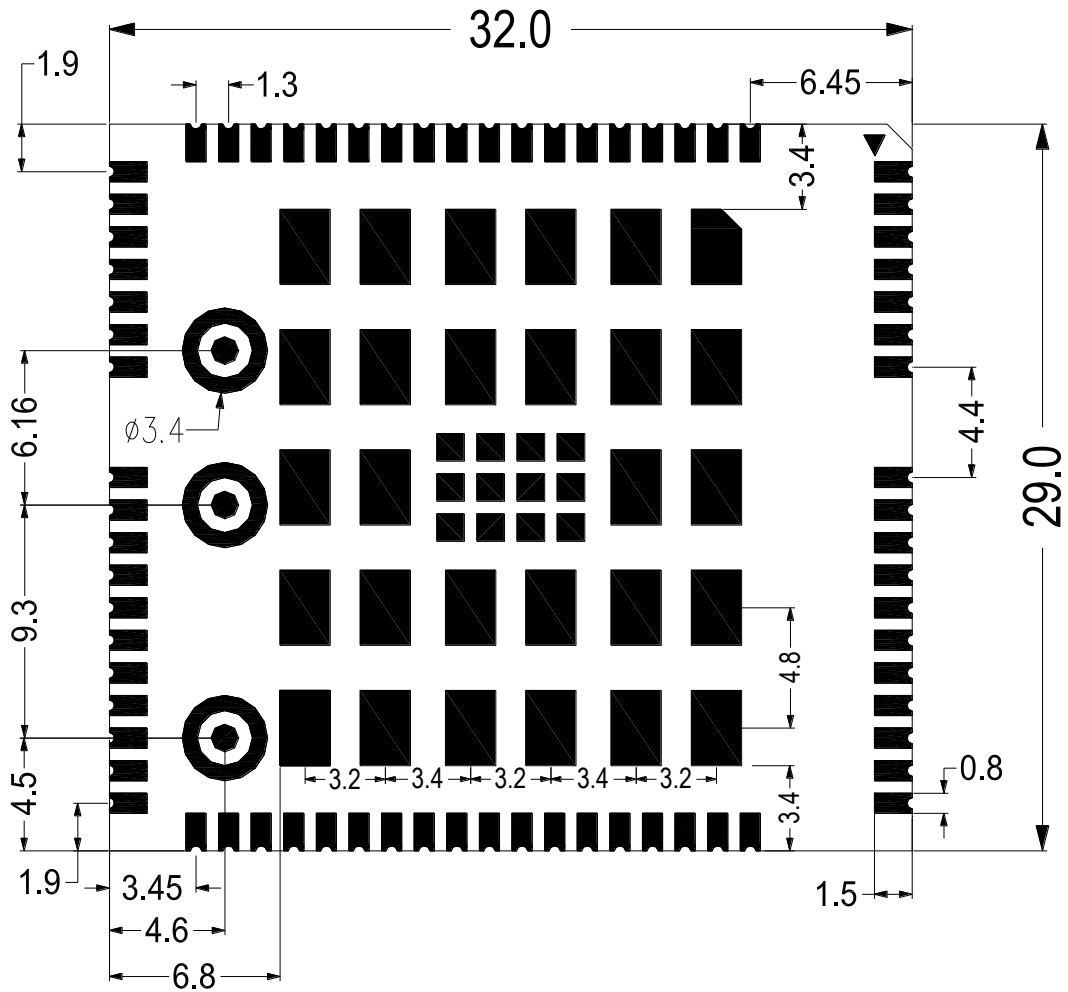


Figure 40: UC20 Bottom Dimensions (Bottom View)

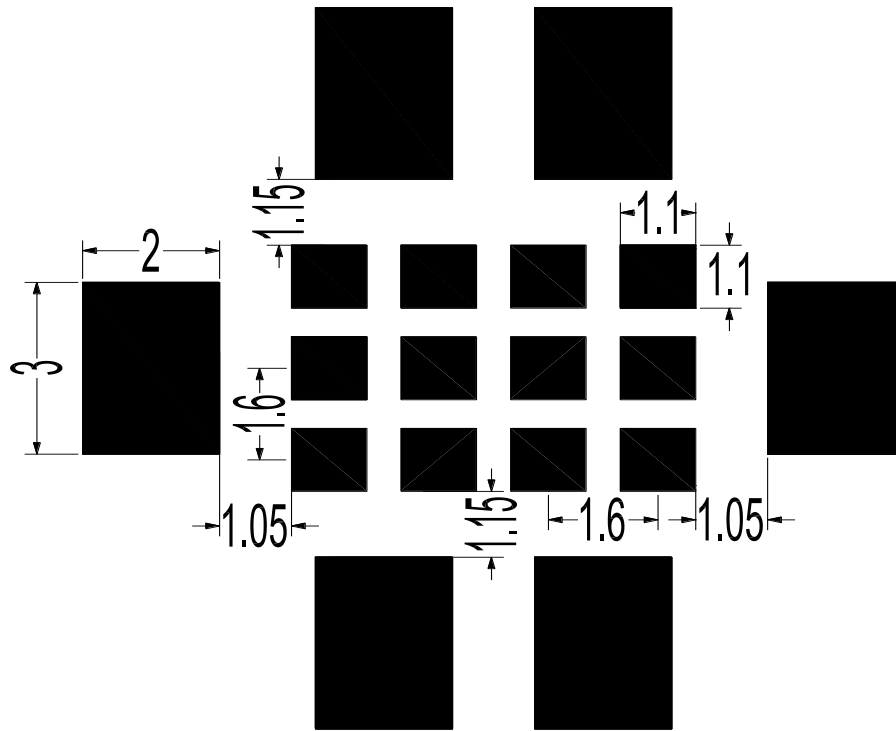


Figure 41: Bottom Pads Dimensions (Bottom View)

7.2. Footprint of Recommendation

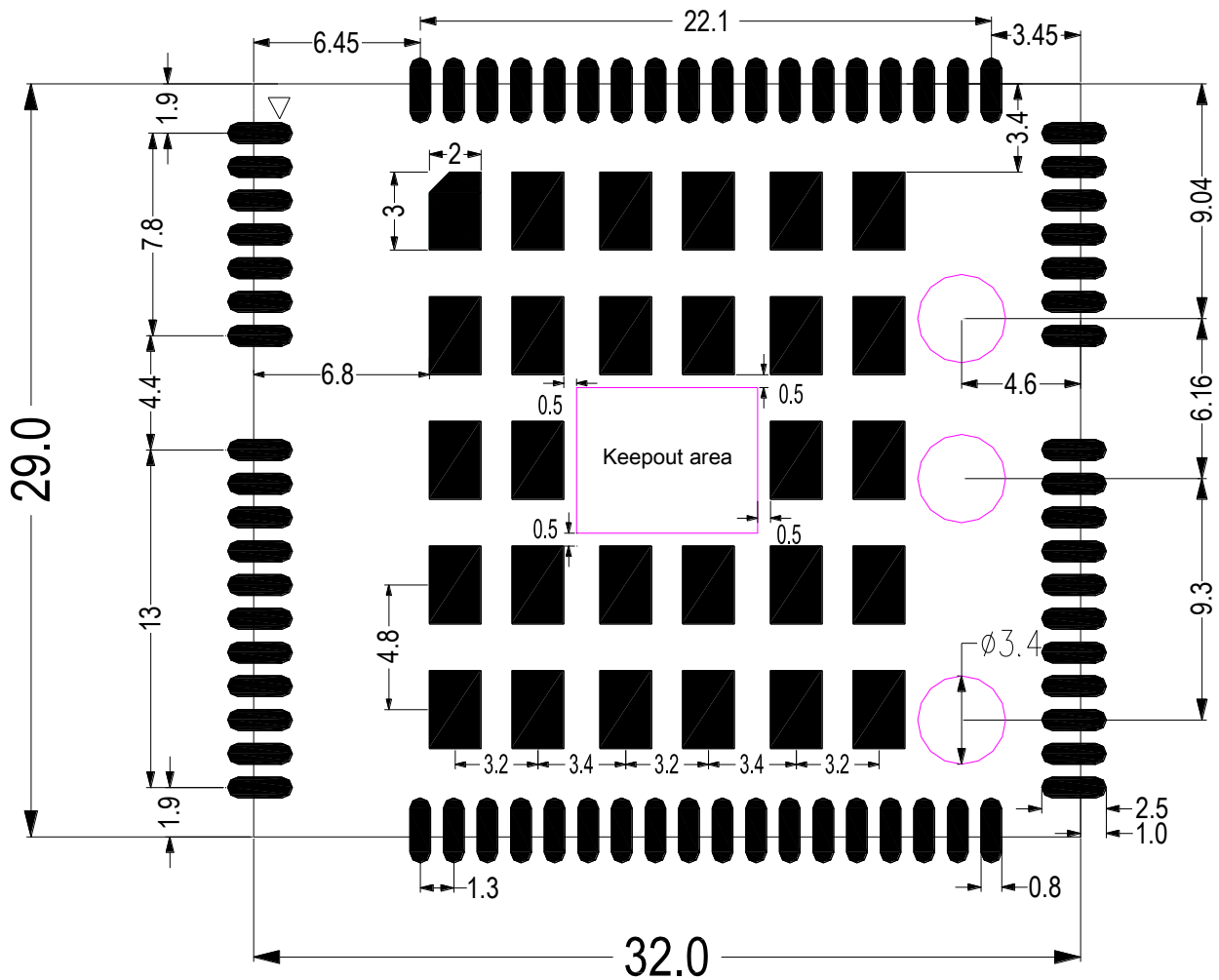


Figure 42: Recommended Footprint (Top View)

NOTES

1. Pads 73~84 at the bottom center of module cannot be designed. And keep out the areas shown in pink on the above figure in the host PCB.
2. In order to maintain the module, keep about 3mm between the module and other components in the host PCB.

7.3. Top View of the Module



Figure 43: Top View of the Module

7.4. Bottom View of the Module

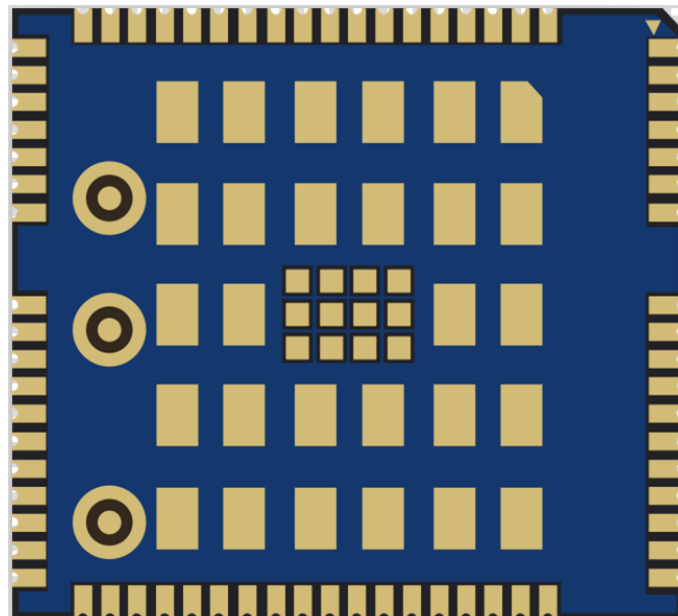


Figure 44: Bottom View of the Module

8 Storage and Manufacturing

8.1. Storage

UC20 is stored in the vacuum-sealed bag. The restriction of storage condition is shown as below.

Shelf life in sealed bag is 12 months at $< 40^{\circ}\text{C}/90\%\text{RH}$.

After this bag is opened, devices that will be subjected to reflow solder or other high temperature process must be:

- Mounted within 72 hours at factory conditions of $\leq 30^{\circ}\text{C}/60\%\text{RH}$.
- Stored at $< 10\% \text{RH}$.

Devices require bake before mounting, if:

- Humidity indicator card is $> 10\%$ when read $23^{\circ}\text{C}\pm 5^{\circ}\text{C}$.
- Mounted for more than 72 hours at factory conditions of $\leq 30^{\circ}\text{C}/60\% \text{RH}$.

If baking is required, devices may be baked for 48 hours at $125^{\circ}\text{C}\pm 5^{\circ}\text{C}$.

NOTE

As plastic container cannot be subjected to high temperature, module needs to be taken out from container to high temperature (125°C) bake. If shorter bake times are desired, please refer to IPC/JEDECJ-STD-033 for bake procedure.

8.2. Manufacturing and Welding

The squeegee should push the paste on the surface of the stencil that makes the paste fill the stencil openings and penetrate to the PCB. The force on the squeegee should be adjusted so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil at the hole of the module pads should be 0.18mm. For details, please refer to **document [6]**.

It is suggested that peak reflow temperature is 235 ~ 245°C (for SnAg3.0Cu0.5 alloy). Absolute max reflow temperature is 260°C. To avoid damage to the module when it was repeatedly heated, it is suggested that the module should be mounted after the first panel has been reflowed. The following picture is the actual diagram which we have operated.

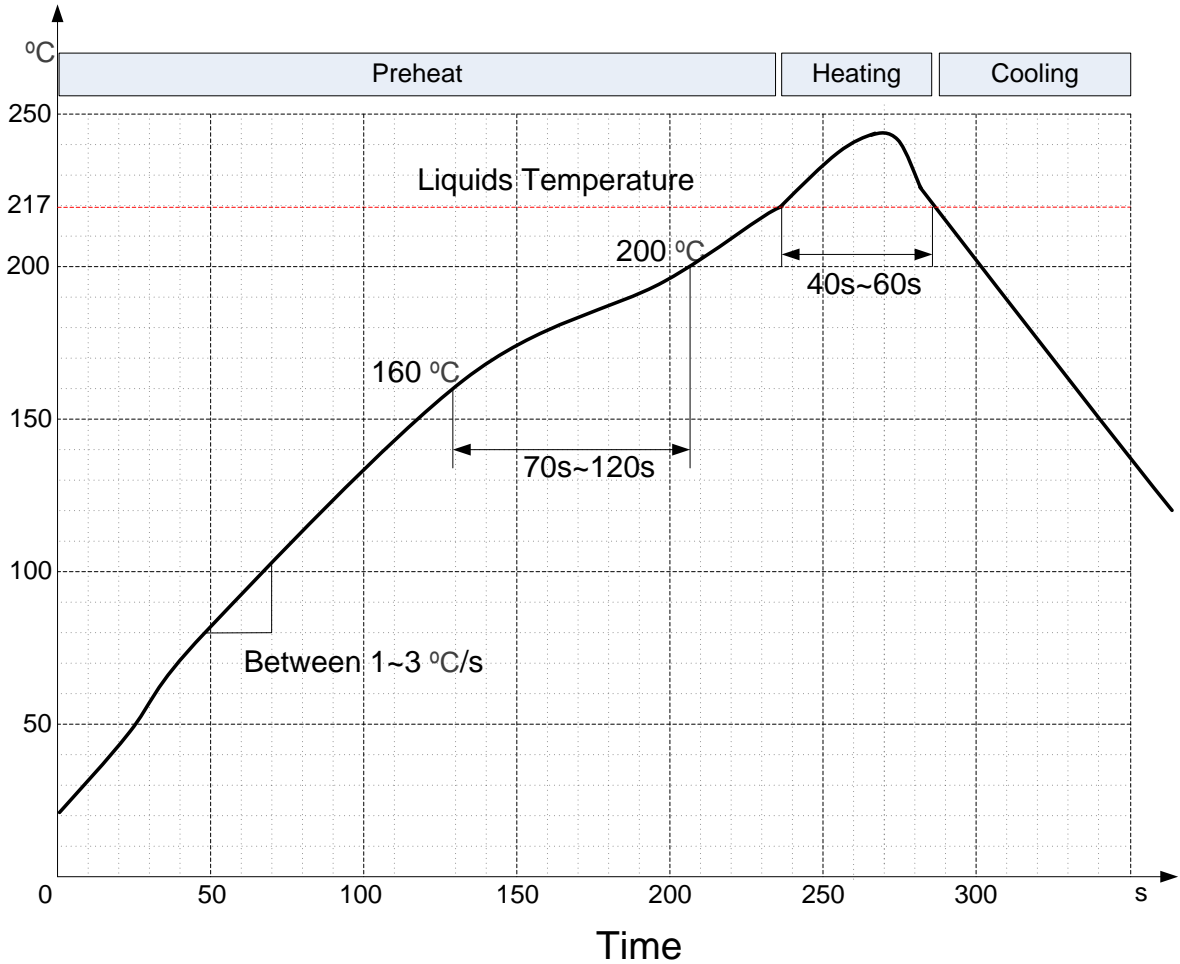


Figure 45: Liquids Temperature

8.3. Packaging

UC20 is packaged in the tap and reel carriers. One reel is 11.53m length and contains 250pcs modules. The figure below shows the package details, measured in mm.

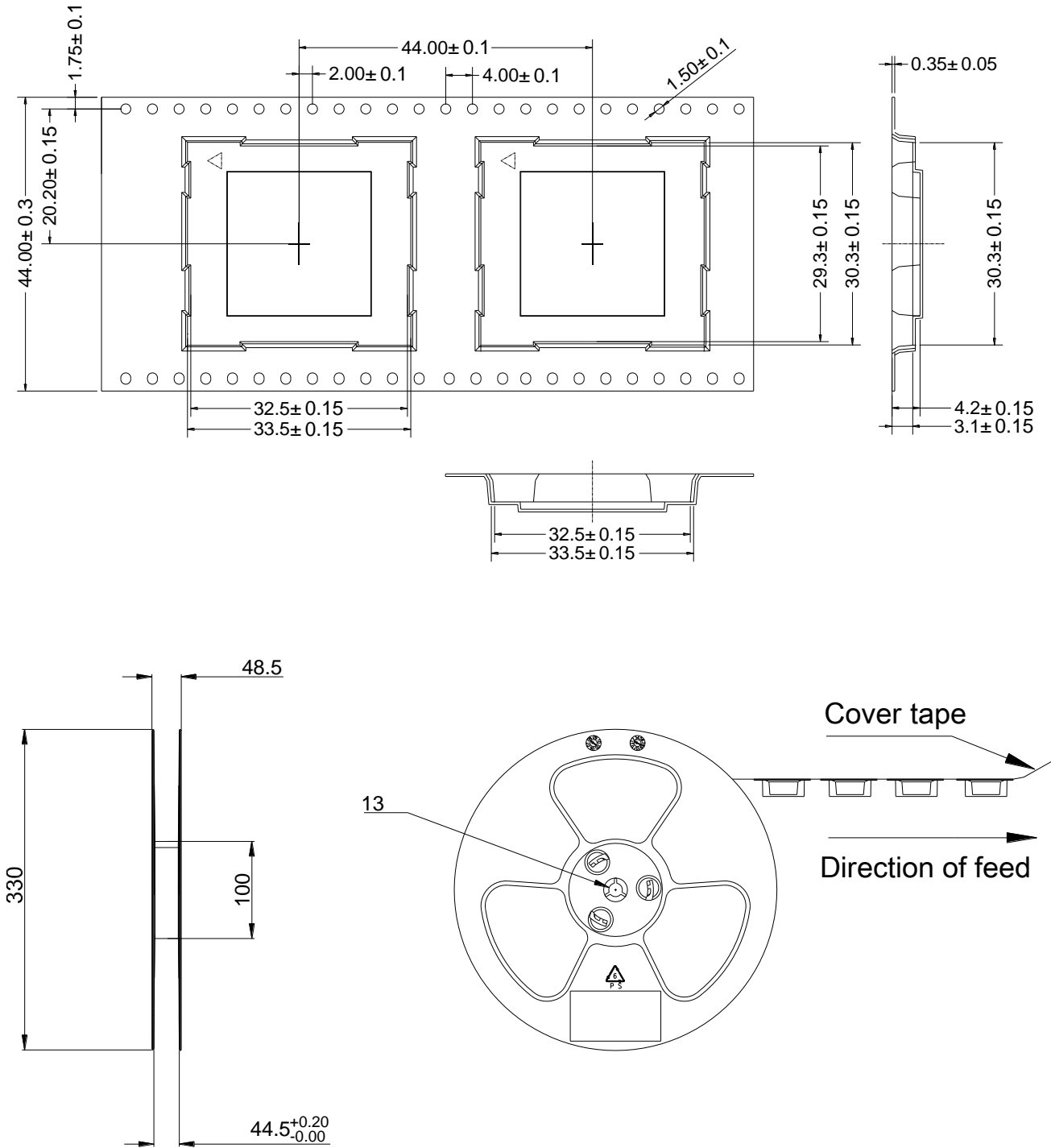


Figure 46: Carrier Tape

9 Appendix A Reference

Table 35: Related Documents

SN	Document Name	Remark
[1]	Quectel_UC20_AT_Commands_Manual	UC20 AT Commands Manual
[2]	Quectel_UC20_EVB_User_Guide	UC20 EVB User Guide
[3]	Quectel_UC20_Reference_Design	UC20 Reference Design
[4]	Quectel_UC20&M10_Reference_Design	UC20 and M10 Compatible Reference Design
[5]	Quectel_UC20&M10_Compatible_Design	UC20 and M10 Compatible Design
[6]	Quectel_Module_Secondary_SMT_User_Guide	Module Secondary SMT User Guide
[7]	Quectel_UC20_GNSS_AT_Commands_Manual	UC20 GNSS AT Commands Manual
[8]	Quectel_UC20_Power_Management_Application_Note	UC20 Power Management Application Note

Table 36: Terms and Abbreviations

Abbreviation	Description
AMR	Adaptive Multi-rate
ARP	Antenna Reference Point
bps	Bits Per Second
CEP	Circular Error Probable
CHAP	Challenge Handshake Authentication Protocol
CS	Coding Scheme
CSD	Circuit Switched Data

CTS	Clear To Send
DCE	Data Communications Equipment (typically module)
DRX	Discontinuous Reception
DTE	Data Terminal Equipment (typically computer, external controller)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Extended GSM900 band (includes standard GSM900 band)
ESD	Electrostatic Discharge
FR	Full Rate
GLONASS	GLObalnaya NAVigatsionnaya Sputnikovaya Sistema, the Russian Global Navigation Satellite System
GMSK	Gaussian Minimum Shift Keying
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HR	Half Rate
HSPA	High Speed Packet Access
I/O	Input/Output
IMEI	International Mobile Equipment Identity
Imax	Maximum Load Current
Inorm	Normal Current
LED	Light Emitting Diode
LNA	Low Noise Amplifier
ME	Mobile Equipment
MO	Mobile Originated

MS	Mobile Station (GSM engine)
MT	Mobile Terminated
PAP	Password Authentication Protocol
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PDU	Protocol Data Unit
PPP	Point-to-Point Protocol
PSK	Phase Shift Keying
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RHCP	Right Hand Circularly Polarized
RMS	Root Mean Square (value)
RTC	Real Time Clock
Rx	Receive
SIM	Subscriber Identification Module
SMS	Short Message Service
TE	Terminal Equipment
UART	Universal Asynchronous Receiver & Transmitter
UMTS	Universal Mobile Telecommunications System
URC	Unsolicited Result Code
USIM	Universal Subscriber Identity Module
USSD	Unstructured Supplementary Service Data
Vmax	Maximum Voltage Value
Vnorm	Normal Voltage Value

V _{min}	Minimum Voltage Value
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
V _{Imax}	Absolute Maximum Input Voltage Value
V _{Imin}	Absolute Minimum Input Voltage Value
V _{OHmax}	Maximum Output High Level Voltage Value
V _{OHmin}	Minimum Output High Level Voltage Value
V _{OLmax}	Maximum Output Low Level Voltage Value
V _{OLmin}	Minimum Output Low Level Voltage Value
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access

10 Appendix B GPRS Coding Scheme

Table 37: Description of Different Coding Schemes

Scheme	Code Rate	USF	Pre-coded USF	Radio Block excl.USF and BCS	BCS	Tail	Coded Bits	Punctured Bits	Data Rate Kb/s
CS-1	1/2	3	3	181	40	4	456	0	9.05
CS-2	2/3	3	6	268	16	4	588	132	13.4
CS-3	3/4	3	6	312	16	4	676	220	15.6
CS-4	1	3	12	428	16	-	456	-	21.4

11 Appendix C GPRS Multi-slot Class

Twenty-nine classes of GPRS multi-slot modes are defined for MS in GPRS specification. Multi-slot classes are product dependant, and determine the maximum achievable data rates in both the uplink and downlink directions. Written as 3+1 or 2+2, the first number indicates the amount of downlink timeslots, while the second number indicates the amount of uplink timeslots. The active slots determine the total number of slots the GPRS device can use simultaneously for both uplink and downlink communications.

The description of different multi-slot classes is shown in the following table.

Table 38: GPRS Multi-slot Classes

Multislot Class	Downlink Slots	Uplink Slots	Active Slots
1	1	1	2
2	2	1	3
3	2	2	3
4	3	1	4
5	2	2	4
6	3	2	4
7	3	3	4
8	4	1	5
9	3	2	5
10	4	2	5
11	4	3	5
12	4	4	5

12 Appendix D EDGE Modulation and Coding Scheme

Table 39: EDGE Modulation and Coding Scheme

Coding Scheme	Modulation	Coding Family	1 Timeslot	2 Timeslot	4 Timeslot
CS-1:	GMSK	/	9.05kbps	18.1kbps	36.2kbps
CS-2:	GMSK	/	13.4kbps	26.8kbps	53.6kbps
CS-3:	GMSK	/	15.6kbps	31.2kbps	62.4kbps
CS-4:	GMSK	/	21.4kbps	42.8kbps	85.6kbps
MCS-1	GMSK	C	8.80kbps	17.60kbps	35.20kbps
MCS-2	GMSK	B	11.2kbps	22.4kbps	44.8kbps
MCS-3	GMSK	A	14.8kbps	29.6kbps	59.2kbps
MCS-4	GMSK	C	17.6kbps	35.2kbps	70.4kbps
MCS-5	8-PSK	B	22.4kbps	44.8kbps	89.6kbps
MCS-6	8-PSK	A	29.6kbps	59.2kbps	118.4kbps
MCS-7	8-PSK	B	44.8kbps	89.6kbps	179.2kbps
MCS-8	8-PSK	A	54.4kbps	108.8kbps	217.6kbps
MCS-9	8-PSK	A	59.2kbps	118.4kbps	236.8kbps