Project on the design of an inertial measurement unit to be used in aerospace vehicles

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola Tècnica Superior d'Enginyeries Industrial i Aeronàutica de Terrassa

Oriol Casamor Martinell

Directors : Joseba Quevedo and Manel Soria

Escola Tècnica Superior d'Enginyeries Industrial i Aeronàutica de Terrassa

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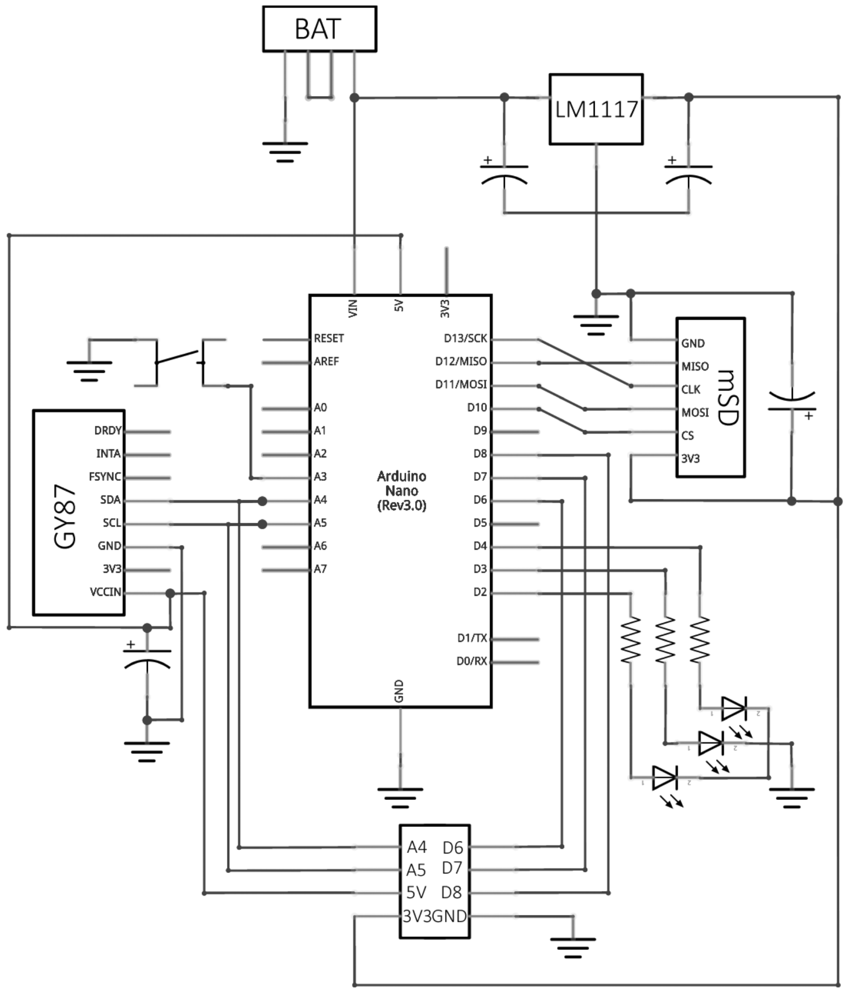
Electronic scheme of the board



Appendix B

Board User Manual

1 Board setup

The only parameters that should be modified in the board software are the following parameteres.

```
#define timeout 20 X
#define AFSR Y
#define GFSR Z
```

X is the maximum time for a logging file. When the specified time has elapsed after starting the recording, it will automatically end it.

Y is the FSR of the accelerometers

Z is the FSR of the gyroscope

Y and Z parameter should be set according to Table 1.1.

Table 1.1: Sensor FSR values

Value	Accelerometers	Gyroscope
1	± 250 deg/s	± 2 g
2	± 500 deg/s	± 4 g
3	± 1000 deg/s	± 8 g
4	± 2000 deg/s	± 16 g

2 Operation

In order to operate the board, the software can identify a long and a short click. Only with one button, it is possible to operate the board as shown in Figure 2.1. In order to store the data, a microSD card is used. This must be formatted in FAT16 and does not work with high capacity cards. In this project, a 1GB card has been used. In order to properly process data, calibration files have to be from the same sensors than the measurements.

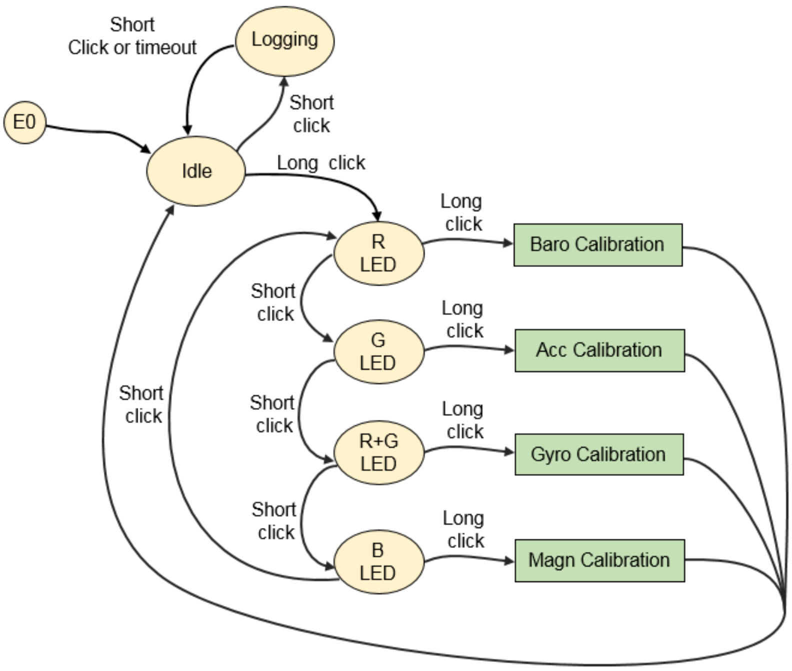


Figure 2.1: Finite state representation of the board software - End user version

Appendix C

Electronic analysis of the board

1 Introduction

Having seen all the difficulties that have arosed during the development of the electronic board, it has been considered interesting to perform a complete analysis of the board signals and power with an analog and digital analyzer.

2 Hardware

In order to perform this analysis, a logic analyzer with analog capabilites has been used. Saleae Logic Pro 16, shown in Figure 2.1. Specifications of this device are shown in Table 2.1. A logic analyzer is a device that allows for recording digital and analog signals. This is used in order to decode protocols, debug, or data logging for example.

Figure 2.1: Saleae Logic Pro 16

FEATURES	
Inputs (A/D)	16
Max. Digital Sample Rate	500 MS/s
Fastest Digital Signal	100 MHz
Supported Logic Levels	1.2-5.5V
Max. Analog Sample Rate	50 MS/s
Bandwidth (-3 dB)	5 MHz
ADC bits	12
Input Voltage Range	-10V to 10V

Table 2.1: Saleae Logic Pro 16 Features

3 Analysis

In order to perform the complete analysis, all channels related to the microSD card, sensors and power were monitored, this is,

- I2C bus (sensors), SDA and SCL
- SPI bus (microSD), MISO, MOSI and CLK and ChipSelect
- Input voltage
- 3.3V Regulated output
- 5.0V Regulated output

This can be seen in Figure 3.1, in which a a screenshot of the Saleae acquisition software is shown. The setup of the measurement analysis is shown in Figure 3.2.

The analysis was done considering the first edition of the PCB and the second one. In the case of the first PCB, the tests were carried using a 10uF capacitor between 3.3V and GND next to the microSD card and without it. The board was powered by means of a laboratory power supply instead of the batteries. What can be seen at first glance with the global image of the signals is that when the microSD is writing, the sensors are not being used. This is an inconvenient in order to have a regular sample rate.

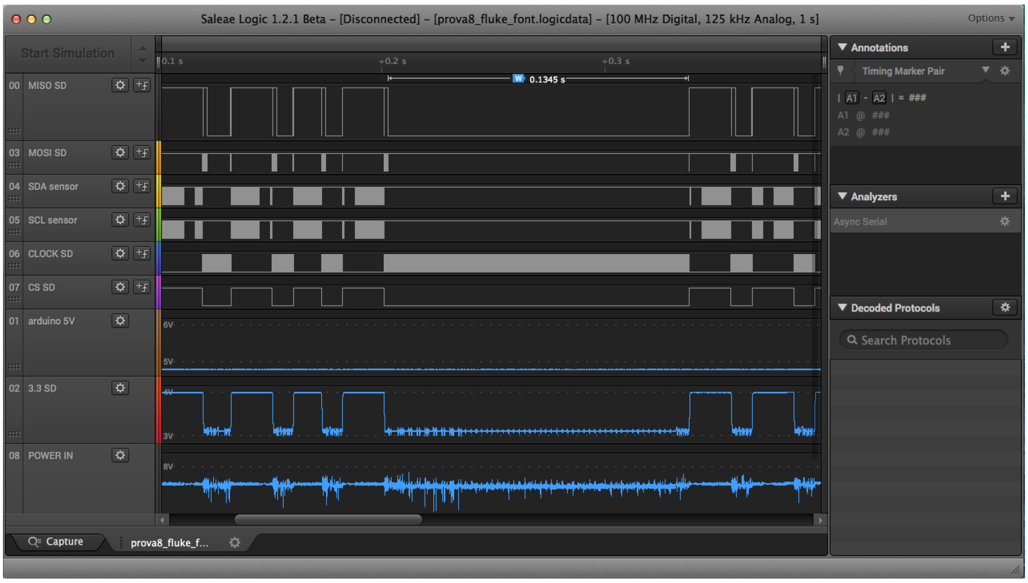


Figure 3.1: Saleae software screenshot

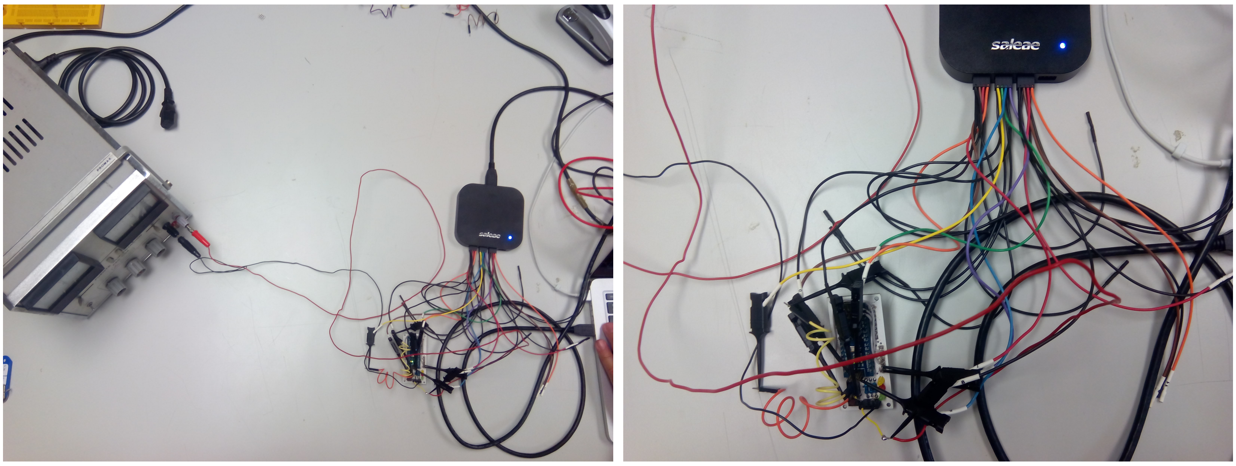


Figure 3.2: Picture of the setup for the analysis

The first thing that can easily be seen is how irregular is the data flow to the microSD card. In Figure 3.3, it is seen that the microSD card does not work continuously. When the ChipSelect signal is LOW, the card is writing. Approximately, every 30 ms the storage device is being used about 20 ms. However, it is easily seen that this times are very irregular. In addition to this, when the microSD card is writing, the supply voltage of the card drops from 4V approximately to 3V. However, the 3.3V regulator was chosen so that the voltage should be always 3.3V. This is clearly an important issue of the hardware that should be checked in future versions.

In addition to this, it is seen in the timeline that sometimes the writing time is extremely long, as seen in Figure 3.4. The reason for this situation has not been solved.

Regarding the effect of the capacitor in the circuit, the voltage drop with the component and without the component can be compared, as shown in Figure 3.5. In both cases, the board was powered with a voltage of 8V. It is seen that the voltage drop is almost the same regarding the initial and final value, however the transient response has a higher time constant in the case of the capacitor being used, as expected. Nevertheless, it seems clear that with this configuration is not possible to avoid the problem. The solution should consider an improvement on the combination of the voltage regulator, the capacitor, and the data flow of the microSD card.

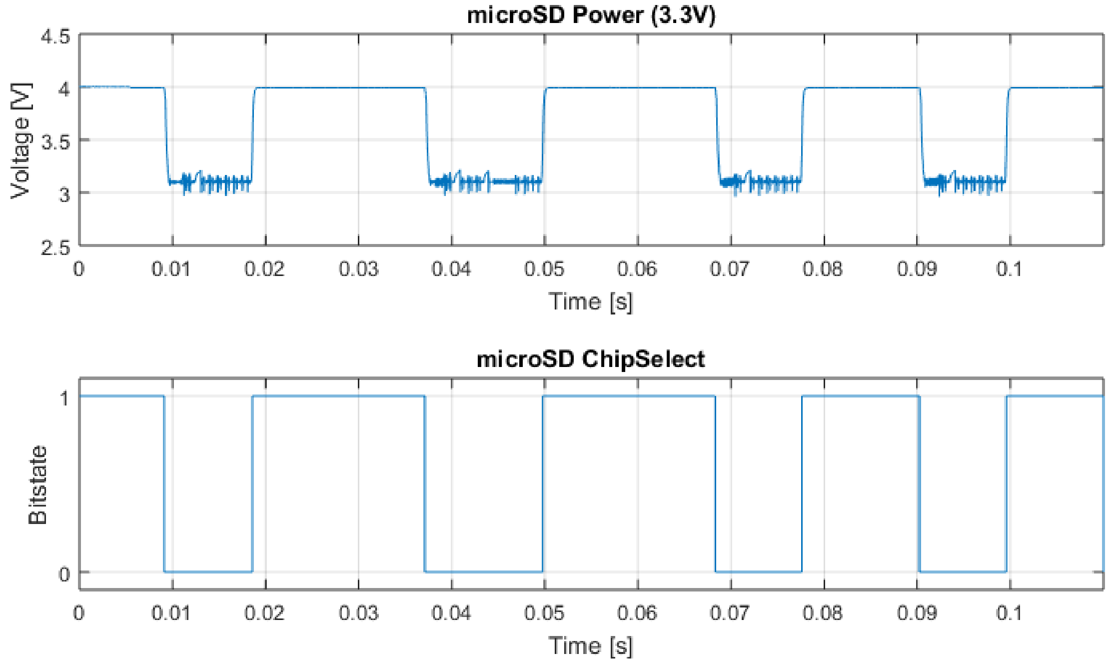


Figure 3.3: Writing to microSD card

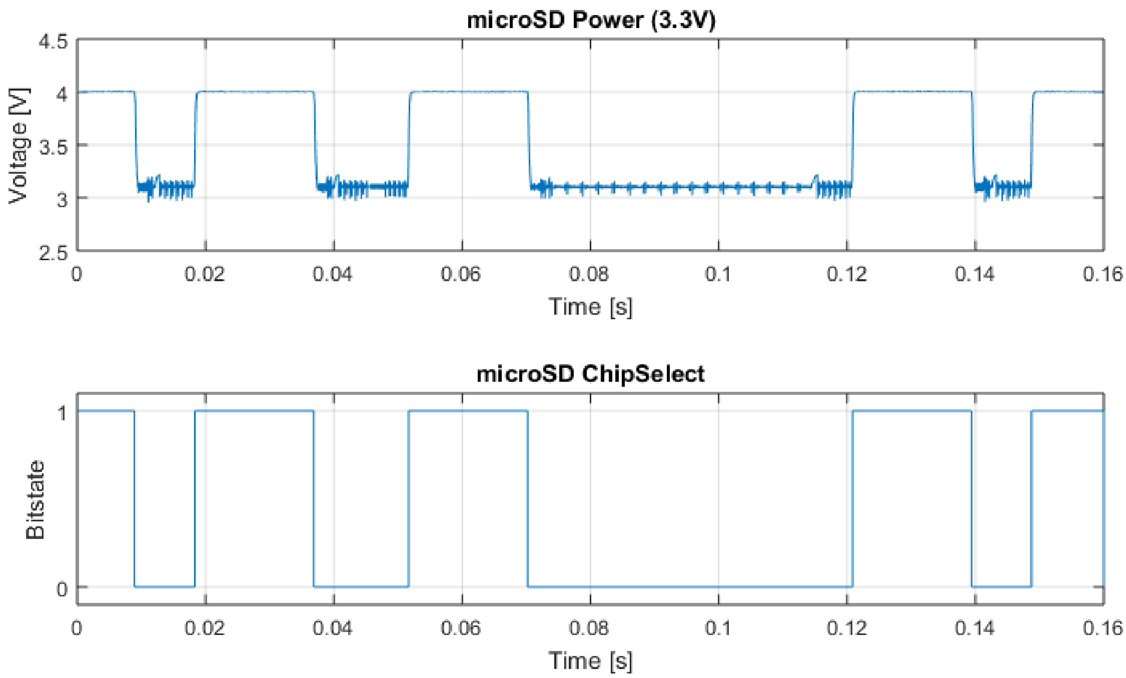


Figure 3.4: microSD writting irregularity

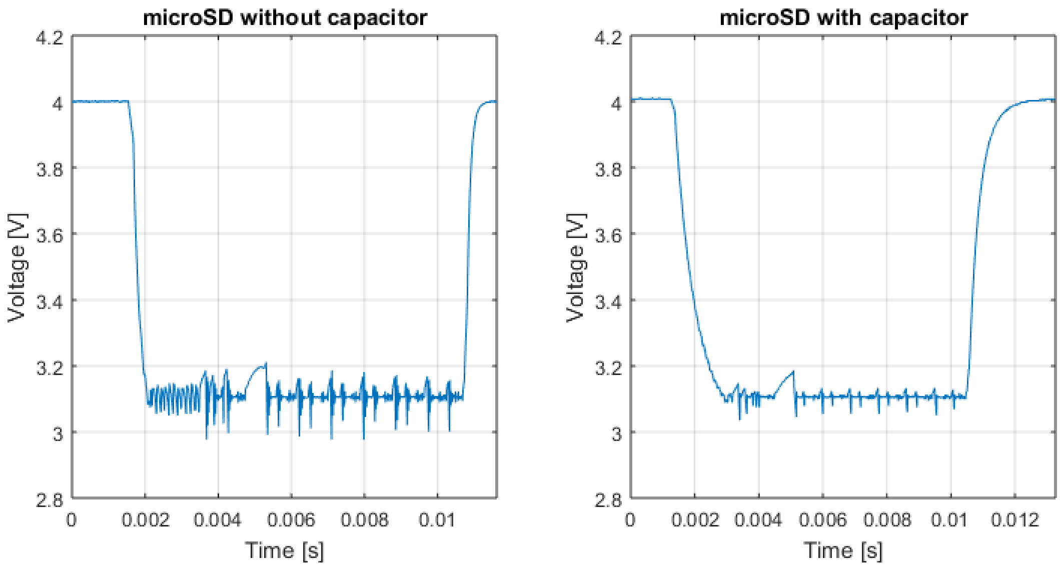


Figure 3.5: Comparison of the voltage drop

4 Conclusions

With the analysis carried out, some conclusions can be drown,

- The modifications in the design of the second version of the PCB have not solved the problem with the power supply of the microSD.
- The data flow to the microSD card is not constant at all. In addition to this, the period of the writing and the duration of it are irregular.
- When the microSD is being written the sensors are not being read, which makes the sample rate not constant in all the log.
- The design of an embedded circuit board requires hard design, many iterations and experience. Despite the bad results in the electronic test, the results of the experiment itself are satisfactory, as it is explained in the conclusions of the memory.
- Arduino is not always an easy support to develop projects, specially when the requirements of it considering speed or performance are crucial.