

# USB MODEM LTE CAT NB2/MTC & GNSS

USB Modem BG95-M2/M3 Technical Specifications & User Manual



# **Purpose of the Document**

The purpose of this document is to explain the technical specifications and manual for using the Cat NB2 NB-IoT & GNSS USB modem.

# **Document History**

Version	Author	Date	Description
Α	5G HUB 08.12.2020 Initial Do		Initial Document
В	5G HUB 02.28.2021		Add download Section
С	5G HUB	05.17.2022	Add Arduino support Section
D	5G HUB 09.30.2023		Add BG95-M2

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# **1** Package contents:

#### **1.1 Cat NB2 NB-IoT USB Modem Package:**

• Cat NB2/Cat M USB modem with LTE & GNSS antenna connectors.

#### 1.2 Download

Arduino software can be downloaded from the following website: <u>5G-NB-IoT/KitSketches at master · 5ghub/5G-NB-IoT (github.com)</u>

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 web site 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 BG95 here: <u>https://github.com/5ghub/5G-NB-IoT/tree/master/Tools</u>

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 for BG95

# **2** General Description

## 2.1 Overview

The Cat NB2 USB modem is a cellular and GPS modem in an USB stick form factor. The USB modem has UFL connectors for LTE & GNSS antennas. The board is a powerful board that features a microcontroller and wireless modem. The microcontroller is an Microchip SAMD21G18A MCU which features a 32-bit ARM Cortex<sup>®</sup> M0+ core. The wireless modem is BG95-M3 which is an embedded Cat NB2 wireless communication module. BG95 wireless modem provides a maximum data rate of 588 Kbps downlink and 1119 Kbps uplink. It provides data connectivity on LTE-FDD/GSM/EGPRS networks. It also provides GNSS to meet customers' specific application demands

The USB modem provides rich sets of Internet protocols, industry-standard interfaces (USB/UART/I<sup>2</sup>C/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 USB modem is a rich hardware board that can be used for the 4G LTE wireless technology and enables a variety of smart applications for devices. 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.

### 2.2 Key Features

- Microchip ATSAMD21G18 MCU
- Quectel BG95-M2 or BG95-M3 Cat NB2/Cat M NB-IoT module
- UFL connectors for LTE & GNSS antenna
- Supports LTE NB-IoT and Machine Type Communications (MTC)
- Supports GSM/EDGE (only with BG95-M3)
- Global Frequency Band B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B28/B66/B71/B85 (B26/B27 for Cat.M1) 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 65.1 mm x 32mm
- 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 be powered via the USB connector

 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 1. USB Modem Overview Diagram – Top View



Figure 2. USB Modem Overview Diagram – Bottom View

# 2.4 Physical Characteristics

The width and length of the USB modem is 32 mm (width) by 65 mm (length). The board have two screw holes in each corner that allows the board to be attached to a surface or case.

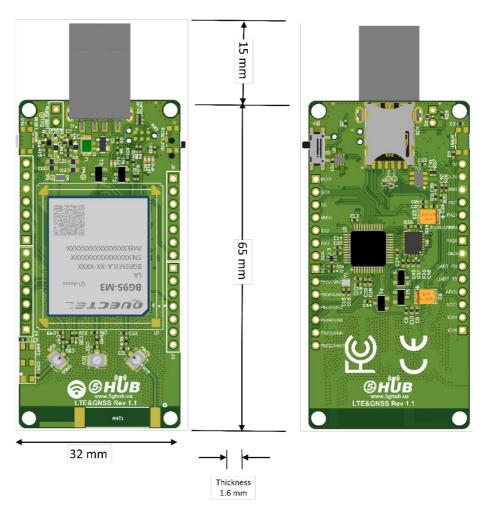


Figure 3. Physical Characteristics.

# 2.5 Peripherals – Key Components

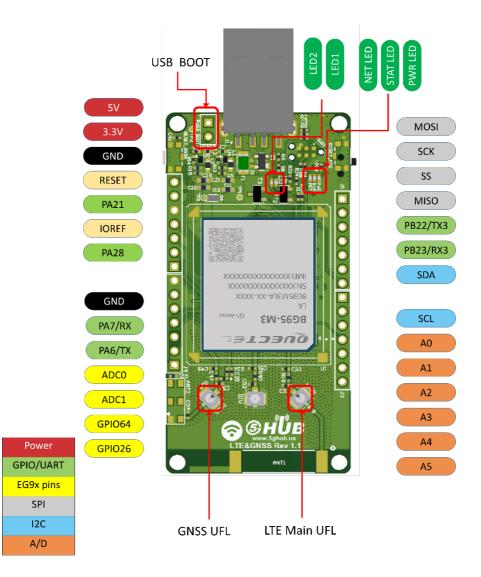


Figure 4. USB Modem Top Side – Key Components

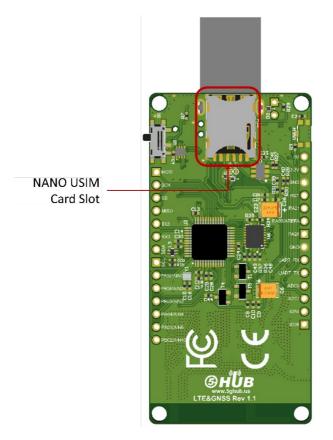


Figure 5. USB Modem Bottom Side – Key Components

# 2.6 Hardware Specification

Technical Specification	
Microcontroller (MCU)	ATSAMD21G18, 32-Bit ARM Cortex M0+
Clock Speed	48 MHz
Flash Memory	256 KB
SRAM	32 KB
NB-IoT Module	Quectel BG95-M2 or BG95-M2
Dimension	30 mm (width) by 65 mm (length)
Weight	22 grams
Power Supply	USB (5V)
LED	LED1, LED2, Status LED, Netlight LED
Interfacing Logic Voltage Level (Operating Voltage)	3.3V
Voltage output	5V, 3.3V
RESET buttons	Not Mounted
User-defined Button	Not Mounted
USB Switch	1 switch to connect to MCU directly or BG95 directly
General-purpose digital I/O Pins	14 (A0-A5, PA6, PA7, SS, MOSI, MISO, SCK, SDA, SCL)
GPIO	2 connected to BG95
ADC	2 connected to BG95
USB	1
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 GNSS antenna
Band	LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B28/B66/B71/B85 (B26/B27 for Cat.M1) GSM/EGPR: 850/900/1800/1900MHz
Certification	FCC, IC, CE
Mobile Operator Certification	Verizon, AT&T, T-Mobile, Vodafone, Rogers, Telus, China telecom, China Mobile, China Unicom

#### Notes:

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

# 2.7 PIN Description

PIN	DIRECTION	Description
USB Connector	I	The USB modem is powered from the USB port (3.8V-5V)
	6	LED which can be controlled from MCU (D25). When the pin is
LED1 (USER)	0	HIGH value, the LED is on, when the pin is LOW, it is off
	6	LED which can be controlled from MCU (D26). When the pin is
LED2 (USER)	0	HIGH value, the LED is on, when the pin is LOW, it is off
LED (NET)	0	Indicate the BG95 operation status
LED (STAT)	0	Indicate the BG95 network activity status
MCU RESET		Net en este l
button	I	Not mounted
BG95 RESET		Net menuted
button	I	Not mounted
User Button	I	Not mounted
USB Switch	I	1 switch to connect to MCU directly or BG95 directly
		Provides the voltage reference with which the MCU operates. A
IODEE	0	device can read the IOREF pin voltage and select the appropriate
IOREF	0	power source or enable voltage translators on the outputs for
		working with the 5V or 3.3V
		3.3V generated by the on-board regulator. Maximum current
3.3V	0	drawn is 3A. The regulator also provides power to the MCU and
		BG95
5V	0	5V generated from the board. The board is supplied with power
50	0	from USB connector (typical 5V)
GND		Ground
A0	IO	Six analog inputs which can provide up to 12 bits of resolution
A1	10	(i.e. 4096 different values). By default, each input measures
A2	10	from ground to 3.3 volts, though is it possible to change the
A3	10	upper end of their range using the AREF pin
A4	10	A0 can also be used as a DAC output and provides a 10 bit
A5	IO	voltage output with <u>analogWrite()</u> function
		Analog pins can be used as GPIOs
SCL	10	I <sup>2</sup> C. The SCL (clock line). Can be used as GPIO
SDA	10	I <sup>2</sup> C. 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	10	SPI Interface. Can be used as GPIO
MISO	10	SPI Interface. Can be used as GPIO
MOSI	10	SPI Interface. Can be used as GPIO
SS	10	SPI Interface. Can be used as GPIO
PA7	10	GPIO. Can be used as GPIO
PA6	10	GPIO. Can be used as GPIO
Cortex Debug	10	Using Single Wire Debug to burn bootloader and debug the
Connector		board
ADC0	I	Connected to BG95. General purpose analogue to digital converter

ADC1	I	Connected to BG95. General purpose analogue to digital converter
GPIO26	IO	Connected to BG95. General purpose IO
GPIO64	IO	Connected to BG95. General purpose IO
USIM	I	Used to insert a Nano USIM. Connected to BG95
USB Boot	I	Connected to BG95. Force the BG95 to enter emergency download mode

#### Precaution

# The USB modem 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

## 2.8 BG95 chipset

All functionality of the BG95 shipset shall be implemented excluding the following features. That is, the following features are not supported:

- Audio, Earphone, and Codes are not supported.
- PCM and I<sup>2</sup>C are not supported
- PSM\_IND and AP\_READY are not supported

### 2.9 Interface between SAM21D and BG95

The Microcontroller communicates with the BG95 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.
- **RI/DCD:** (PB10/PB11).

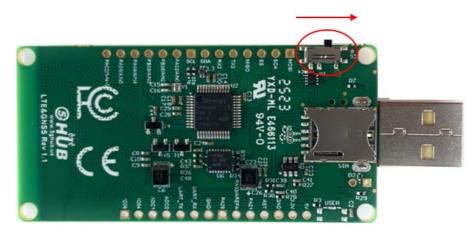
# 3 Using the Board with Arduino IDE

# 3.1 Installing the Software

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

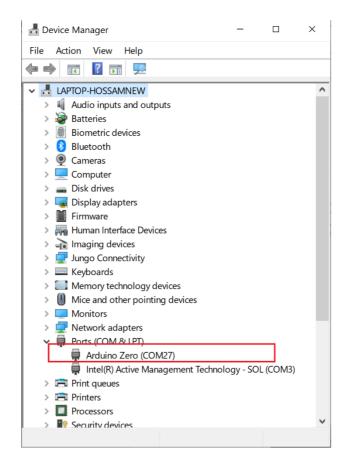
# 3.2 Setting Up the Board

Gently move the switch S1 upward to put the board in Arduino mode as in the picture below.



## 3.3 Setting Up Arduino IDE

1- Insert the USB modem into the USB port of a computer. Launch Windows device manager and you shall see the Arduino board as below.



2- 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

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	C:\Users\hossa\Documents\Ardsino Browse	
}	Editor language: System Default V (requires restart of Arduino)	
	Editor font size: 12	
	Interface scale: Automatic 100 0 % (requires restart of Arduino)	
	Theme: Default theme ~ (requires restart of Arduino)	
	Show verbose output during:  compilation upload	
	Compiler warnings: Nane ~	
	Display line numbers	
	Enable Code Folding      Verify code after upload	
	Use external editor	
	Aggressively cache compiled core	
	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/Sghub/SG-NB-1oT/master/package_SG-NB-1oT_inds	
	More preferences can be edited directly in the file C:\Users\hossa\kpData\users\ppData\users\pstreamses.bt	
	(edit only when Arduino is not running)	
	OK Cancel	
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		~
		5G-NB-IoT (Native USB Port) on COM5

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

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	Arduino Yún on COM5

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	Serial Plotter	Ctrl+Shift+L							
}	WiFi101 / WiFiNINA Firmware Updat		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						
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5- In the Arduino IDE, Choose **Port** and select the serial port where the board appears.

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File Edit Sketch To						
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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					
<pre>void loop()</pre>	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 mkll"	x	<ul> <li>COM5 (5G-NB-IoT (Native USB Port))</li> </ul>			
	Burn Bootloader					
						~

6- 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.

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sketch	Verify/Compile Upload Upload Using Programmer Export compiled Binary	Ctrl+R Ctrl+U Ctrl+Shift+U Ctrl+Alt+S						
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// put }	your main code here, 1	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	aloading https://raw.g	ithubuserco	Contributed libraries 5G-NB-IoT HID I2S SAMD_AnalogCorrectic SDU	on	master/package_5	G-NB-IOT	_index.	json
			SPI		5G-NB-	IoT (Native US	B Port) on	COM5

### 3.4 Running Arduino Sketch

1- Using Arduino IDE, open any Arduino sketch such as **TurnOnAllPins.ino**, choose **Sketch->Upload** and it will run on the USB modem.

