Data Logger For Mechanical Systems

TEXAS A&M UNIVERSITY at QATAR

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Mentor:
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Outline

- Introduction: Abdulrahman
- Literature Review and Fall Tasks: Yasmin
- Detailed System Design - Programming: Faisal
- Detailed System Design – PCB Design: Mohammed
- Testing/Prototyping and Conclusion: Abdulrahman

Introduction

- Problem Statement

Dumb tool

+our product

Smart tool

Citations 1-2

Literature Review and Fall Tasks

Market Analysis – Customer Needs

- Two personal interviews and one phone interview

- Focus on:
  - Rotation is desired
  - Prioritize accuracy

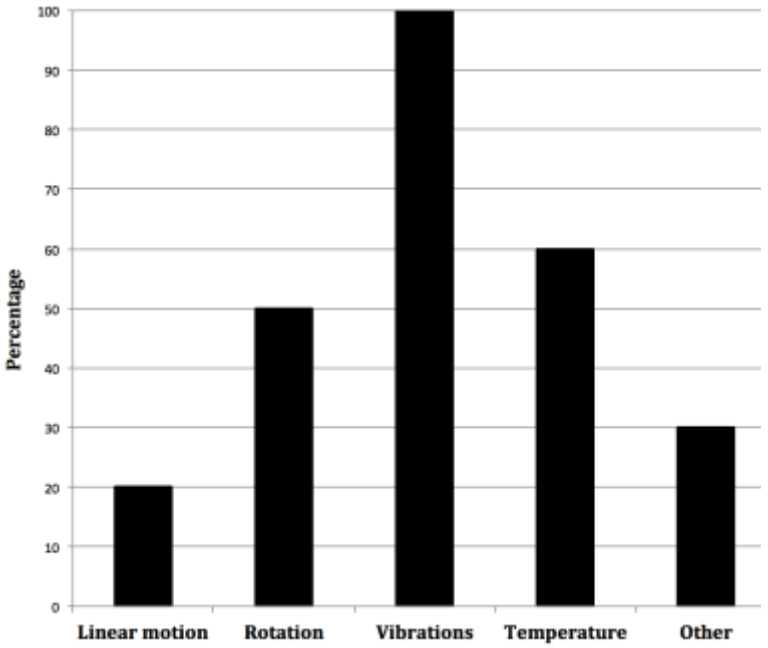


Figure 1

Market Analysis - Ethnographic Study

- RasGas and Schlumberger visits.
- Background information about mechanical tools.
- Focused on down-hole tools used in the oil & gas industry.

Market Analysis - Benchmarking

Table 1: Comparison between our project and an existing product

Metric	Our Design Project	H.E.A.T Evaluation Module
Power Source	9V battery	3.3 V External Supply
Dimensions (LxWxH)	7x2x1 inches	15.6x1x0.93 inches
Data Type	Tilt angles	Rotation, pressure, temperature
Memory	32 KB	32 MB
Acquisition Frequency	Up to 100 Hz	Up to 128k Hz
Connectivity	Serial to USB	CAN

Citation 3

Functional Modeling

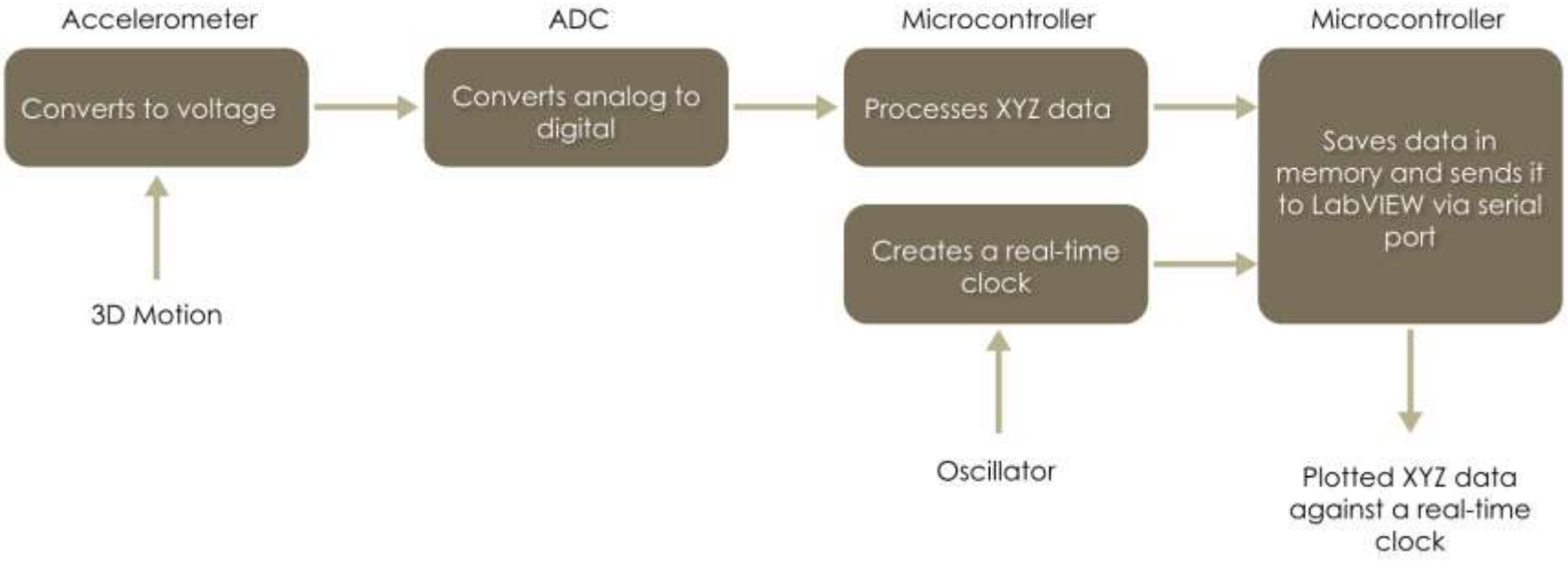


Figure 2

Top-level Model

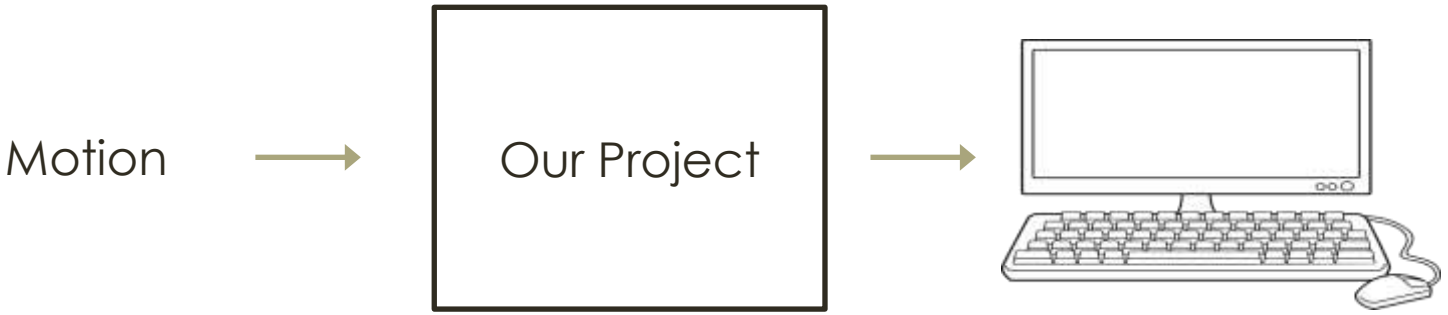


Figure 3

- Software: Abdulrahman and Faisal
- Hardware: Mohammed and Yasmin

Detailed System Design

Programming

Programming – Flow Chart

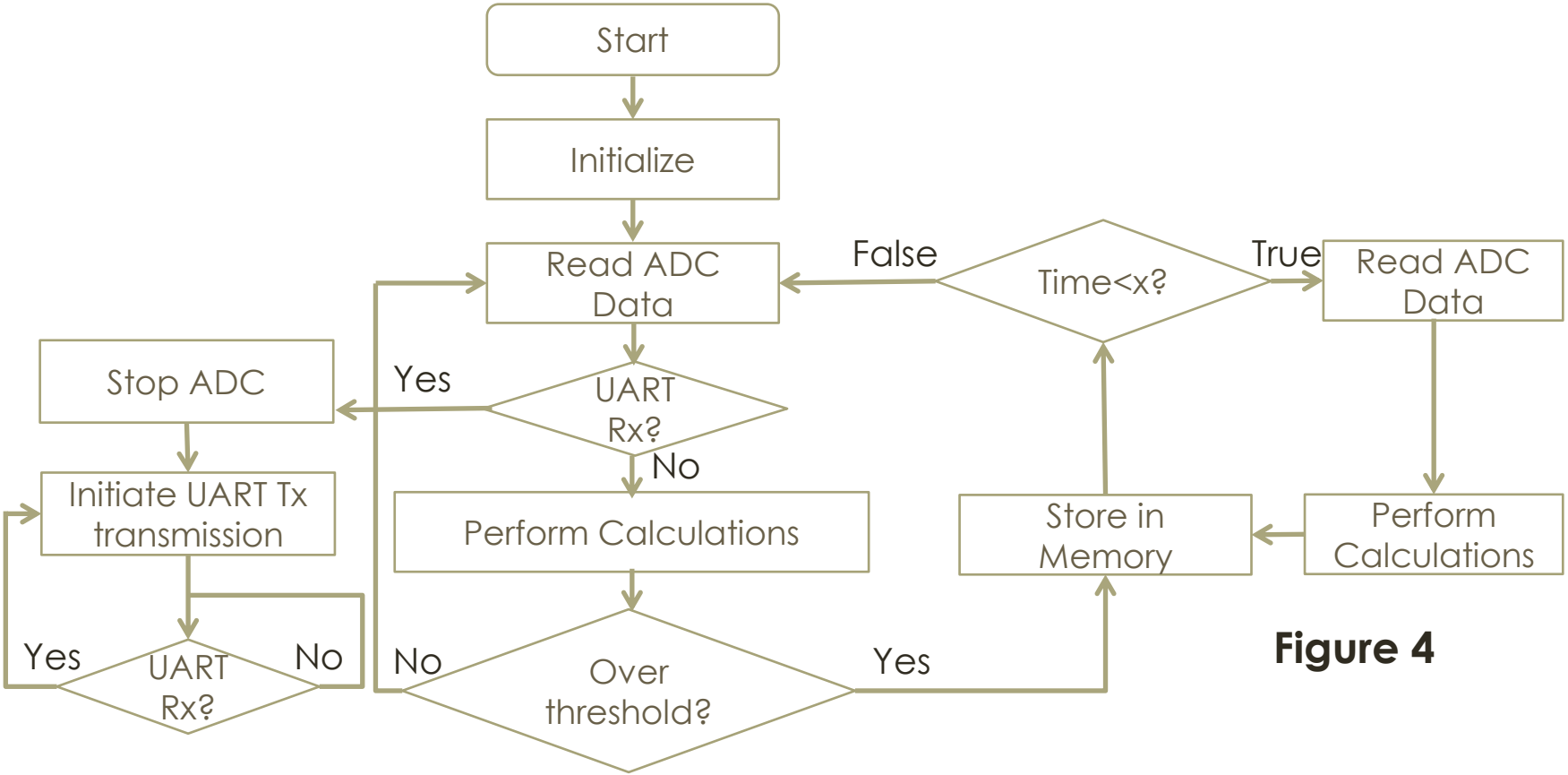
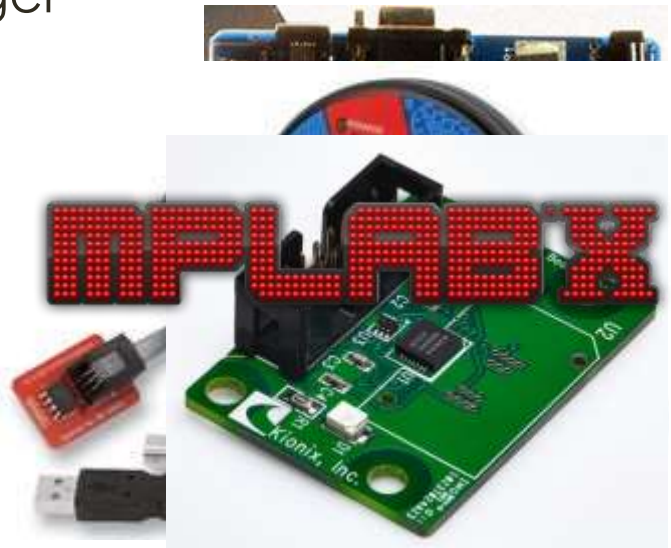


Figure 4

Development Environment

- **Hardware:**
  - dsPIC33FJ
    - dsPICDEM Starter Development Board
  - MPLAB ICD3 In-Circuit Debugger
  - Kionix KXD94 Evaluation Board
- **Software:**
  - MPLAB X IDE
    - XC16 Compiler



Programming – RTC

- Real-Time Clock for “Time-Stamping” logs
- Uses an External oscillator of 32.768Khz
- Interrupt Based
- Accurate to 100ms (HH:MM:SS.U)

Programming – ADC/Saving

ADC:

- Analog to Digital Conversion using dsPIC built in ADC unit
- 3 Channels: Ch0 for X, Ch1 for Y, Ch2 for Z
- Sampling rate up to 100 Samples/Sec

Saving Routine:

- Using the dsPIC 32KB memory to save up to 2500 readings
- Each reading includes:
  - accelerometer value (X,Y,Z)
  - Time Stamp (Hour, Minute, Second, Millisecond)

Programming – Send/Receive

- UART RS-232 Connection to the PC
- At 19200 Baud Rate
- Interrupt based
- Received signal initiate transmission/sending

Programming – Threshold Mode

- ±1.5g< Acceleration in any axis starts the logging process
- “Shake to Log”
- Real-life application, sudden change of velocity
- Bump against a wall/ Hitting an obstacle/ sudden stops
- Logs after threshold for a specified period of time

Programming – Call Graph

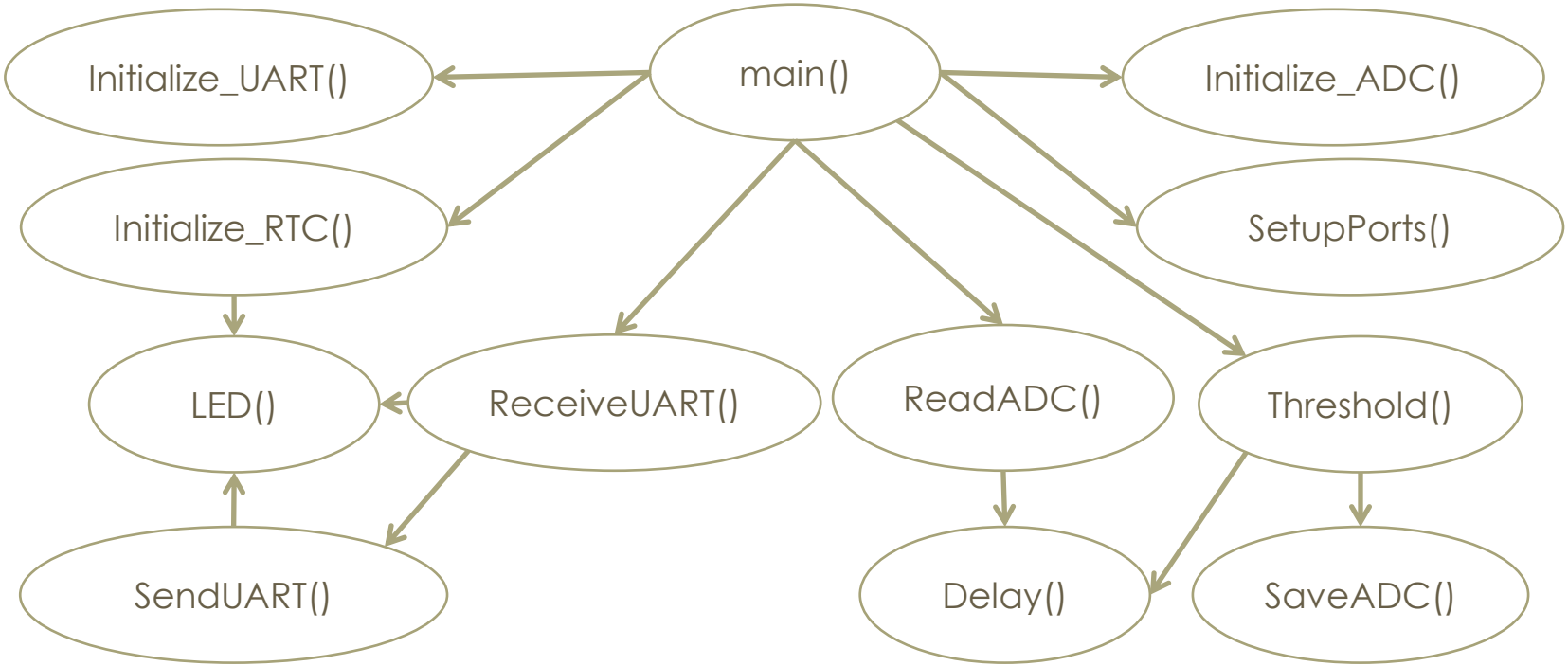


Figure 5

Detailed System Design

PCB Design

Components

Table 2: Components used in the project along with the budget			
Parts Description	**Quantity**	**Unit Price**	**Total**
dsPIC33FJ256GP710a processor	1	$9.37	$9.37
Terminal blocks	7	$12.93	$90.51
Crystal Oscillators	2	$0.36	$0.72
Push buttons	3	$5.11	$15.33
LEDs	6	$0.19	$1.14
RS232 chip	2	$2.34	$4.68
Serial port	2	$2.44	$4.88
Connectors	2	$0.93	$1.86
Full-bridge rectifier	2	$0.69	$1.38
Capacitors (22p, 33p,0.1u, 0.47 u, 10u, 470u)	40	N/A	$355.48
Resistors (10, 100, 250, 410, 470, 4.7k)	28	N/A	$42.00
KXD94 and KXR94 accelerometer chips	4	$9.87	$6.00
QSTB40 diode	2	$0.90	$3.00
		Total	**$536.35**

Schematic

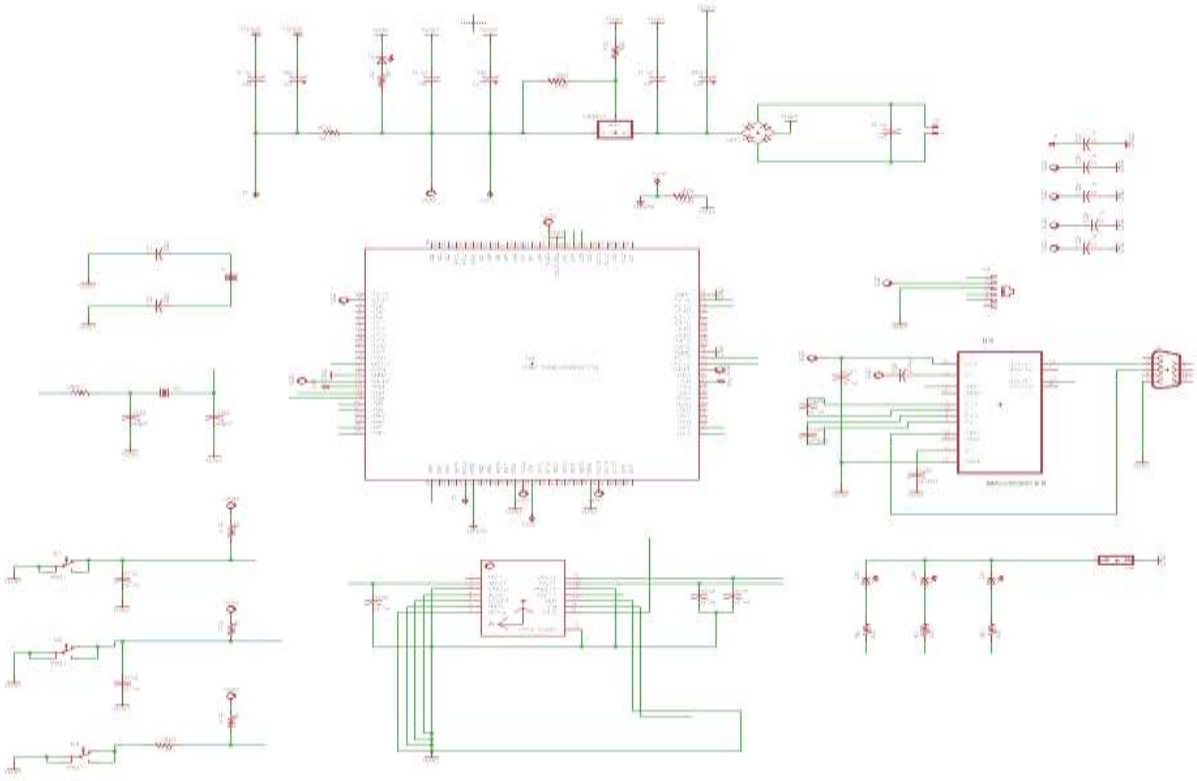


Figure 6a

Schematics – Processor

- DSPIC processor with100 pins
- Virtual connections

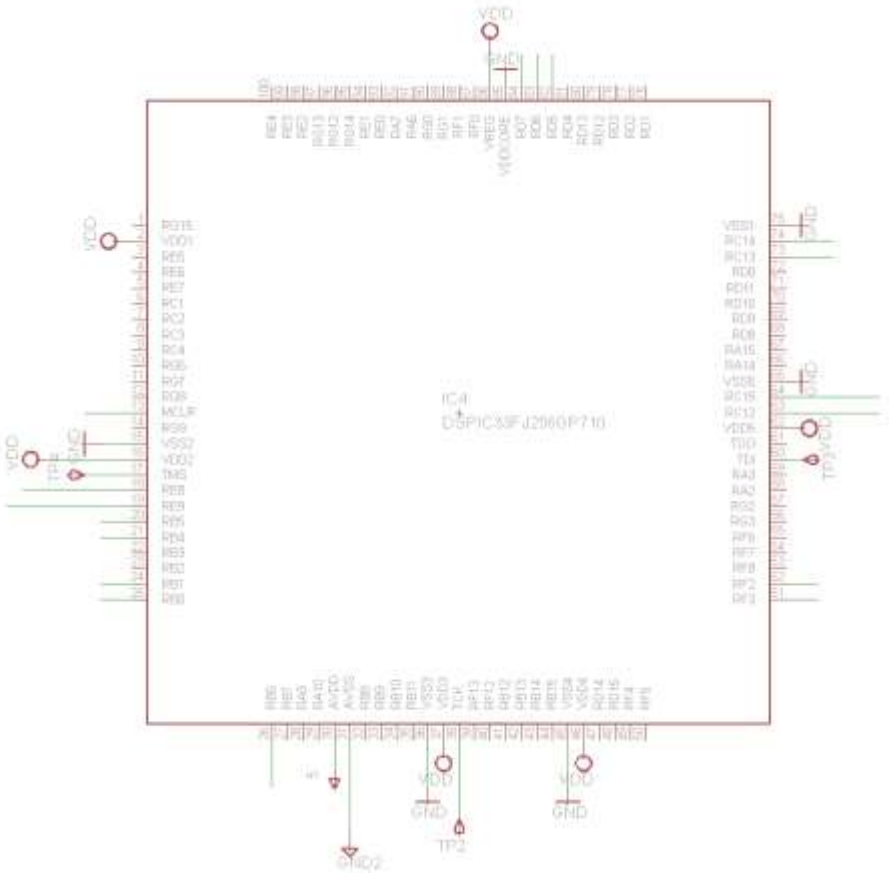


Figure 6b

Schematics – Power Supply

- 9V DC input voltage
- Filter capacitors
- Voltage regulator

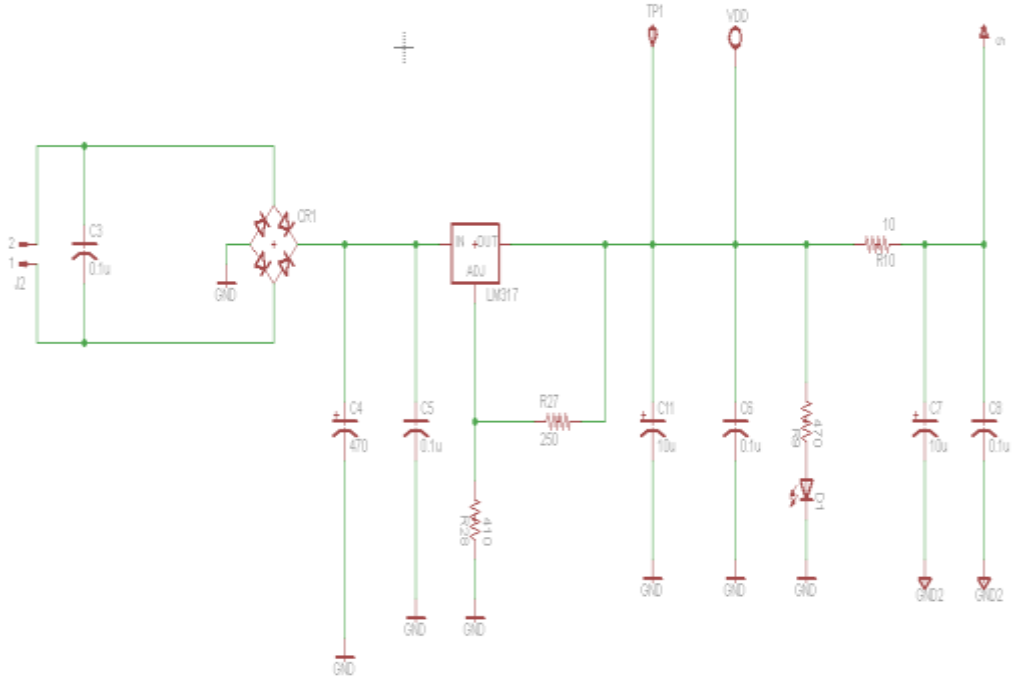


Figure 6c

Schematics – Oscillators

- Provide a stable clock signal for digital integrated circuits
- Operates at 32.7 KHz and 7.3 MHz

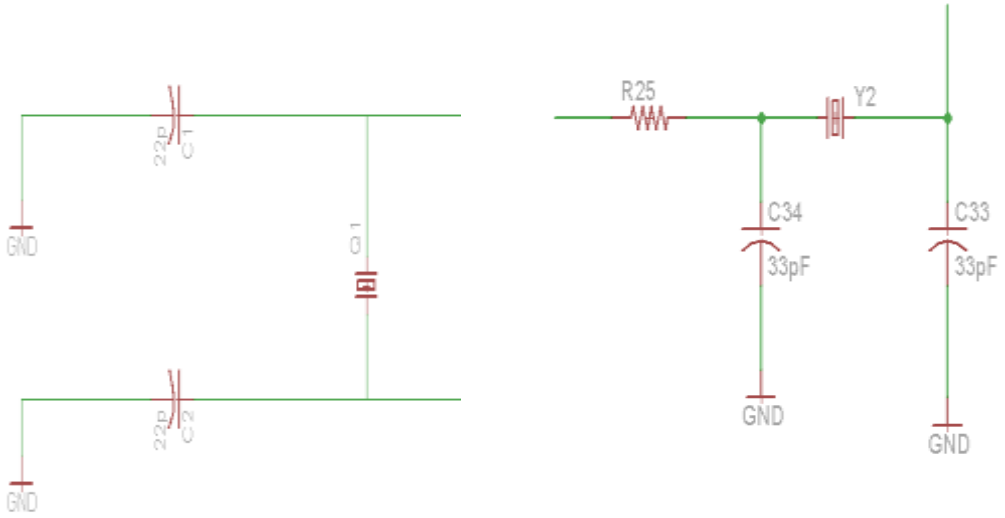
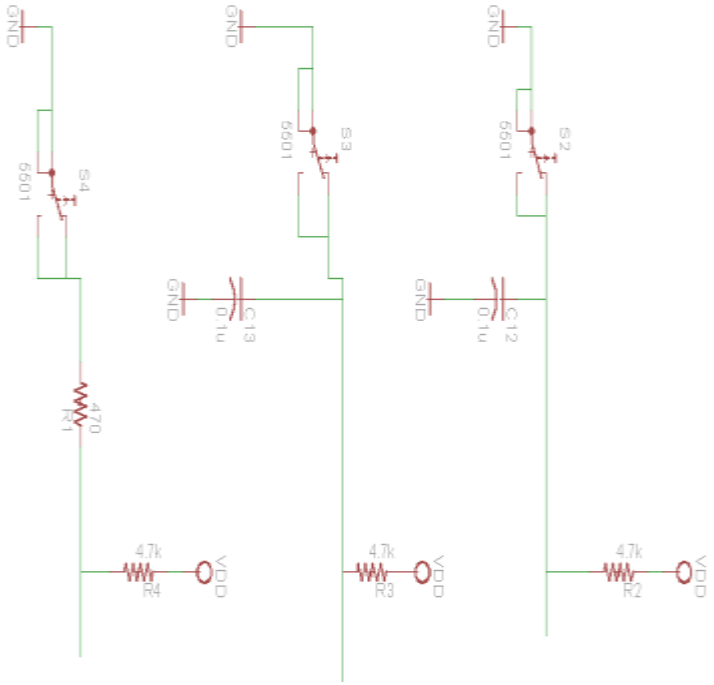


Figure 6d

Schematics – Push Buttons and LEDs



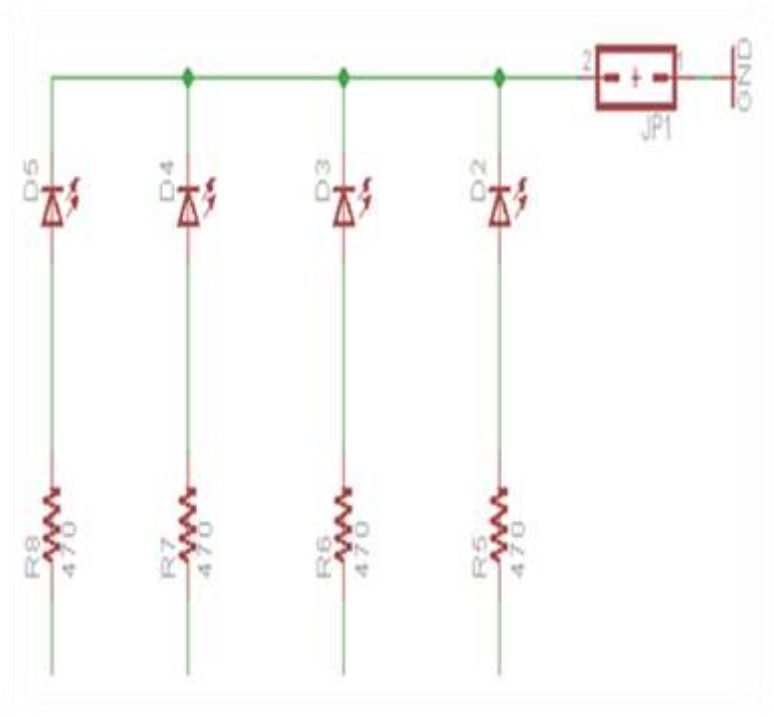


Figure 6e

Schematics – connectors

- Interface between an UART and the serial-port connector (RS232)
- RJ11 is used for debugging

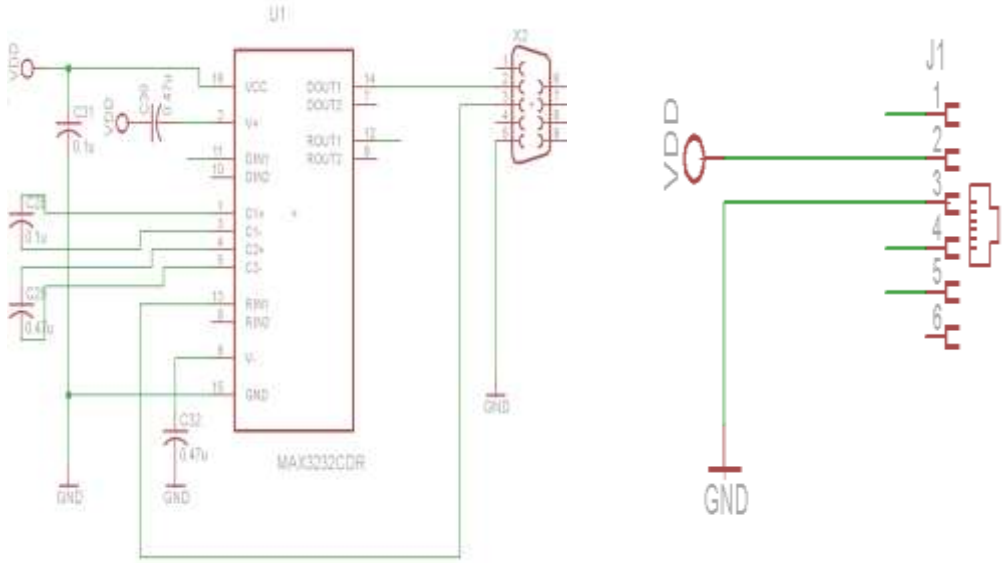


Figure 6f

Schematics –Accelerometer

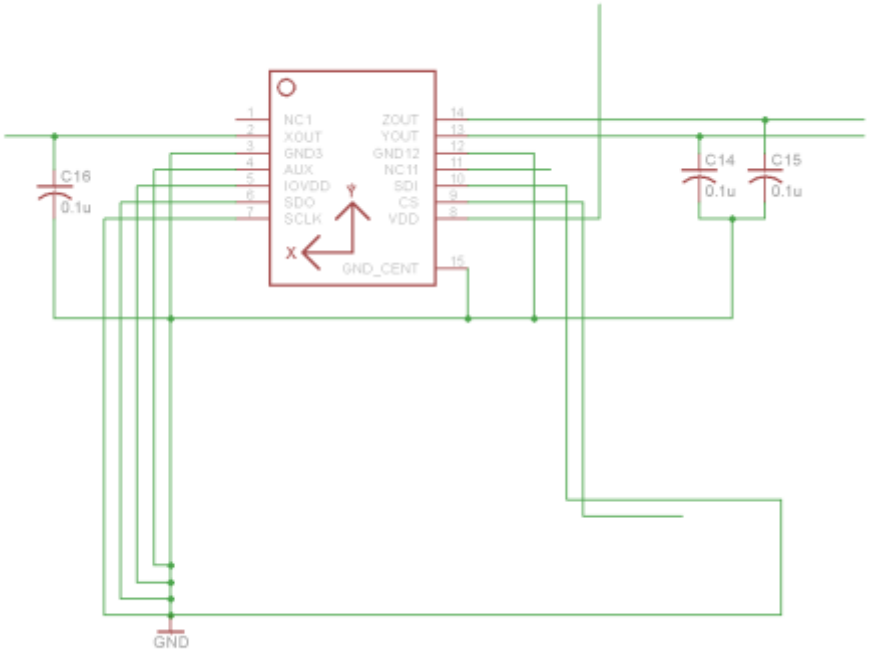


Figure 6g

PCB layout

- 1.27 mm and 0.3 mm width routings
- Two layers on the board

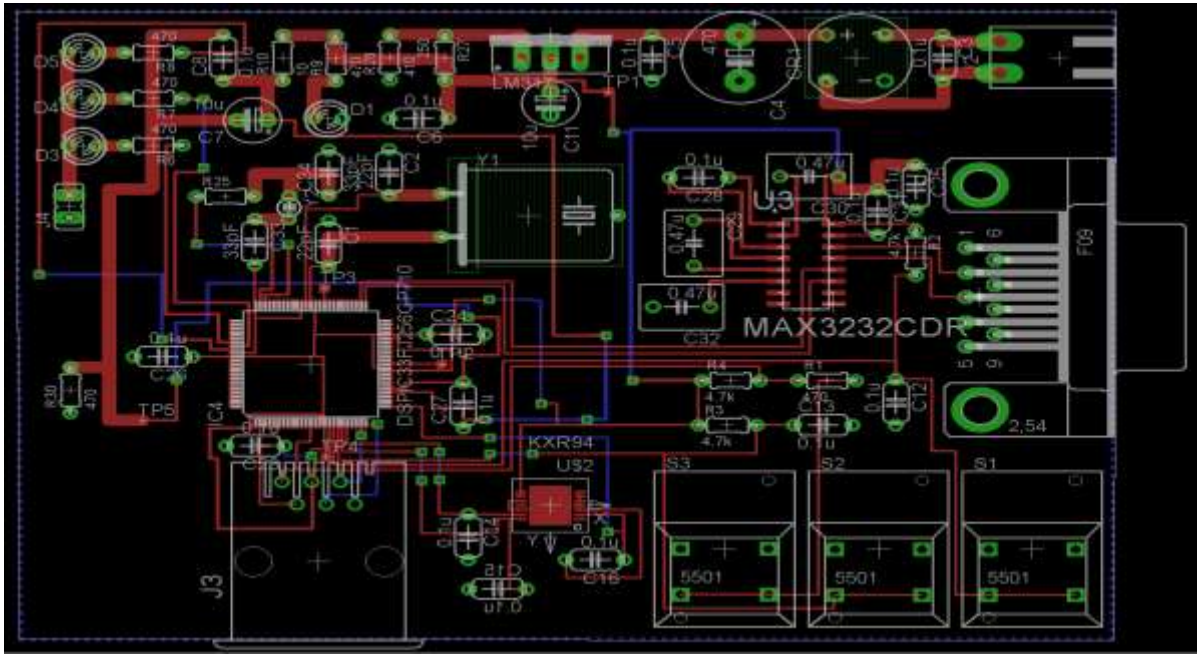


Figure 7a

Processor and Power supply

- Updated our plan and separated the board
- Three headers to connect this board with the other boards

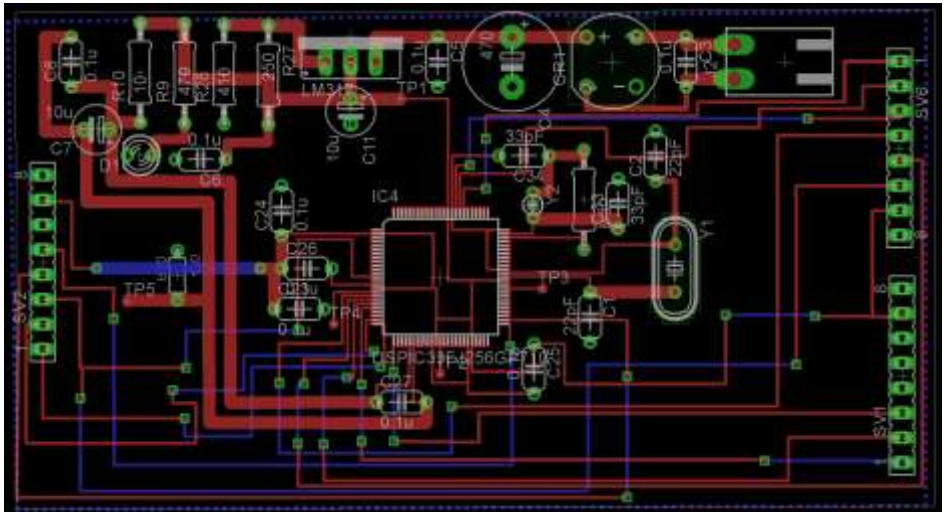


Figure 7b

Connectors

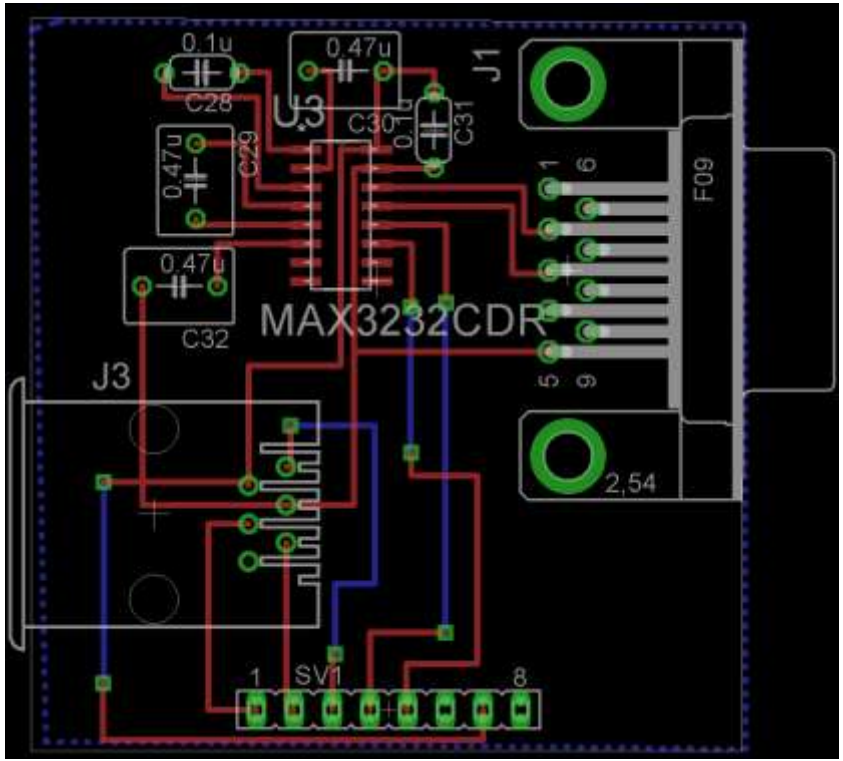


Figure 7c

Switches and LEDs - Accelerometer

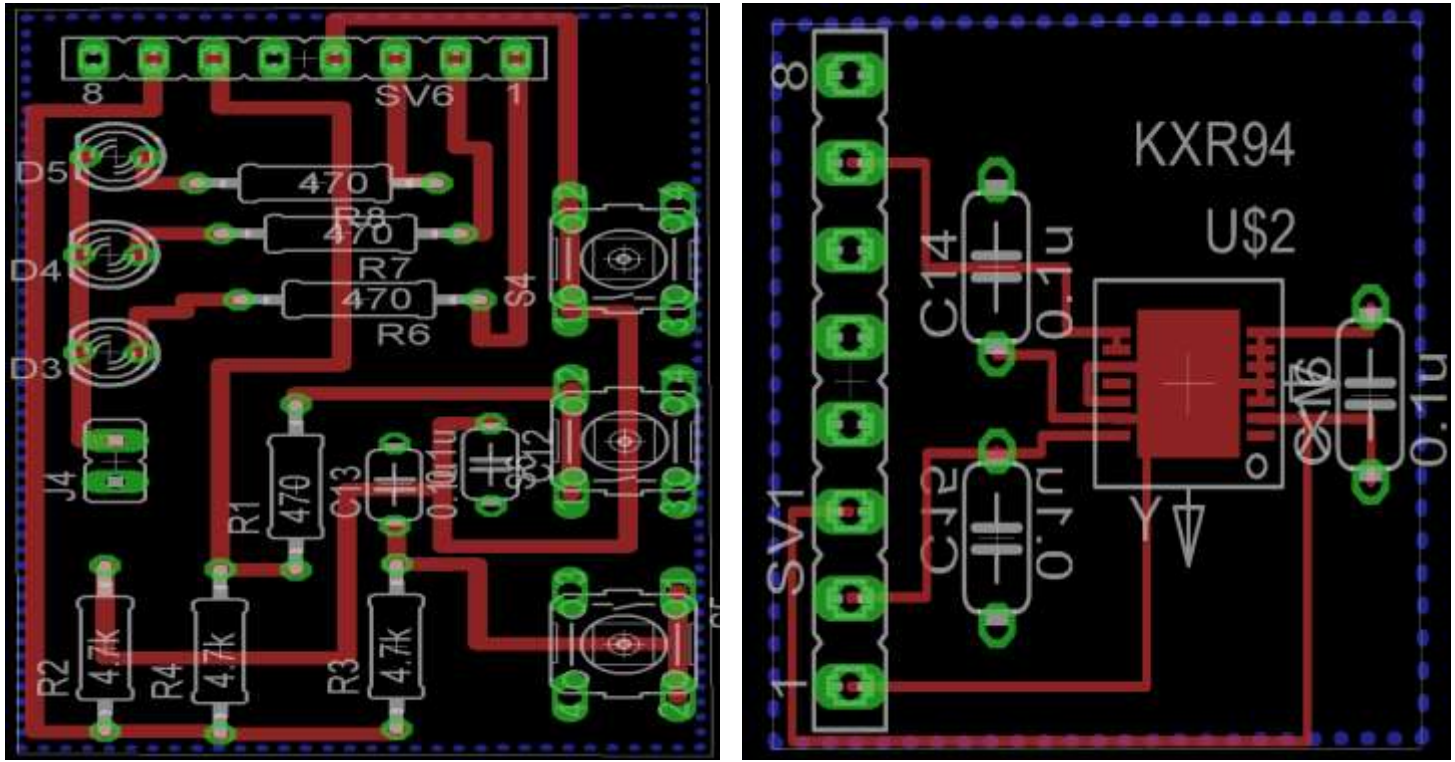


Figure 7d

Testing/Prototyping and Conclusion

Testing and Prototyping

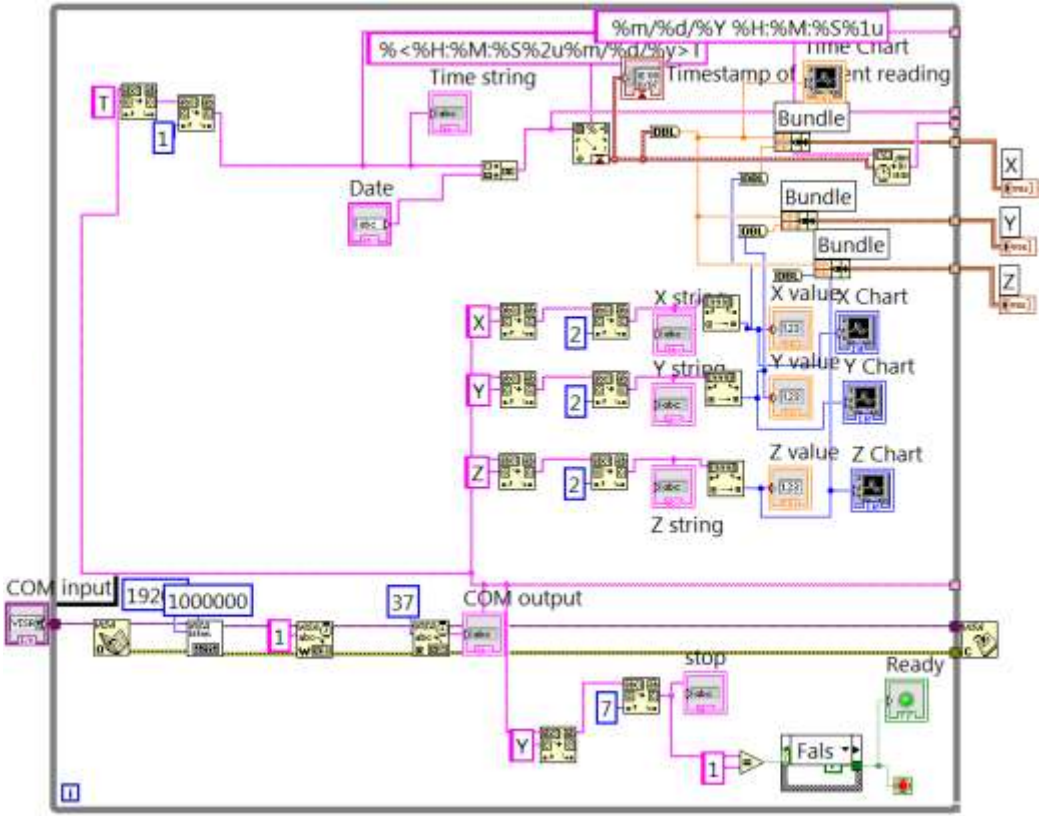


Figure 8

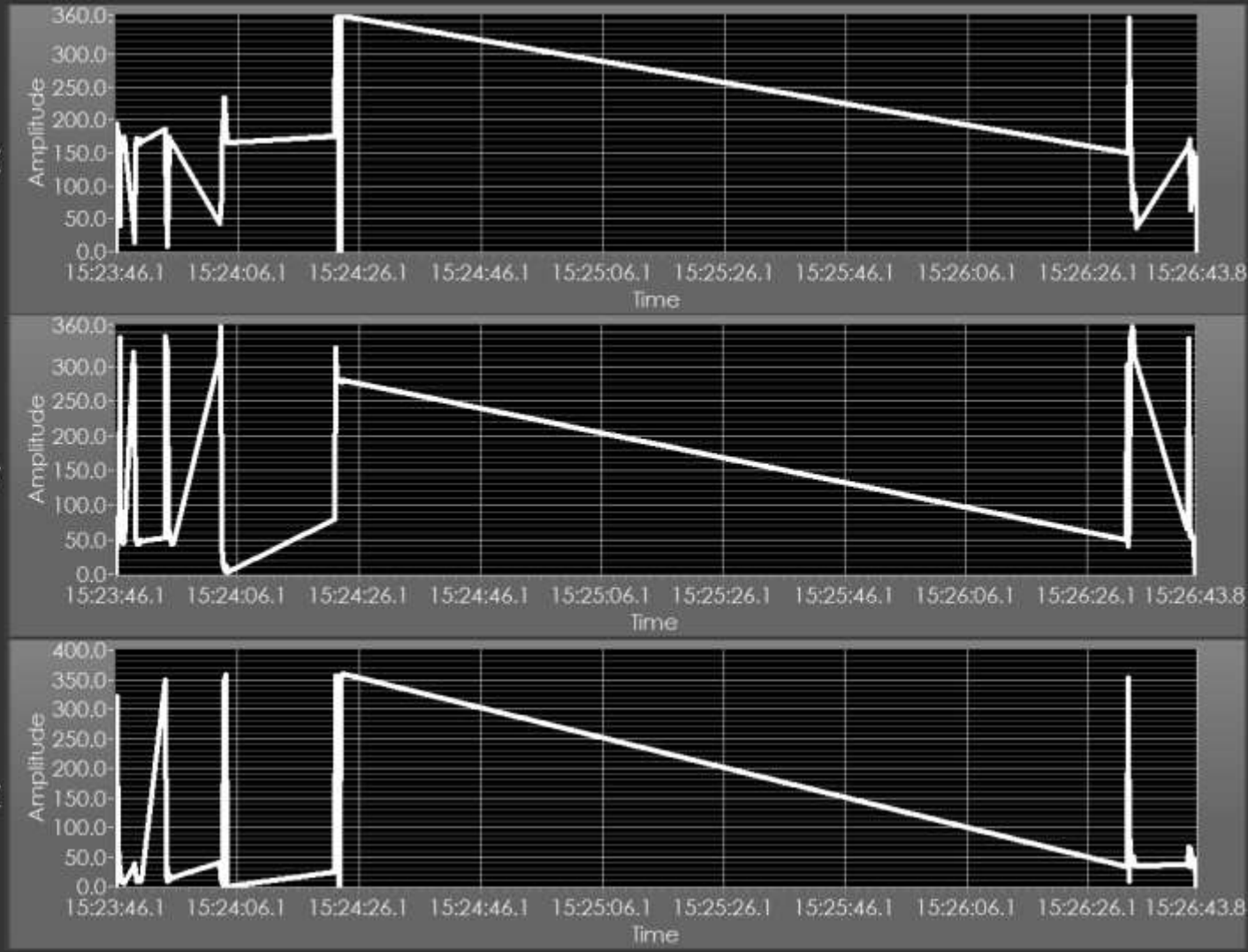
COM input

COM1

Ready

Timestamp of current reading

3:26:43.800 PM
4/26/2015



Conclusion

- Final specifications
- Demo Day plans
- Future work
  - Add more sensors
  - Single board design
  - More memory (EEPR
  - Harsh environment

Table 3: Project Final Specifications	
Power Source	9V battery
Dimensions (LxWxH)	7x2x1 inches
Data Type	Tilt angles
Memory	32 KB (25k samples)
Acquisition Frequency	10 Hz
Connectivity	Serial to USB

References

1. Downhole Tools Market Analysis, Size, Share, Trends and Forecast 2020 by Sandip Ghate
2. http://www.logwell.com/capabilities/downhole_tools.html
3. http://www.ti.com/tool/HEATEVM

Thank you for listening!

Any questions?