Mooving IoT Guidebook

DAV Research Ltd
Kaufmann 4, Tel Aviv 6801296,
Israel

+38 032 240 1111
www.dav.city

Content

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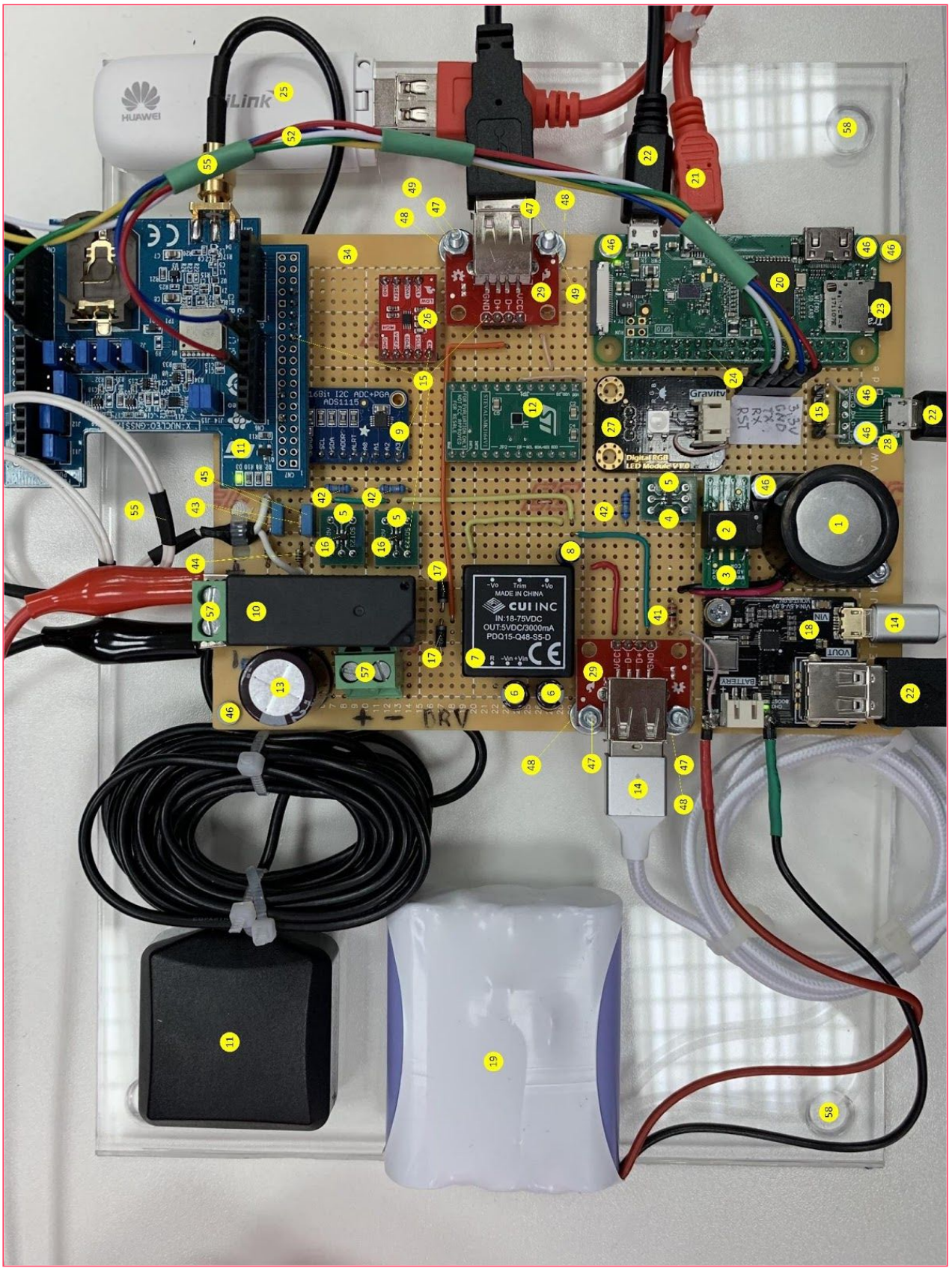

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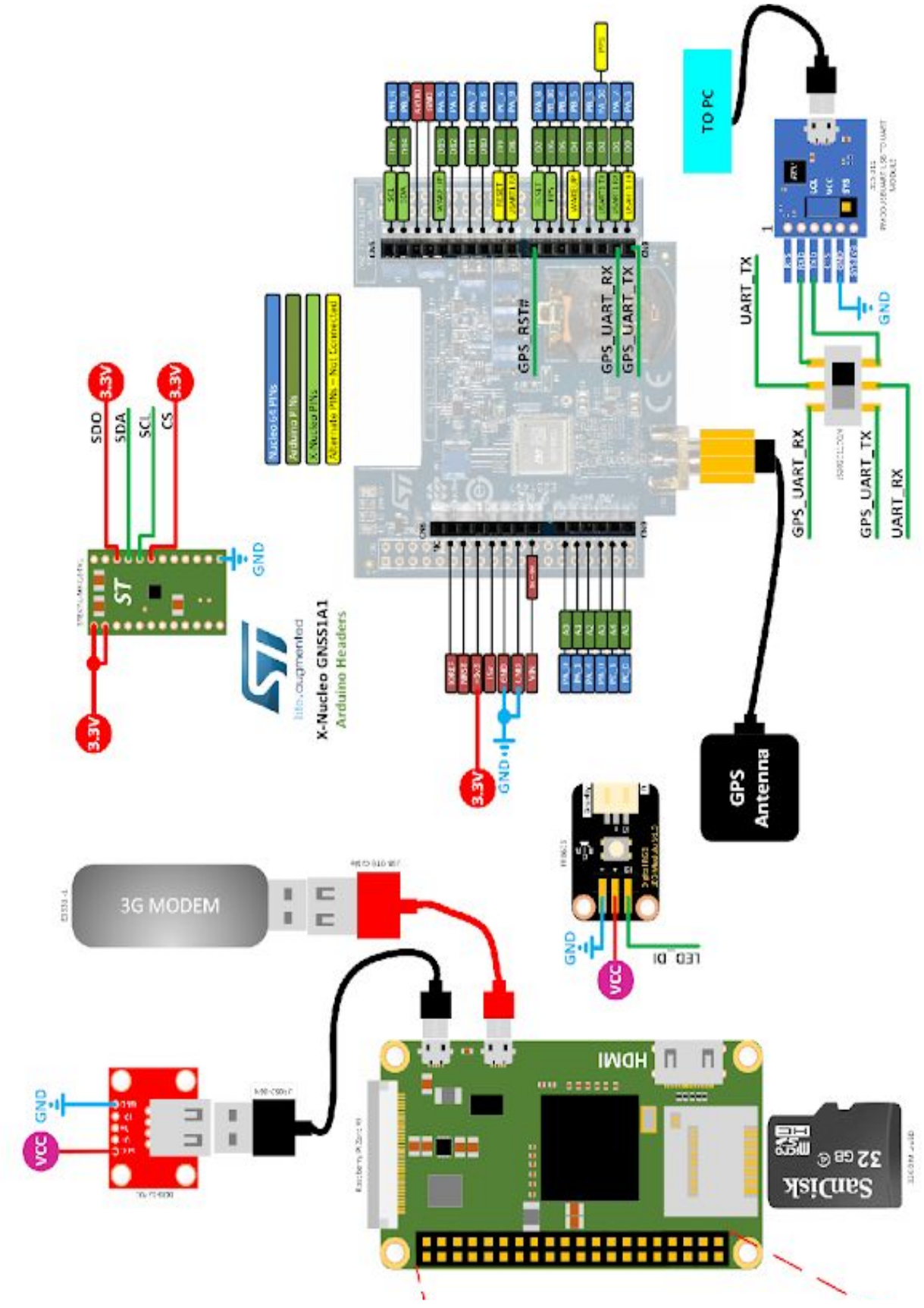

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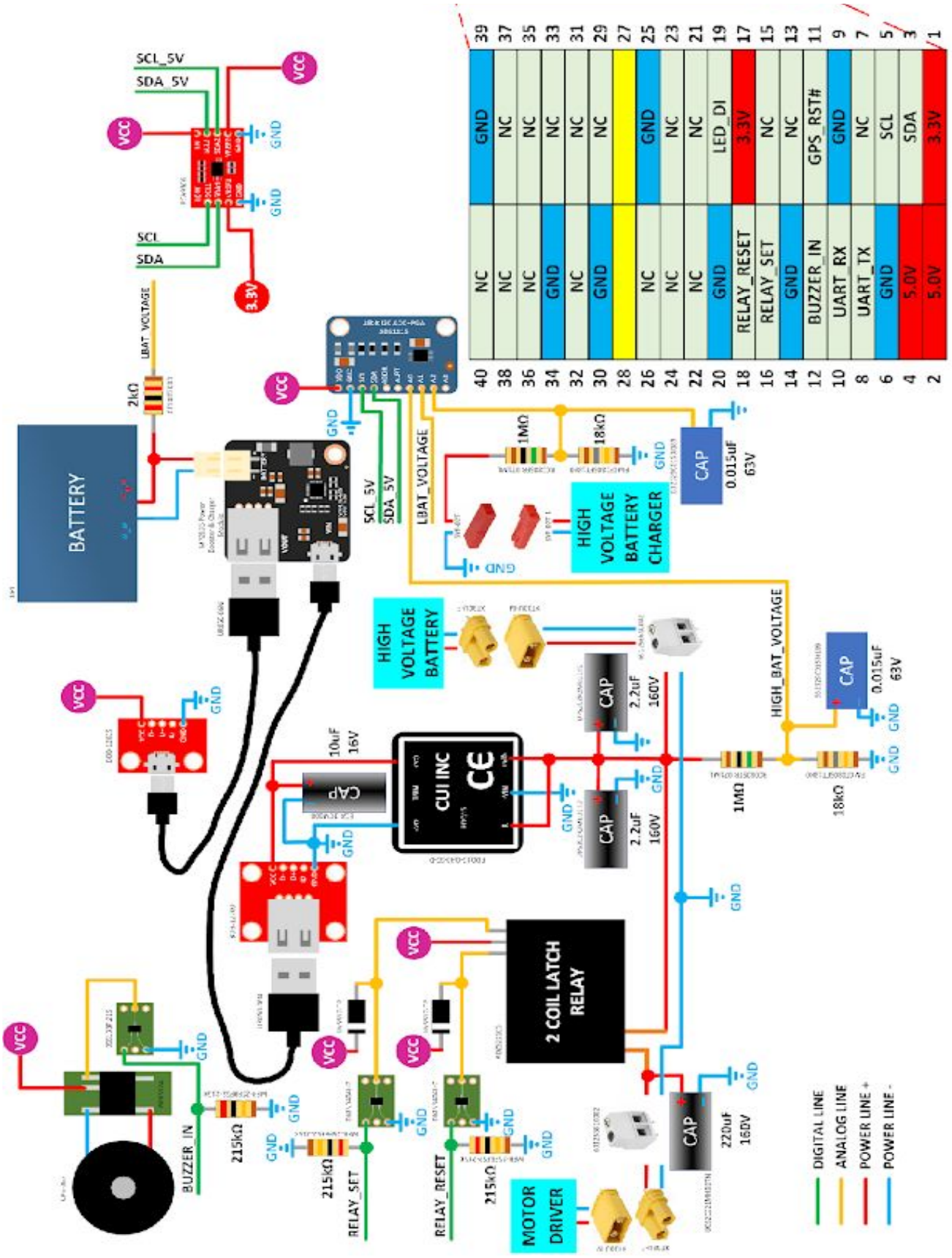

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Bill of Material

Table. 1 Prototype components list

	Description	Manufacturer	Manufacturer PN	Q-ty
1	AUDIO PIEZO INDICATOR 6-14V CHAS	CUI Inc.	CPE-267	1
2	DC DC CONVERTER 12V 1W	XP Power	ISE0512A	1
3	SOP-8 TO DIP-8 SMT ADAPTER	Chip Quik	IPC0142	1
4	MOSFET N-CH 60V 360MA TO-236AB	Nexperia USA Inc.	BSS138P,215	1
5	SOCKET ADAPTER SOT-23 TO 6DIP	Aries Electronics	LCQT-SOT23-6	3
6	CAP ALUM 2.2UF 20% 160V RADIAL	Nichicon	UPS2C2R2MED1TD	2
7	Isolated Module DC DC Converter 5V 3A 18V - 75V Input	CUI Inc.	PDQ15-Q48-S5-D	1
8	CAP ALUM 10UF 20% 16V RADIAL	Panasonic	ECA-1CM100I	1
9	ADS1115 16BIT ADC 4CH PROG GAIN	Adafruit	1085	1
10	RELAY GEN PURPOSE SPST 50A 5V	Panasonic	ADJH23005	1
11	X-NUCLEO-GNSS1A1	STMicroelectronics	X-NUCLEO-GNSS1A1	1
12	ADAPTER BOARD LIS2HH12 DIL24	STMicroelectronics	STEVAL-MKI164V1	1
13	CAP ALUM 220UF 20% 160V RADIAL	Nichicon	493-13277-3-ND	1
14	USB 2.0 Cable A Male to Micro B Male 0.50'	Tripp Lite	UR050-06N	2
15	CONN HEADER VERT 40POS 2.54MM	Sullins	PREC040SABN-RC	4
16	MOSFET N-CH 30V 5.8A SOT-23	Diodes Incorporated	DMN3404L-7	2
17	DIODE SCHOTTKY 20V 1A DO41	Micro Commercial Co	1N5817-TP	2
18	MP2636 Power Booster & Charger Module	DFRobot	DFR0446	1
19	BATTERY LITHIUM 3.7V 4.4AH	Adafruit	354	1
20	Raspberry Pi Zero W	sparkfun	Raspberry Pi Zero W	1
21	USB OTG Cable - Female A to Micro B - 5in	sparkfun	USB OTG Cable	1
22	Raspberry Pi micro-USB power cable	reichelt	AK67421-0.5	2
23	microSD Card with Adapter - 32GB (Class 10)	sparkfun	32GB MicroSD	1
24	CONN HEADER VERT 40POS 2.54MM	Amphenol ICC (FCI)	67997-240HLF	1
25	3G GSM modem Huawei E3531i-1	Huawei	E3531i-1	1
26	SPARKFUN LEVEL TRANSLATOR BREAKOUT - PCA9306	sparkfun	PCA9306	1
27	Gravity: Digital RGB LED Module	dfrobot	FR0605	1
28	SparkFun microB USB Breakout	sparkfun	BOB-12035	1
29	SparkFun USB Type A Female Breakout	sparkfun	BOB-12700	2
30	Slide Switch DPDT Through Hole	C&K	JS202011CQN	1
31	DC supply male plug	AMASS	AMASS XT30U-M	2

32	DC supply female plug	AMASS	AMASS XT30U-F	2
33	PMODUSBUART USB TO UART MODULE	Digilent, Inc.	410-212	1
34	BREADBOARD GENERAL PURPOSE PTH	SCI	PC-01LAM	1
35	Black colored power 16AWG lead cable	STÄUBLI	60.7031-21	1
36	Red colored power 16AWG lead cable	STÄUBLI	60.7031-22	1
37	RCY receptacle housing (for pin contact)	JTS	SYR-02T	1
38	RCY plug housing (for socket contact)	JTS	SYP-02T-1	1
39	RCY pin contact	JTS	SYM-001T-P0.6(N)	2
40	RCY socket contact	JTS	SYF-001T-P0.6(LF)(SN)	2
41	RES 2K OHM 1/4W 5% AXIAL	Stackpole	CF14JT2K00	1
42	RES 215K OHM 1/4W 1% AXIAL	Yageo	MFR-25FBF52-215K	3
43	RES 18K OHM 1/4W 1% AXIAL	Stackpole	RNMF14FTC18K0	2
44	RES 1M OHM 1/4W 1% AXIAL	Stackpole	RNF14FTD1M00	2
45	CAP FILM 0.015UF 5% 63VDC RADIAL	EPCOS (TDK)	B32529C0153J189	2
46	M3 Pan Head Machine Screw Phillips Drive Nylon	Wurth Electronics Inc.	97790603111	16
47	M3 Pan Head Machine Screw Phillips Drive Nylon	Essentra Components	NMS-310	6
48	M3 Flat, Retaining Washer 0.055" (1.40mm) Thick Plastic	Essentra Components	015003000503	16
49	M3 Hex Nut 0.217" (5.50mm) Nylon	Wurth Electronics Inc.	709940300	16
50	Hex Standoff Threaded M3 Nylon 0.394" (10.00mm) Natural	Keystone Electronics	'25510	4
51	uxcell AWG30 1000.7FT Breadboard Wrapping Wire	uxcell	AWG30	1
52	Jumper Wires Standard 7" M/M - 30 AWG (30 Pack)	sparkfun	Jumper Wires	2
53	Heavy Duty Mounting Tape Clear	Amazon	VHB	1
54	Multi-Purpose Cable Tie (100 Piece), 8", Black	TR	TR88302	1
55	HEATSHRINK 3/16 IN X 4FT BLACK	Alpha Wire	F221B3/16 BK100	1
56	HEATSHRINK 3/16" X 4' RED	Panduit Corp	HSTT19-48-Q2	1
57	TERM BLK 2P SIDE ENT 10.16MM PCB	Wurth Electronics Inc.	691256610002	2
58	BUMPER CYLINDRICAL 0.5" DIA CLR	Essentra Components	RBS-6	4
59	PCB terminal DG381-3.81-02P-12-00A(H)	DEGSON ELECTRONICS	DG381-3.81-02P-12-00A(H)	1

1. High Power switch assembly

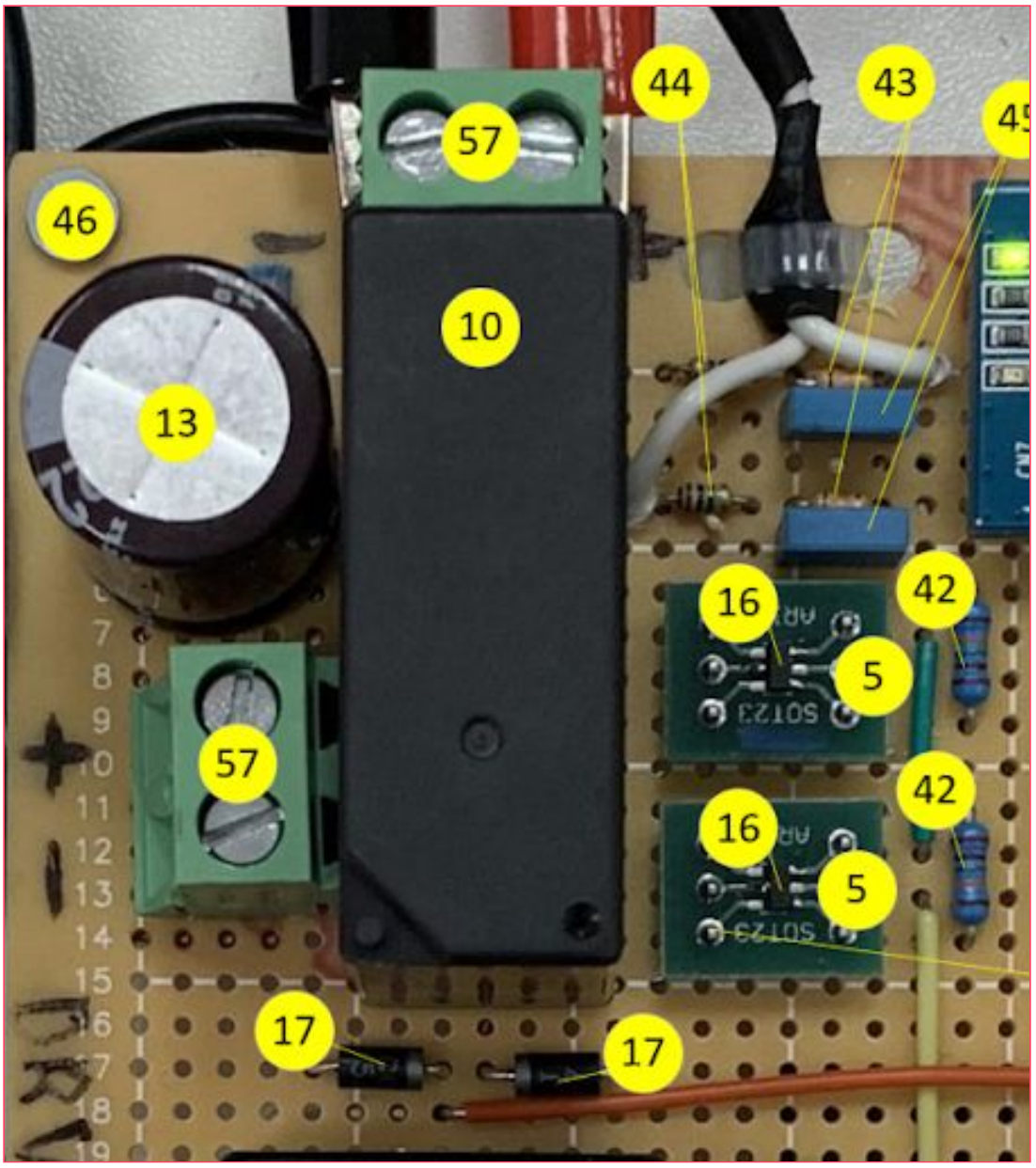


Figure 4. High power switch prototype view

All components in Table.1 mount and solder as shown on the Figure 4.

Table 2. High power switch main components

Number	Description	Company	Part number	Quantity
5*	SOCKET ADAPTER SOT-23 TO 6DIP	Aries Electronics	LCQT-SOT23-6	2
10	RELAY GEN PURPOSE SPST 50A 5V	Panasonic	ADJH23005	1
13	CAP ALUM 220UF 20% 160V RADIAL	Nichicon	493-13277-3-ND	1
16	MOSFET N-CH 30V 5.8A SOT-23	Diodes Incorporated	DMN3404L-7	2
17	DIODE SCHOTTKY 20V 1A DO41	Micro Commercial Co	1N5817-TP	2
42	RES 215K OHM ¼W 1% AXIAL	Yageo	MFR-25FBF52-215K	2
57	TERM BLK 2P SIDE ENT 10.16MM PCB	Wurth Electronics Inc.	691256610002	2
31	DC supply male plug	AMASS	AMASS XT30U-M	1
32	DC supply female plug	AMASS	AMASS XT30U-F	1
35	Black colored power 16AWG lead cable	STÄUBLI	60.7031-21	1
36	Red colored power 16AWG lead cable	STÄUBLI	60.7031-22	1

After components mounting, use the functional schematic on the Figure.5 for signal wires soldering

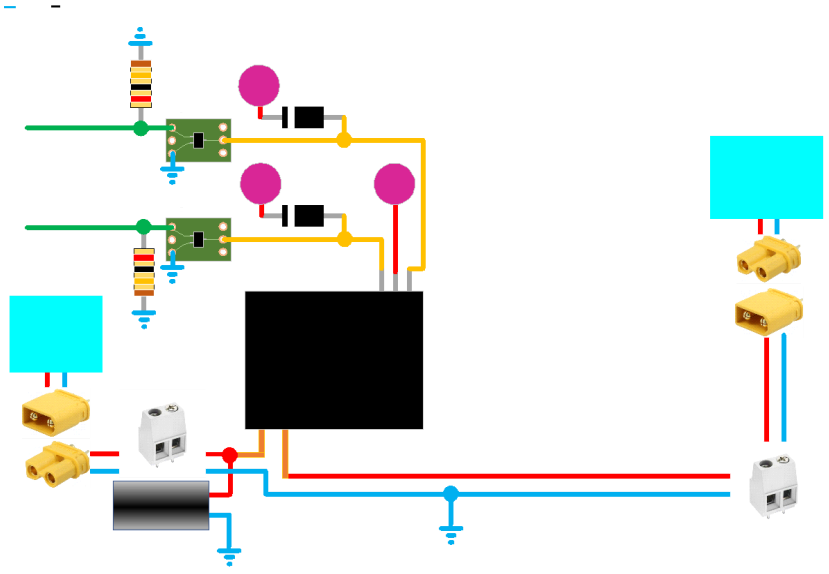


Figure.5 high power switch with connector and driver functional schematic part

2. Voltage sense assembly

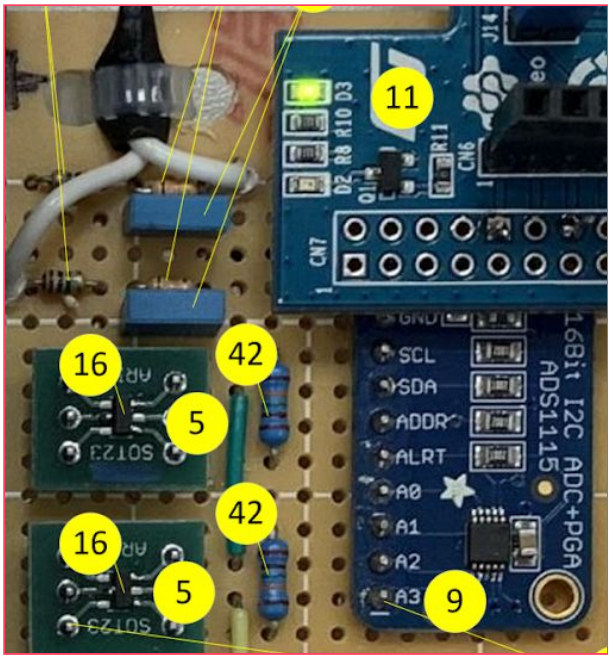


Figure.6 Voltage sense prototype view

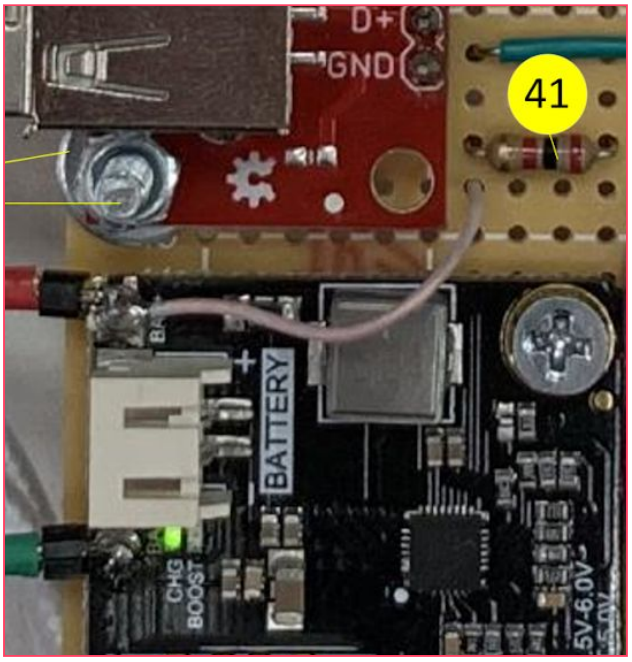


Figure.7 Voltage sense prototype view

All components in Table.2 mount and solder as shown on the Figure.6, Figure.7

Table.3 Voltage sense main components

Number	Description	Company	Part number	Quantity
43	RES 18K OHM 1/4W 1% AXIAL	Stackpole	RNMF14FTC18K0	2
44	RES 1M OHM 1/4W 1% AXIAL	Stackpole	RNF14FTD1M00	2
45	CAP FILM 0.015UF 5% 63VDC RADIAL	EPCOS (TDK)	B32529C0153J189	2
9	ADS1115 16BIT ADC 4CH PROG GAIN	Adafruit	1085	1
41	RES 2K OHM 1/4W 5% AXIAL	Stackpole	CF14JT2K00	1

After components mounting, use the functional schematic on the Figure.8 for signal wires soldering

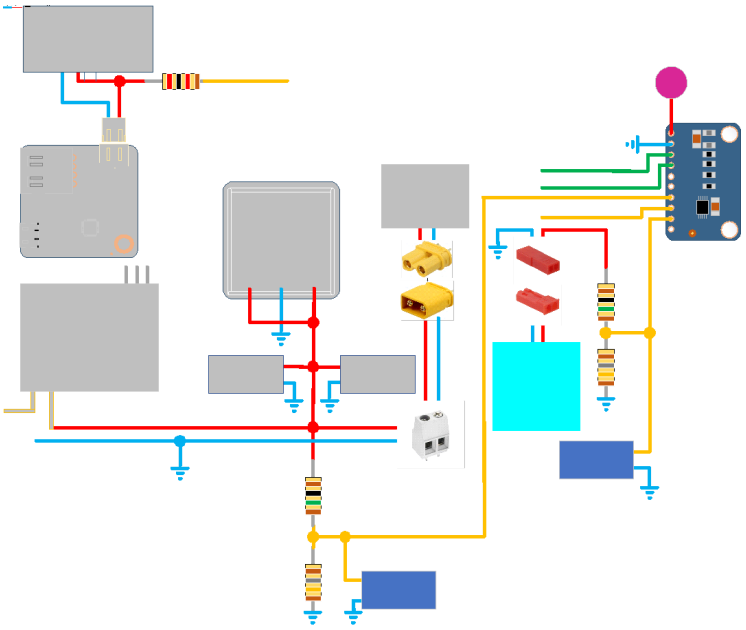


Figure.8 voltage sense functional schematic part

3. High Voltage DCDC assembly

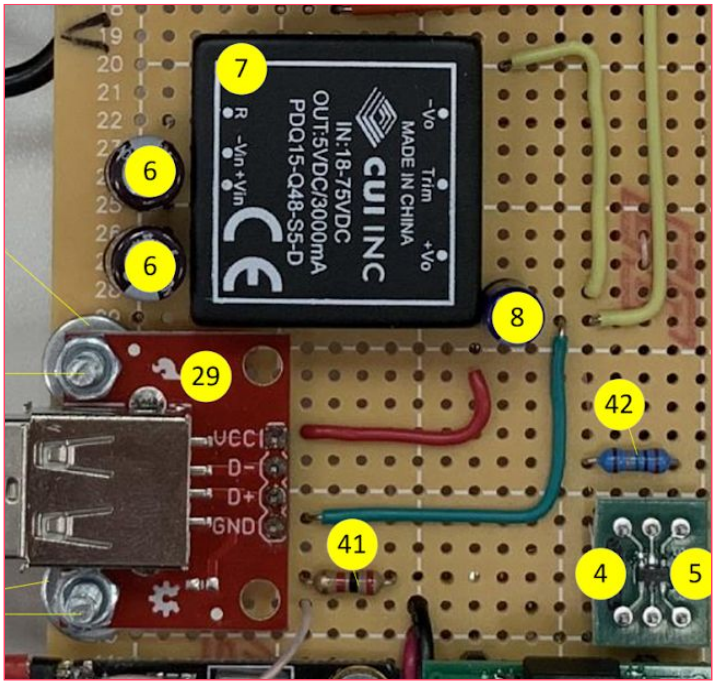


Figure.9 High voltage DCDC prototype view

All components in Table.3 mount and solder as shown on the Figure.9

Table.4 High voltage DCDC main components

Number	Description	Company	Part number	Quantity
7	Isolated Module DC DC Converter 5V 3A 18V - 75V Input	CUI Inc.	PDQ15-Q48-S5-D	1
6	CAP ALUM 2.2UF 20% 160V RADIAL	Nichicon	UPS2C2R2MED1TD	2
8	CAP ALUM 10UF 20% 16V RADIAL	Panasonic	ECA-1CM100I	1
15	CONN HEADER VERT 40POS 2.54MM	Sullins	PREC040SABN-RC	1
29	SparkFun USB Type A Female Breakout	sparkfun	BOB-12700	1
47	M3 Pan Head Machine Screw Phillips Drive Nylon	Essentra Components	NMS-310	2
48	M3 Flat, Retaining Washer 0.055" (1.40mm) Thick Plastic	Essentra Components	015003000503	4
49	M3 Hex Nut 0.217" (5.50mm) Nylon	Wurth Electronics Inc.	709940300	2
14	USB 2.0 Cable A Male to Micro B Male 0.50'	Tripp Lite	UR050-06N	1

After components mounting, use the functional schematic on the Figure.10 for signal wires soldering

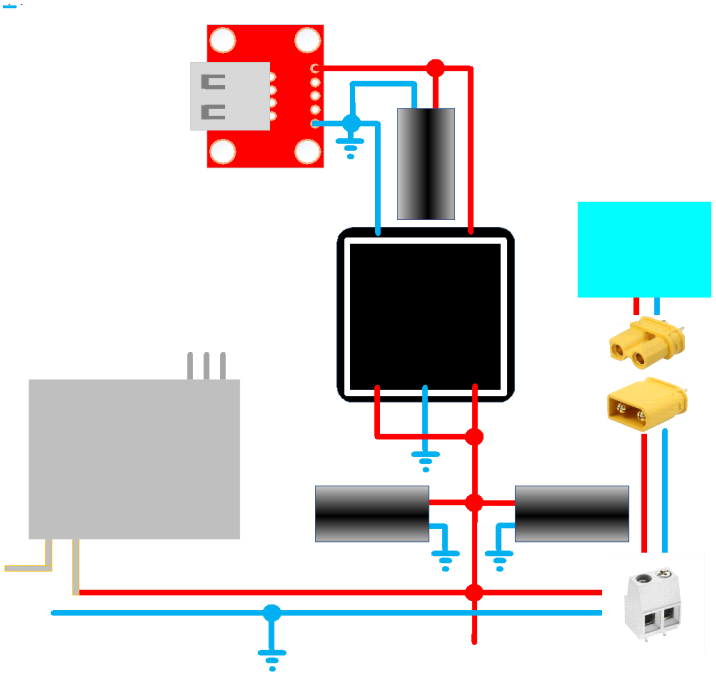


Figure.10 High voltage DCDC functional schematic part

4. Buzzer driver assembly

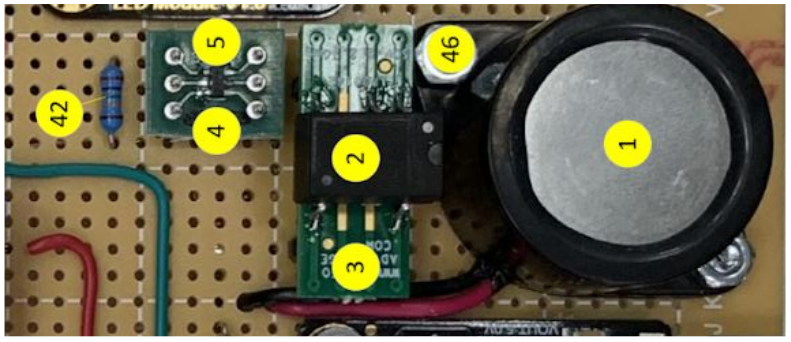


Figure.11 Buzzer driver

All components in Table.4 mount and solder as shown on the Figure.11

Table.5 Buzzer driver main components

Number	Description	Company	Part number	Quantity
1	AUDIO PIEZO INDICATOR 6-14V CHAS	CUI Inc.	CPE-267	1
2	DC DC CONVERTER 12V 1W	XP Power	ISE0512A	1
3	SOP-8 TO DIP-8 SMT ADAPTER	Chip Quik	IPC0142	1
4	MOSFET N-CH 60V 360MA TO-236AB	Nexperia USA Inc.	BSS138P,215	1
5	SOCKET ADAPTER SOT-23 TO 6DIP	Aries Electronics	LCQT-SOT23-6	1
46	M3 Pan Head Machine Screw Phillips Drive Nylon	Wurth Electronics Inc.	97790603111	2
49	M3 Hex Nut 0.217" (5.50mm) Nylon	Wurth Electronics Inc.	709940300	2

After components mounting use the functional schematic on the Figure.12 for signal wires soldering

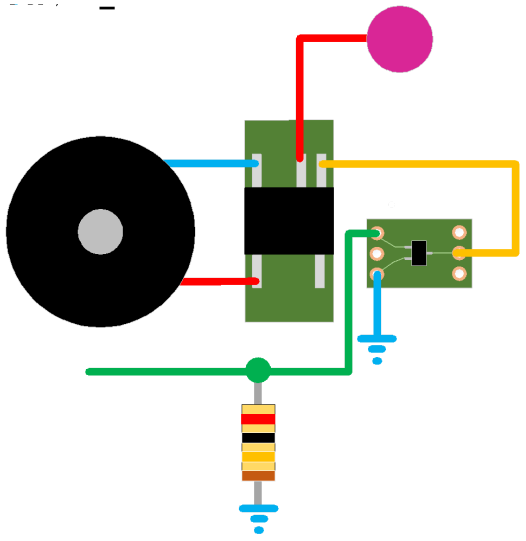


Figure. 12 Voltage sense main components

5. Internal Battery controller

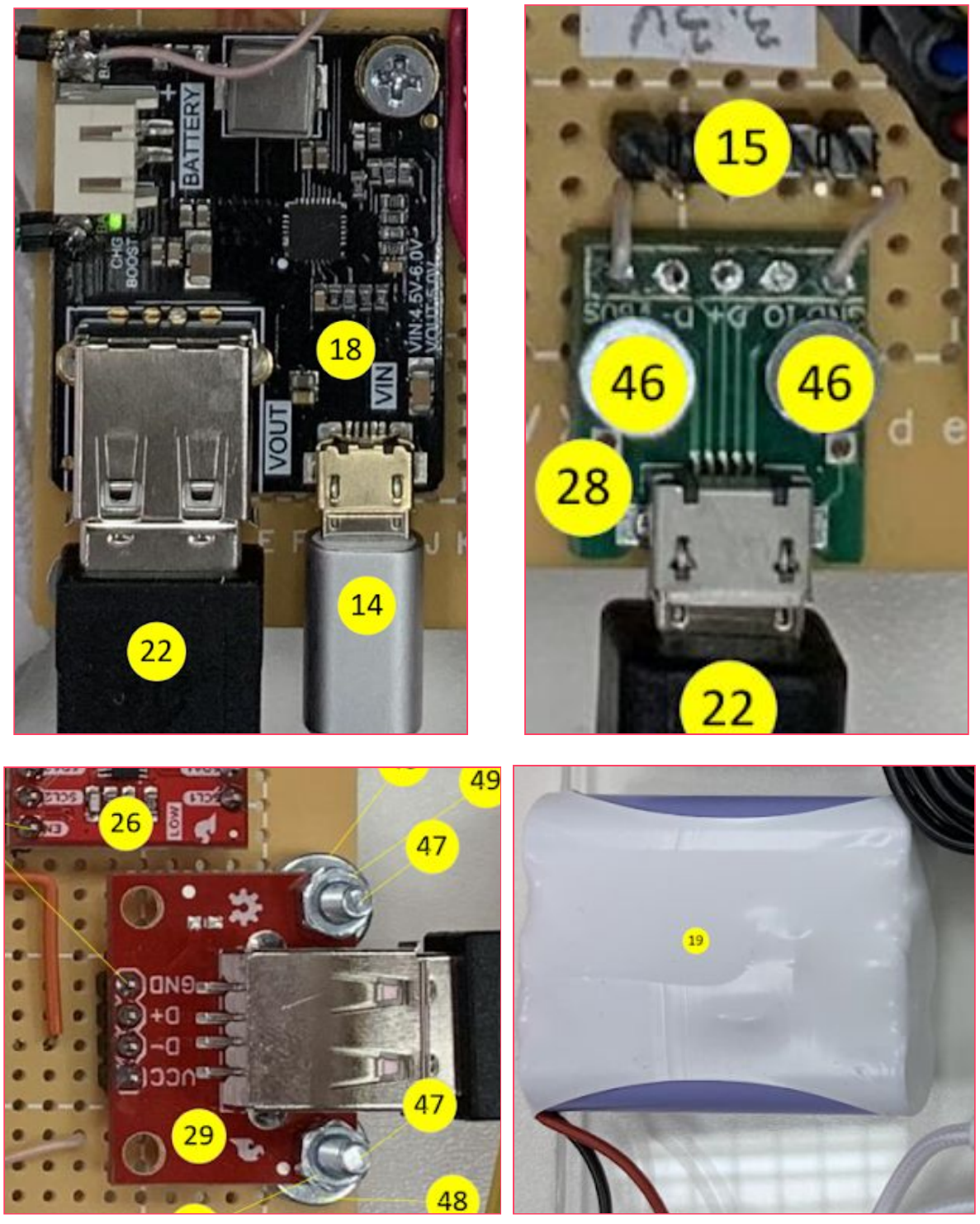


Figure. 13 Internal battery controller with power connectors prototype view

All components in Table.5 mount and solder as shown on the Figure.13

Table.6 Internal battery controller components

Number	Description	Company	Part number	Quantity
18	MP2636 Power Booster & Charger Module	DFRobot	DFR0446	DFRobot
28	SparkFun microB USB Breakout	sparkfun	BOB-12035	sparkfun
29	SparkFun USB Type A Female Breakout	sparkfun	BOB-12700	sparkfun
15	CONN HEADER VERT 40POS 2.54MM	Sullins	PREC040SABN-RC	Digikey
47	M3 Pan Head Machine Screw Phillips Drive Nylon	Essentra Components	NMS-310	4
48	M3 Flat, Retaining Washer 0.055" (1.40mm) Thick Plastic	Essentra Components	015003000503	9
49	M3 Hex Nut 0.217" (5.50mm) Nylon	Wurth Electronics Inc.	709940300	5
49	M3 Hex Nut 0.217" (5.50mm) Nylon	Wurth Electronics Inc.	709940300	1

After components mounting, use the functional schematic on the Figure.14 for signal wires soldering

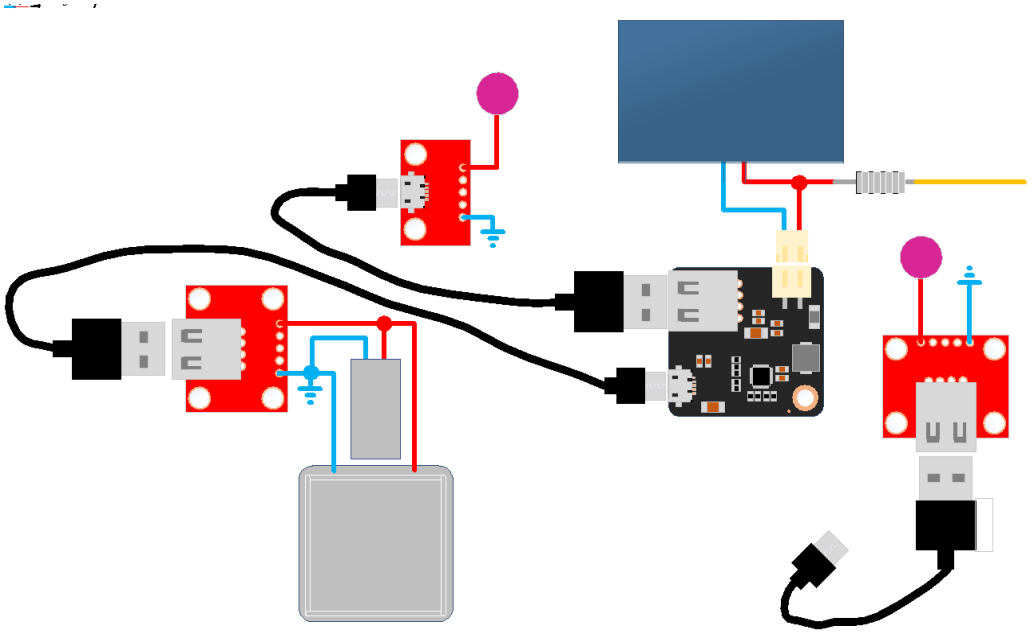


Figure. 14 Internal battery controller with connectors functional schematic part

6. LED indication assembly

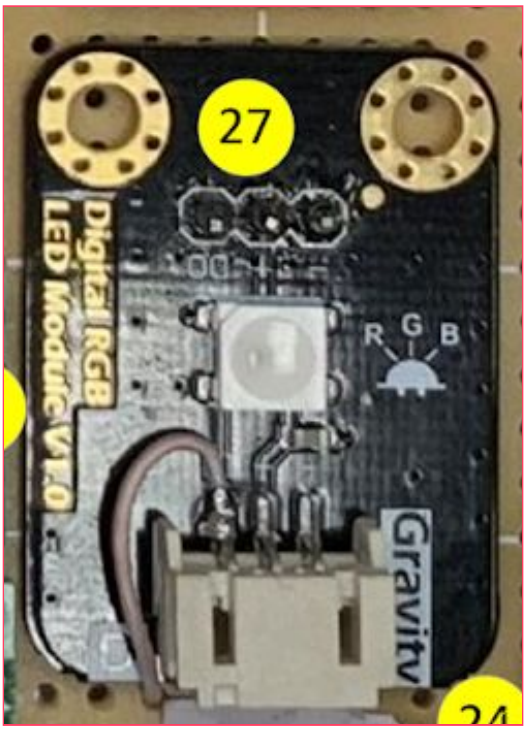


Figure. 15 LED indication module ptototype view

All components in Table.6 mount and solder as showed on the Figure.15

Table.7 LED indication components

Number	Description	Company	Part number	Quantity
27	Gravity: Digital RGB LED Module	dfrobot	FR0605	1
15	CONN HEADER VERT 40POS 2.54MM	Sullins	PREC040SABN-RC	1

After components mounting, use the functional schematic on the Figure.16 for signal wires soldering

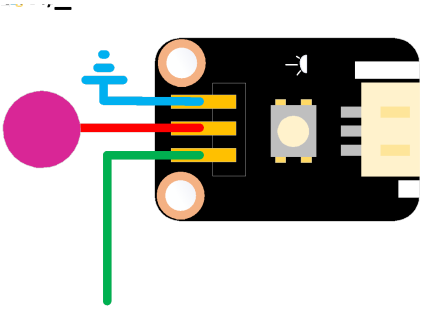


Figure. 16 LED indication module functional schematic part

7. Accelerometer assembly

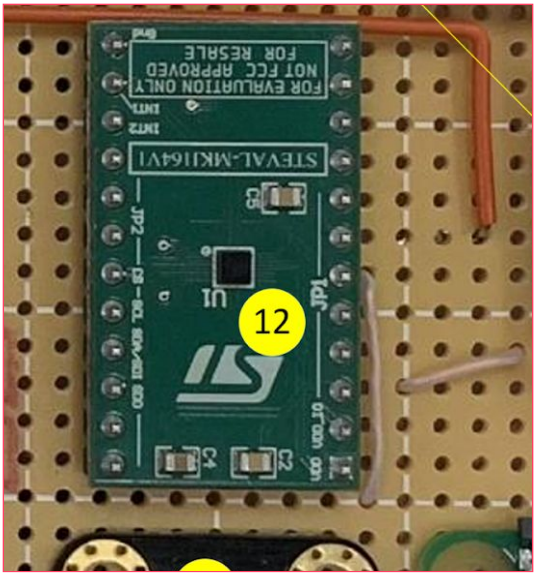


Figure. 17 Accelerometer module ptototype view

All components in Table.7 mount and solder as shown on the Figure.17

Table.8 Accelerometer components

Number	Description	Company	Part number	Quantity
12	ADAPTER BOARD LIS2HH12 DIL24	STMicroelectronics	STEVAL-MKI164V1	Digikey

After components mounting, use the functional schematic on the Figure.18 for signal wires soldering

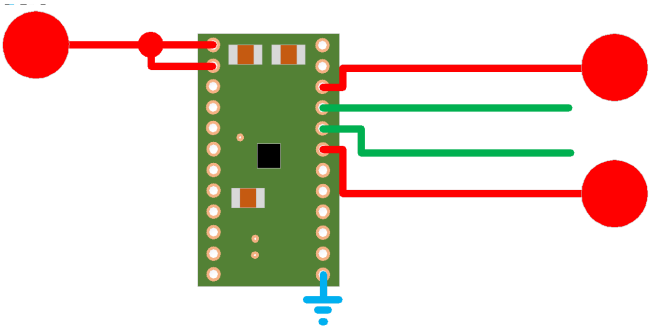


Figure. 18 LED indication module functional schematic part

8. GPS Module and USB UART bridge assembly

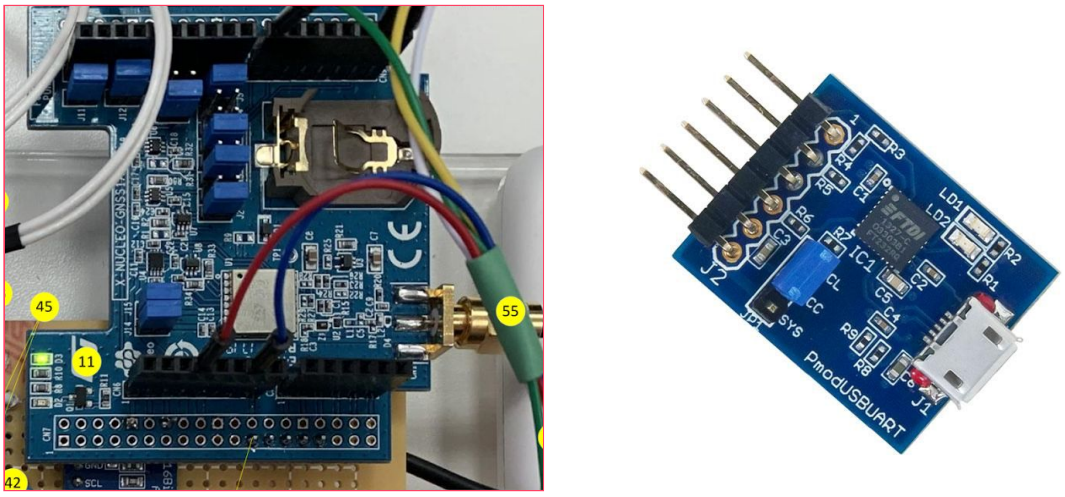


Figure. 19 GPS module and USB to UART bridge prtototype view

All components in Table.7 mount and solder as shown on the Figure.19

Table.9 GPS module connection components

Number	Description	Company	Part number	Quantity
11	X-NUCLEO-GNSS1A1	STMicroelectronics	X-NUCLEO-GNSS1A1	1
52	Jumper Wires Standard 7" M/M - 30 AWG (30 Pack)	sparkfun	Jumper Wires	1
14	USB 2.0 Cable A Male to Micro B Male 0.50'	Tripp Lite	UR050-06N	1
30	Slide Switch DPDT Through Hole	C&K	JS202011CQN	1
33	PMODUSBUART USB TO UART MODULE	Digilent, Inc.	410-212	1

After components mounting, use the functional schematic on the Figure.20 for signal wires soldering

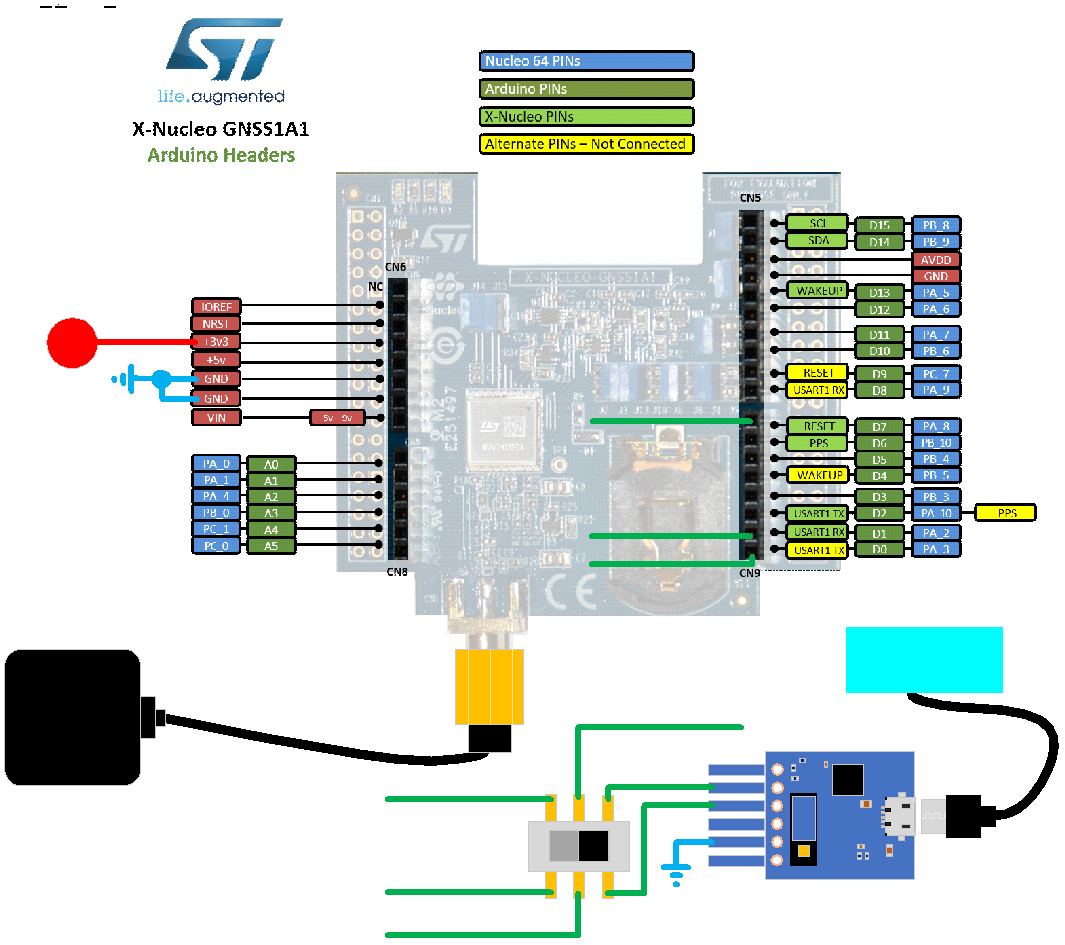


Figure. 20 GPS module functional schematic connection

9.Logic level translator assembly

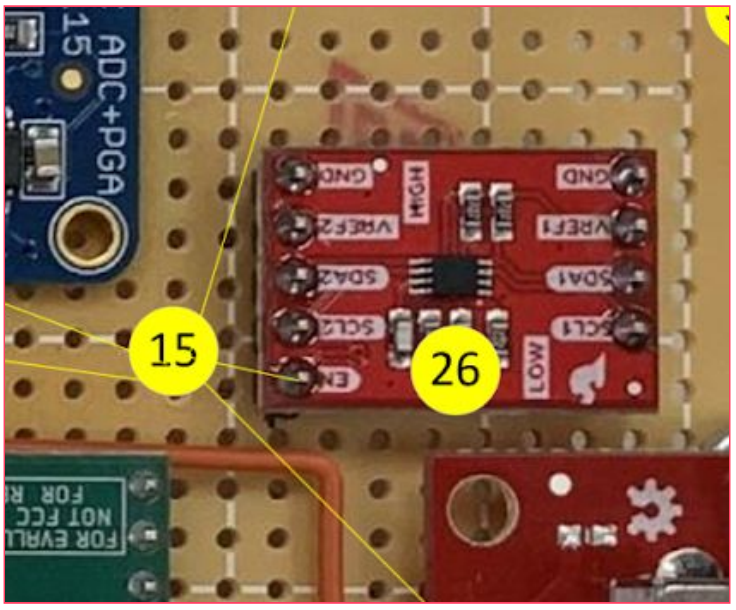


Figure. 21 Logic level translator module prototype view

All components in Table.9 mount and solder as showed on the Figure.21

Table.10 Logic level translator module components

Number	Description	Company	Part number	Quantity
26	SPARKFUN LEVEL TRANSLATOR BREAKOUT - PCA9306	sparkfun	PCA9306	1
15	CONN HEADER VERT 40POS 2.54MM	Sullins	PREC040SABN-RC	1

After components mounting, use the functional schematic on the Figure.22 for signal wires soldering

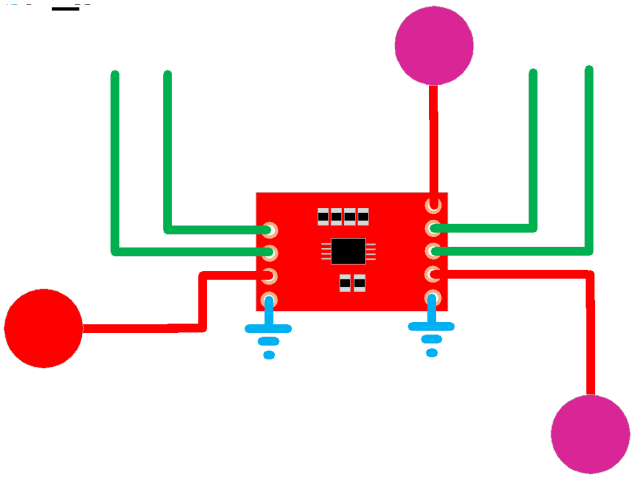


Figure. 22 Logic level translator module functional schematic connection

10.Raspberry Pi and 3G Modem

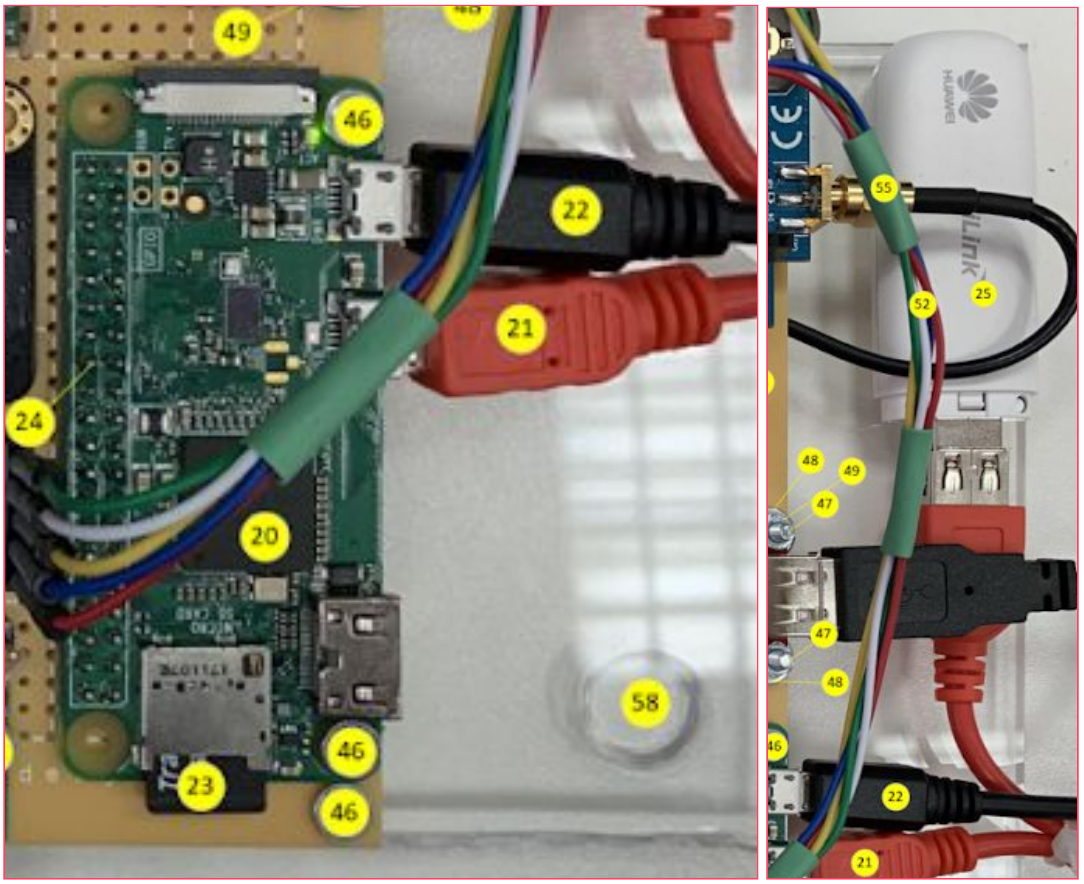


Figure. 23 Raspberry Pi and 3G modem prototype view

All components in Table.7 mount and solder as shown on the Figure.23

Table.11 Raspberry Pi and 3G modem connection components

Number	Description	Company	Part number	Quantity
23	microSD Card with Adapter - 32GB (Class 10)	sparkfun	32GB MicroSD	1
24	CONN HEADER VERT 40POS 2.54MM	Amphenol ICC (FCI)	67997-240HLF	1
25	3G GSM modem Huawei E3531i-1	Huawei	E3531i-1	1
21	USB OTG Cable - Female A to Micro B - 5in	sparkfun	USB OTG Cable	1
22	Raspberry Pi micro-USB power cable	reichelt	AK67421-0.5	1
20	Raspberry Pi Zero W	sparkfun	Raspberry Pi Zero W	1

After components mounting, use the functional schematic on the Figure.24 for signal wires soldering

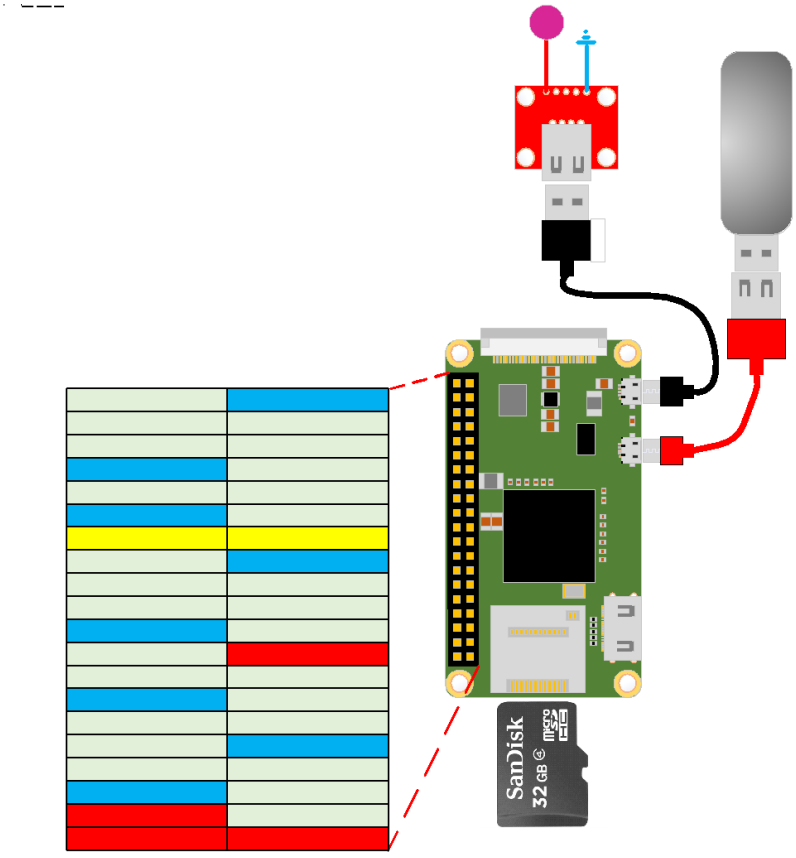
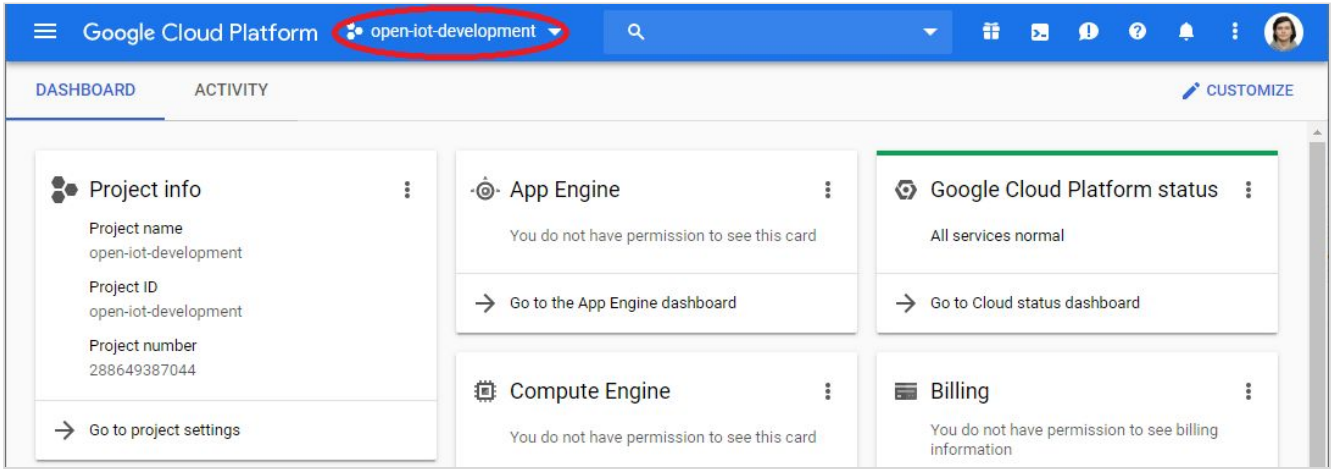


Figure. 24 Raspberry Pi and 3G functional schematic connection

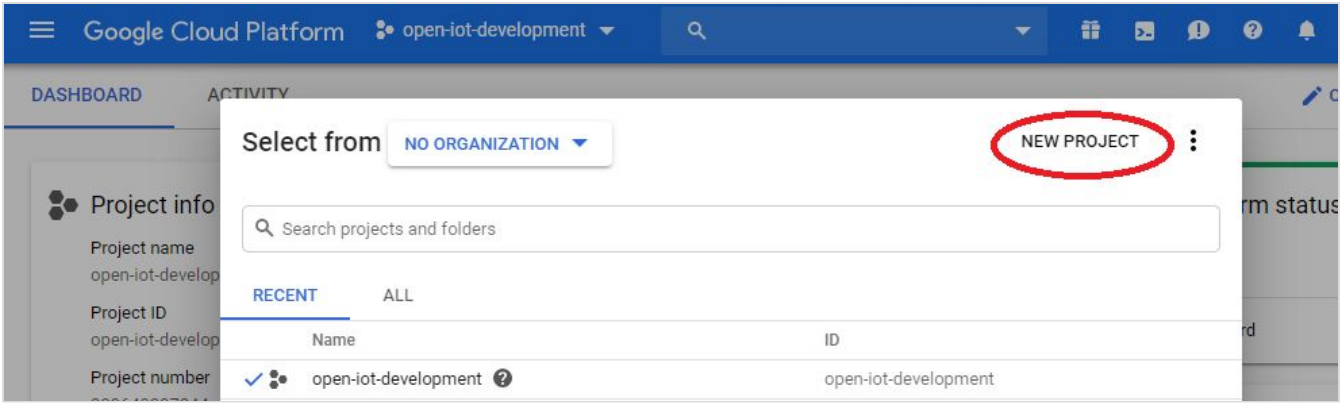
How to connect the device to Cloud

At first, create a Google Cloud account. For this purpose go **here** and click on the "Get started for free" button. After you have finished registration you should head to Console, if it has not been automatically done, click on the Console button which is located on the top right corner of the screen.

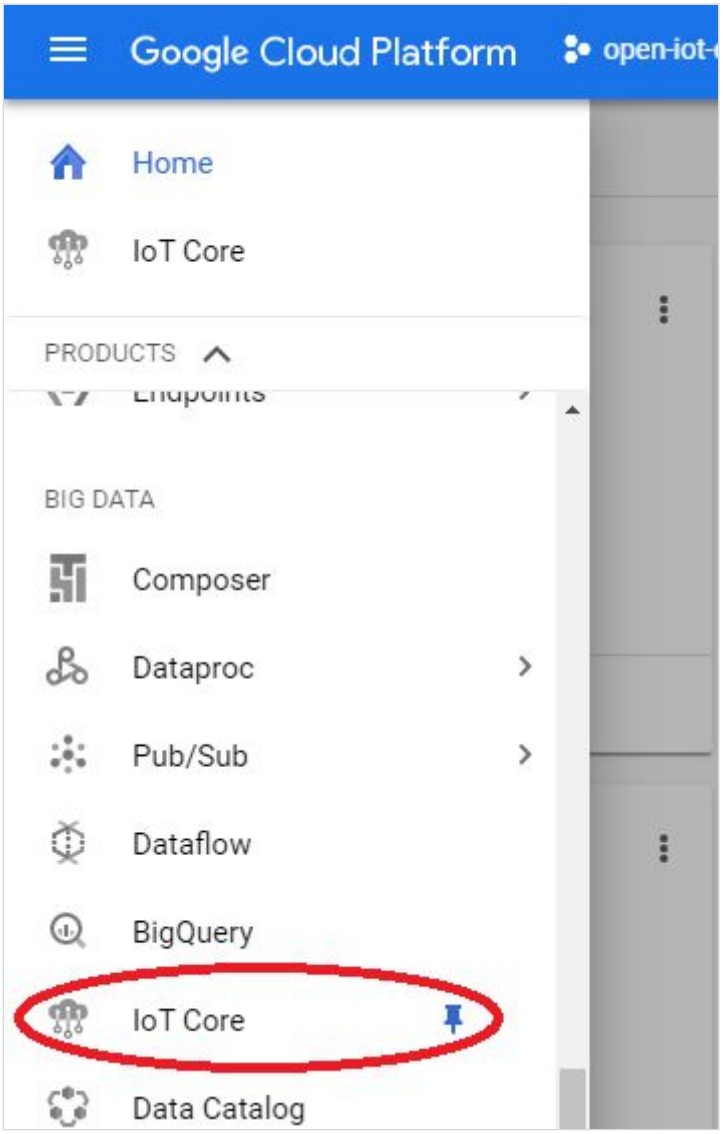
1) If you haven't already, create a project in Google Cloud. To create a project, click here:



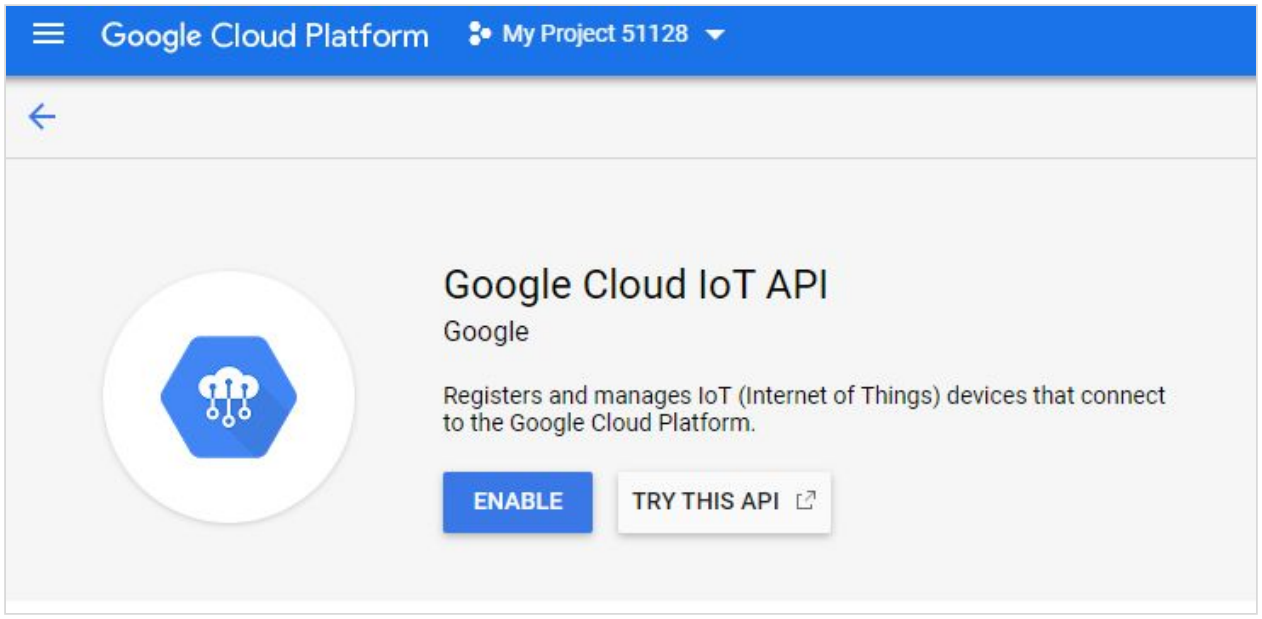
After, click on NEW PROJECT button and enter your Project name and location:



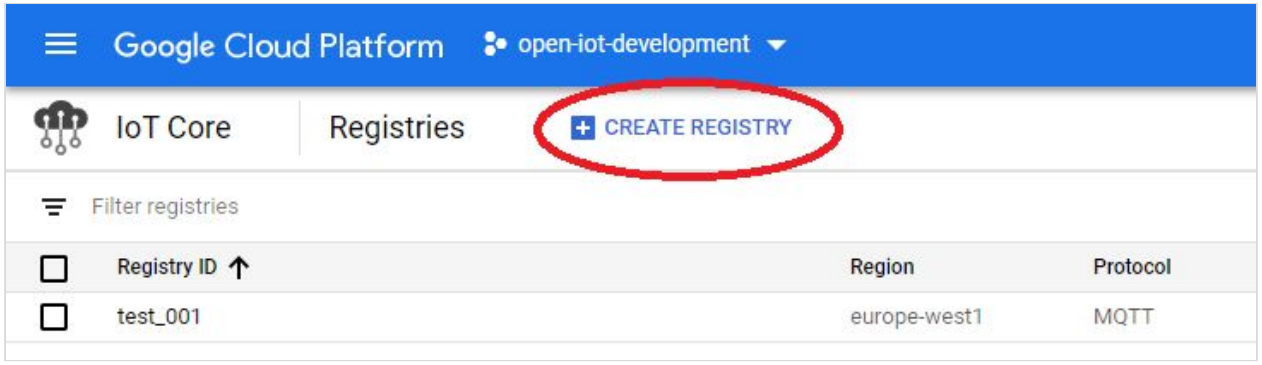
2) After you have a project, go to the navigation menu in the top left corner and find IoT Core or just type IoT in the search bar.



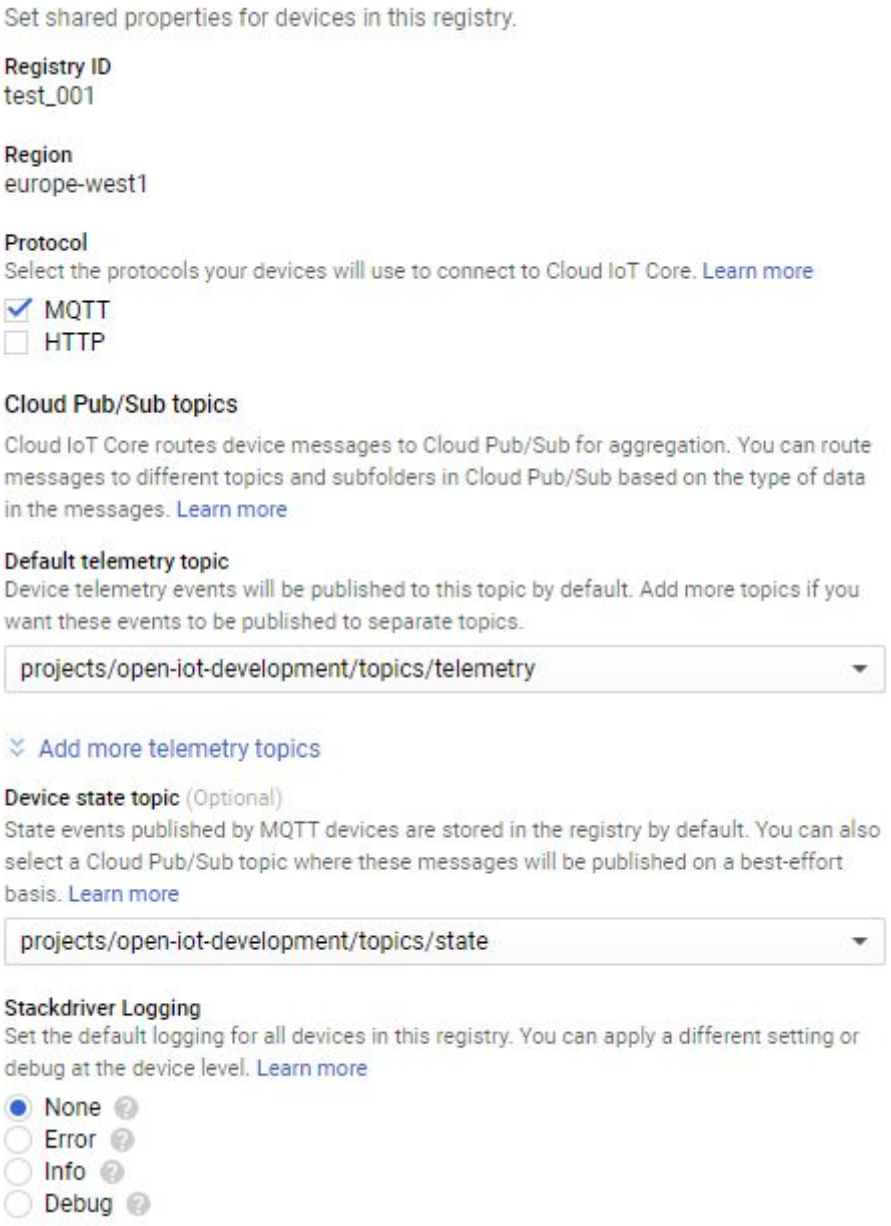
If you are entering Cloud IoT API for the first time, you need to click on the “ENABLE” button.



Now you should see the Registries page. Here, click on a “create registry” button.



For topic fields, you have to create a topic. You can use one topic for telemetry and state fields, or create topics for each of them. Here is an example of filled out registry:



You must fill out all required fields and hit the Create button.

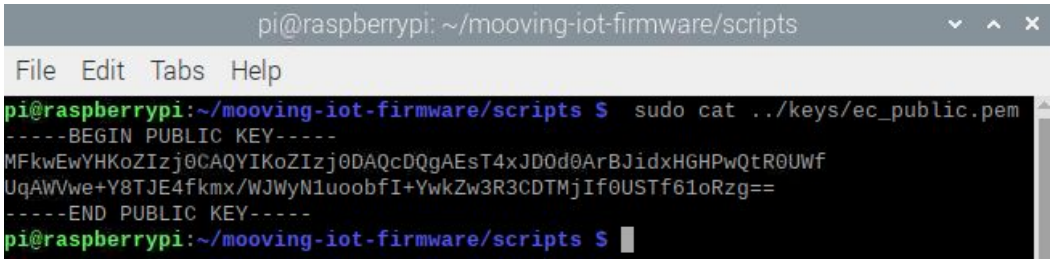
3) For a device to function properly you need to enter keys that are generated on the device. Read the instructions here on how to generate keys on the device.

In the process of setting up your device, you will do these steps:

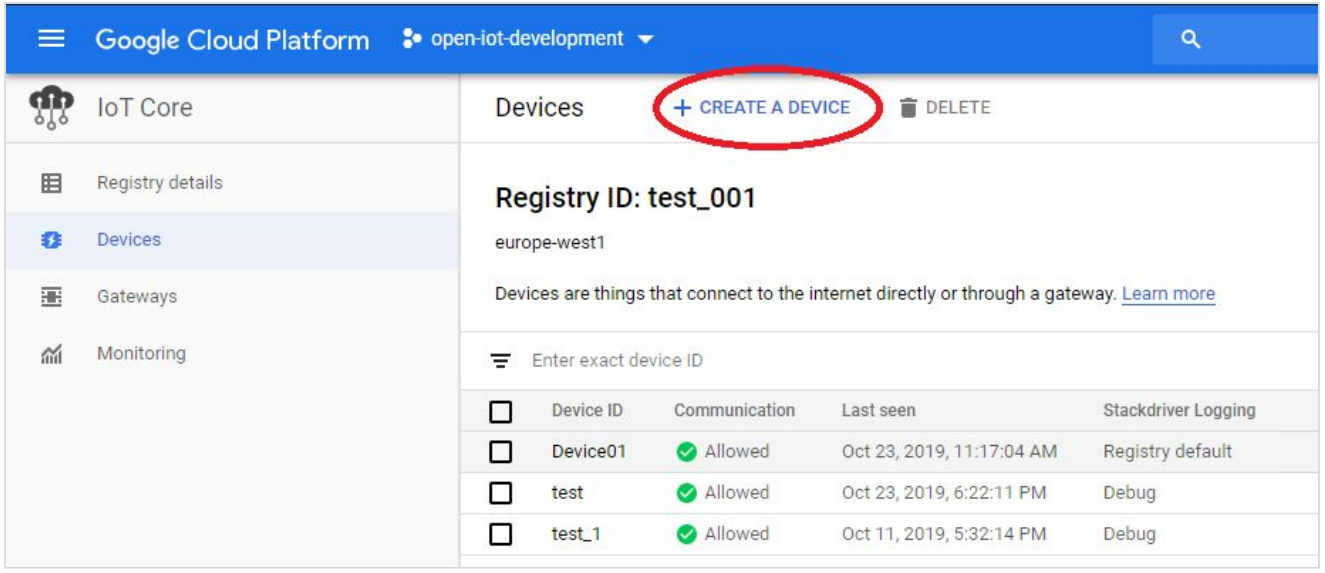
8. Generate ES256 encryption keys:
sudo sh generate_keys.sh

9. Add device public key on Google Cloud IoT. To display the generated device public key, enter:
sudo cat ../keys/ec_public.pem

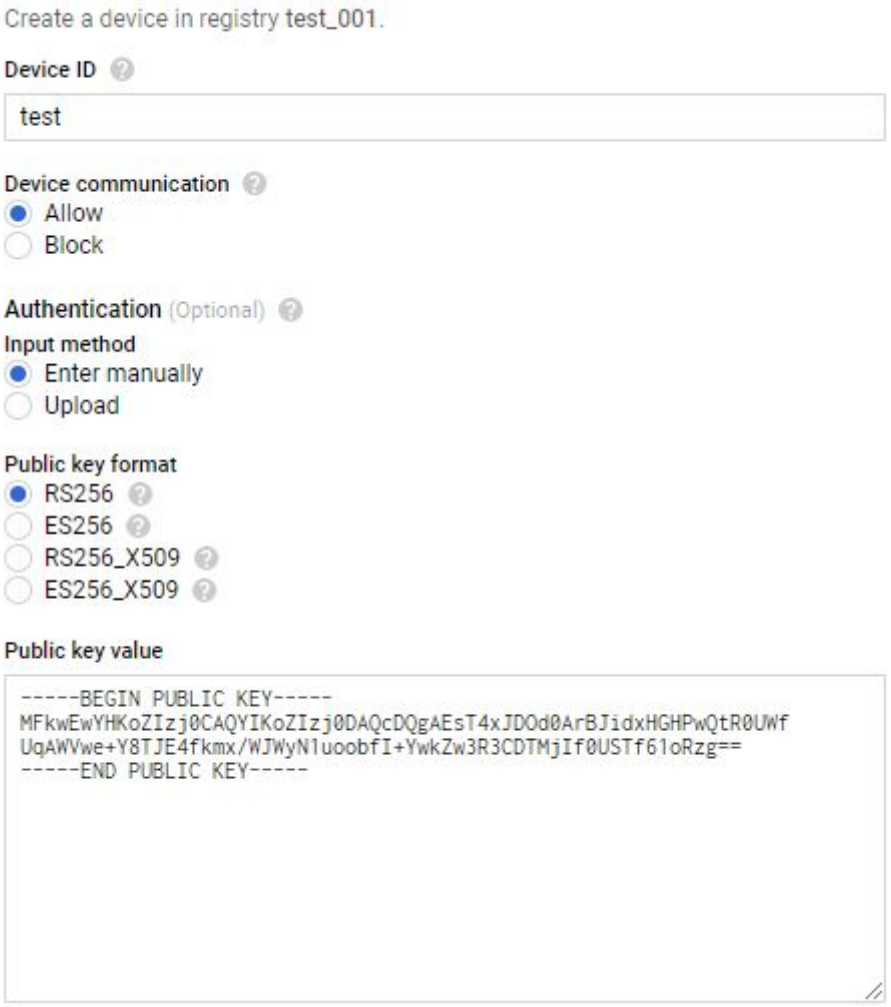
After doing them, you should see in your console generated security key:



Copy them and go to the Devices tab on left and create a new device.

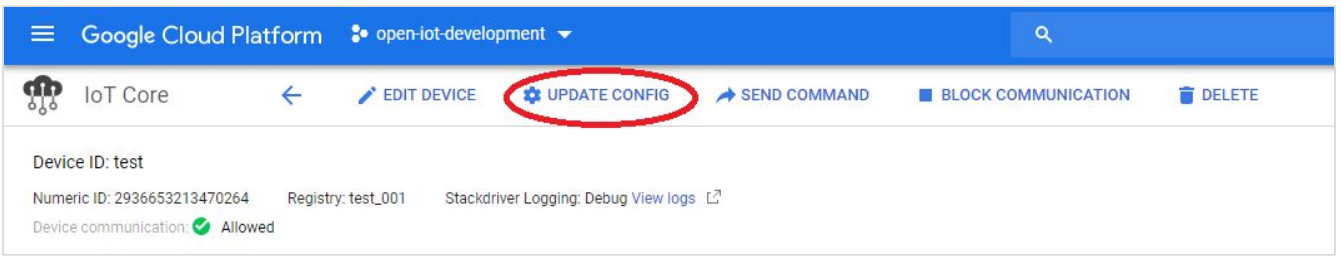


In the opened window enter device ID, in the “Public key format” select ES256 and in the “Public key value” field enter the generated key.
The final result should look like this:



After you finished filling out all required fields, click on the “Create” button and you will be transferred to your created device page.

4) Before sending any commands to the device you need to send the configuration to it. For this, click on “UPDATE CONFIG” button:

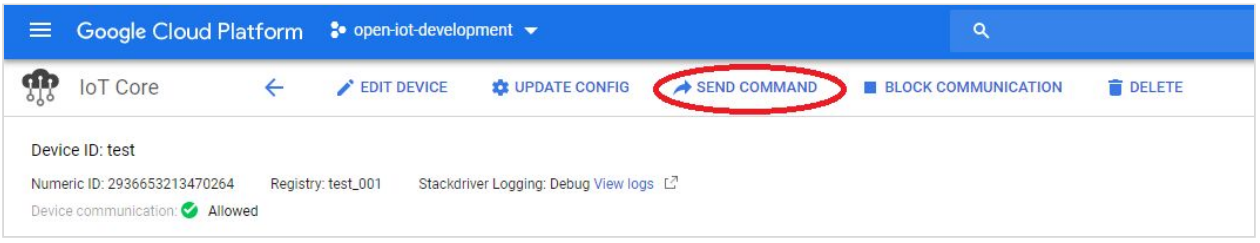


In the appeared “Update configuration” window message enter this JSON:

```
{
  "telemetryIntervalPowerOn": 10,
  "telemetryIntervalPowerOff": 10
}
```

And click on “Send to device” button.

To send commands you need to click on the “SEND COMMAND” button.



And in the appeared “Update configuration” window message enter the command from the list below and click on “Send command” button:

In "vehicleId" field you should enter the name of your device ID, so if your Device ID is “test”, the commands are:

To unlock:

```
{
  "command": "unlock",
  "vehicleId":"test"
}
```

To lock:

```
{
  "command": "lock",
  "vehicleId":"test"
}
```

To set to unavailable:

```
{
  "command": "unavailable",
  "vehicleId":"test"
}
```

To make a constant beep pattern (volume is from 1 to 100):

```
{
   "command": "beep",
   "volume": 50,
   "vehicleId":"test"
}
```

To make a constant alarm pattern (volume is from 1 to 100):

```
{
   "command": "alarm",
   "volume": 50,
   "vehicleId":"test"
}
```

Firmware Installation

Getting Started

1. Download and install on SD card latest Raspbian Buster Lite image:
   Raspbian Buster Lite.
   Install Raspbian Buster Lite on SD card using Etcher.

2. Enable WIFI and SSH on Raspberry Pi:
   How to enable WIFI and SSH.

3. Connect to Raspberry Pi via SSH:
   More details about SSH on Raspberry Pi.

4. Enter commands to install Git client:
   sudo apt-get update
   sudo apt-get install git

5. Clone mooving-iot-firmware repository using Git client.

6. Move to the repository scripts folder:
   cd mooving-iot-firmware/scripts

7. Run setup script:
   sudo sh setup_project.sh

8. Generate ES256 encryption keys:

sudo sh generate_keys.sh

9. Add device public key on Google Cloud IoT. To display the generated device public key, enter:

sudo cat ../keys/ec_public.pem

10. Open file run_project.sh and change Google Cloud IoT details for the device to your own. Here you must enter **project_id** (ID of your project, can be found on the main Google Cloud Console page), **registry_id** (name of your registry, can be found in IoT Core tab), **device_id** (name of your device, can be found in IoT Core tab) and **region** (location of your project, can be found on the main page or in IoT Core tab). :

CLOUD_REGION="region"
PROJECT_ID="project_id"
REGISTRY_ID="registry_id"
DEVICE_ID="device_id"

11. Reboot device:

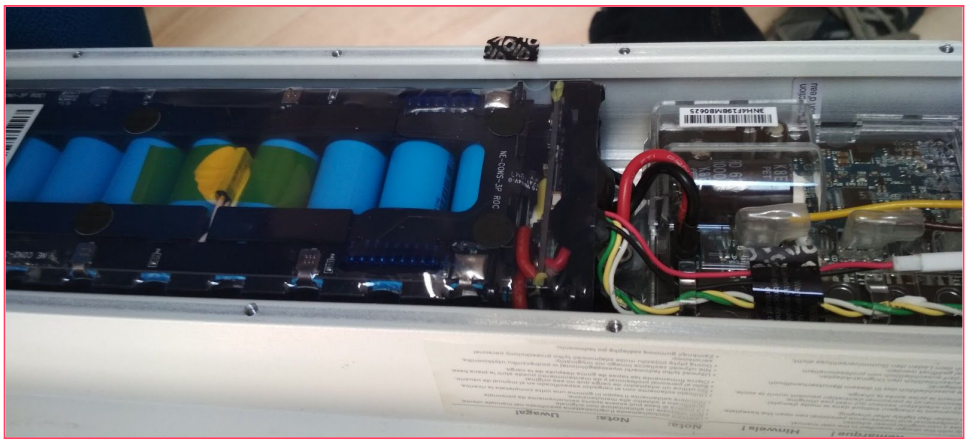
sudo reboot

Connection instruction to Xiaomi Mi Electric Scooter

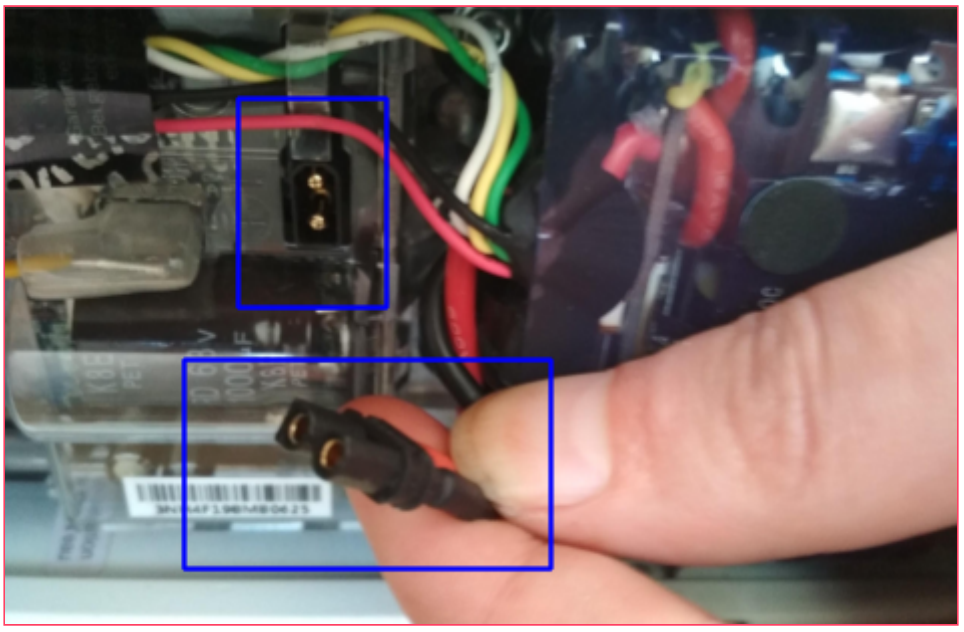
This document offers step-by-step instructions for how to set up the IoT device on a test vehicle - we'll use the Xiaomi Mi electric scooter as an example.

1) First of all, you need to turn off your scooter. After that, you have to disassemble the scooter's bottom lid. For this operation you will need a Torx screwdriver.

After you take off the bottom lid you will be able to see the battery (right) and main circuit board (Left).

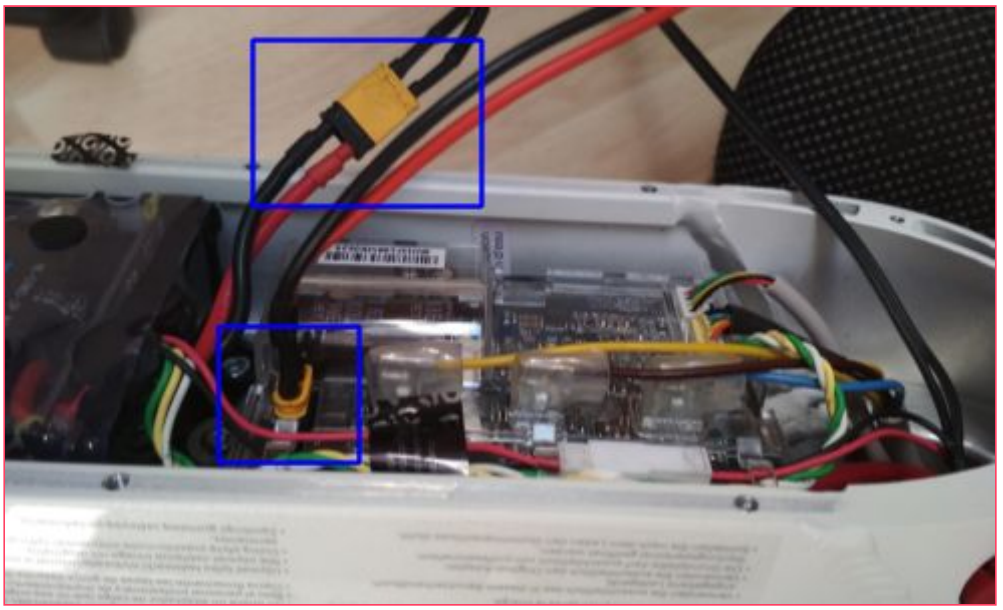


2) Pull out the battery connector from the main circuit board.

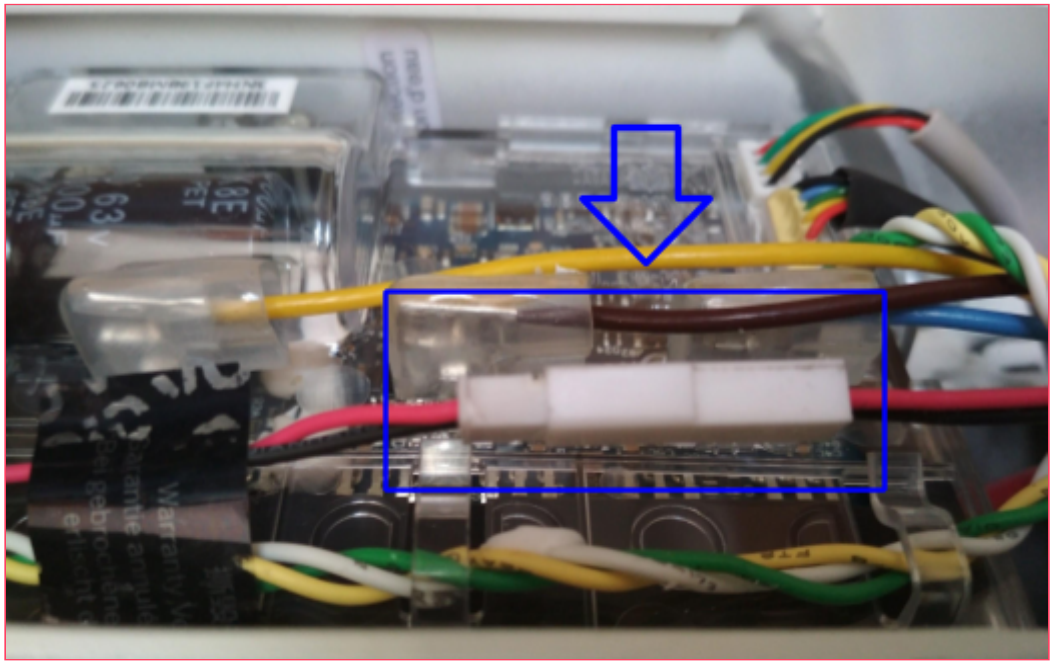


3) Make a hole in the rear part of the bottom lid. Then pass all wires from Mooving IoT device through this hole. Wires should go from the outside to inside the scooter.

4) Connect power wires from Mooving IoT device to battery and main circuit board (in the split). Connectors have special shape to follow polarity and avoid short circuit.

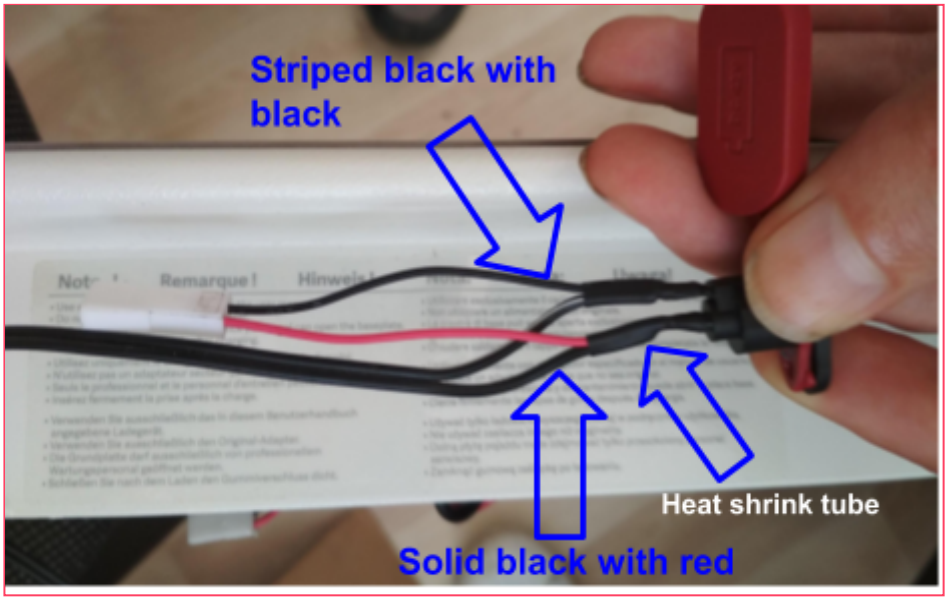


5) Disconnect charger connector.

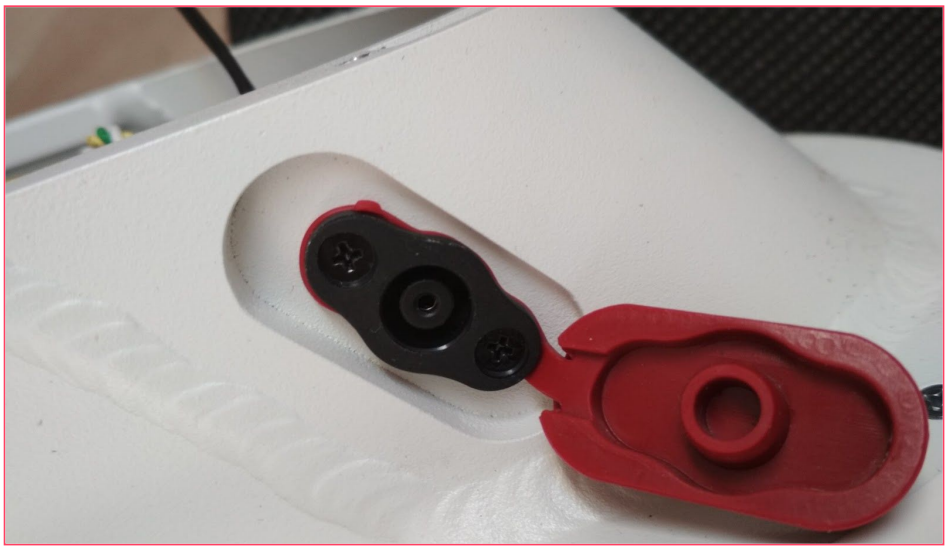


6) Disassemble a charger port connector from the hole using a screwdriver.

7) Now part of charging cable could be pulled out from the scooter. You should solder 2 wires from Mooving IoT device to charger port as it is shown in the image below. Stripped (or black) wire should be connected with black wire at the charger socket and solid (or red) wire should be connected with red wire at the charger socket. Before soldering please ensure that wire from Mooving IoT device goes through the charger port hole. Use heat shrink tube to isolate and protect connectors and wires after soldering.

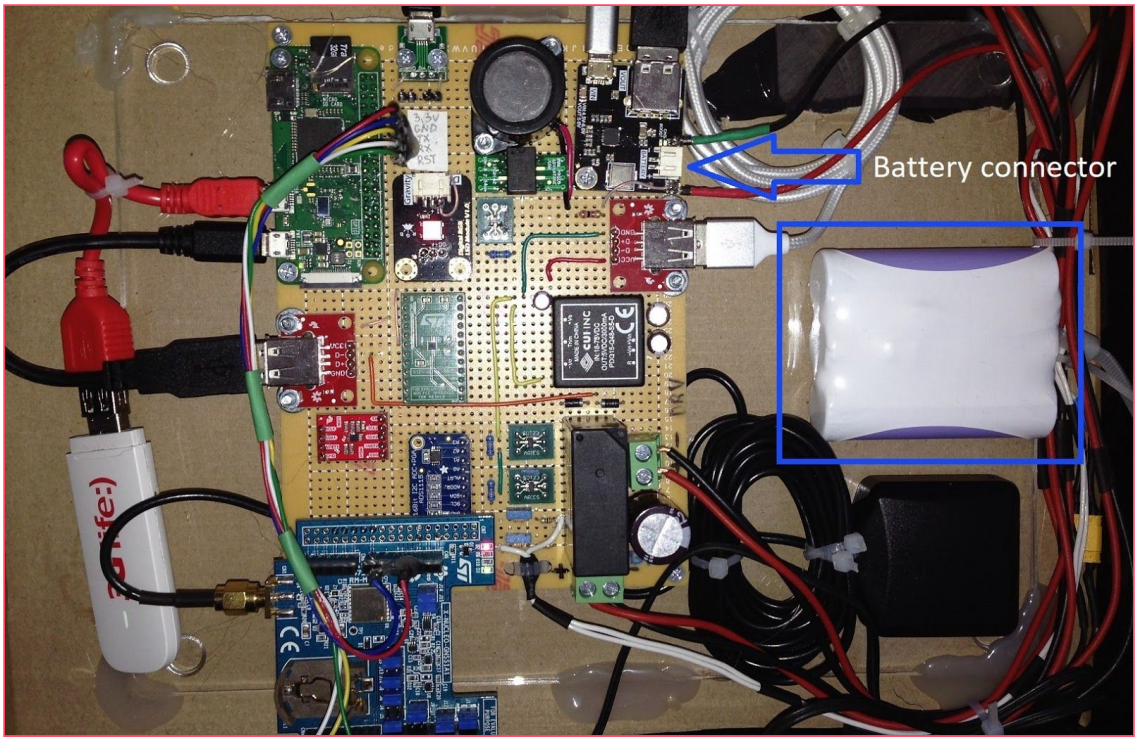


8) Mount charger wire back to the hole and fix using a screwdriver.



9) Close the bottom lid and fix using a screwdriver.

10) Pla c e box with the device on a plane surface. Fix power wires with scotch tape. You should also place the battery and attach the battery connector to the board.



Attach the IoT device to the scooter pole.