# 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 |
|---|---|---|---|
| A | 5G HUB | 08.12.2020 | Initial Document |
| B | 5G HUB | 02.28.2021 | Add download Section |
| C | 5G HUB | 05.17.2022 | Add Arduino support Section |
| D | 5G HUB | 09.30.2023 | Add BG95-M2 |
| | | | |

# Table of Contents

# 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:
5G-NB-IoT/KitSketches at master · 5ghub/5G-NB-IoT (github.com)

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

Download and install Arduino library (**5G-NB-IoT_Arduino.zip**) here:
https://github.com/5ghub/5G-NB-IoT

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

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® 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$^2$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

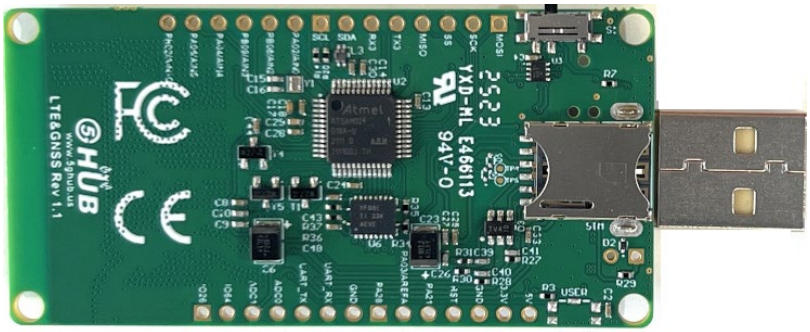



Figure 2. USB Modem Overview Diagram – Bottom View

## 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.

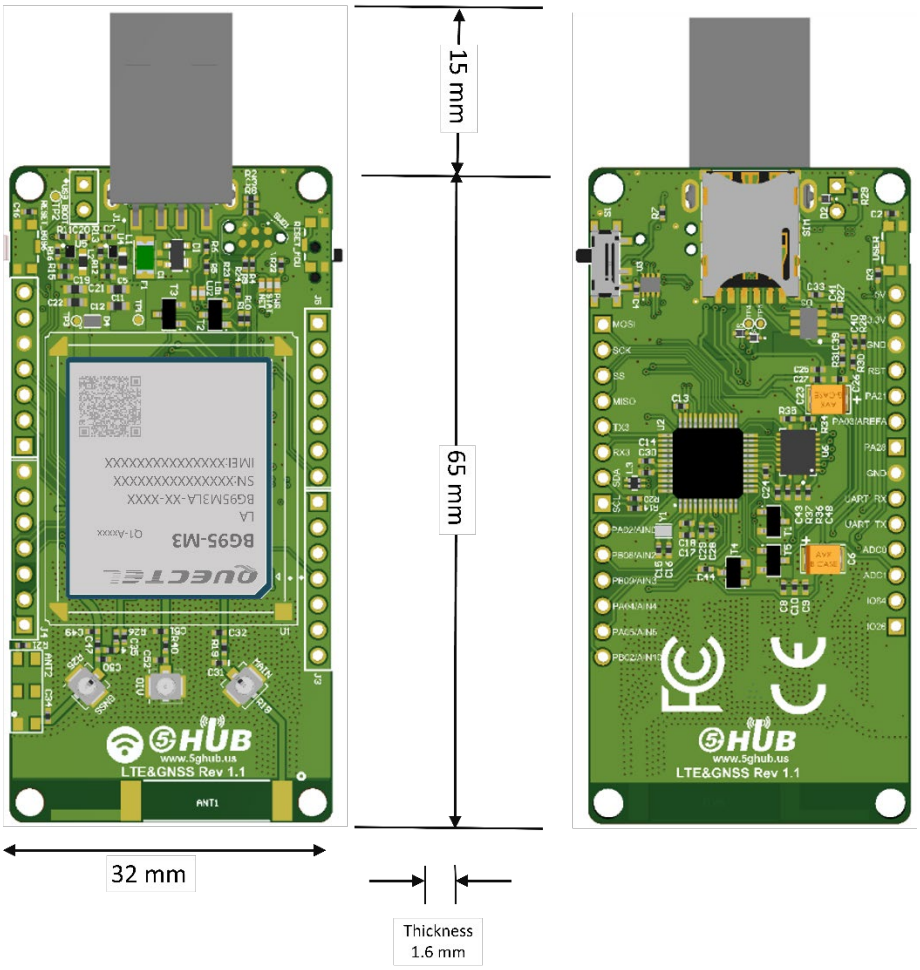



Figure 3. Physical Characteristics.

## 2.5 Peripherals – Key Components

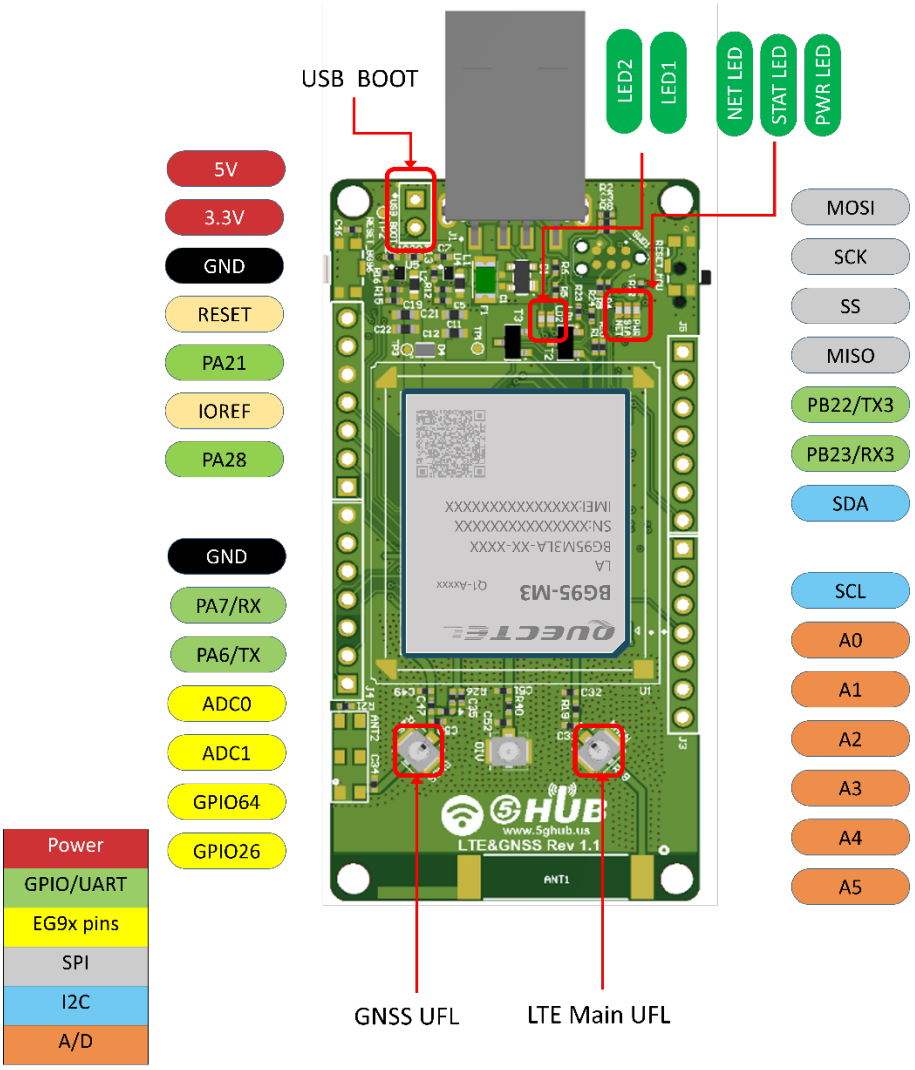



Figure 4. USB Modem Top Side – Key Components

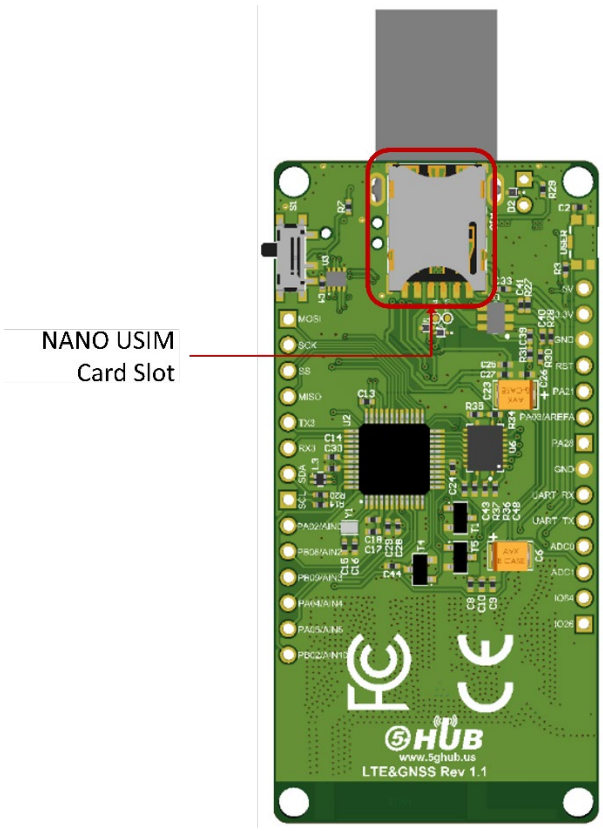



Figure 5. USB Modem Bottom Side – Key Components

## 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 |
| $I^2C$ | 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:<br>B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B28/B66/B71/B85 (B26/B27 for Cat.M1)<br>GSM/EGPR:<br>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) |
| LED1 (USER) | O | 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) | O | 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) | O | Indicate the BG95 operation status |
| LED (STAT) | O | Indicate the BG95 network activity status |
| MCU RESET button | I | Not mounted |
| BG95 RESET button | I | Not mounted |
| User Button | I | Not mounted |
| USB Switch | I | 1 switch to connect to MCU directly or BG95 directly |
| IOREF | O | 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 | O | 3.3V generated by the on-board regulator. Maximum current drawn is 3A. The regulator also provides power to the MCU and BG95 |
| 5V | O | 5V generated from the board. The board is supplied with power from USB connector (typical 5V) |
| GND | | Ground |
| A0 | IO | Six analog inputs which can provide up to 12 bits of resolution (i.e. 4096 different values). By default, each input measures from ground to 3.3 volts, though is it possible to change the upper end of their range using the AREF pin<br>A0 can also be used as a DAC output and provides a 10 bit voltage output with analogWrite() function<br>Analog pins can be used as GPIOs |
| A1 | IO | |
| A2 | IO | |
| A3 | IO | |
| A4 | IO | |
| A5 | IO | |
| SCL | IO | $I^2C$. The SCL (clock line). Can be used as GPIO |
| SDA | IO | $I^2C$. The SDA (data line). Can be used as GPIO |
| AREFA | I | 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 Connector | IO | Using Single Wire Debug to burn bootloader and debug the 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 BG95shipset shall be implemented excluding the following features. That is, the following features are not supported:

- Audio, Earphone, and Codes are not supported.
- PCM and $I^2C$ 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).

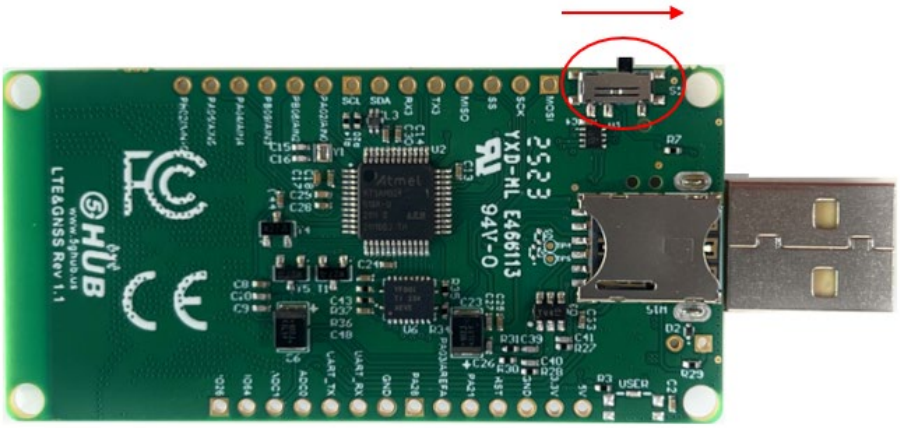
# 3 Using the Board with Arduino IDE

## 3.1 Installing the Software

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

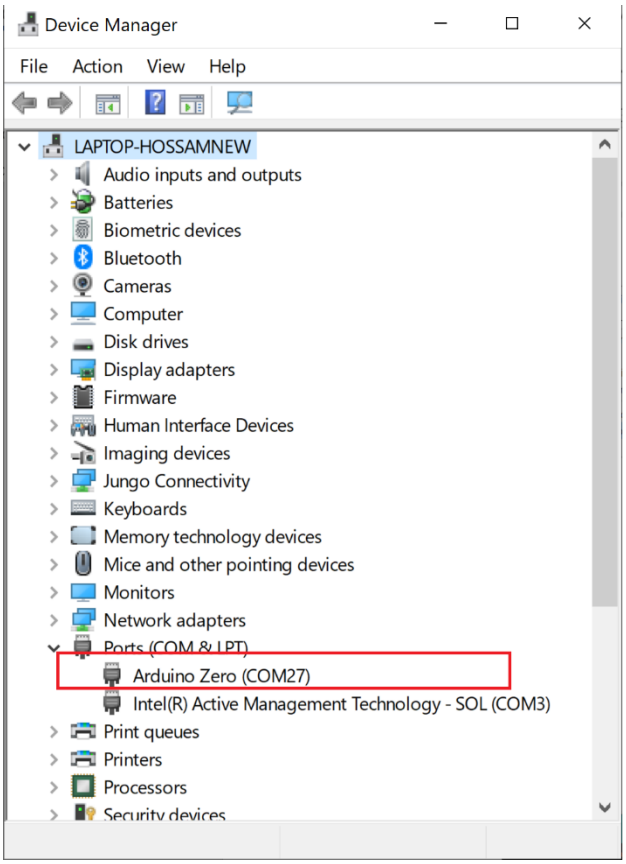
## 3.2 Setting Up the Board

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

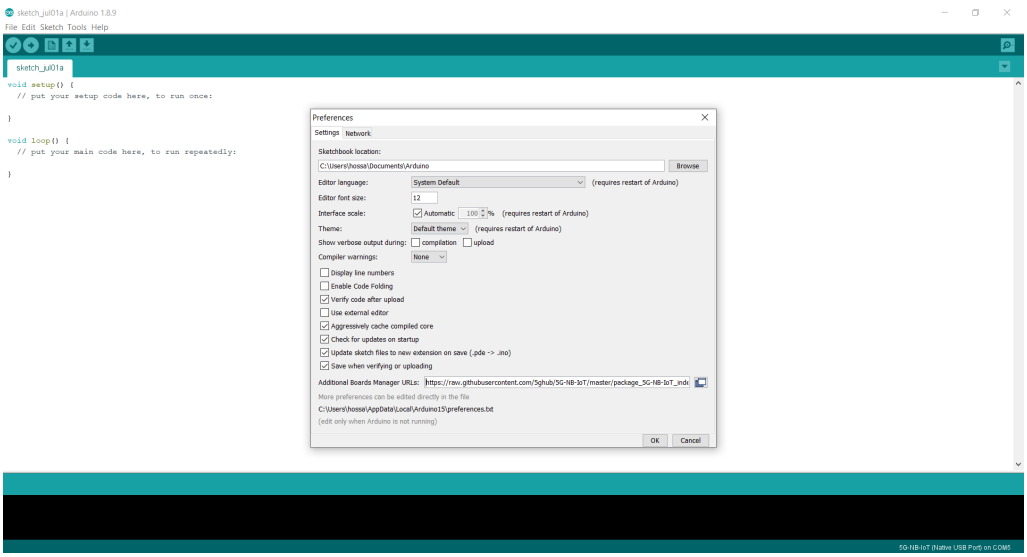


## 3.3 Setting Up Arduino IDE

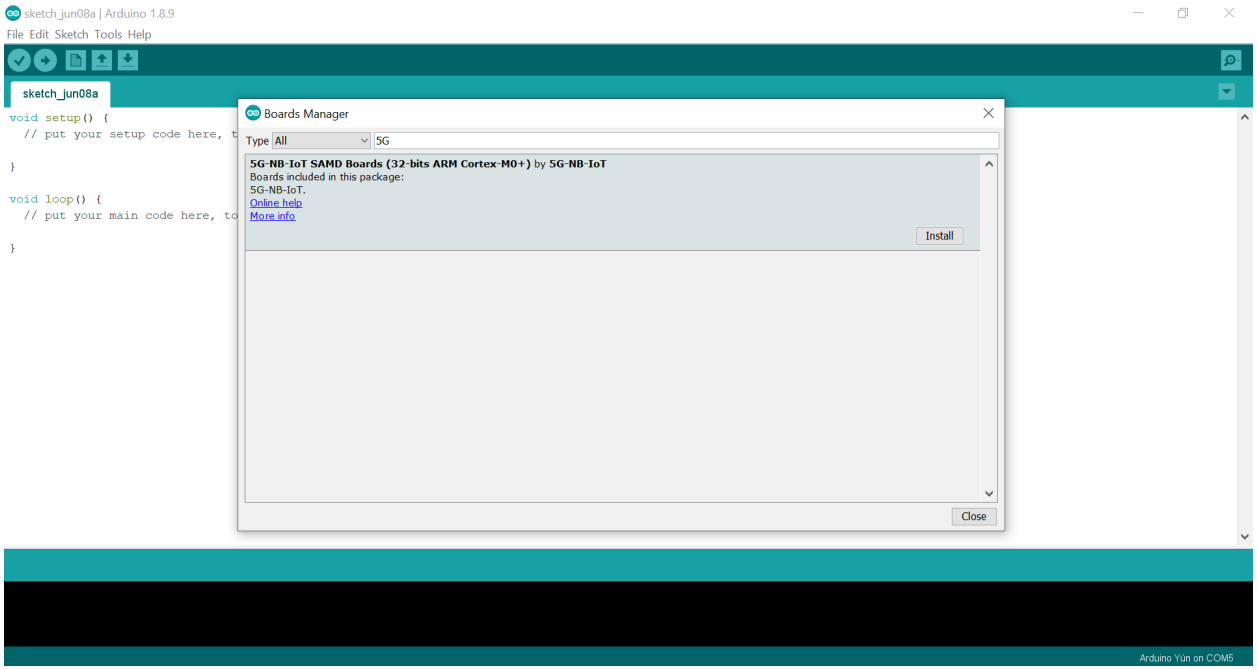
1- Insert the USB modem into the USB port of a computer. Launch Windows device manager and you shall see the Arduino board as below.



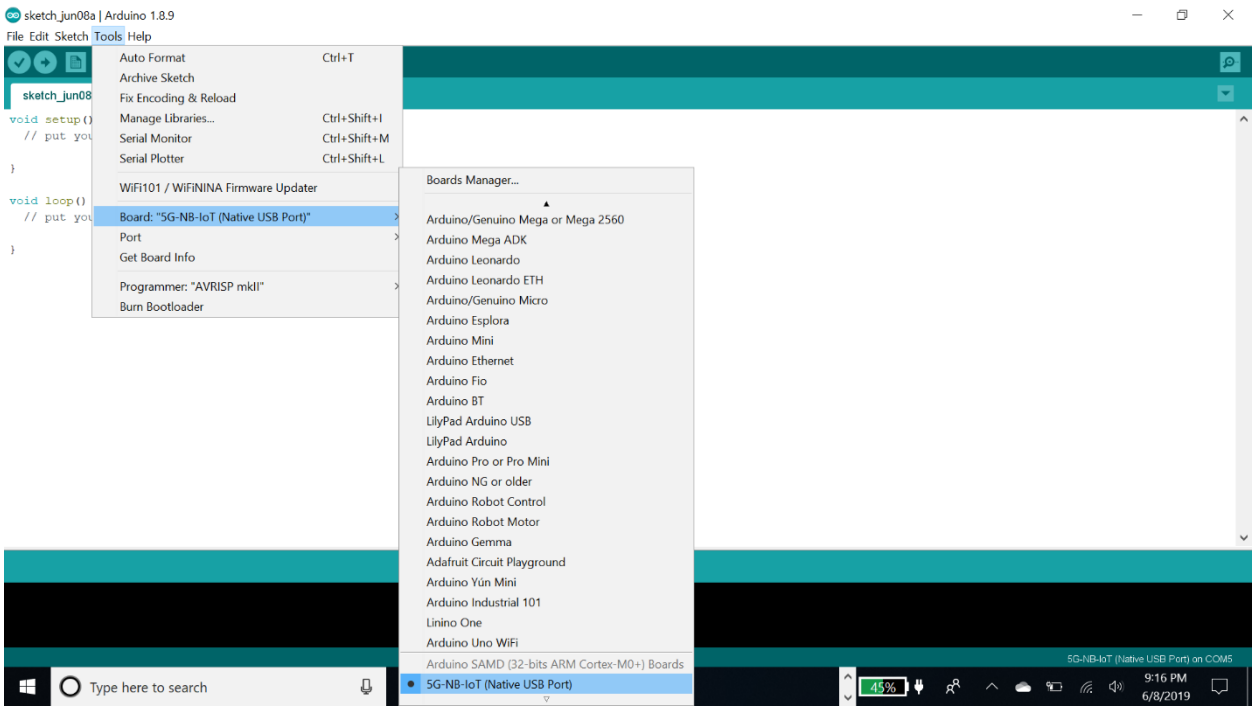

2- Launch Arduino IDE and choose **File->Preferences**. In the Additional Boards Manager URLs, insert the following URL:
https://raw.githubusercontent.com/5ghub/5G-NB-IoT/master/package_5G-NB-IoT_index.json



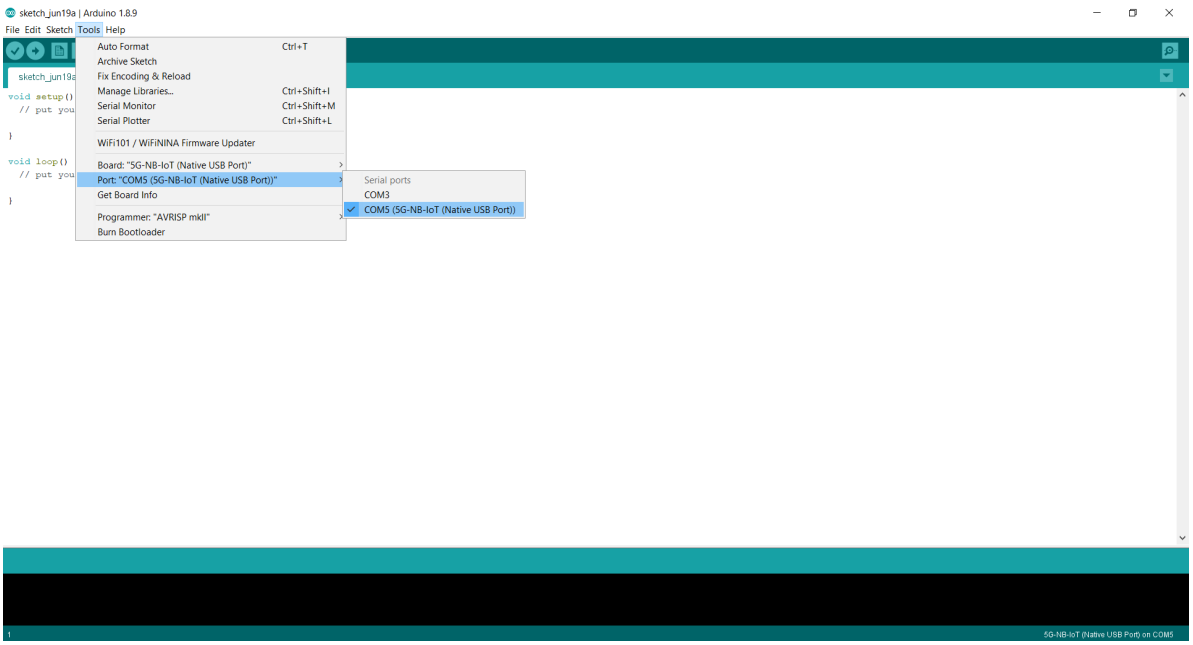

3- In Arduino IDE, choose **Tools->Board->Boards Manager**, select and install "**5G-NB-IoT SAMD Boards**".




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

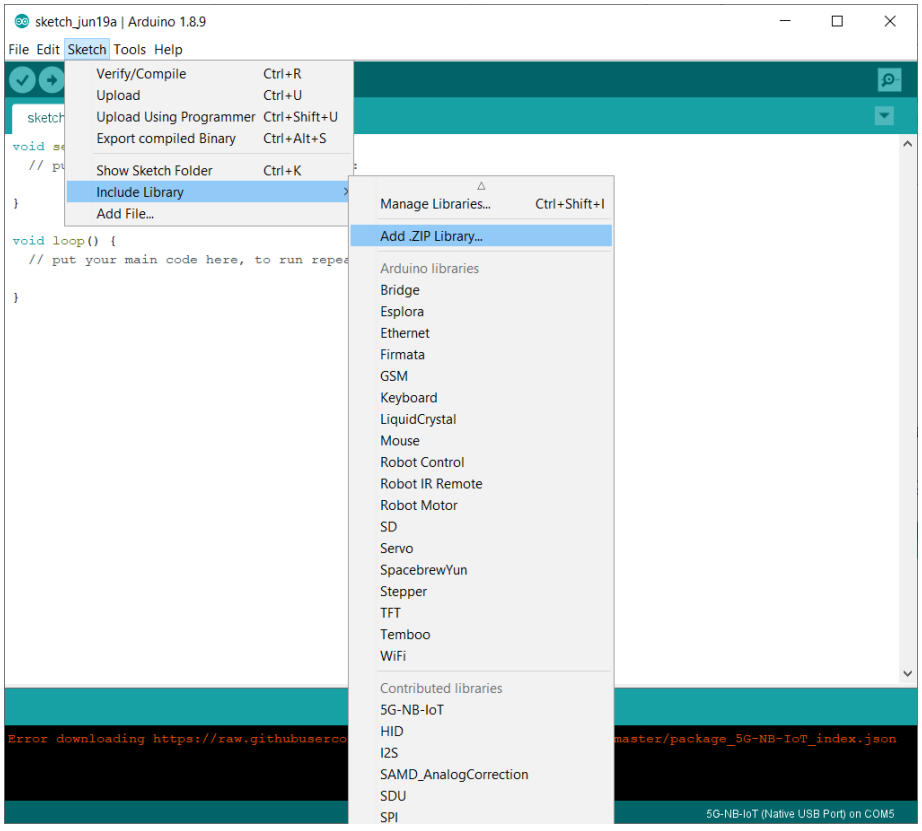



5- In the Arduino IDE, Choose **Port** and select the serial port where the board appears.




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.



## 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.