

Curtis Rees 2003711

by Curtis Rees

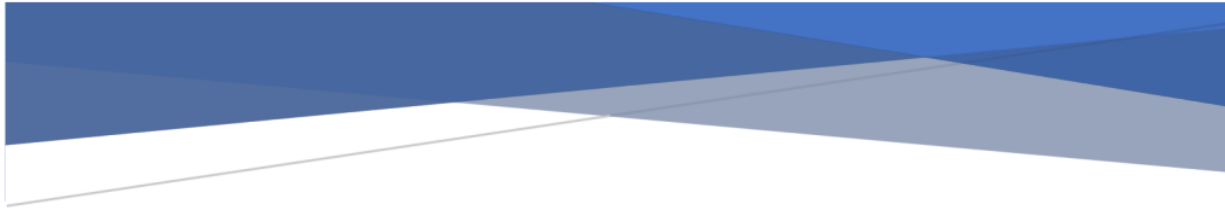
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MOTOR VEHICLE DATA LOGGER

Electronic Systems Design

University of Wales Trinity Saint David
Electrical & Electronic Engineering

Curtis Rees (2003711)
2003711

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Introduction

A data acquisition system designed featuring a microcontroller is required, the system must be reusable, portable and adaptable for any class of vehicle. The data acquisition system is intended to be fitted to a production prototype car, in this case, the vehicle is targeted for the family saloon market. Data will be gathered over a 2 hour period whilst on a test track and the intended use of this data will be to confirm that the vehicle is operating within safe limits and provides a comfortable means of transport.

Requirements

The following data will be acquired during a 2 hour test track run:

- Engine RPM
- Engine Temperature
- Front and rear suspension travel (Four corners of the vehicle)
- Pitch (nose up or tail up)
- Roll (circular movement of the body as it moves forward)
- Yaw (nose moves from side to side)
- Vehicle speed MPH

The system must store the collected data to a non-volatile memory, which can be externally read and cleared when connected to a computer via USB.

Sensors are not to be connected to the vehicle's electronics or signals and must be independent of the subject vehicle's power supply to ensure no interference.

Design must be portable, adaptable, and suitable for its intended environment. As well as ensuring that adequately sized variables are used for each parameter measured.

Review of existing portable vehicular data acquisition systems

IMC CRONOS-XT DAC



Caption - description

Figure 1

Figure 1 is an imc CRONOSXT rugged data acquisition system for harsh environments. It is offering an ultra-robust device in a completely modern platform. It states that 'The rugged data acquisition base unit and a number of amplifiers can be conveniently connected to form a complete system: without tools and cables via a simple click-mechanism. With protection class IP67 and MIL-STD810F, the system is protected against dirt, dust and water as well as severe shocks and vibrations.

The rugged data logger is therefore ideal for mobile measurements on construction machinery, tractors, agricultural machinery and vehicle testing that takes place in harsh environments.' [1]

Aim EVO4S vehicle Datalogger



Figure 2\

Caption - description

The datalogger shown in figure 2, has the ability to read both analogue and digital inputs. It can be connected directly to the ECU via CAN. It has its own accelerometer and gyroscope already built into the device and even has expansion modules available to increase the amount of inputs and outputs. [2]

Features:

- 5 analogue channels.
- 2 speed inputs
- 1 RPM input
- Internal three-axial accelerometer and gyro sensor
- CAN/RS232 output

BOSCH Data Logger C 60



Figure 2\

1

The data logger C 60, made by bosch motorsport, is a compact and light weight data logging system for motorsport applications. This device allows for synchronised acquisition of engine data from the ECU, along with chassis data from up to 26 analog and 4 digital input channels. In addition to this, input devices can be connected via ethernet and CAN buses. [3]

IMC CRONOS-XT	Aim EVO4S vehicle Datalogger	BOSCH Data Logger C 60
		
Wide temperature range from -40 °C to +85 °C	Wide temperature range from -20 °C to +70 °C	Operating temperature range of -20 °C to +65 °C
Water and dustproof according to IP67 + MIL 810F	Water and dustproof according to IP65	Protection classification rating of IP67 to DIN 40050
Size: 130 x 35 x 46.6 mm	Size: 130 x 35 x 46.6 mm	Size: 105 x 34.5 x 137.5 mm
Weight: 330g	Weight: 330g	Weight: 495g
Supply voltage: 10V to 50V	Supply voltage: 5 to 12 V	Supply voltage: 8 to 18 V
Power consumption: 25W	Power consumption: 350mA	Power consumption: 10W at 14V
Sampling rate: 2000kS/s	Sampling rate: 1000Hz	Sampling rate: 1000Hz
5 analog channels/ 2 digital inputs	5 analog channels/ 2 digital inputs	6 analog channels
	1 digital output	Input range 0 to 5V
Resolution 10 bit	Resolution 12 bit	Resolution 12 bit
Internal storage capacity 4GB	Internal storage capacity 4GB	Internal storage capacity 2GB
GPS	GPS	GPS
£3500	£1180	£3880

Caption required



Sensor Selection

Engine RPM

Compact VLS/5J Tachometer Optical Speed Sensor [4]	BOSCH Inductive Speed Sensor IS-C [5]	Celduc Cylindrical Magnetic Proximity Sensor
		
25mm to 1000mm Optical Range	Max frequency: ≤ 15 kHz	Distance <20mm

4 to 7.5 Vdc	Target wheel air gap AG 0.8 ± 0.3 mm	Max 300V
3 to 250,000 rpm	High operating temp. range (sensing head) -40 to 230°C	IP67. -40 to 75°C
Detection angle: 45° to reflective marker	Weight w/o wire 25 g	Contact Resistance 150mΩ
Reflection Tape	For use on crankshaft or wheel speed	Length 80mm
Dimensions are $\varnothing$ 34mm x 130mm long	Strong and Robust featuring metal housing	Max frequency 200Hz
£233.33	£540	£155.78

The component which was been selected for RPM in Table 2 is the Compact VLS/5J Tachometer Optical Speed Sensor. The main reason in which an optical tachometer was selected is because it is a non-contact sensor and, in this case, has a working range of up to 1 metre. In addition to this, it can operate on a voltage as low as 4V and can measure RPMs ranging from 3 to 250,000, which is more than adequate.



Engine Temperature

Optris CATCSMALT15SF0505K Thermometer USB Infrared Temperature Sensor [6]	Digital Temperature probe sensor [7]	Temperature Sensor NTC M12-H [8]
		
Response time: 0.014 s	0.25°C accuracy	1.4°C accuracy
Accuracy: +-1%	Probe: diameter 7mm x 40mm long	57.9mm long x M12.5
Min temperature: -50 °C	Min temperature: -45 °C	Min temperature: -30 °C
Max Temperature: 1030 °C	Max Temperature: 130 °C	Max Temperature: 150°C
USB interface	USB	USB
Supply voltage: 2.7 to 5.5 Vdc	Supply voltage: 5 to 37V	Supply voltage: microvolts
Cable Length: 0.5m	Cable length: 5Metres	Cable length
65 IP rating	Durable stainless steel tube	Plastic connection
£267.86	£70	£42

The highlighted chosen temperature sensor in the table above is a non-contact sensor that uses infrared to sense surface temperature. As previously mentioned, the data logger will need to be

portable, so choosing sensors which don't need physically make contact will be beneficial. This sensor has a supply voltage of 2.7 to 5.5V making it perfect to be interfaced within the design along with the microcontroller. Additionally, the device will need to measure temperatures of 50-150°C to appropriately measure the vehicles engine temperature, this sensor however, can measure temperatures ranging from -50°C to 1030°C which is more than adequate.

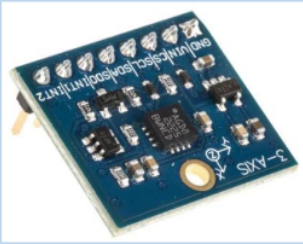
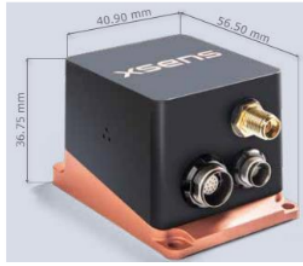
Suspension Travel

Non-Contact Laser Ride Height Sensor [9]	Linear Potentiometer MLS130 [10]	CD50 STRING POTENTIOMETER [11]
		
Size: 4.59mm x 73.90mm x 2.30mm	Available strokes: 25 to 200 mm	Range 0 to 1,250 mm
Temperature Range: 0°C-95°C	Temperature range: -30 to 100°C	Operating temperature -20° to +150°C
Resolution: 0.02mm	Resolution: virtually infinitive	Resolution: virtually infinitive
60 - 260mm measurement range	Resistance: 1 KOhm every 25 mm of stroke	Linearity: +/- 0,25% f.s. – stroke ≤500mm
Voltage Input Range: 11-16V	Applied Voltage Vdc: 22-74V	Supply voltage of 5VDC and a maximum current consumption of 10mA
Protection Class: IP65	Protection Class: IP66	IP67 option
A measurement rate of 1KHz and linearity of 0.1% ensures a fast and accurate recording of your real-time car data	Life cycles at 250 mm/sec: 100 millions of operations or 50 millions of cycles	Output ratiometric to supply voltage
£1215	£229	£215

Table 4 above shows some potential products in which could be added to the design. First option was the ‘Non-Contact laser ride height sensor’ which costs substantially more than the two other options. This product was not chosen to be part of the design for a few reasons, in comparison to the two other options it had lower protection class, lower temperature range and also worse resolution. Out of the two potentiometers, the string potentiometer was selected because of a few reasons. Firstly the MLS130 would not be suitable because of the available strokes, it will need to have a range of 300mm. Secondly, the supply voltage on the ‘CD50’ is 5V which makes it suitable to work at

the same voltage as the microcontroller. Finally a better 'IP' rating which along with the price being the cheapest was the reasons in which this product was selected.

Pitch Roll & Yaw

Parallax Inc 3-axis Gyroscope Sensor Module [12]	Xsens by Movella MTi-680G Accelerometer Sensor, Barometric Pressure Sensor, Gyroscope Sensor, Magnetometer Sensor [13]	MEMS Gyroscope [14]
		
Supply voltage: 2.7 to 6.5 VDC	Supply voltage: 4.5 to 24V	Supply voltage: 3.15V to 5.25V
Communication Interface: I2 C (up to 400 kHz) or SPI (10 MHz; 4 & 3 wire)	<1 W power consumption	Measurement range from ± 300 to $\pm 400^\circ/\text{sec}$
Operating Temp: (-40 to +85°C)	Operating Temp: (-40 to +85°C)	Operating temp: -40°C to +105°C
Dimensions: 0.85 X 0.80 in (2.16 X 2.03 cm)	IP rating IP68	SPI digital output with 16bit data-word, low noise and low power
High shock survivability	Bandwidth 500Hz	16 lead SOIC-CAV package
£24.85	£2470.55	£77.94

The highlighted sensor in table has been chosen in the design due to its low supply voltage, high shock survivability and the I2C communication interface which is more efficient during the coding process. Fully customisable through software and very affordable. Although the Xsens by Movella MTi-680G sensor is very accurate and can measure extra features, it has not been chosen due to its very high cost.

MPH

Honeywell VRS Series Magnetic Speed Sensor [15]	Monarch 6180-056 Optical Sensor [15]	Aim GPS 08 [17]
		
	Distance: up to 3 feet	Supply 12 V
non-contact devices, there's less risk of wear for a longer service life	315 Volts at 40mA	Average 20 satellite lock
Simple installation	RPM: 1 – 250,000	CAN connections
-55°C and +120°C	Reflective tape	1 metre precision
Switching freq: 15kHz	Detection angle: 45 degrees	Works best outdoors
Height: 5.12mm Depth: 5.88	Stainless Steel	Fast satellite lock
£163.25	£257.90	£265

Enclosure



External Height - Metric

45mm

External Width - Metric

80mm

External Depth - Metric

108.5mm

This enclosure was chosen mainly due to  material being and being able to withstand the harsh environments. Its also just enough room for the PCB board to fit into as well as the connectors while ensuring the design stays as small as possible. Additionally, the front and rear panels are detachable meaning that maintenance can easily be done. £24.92

Microcontroller Selection

A data acquisition system designed featuring a microcontroller is required, this section showcases the decision making process and requirements in which was needed from a microcontroller. Below is a table showing the calculations that were made in order to calculate the minimum required clock speed from the microcontroller. The clock speed of a microcontroller is an important factor to be considered in the design stage as it will determine the maximum rate at which the analog signal can be sampled. Clock speed will govern the conversion rate of any analog to digital operations, such as the potentiometer sensor for the suspension. Very slight and fine movement is likely to occur within the suspension travel and to enable this data to be recorded, a higher number of clock cycles will be required in comparison to the engine temperature where less is needed.

Sensor	Required clock cycles
Gyroscope	12
Suspension	16
Temperature	4
MPH	4
RPM	4
Total clock cycles	40
Time period	0.0001
40/0.0001	400000 Hz
Required clock speed	4 MHz

In order to choose a microcontroller it is now necessary to set parameters for each of the sensors featured within the data acquisition system. After reading the specification the table below shows each parameter along with the amount of bytes. A max value expected from that sensor, the resolution necessary to record accurate but sensible data, number of possible values were all needed in order to calculate this.

Parameter	Max Value	Resolution	Number of possible values	Number of bits required	Bytes
Engine RPM	0 – 8k	10RPM	800	10	2
Engine Temp	50 - 150	1	100	7	1
Suspension Travel	300mm	1mm	300	9	2
Front Right	-150 to +150 mm	1mm	300	9	2
Front Left	-150 to +150 mm	1mm	300	9	2
Rear Right	-150 to +150 mm	1mm	300	9	2
Rear Left	-150 to +150 mm	1mm	300	9	2
Pitch	-45 to +45 degrees	0.5	180	8	1
Roll	-45 to +45 degrees	0.5	180	8	1
Yaw	0 – 360 degrees	1	360	9	2
Road Speed	0-255mph	1mph	256	8	1

16 bytes

x50 Samples/second

x60 Samples/minute

x60 minute/hour

x2 hour test drive

=5,760,000 bytes

This table shows the total amount of bytes required in order to record each parameter to the chosen resolution throughout the 2 hour test drive.

	PIC18F97J94 Microchip delete	PIC18F87K90 Microchip delete	PIC18F44J50 Microchip delete
Family	8-bit MCU	8-bit MCU	8-bit MCU
CPU Type	8-bit PIC MCU	8-bit PIC MCU	8-bit PIC MCU
Max CPU Speed (MHz)	64 MHz	64 MHz	48 MHz
FPU			
Operation Voltage	(2V-3.6V)	(1.8V-5.5V)	(2V-3.6V)
Temp Range	(-40 to 85)	(-40 to 125)	(-40 to 85)
Pin count	100	80	44
Program Memory Size (KB)	128 Flash	128 Flash	16 Flash
Error Correction Code Program Flash			
SRAM	3,771,484,375 KB	4 KB	3,710,937,5 KB
Data EEPROM/HEF (Bytes)		1024	
Internal DRAM Type			
Internal DRAM Amount (MB)			
Low Power	Yes	Yes	Yes
ADC Input	24	24	13
Max ADC Resolution (Bits)	12	12	10
DAC Outputs			
Number of Op Amps			
Hardware Touch Peripheral			
UART	4	2	2
SPI	2	2	2
I2C	2	2	2
I2S			
SSC			
Number of USB Modules	1		1
USB Interface	P5 Device	None	P5 Device
Number of CAN Modules			
Type of CAN module			
Ethernet			
Max 8-Bit Digital Timers	4	6	2
Max 16-Bit Digital Timers	4	5	3
Max 32-Bit Digital Timers			
Hardware RTCC/RTC	Yes	Yes	Yes
Max PWM outputs (including complementary)	19	19	
Number of PWM Time Bases			
Crypto Engine			
ARM TrustZone®			
Segmented LCD	480	192	
Graphics Controller/GPU			
Video Decoder			

An example of the comparison table in which I used to compare the different microcontrollers is shown above. Previously the parameters were decided so that the clock speed as well as the storage could be measured. This table shows all the information needed to choose a suitable PIC. Voltage, CPU type, ADC inputs, I2C and USB interface were all among the table and after comparing multiple microcontrollers, the PIC18F45K50 was chosen.

8

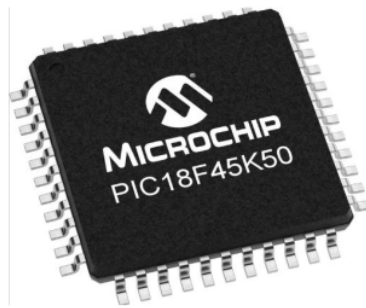


Figure 12

Figure 12 shows the chosen microcontroller PIC18F45K50 for vehicle acquisition system. The chip comes in various formats however, the surface mount package will ensure the design stays compact and as small as possible.

Connectors & Battery

RS232



Figure 6

RS232 is simply a form of serial communications and a way in which to transmit data. It's the interface between data terminal equipment and data communications equipment using serial binary data exchange which is needed within my vehicle data acquisition system. Figure 6 shows the female DB9 socket chosen. [18] £7.49

USB

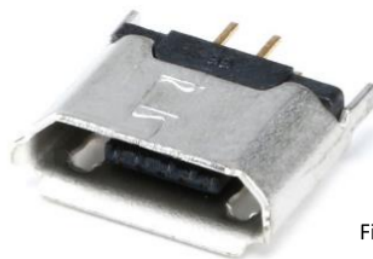


Figure 7

The USB connector shown in figure 7 is the micro USB socket. The USB can be used for storage, data backup and transferring of files between different devices that are USB compatible. For example this micro USB socket will enable the tester to withdraw the data from the data acquisition system and upload them onto a laptop/computer etc where the results are visible. [19] The micro USB has been chosen as its smaller and more compact than a traditional USB socket. £1.58

Input for sensors



10 Figure 8

Figure 8 is the 25-way right angle PCB female D socket connector that's will be used for the input/outputs. This socket has been chosen as it enables easier expansion of the input/outputs. It allows all sensors to be connected via the same connection which will be secure and highly vibration proof due to the metal screw on clamps. [20] £0.84

Molex



Figure 9

With their secure connections, flexibility and ability to withstand harsh environments, molex connectors have been selected. The data acquisition system is required to operate in harsh environments so these connectors are vital. They can accommodate different wire sizes and types. [21] £7.34

Micro SD Card



Figure 10

The system will feature a micro SD card which is used to expand the storage and allow the data that's been recorded via the multiple sensors to be stored and then later removed and downloaded onto a laptop or computer for the data analysis. A micro SD card is smaller and more compact making my design smaller and more suitable to be mounted to the vehicle. £1.24

Push Button Switch



Figure 11

Figure 11 is an RS PRO Miniature Push Button Switch. The design consists of two of these push buttons, one will be the main on/off switch for the whole device, and the other will be positioned in a safe and convenient position for the driver of the vehicle to be access and start/stop the testing equipment from the drivers seat of the vehicle. [22] £3.57 for one

LED



Figure 15

Figure 14 is an Oxley OXL/CLH/80 Series Green Panel LED. It has a voltage rating of 5V which makes connectivity within the circuit easier and the chosen colour is green. The LED will be

programmed to turn on when the device is switched on and recording data. Similarly to the push button switch, two of these will be required, one of the surface of the enclosure and one positioned next to the push button accessible from the drivers seat. It has an IP67 rating making it suitable for the harsh environments that might occur on the vehicle. £8.01 for one

Battery



Figure 16

For the battery selection a RS PRO, 3.7V, Lithium Polymer rechargeable battery has been chosen. Its nominal voltage is 3.7V and has a capacity of 1.8Ah. [23] Lithium batteries are designed to last longer than normal aaa batteries. The intended goal of the data acquisition system is to be as light and compact as possible making it as easy to be mounted or attached as possible. The enclosure will be adapted so the battery can be accessible to charging. £11.47

Schematic Break down

This section of the report explains part of the schematic created in proteus, along with the schematic created in Easy-PC. As shown later on, some of the sensors were not included within the Easy-PC schematic as they were not to be constructed onto the PCB board.

Circuit Block Diagram

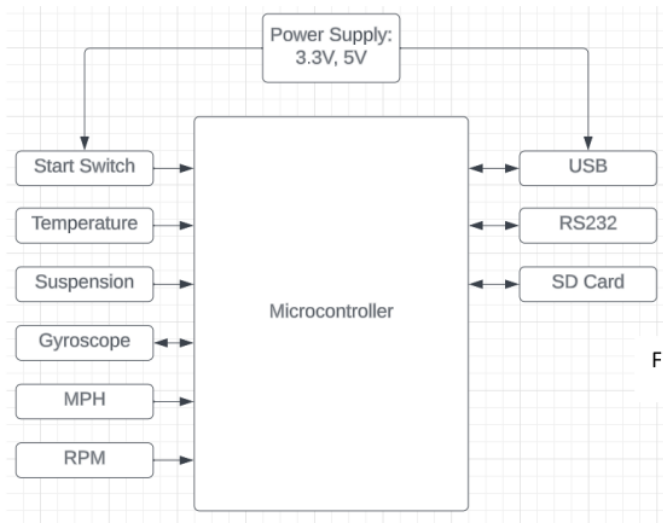


Figure 17

Circuit Block Diagram shows the simplified theory behind the circuit. As figure 17 shows, a power supply of 3.7V from the lithium Polymer rechargeable battery is fed into the circuit. The left hand side shows the input sensors from the different sensors each recording their relevant data that is then inputted into the microcontroller. In addition to these sensors, a start switch, fed by the power supply is inputting into the microcontroller turning it on/off. On the right hand side of the circuit block diagram are all the output sensors. For example the USB which will make the data transferrable from the microcontroller to another device compatible, such a laptop/computer.

RPM

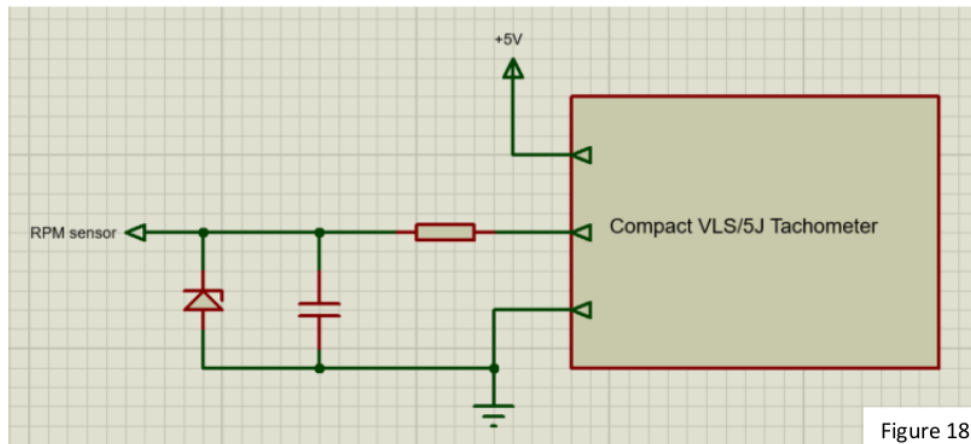


Figure 18

Figure 18 is the RPM sensor design made on proteus which will later be incorporated into the Easy-PC design. The purpose of the Zener diode within figure 18 is to permit Zener current to flow when the voltage is above the specified Zener voltage therefore, protecting the circuit. The resistor and capacitor being connected in that configuration applies as a low pass filter. The low pass filter is crucial within the design to ensure accurate and readable results. The low pass filter will filter the unwanted signals or noise.

MPH

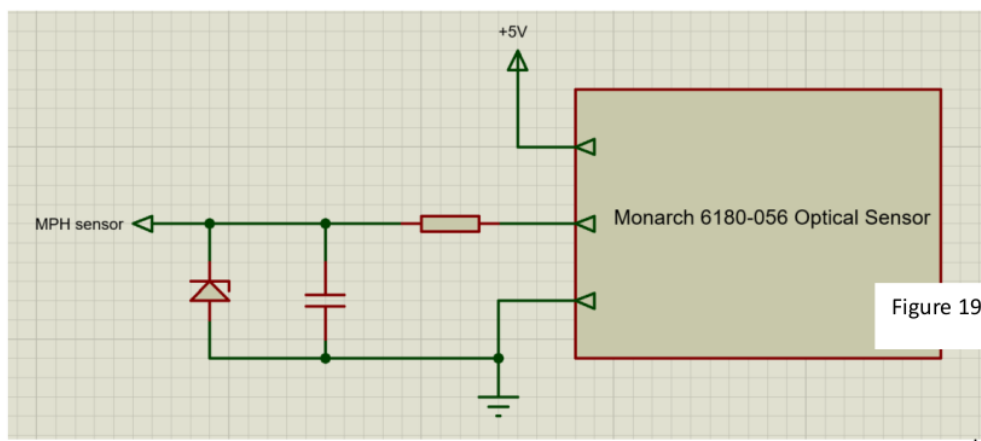


Figure 19

Figure 19 now shows the design made on proteus for the MPH sensor. Similarly to figure18, the optical sensor features a low pass filter to filter any unwanted signal or noise.

System On Start Up Switch

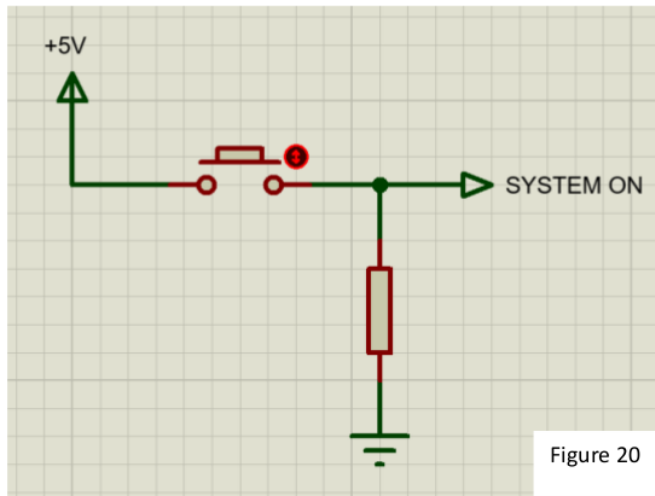


Figure 20

Figure 20 is the push button start up switch, this enables the device to be turned on/off saving battery.

LED

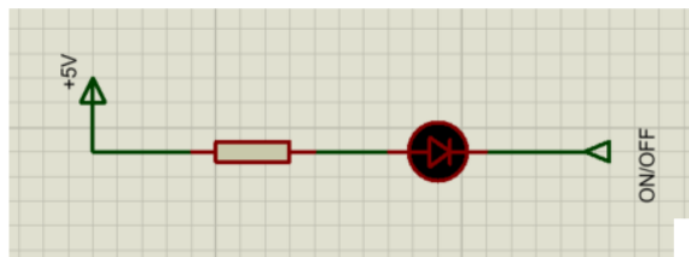


Figure 21

This LED design shown figure 21 is a simple design with the purpose of turning the LED when the microcontroller is turned on, therefore showing the user that its ready to record and store the data. The LED is green to showcase the vehicle acquisition system is on.

Potentiometer Suspension Travel

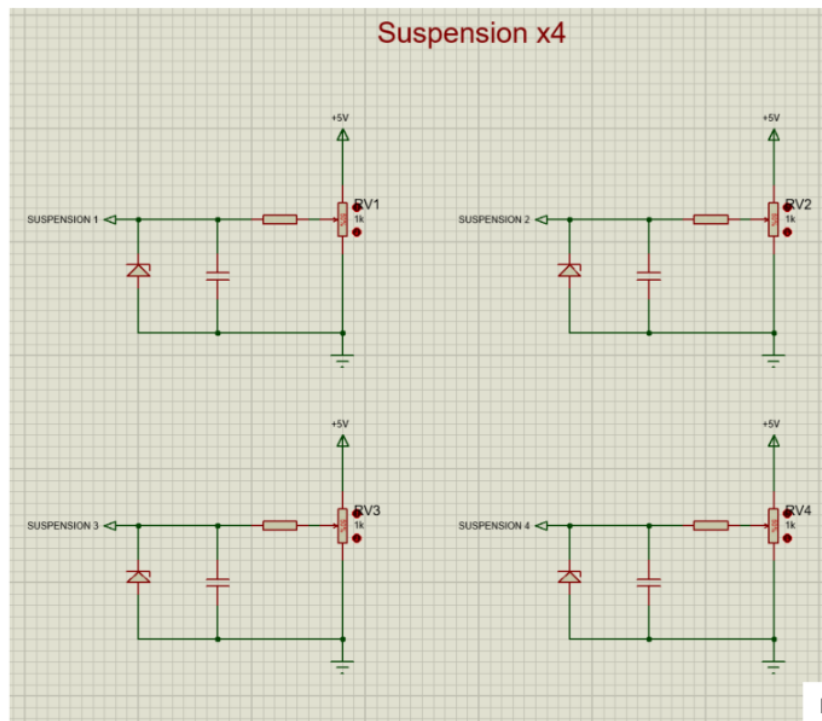


Figure 22

Finally for the proteus design, the potentiometer suspension travel circuits are shown in figure 22. The potentiometer is represented by a variable resistor. The resistor and capacitor are acting as a low pass filter, filtering unwanted signal and noise. Zener diode protects the circuit from Zener current.

Easy-PC

The Easy-PC full schematic is shown in figure 23. The only sensor being directly mounted to the PCB board in the gyroscope. The rest of the vehicle sensors will be connected to the 25 way connector port shown in figure 23. All these sensors will have a low pass filter to block unwanted signals and noise and a Zener diode to protect the microcontroller against Zener current. The USB port, micro SD card as well as the LED are all connected to the PCB board. The push button to turn the microcontroller on/off is connected into pin 25 of the 25 way connector to then be added to the outside of the enclosure making it useable.

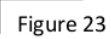


Figure 24 is the trace lines connecting the different components, ensuring they don't cross or interfere with one another.

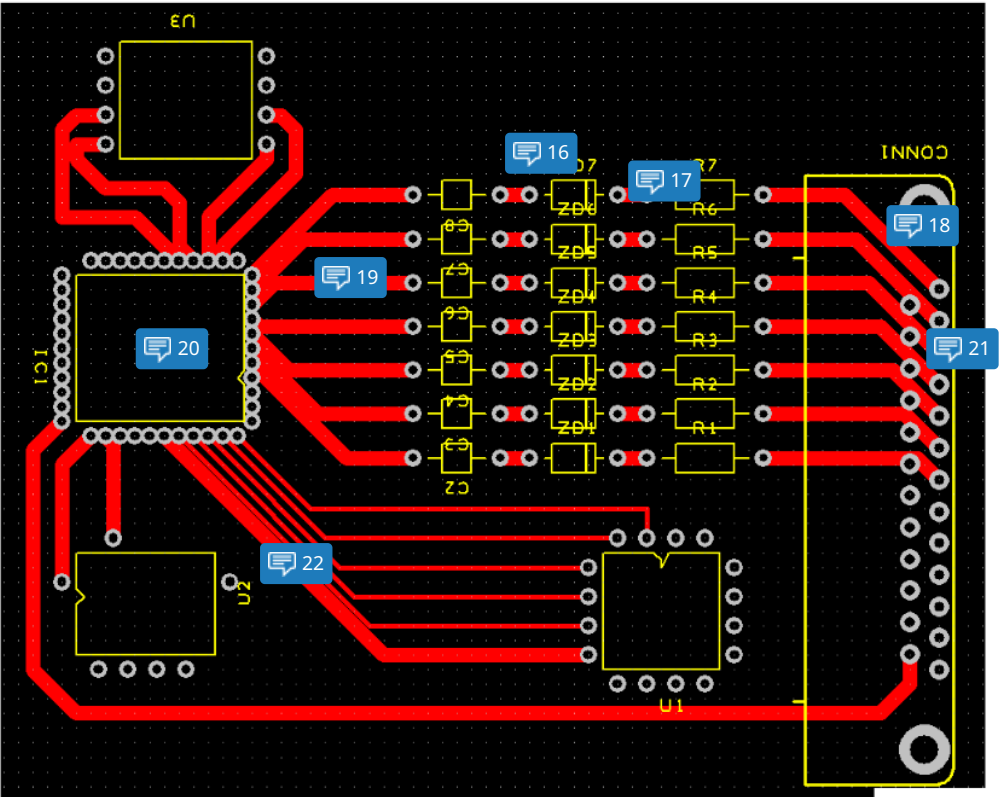


Figure 24

A 3D view of the PCB board is shown with and without copper in figure 25 & 26.

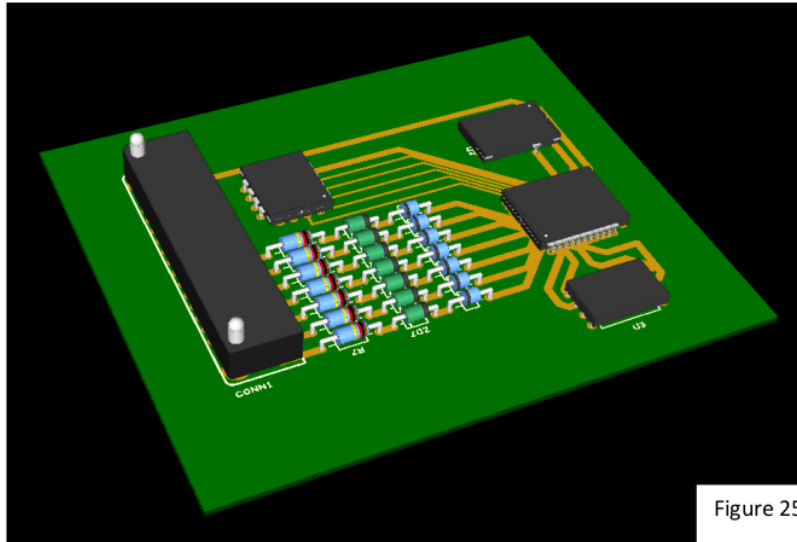


Figure 25

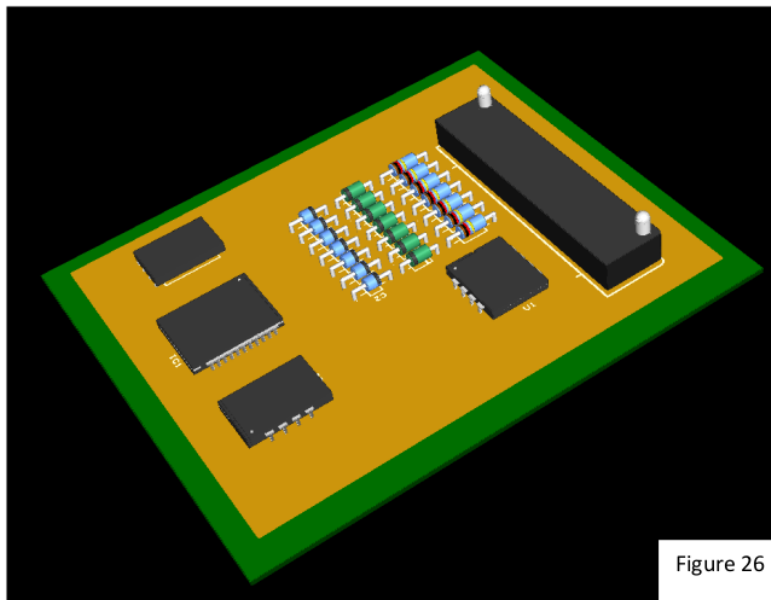
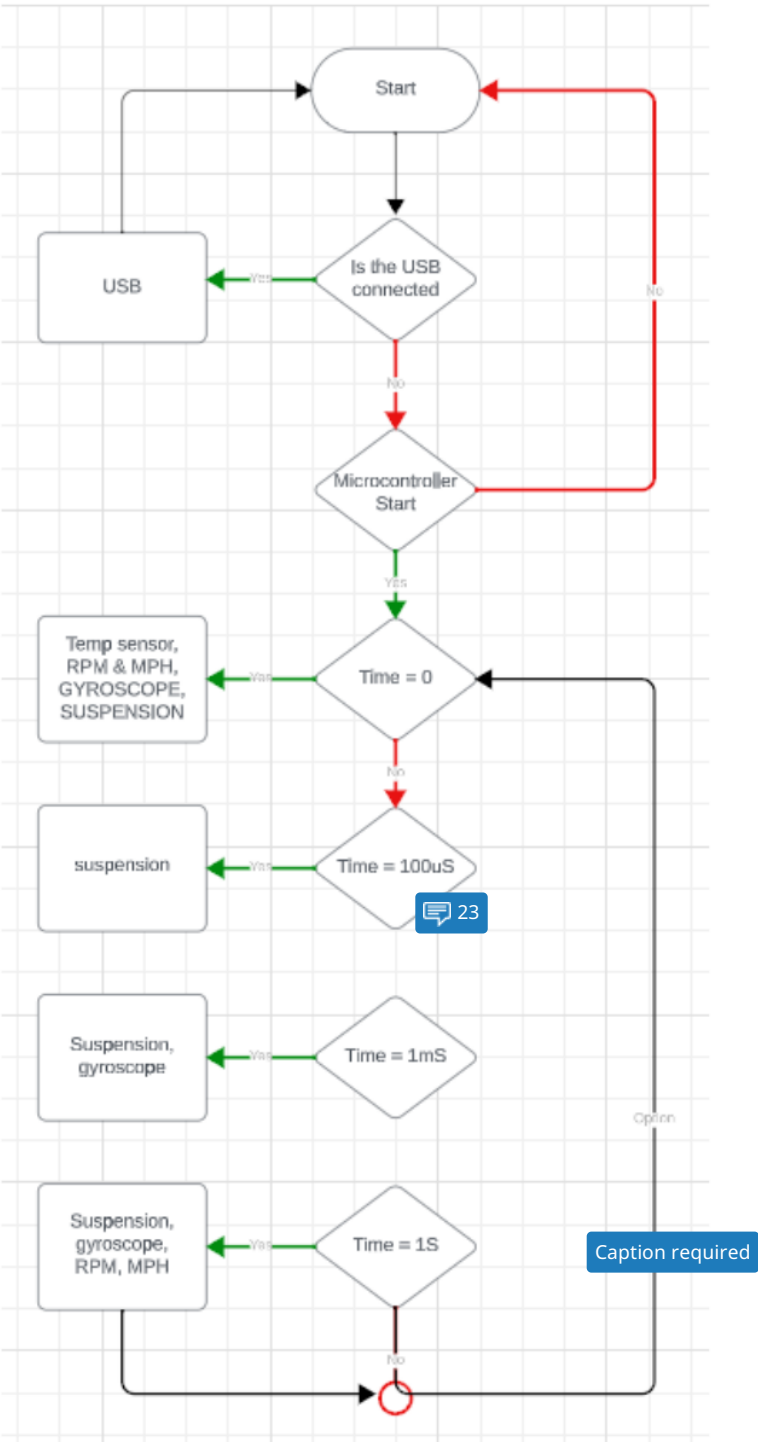
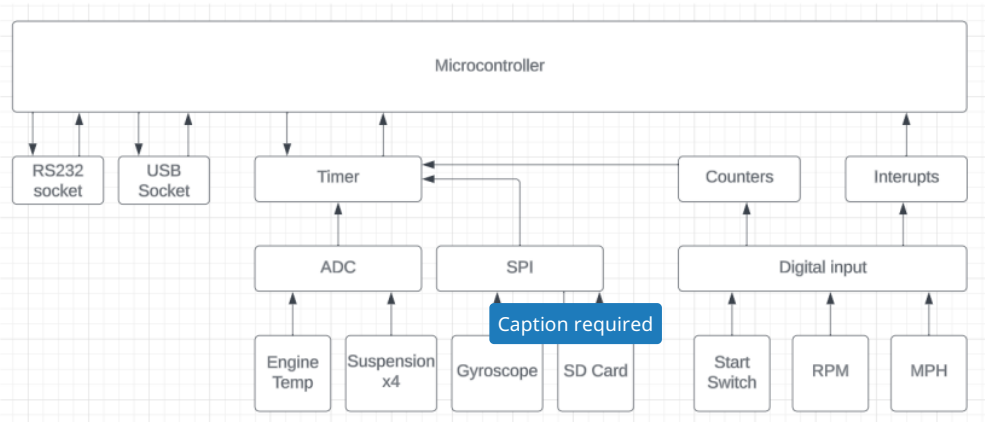


Figure 26

Systematic Diagram



Structure Diagram



Cost of PCB Board

Reset

Calculate

Speed

What's the difference between 'Standard' and 'Quick-Turn' PCB

Learn More

PCB Specification Selection

Simple tutorial (suitable for beginners) Online Gerber Viewer

PCB file (optional) Add Gerber File

Automatically sets the board size, hole, track/spacing only accept .rar or .zip & Maximum 20M

Board type

Single pieces Panel by Customer Panel by PCBWay

Different design in panel

1 2 3 4 5 6 e.g.

Size (single)

90 X 70 mm Inch<=>mm

Quantity (single)

5 pcs

Layers

1 Layer 2 Layers 4 Layers 6 Layers 8 Layers 10 Layers 12 Layers 14 Layers

Material

FR-4 Aluminum Rogers HDI (Buried/blind vias) Copper Base

FR4-TG

TG 130-140 TG 150-160 TG 170-180 S1000H TG150

Thickness

0.2 0.3 0.4 0.6 0.8 1.0 1.2 1.6 2.0 2.4 2.6 2.8 3.0 3.2

Min track/spacing

3/3mil 4/4mil 5/5mil 6/6mil 8/8mil

Min hole size

0.15mm 0.2mm 0.25mm 0.3mm 0.8mm 1.0mm No Drill

Solder mask

Green Red Yellow Blue White Black Purple Matte black Matte green None

Pricing And Build Time

PCB Price

Price Comparison Matrix

Build Time	Qty	Total
24hours	5	\$ 5.00
Extra Urgent!	5	\$ 94.56

Final price is subject to our review

Shipping Cost: US \$20.86

UNITED STATES OF AMERICA

DHL 2-4 business days, wt.0.11kg

Shipment Date 2023/11/26 AM

Delivery Date 2023/11/29

PCB Cost: US \$ 5.00

Shipping: US \$ 20.86

Total: US \$ 25.86

Save to Cart

Final Build Cost

Selection	Part	Price Each	Quantity	
RPM	Compact VLS/5J Tachometer Optical Speed Sensor	£233.33	1	
TEMP	Opttris CATCSMALT15SF0505K Thermometer USB Infrared Temperature Sensor	£267.86	1	
SUSPENSION	CD50 STRING POTENTIOMETER	£215	1	
PITCH ROLL & YAW	Parallax Inc 3-axis Gyroscope Sensor Module	£24.85	1	
MPH	Monarch 6180-056 Optical Sensor [15]	£257.90	1	
ENCLOSURE	MULTICOMP MC002221	£24.92	1	
PIC		£18.76	1	
CONNECTORS	RS232	£7.49	1	
	USB	£1.58	1	
	INPUT FOR SENSORS	£0.84	1	
	MOLEX	£7.34	1	
	MICRO SD CARD	£1.24	1	
	PUSH BUTTON SWITCH	£3.57	2	
	LED	£8.01	2	
	BATTERY	£11.47	1	
PCB	PCB BOARD	£5 excluding delivery	1	
		£1,089.16	17 TOTAL	

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Improvements

25

- **Cameras.** Numerous cameras could be used to better gauge the vehicles performance. It could help visualise terrain and weather conditions and consider these when analysing the data.
- Incorporate a switch with an LED to show when the device is switched on instead of having a separate LED. This making design smaller as well as avoiding more holes within the enclosure.
- Wireless. This allowing it to be used as another form of data transfer, not limiting its capabilities.
- Real time clock. This would enable time stamps which could be useful to further analyse the cars performance.
- Use of the linear potentiometer instead of the wire potentiometer to ensure it can withstand harsh environments.

Bibliography

- [1 imc, "imc," imc, -- -- --. [Online]. Available: <https://www.imc-tm.com/products/daq-systems/imc-cronos-xt>. [Accessed 22 10 2023].
- [2 "aim technologies," aim technologies, -- -- --. [Online]. Available: <https://www.aimtechnologies.com/aim-evo4s/#:~:text=The%20EVO4S%20car%20racing%20data logger,well%20as%20predefined%20mat h%20channels..> [Accessed 23 10 2023].
- [3 "bosch motorsport," bosch, -- -- --. [Online]. Available: https://www.bosch-motorsport.com/media/downloads/2019-01_data_logger_c_60_datasheet.pdf. [Accessed 24 10 2023].
- [4 RS, "RS," [Online]. Available: <https://uk.rs-online.com/web/p/tachometer-accessories/0622565>. [Accessed 25 10 2023].
- [5 "BOSCH MOTORSPORT," [Online]. Available: https://www.bosch-motorsport.com/media/downloads/inductive_speed_sensor_is-c.pdf. [Accessed 25 10 2023].
- [6 rs, "RS online," -- -- --. [Online]. Available: https://uk.rs-online.com/web/p/infrared-temperature-sensors/2410170?cm_mmc=UK-PLA-DS3A-_google-_CSS_UK_EN_PMAX_Catch+All-_-2410170&matchtype=&&gad_source=1&gclid=EAlaIqobChMI27O0xKXlggMV2pGDBx1Ev gKMEAYAYABEGKRdF_D_BwE&gclsrc=aw.ds. [Accessed 27 11 2023].
- [7 "mm selectronics," MMS Electronics Ltd, [Online]. Available: https://www.mmselectronics.co.uk/products/sensors/temperature-sensors/digital-temperature-probe-sensor-01-c-accuracy?gclid=EAlaIqobChMI9dKFW6flggMV-5aDBx2CpQGrEAYYBCABEgJIn_D_BwE. [Accessed 27 11 2023].
- [8 "Darkside," -- -- --. [Online]. Available: <https://www.darksidedevelopments.co.uk/products/universal-temperature-sensor-engine-fluid-temperature-sensor.html?setCurrencyId=1&sku=DSD3469>. [Accessed 27 11 2023].
- [9 "aim shop," -- -- --. [Online]. Available: https://www.aimshop.com/products/aim-non-contact-laser-ride-height-sensor?currency=GBP&utm_source=google&utm_medium=cpc&utm_campaign=google%2Bshopping&gad_source=4&gclid=EAlaIqobChMI2vLY88blggMVAvtCh0yawv4EAQYASABEglzvD_BwE. [Accessed 28 11 2023].
- [1 "fama engineering," [Online]. Available: <https://www.famaengineering.com/en/products-0/catalog/distance-displacement-en/linear-potentiometers/mls130/>. [Accessed 10 11 2023].
- [1 "strain sense," [Online]. Available: <https://www.strainsense.co.uk/product/cd50-string-1/potentiometer-1065/>. [Accessed 10 11 2023].
- [1 "RS," [Online]. Available: <https://uk.rs-online.com/web/p/sensor-development-2/tools/7813033?gb=a>. [Accessed 11 11 2023].

[1 "RS," [Online]. Available: [https://uk.rs-online.com/web/p/sensor-development-3\] tools/2614491?gb=s](https://uk.rs-online.com/web/p/sensor-development-3] tools/2614491?gb=s). [Accessed 15 11 2023].

[1 "Farnell," [Online]. Available: [https://uk.farnell.com/analog-devices/adxrs450brgz/mems-4\] gyroscope-3-15-5-25v-soic/dp/4030131](https://uk.farnell.com/analog-devices/adxrs450brgz/mems-4] gyroscope-3-15-5-25v-soic/dp/4030131). [Accessed 15 11 2023].

[1 "RS online," [Online]. Available: [https://uk.rs-online.com/web/p/motion-control-5\] sensors/8228398?gb=s](https://uk.rs-online.com/web/p/motion-control-5] sensors/8228398?gb=s). [Accessed 17 11 2023].

[1 "cole parmer," [Online]. Available: [https://www.coleparmer.co.uk/i/monarch-6180-056-optical-6\] sensor-for-up-to-3-feet-range-from-1-to-250-000-rpm/0821253](https://www.coleparmer.co.uk/i/monarch-6180-056-optical-6] sensor-for-up-to-3-feet-range-from-1-to-250-000-rpm/0821253). [Accessed 17 11 2023].

[1 "aim technologies," [Online]. Available: <https://www.aimtechnologies.com/aim-gps08-module/>. [Accessed 18 11 2023].

[1 "omega," [Online]. Available: <https://www.omega.co.uk/temperature/z/rs232standard.html>. [Accessed 18 11 2023].

[1 h. (20958), "ebay," [Online]. Available: <https://www.ebay.co.uk/itm/263895372412>. [Accessed 18 9] 11 2023].

[2 "SWITCH ELECTRONICS," [Online]. Available: [https://www.switchelectronics.co.uk/products/25-0\] way-right-angle-pcb-female-d-socket-connector](https://www.switchelectronics.co.uk/products/25-0] way-right-angle-pcb-female-d-socket-connector). [Accessed 19 11 2023].

[2 "molex," [Online]. Available: <https://www.molex.com/en-us/products/connectors#:~:text=With%20their%20flexibility%2C%20secure%20connections,popular%20choice%20in%20many%20industries..> [Accessed 19 11 2023].

[2 [Online]. Available: <https://uk.rs-online.com/web/p/push-button-switches/7346704>. [Accessed 2] 19 11 2023].

[2 "RS online," [Online]. Available: [https://uk.rs-online.com/web/p/speciality-size-rechargeable-3\] batteries/1449405?gb=s](https://uk.rs-online.com/web/p/speciality-size-rechargeable-3] batteries/1449405?gb=s). [Accessed 20 11 2023].

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

QM

Caption - description

Caption should include a description

PAGE 5

QM

Caption - description

Caption should include a description

Comment 1

Figure 3

PAGE 6

Comment 2

Good comparison

QM

Caption required

You should always include a caption on figures, equations and tables to allow you to refer to them in your text.

e.g. An illustration of this can be seen in figure 2. The relationship of the variables is shown in equation 2. Table 1 shows the results of the first experiment where the control variable, temperature in degrees celsius is shown in the first column....



Comment 3

Why not discuss the range of possible values before looking at sensors?

PAGE 7



Comment 4

Good justification

PAGE 8



Comment 5

Good justification, although this sensor uses USB to connect to a host. This may not work well with a PIC as usually they don't have USB host functionality

PAGE 9

PAGE 10



Comment 6

Did you look at any other enclosures?

PAGE 11

PAGE 12



Comment 7

Is this going to be fast enough? A car travelling at 70mph will cover 626mm in 20ms (your chosen sample period) This is far enough that your system will miss small bumps in the road.



Comment 8

This isn't in your table. How can you select a device which is not in the comparison?

PAGE 13



Comment 9

This is not a socket, it is a gender changing adapter.



Comment 10

Where are the other connectors you have compared this with before making your choice?



Comment 11

This isn't high enough to run your RPM sensor. Will you use a DC-DC converter or some sort of switched mode inverter to get the required voltage?



Comment 12

PCB



Comment 13

Zener current?



Comment 14

There should be a ground connection between the zeners and capacitors. This is not clear in your schematic.



Comment 15

Shouldn't there also be power and ground for your sensors?



Comment 16

Where does the power plug in?

Where does the USB connect?

Where are the status and power LEDs?



Comment 17

This arrangement of components will not work. In your schematic they were not in series like this.



Comment 18

CONN1 is facing into the board. This means you will not be able to plug anything into it.



Comment 19

tracks crossing means they connect - if you want them to or not



Comment 20

incorrect footprint for IC1. This should have rectangular pads, not round ones with holes. This comment also goes for U1 and U2



Comment 21

tracks crossing pads means they connect - if you want them to or not



Comment 22

tracks crossing means they connect - if you want them to or not

PAGE 22

PAGE 23



Comment 23

I thought you were sampling all your sensors at 50Hz?



Caption required

You should always include a caption on figures, equations and tables to allow you to refer to them in your text.

e.g. An illustration of this can be seen in figure 2. The relationship of the variables is shown in equation 2. Table 1 shows the results of the first experiment where the control variable, temperature in degrees celsius is shown in the first column....

PAGE 24



Caption required

You should always include a caption on figures, equations and tables to allow you to refer to them in your text.

e.g. An illustration of this can be seen in figure 2. The relationship of the variables is shown in equation 2. Table 1 shows the results of the first experiment where the control variable, temperature in degrees celsius is shown in the first column....

PAGE 25



Comment 24

What about the resistors, capacitors and diodes?



Comment 25

This would mean a completely new system. Your chosen PIC would not be able to process this amount of data.

PAGE 26

PAGE 27

GRADING FORM: SMU GENERIC_SMOSEY

CURTIS REES

45.65

ENGAGEMENT WITH LITERATURE

including reading, referencing, academic conventions and academic honesty



More caparisons should have been made and more research on the parts chosen. You need to read the datasheets for the parts you have chosen to understand how they work and how to connect them up.

4.7

KNOWLEDGE & UNDERSTANDING

Knowledge of the basic underlying concepts and principles of a subject.



Hardware design is not accurate to schematics from Proteus. details lost between Proteus and Easy-PC schematics, and between Easy-PC schematic and PCB design.

11.25

You need to consult datasheets for how to connect components. It is clear this has not happened.

You have not implemented features like the status and power LEDs and start stop switch as mentioned in your text, nor have you indicated how the battery will be connected to the circuit or how it will be charged.

COGNITIVE & INTELLECTUAL

Evaluate underlying concepts and principles of a subject and interpret qualitative and quantitative data in order to develop lines of argument and make sound judgements.



Package is suitable, although you have not compared any. Justifications given but no comparisons made in some cases. Memory size is based on one sample rate, but another is mentioned in your software diagrams.

14.7

PRACTICAL APPLICATION SKILLS

Different approaches to solving problems in particular contexts.



Costing is inaccurate as it is missing almost every part on the board, plus the parts which you

10

mentioned in the text which for some reason didn't make it to the board.

Suggested improvements are mostly ok

TRANSFERABLE SKILLS

Communicate the results of their study/work accurately and reliably, and with structured and coherent arguments; the qualities needed for employment requiring the exercise of some personal responsibility within a structured and managed environment.



Can communicate effectively in a suitable format, but may have minor errors. - Use captions correctly.

Mostly coherent work. Could be structured better.

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