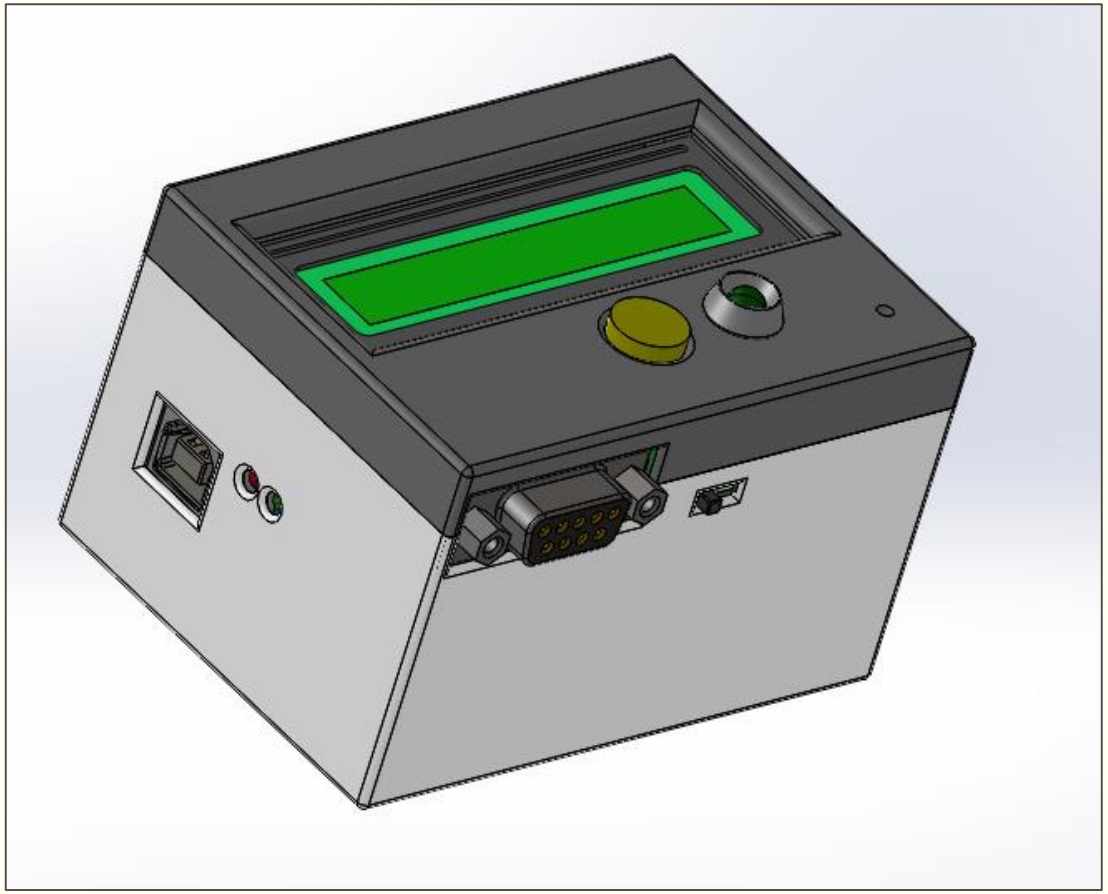
# SOLID FUEL ROCKET MOTOR POWER METER

Francisco Javier Romero Maldonado
Víctor Martínez Velasco

Printed Circuit Technology – University of Granada

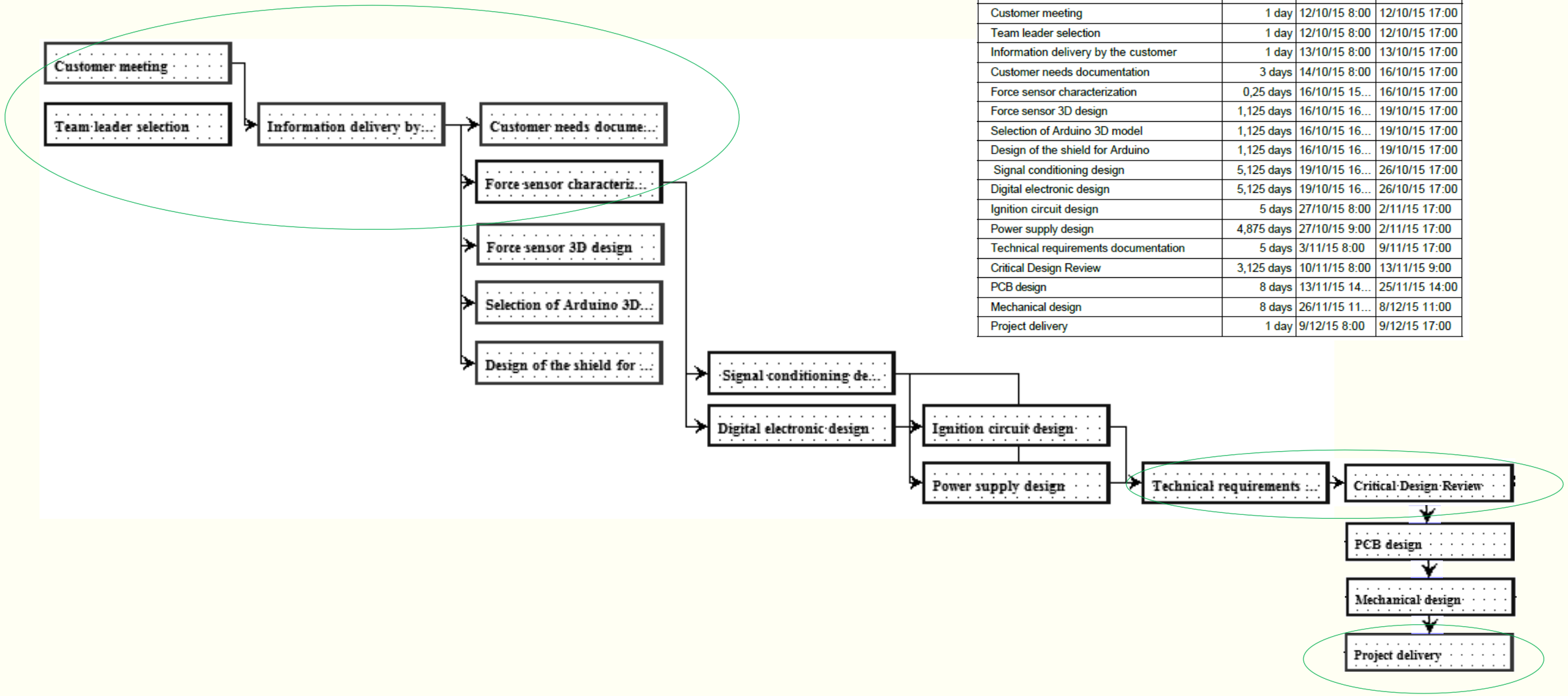


# INDEX

# CUSTOMER NEEDS

- The goal was the design of an electronic device to control the ignition of a solid fuel rocket motor and getting its force characterization.
- The force sensor to use was the model 620 (300 kg / 500 kg) of the manufacturer *Utilcell* [1].
- To ignite the fuel a *NiCr* coil [2] is required.
- The device controller must be an *Arduino Uno* [3], using the USB connector for the data transfer.
- Due its portable nature, the device has to be self-sufficient.
- An user interface with acoustic and visual elements is needed.
- The maximum final product size is fixed to 85 x 65 x 55 mm.

# TEAM ORGANISATION AND PLANNING.

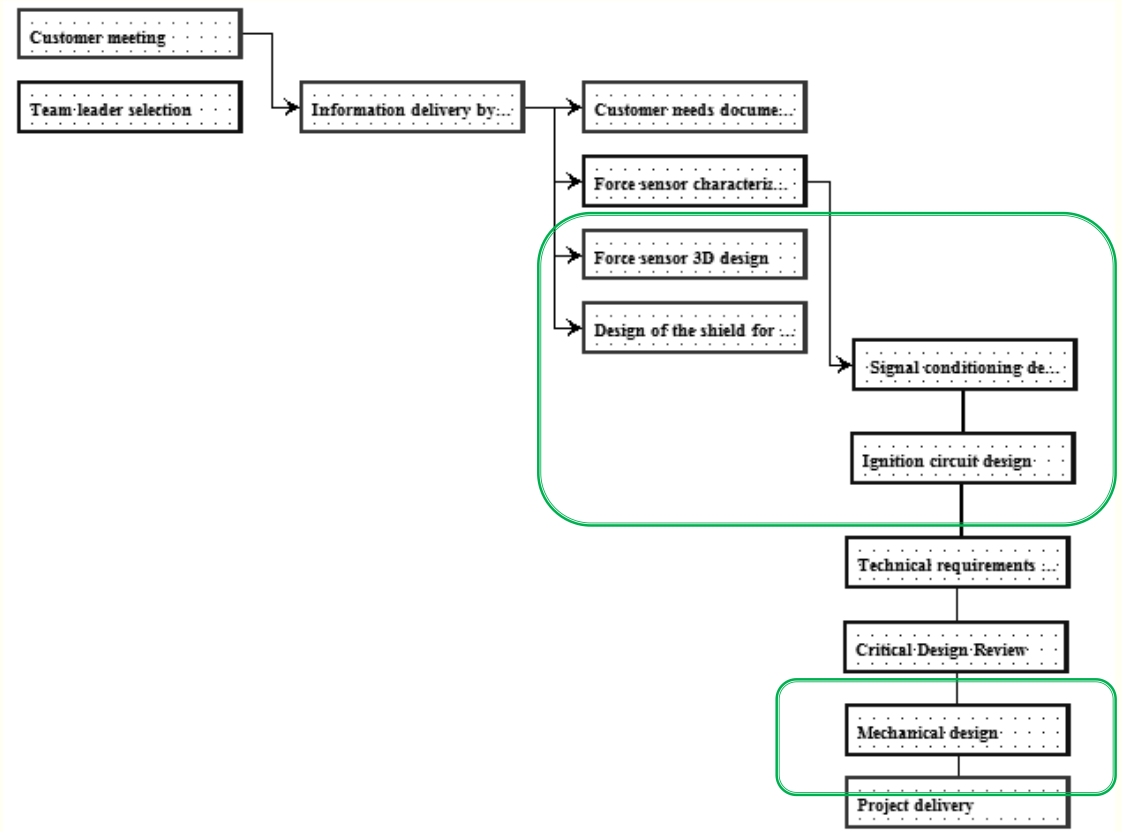



| TASK | Duration | Start | Finish |
|---|---|---|---|
| Customer meeting | 1 day | 12/10/15 8:00 | 12/10/15 17:00 |
| Team leader selection | 1 day | 12/10/15 8:00 | 12/10/15 17:00 |
| Information delivery by the customer | 1 day | 13/10/15 8:00 | 13/10/15 17:00 |
| Customer needs documentation | 3 days | 14/10/15 8:00 | 16/10/15 17:00 |
| Force sensor characterization | 0,25 days | 16/10/15 15... | 16/10/15 17:00 |
| Force sensor 3D design | 1,125 days | 16/10/15 16... | 19/10/15 17:00 |
| Selection of Arduino 3D model | 1,125 days | 16/10/15 16... | 19/10/15 17:00 |
| Design of the shield for Arduino | 1,125 days | 16/10/15 16... | 19/10/15 17:00 |
| Signal conditioning design | 5,125 days | 19/10/15 16... | 26/10/15 17:00 |
| Digital electronic design | 5,125 days | 19/10/15 16... | 26/10/15 17:00 |
| Ignition circuit design | 5 days | 27/10/15 8:00 | 2/11/15 17:00 |
| Power supply design | 4,875 days | 27/10/15 9:00 | 2/11/15 17:00 |
| Technical requirements documentation | 5 days | 3/11/15 8:00 | 9/11/15 17:00 |
| Critical Design Review | 3,125 days | 10/11/15 8:00 | 13/11/15 9:00 |
| PCB design | 8 days | 13/11/15 14... | 25/11/15 14:00 |
| Mechanical design | 8 days | 26/11/15 11... | 8/12/15 11:00 |
| Project delivery | 1 day | 9/12/15 8:00 | 9/12/15 17:00 |

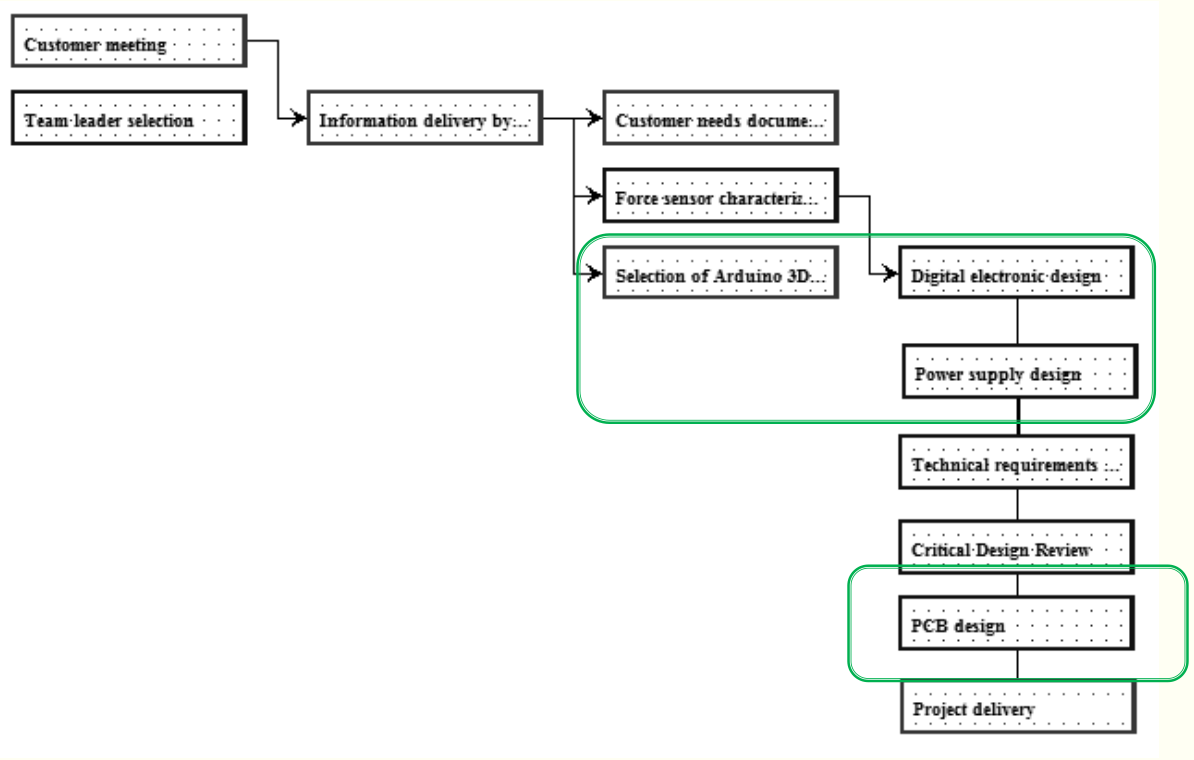
# ORGANISATION AND PLANNING OF EACH ONE.

Although the collaboration was constant, mainly our tasks were:

## Francisco Romero




## Víctor Martínez



# TECHNICAL REQUIREMENTS

## FORCE SENSOR SIGNAL CONDITIONING

- First, to improve the accuracy a low pass filter is needed.
- To adapt the force sensor signal to the 0 – 5 Volts ADC of the Arduino we use an instrumentation amplifier [4].
- With a slide switch [5] we will be able to indicate the force cell that is connected.

## IGNITION CONTROL

- To be more accurate we will control the ignition by software .
- To ignite the fuel we use a *NiCr* coil which needs a peak of approximately 2 A to be burned, we use a MOSFET [6] to have it.
- Monitoring the continuity in the coil we can know when starting with the measurements.

Sensor and ignition control are both connected by a DB-9 connector to the device

# TECHNICAL REQUIREMENTS

## USER INTERFACE

- Visual:

  1 LED to inform about the conversion state.

  A couple of small LEDs to inform about the level of battery.

  1 LCD 16x02 for data visualization [8].

- Sound:

  12 mm buzzer to give resounding information.

- Control:

  A push button is used by the user to control the device.

## POWER SUPPLY

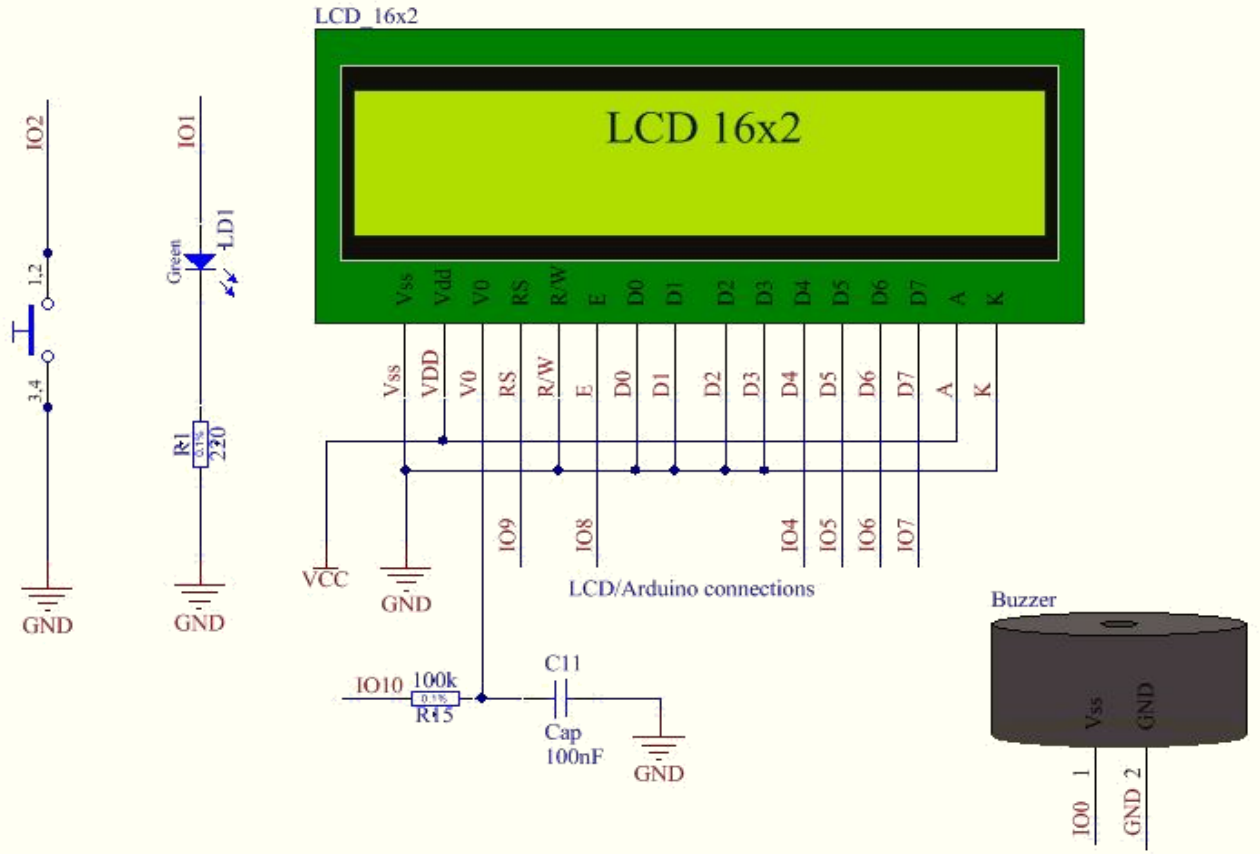
- A lithium-ion battery of 3,7 volts supplies the device [8].
- The battery is charged by the Arduino USB interface.
- If the USB is connected the battery can not be used.
- The battery level has to be monitored.

# SCHEMATICS

## ARDUINO CONNECTORS

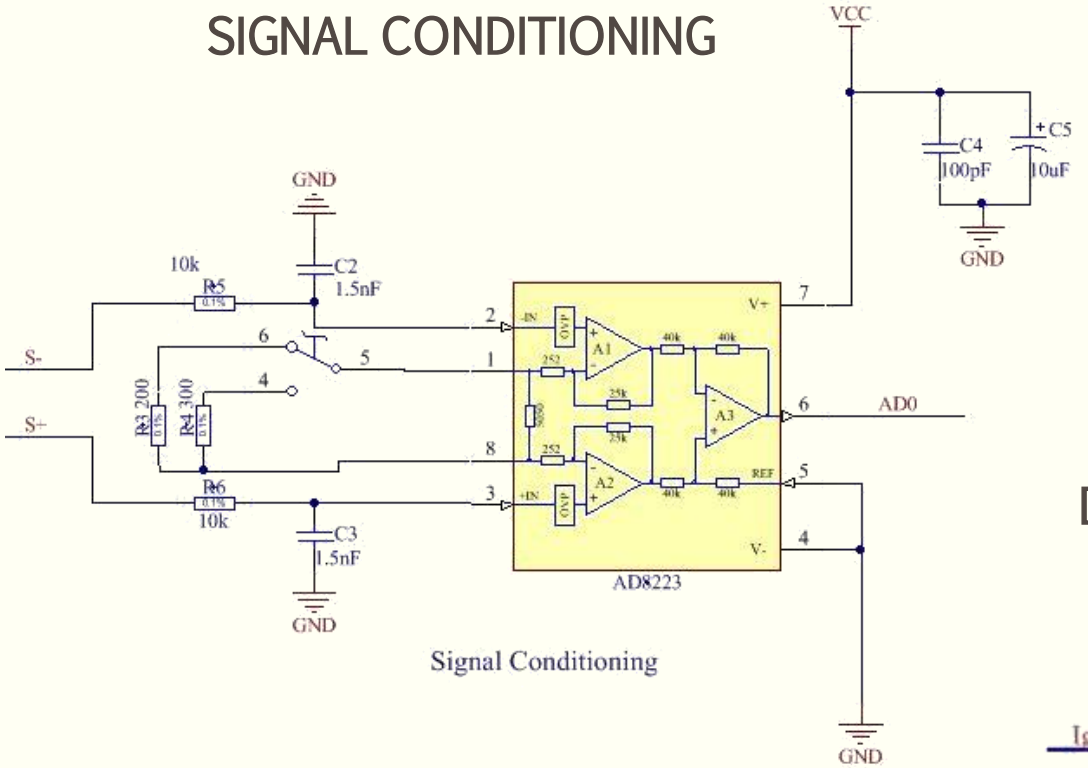
| PIN | FUNCTION | TYPE (I/O) |
|---|---|---|
| AD0 | Input voltage force sensor | I |
| AD3 | Battery level monitoring | O |
| USB | Battery charger<br>Data transfer | I/O |
| IO0 | Buzzer control | O |
| IO1 | LED user interface | O |
| IO2 | Push button | I |
| IO4<br>IO5<br>IO7<br>IO8<br>IO9<br>IO10 | LCD interface | O |
| IO11 | Ignition control | O |
| IO12 | Ignition monitoring | I |

## USER INTERFACE



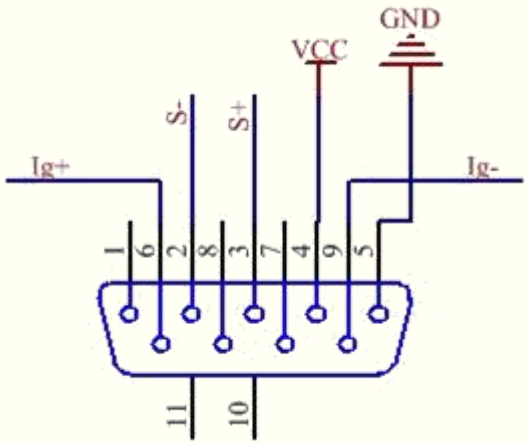
# SCHEMATICS

## SIGNAL CONDITIONING

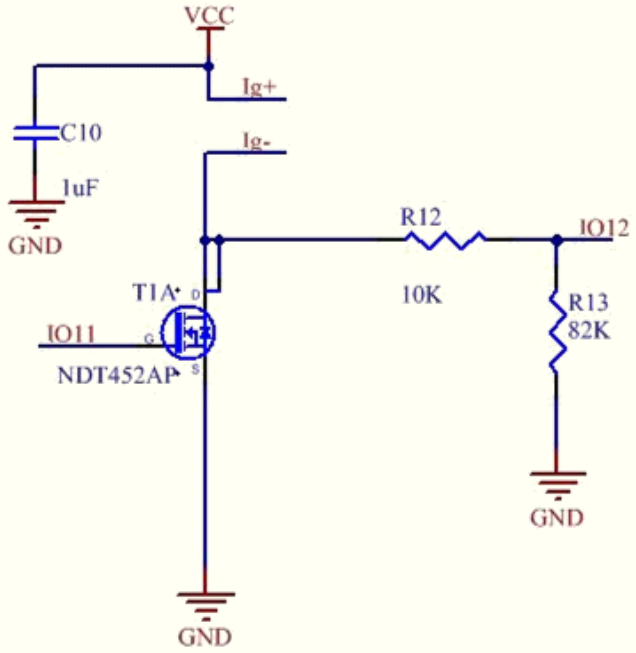



Signal Conditioning

## DB9 CONNECTOR

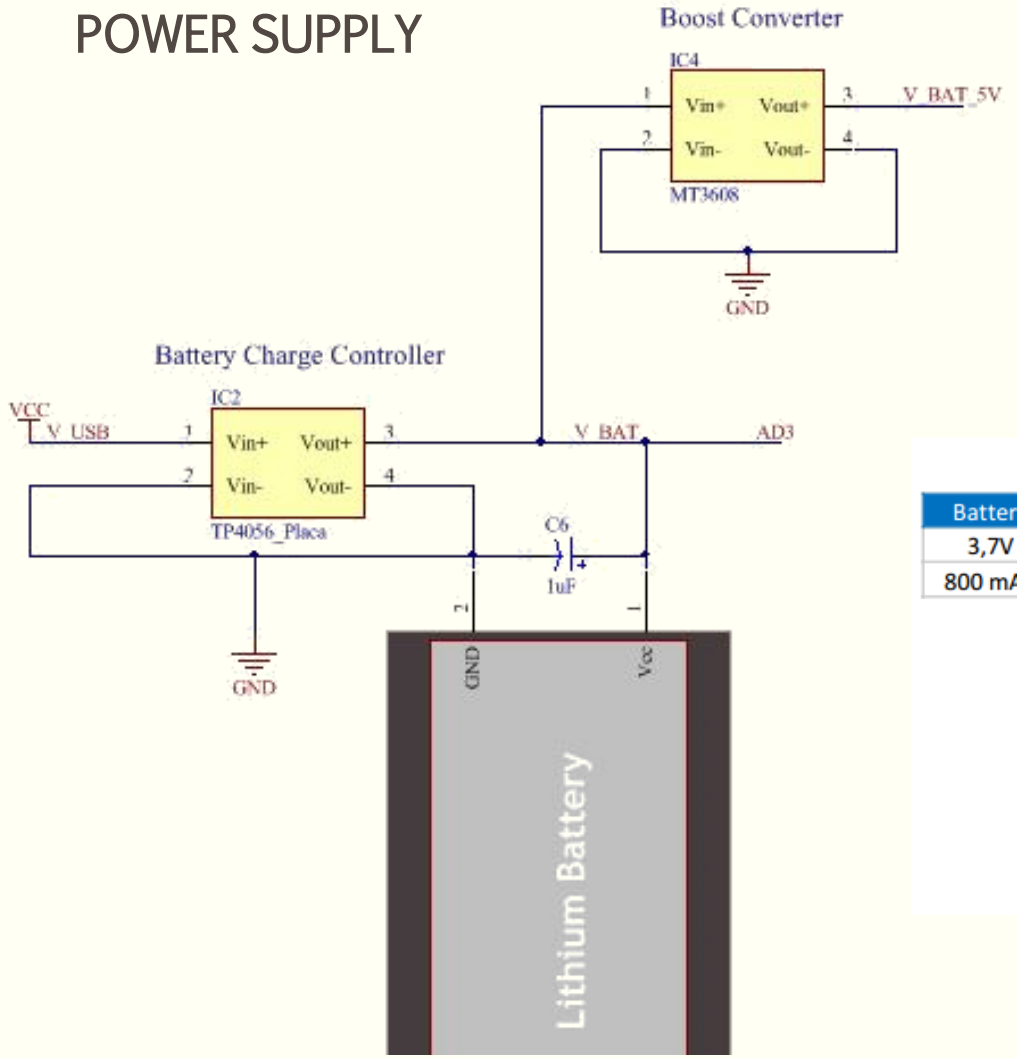


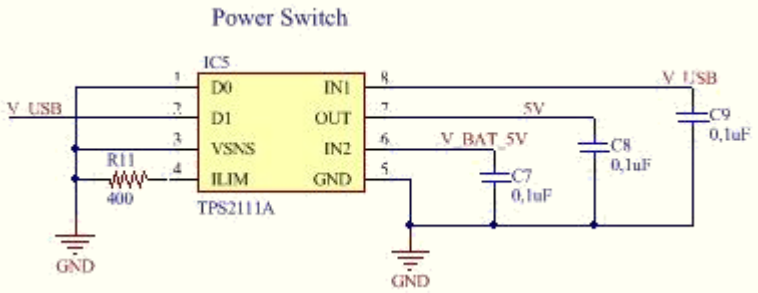

## IGNITION CONTROL



# SCHEMATICS

## POWER SUPPLY



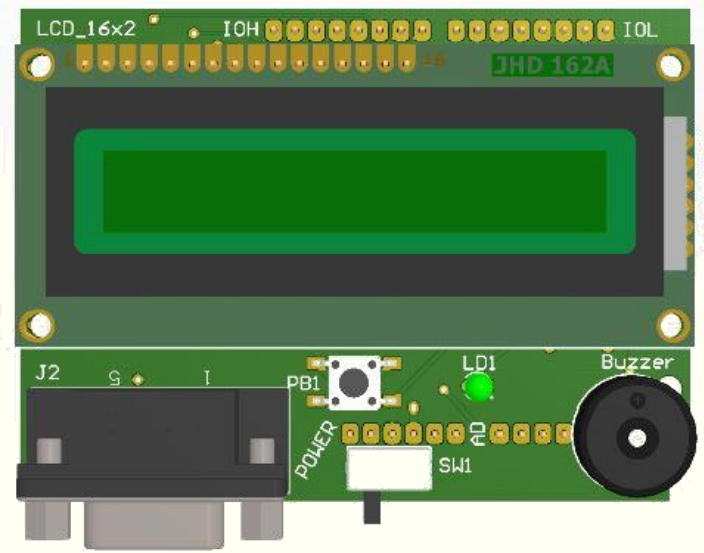



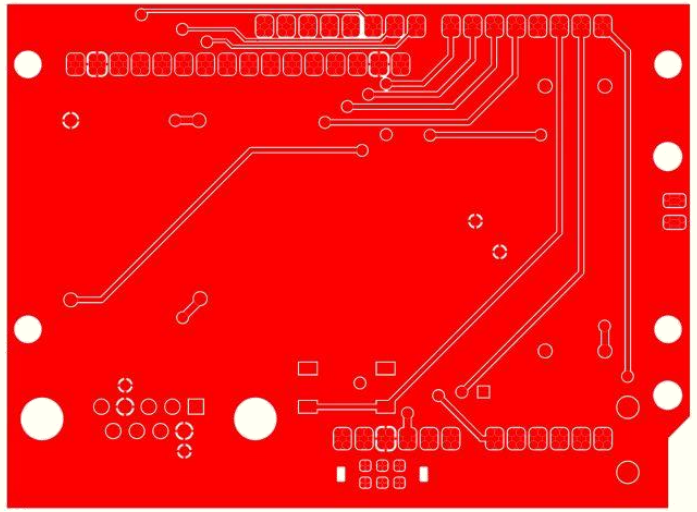

| Battery |
|---|
| 3,7V |
| 800 mAh |

| Power consumption | |
|---|---|
| Component | Consumption (máx.) (mA) |
| Arduino | 200 |
| LCD | 25 |
| Buzzer | 7 |
| LEDs (x3) | 60 |
| Force sensor | 15 |
| Ignistor | 1500 |
| Total maximum consumption (without ignistor) | 307 |
| Total maximum consumption (with ignistor) | 1807 |

# PCB DESIGN

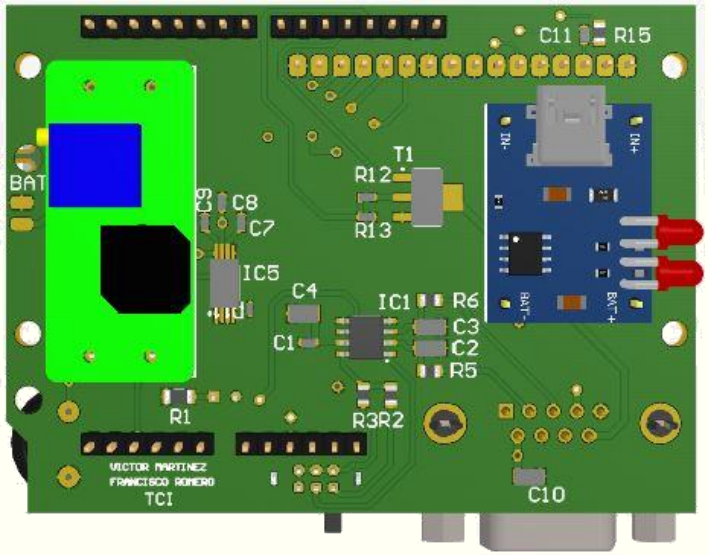
TOP SIDE

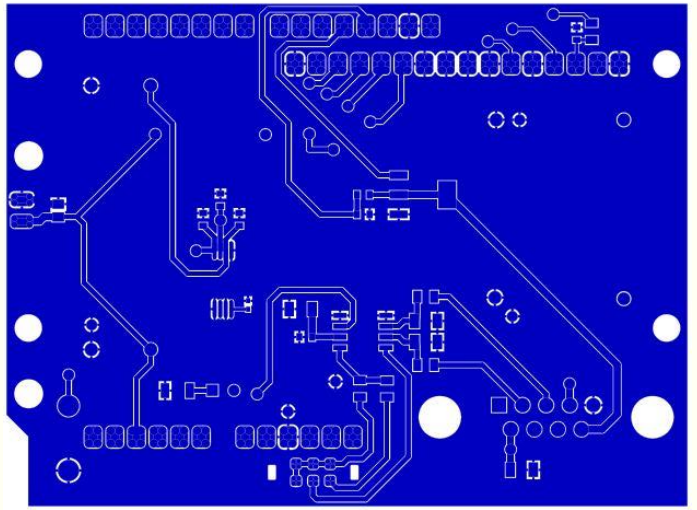


TOP LAYER

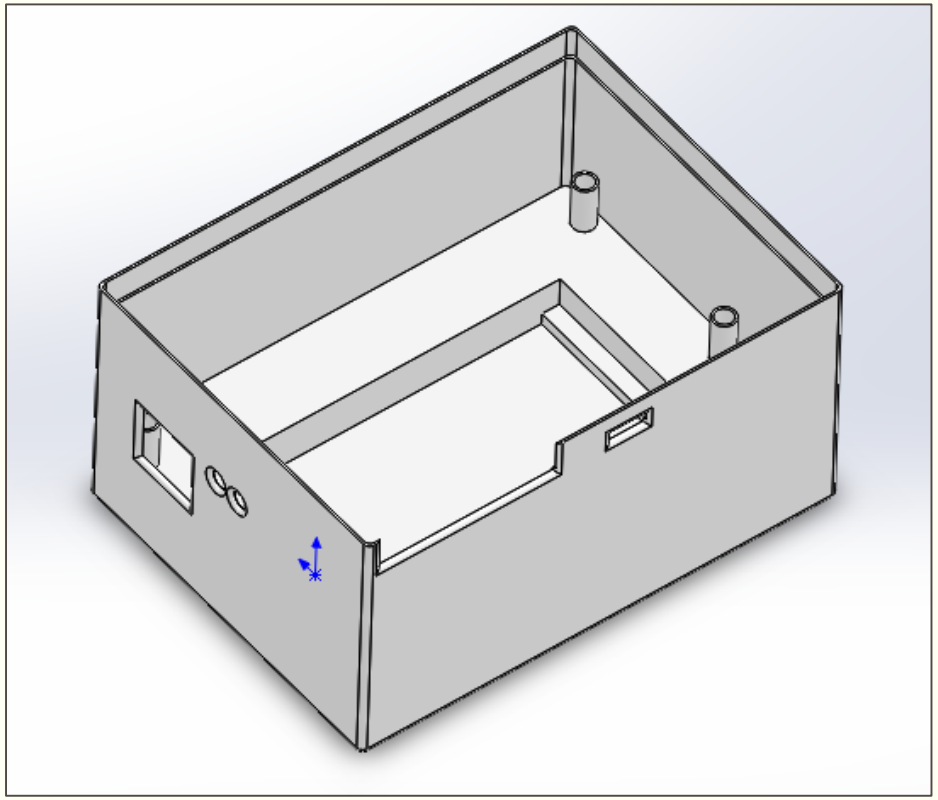
BOTTOM SIDE



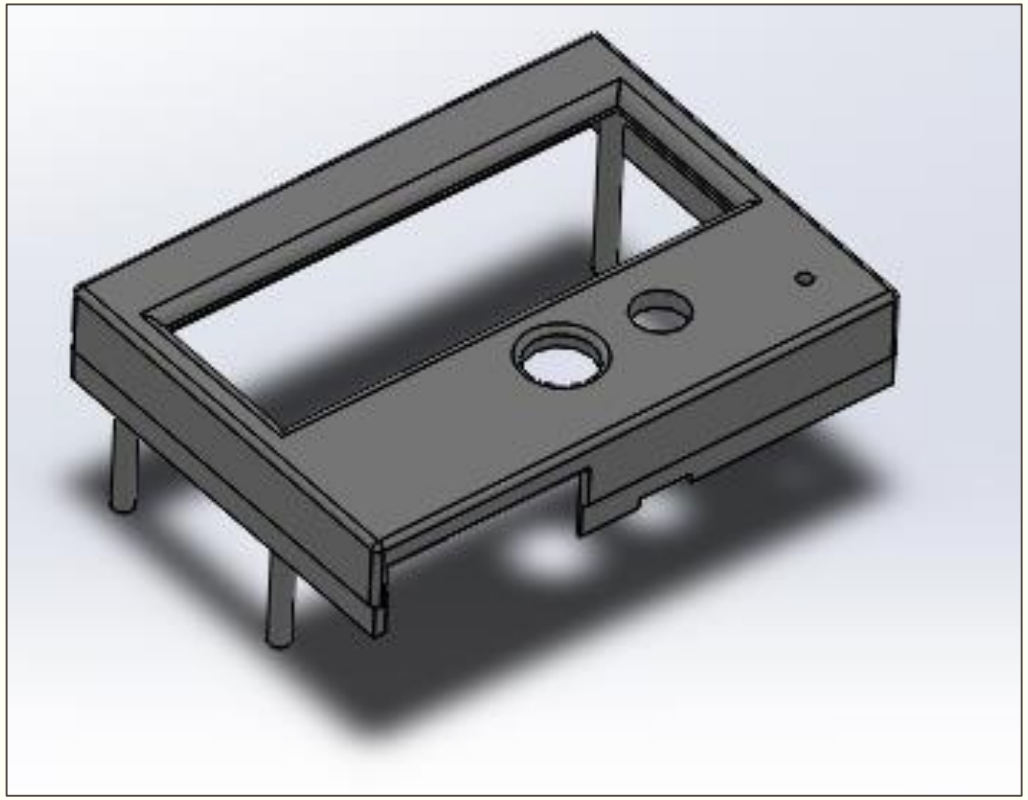



BOTTOM LAYER

# MECHANICAL DESIGN

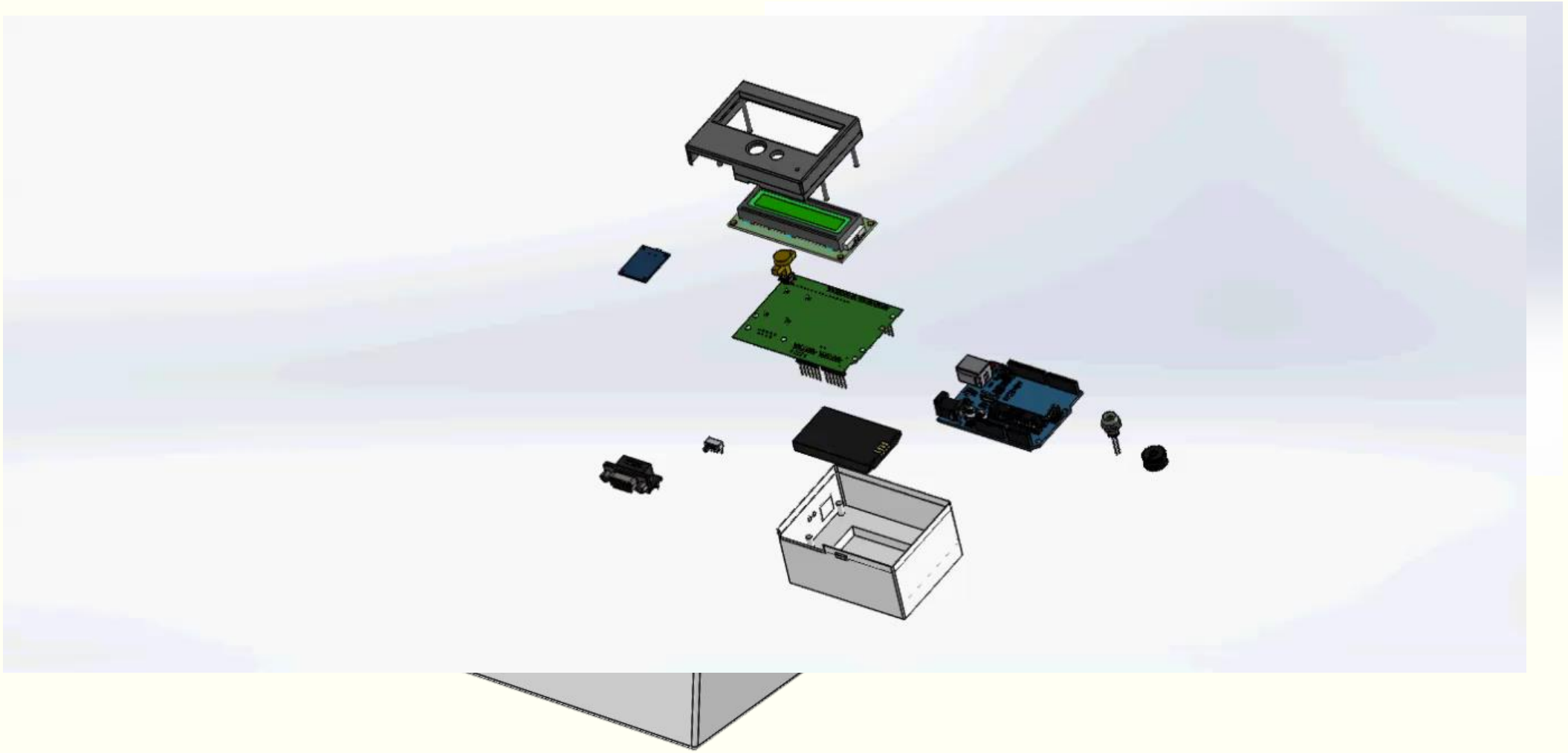


BOX



COVER

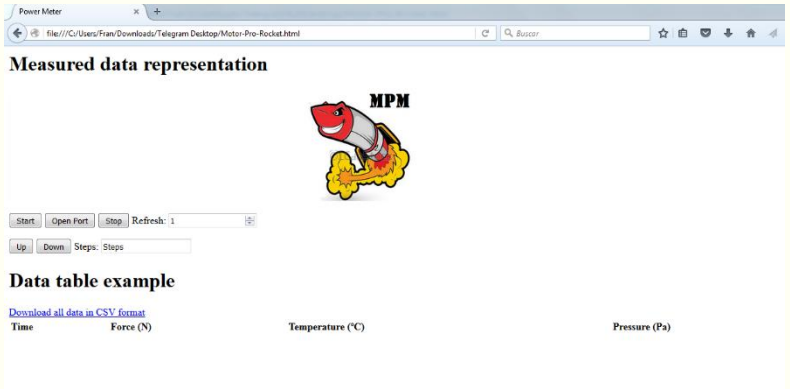
# MECHANICAL DESIGN



# MORE WORK

- Pending tasks:
  - Implementation of the software power switch.
  - Programming the Arduino.

- Future improvements:
  - Creation of a visualization data environment.
  - Temperature and pressure measure [7].
  - Build physically the test bench.





# REFERENCES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[2] http://www.lelong.com.my/temco-nichrome-wire-26awg-100-ft-rba-vape-free-coil-master-cotto-herbamlk-169123021-2016-10-Sale-P.htm

[3] https://www.arduino.cc/en/Main/ArduinoBoardUno

[4] http://www.farnell.com/datasheets/638082.pdf

[5] http://g02.a.alicdn.com/kf/HTB1HblRJFXXXXaqXVXXq6xXFXXXA/10-Pcs-x-Panel-PCB-3-Pin-2-Position-font-b-1P2T-b-font-SPDT-Slide.jpg

[6] http://www.alldatasheet.es/datasheet-pdf/pdf/54229/FAIRCHILD/NDT452.html

[7] http://www.sts-sensors.com/us/

[8] http://www.kakatech.com/wp-content/uploads/2009/03/nokia-5c-battery-2.jpg

[9] BOM & BUDGET https://drive.google.com/file/d/0B335P8x_QjXqTGFnTnFuZ2s0ZUU/view?usp=sharing

# THANKS!