

ESD Assignment 1

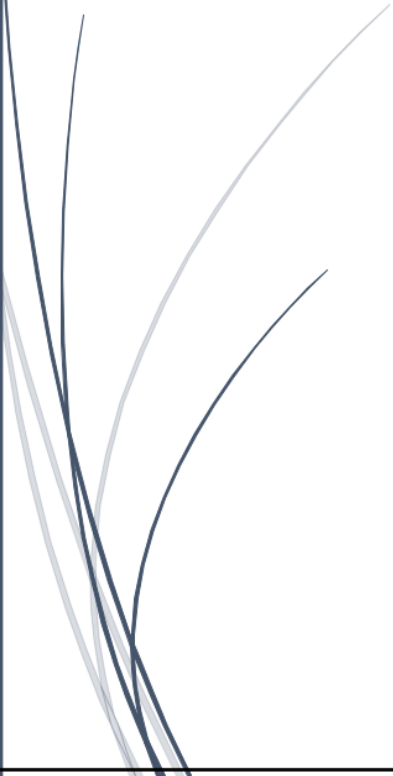
by John Davies

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11/26/2019

Electronic Design Systems



John (Jack) Steven Davies (P144338/1504731)
UNIVERSITY OF WALES TRINITY SAINT DAVID

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Introduction

This assignment will include the design of a microcontroller based automotive data acquisition system. The system will be intended to be fitted to a production prototype car, but will be designed to be re-useable, portable, affordable and adaptable for any class of vehicle. It will also be designed to be within safe limits and still provide a comfortable means of transportation and the data will be acquired during a two-hour test track simulation to provide;

- Engine Temperature
- RPM (revolutions per minute)
- Front and rear suspension travel
- Pitch, roll and yaw
- Vehicle speed

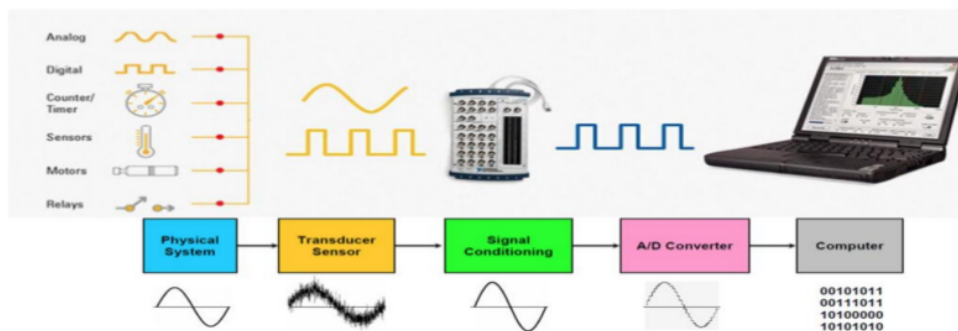
The system must have the following requirements;

- . The ability to store the data collection to a non-volatile memory, which can be externally read and cleared when connected to a pc via USB.
- . To be battery powered to ensure it has an external power source to that of which is in the vehicles power supply, none of the sensors will be connected to the vehicle's electronics.

Literal Review of VDAS

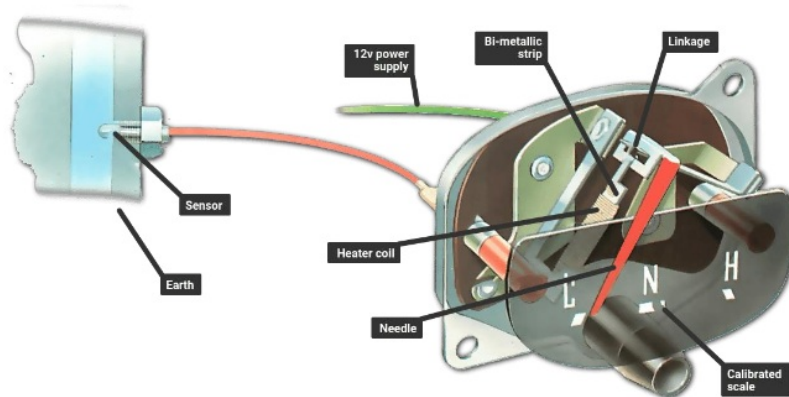
A vehicular data acquisition system (VDAS), is a interface between the sensors and the computer. The function of a data acquisition system (DAS), is to convert analogue based signals, coming from a sensor into a digital signal by using a A to D converter fed into the computer. The (DAS) measures the quantity in either physical or electrical circumstances like temperature, pressure, sounds, voltage, current etc. The sensor may also be a photo sensor, microphone, potentiometer, strain gauge etc. The signal may be required amplification after passing through the sensor.

The sensors convert the measuring signal into a unified form, which is then sampled by the (DAS). The sensor is connected to the (DAS) hardware which is connected to the computer via a universal serial bus or (USB). The (DAS) hardware is a microcontroller and a combination of A to D, D to A converters and multiplexers. There is drivers and software within the computer that analysis this data in the form of binary, which the data is then processed, measured and stored. (DAS) applications are made from C languages or java script, controlled by the computer. [1]



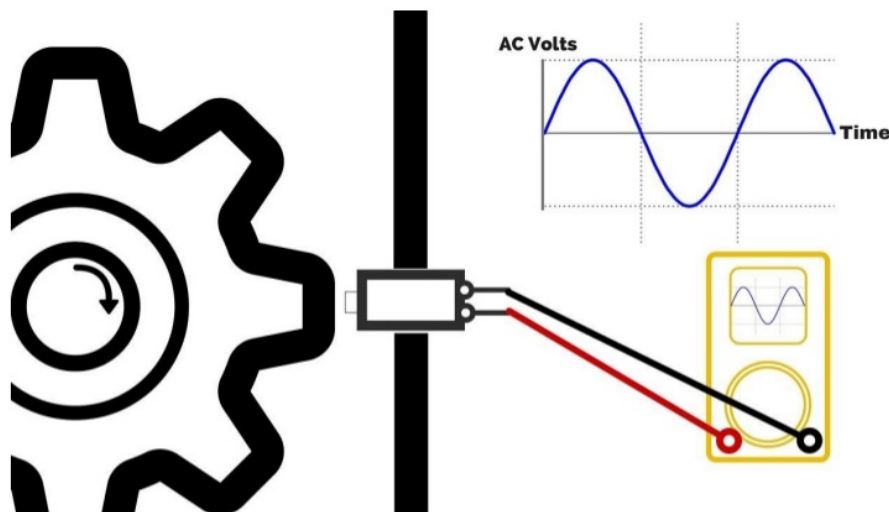
Engine temperature

There are several ways in which a person can measure the temperature of a vehicle engine. The most common are; Bimetallic gauges and sensors, although the engine temperature can vary depending on separate circumstances within the vehicle. Each element may be monitored individually such as, air temperature, oil, exhaust, coolant, brakes, water, tyres and fuel. Each can be monitored by their own sensors or gauges. With regards to sensors the most common engine temperature sensors are semiconductors, consisting of semiconductor element in a metal casual. Other variants include Capillary gauges, the older types of temperature gauges used a direct linkage between the sensor and the gauge to conduct the monetisation. [2]



RPM (Revolutions per minute)

RPM (revolutions per minute), is used to measure the engine speed, the faster the engine spins, the greater power generated. A typical device used for measure RPM is a Tachometer. Tachometers displays the measurement reading of RPM in thousands, i.e. the Tachometer displays the number 3, then the engine is turning at 3,000 revolutions per minute. Infra-red sensors are also used to measure RPM within a vehicle. [3]



[Gyroscope \(Pitch, Roll and Yaw\)](#)

[Suspension \(Front and Rear\)](#)

[Vehicle speed measurement \(MPH\)](#)

Data Loggers

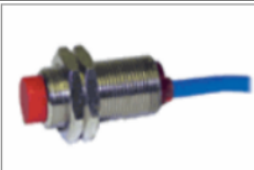
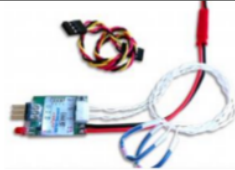
Sensors

Engine Temperature (-20 °C to +160 °C)

Brand	Autosen [4]	Ka sensors [5]	Process Parameters [6]	Omega [7]
Name	AT103 Cable Temperature Sensor PT1000	The KIR3 Series of Infra-Red Temperature Sensors	Optris CSmicro LT Miniature Infrared Pyrometer	Miniature Low-Cost Non-Contact Infrared Temperature Sensor/Transmitter
Temp Range	-30 °C to 180 °C	-20°C to +1000°C	-50 °C to +1030 °C	-18°C to 202°C
Voltage (Volts)	N/A	0V-5V (Adjustable)	0V - 5V – 30V	0V – 5V DC
Current (Amps)	N/A	N/A	N/A	4mA – 20mA
Sensor Connector	Wire end sleeves, grey 0.75 mm ²	50cm from Sensor to Electronics, 100cm from Electronics to Flying Leads, 55Spec, 26 AWG Cable + DR25 Sleeve	M12x1, 28 mm long, stainless steel housing, Rugged coated silicon optics	Packaged into a 19 mm OD by 89 mm Long Stainless-Steel Housing, Sensor and Transmitter Combined
Number of Cables	2	3	1	1
Accuracy	T05 = 6 s / T09 = 18 s	<±1.5°C FS	8 – 14 µm	3% of rdg or 4.4°C (8°F)
Cost £ (GBP)	£6.60	£400	£186.00	£204
Signal Type	Analogue	Analogue	Analogue	Analogue
Image				

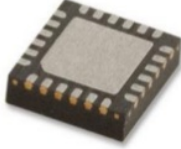
The sensor chosen is the; The Omega Miniature Low-Cost Non-Contact Infrared Temperature Sensor/Transmitter, as the designated main temperature sensor. It is a low-cost, high-performance infra-red sensor, with the abilities to be installed in small, hard-to-reach and confined areas and is able to overcome harsh environments, which it would no doubt come in contact with, inside the engine of a vehicle. It is also capable of making fast measurements and is compatible with various software's such as; data loggers, PLC's, computer boards and with no adjustments required during the use or the installation.

RPM (Revolutions per minute)

Brand	Reliability Direct [8]	Hydrotechnik [9]	T9hobbysport [10]
Name	P5-11 Proximity Sensor	RS110 Infra-red RPM Probe	RPM Smart-Port Sensor
Voltage (Volts)	5V – 24V DC	10V DC	4V – 10V
Current (Amps)	3mA	<30mA	25mA
Number of Cables	2	1	6
Number of pins	2	5	3
Frequency (Hz)	1,000	1,000	N/A
Output Range	1 – 60,000 RPM	500 μ s	1000rpm to 300000rp
Output Signal	Namur (DIN 19 234)	4 ... 20 mA	N/A
Cost £ (GBP)	£89.52	£100	£16.32
Image			

Why have you chosen this sensor....?

Gyroscope (Pitch, Roll and Yaw)

Brand	RobotShop [11]	Farnell [12]	Continental-Automotive [13]	VBox Automotive
Name	MPU6050 6 DOF Gyro Accelerometer IMU	ITG-3200 - MEMS Gyroscope	Inertial Sensor (6DoF)	VBOX Inertial Measurement Unit
Signal Range	$\pm 2 \text{ g}/\pm 4 \text{ g}/\pm 8 \text{ g}/\pm 16 \text{ g}$	$\pm 2000^\circ/\text{s}$	$(x/y/z) \pm 59\text{m/s}^2$	$0.5^\circ \text{ RMS}^* - 0.06^\circ \text{ RMS}^*$
Output Signal	32.768KHz	Various	N/A	400 Hz
Accuracy	$\pm 250^\circ/\text{sec}$ (dps), ± 500 dps, ± 1000 dps, and ± 2000 dps	$14.375\text{LSB}/^\circ/\text{s}$	$\pm 300^\circ/\text{s}$	$\pm 450^\circ/\text{s}$
Voltage (Volts)	5V	3.6V	7V – 17V	8V – 30V DC
Current (Amps)	3.6mA	$5\mu\text{A}$	150mA	150mA
Signal Type	Analogue	Digital	Digital	Analogue
Number of Cables	5	N/A	3	2
Number of Pins		24 pins	4 pins	N/A
Cost	£7.25	£7.23	£21.53	£150
Image				

Suspension (Front and Rear) (x4)

Brand	The Sensor Connection		
Name	LPPS-22 series linear potentiometer position sensor		
Accuracy	0.01mm (0.0004 inch)		
Voltage (Volts)	12V		
Current (Amps)	25mA		
Number of Cables	3		
Cost	£112.80		
Image			

Vehicle Speed Measurement (MPH)

Brand			
Name	digital, Speedo, odometer, KPH, MPH, sensor, cable, 3, wire,		
Distance	N/A		
Number of Cables	3		
Frequency (Hz)	1000		
Output Signal	N/A		
Voltage (Volts)	12V		

Current (Amps)	14mA		
Cost	£9.29		
Image			

Pic Selection



High performance PIC18 core with 8x8 Hardware Multiply

Flash Program Memory with self-read/write capability

256 Bytes of integrated EEPROM

Internal 48MHz Oscillator with USB Accuracy - Via Active Clock Tuning from USB Host

Enhanced Capture Compare PWM (ECCP) Module with up to 4 outputs

Integrated Temperature Indicator Module

Up to 25 Channel 10-bit ADC with Voltage Reference

2 Analog Comparators

5-bit Digital to Analog Converter (DAC)

MI2C / SPI Module (MSSP)

Enhanced Addressable USART Module

Charge Time Measurement Unit (CTMU) for measurement applications

25mA Source/Sink current I/O

2x 8-bit Timers

2x 16-bit Timers

Enhanced Power-On/Off-Reset

Low-Power Brown-Out Reset (LPBOR)

Programmable Brown-Out Reset (BOR)

PIC18F2xK50 (1.8V – 5.5V)

[14]

The Design

Memory Storage

Name	Time (seconds)	Bytes
Temp	150	2
RPM	15	1
MPH	15	1
Pitch	0.001	2
Roll	0.001	2
Yaw	0.001	2
Sus F-R	0.0001	2
Sus F-L	0.0001	2
Sus R-R	0.0001	2
Sus R-L	0.0001	2

Name	Time (seconds)	Bytes
Temp	15	2
RPM	1	1
MPH	1	1
P.R.Y. x3	0.001	2
Sus x4	0.0001	2

Total Current

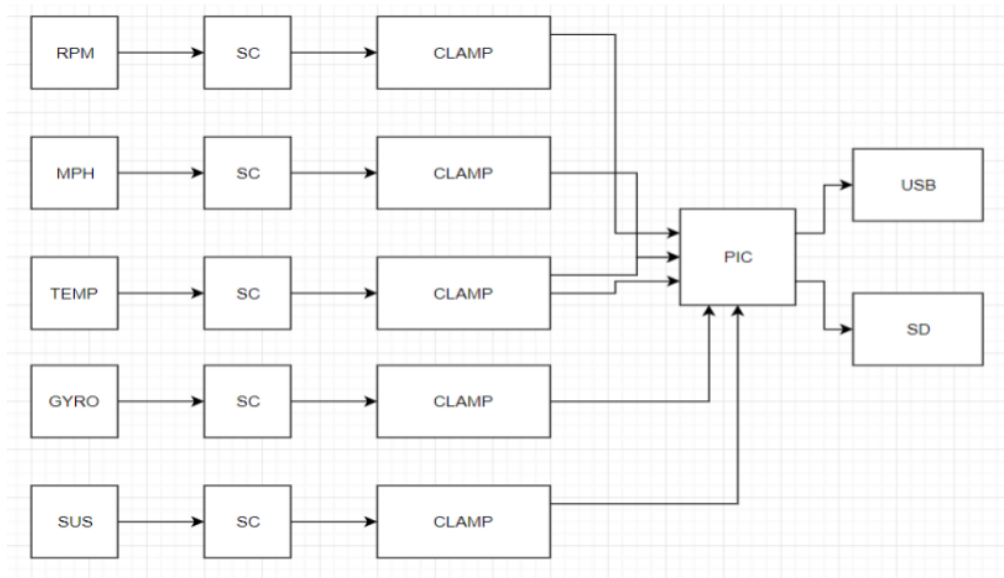
Name	Current (Amps)
Miniature Low-Cost Non-Contact Infrared Temperature Sensor/Transmitter	4 – 20mA
RS110 Infra-red RPM Probe	30mA
<u>VBOX Inertial Measurement Unit</u>	150mA
LPPS-22 series linear potentiometer position sensor	25mA
digital, Speedo, odometer, KPH, MPH, sensor, cable, 3.wire,	14mA
Total: 73mA	

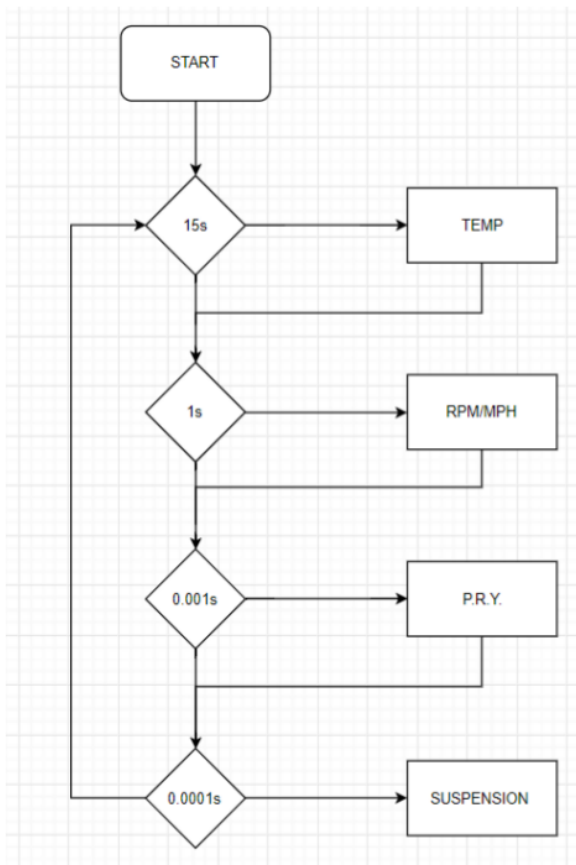
Total Voltage

Name	Voltage (Volts)
------	-----------------

Miniature Low-Cost Non-Contact Infrared Temperature Sensor/Transmitter	0V – 5V	Total: 12V
RS110 Infra-red RPM Probe	4V – 10V	
<u>VBOX Inertial Measurement Unit</u>	8V	
LPPS-22 series linear potentiometer position sensor	12V	
digital, Speedo, odometer, KPH, MPH, sensor, cable, 3, wire,	12V	

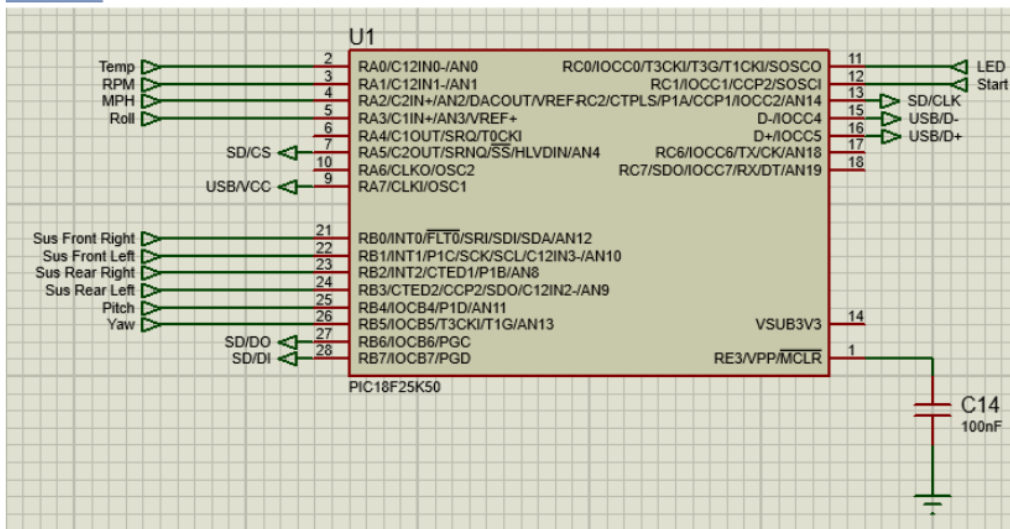
Diagrams

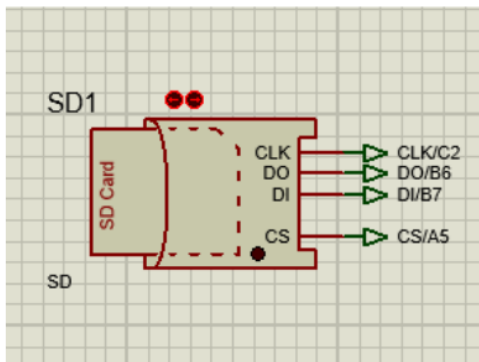
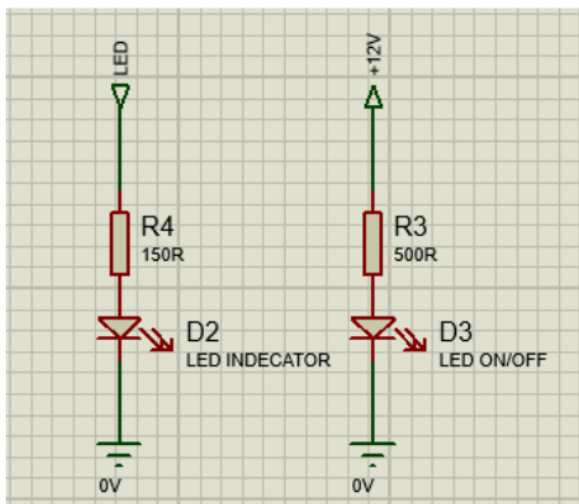
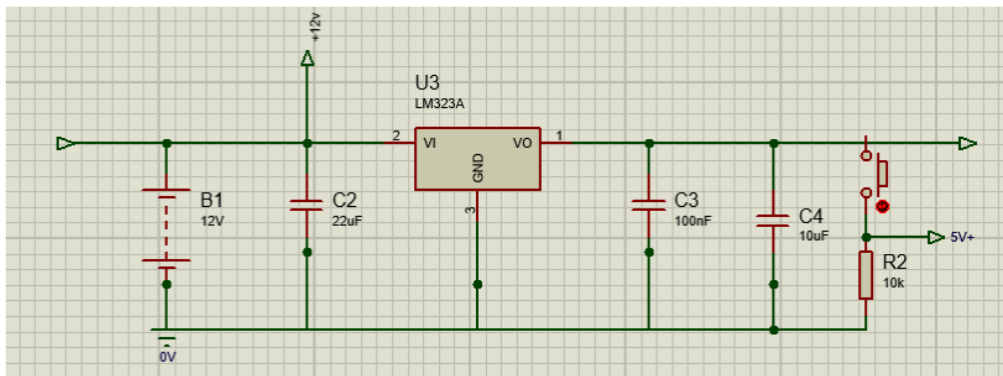


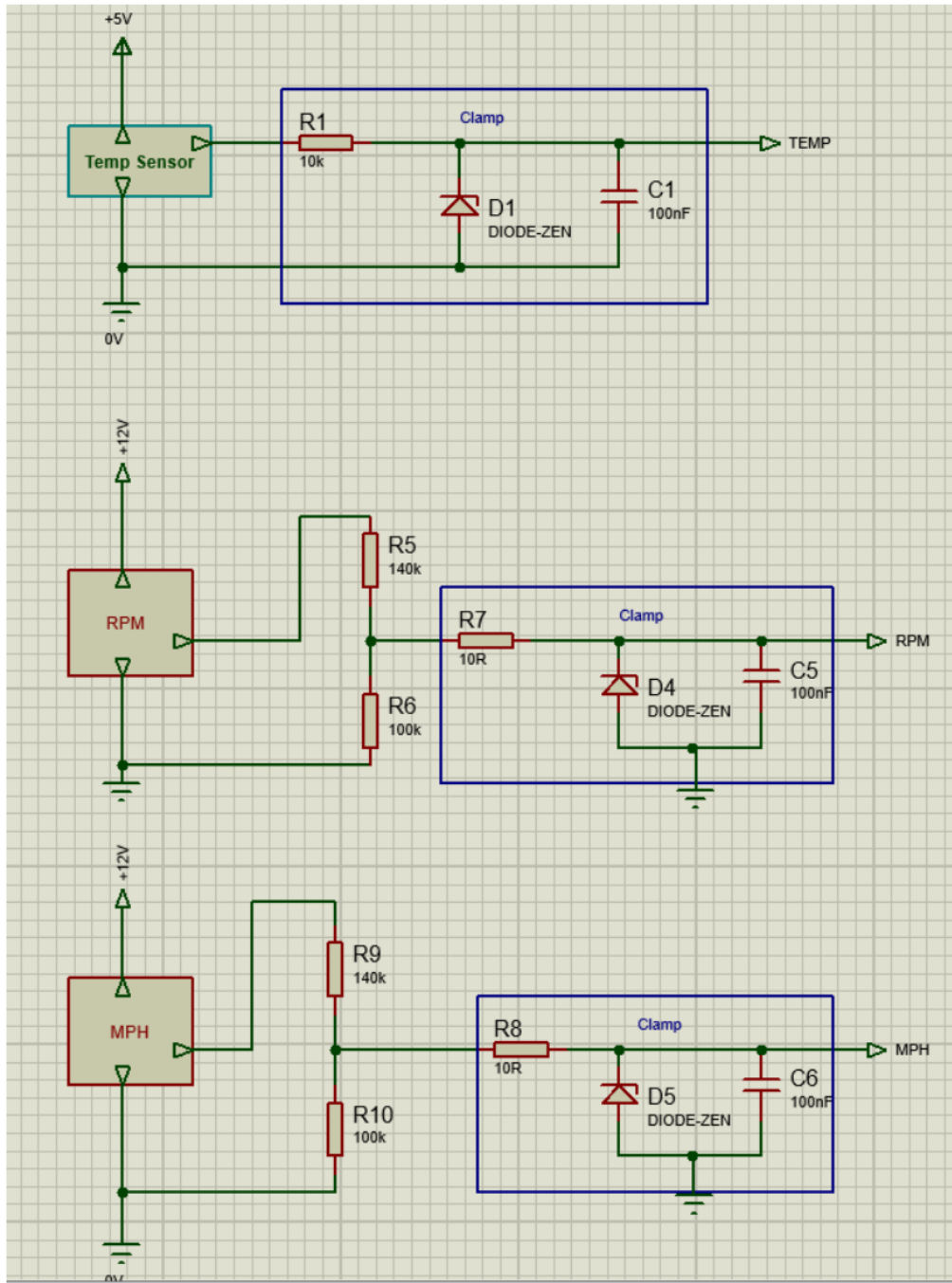


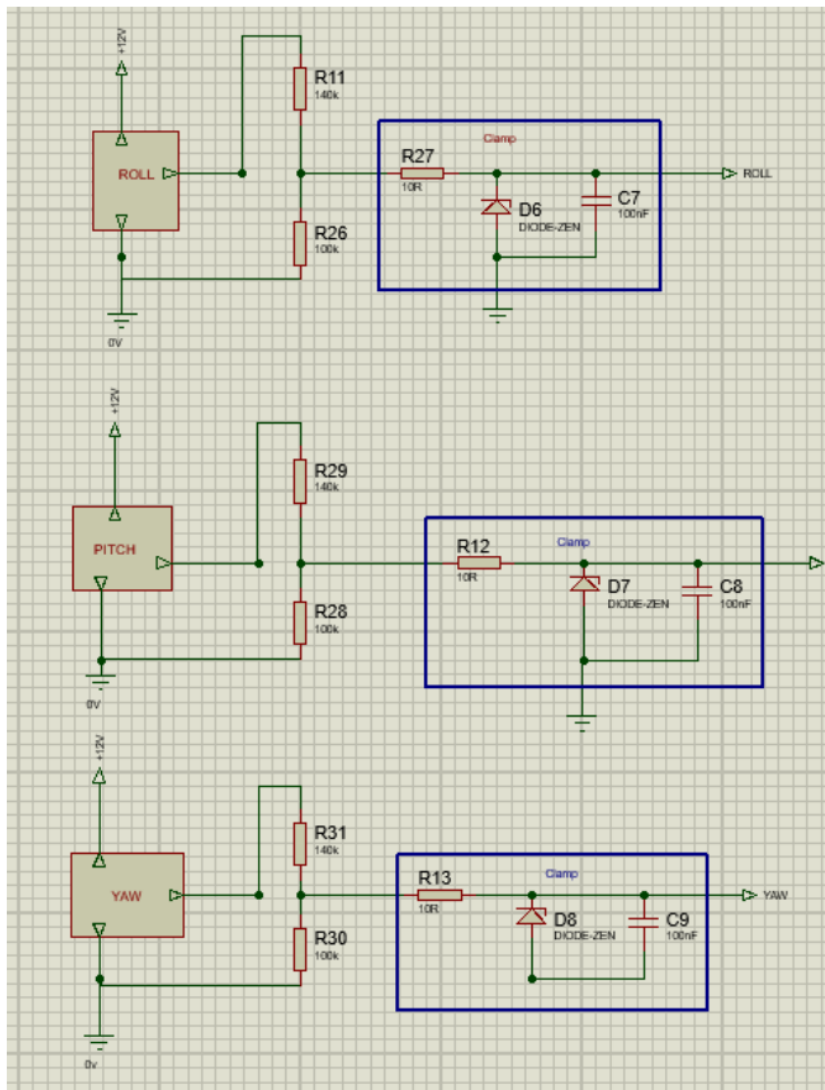
The Programs

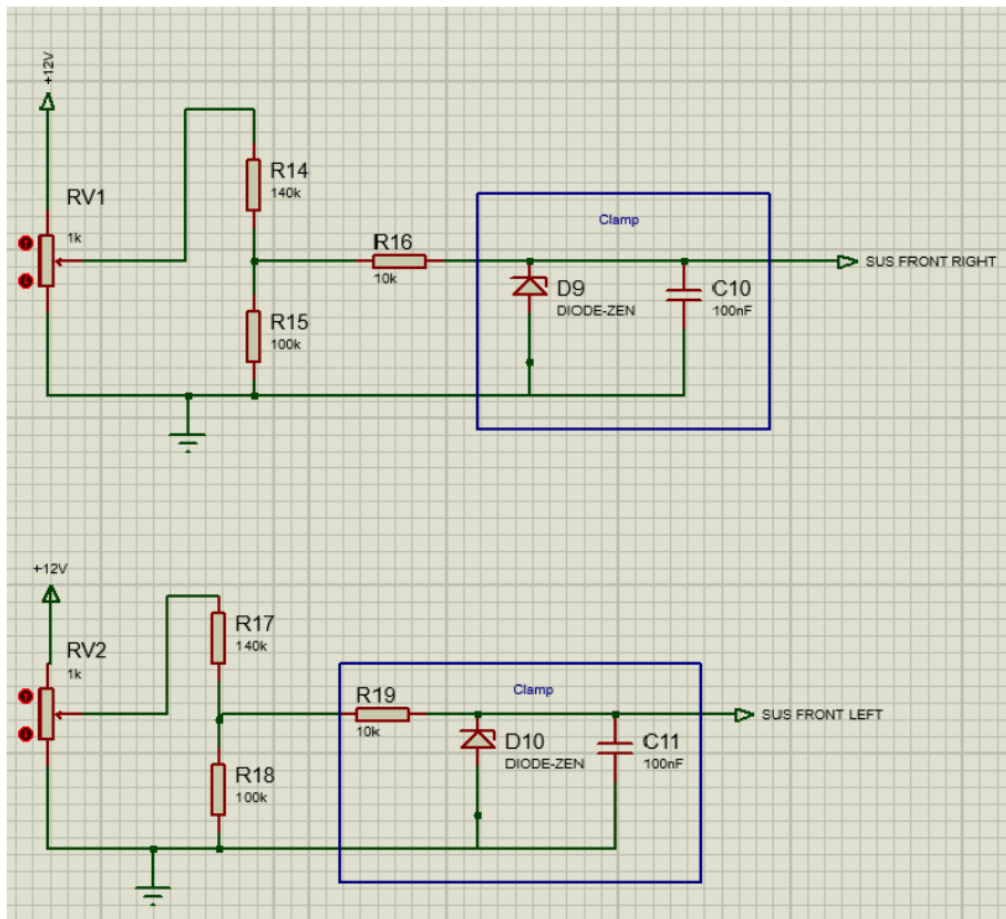
Proteus

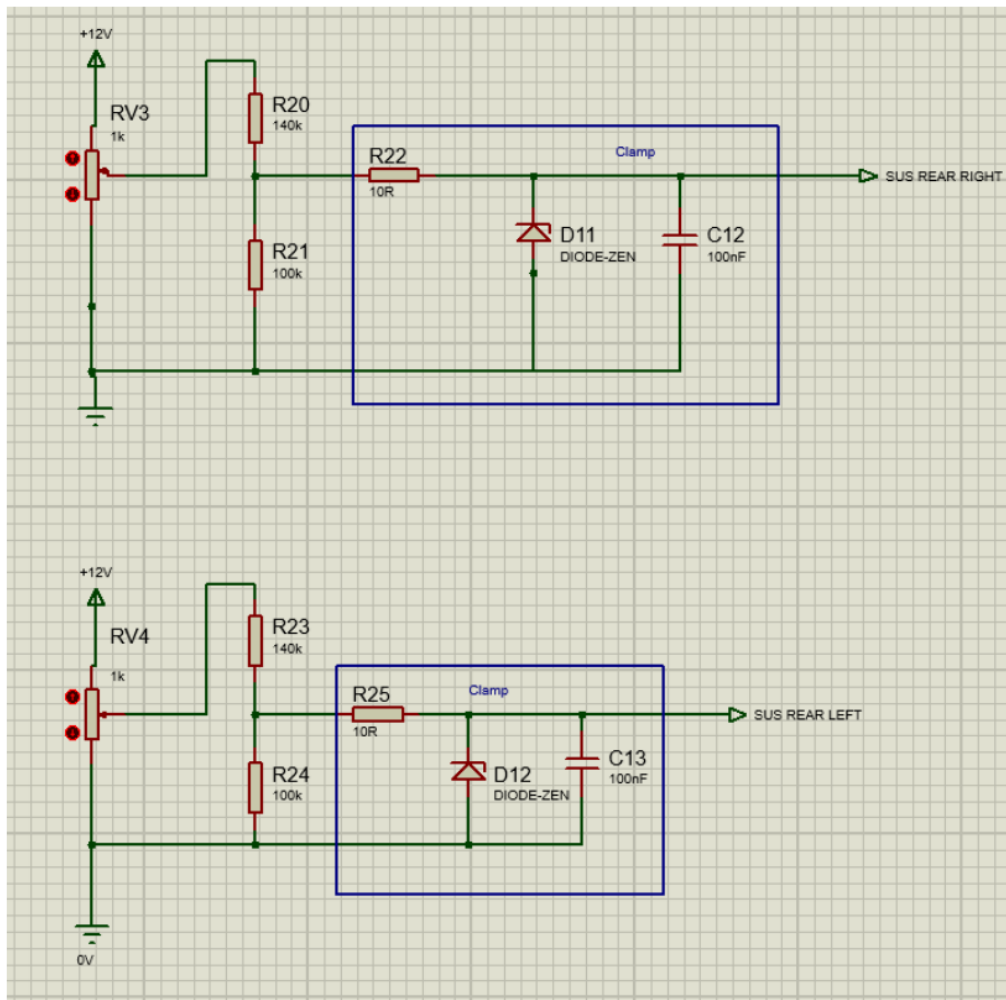




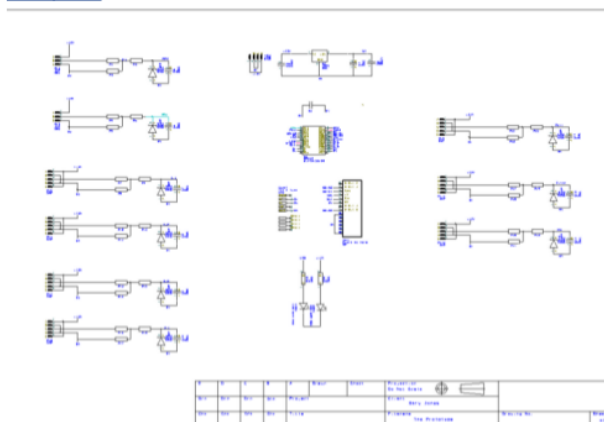


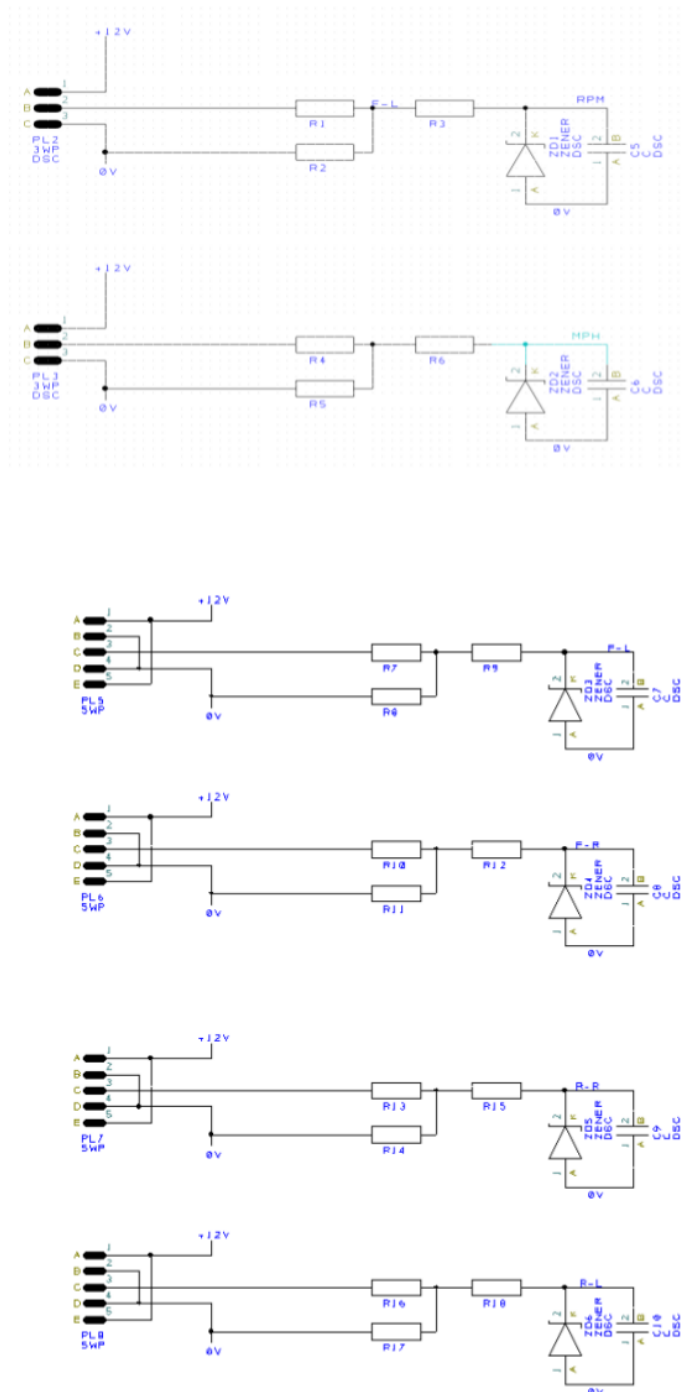


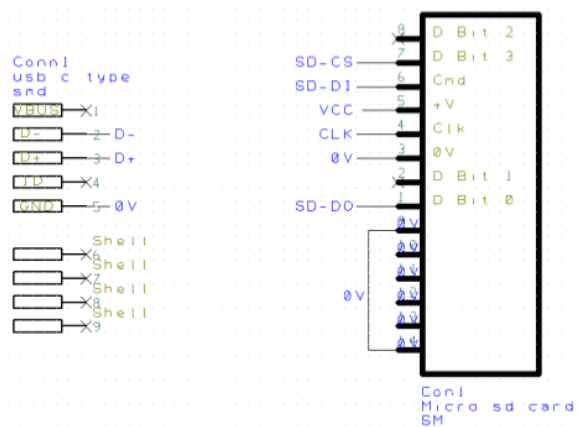
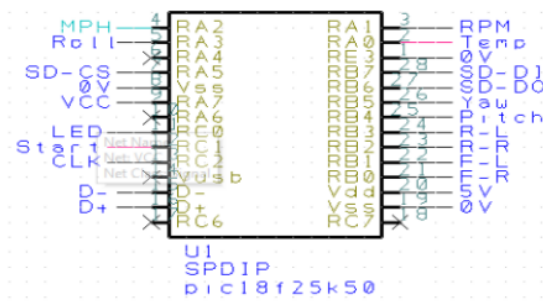
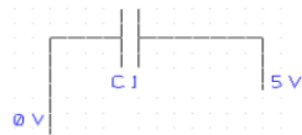
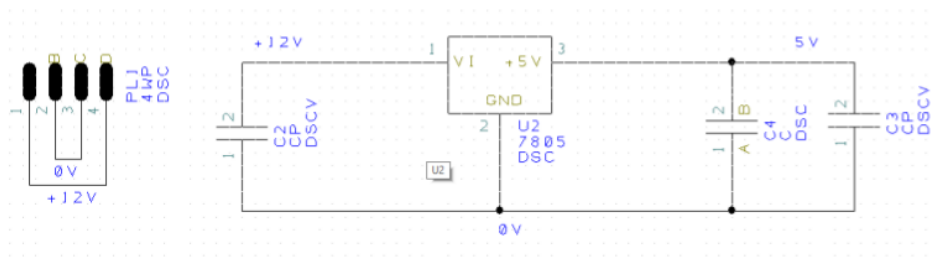


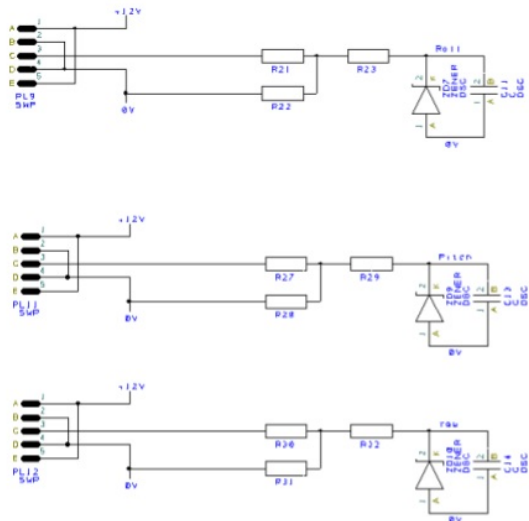


Easy-Pc

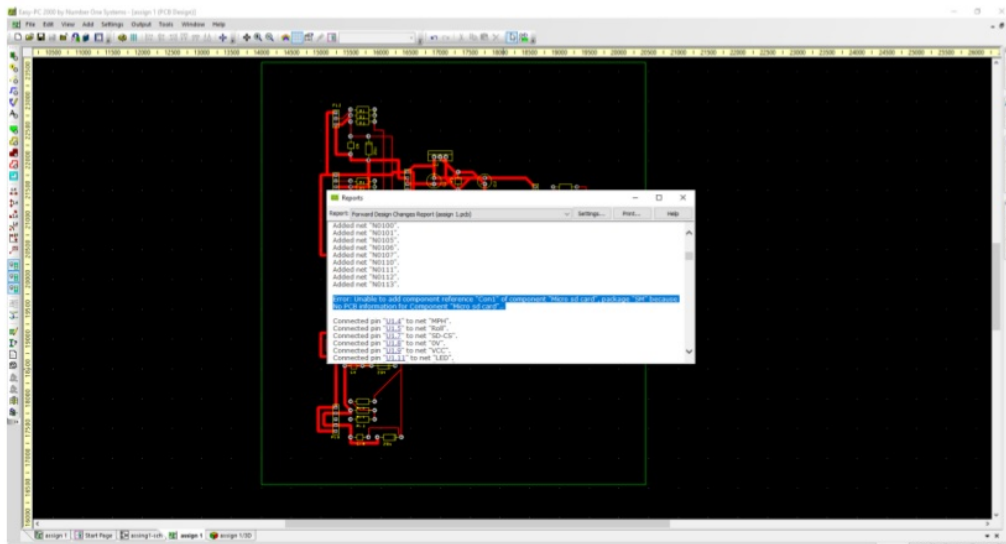


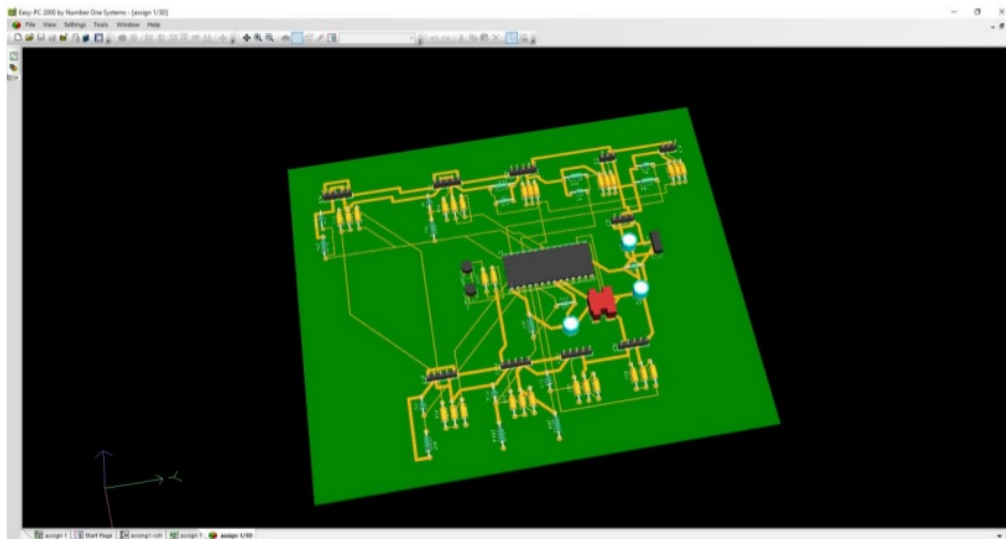
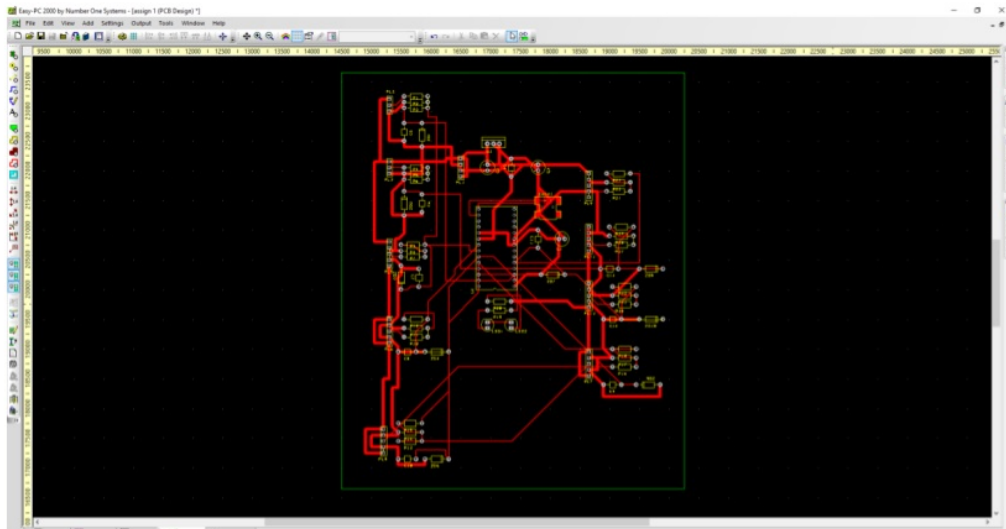






PCB Board





The Prototype

Connectors

Encasement

Battery Selection

Yucel 12V 7Ah Sealed Lead Acid Battery - Y7-12



Costing

Conclusion

Write a brief description on how you'd measure each element

Improvements

Tyre temp sensor

Bibliography

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Appendix

Pitch, roll and yaw sensor all in one

ESD Assignment 1

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

40/100

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GRADING FORM: SMU GENERIC_GJ

JOHN DAVIES

39.65

RESEARCH-INFORMED LITERATURE



literature review is very limited it would be improved by adding images of the devices, a review of each device and followed up with a comparison table but the basic explanations are good but incomplete. 42%

4.2

KNOWLEDGE AND UNDERSTANDING



Good overall schematic design but a things to be kept in mind. When designing a complex board it is beneficial from a understanding point of view to limit the number of lines travelling around and instead use net names which you have done but the names must be the same on both ends of the link and not chaged to show where they are coming from or going to. In

11.25

line resistors in the clamp should be in the region of 10-50ohms to allow sufficient current to turn on the zener, you have done this in some places but not all and some only have destinations shown one end. The PCB is incomplete and would not run due to the number of short circuits present. 45%

ANALYSIS

 Good selection of microcontroller. Reasonable selection of sensors with some tables showing the selection of sensors to be chosen from with an image or illustration of each. No case selection. No selection of connectors. 42%

14.7

PRACTICAL APPLICATION AND DEP.

 No costings and very poor attempt at future enhancements.15%

3

SKILLS FOR PROFESSIONAL PRAC.

 The report is reasonably presented with very well presented tabled data and informative diagrams. Some references. More care and better time management would have seen a vast improvement in the quality of this submission. 65%

6.5