

Data Logger

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Vehicle Data Acquisition System

THE ABILITY TO PRODUCE SUITABLE SYSTEM DESIGNS OVER A RANGE OF
TECHNOLOGICAL APPLICATIONS

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1. Introduction

The purpose of this assignment is to design a microcontroller based data logger which ideally will gather data from different sensors with regard to a vehicle. This data has to be stored to non-volatile memory and it should be able connected to the pc via USB. A power supply must also be considered for all selected sensors and the microcontroller. There are five different sensors sending information to the data logger, this information being RPM, speed, engine temperature, pitch, yaw, roll and suspension height. Different sensor technologies will be compared to ensure best possible design. The design specification states that the system must be re-usable, portable and adaptable for any class of vehicle. Final design will be drawn using proteus and a PCB schematic will be created.

2. Design Specification

Below is the design specification for followed:

1. Must be portable data logger
2. Must be reusable for any car type
3. Must measure the specified information
4. Must not modify the vehicle in anyway
5. Must store the information in specified time intervals
6. Must have USB connectivity

3. Existing Products

Data loggers are designed to store data (during the time or/and regarding location) provided from sensors which are either built in to the data loggers or external sensors. Most data loggers (but not all of them) are designed and built based on a digital processor with internal memory in order to receive, process and record the information.

Generally, the ideal data logger should be:

- ✓ Small
- ✓ Portable
- ✓ Low running power
- ✓ Small microprocessor with high capability
- ✓ Build in sensors
- ✓ Ability to connect to PC
- ✓ High quantity storage
- ✓ Low price

Nowadays, the requirement of data loggers in car industry is essential. There are significant numbers of different model are accessible in market. The manufactures produce them depending on the user utilization. In below, five of existing data logger in market from different company are briefly described and technically compared to achieve to the ideal device from specification perspective.

3.1 VBOX 3i

VBOX 3i is very accurate due to it having a built in GPS receiver which logs data 100 times a second. Other advantages include USB and Bluetooth connectivity, audio functionality for voice tagging, IMU integration and compact flash card logging as well as providing wide range of testing result for different situation. In real time, data from RACELOGIC IMU and Kalman Filter are used to enhance all parameter measurement. Dual antenna system is not necessarily used to measure vehicle's body angel [1].



Technical specification:

- 100 Hz logging to CF memory card
- High brake stop accuracy up to ± 1.8 cm
- Very low latency: 8.5 ± 1.5 mS
- Oversampled brake/event trigger input (25 nS)
- 4x analogue inputs
- 1x default CAN Bus port for input module expansion
- 1x configurable CAN Bus for vehicle CAN interface or VBOX data output
- Easy to fit and transport
- Real-time result display via serial, USB or Bluetooth
- User configurable logging conditions
- IMU integration
- Wide 7 V to 30 V operating range
- Low current consumption
- Audio voice tagging

3.2 Influx rebel CT standard

The standard Rebel Compact (CT) is a small powerful data logger which is very good for applications that need vehicle network data. Dependant on the package, it can have features such as GPS, accelerometer, Wifi and 3G.

Features are included such as:

- ✓ Robust metal enclosure
- ✓ Simple configuration using Dialog's integrated BUS settings
- ✓ Enables 8 K-Type connections at 2Hz sampling rate and 7 BNC Analog inputs at 1KHz sampling rate
- ✓ Analog input range -20V to +20V
- ✓ Regulated +5V and +12V output power supply for external sensors
- ✓ Instrumentation data time synchronised with the recorded vehicle network data
- ✓ H-Box power up and power down is controlled by the Rebel data logger in sleep modes so there is no user action required.



Technical specification:

- CAN x3
- LIN No
- FlexRay No
- K-Line x1
- Ethernet (LAN) Yes
- Analog inputs x4
- Digital I/O x4
- USB interface Yes
- Dimension (LxHxW) mm 126x35x110
- IP rating IP 65
- SD HC (max) 64 Gbyte
- H-Box Instrumentation Port No
- GPS 18Hz (option)
- Modem 3G (option)
- Wifi option
- Accelerometer 1kHz (option)

3.3 DL2 Race Technology

The D-type data connections are reliable connections that can be quick and easy, and it does not need any specific tools associated with micro miniature connector systems to be populated. Secure thumbs screws are used to hold the robust connections.



Technical specification:

- Log data to removable memory card for fast data transfer
- A range of enhancement options enable customisation of the DL2 to suit the application
- Supplied with complete PC software package from configuration to data analysis
- Configure the DL2 over the USB connection (configuration can also be read back and modified, ideal for making small adjustments)
- Potentially 1000s of channels of data
- Built in GPS and 3 axis accelerometers
- Up to 12 Analogue inputs (8 standard)
- 4 Frequency inputs + RPM high/low level
- Analogue inputs sampled at up to 1000Hz
- 2 serial ports support ASCII or binary data (2nd port optional)
- 2 CAN ports, supporting raw and J1939 at up to 1Mbit (2nd port optional)

3.4 PM-200 tttech

PM-200 is one of the powerful automotive data logger for protecting, securing and testing vehicles logs bus systems such as CAN, CAN-FD, FlexRay™, LIN, MOST150 and Automotive Ethernet at speeds of up to 120 MB/s, as well as making able fast measurement and distribution of the logged data.



Technical specification:

- PC Interfaces 1 x USB 2.0 High Speed / Master
- 1 x USB 2.0 High Speed Slave
- 1 x USB 3.0 Super Speed / Master (can be used as logging medium)
- Ethernet (10/100/1000 MBit/s) for quick data transmission to PC
- ePCIe 2.0 x1
- Vehicle Interfaces 12 x CAN (of which 4 can be switched to high speed and low speed)
- Optional upgrade with 12 x CAN-FD
- 3 x FlexRay (channels A/B synchronous and asynchronous respectively)
- 12 x LIN
- Optional 1 x MOST150, SPY mode
- 15 x analog inputs (12 Bit)
- 15 x digital inputs (interruptible)
- 6 x RS232
- 6 x digital outputs + 3 x analog outputs
- 2 x Ethernet 1000 MBit/s with hardware time stamp of 1µs
- Operating Temperature -40°C to +75°C
- Power Use 1.7A (operating) up to 100 µA (sleep modus) (tentative)
- Operating Voltage 6 V to 32 V (protects against outage due to strain)
- Dimensions 200 x 280 x 80 mm (L x B x H, height tentative)
- Weight 3.2 kg (tentative)

3.5 IPElog

IPElog is the most efficient data logger from IPETRONIK and is able to collect event-driven up to 12 CAN busses with the required protocols XCP and CCP. The configuration of the data logger will be done with the IPEmotion software.

Features are included such as:

- ✓ Protocol measurement on various control units:
CCP = CAN Calibration Protocol
XCP = Universal Calibration Protocol
- ✓ CAN traffic measurement with NoMessageLost (NML)
- ✓ Integrated functions for long-distance data transmission
- ✓ High computing power for storing and synchronous calculations for more than 1500 signals
- ✓ Extensive internal arithmetic and logic channels for defining complex trigger conditions
- ✓ Big storage medium of up to 128 GB on SSD



Technical specification:

- Input: 12x CAN, 2x Ethernet, 4x DIG IN, 4x DIG OUT
- Voltage supply: 9 VDC ... 36 VDC
- Power consumption: typical: 12.0 W
- Working temperature range: -40 °C ... +85 °C (-40 °F ... +185 °F)
- Storage temperature range: -45 °C ... +95 °C (-49 °F ... +203 °F)
- Relative humidity: 5 % ... 95 %
- IPC-Code (Ingress protection): IP 54 (acc. to DIN EN 60529)
- Dimensions: W206.5 mm x H72 mm x D151 mm (W8.13 in x H2.83 in x D5.94 in)
- Weight: approx. 1890 g (4.17 lb)

4. Design Method

In this section the design method is presented. The method opted for in this assignment is component compression through research. In each subsection sensors for RPM, engine temperature, suspension, pitch, yaw, roll and speed are identified.

4.1 Temperature

There are various models of temperature sensors available in the market. Thermistor, thermocouple, thermometer, infrared, pyroelectric detector, colour pyroelectric detector includes some examples. Below these to be compared against each other for the suitability of the design.

	Thermistor	Thermocouple	Thermometer	Infrared	Resistor temperature detector	Semiconductors
Contact type	Wired/contact	Wired/contact	Contact	Non-contact	Wired/contact	Contact
Accuracy	High	Medium	Medium	High	Medium	High
Ruggedness	Low	High	Medium	High	High	High
Size	Small	Small	Medium	Small	Small	Small

Regarding design specification all type of sensors have to be non-connected as no modifications can be made to the vehicle. Therefore, infrared sensor is the best choice for temperature. Below five of different type of infrared sensors which are going to be compare.

	thermoMETER CS	Wenglor TIF352U0089	Omega USB interface	UWE electronic	Raytek CM
Photo					
Temperature Range (°C)	-40 to 400	-25 to 350	-18 to 538	-40 to 1030	-20 to 500
System Accuracy	±1.5% or ±1.5°C	0,1 °C	±2% rdg or 2.2°C (4°F)	±1,5% oder ±1,5°C	1.5% or 2°C
Response time	25 ms	65 ms	100 ms	25 ms	150 ms
Output Type	Digital	Analogue	Digital	Analogue/Digital	Analogue/Digital
Output	0 to 5V or 0 to 10V / USB	0 to 10V	0 to 5V/USB	0 to 5V or 0 to 10V	0 to 5VDC
Power supply	5 to 30VDC	18 to 30VDC	0 to 5VDC	5 to 30VDC	12 to 24 VDC

The engine temperature is measured in degree Celsius and its considered over range of -30 up to 150. Therefore, ideal temperature sensor would be the one that it can read the information once every 15 second.

From the previous table Wenglor and Reytak sensors cannot be picked because they both require more than 5-volt DC to be run which would require more components. They are also

out of temperature range. Omega device has issues, it also has low response time which is not good. UWE electronic is better than the others in most parameters but still temperature range is not too close to the desired range. Therefore, CS thermometer is the most suitable one because temperature range is close to the desired range. Also, it runs at 5-V DC which is ideal for system design.

4.1.1 Temperature Specification

Range: -30 to 150

Type: Infrared

Reading: 1 every 15sec

Signal type: Analogue

4.2 RPM and Speed

Average RPM measurement within vehicles is around 0 to 9000 rpm. A sensor to measure within this range is necessary. Below are considered sensor types for RPM measurement.

RPM and speed sensors such as:

- Optical
 - Reflective
 - Beam breaker (descriptive)
- Magnetic
 - Hall effect
 - Coil
- Switch

There are common sensors which can be used in vehicle manufacturing industry. They are going to be compared on their advantages and disadvantages in below.

	Reflective	Beam breaker	Hall effect	Coil	Switch
Contact type	Non-contact	Non-contact	Wired/contact	Wired/contact	Wired/contact
Accuracy	High	Medium	Medium	High	Low
Ruggedness	Low	High	Medium	High	Medium
Size	Small	Small	Medium	Small	Small

Magnetic sensors work perfectly but it required to have a magnet fitted. Problem to having the magnet is it should attach somewhere to the internals of vehicle which is not suitable in this case. Switches need to be very strong otherwise they will break easily due to pressure of camshaft therefore not a good option.

The functionality of reflective sensors is based on detecting motions. The phototransistor as a receiver picks up reflected light from objects in front of the sensor. With optical sensors identifying the location of signal is an issue. It can be resolved by placing a reflective target (it can be simply painted or anodized as a signal pointer) on rotating shaft (camshaft pulleys) and the wheel for measuring speed. Reflective sensors work like this and it will not modify the vehicle therefore it is acceptable as an RPM and speed sensor. However, a beam breaker sensor requires some object to cut the beam in order to work, this would be difficult to achieve.

In table below 5 of different RPM reflective sensors will compare to choose the best one for this section.

	Electromatic MCS	Wenglor P1KT001	Zetlab BC 401	RS Pro 729-5117	Electromatic LS-S50MLR
Photo					
Temperature Range (°C)	-25 to 55	-40 to 60	-20 to 70	-25 to 55	-25 to 70
Response time	≤0.5 ms	1 ms	≤0.5 ms	≤0.5 ms	≤1.0 ms
Output Current	≤100 mA	<20 mA	<30 mA	100 mA	200 mA
Power supply	10 - 30VDC	10 – 30 VDC	5VDC	10 – 30VDC	10 – 30VDC
Switching frequency	1000 Hz	500 Hz	1000 Hz	1000 Hz	500 Hz
Sensing Range	0.05 - 7 m	700 mm		140 mm	25 - 400 mm

In the above comparison table all reflective sensors have same specification except BC 401 running with 5 VDC which is ideal for the design as it can run off the same supply as the microcontroller, cutting the need for more circuitry. This is a big advantage as it can reduce costs for the system.

4.2.1 RPM and speed specification

Because RPM sensor is going to be right next to the engine, it will pick up lots of noises. The signal coming out from reflective sensor should be less than 6000 pulses per minutes which is 100 pulses per second. But the actual signal is coming out from sensor is combined with noises. Therefore, differential amplifier will use to get read off from noises. Basic principle is to pick up the zero point (ground) on phototransistor and twisted with output, then feeding it to the differential amplifier with gain of 1 which means output is equal to input with different between them. Using analogue technic in order to destroying noise is not necessarily means output signal is analogue. In fact, output signal is digital.

For speed measurement the rotation of speed of the wheel is considered. Let's assume a wheel with 20-inch diameter.

$$2 \times \pi \times 10 = \text{Distance/revolution} = 62.8"$$

$$1760 \times 3 \times 12 = 63360 \text{ inch / mile}$$

Therefore, traveling is 62.8" per revolution. hence revolution in a mile is equal to:

$$\frac{62.8}{63360} \approx 1009 \text{ revolution/mile}$$

If car moving 60 miles per hour 1009 revolution accruing in one minutes and it is 16.8 revolution (pulses) per second.

Now, let's assume revolution of speed that vehicle moving at is needed in 1 mph. same way as reading RPM if only one painted mark been provided for reading point, there is not

sufficient reading to be recorded in one second. Therefore, by increasing number of painted pointer to 4, the result of reading at least reaches to 1 every 1 second. In this occasion for maximum of test if car runs 80 mph maximum pulses per second would be 89. It means taking the count every once a second and every second it reset to zero therefore 8 bits would be enough to record this data. Reading for RPM and speed is 1 every 1 second.

4.3 Suspension

Measuring deflection of the wheel up and down on the suspension could be done by different sensors on the wheel with swing arm.

Rotary encoder can move up and down and rotates the swing arm and it converts the angular position or motion of a shaft or axle to an analogue or digital signal.

Potentiometer as well as ultrasonic and infrared sensors measure rotation and could be the options to use in this aspect.

Therefore 4 different type of suspension sensors are going to be compared in the table below.

	Rotary encoder	Potentiometer	Infrared	Ultrasonic
Contact type	Wired/contact	Wired/contact	Non-contact	Non-contact
Accuracy	Medium	Medium	Low	Low
Ruggedness	High	High	Low	High
Size	Medium	Small	Small	Medium

Wind passes by side of vehicle with high percentage of pressure when traveling at 80 miles per hour. It will produce lots of white noises. Most of these noises are in ultrasonic range. Infrared also over any sort of distance will be observed in water. So, rain causes to lose signal. Other disadvantage of using infrared is dirtiness of reflective sensor over period of time. Actual angular displacement is quite small due to size of swing arm in this case. Therefore, very fine rotary encoder is required to solve the issue. There are different types of potentiometers available in the market. The best one in this case would be multi-turn potentiometer with 20 turns which take 20 turns from one end to the other and therefore gives enough resolution. In the below 5 different potentiometers are going to be compared against each other.

	VISHAY RP12	DY WX010	Altheris 30FLPA	ROCKET WH138-1AK—3	3323U BOCHEN
Photo					
Temperature Range (°C)	-15 to 55	55 to 125	±400	50	-55 to 125
Resistance (Ω)	2K, 4.7K	200 to 100K	Over 1M	5K to 2M	10 to 2M
Maximum operation voltage	500V	220V	500V	500V	250V
Power Rating (W)	0.5	2	1.25 to 10	A 0.5 other 0.25	0.5

Altheris sensor has been found to be more accurate during researching sensor for suspension.

4.3.1 Suspension specification

Suspensions required 1 reading every 0.5 millisecond. If swing arm has vertical movement from 0 to 760 millimetres with input voltage from 0 to 5 volts, the stationary position is on 350 mm which gives 2.3V. so maximum deflection would be 2 volts. 1-millimetre steps have to be measure whereby 300 mm across 2V:

$$\frac{2}{300} = 0.006 \text{ voltage/millimeter}$$

Therefore in 5 volts range the resolution in 8 bits would be 0.0195 which is not sufficient to resolve the issue. In 10 bits it will increase to 0.0049 which is enough to work with.

4.4 Pitch, roll and yaw

Pitch: it is typically considered as upward and downward movement of the vehicle nose. In another word pitch is front and back motion of a car. It should be measured to knowing how much speed increase or decrease when vehicle goes up and down the hill.

Roll: is about distribution of car weight when is turning around or passing on the corner. In another word vehicle on either side can tip on two wheels and topple over. The purpose of measuring roll is due to passenger's comfortability.

Yaw: is clockwise or anticlockwise movement of rod and car. The difference between speed of wheels rotation in both side when vehicle turns right or left, called yaw. The reason for measuring yaw is that how fast it will start brakes free. I.e. when driving by the corner quite quickly, speed of the car plus fast reaction of spin have to identify.

G-sensors or accelerometers and gyroscopes etc. are preferred sensors to measure PRY. The different between these two methods are that gyroscope giving information constantly about changing direction, whereas accelerometer shows how fast direction is changing. In below these two types of PRW are going to be compare against each other.

	Accelerometer	Gyroscope
Stabilization	Medium	High
Accuracy	High	High
Ruggedness	High	High
Size	Small	Small
Noisiness	Medium	High

Because reading and measuring and recording vehicle pitch, roll and yaw are considered in this section, the problem with accelerometers is when car starting to move up hill, it is accelerating upwards and accelerometer will respond. But when it reaches to steady speed the reading of accelerometer will be zero due to not accelerating anymore. This is not the case in gyroscope. Therefore, gyroscopes are preferred instead of accelerometers. 5 different types of gyroscopes are going to be compare in below.

	Analog Devices ADXRS453BEYZ	Analog Devices ADIS16265BCCZ	STL3GD20HTR Microelectronics	SCR2100-D08 Murata	M-G350-PD11 EPSON
Photo					
Temperature Range (°C)	-40 to 105	-40 to 105	-40 to 85	-40 to 125	-40 to 85
Number of Axis	1	1	3	1	3
Operation voltage	3.15 to 5.25	4.75 to 5.25	2.2 to 3.6	3 to 3.6	3.3
Pin Count	14	20	16	24	13
Frequency Response range	Max of 77.5 Hz	Max of 330 Hz	0 to 400 kHz	0.1 to 8 MHz	133
Interface Type	SPI	SPI	I2C, SPI	SPI	SPI / UART

M-G350 has been picked up as PRY sensor as it runs at 3.3-volt DC and it covers 3 axis which is very suitable.

4.4.1 Pitch, Roll and Yaw specification

PRW also required 10 bits to store the data and it needs the reading every 2 millisecond which means taking 3 reading every 2 ms.

5. Data Recording Table

0 Second	T	S	RPM	P	R	Y	Suspension
0.5m/s	Suspension				Suspension		
	Suspension				Suspension		
	P				Y		
1 s	S	RPM	P	R	Y	Suspension	
15 s	T	S	RPM	P	R	Y	Suspension
	Suspension				Suspension		
	Suspension				Suspension		
	P				Y		
	S	RPM	P	R	Y	Suspension	

Connectors

This project like any other electronics project including wires for connection. Choosing right connectors will improve accuracy and reliability of circuit. There are different company in the market producing connectors. LEMO is the one that considered as standard provider with high percentage of safeguarding on their product. T series of LEMO connectors with IP range of 68 are include an inner sleeve and seals to prevent penetration of solids or liquids and they profited features such as:

- ✓ IP68 mated
- ✓ Compatible with existing B sockets
- ✓ Push-Pull self-latching system
- ✓ Same mounting hole as B sockets
- ✓ Mechanical key (FGG) with multiple keys
- ✓ Black-chrome plated brass and plastic outer shell available to avoid cross-mating
- ✓ Multipole types 2 to 32 contacts
- ✓ High packing density for space savings
- ✓ For cables 1.0 up to 10.5 mm
- ✓ 360° shielding for full EMC shielding
- ✓ Solder, crimp or print contacts

	Series	Sensor use
	303	Suspension
	303	Suspension
	303	Suspension
	303	Suspension
	304	Pitch
	304	Roll
	304	Yaw
	305	RPM
	305	Speed

	306	Temperature
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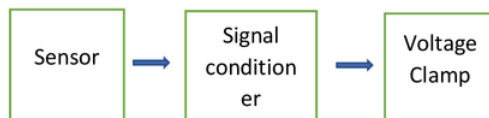
As shown in above table 4 of 303 series connectors are considered for suspension measurement, 3 of 304 series for pitch, roll, yaw and 2 of 305 series for RPM and speed and a 306 series for temperature.

Although all the sensors have 3 pin connections but except suspensions sensors 6 other sensors have extra connection pin. This is due to identifying different measurement when all sensors are connected to the data logger through wires.

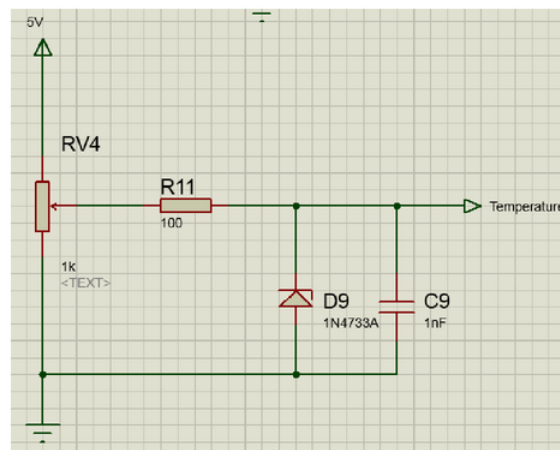
Circuit schematic

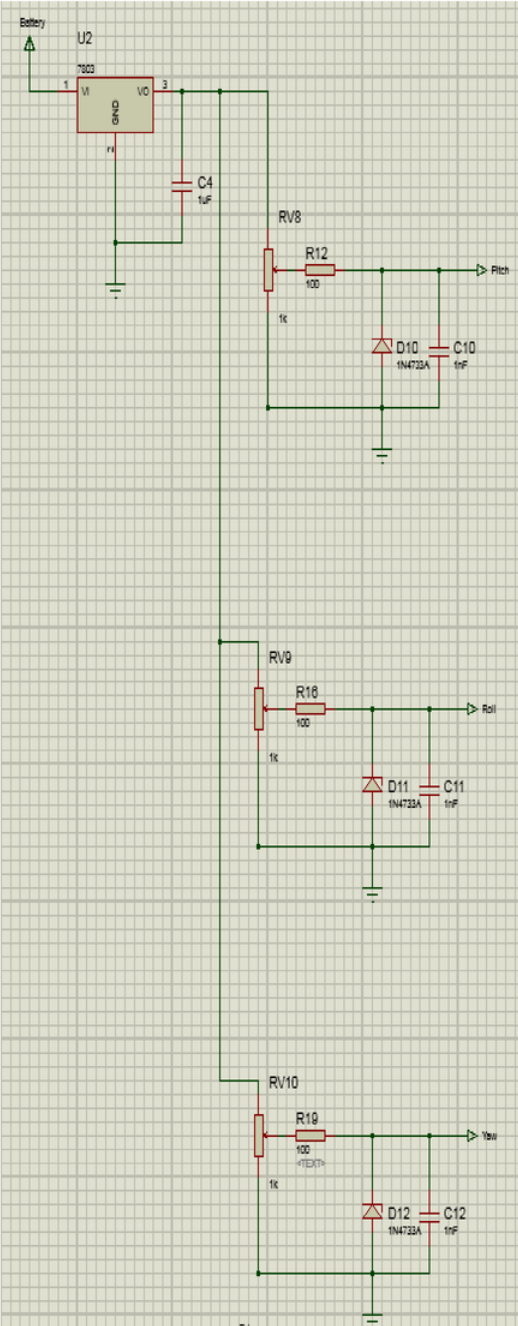
Totally 10 sensors have been used in this project. 8 of them analogue and 2 of them are digital signal. 12-volt battery supplying enough voltage for circuit. Two voltage regulators have been designed to giving certain amount of voltage for different blocks of circuit. 7803 has been utilized to give 3.3V regulated and 7805 producing 5V regulation. Pitch, roll and yaw are running at 3.3 volt and rest of circuit is running at 5 volts. USB and SD card are also connecting to the PIC in order to gathering data, reading and storing them then wipe the data up if is needed. each signal also connected to the pic through signal conditioner and voltage clamp.

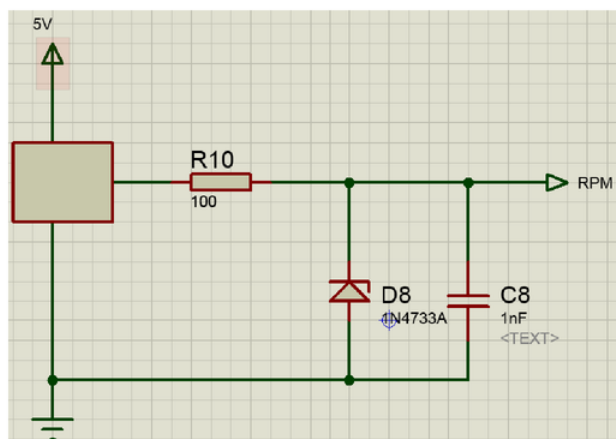
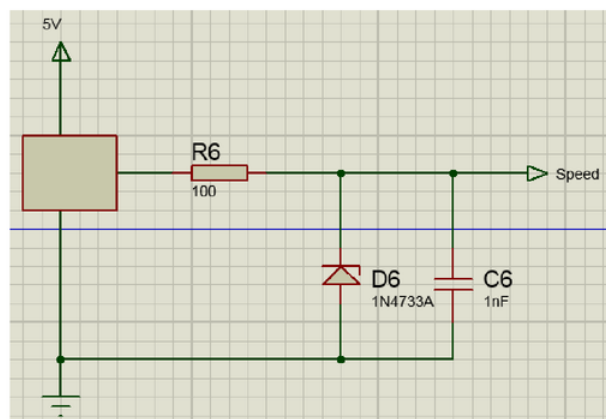
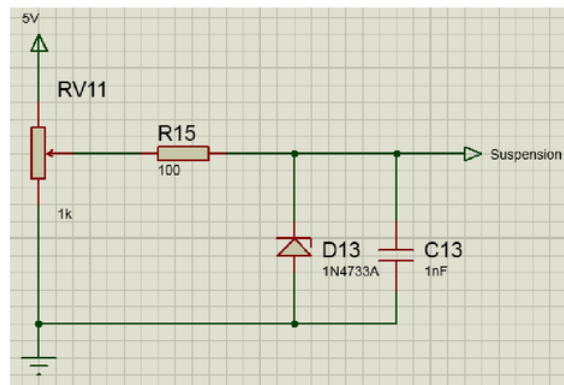
Signal conditioner would be either amplifier or attenuator which will prepare enough voltage for next block. Voltage clamp is a block that each signal needed pass through before driving to the microcontroller. It is simply consisting of 3 elements. Resistor, diode which conducts electric current in only one direction and prevents the signal exceeding the reference value and a capacitor which provides a DC offset from the stored charge.

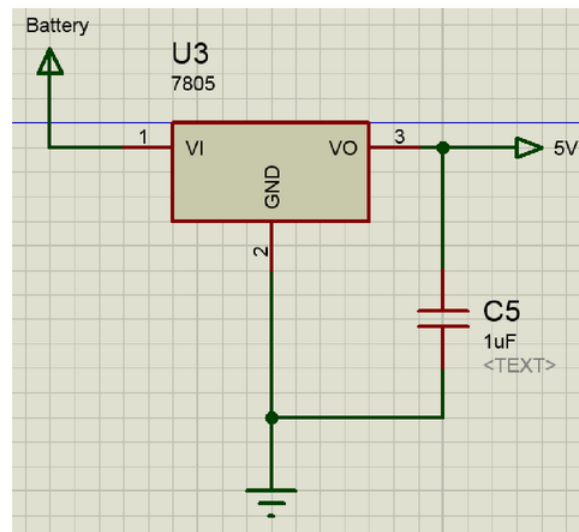


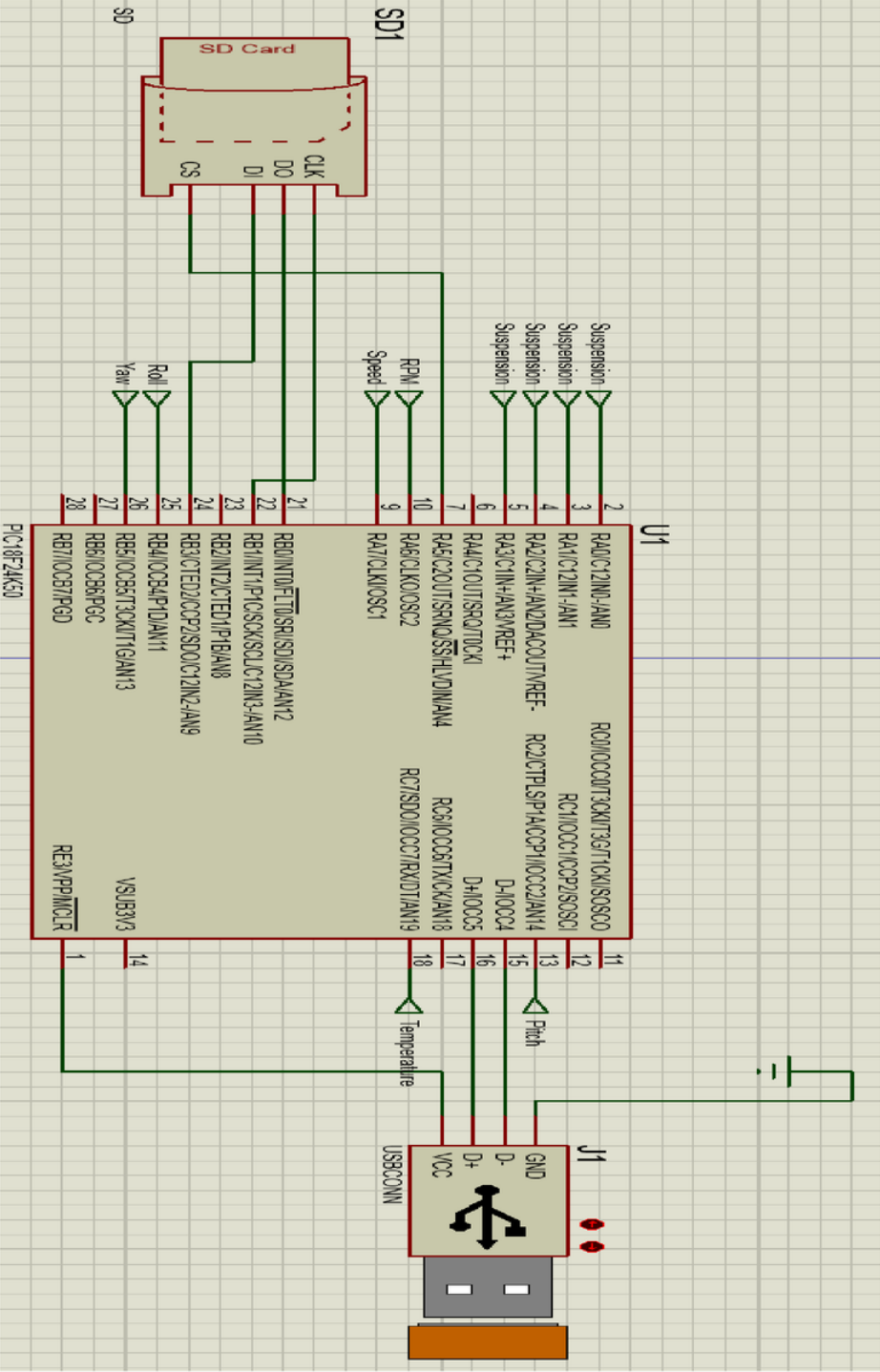
The circuitry has been implemented in proteus. In below screen shots are indicating different part of circuit.











Microcontroller Selection

Pick cannot be selected till number of parameters will verified. These parameters are:

- ✓ How many analogue input
- ✓ How many digital input
- ✓ How many output
- ✓ Amount of memory
- ✓ How to store data
- ✓ What to do with information been stored

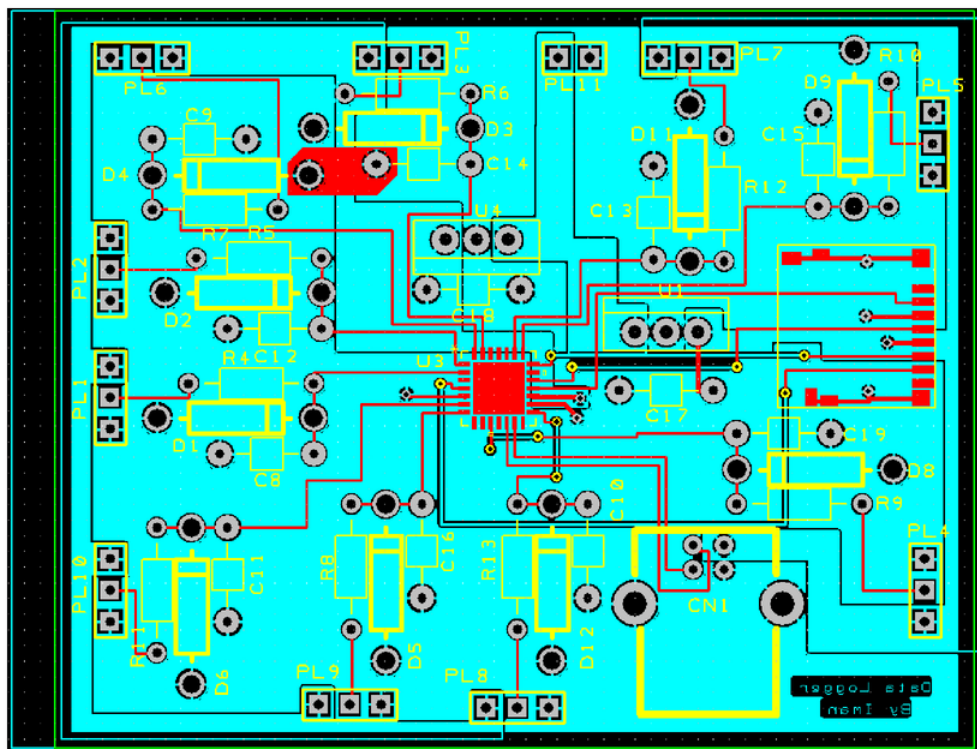
This clarification will assist to not picking up as biggest microchip as possible when only smaller version of it can offer everything that needed in piratical purpose. It effects to the land of pcb that employers have to pay for, that is much bigger than it should be. It's good to leave the headroom but it doesn't mean that choose the biggest one to having plenty of scope.

PIC18f24K50 has been used from microchip site trough specifying the parameters.

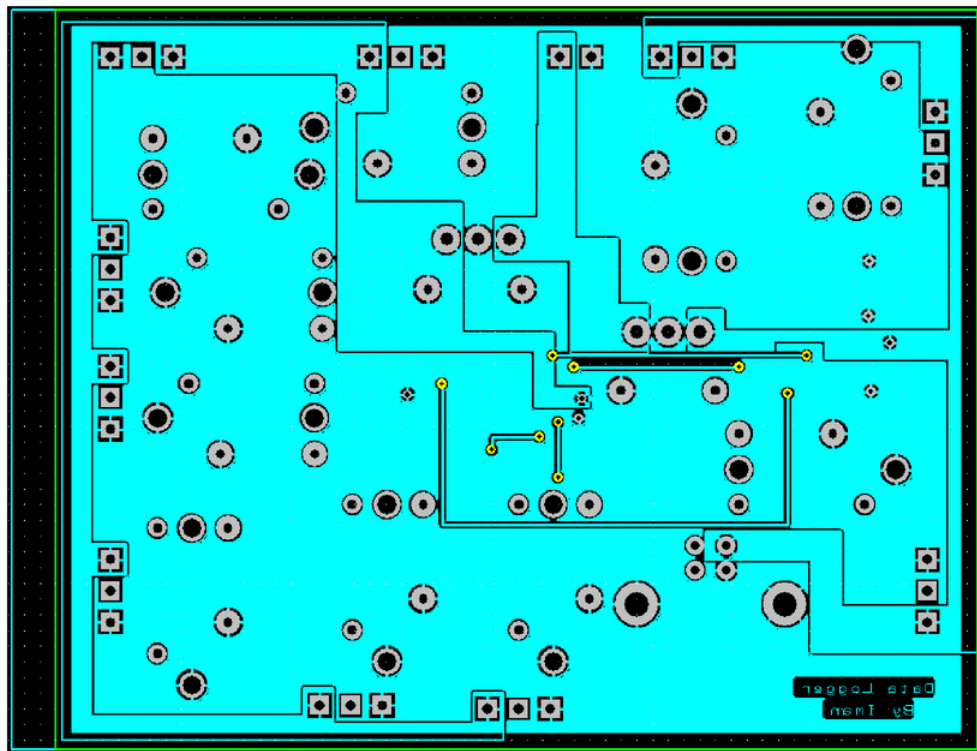
Product	Buy	Status	Documents	5K Pricing	Program Memory Size (Kbytes)	RAM (bytes)	EEPROM / HEF	Pin count	Max. CPU Speed MHz	Peripheral Pin Select (PPS)
[Reset] PIC18F200 PIC18F202 PIC18F204 PIC18F206 PIC18F220 PIC18F222 PIC18F224 PIC18F226 PIC18F228 PIC18F230 PIC18F232 PIC18F234 PIC18F236 PIC18F238 PIC18F240 PIC18F242 PIC18F244 PIC18F246 PIC18F248 PIC18F250 PIC18F252 PIC18F254 PIC18F256 PIC18F258 PIC18F260 PIC18F262 PIC18F264 PIC18F266 PIC18F268 PIC18F270 PIC18F272 PIC18F274 PIC18F276 PIC18F278 PIC18F280 PIC18F282 PIC18F284 PIC18F286 PIC18F288 PIC18F290 PIC18F292 PIC18F294 PIC18F296 PIC18F298 PIC18F300 PIC18F302 PIC18F304 PIC18F306 PIC18F308 PIC18F310 PIC18F312 PIC18F314 PIC18F316 PIC18F318 PIC18F320 PIC18F322 PIC18F324 PIC18F326 PIC18F328 PIC18F330 PIC18F332 PIC18F334 PIC18F336 PIC18F338 PIC18F340 PIC18F342 PIC18F344 PIC18F346 PIC18F348 PIC18F350 PIC18F352 PIC18F354 PIC18F356 PIC18F358 PIC18F360 PIC18F362 PIC18F364 PIC18F366 PIC18F368 PIC18F370 PIC18F372 PIC18F374 PIC18F376 PIC18F378 PIC18F380 PIC18F382 PIC18F384 PIC18F386 PIC18F388 PIC18F390 PIC18F392 PIC18F394 PIC18F396 PIC18F398 PIC18F400 PIC18F402 PIC18F404 PIC18F406 PIC18F408 PIC18F410 PIC18F412 PIC18F414 PIC18F416 PIC18F418 PIC18F420 PIC18F422 PIC18F424 PIC18F426 PIC18F428 PIC18F430 PIC18F432 PIC18F434 PIC18F436 PIC18F438 PIC18F440 PIC18F442 PIC18F444 PIC18F446 PIC18F448 PIC18F450 PIC18F452 PIC18F454 PIC18F456 PIC18F458 PIC18F460 PIC18F462 PIC18F464 PIC18F466 PIC18F468 PIC18F470 PIC18F472 PIC18F474 PIC18F476 PIC18F478 PIC18F480 PIC18F482 PIC18F484 PIC18F486 PIC18F488 PIC18F490 PIC18F492 PIC18F494 PIC18F496 PIC18F498 PIC18F500 PIC18F502 PIC18F504 PIC18F506 PIC18F508 PIC18F510 PIC18F512 PIC18F514 PIC18F516 PIC18F518 PIC18F520 PIC18F522 PIC18F524 PIC18F526 PIC18F528 PIC18F530 PIC18F532 PIC18F534 PIC18F536 PIC18F538 PIC18F540 PIC18F542 PIC18F544 PIC18F546 PIC18F548 PIC18F550 PIC18F552 PIC18F554 PIC18F556 PIC18F558 PIC18F560 PIC18F562 PIC18F564 PIC18F566 PIC18F568 PIC18F570 PIC18F572 PIC18F574 PIC18F576 PIC18F578 PIC18F580 PIC18F582 PIC18F584 PIC18F586 PIC18F588 PIC18F590 PIC18F592 PIC18F594 PIC18F596 PIC18F598 PIC18F600 PIC18F602 PIC18F604 PIC18F606 PIC18F608 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PIC18F1918 PIC18F1920 PIC18F1922 PIC18F1924 PIC18F1926 PIC18F1928 PIC18F1930 PIC18F1932 PIC18F1934 PIC18F1936 PIC18F1938 PIC18F1940 PIC18F1942 PIC18F1944 PIC18F1946 PIC18F1948 PIC18F1950 PIC18F1952 PIC18F1954 PIC18F1956 PIC18F1958 PIC18F1960 PIC18F1962 PIC18F1964 PIC18F1966 PIC18F1968 PIC18F1970 PIC18F1972 PIC18F1974 PIC18F1976 PIC18F1978 PIC18F1980 PIC18F1982 PIC18F1984 PIC18F1986 PIC18F1988 PIC18F1990 PIC18F1992 PIC18F1994 PIC18F1996 PIC18F1998 PIC18F2000										
PIC18F24K50	\$	In Production		\$1.65	16	2048	256 / HEF	28	48	No
PIC18F25K50	\$	In Production		\$1.76	32	2048	256 / HEF	28	48	No
PIC18F45K50	\$	In Production		\$1.99	32	2048	256	40	48	No

In below different view of PCB schematic of actual data logger circuit added.

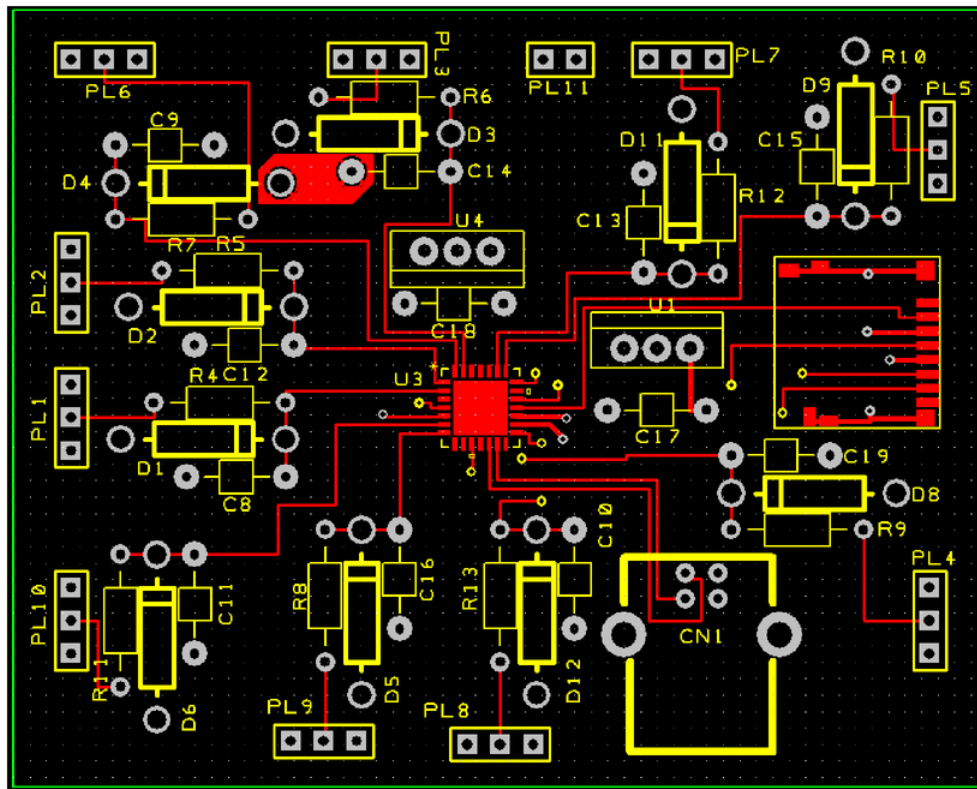
Composite view



Button view



Top view





References

Data Logger

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

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GRADING FORM: SMU GENERIC_GJ

IMAN SAYADICHOOBARI**47.80****RESEARCH-INFORMED LITERATURE**

Literature revue is reasonable manufacturer information is well presented but it would be improved by following up with a comparison table of relevant information. 65%

6.5**KNOWLEDGE AND UNDERSTANDING**

Good overall schematic design but a few problems can be seen. There is a little confusion over the voltage the Pic is running at, the sensor voltage would seem to indicate that the Pic is running at 3V3 but the Proteus schematic indicates 5V. Make sure that any chip voltage away from VCC is documented on the schematic. The suspension inputs are indicated as all being on the same net as they all have the same name, more care is required on your designs. 60%

15**ANALYSIS**



Good selection of microcontroller. Good selection of sensors showing calcs for each one with a very nicely laid out table showing the selection of sensors to be chosen from with an image or illustration of each. No case selection shown. Good selection of connectors but no discussion or reflection of other suitable connectors. No battery calcs. 58%

20.3

PRACTICAL APPLICATION AND DEP.



No costings put forward. No attempt at future enhancements. 0%

SKILLS FOR PROFESSIONAL PRAC.



The report is well presented with very well presented tabled data but no structure diagrams. No references were shown in the report but these were found in the accompanying files, these need to be in the document. 60%

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