

# 5G NB-IOT & GNSS KIT

BG96 Technical Specifications & User Manual



## **Purpose of the Document**

The purpose of this document is to explain the technical specifications and manual for using the 5G NB-IoT & GNSS board.

## **Document History**

Version	Author	Date	Date Description		
Α	5G HUB	04.05.2019	Initial Document		
В	5G HUB	06.08.2019	Add Arduino IDE instructions		
С	5G HUB	06.10.2019	Add Serial Interface		
D	5G HUB	09.11.2019	Add more information about Arduino IDE		
E	5G HUB	01.02.2020	Update Information regarding Input voltage and Current		
F	5G HUB	07.11.2020	Update pictures and information		
G	5G HUB	02.28.2021	Update pictures and add download Section		

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## **1** Package contents:

### 1.1 NB-IoT Kit Package:

- Hardware board
- One USB cable
- One LTE & GPS antenna

### 1.2 Download

Arduino software can be downloaded from the following website: <a href="https://github.com/5ghub/5G-NB-IoT/tree/master/KitSketches">https://github.com/5ghub/5G-NB-IoT/tree/master/KitSketches</a>

To use the board with Arduino IDE and starts running Arduino projects and sketches, install the following software:

Install Arduino IDE for Windows from the following website: https://www.arduino.cc/en/Main/Software

Download and Install LTE&GNSS modem driver for Windows OS: https://github.com/5ghub/5G-NB-IoT/tree/master/Driver

Download and Install QNavigator and QCOM tools for Quectel BG96 here: https://github.com/5ghub/5G-NB-IoT/tree/master/Tools

Download and install Arduino library (**5G-NB-IoT\_Arduino.zip**) here: <u>https://github.com/5ghub/5G-NB-IoT</u>

All the following software can be installed from the GitHub location here: <u>https://github.com/5ghub/5G-NB-IoT</u>

LTE cellular connectivity on Windows OS

## **2** General Description

### 2.1 Overview

The NB-IoT kit is a cellular and GPS kit that can be used for the 5G wireless technology. The kit includes a hardware board, LTE&GPS antenna, and USB cables. The board is a powerful board that features a microcontroller and wireless modem. The microcontroller is an Atmel's SAMD21G18A MCU which features a 32-bit ARM Cortex<sup>®</sup> M0+ core. The wireless modem is BG96 which is an embedded IoT (LTE Cat-M1, LTE Cat-NB1 and EGPRS) wireless communication module. BG96 wireless modem provides a maximum data rate of 375Kbps downlink and 375Kbps uplink. It features ultra-low power consumption, provides data connectivity on LTE-TDD/LTE-FDD/GPRS/EDGE networks, and supports half-duplex operation in LTE networks. It also provides GNSS to meet customers' specific application demands

The board provides rich sets of Internet protocols, industry-standard interfaces (USB/UART/I2C/Status Indicator) and abundant functionalities. The board offer a high integration level and enables integrators and developers to easily design their applications and take advantage of the board low power consumption, many functionalities, and USB drivers for Windows 7/8/8.1/10, Linux and Android.

The kit board is a rich hardware board that can be used for the latest 5G wireless technology and enables a variety of smart and 5G applications for devices, and acts as a great educational tool for learning about 5G and 32-bit application development. It enables large number of applications such as wireless POS, smart metering, tracking, smart transportation, smart buildings, smart city, and smart homes.

The board is also compatible with Arduino and Arduino software (IDE). Arduino sketches and examples are provided with the kit and additional sketches can be developed and uploaded to the board.



Figure 1. Hardware Board – unboxed with one LTE/GPS antenna and one USB cable

### 2.2 Key Features

- Atmel ATSAMD21G18 MCU
- Quectel BG96 NB-IoT module
- External GPS antenna Connector
- External LTE antenna connector
- Supports LTE NB-IoT and Machine Type Communications (MTC)
- Supports EGPRS
- Global Frequency Band B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B26/B28/B39 (B39 for Cat.M1 only) for LTE and 850/900/1800/1900MHz for EGPRS
- Supports the protocols TCP/UDP/PPP/ SSL/ TLS/ FTP(S)/ HTTP(S)/ NITZ/ PING/ MQTT
- Supports SMS
- Supports GNSS technology (GPS, GLONASS, BeiDou/Compass, Galileo, QZSS)
- Compact board size of 58mm x 42mm
- Nano USIM card slot
- Arduino IDE Compatible
- Works with Windows, Linux, or Android
- Ready for smart applications and development (smart home, smart city, smart transportation, smart metering, smart farming, smart waste management, asset tracking, location, navigation, mapping, and timing applications). Application such as Gas Detector, Soil PH Tester, Optical Sensor, Machinery Alarm System, Irrigation Controller, Elevator, Asset Tracking Electronics, Person/Pet Tracking, Water/Gas Metering, Smart Parking System, Fire Hydrant, Smoke Alarm, Trash Bin, Street Lighting
- The board can operate on an external power supply of 3.3V to 5V. The recommended voltage is 5V.
- The board can be powered via the USB connector or with an external DC power supply. The power source is selected automatically.
- External DC Power supply (non-USB) can be provided from an AC-to-DC adapter (such as a wall-wart) or battery, and can be connected using a 2.1mm center-positive plug connected to the board's power jack, or directly to the GND and VIN pins.
- Each of the 14 general purpose I/O pins on the board can be used for digital input or digital output using pinMode(), digitalWrite(), and digitalRead() functions. Pins used for PWM can be using analogWrite() function. All pins operate at 3.3 volts. Each pin can source or sink a maximum of 10 mA and has an internal pull-up resistor (disconnected by default) of 20-60 K ohm.

### 2.3 Overview Diagrams



Figure 2. Hardware Board Overview Diagram – Top and Bottom View



Figure 3. Top and Bottom Views

### 2.4 Physical Characteristics

The width and length of the board is 48mm (width) by 52 mm (length). The board have four screw holes in each corner that allows the board to be attached to a surface or case.



Figure 4. Hardware Board Top View – External Dimensions

### 2.5 Peripherals – Key Components



Figure 5. Board Top Side – Key Components



Figure 6. Board Bottom Side – Key Components

### 2.6 Peripherals – IO Connections



Figure 7. Board Extension Connectors

\* I2C interface lines might be configured as USART interface SDA line can work then as USART TXD and SCL line can work as USART RXD)

\*\* MOSI and SCK lines might be configured as USART interface (MOSI line can work then as USART TXD and SCK line can work as USART RXD)

### 2.7 Hardware Specification

Technical Specification				
Microcontroller (MCU)	Atmel ATSAMD21G18, 32-Bit ARM Cortex			
	M0+			
Clock Speed	48 MHz			
Flash Memory	256 КВ			
SRAM	32 KB			
NB-IoT Module	Quectel BG96			
Dimension	48mm (width) by 52 mm (length)			
Weight	18 grams			
Dowor Supply	DC Power Supply (3.8-5V), USB (5V), VIN (3.8-5V),			
Power Supply	or Battery			
LED	LED1, LED2, Power LED, Status LED, Netlight LED			
Interfacing Logic Voltage Level (Operating	3.3V			
Voltage)	5.5V			
Voltage output	5V, 3.3V			
RESET buttons	Two; one for MCU and one for BG96			
User-defined Button	1 connected to MCU			
General-purpose digital I/O Pins	14 (A0-A5, PA6, PA7, SS, MOSI, MISO, SCK, SDA,			
General-pul pose digitar 1/0 Pilis	SCL)			
GPIO	2 connected to BG96			
ADC	2 connected to BG96			
USB	2			
I <sup>2</sup> C	1			
SPI	1			
UART	1			
ADC pins	6 (8/10/12-bit ADC channels)			
DAC pin	1 (10-bit DAC)			
External interrupts	14 (All general-purpose PINs)			
PWM pin	6			
DC Current per I/O Pin	10 mA			
JTAG Debug	Cortex Debug Connector (Single Wire Debug)			
USIM	Nano			
GNSS	GPS, GLONASS, BeiDou/Compass, Galileo, QZSS			
Antenna	1 main antenna and 1 GPS antenna			
	LTE-FDD, B1/B2/B3/B4/B5/B8/B12/			
Band	B13/B18/B19/B20/B26/B28			
	LTE-TDD: B39 (for Cat M1 only)			
Certification	FCC, CE			
Mobile Operator Certification	Verizon and currently for AT&T			

Notes:

- UART can be programmed through any of general-purpose pins.
- SPI can be programmed through any of general-purpose pins.

## 2.8 PIN Description

PIN	DIRECTION	Description			
DC Power Jack	I	The board can be supplied with power either from the DC power jack (3.8V-5V), the USB connector (5V), or the VIN pin of the board (3.8V-5V)			
LED (PWR)	0	LED is lighted on when the board is power on from the MCU USB port			
LED1 (USER)	0	LED which can be controlled from MCU (D25). When the pin is HIGH value, the LED is on, when the pin is LOW, it is off			
LED2 (USER)	0	LED which can be controlled from MCU (D26). When the pin is HIGH value, the LED is on, when the pin is LOW, it is off			
LED (NET)	0	Indicate the BG96 operation status			
LED (STAT)	0	Indicate the BG96 network activity status			
MCU RESET button	I	Reset the MCU			
BG96 RESET button	I	Reset the BG96 module			
User Button	I	Connected to digital pin, D0, of MCU and can be used for user- defined purposes			
IOREF	0	Provides the voltage reference with which the MCU operates. A device can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V			
3.3V	0	3.3V generated by the on-board regulator. Maximum current drawn is 300 mA. The regulator also provides power to the MCU and BG96			
5V	0	5V generated from the board. The board can be supplied with power either from the DC power jack (3.3V - 5V), the USB connector (5V), or the VIN pin of the board (3.3-5V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator and can damage the board if it is not sufficiently regulated (This is not recommended)			
GND		Ground			
VIN	I	Input voltage to the board when it uses an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or if supplying voltage via the power jack, access it through this pin			
A0	10	Six analog inputs which can provide up to 12 bits of resolution			
A1	IO	(i.e. 4096 different values). By default, each input measures			
A2	IO	from ground to 3.3 volts, though is it possible to change the			
A3	IO	upper end of their range using the AREF pin			
A4	IO	A0 can also be used as a DAC output and provides a 10 bit			
A5	10	voltage output with <u>analogWrite()</u> function Analog pins can be used as GPIOs			
SCL	IO	I2C. The SCL (clock line). Can be used as GPIO			
SDA	10	I2C. The SDA (data line). Can be used as GPIO			

AREFA	1	Input reference voltage for the analog inputs used for either he
,	•	ADC or the DAC
SCK	IO	SPI Interface. Can be used as GPIO
MISO	IO	SPI Interface. Can be used as GPIO
MOSI	IO	SPI Interface. Can be used as GPIO
SS	IO	SPI Interface. Can be used as GPIO
PA7	IO	GPIO. Can be used as GPIO
PA6	IO	GPIO. Can be used as GPIO
Cortex Debug	10	Using Single Wire Debug to burn bootloader and debug the
Connector	10	board
ADC0	I	Connected to BG96. General purpose analogue to digital converter
ADC1	I	Connected to BG96. General purpose analogue to digital converter
GPIO26	IO	Connected to BG96. General purpose IO
GPIO64	IO	Connected to BG96. General purpose IO
USIM	I	Used to insert a Nano USIM. Connected to BG96
		Connected to BG96. Force the BG96 to enter emergency download
USB Boot	I	mode
USB1	IO	Connected to MCU
USB2	IO	Connected to BG96

### Precaution

## The board runs at 3.3V. The maximum voltage that the I/O pins can tolerate is 3.3V. Applying voltages higher than 3.3V to any I/O pin could damage the board

### 2.9 BG96 chipset

All functionality of the BG96 shipset shall be implemented excluding the following features. That is, the following features are not supported [1][2].

- Audio, Earphone, and Codes are not supported.
- PCM and I2C are not supported
- PSM\_IND and AP\_READY are not supported

### 2.10 Interface between SAM21D and BG96

The Microcontroller communicates with the BG96 through UART interfaces:

- UART1: (PA12/PA13/PA14/PA15). Used for data transmission and AT command communication 115200bps by default. The default frame format is 8N1 (8 data bits, no parity, 1 stop bit) Support RTS and CTS hardware flow control.
- **UART3:** (PB23/PB22). Used for outputting GNSS data or NEMA sentences 115200bps baud rate.

## 3 Using the Board with Arduino IDE

### 3.1 Installing the Software

To use the board with Arduino IDE and starts running Arduino projects and sketches, install the following software:

- 1- Install Arduino IDE for Windows from the following web site https://www.arduino.cc/en/Main/Software
- 2- Download and Install Quectel Driver here: This will install Quectel driver on Windows. <u>https://github.com/5ghub/5G-NB-IoT/tree/master/Driver</u>
- 3- Download and Install QNavigator tool for Quectel BG96 here: https://github.com/5ghub/5G-NB-IoT/tree/master/Tools
- 4- Download and save the file **5G-NB-IoT\_Arduino.zip** here: <u>https://github.com/5ghub/5G-NB-IoT</u>

All the following software can be installed from the GitHub location here:

https://github.com/5ghub/5G-NB-IoT

### 3.2 Setting Up Arduino IDE

- 1- Connect a USB cable from the **computer USB** to the **USB\_SAMD21 port** to power on the board.
- 2- Connect a USB cable from the **computer USB** to the **USB\_BG96 port** to connect to the BG96.
- 3- Launch Arduino IDE and choose **File->Preferences**. In the Additional Boards Manager URLs, insert the following URL:

https://raw.githubusercontent.com/5ghub/5G-NB-IoT/master/package\_5G-NB-IoT\_index.json

sketch_jul01a   Arduino 1.8.9 File Edit Sketch Tools Help		- 0	×
			ø
sketch jul01a			
void setup() (			^
// put your setup code here, to run once:			
1	Preferences X		
void loop() {	Settings Network		
<pre>// jut your main code here, to run repeatedly:</pre>	Sketchbook location:		
	C:\Users\hossa\Documents\Arduino Browse		
1	Editor language: System Default  v (requires restart of Arduino)		
	Editor font size: 12		
	Interface scale: Automatic 100 2 % (requires restart of Arduino)		
	Theme: Default theme ~ (requires restart of Arduino)		
	Show verbose output during:compliationupload		
	Compiler warnings: None V		
	Display line numbers		
	Enable Code Folding		
	Verify code after upload Use external eddor		
	Obe external extor     Appressively cache compiled core		
	C Check for updates on startup		
	✓ Update sketch files to new extension on save (.pde -> .ino)		
	Save when verifying or uploading		
	Additional Boards Manager URLs: https://raw.gthubusercontent.com/5ghub/5G-NB-boT/master/package_5G-NB-IoT_ind+		
	More preferences can be edited directly in the file		
	C:\Users\hossa\AppData\Local\Arduno15\preferences.bit		
	(edt only when Arduino is not running)		
	OK Cancel		
			~
	SG-NR-1	oT (Native USB Port) on (	20145
	- The second		

4- In Arduino IDE, choose **Tools->Board->Boards Manager**, select and install **"5G-NB-IoT SAMD Boards**".

⊗ sketch_jun08a   Arduino 1.8.9		- 0 ×
File Edit Sketch Tools Help		<mark>.</mark> ₽
sketch_jun08a		
<pre>void setup() {</pre>	💿 Boards Manager X	^
// put your setup code here, t	Type All V 5G	
}	5G-NB-IOT SAMD Boards (32-bits ARM Cortex-M0+) by 5G-NB-IOT A Boards included in this package:	
<pre>void loop() {</pre>	5G-NB-IoT. Online help	
<pre>// put your main code here, to</pre>	More info Install	
}		
	×	
l	Close	

### 5- Choose "5G NB-IoT (Native USB Port)"

Sketch_jun08a   ↓ File Edit Sketch To							-	- 0	×
	Auto Format	Ctrl+T		<u></u>	<u></u>				
	Archive Sketch	Culti							<b>9</b>
sketch jun08	Fix Encoding & Reload								
void setup()	Manage Libraries	Ctrl+Shift+I							^
// put you	Serial Monitor	Ctrl+Shift+M							~
	Serial Plotter	Ctrl+Shift+L							
}	WiFi101 / WiFiNINA Firmware Upda		Boards Manager						
<pre>void loop()     // put you</pre>	Board: "5G-NB-IoT (Native USB Port		Arduino/Genuino Mega or Mega 2560						
// put jot	Port	,	Arduino/Genuino Mega or Mega 2560 Arduino Mega ADK						
}	Get Board Info		Arduino Leonardo						
			Arduino Leonardo ETH						
	Programmer: "AVRISP mkII"	>	Arduino/Genuino Micro						
	Burn Bootloader		Arduino Esplora						
			Arduino Lispiora Arduino Mini						
			Arduino Ethernet						
			Arduino Fio						
			Arduino BT						
			LilyPad Arduino USB						
			LilyPad Arduino						
			Arduino Pro or Pro Mini						
			Arduino NG or older						
			Arduino Robot Control						
			Arduino Robot Motor						
			Arduino Gemma						~
			Adafruit Circuit Playground						
			Arduino Yún Mini						
			Arduino Industrial 101						
			Linino One						
			Arduino Uno WiFi						
			Arduino SAMD (32-bits ARM Cortex-M0+) Boards				5G-NB-IoT (Nati	ve USB Port) o	on COM5
	be here to search	Ū.	5G-NB-IoT (Native USB Port)	^	15% I₩ s <sup>2</sup>	^ 📥 🛍		9:16 PM	
	Se fiere to search	Ŷ.					116 310	6/8/2019	~

6- In the Arduino IDE, Choose **Port** and select the serial port where the board appears.

💿 sketch_jun19a   /	Arduino 1.8.9				-	0	×
File Edit Sketch To							
	Auto Format Archive Sketch	Ctrl+T					<u>@</u> -
sketch_jun19a	Fix Encoding & Reload						
<pre>void setup()</pre>	Manage Libraries Serial Monitor	Ctrl+Shift+I Ctrl+Shift+M					^
// put you	Serial Plotter	Ctrl+Shift+L					
}	WiFi101 / WiFiNINA Firmware Updater						
void loop()	Board: "5G-NB-IoT (Native USB Port)"	>					
// put you	Port: "COM5 (5G-NB-IoT (Native USB Port	))" >	Serial ports				
}	Get Board Info		COM3				
	Programmer: "AVRISP mkli"	x	<ul> <li>COM5 (5G-NB-IoT (Native USB Port))</li> </ul>				
	Burn Bootloader						
							~

7- In the Arduino IDE, Choose Sketch->Include Library->Add .Zip Library and select the file 5G-NB-IoT\_Arduino.zip

You are now ready to start running Arduino sketches and projects.

💿 sketch_ju	n19a   Arduino 1.8.9				-		$\times$
File Edit Ske	tch Tools Help						
sketch	Verify/Compile Upload Upload Using Programmer Export compiled Binary	Ctrl+R Ctrl+U Ctrl+Shift+U Ctrl+Alt+S					
// pi	Show Sketch Folder	Ctrl+K :					
	Include Library	>	Δ				
}	Add File		Manage Libraries	Ctrl+Shift+I			
void loop	() {		Add .ZIP Library				
// put ; }	your main code here, 4	to run repe«	Arduino libraries Bridge Esplora Ethernet Firmata GSM Keyboard LiquidCrystal Mouse Robot Control Robot IR Remote Robot Motor SD Servo SpacebrewYun Stepper TFT Temboo WiFi				
Error down	loading https://raw.g	ithubuserco	Contributed libraries 5G-NB-IoT HID I2S		master/package_5G-NB-IoT_	index.;	json
			SAMD_AnalogCorrection	n	5G-NB-IoT (Native USI	Port) on (	COME
			SPI		56-INB-IOT (INAINE OSI		JOINIO

### 3.3 Running Arduino Sketch

1- Using Arduino IDE, open the Arduino sample TurnOnAllPins.ino, choose Sketch->Upload.



2- In the Device manager, the Arduino and Quectel USB Modem and ports shall show up as in this screen shoot:



After compiling and uploading the Arduino sketch, the LEDs will blink and the BG96 is enabled as in the following picture:



PWR, STAT LEDs are ON LD1, LD2 LED are blinking

The following table show different five LEDs status after uploading this sketch

LED	Behavior	Description
PWR	ON	Indicates the MCU is powered on
STATE	ON	Indicates the BG96 is powered on
NET	Flicker slowly (200ms High/1800ms Low)	Network Searching
	Flicker slowly (1800ms High/200ms Low)	Idle
	Flicker slowly (125ms High/125ms Low)	Data transfer is ongoing
LD1	Blinking	User controlled LED
LD2	Blinking	User controlled LED

## 4 Using the Arduino Sketches with Serial Interface

The board has a serial interface where output can be sent via the serial interface to the computer. Use USB-to-Serial cable such as the Prolific USB-to-Serial cable.



Connect the USB-to-Serial cable to the PC, and the device manager shall display a new COM port.

🛃 Device Manager —	[		×
File Action View Help			
V 📩 LAPTOP-HOSSAMF			^
> 💐 Audio inputs and outputs			
> 嵾 Batteries			
> 🚯 Bluetooth			
> 👰 Cameras			
> 💻 Computer			
> 🕳 Disk drives			
> 🔙 Display adapters			
> 🎬 Firmware			
> 🛺 Human Interface Devices			
> 🚠 Imaging devices			
> 🔤 Keyboards			
> II Mice and other pointing devices			
> 🛄 Monitors			
> 🚽 Network adapters			
🗸 🛱 Ports (COM & LPT)			
🖷 Arduino Zero (COM5)			
Intel(P) Active Management Technology - SC		13)	
Prolific USB-to-Serial Comm Port (COM4)			
Print queues			
> Processors			
> I Security devices			
> 📑 Software components			
Software devices			

The board has the serial interface on the J101 as in the following figure.



Connect the USB-to-Serial cable from the PC to the board as shown.



Launch any serial port software to connect to the board serial board. Set the COM speed to 115200.

✓ Untitled_0 *						_	o ×
File Edit Connection View Window Help	onnection Options (Untitled_(	D)					
New Open Save Connect Disconnect Clear Data Option	Serial Port Terminal Receive Transmit Miscellaneous	Serial Port Optio Port: Baudrate: Data Bits: Parity: Stop Bits: Flow Control:	ns  COM4  115200  8  Come  Come Come				
COM4 / 115200 8-N-1 Disconnected			Cancel OK	(		CTS D	

#### Click connect and the Arduino sketch output shall be displayed on the terminal software



## 5 Procedure for Operating the BG96 Wireless Unit

- 1. Insert a USIM (or a test USIM) into the USIM slot on the hardware board.
- 2. Connect the LTE/GPS Antenna to the MAIN and GNSS antenna ports respectively on the board.
- 3. Connect the two USB cables to the board and to the PC (Windows 10 PC).
- 4. In the Device manager, the Quectel USB Modem and ports are shown up.



5. Launch QNavigator. Choose the correct Quectel USB AT port in Settings->Serial Port Parameter Set.

File Setting Tool	🖪 🛃 🌭 🖭 👶 🧃					
Home to the second	Home			[2019-03-22 22:12:30:87 [2019-03-22 22:12:30:88 [2019-03-22 22:12:30:88	30_R:] +QCCID: 8901260143747870016F	^
-	ري. ا			12019-03-22 22:12:30:88		
SMS	Automatic initialization	Serial port paramet	er set	>	< R:] AT+CSQ R:] +CSQ: 18,0	
Voice Call	Module information		Serial port		R:] OK REG? to query the network registration status. */	
(î:	Manufacturer ID: Qu	Port:	Quectel USB AT Port (COM15)	•	S:] AT+CREG? R:] AT+CREG?	
TCP/UDP	Device module: BO	Baudrate:	115200		R:] +CREG: 0,1	
یک	Firmware version: BO	DataBits:	8	•	R:] OK S:] AT+CGREG?	
GNSS	Registration information	StopBits: Parity:	1 None	•	R:] AT+CGREG? R:] +CGREG: 0,1 R:] OK	
PPP	Network registration: R	FlowCtrl:	H₩ Ctrl	•		
	GPRS network status: Ri Preferred operator: T-				y current Network Operator */ S:] AT+COPS? R:] AT+COPS?	
AT Command	SIM card information		ОК С	ancel	R:] +COPS: 0,0,"T-Mobile",0 _R:] OK	~
	SIM card IMSI: 31	10260144787001		• Text • Hex	🔿 SpecialChars 🔿 File	I

6. Click "Connect". The board will connect to Mobile operator. Screen shot below shows it connects to T-Mobile network.



7. On the Windows PC, disable all network connections (WiFi or Ethernet) except the Quectel cellular Modem. You can, for example, do a "Ping" to any IP address and this illustrates transmitting and receiving from the T-Mobile cellular network. This is illustrated as in this screen shot:



🔤 Command Prompt - ping yahoo.com -4 -n 1000	-	×
		^
Pinging yahoo.com [98.137.246.8] with 32 bytes of data:		
Reply from 98.137.246.8: bytes=32 time=166ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=198ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=2032ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=2592ms_TTL=52		
Reply from 98.137.246.8: bytes=32 time=547ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=580ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=174ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=603ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=608ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=634ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=185ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=730ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=163ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=769ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=1522ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=3267ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=569ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=1436ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=841ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=653ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=202ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=523ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=215ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=242ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=428ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=882ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=554ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=1723ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=979ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=183ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=923ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=1848ms TTL=52		
Request timed out.		
Reply from 98.137.246.8: bytes=32 time=961ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=1732ms TTL=52		
Reply from 98.137.246.8: bytes=32 time=910ms TTL=52		

## 6 Running the GNSS

You can use the GNSS module to get location and position information:

 Connect the second Antenna to the GNSS antenna port on the board. In the QNavaigator, click "GNSS" and then "Connect". You will get location and positioning information. Sample screen shots as below:



🖬 ⁄ 🔄 🗸 🔯 👘	
CRSS [2019-03-22 22:42:54:223_R:] AT+CSQ [2019-03-22 22:42:54:223_R:] +CSQ: 16,0	
Home USB NMEA Port: Quectel USB NMEA Port (COM16)  USB NMEA PORT (CO	
Port property: 115200,8,1,None,None VAuto start/stop GNSS /* use AT+CPIN? to query the SIM card status or unlocked '/	s : SIM card inserted or not, locked
SMS [2019-03-22 22:42:55:556], S;] AT+CPIN? [2019-03-22 22:42:55:556], R;] AT+CPIN? [2019-03-22 22:42:55:556], R;] AT+CPIN? [2019-03-22 22:42:55:556], R;] AT+CPIN?	(
Voice Call         Latitude:         47.826800N         Longitude:         122.206375W         [2019-03-22.22:42:55:556_R:] OK	
Altitude(m):         72.1         Speed(km/h):         0.00         /* use AT+CSQ to query current signal quality [2019-03-22 22:42:55:567_S:] AT+CSQ	/*/
TCP/UDP         Satellite_used:         6         Locating type:         2D         [2019-03-22 22:42:55:571_R:] AT+CSQ           *DOP:         PDOP:12         HDOP:08         VDOP:0.9         [2019-03-22 22:42:55:571_R:] +CSQ: 16,99	
[2019-03-22 22:42:55:571_R:] OK	
// use AT+CREG? /AT+CGREG? to query the return value is [0,1] or [0,5], it is successfully register */	
PPP 315 45 [2019-03-22 22:42:55:583_S:] AT+CREG? [2019-03-22 22:42:55:589_R:] AT+CREG?	
300         40         60         [2019-03-22 22:42:55:589]R:] +CREG: 0,1           AT command         000         220         220         75         [2019-03-22 22:42:55:589]R:] OK	
280 4 42 4/0 [2019-03-22 22:42:55:593_S:] AT+CGREG? [2019-03-22 22:42:55:598_R:] AT+CGREG?	
QCOM (221) (21) (22) (20) (20) (20) (20) (20) (20) (20	
255 240 120	⊖ File
225 225 135	
210 195 S 165 DIR	RIS





## 7 AT Commands

The QNavigator can be used to communicated with the transmitter and receiver. For example, you can use the following AT commands:

- a. **ATI:** The ATI command displays the module information, such as the name and version
- b. **AT+CFUN?:** This commands sets up phone functionality in the module. In our case it is 1, because we require full functionality.
- c. **AT+CSQ:** This command is used to get the signal strength and it makes sure that the USIM is receiving signals.
- d. **AT+CREG?:** This command is used to enquire about the network registration status. Response 1 means registered.
- e. AT+CGREG?: This command is also used to enquire the network registration status.
- f. **AT+COPS?:** This commands returns the current mode and currently selected operator. (e.g. T-Mobile).
- g. AT+QCFG = "BAND", f,400a0e189f,a0e189f: In order for the USIM to get registered with the 5G NB network we set up the device to look for the above frequency band configuration.
- h. **AT+QCFG = "NWSCANMODE",1:** This command is used to set the scan mode. We set it to 1 to scan for GSM networks to register.
- i. **AT+QCFG = "iotopmode",1:** This command is used to specify the network category which is to be searched under the LTE network mode. We set it to 1 to search for LTE Cat.NB1.
- j. AT+QCFG = "NWSCANSEQ",010302: This command configures the sequence of searching for the network. Our sequence means GSM→LTE Cat.NB1→LTE Cat.M1
- k. AT+CGDCONT=1,"IPV4V6": This command sets the PDP context, we have set the PDP context to IPV4 and V6.

- I. **AT+CGPADDR:** This command returns a list of PDP addresses.
- m. **AT+QNWINFO:** This command queries the network information such as access technology, operator's numeric code, the band and channel ID.
- n. **AT&WO**: Use this command to stores the current AT command settings to a user defined profile in non-volatile memory

For GNSS to work with QNavigator, make sure the following is issued:

o. **AT+QGPSCFG="outport", "usbnmea"**: Use this command to configure various GNSS settings, including NMEA sentences output to the BG96 USB port.

The BG96 is connected to two GPIOs (GPIO26 and GPIO64) which produces a maximum of 1.8V. You can set them using the following commands:

AT+QCFG="gpio",1,26,1,0,7 //configure pin 26 as output, no pull, 17mA drive, clean last configuration AT+QCFG="gpio",3,26,1 // write pin 26 high value, clean last configuration AT+QCFG="gpio",1,64,1,0,7 //configure pin 64 as output, no pull, 17mA drive, clean last configuration

AI+QCFG="gpio",1,64,1,0,7 //configure pin 64 as output, no pull, 17mA drive, clean last configuration AT+QCFG="gpio",3,64,1 // write pin 64 high value, clean last configuration

The following are screen shots of some of these AT commands:

QNavigator_V	1.6								×
File Setting To	ol View	Help							
🖬 🖄 Ϋ		1 🌭 🖭 🌖 🧃							
	QCOL					.1	[2019-03-22 20:06:19:205_R:] AT+CFUN? [2019-03-22 20:06:19:205_R:] +CFUN: 1		^
Home	💌 Cho	oose all commands	Hex	💌 En	ter	Delay(ms)	[2019-03-22 20:06:19:205_R:] OK		
	☑ 1	AT+CSQ		<b>V</b>	1	500	[2019-03-22 20:06:20:192_S:] AT+COPS? [2019-03-22 20:06:20:192_R:] AT+COPS?		
	₹ 2	AT+CPIN?		7	2	500	[2019-03-22 20:06:20:192_R:] +COPS: 0,0,"T-Mobile",0		
SMS	₹ 3	AT+CREG?	-	<b>V</b>	3	500	[2019-03-22 20:06:20:192 R:] OK		
C		AT+CGREG?			4	500	[2019-03-22 20:06:21:781_S:] AT+QCFG = "BAND", f,400a0e189f,a0e189f		
Voice Call	· 4 ▼ 5	AT+GSN			5	500	[2019-03-22 20:06:21:781_R:] AT+QCFG = "BAND", f,400a0e189f,a0e189f [2019-03-22 20:06:21:781_R:] OK		
	₩ 5 ₩ 6	AT+QCCID		V		500	[2019-03-22 20:06:23:241_S:] AT+QCFG = "NWSCANMODE",1		
হি					6		[2019-03-22 20:06:23:257_R:] AT+QCFG = "NWSCANMODE",1 [2019-03-22 20:06:23:257 R:] OK		
TCP/UDP	₹ 7	ATI			7	500	[2019-03-22 20:06:24:641_S:] AT+QCFG = "iotopmode",1		
<u>6</u>	8 🕅	AT+CFUN?		7	8	500	[2019-03-22 20:06:24:641_R:] AT+QCFG = "iotopmode",1 [2019-03-22 20:06:24:641 R:] OK		
ی کھی	<b>₽</b> 9	AT+COPS?			9	500	[2019-03-22 20:06:25:666_S:] AT+QCFG = "NWSCANSEQ",010302		
GNSS	<b>⊠</b> 10	AT+QCFG = "BAND", f,400a0e18		~	10	500	[2019-03-22 20:06:25:666_R:] AT+QCFG = "NWSCANSEQ",010302 [2019-03-22 20:06:25:682_R:] OK		
-	M 11	AT+QCFG = "NWSCANMODE",1			11	500	[2019-03-22 20:06:27:370_S:] AT+CGDCONT=1,"IP"		
PPP	☑ 12	AT+QCFG = "iotopmode",1		~	12	500	[2019-03-22 20:06:27:370_R:] AT+CGDCONT=1,"IP" [2019-03-22 20:06:27:385 R:] OK		
	☑ 13	AT+QCFG = "NWSCANSEQ",010		~	13	500	[2019-03-22 20:06:29:421_S:] AT+CGPADDR		
<b></b>	☑ 14	AT+CGDCONT=1,"IP"		V	14	500	[2019-03-22 20:06:29:421_R:] AT+CGPADDR [2019-03-22 20:06:29:421 R:] +CGPADDR: 1.0.0.0.0		
AT Command	☑ 15	AT+CGPADDR	-	<b>V</b>	15	500			
4.	☑ 16	AT+QNWINF0	Ē	<b>v</b>	16	500	[2019-03-22 20:06:29:421_R:] OK [2019-03-22 20:06:31:480_S:] AT+QNWINFO		
📫 🔶	☑ 17	AT+CGDCONT=1,"IP","fast.t-mot			17	500	[2019-03-22 20:06:31:495_R:] AT+QNWINFO	-	~
QCOM					and the second second second		• Text		
	☑ 18	AT&WO		<b>v</b>	18	500	e rext e riex e opecial citars e rite		
	<b>1</b> 9			•	19				
	E 20				20				

2. You can send SMS from the SMS pane of the QNavigator. Screenshots below shows the SMS transmitted by the device and received on the phone.







## 8 References

- [1] Quectel\_BG96\_Hardware\_Design\_V1.2.pdf
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- [8] Microchip, "Low-Power, 32-bit Cortex-M0+ MCU with Advanced Analog and PWM"

## **APPENDIX A – SCHEMATIC**

