5G NB-IOT & GNSS USB KIT

USB Dongle BG77 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 USB Dongle.

Document History

Version	Author	Date	Description
A	5G HUB	04.25.2020	Initial Document

Table of Contents

1 Package contents:

NB-IoT Cat NB2 & GNSS USB Dongle Kit Package:

- USB Dongle with on-board LTE & GNSS antennas.

Download software:

Software can be downloaded from the following website:

https://www.5ghub.us/download

Software to download:

- QNavigatorV1.6 (in the folder \Tools).
- Quectel driver (in the folder \Driver).

Documentation:

- Quectel AT commands and GNSS commands manual (in the folder \Doc).

2 General Description

2.1 Overview

The NB-IoT & GNSS USB dongle is a cellular and GPS USB stick based on Quectel BG77. It has on-board LTE & GNSS antennas. The USB dongle features a microcontroller and wireless modem. The microcontroller is an Atmel's SAMD21G18A MCU which features a 32-bit ARM Cortex® M0+ core. The wireless modem is BG77 which is an embedded IoT (LTE Cat-M1, LTE Cat-NB2 and EGPRS) wireless communication module. BG77 wireless modem provides a maximum data rate of 589Kbps downlink and 1.12Mbps 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 USB dongle 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 kit 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.

2.2 Key Features

- Atmel ATSAMD21G18 MCU
- Quectel BG77 NB-IoT & GNSS module
- On-board LTE & GPS antenna
- 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 65mm x 30mm
- 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 is powered via the USB connector
- Each of the 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 Dongle Overview Diagram – Top View

Figure 2. USB Dongle Overview Diagram – Bottom View

2.4 Physical Characteristics

The width and length of the USB dongle is 30 mm (width) by 65 mm (length). The board have two screw holes in opposite corner that allows the board to be attached to a surface or case.
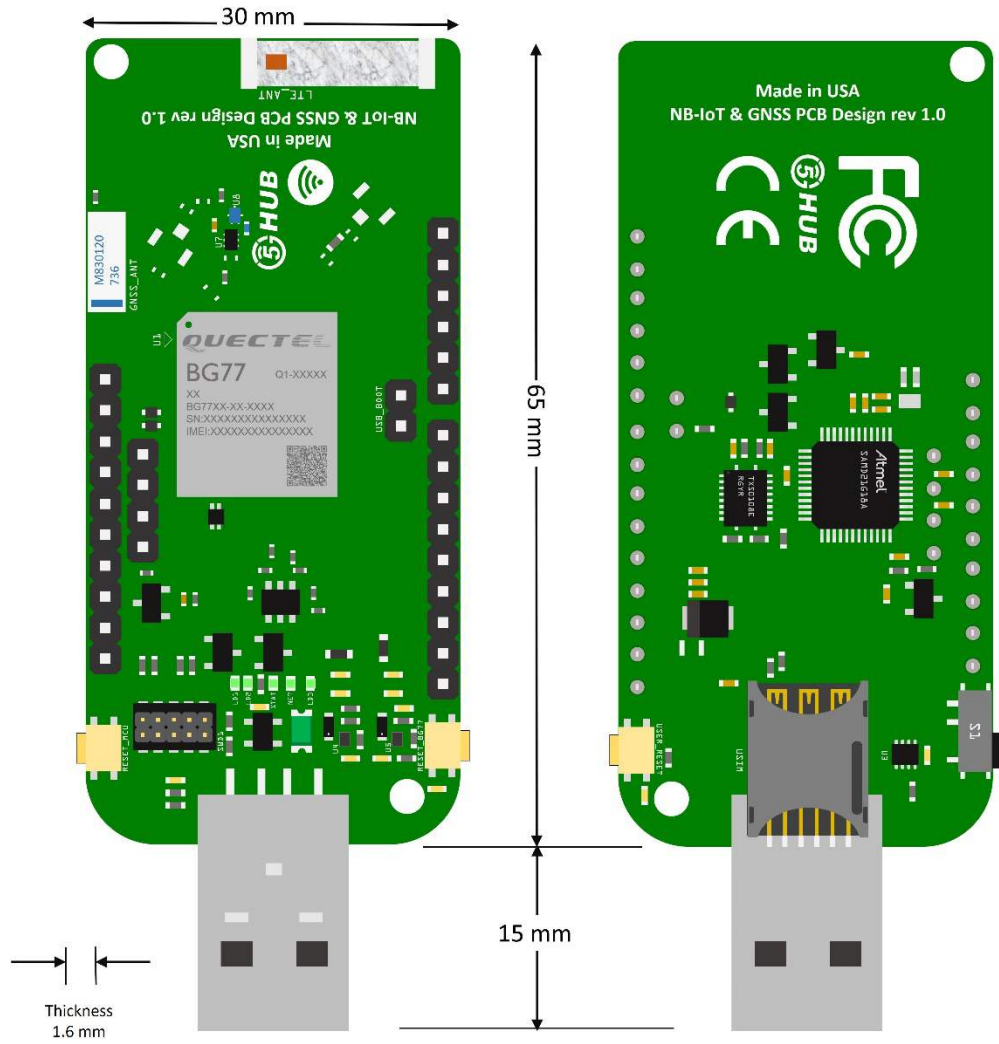
Figure 3. Physical Characteristics.

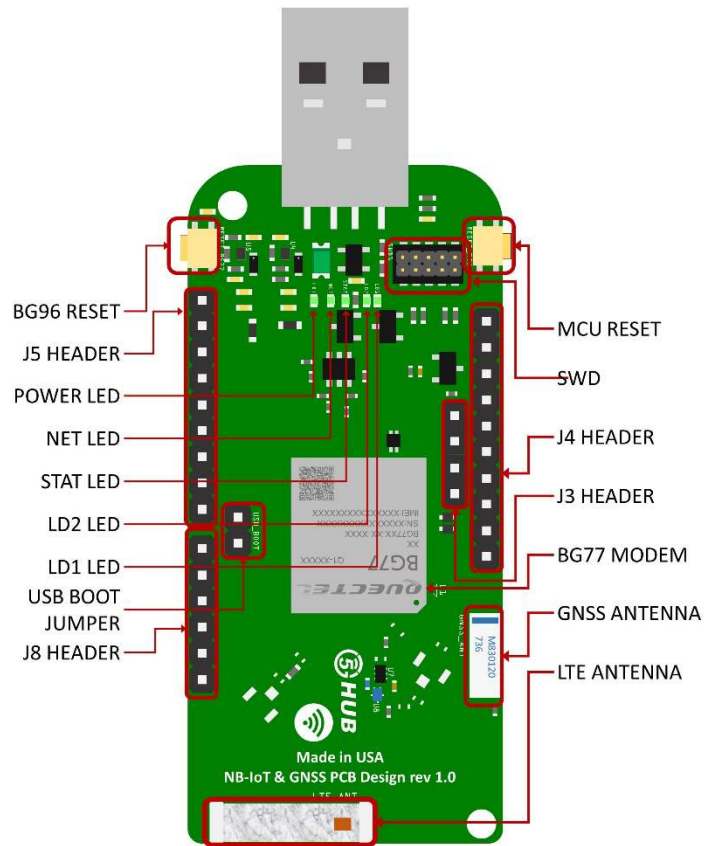## 2.5 Peripherals – Key Components

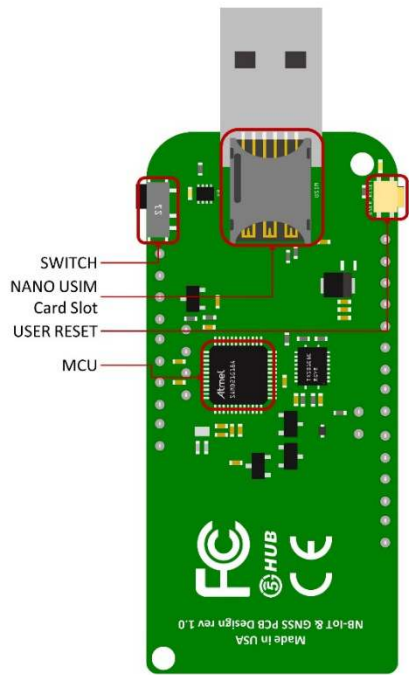Figure 4. USB Dongle Top Side – Key Components

Figure 5. USB Dongle Bottom Side – Key Components

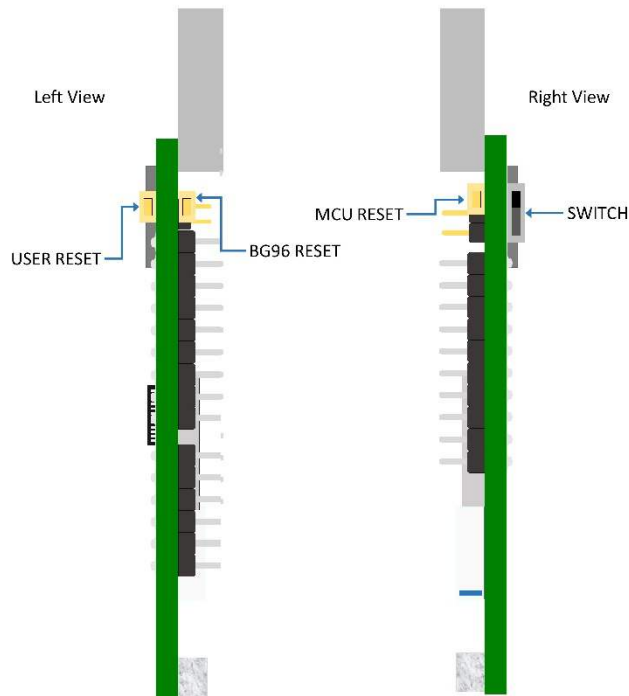

Figure 6. USB Dongle Side View – Key Components

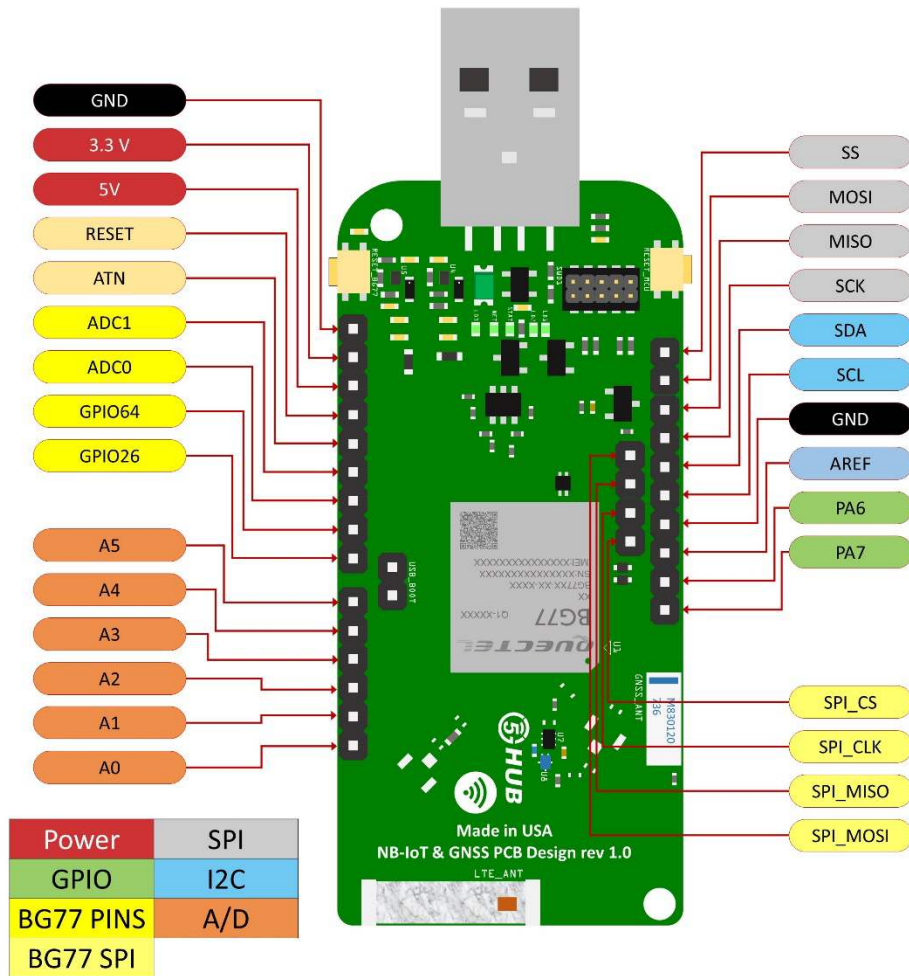## 2.6 Peripherals – IO Connections

Figure 7. USB Dongle Connectors

* I^{2}C 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 KB
SRAM	32 KB
NB-IoT Module	Quectel BG77
Dimension	30 mm (width) by 65 mm (length)
Weight	22 grams
Power Supply	USB (5V)
LED	LED1, LED2, LED3, Status LED, Netlight LED
Interfacing Logic Voltage Level (Operating Voltage)	3.3V
Voltage output	5V, 3.3V
RESET buttons	Two; one for MCU and one for BG77
User-defined Button	1 connected to MCU
USB Switch	1 switch to connect to MCU directly or BG77 directly
General-purpose digital I/O Pins	14 (A0-A5, PA6, PA7, SS, MOSI, MISO, SCK, SDA, SCL)
GPIO	2 connected to BG77
ADC	2 connected to BG77
USB	1
I²C	2 (1 connected to BG77)
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
Band	LTE-FDD, B1/B2/B3/B4/B5/B8/B12/ 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
USB Connector	I	The USB dongle 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
LED3 (USER)	O	LED on powering on the USB
LED (NET)	O	Indicate the BG77 operation status
LED (STAT)	O	Indicate the BG77 network activity status
MCU RESET button	I	Reset the MCU
BG77 RESET button	I	Reset the BG77 module
User Button	I	Connected to digital pin, D0, of MCU and can be used for user-defined purposes
USB Switch	I	1 switch to connect to MCU directly or BG77 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 BG77
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 A0 can also be used as a DAC output and provides a 10 bit voltage output with analogWrite() function Analog pins can be used as GPIOs
A1	IO	
A2	IO	
A3	IO	
A4	IO	
A5	IO	
SCL	IO	I^{2}C. The SCL (clock line). Can be used as GPIO
SDA	IO	I^{2}C. 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 BG77. General purpose analogue to digital converter
ADC1	I	Connected to BG77. General purpose analogue to digital converter
GPIO26	IO	Connected to BG77. General purpose IO
GPIO64	IO	Connected to BG77. General purpose IO
SPI	IO	Connected to BG77.
USIM	I	Used to insert a Nano USIM. Connected to BG77
USB Boot	I	Connected to BG77. Force the BG77 to enter emergency download mode

Precaution

The USB dongle 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 BG77 chipset

All functionality of the BG77 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 I^{2}C are not supported
- PSM_IND and AP_READY are not supported

2.10 Interface between SAM21D and BG77

The Microcontroller communicates with the BG77 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 References

[1] Quectel_BG77_Hardware_Design_V1.2.pdf

[2] Quectel_BG77_Reference_Design_Rev.A_20170814.pdf

[3] Quectel_Antenna_Design_Note_V2.0.pdf

[4] Quectel_RF_Layout_Application_Note_V2.2.pdf

[5] Quectel_QFlash_User_Guide_V2.3

[6] Arduino IDE, https://www.arduino.cc/en/Main/Software

[7] Arduino IDE, https://www.arduino.cc/en/Guide/ArduinoZero

[8] Microchip, "Low-Power, 32-bit Cortex-M0+ MCU with Advanced Analog and PWM"