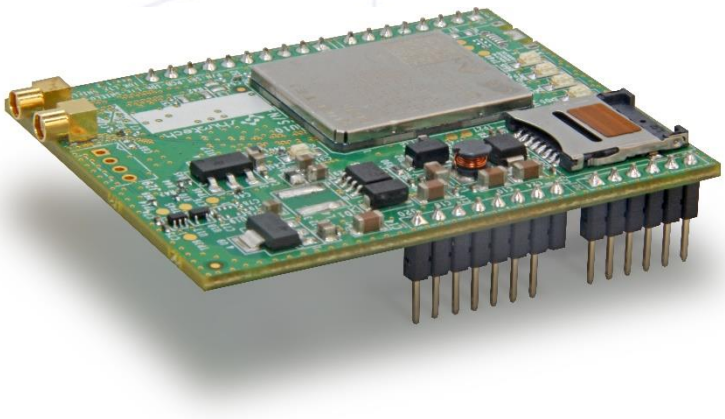
# IoT Shield for Arduino
# User Manual



# INDEX

## 1. Introduction

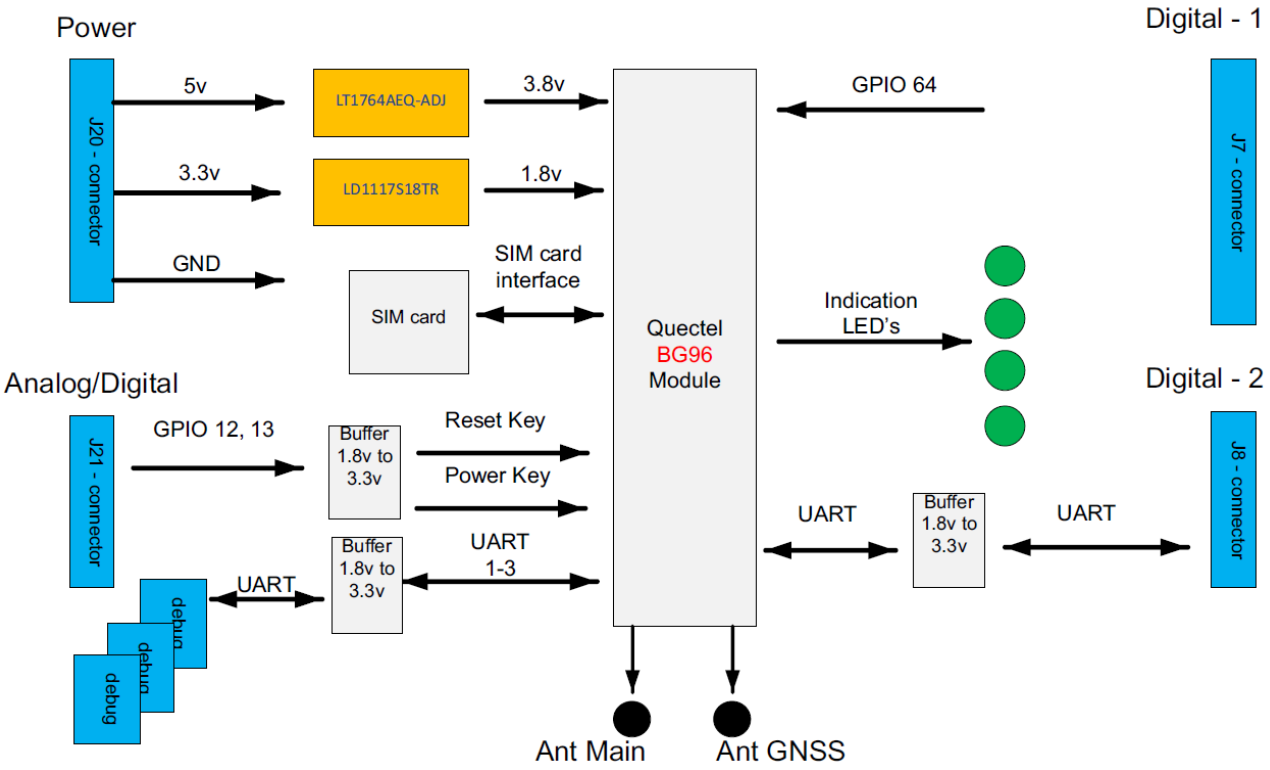
Shiratech Arduino IoT Shield is an Arduino format shield hosting Quectel BG96 LTE CAT-M1/NB1 modem enabling low power cellular connectivity.
A built in GNSS device adds location and navigation to your application. The shield enables rapid development and prototyping of industrial grade low power IoT applications requiring cellular network connectivity.
Arduino format connectors allow using the shield with Arduino boards and other development platforms that use Arduino connector format.

The shield is based on the Quectel BG96 LTE CAT-M1/NB1 – An ultra-low power consumption LTE CAT-M1/Cat-NB1/EGPRS module delivering 375Kbps downlink and 375Kbps uplink data rates.

The board displays the following key benefits:

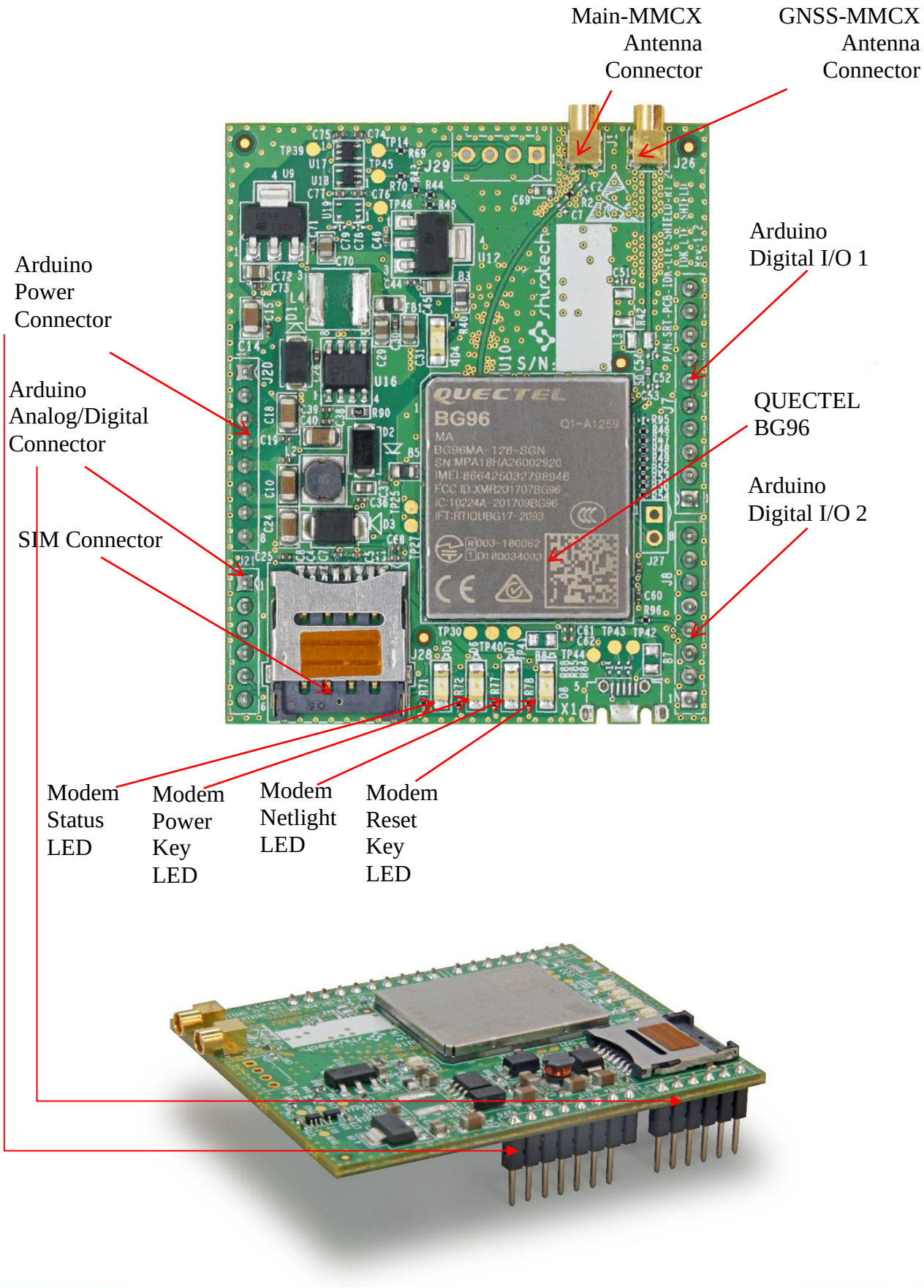
- Quectel BG96 LTE CAT-M1/NB1/EGPRS module
- 375Kbps downlink and 375Kbps uplink data rates.
- Ultra-low power consumption.
- Modem control via UART and GPIO.
- Arduino connector format.
- Industrial grade.
- Built in GNSS.

## 2. Functional Block Diagram




- The shield is connected to a 5V and 3.3V power feed through the J20 connector. The LT1764AEQ-ADJ Translates the 5V input to a 3.8V voltage to feed the BG96, and the LD1117S18TR translates the 3.3V input to 1.8V voltage.
- Quectel BG96 CAT-M1/CAT-NB1/EGPRS Module:
    - The module is powered by 3.8V.
    - Connected to a (u)SIM connector.
    - Connected to two RF antenna jacks: Main and GNSS.
    - J21 connector GPIO pins are used for the BG96 Reset and power keys, after transformation from 3.3V to 1.8V.
- UART 1-3 debug lines are not currently utilized.
- J8 connector UART provides the communication necessary to control the BG96. The signal goes through a transformation from 3.3V to 1.8V.
- The SIM card interface is powered and managed by the BG96.
- The BG96 USB connector is not enabled on this shield.

## 3. Overview


Main-MMCX Antenna Connector
GNSS-MMCX Antenna Connector
Arduino Power Connector
Arduino Digital I/O 1
Arduino Analog/Digital Connector
QUECTEL BG96
SIM Connector
Arduino Digital I/O 2
Modem Status LED
Modem Power Key LED
Modem Netlight LED
Modem Reset Key LED

## 4. Using the Shield for the First Time

Prerequisites:

- Arduino Uno
- Shiratech Arduino IoT Shield
- PC, with Arduino IDE installed
- USB 2.0 cable
- SIM card

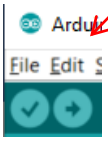
These instructions assume the use of Arduino Uno as a base board. The communication with the shield is based on the UART protocol using a baud rate of 115200 baud. This short tutorial we take us through these main steps:

- Download a test script used to verify the Shield functionality by sending an SMS message.
- Upload the test script to the Arduino base board.
- Connect the NB-IOT shield to the Arduino base board.
- Run the test script.

To start using the NB-IOT Shield, perform the following steps:

1. Make sure your base board is not connected to the power supply, and that the NB-IOT shield is not connected to the base board.
2. Navigate to the Shiratech Arduino IoT Shield page and download the test script to your PC: http://www.shiratech-solutions.com/products/nb-iot-shield-for-arduino/
3. Run the Arduino IDE (may be downloaded from: https://www.arduino.cc/en/Main/software).
4. Launch the Device Manager.
5. Connect the Arduino to your PC using the USB 2.0 cable.
6. Once the Arduino has been connected to the PC, a new COM Port should appear in the device manager under “Ports (COM & LPT)”. Note the COM Port number, as it will be needed in the following steps.
7. To open the test script in the Arduino IDE, extract the downloaded file, open the project folder and double click on the .ino file located in the folder.
8. Scroll down to find this line:
   - Serial.write("AT+CMGS=\"+972xxxxxxxxx\"\r\n");
9. Edit the phone number in the string to the phone number which should receive the SMS.
10. Save, then click on verify, to compile your code.

11. Once verification (compilation) has succeeded, click on the 'Upload' button, to burn the script onto the Arduino.

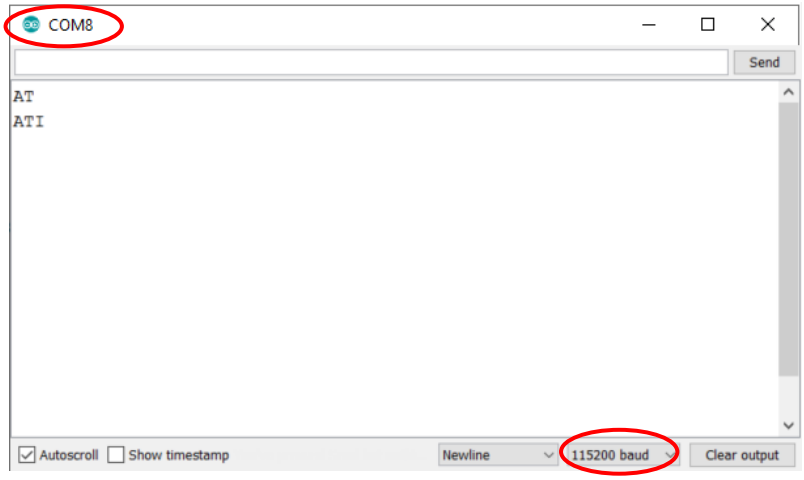



Note: In order for the script to be successfully burned onto the Arduino base board, the NB-IOT shield must be disconnected. After burning is completed, shield may be connected.

12. Disconnect the Arduino from the PC. Make sure it is disconnected from any power supply.
13. Insert a SIM Card to the shield SIM Card connector.
14. Connect the shield to the base board. If you are using an Arduino Mega base board, refer to the location of Tx and Rx pins to be sure that the shield is connected correctly.

Note: Do not connect the power supply if you are not sure that the shield is correctly connected! This may result in irreversible damage to the shield and/or the base board.

15. Connect the Arduino to your PC using the USB 2.0 cable. The test script should start running. Please refer to the next chapter, "Basic Modem Operation", for further details on the specific AT commands being sent to the BG96.
16. Launch the Serial Monitor tool to follow the AT commands being sent through the Serial port – make sure you have picked the same COM Port which appeared in the device manager, and that the baud rate is 115200 baud.



## 5. Basic Modem Operation

This is a short collection of a few examples and basic AT commands, used to test the basic functionality of the Quectel BG96 module. The full Quectel BG96 AT commands manual is available at http://www.quectel.com.

**Reset Sequence**

BG96 Reset sequence has to be performed every time that the shield is powered up, in order for the BG96 to enter a known electrical state. Before executing this sequence, there is no guarantee that the BG96 is properly functioning and ready to execute AT commands.

The BG96's RESET and PWRKEY lines should be activated and disactivated (HIGH/LOW) in the following manner (the set of instructions below is taken from the BG96's test script).

```
pinMode(PIN_BG96_RESET,OUTPUT);          //Setting the gpio connected to the RESET line to output
pinMode(PIN_BG96_PWRKEY,OUTPUT);         //Setting the gpio connected to the PWRKEY line to output
//Verifying that both RESET and POWERKEY are LOW
digitalWrite(PIN_BG96_PWRKEY,LOW);
digitalWrite(PIN_BG96_RESET,LOW);
//Toggling PWRKEY
digitalWrite(PIN_BG96_PWRKEY,LOW);
delay(1000);
digitalWrite(PIN_BG96_PWRKEY,HIGH);
delay(200);
digitalWrite(PIN_BG96_PWRKEY,LOW);
//Toggling RESET
digitalWrite(PIN_BG96_RESET,LOW);
delay(500);
digitalWrite(PIN_BG96_RESET,HIGH);
delay(500);
digitalWrite(PIN_BG96_RESET,LOW);
delay(500);
```

**Basic AT Commands**

- **ATI - Display Product Identification Information**

  This command will return the BG96 module information. It is useful to start with this command, to make sure that connection with the modem was established.
- **AT+GSN Request International Mobile Equipment Identity (IMEI)**

  Returns the IMEI of the module.
- **AT+QPOWD**

  The safe and recommended way to turn off the module, logging off from the network and switching into a safe state, waiting for power supply to be switched off.
- **AT+CIMI – Request International Mobile Subscriber Identity (IMSI)**

  Returns the SIM card's unique ID. This command is useful to verify that the SIM card is recognized by the module.
- **AT+CREG? – Network Registration Status**

  Returns information regarding the module's registration to the network. Helpful in verifying connection establishment before attempting further steps.

**Example – SMS**

The following command sequence is intended to send an SMS message using the Quectel BG96 module.
Note: The expected command feedback appears under each command.

Set the SMS message format to text mode

- **AT+CMGF=1**

  OK

Send SMS to the phone number. After entering this command, a prompt will appear. Enter your message text. When done entering text, press ctrl+z to send.

- **AT+CMGS="+972xxxxxxxxx"**

  **> This is a test message**

  +CMGS: 230

Text message should now be sent.

**Example - Ping a URL**

The following command sequence is intended to ping a URL using the Quectel BG96 module, verifying internet connection is established.

Configure HTTPS server parameters.

- **AT+QHTTPCFG="contextid",1**

  OK

- **AT+QHTTPCFG="responseheader",1**

  OK

Query the context state.

- **AT+QIACT?**

  OK

Configure the PDP context. Note that the APN settings are operator specific.

- **AT+QICSGP=1,1,"sphone.pelephone.net.il","pcl@3g","rl",1**

  OK

Activate context 1

- **AT+QIACT=1**

Query the context state.

- **AT+QIACT?**

  +QIACT: 1,1,1,”10.106.29.80”

Perform ping. In this example we ping Google’s DNS server 8.8.8.8 .

- **AT+QPING=1,”8.8.8.8”**

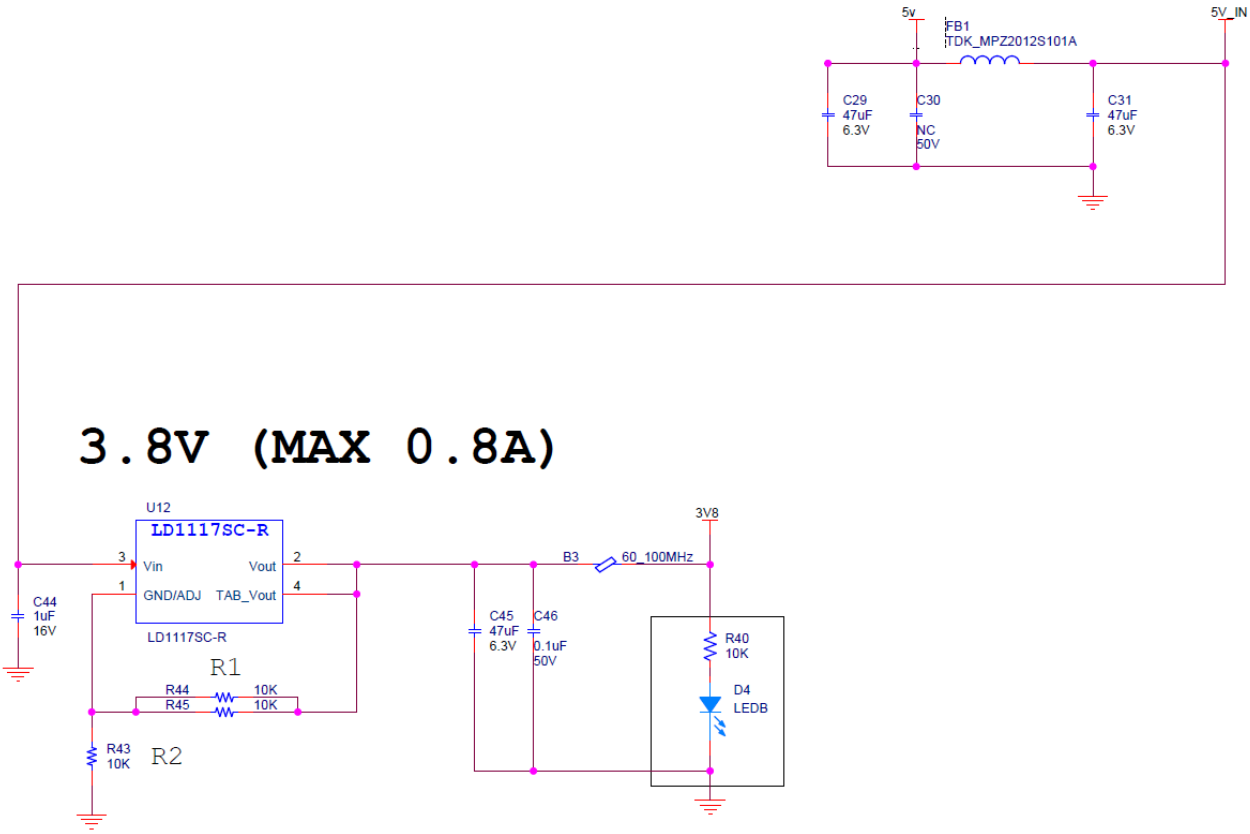
  +QPING: 0,”8.8.8.8”,32,196,255

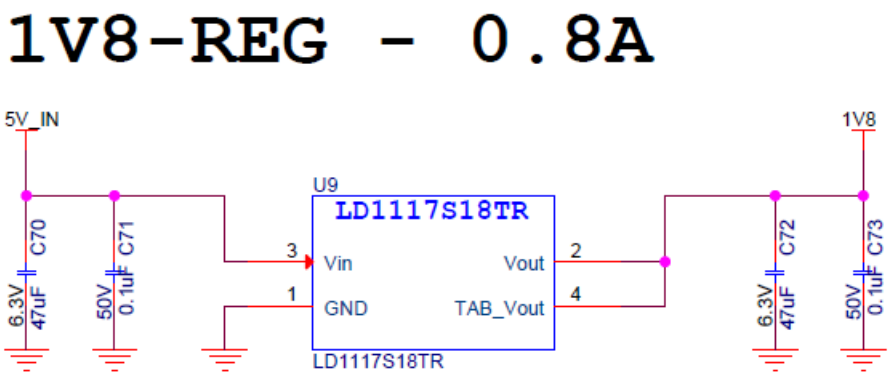
  +QPING: 0,”8.8.8.8”,32,149,255

  +QPING: 0,4,2,0,149,196,172

## 6. Power Supply

The shield accepts 3.3V and 5V power supply. These voltages are further transformed to 3.8V and 1.8V respectively.



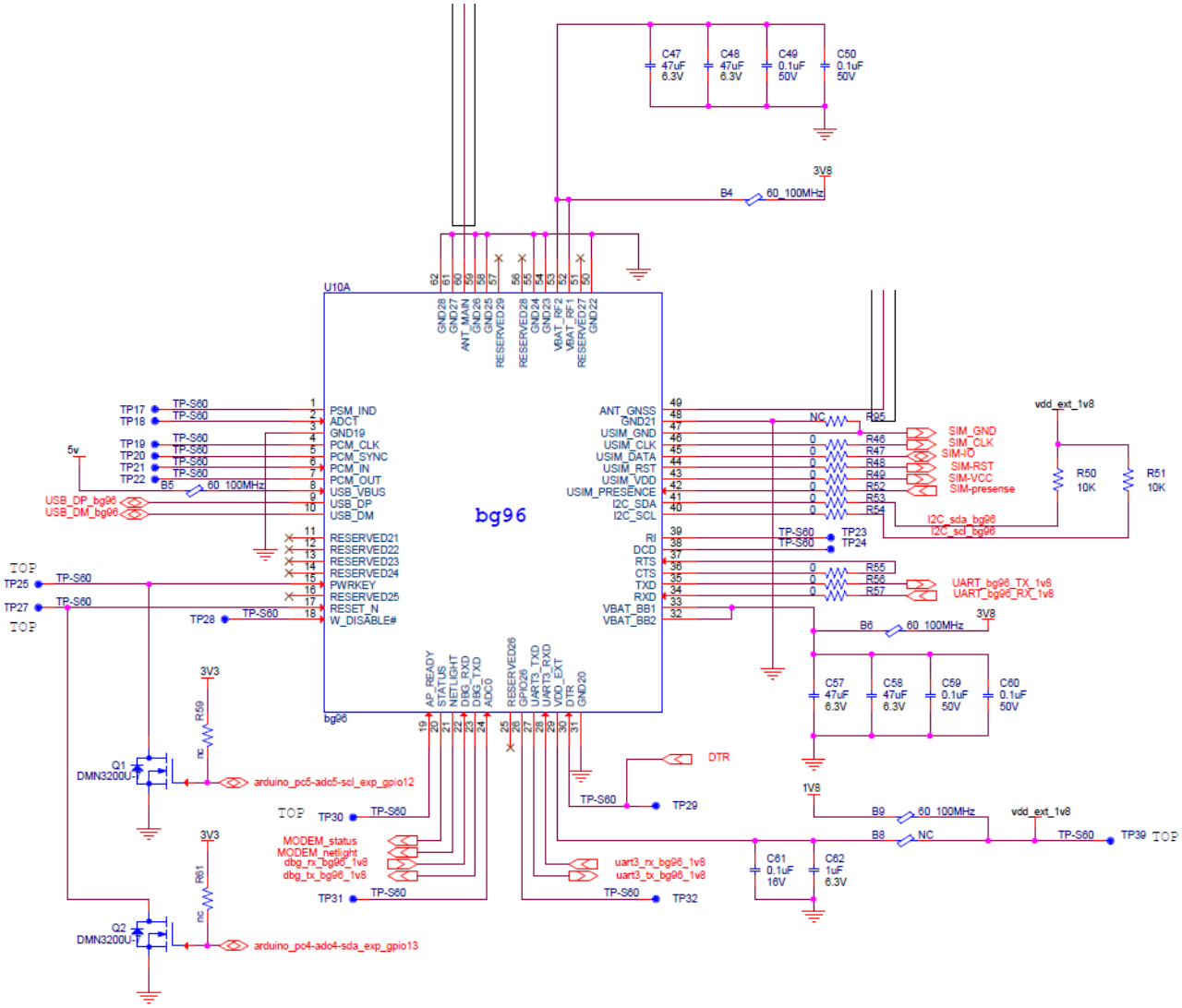
## 7. BG96 LTE CAT-M1/CAT-NB1/EGPRS Module

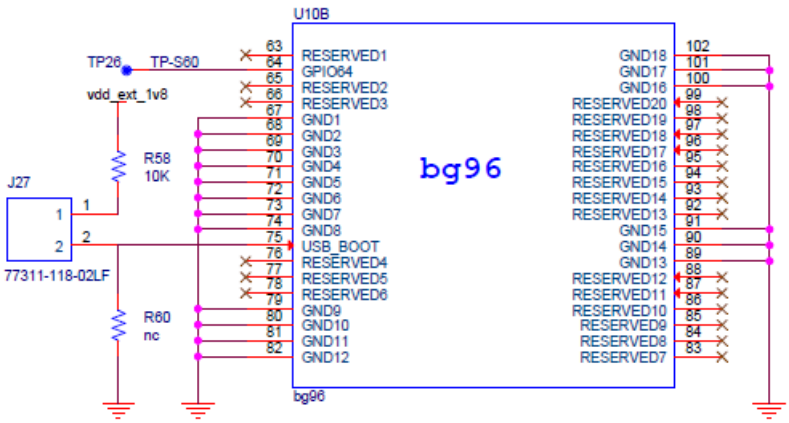
BG96 is a series of LTE CAT-M1/CAT-NB1/EGPRS module offering a maximum data rate of 375Kbps downlink and 375Kbps uplink. It features ultra-low power consumption, and provides pin-to-pin compatibility with Quectel LTE module EG91/EG95, Cat NB1 (NB-IoT) module BC95, UMTS/HSPA module UG95/UG96 and GSM/GPRS module M95.

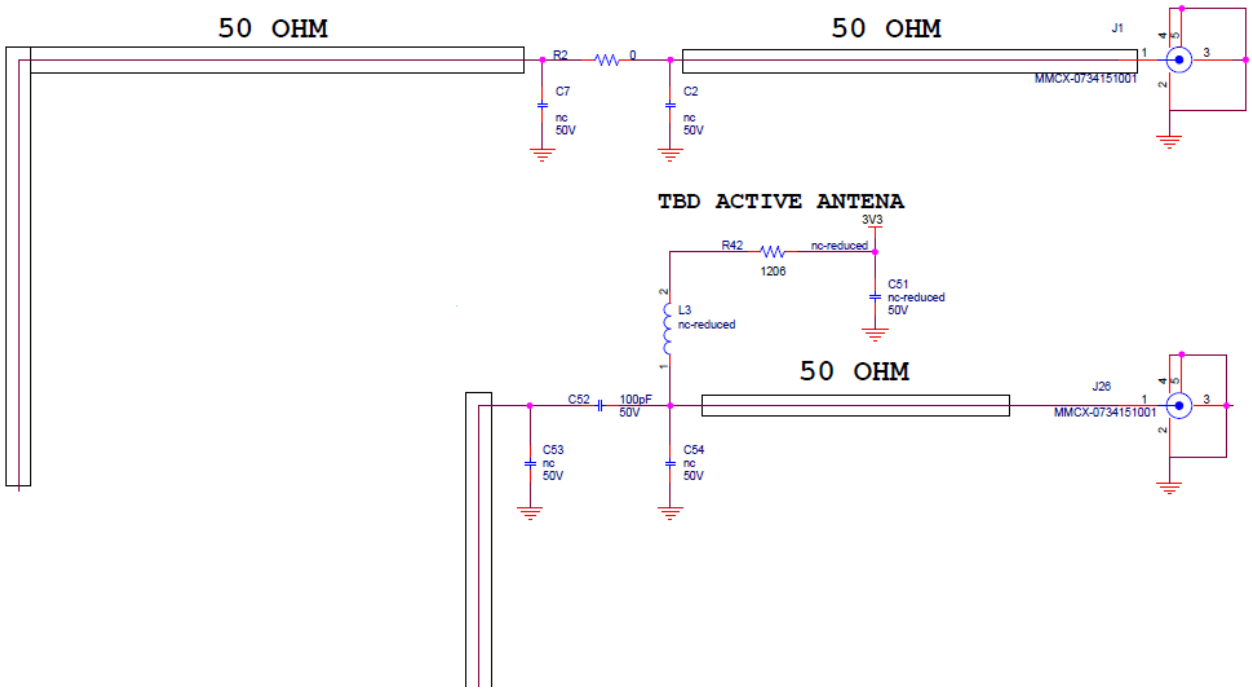
With a cost-effective SMT form factor of 26.5mm × 22.5mm × 2.3mm and high integration level, BG96 enables integrators and developers to easily design their applications and take advantage from the module's low power consumption and mechanical intensity. Its advanced LGA package allows fully automated manufacturing for high-volume applications.

A rich set of Internet protocols, industry-standard interfaces (USB/UART/I2C/Status Indicator) and abundant functionalities (USB drivers for Windows 7/8/8.1/10, Linux and Android) extend the applicability of the module to a wide range of M2M applications such as wireless POS, smart metering, tracking, etc.

The Quectel BG96 CAT M1/Cat NB1/GPRS module is powered by 3.8V.
Connected to a (u)SIM connector.
RF lines connected to two RF antenna jacks: Main and GNSS.
Four LEDs are used to indicate modem status.

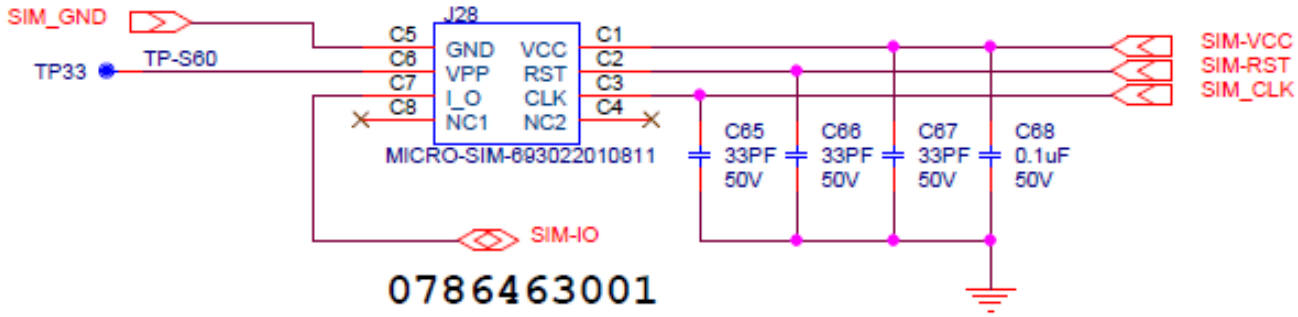

U10A
bg96
C47 47uF 6.3V
C48 47uF 6.3V
C49 0.1uF 50V
C50 0.1uF 50V
3V8
B4 60_100MHz
PSM_IND
ADC1
GND19
PCM_CLK
PCM_SYNC
PCM_IN
PCM_OUT
USB_VBUS
USB_DP
USB_DM
RESERVED21
RESERVED22
RESERVED23
RESERVED24
PWRKEY
RESERVED25
RESET_N
W_DISABLE#
ANT_GNSS
GND21
USIM_GND
USIM_CLK
USIM_DATA
USIM_RST
USIM_VDD
USIM_PRESENCE
I2C_SDA
I2C_SCL
RI
DCD
RTS
CTS
TXD
RXD
VBAT_BB1
VBAT_BB2
vdd_ext_1v8
R50 10K
R51 10K
SIM_GND
SIM_CLK
SIM-IO
SIM-RST
SIM-VCC
SIM-presense
I2C_sda_bg96
I2C_scl_bg96
UART_bg96_TX_1v8
UART_bg96_RX_1v8
B6 60_100MHz
C57 47uF 6.3V
C58 47uF 6.3V
C59 0.1uF 50V
C60 0.1uF 50V
1V8
B9 60_100MHz
B8 NC
C61 0.1uF 16V
C62 1uF 6.3V
TP-S60
TOP
5v
B5 60_100MHz
USB_DP_bg96
USB_DM_bg96
TP17
TP18
TP19
TP20
TP21
TP22
TP23
TP24
TP25
TP26
TP27
TP28
TP29
TP30
TP31
TP32
TP39
3V3
R59 nc
R61 nc
Q1 DMN3200U-7
Q2 DMN3200U-7
arduino_pc5-adc5-scl_exp_gpio12
arduino_pc4-adc4-sda_exp_gpio13
DTR
MODEM_status
MODEM_netlight
dbg_rx_bg96_1v8
dbg_tx_bg96_1v8
uart3_rx_bg96_1v8
uart3_tx_bg96_1v8
AP_READY
STATUS
NETLIGHT
DBG_RXD
DBG_TXD
ADC0
RESERVED26
GPIO26
UART3_TXD
UART3_RXD
VDD_EXT
DTR
GND20


U10B
bg96
TP26
TP-S60
vdd_ext_1v8
R58 10K
R60 nc
J27
77311-118-02LF
RESERVED1
GPIO64
RESERVED2
RESERVED3
GND1
GND2
GND3
GND4
GND5
GND6
GND7
GND8
USB_BOOT
RESERVED4
RESERVED5
RESERVED6
GND9
GND10
GND11
GND12
GND18
GND17
GND16
RESERVED20
RESERVED19
RESERVED18
RESERVED17
RESERVED16
RESERVED15
RESERVED14
RESERVED13
GND15
GND14
GND13
RESERVED12
RESERVED11
RESERVED10
RESERVED9
RESERVED8
RESERVED7

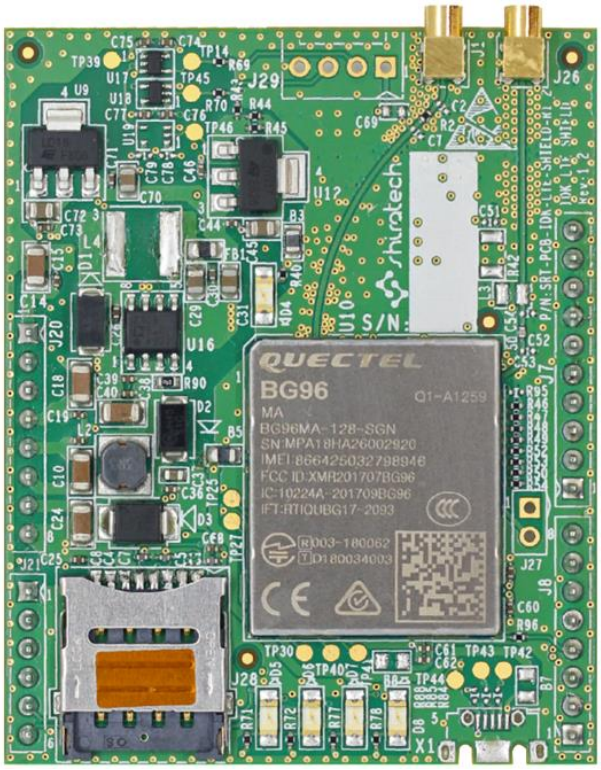



## 8. SIM Card Connector

The SIM card connector is powered, utilized and managed by the BG96 module.



## 9. Connectors



| | | | | | | |
|---|---|---|---|---|---|---|
| | | | 10 | | | |
| | | | 9 | | | |
| | | | 8 | AREF | | |
| | | | 7 | GND | | |
| 3.3V_KNX | | 1 | 6 | 13 | | |
| 3.3V | IOREF | 2 | 5 | 12 | | |
| | RESET | 3 | 4 | ~11 | | |
| 3.3V | 3.3V | 4 | 3 | ~10 | | |
| Supply 3.8V/1.8V | 5V | 5 | 2 | ~9 | | |
| GND | GND | 6 | 1 | 8 | | |
| GND | GND | 7 | | | | |
| | VIN | 8 | 8 | 7 | | |
| | | | 7 | ~6 | | |
| | A0 | 1 | 6 | ~5 | | |
| | A1 | 2 | 5 | 4 | | |
| | A2 | 3 | 4 | ~3 | | |
| | A3 | 4 | 3 | 2 | | |
| BG96 Reset | A4 | 5 | 2 | TX>1 | UART0_TX | |
| BG96 Powerkey | A5 | 6 | 1 | RX<0 | UART0_RX | |

## 10. Document Revision History

| Revision | Date | Author | Status and Description |
|---|---|---|---|
| 0.22 | 17/07/2019 | Ori Makover | Initial version |
| 0.23 | 08/01/2020 | Ori Makover | Version update |
| 1.01 | 29/01/2020 | Ori Makover | Revision |

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