

ESD1

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L6-Electrical System Design (ACDA6002)

ASSIGNMENT 1 – VEHICLE DATA ACQUISITION
STAPLETON RYAN (SAFRAN SEATS)

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1.0 Assignment Brief

The assignment brief outlines design specifications of a vehicle data logger that is required to last a full 2 hour test drive.

The brief outlines key aspects of the vehicle that need monitoring, so the data can reviewed and determine if they are achieving their intended purpose.

These keys aspects are as follows:

- Vehicle Road Speed (MPH)
- Engine RPM
- Engine Temperature
- Roll, Pitch and YAW
- Suspension Travel

To achieve this, various sensors, microcontrollers and controllers need to be specified to achieve the desired outcome, whilst being packaged in a suitable housing to withstand the harsh elements of a 2 hour test drive.

2.0 Introduction

The following document will outline the various stages of designing a Vehicle Data Logger for a 2hour test drive.

This document will outline aspects such as component selection and justification for these selections. The components include items such as connectors, Microcontrollers, sensors and a suitable enclosure for this to be stored in.  2

This document will also provide detailed schematics of the prototype and final design of the data logger, with explanations as to why certain design details have been implemented.

Finally, the document will also outline future improvements, and a critical analysis of the design produced, highlighting weaknesses in the design that could be implemented out if this task was to be completed again.

3.0 Background Research

3.1 Vehicle Data Acquisition Systems

There are various Data acquisitions systems currently on the market to inspiration from when completing this task.

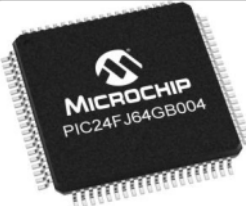
The following table shows the comparisons between these various data loggers.

	Channels	Sample Rate	Internal Memory	USB Ports	Base Rate	Recording Rate	GPS Input?
 2D Data Recording Logger 9 [1]	600 Channels (512 via CAN)	1000Hz sampling rate for each CAN channel	8 GB internal memory	1 USB, 1 RS232 serial interface	Base rate 1 kHz / 10 kHz	up to 1800 kByte/s total recording rate	Yes
 GL Logger Families [2]	10 CAN Channels	1kHz sample rate	SD memory cards up to 2 GB SDHC memory cards up to 32 GB	1 x 2.0 USB	N/A	N/A	Yes
 RAD-Galaxy Data Logger [3]	8 CAN Channels	1kHz sample rate	Full size SD Card slot	No USB, connection through Ethernet cable	N/A	N/A	Yes

3.2 Component Selection

The following section will showcase the component selection for the data logger, and the justification for selecting these components.

3.2.1 Microcontroller Selection

		
• [4]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 • Universal Serial Bus 2.0 Module • 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 • 2x 8-bit Timers • 2x 16-bit Timers • Extended Watchdog Timer (WDT) • Enhanced Power-On/Off-Reset • PIC18LF2xK50 (1.8V – 3.6V) with nanoWatt XLP • PIC18F2xK50 (1.8V – 5.5V)	[5]<u>CPU</u> • Up to 16 MIPS performance • 16 x 16 Hardware Multiply, Single Cycle Execution • 32-bit x 16-bit Hardware Divider • C Compiler Optimized Instruction Set <u>System</u> • Internal oscillator support - 31 kHz to 8 MHz, up to 32 MHz with 4X PLL • On-chip LDO Voltage Regulator • JTAG Boundary Scan and Flash Memory Program Support • Fail-Safe Clock Monitor – allows safe shutdown if clock fails • Watchdog Timer with separate RC oscillator <u>Extreme Low Power Managed Modes</u> • Run, Idle and Sleep modes • Deep sleep mode for lowest current consumption • Multiple, Switchable Clock Modes for Optimum Performance and Power Management <u>Analog Features</u> • 10-bit ADC, 13 channels, 500k samples per second • 3 Analog comparators	[6]<u>Full Speed USB 2.0</u> • Full Speed USB 2.0 – Host, Device and OTG • DMA Interface for Data RAM Access <u>Core and Operating Conditions</u> • 2.0V to 3.6V, -40°C to 125°C, up to 16 MIPS operation • Single-cycle instruction execution • 16 x 16 Hardware Multiply, and 32-bit x 16-bit Hardware Divider • C compiler optimized instruction set system • AEC Q100 Grade 1 qualification <u>Extreme Low Power</u> • Ultra-low-power operation with sleep current down to nA with full RAM retention • A range of power-saving modes to reduce current consumption, while balancing performance: PMD bits, DOZE, Idle, Sleep and Retention Sleep modes • A range of Core Independent Peripherals (CIPs) that operate in power saving modes, while off-loading the Central Processing Unit (CPU)

PIC18F45K50

[4]The PIC selected was the PIC18F45K50 due to the number of pins and the pin layout. The advantages of using this PIC are as follows:

- The PIC18F45K50 is built on a high-performance RISC (Reduced Instruction Set Computing) architecture, providing efficient and fast execution of instructions.  4
- It comes with a significant amount of Flash memory for program storage. This allows for the implementation of more complex programs and applications.
- Includes a variety of integrated peripherals such as analog-to-digital converters (ADC), timers, UART, SPI, I2C, and USB. These peripherals enhance the capabilities of the microcontroller and make it versatile for different applications.
- USB 2.0 interface, which makes it suitable for applications requiring USB connectivity. This is particularly useful in applications such as USB communication, USB data logging, and USB device control.
- The built-in ADC allows for easy interfacing with analog sensors and signals. This is crucial in applications that require accurate analog measurements, such as sensor interfacing and data acquisition systems.
- Microchip provides a comprehensive set of development tools, including compilers, debuggers, and integrated development environments (IDEs). Additionally, there is a large community of developers and resources available for PIC microcontrollers, which can be beneficial for troubleshooting and sharing knowledge.



3.2.2 Sensor Selection

Pitch, Roll and Yaw

		
[7]Yaw rate sensor 200 or 500°/s (gyro) To measure pitch-, roll- and yaw-speed of vehicle To measure banking angle speed of a bike To calculate the inclination of the bike (the required function is included in the software). - Power supply..... 4.75 - 5.25 V DC - Operating current..... max. 50 mA - SA-GY200V4-000..... ~ 200°/s@0.5V 200°/s@4.5V	[8]All-in-one sensor node, which fits into the palm of your hand (40x63 mm) for any IoT applications - Ready-to-go development kit - Ultra-low-power with FPU Arm-Cortex-M33 with TrustZone® microcontroller (STM32U585AI) - microSD™ card slot for standalone data logging applications - On-board Bluetooth® Low Energy 5.2 (BlueNRG-LP) and NFC tag (ST25DV04K)	[9]Voltage 3.3V to 5V - Current is <40mA - Size 51.33x61.0mm - Measuring dimension acceleration 3D, angular velocity 3D, attitude angle 3D - Hardware DFRduino UNO R3 (https://www.dfrobot.com/product-838.html) (or similar) x 1 Serial 6-Axis Accelerometer x1 - Software Arduino IDE (https://www.arduino.cc/en/Main/Software)

The sensor selected to measure Roll, Pitch and Yaw was the [7]2D-Daterecording yaw rate sensor. This sensor was selected as it's designed for automation applications. The power supply is suited to this concept, and is easily mountable onto the vehicle under test.

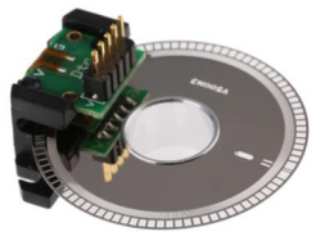
Suspension Travel

		
• [10] Compact lightweight design • Cost-effective measuring system • Stroke lengths from 25 to 300 mm (1 to 12 inches) • Industrial duty, liquid and corrosion resistant • Features • Specifications • Output: 0 to 100% of Input Voltage (potentiometer circuit) • Non-Linearity, Full Stroke: $\leq \pm 2.5\%$ of FSO • Best Fit Straight Line (BFSL) • Resolution: Infinite • Repeatability: 0.01 mm (0.0004 inch) • Element Type: Conductive Plastic • Max Operating Speed: 5 m/S (16 ft/S) • Operating Current: Input Voltage / Potentiometer Resistance Value (refer to chart on Page 2 for Resistance Value) • Operating Temperature: -40 to +95°C (-40 to +203°F) • Temperature Coefficient: $\leq \pm 0.03\%$ of FS / °C • IP Rating: IP61	• [11] Laser Type- Diode • Laser Colour- Red • Emission Pattern- Dot • Laser Wavelength- 658nm • Laser Class- 3R • Control Type- Self Pulsed • Application- Beam Break • Supply Voltage Range- 5	• [12] Low cost • Industry standard, single element conductive track • Measurement range 25mm to 350mm • Superior non-linearity $\leq \pm 0.15\%$ FS • 13mm Ø slim aluminium body • 4mm Ø stainless steel shaft • Sealed to IP65

The sensor selected to measure suspension travel was the [12]linear displacement potentiometer. The travel of this potentiometer meets the requirements of the guidelines set out, along with the operating temperatures of this sensor. This sensor is also IP65 rated which should prevent water damage when the vehicle is driving wet weathers.



Road Speed (MPH) and Engine RPM

		
• [13]Operating current is = 50 mA (without load) • Supply voltage 4.5 to 5.5 V • Output frequency is = 300 kHz • Encoder Technology- Incremental • Pulses Per Revolution- 100 • Maximum Revolutions- 8000rpm • Output Signal Type- TTL • Shaft Type- Solid • Shaft Diameter- 6mm • Supply Voltage- 4.5 to 5.5 V dc	• [14]Sensor Style- Block • Detection Type- Through Beam • Detection Range- 0 → 3 m • Output Type- Dark Switching • Electrical Connection- Cable • Maximum DC Voltage- 30V • Terminal Type- 3 Pin Connector • Light Source- Polarized Red Light • IP Rating- IP68, IP69K • Maximum Current- 100 mA • Response Time- 0.0005 seconds • Housing Material- Plastic • Series- W4-3 PTFE • Minimum Operating Temperature- -40 °C • Maximum Operating Temperature- +60°C	• [15]Possible applications include: • printers • copiers • scanners • servo and stepper motor feedback systems • robotic arms • wafer-handling machines • Small Size • Low Cost • Easy to Mount • TTL Compatible • Resolution from 100 CPR to 500 CPR (Counts Per Revolution) • Two Channel Quadrature Output with Index Pulse • Operating Temperature: - 10°C to 85°C

[13]An encoder is to be used to measure the road speed of the vehicle (MPH) and the engine RPM. The reason for this selection is the supply voltage suits the design, but also the pulses per revolution. At 6000RPM, the encoder has the ability to give 300,000 readings, giving a 'live' report of what speed the engine is rotating at.

Engine Temperature

		
• [16]Sensor Type- PT100 • Probe Length- 27.5mm • Probe Diameter -5.4mm • Minimum Temperature Sensed- -50°C • Maximum Temperature Sensed- +200°C • Termination Type- Cable • Cable Length- 2.5m • Probe Material- Stainless Steel • Process Connection- Probe • Number Of Wires- 2 • Accuracy- Class B	• [17]High quality, low cost, non-contact Infra-red temperature sensors suitable for measuring the temperature of inaccessible or moving objects and materials. • Fast response with high stability • Types available with air/water cooled housings • Quick and easy to install • Available as either two-wire or four-wire units • 240 ms to 90% response time • Stainless steel housing • 16 x 1 mm mounting thread • Prewired 1 m cable connection • 6 V dc minimum sensor voltage • 0.95 emissivity • Temperature change varies by model	• [18]Maximum operating temperature of +350 °C • Meets IEC standards • Various probe diameters are available in this range. • Fast response time provided by the grounded tip at the junction • Thermocouple Type - K • Probe Diameter- 3.18mm • Probe Length- 40mm • Maximum Temperature Sensed- +350°C • Probe Material- Stainless Steel • Termination Type- Cable • Cable Length- 2m • Standards Met- IEC

To measure engine temperature, the sensor selected was an RTD. The reason for this selection was the operating temperatures. This sensor can detect temperatures ranging from -50°C to +200°C. These sensors tend to be more accurate and more robust than a thermocouple. These sensors are also relatively inexpensive.

3.2.3 PCB Board Selection

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Standard PCB/PCBA Advanced PCB/PCBA SMT-Stencil 3D/CNC

Detected 2 layer board of 83.82x107.95mm(3.3x4.25 inches) Gerber Viewer

Back to Upload File

Base Material: FR-4, Flex, Aluminum, Copper Core, Rogers, PTFE Teflon

Layers: 1, 2, 4, High Precision PCB, 6, 8, 10, 12, 14, 16, 18, 20

Dimensions: 107.95, 83.82

PCB Qty: 5

Product Type: Industrial/Consumer electronics, Aerospace, Medical

PCB Specifications

Different Design: 1, 2, 3, 4

Delivery Format: Single PCB, Panel by Customer, Panel by JLCPCB

PCB Thickness: 0.4, 0.6, 0.8, 1.0, 1.2, 1.6, 2.0

PCB Color: Green, Purple, Red, Yellow, Blue, White, Black

Charge Details

Engineering fee	\$4.00
Via Covering	\$0.00
Surface Finish	\$0.00
Board	\$3.40

Build Time

PCB: 2 days \$0.00, 24 hours \$7.10

Calculated Price: \$7.40

SAVE TO CART

Weight: 0.27kg

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After completing the design of the PCB board, a quote was requested for the cost of manufacturing the PCB board. This was done through [19] 10.

From the quote received, the cost of manufacturing this PCB board and assembling came to \$7.40.

3.2.4 Connector Selection

	[20]Molex Single Row (3-Pin) Male & Female Receptacle Plug, w/Terminal sockets Micro-Fit 3.0 (Pack of 3 Set)
	[21]FCT Mixed Layout D-Sub Housing, Male, Tin-plated Shell with Dimples, 3 Circuits, Green Insulator
	[22]Pluggable Terminal Socket Connector with CAGE CLAMP Actuation, 3 way, 7.5mm pitch, Grey - 231-203/026-000
	[23]BINDER 09 9789 71 05 – 5 Pin Connector for 2D Date recording gyroscope.
	[24]Molex Micro-Fit 3.0™ Single Row (5-Pin) Male & Female Receptacle Plug, w/Terminal sockets

The table above shows various types of connectors which are viable to use for the vehicle data logger.

The connectors selected are as follows:



- Molex 3-pin connector – selected due to simplicity and price. As these aren't specialist connectors, there is always stock of these connectors reducing long lead times.
- Molex 5-pin connector – selected for simplicity and price. These also are not specialist connectors so there is always stock of these, reducing long lead times.
- Binder 5-pin connector – selected due to it being the mating connector for the 2D Data recording Gyro selected. To prevent voiding warranties on parts, it's not feasible to remove the connector that is on the gyro for a cheaper alternative. Even though this connector is more specialist, there could be a longer lead time, and the part is more expensive. However, this will still be cheaper in the long term than voiding warranties.

3.2.5 Enclosure Selection

		
[25]SA-39 NEMA Stainless Steel Enclosure	[26]SB-39 NEMA Steel Enclosure	[27]AN-16F Diecast Aluminum NEMA Enclosure

The enclosure selected was the AN16-F Diecast Aluminium enclosure. The reasons as to why this enclosure was selected over the others are as follows:

- 160x100x60mm
- NEMA 4, 4X, 6, 6P, 12 & 13 rated
- IP67 rated
- Meets IP65, IP66, IP67 & IP68 specifications based on NEMA/UL Type rating conversion
- Molded on flanges
- Watertight gasket

Structure Diagram

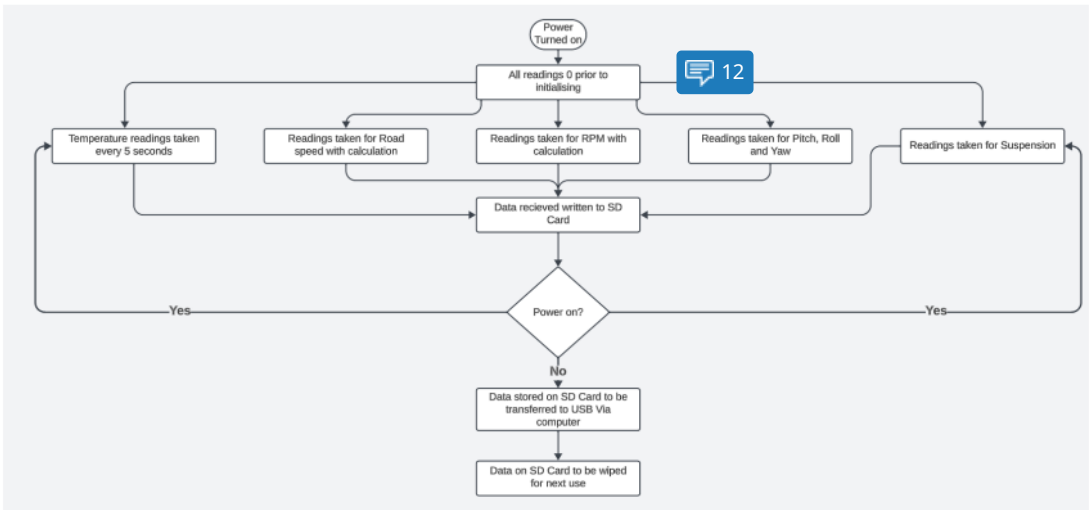


Figure 1- Vehicle Data Logger Structure Diagram

4.0 Prototype Schematics

4.1 Proteus Schematics

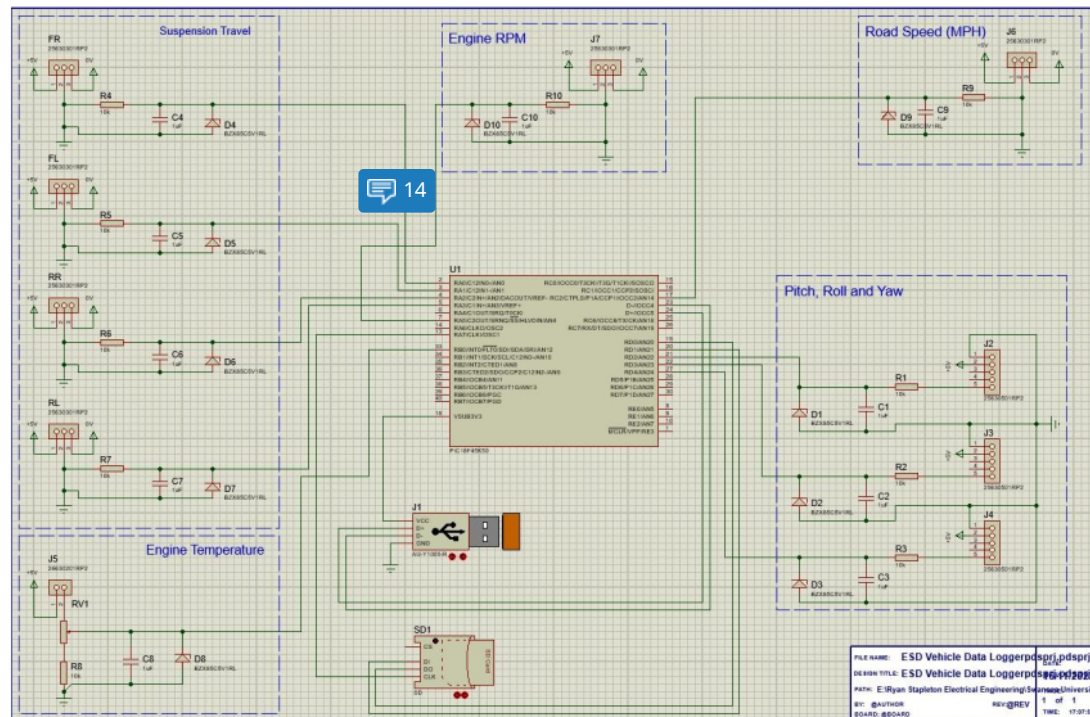


Figure 2- Proteus Prototype Schematic

The figure above shows the prototype schematic of the vehicle data logger created using Proteus.

To ensure the PIC or any of the sensors don't exceed the required supply voltage, over voltage protection has been added to each sensor. As the supply voltage for all of these components is 5V, a 5.1V Zener diode has been added to ensure any voltage over this threshold doesn't get through to the PIC or to the sensors.

Calculations

Each sensor will require various resistors and capacitors depending on the frequency of readings required. For example, engine RPM will need a high frequency of readings as you will require intervals of every 10 rotations. Compare that to engine temperature, the frequency of readings can be less as it's not constantly changing like engine RPM.

The calculations for these components is shown below;

Road Speed (MPH) and Engine RPM

$$500\mu A = \frac{V}{R}$$

$$500\mu A = \frac{5 - 3.3}{(500 \times 10^{-6})} = 3.4k \text{ ohms}$$

$$V_{out} = V_{in} \times \frac{R2}{R1 + R2}$$

$$\frac{5}{3.3} - 1 = \frac{3300}{R2}$$

$$R2 = \frac{3300}{0.515} = 6.4k \text{ ohms}$$

Engine Max RPM of 8000RPM  15

$$\text{Frequency} = 133.33\text{Hz}$$

$$C = \frac{1}{2\pi R c}$$

$$C = \frac{1}{2\pi \times 133.33 \times 3300} = 36.172\mu F$$

Suspension Travel

$$V_{out} = V_{in} \times \frac{R2}{R1 + R2}$$

$$\frac{5}{3.3} - 1 = \frac{3300}{R2}$$

$$R2 = \frac{3300}{0.515} = 6.4k \text{ ohms}$$

$$\text{Frequency} = 100\text{Hz}  16$$

$$C = \frac{1}{2\pi R c}$$

$$C = \frac{1}{2\pi \times 100 \times 3300} = 48.229\mu F$$

Engine Temperature

$$V_{out} = V_{in} \times \frac{R2}{R1 + R2}$$

$$\frac{5}{3.3} - 1 = \frac{3300}{R2}$$

$$R2 = \frac{3300}{0.515} = 6.4k \text{ ohms}$$

$$\text{Frequency} = 50\text{Hz}$$

$$C = \frac{1}{2\pi R c}$$

$$C = \frac{1}{2\pi \times 50 \times 3300} = 96.457\mu F$$

Calculating Vehicle Speed (MPH)

$$\text{Vehicle speed} = \frac{\text{Wheels RPM} \times \text{Tire diameter} \times \pi \times 60}{63360}$$

$$\frac{2000 \times 18 \times \pi \times 60}{63360} = 107 \text{ MPH}$$

Calculating Engine RPM

$$\text{RPM} = \frac{\text{Speed in meters per second}}{\text{Circumference in meters}}$$

RPM @ 60MPH

60 Miles = 96560.64 meters

1 hour = 3600 seconds

$$\text{RPM} = \frac{26 \text{ m/s}}{0.457} \times 60 = 3600 \text{ RPM}$$

4.2 Easy PC Schematics

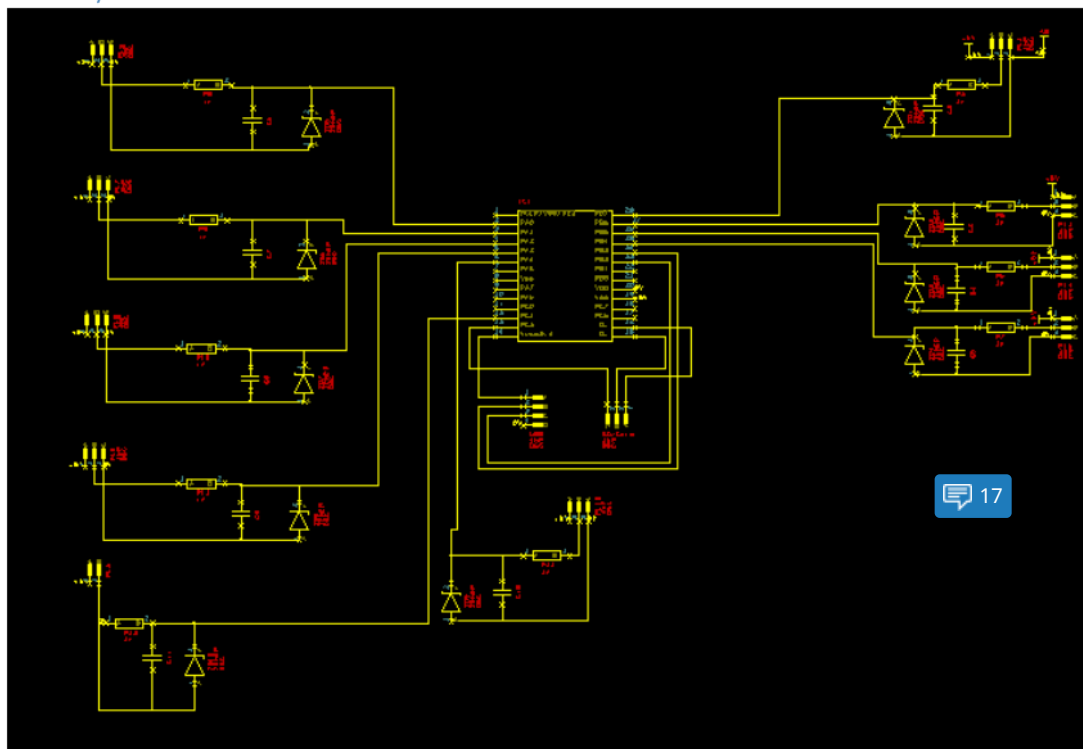


Figure 3- Easy PC Schematic Diagram

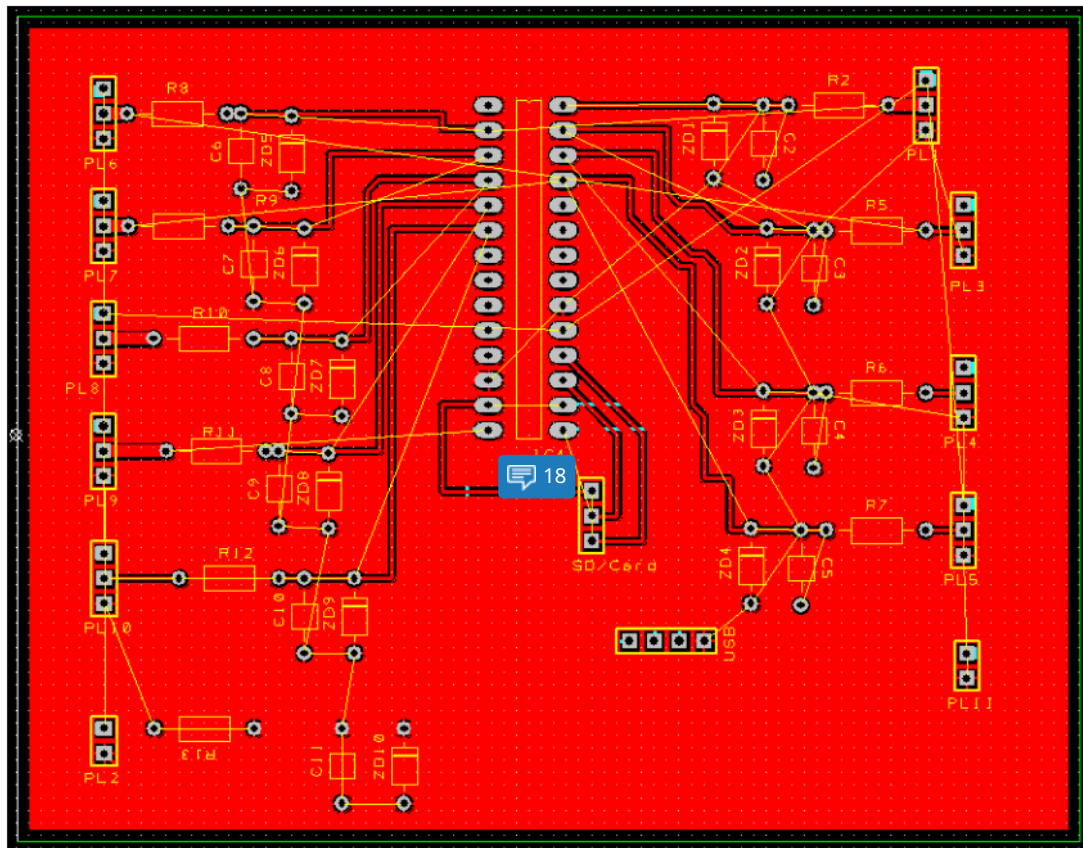


Figure 4- Easy PC PCB Design

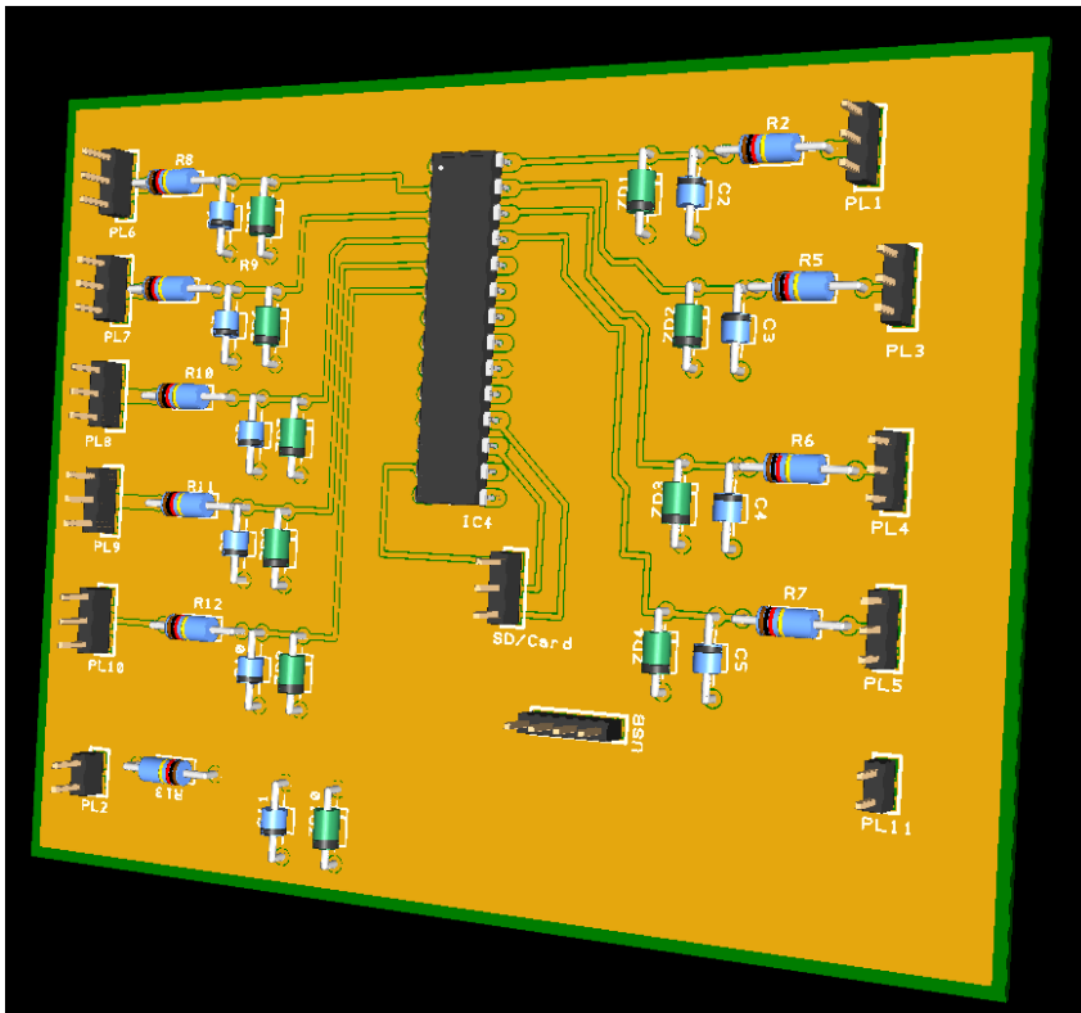


Figure 5- Easy PC PCB Board Front View

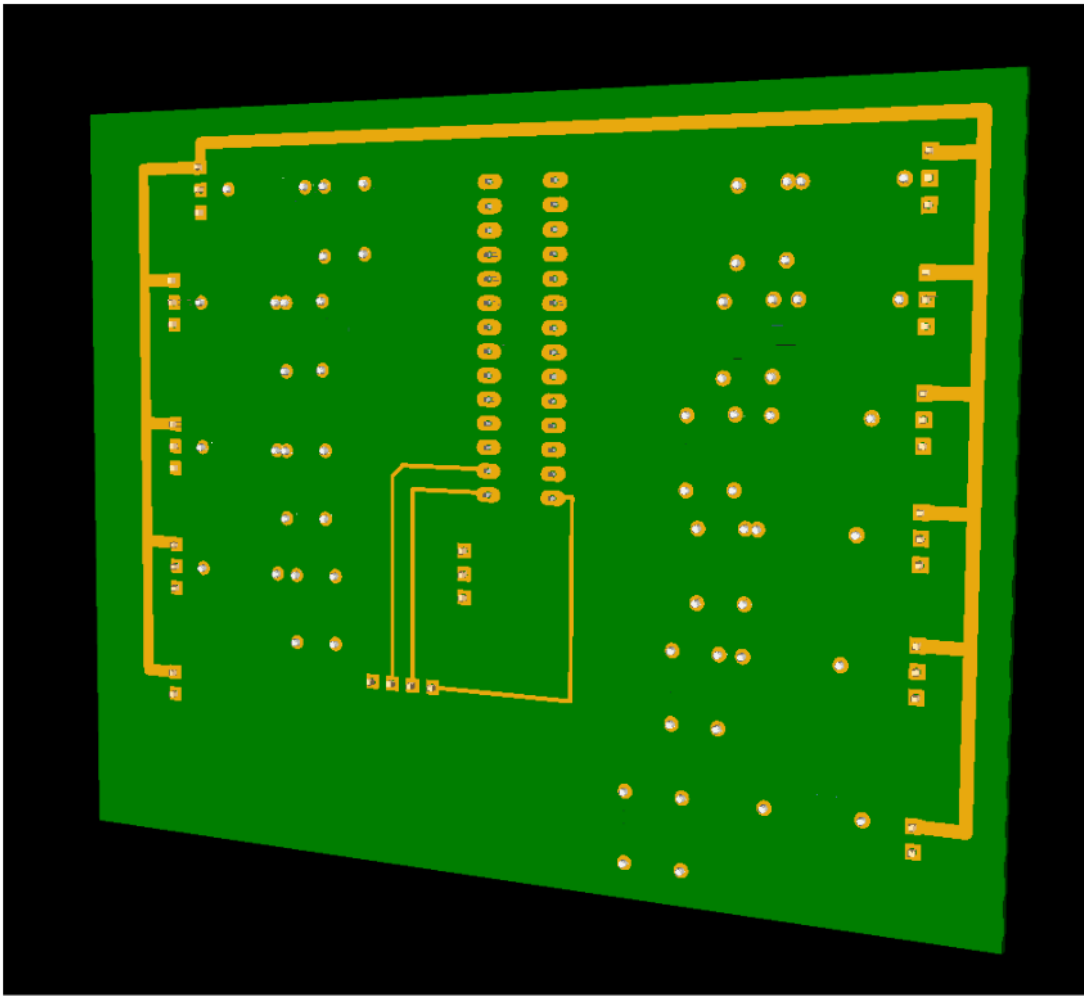


Figure 6- Easy PC PCB Board Rear View

5.0 Build Costs

Item Description	Cost Per Unit	Quantity	Total Cost
Jumo PT100 RTD Sensor, 5.4mm Dia, 27.5mm Long, 2 Wire, Probe, Class B +200°C Max	£88.49	1	£88.49
Sick Incremental Incremental Encoder, 100 ppr, TTL Signal, Solid Type, 6mm Shaft	£112.96	2	£225.92
SLS1300 Series Linear Potentiometer	£250-£450 20	4	£1000-£2800
Yaw rate sensor 200 or 500°/s (gyro)	£605	3	£1815
PIC18F45K50	£2.85	1	£2.85
Molex Single Row (3-Pin) Male & Female Receptacle Plug, w/Terminal sockets Micro-Fit 3.0 (Pack of 3 Set)	£9	2	£18
BINDER 09 9789 71 05 5-Pin Connector	£7.77	1	£7.77
Molex Micro-Fit 3.0™ Single Row (5-Pin) Male & Female Receptacle Plug, w/Terminal sockets	£3	3	£9
JCL PCB Board	£7	21	£7
AN16-F Diecast Aluminium enclosure	£30	1	£30
		Total Cost =	£3204.03 - £5004.03

6.0 Improvements

After reviewing the proposed design of the vehicle data logger, there are few improvements which could be made to the design.

The first improvement would be to reduce the number of connectors on the enclosure. Due to the various sensors having varied amounts of outputs, it made for difficult packaging. The quick solution was to have an individual connector for each of the sensors. This may have been the quickest solution, but probably not the most practical for packaging of  22 duct. The outputs of the sensors could have been reduced into one connector, something like a 20-pin connector. This would have reduced the footprint of the PCB board, resulting in a cheaper manufacturing cost, and a smaller enclosure could have been used.

Another improvement could be made to the PCB board itself. The current design isn't compact, as there is are a few open spaces on the board. This has resulted in a greater manufacturing cost of the PCB board itself and a greater cost in the enclosure as it had to be bigger.

The final improvement I would make it to add some more protection to the circuit. Granted, there is over voltage protection on the components, however more could still have been done. For example, adding some sort of fuse to the PCB board, therefore all individual components were protected, but also the circuit as a whole would be protected from too much voltage and current.  23

7.0 Conclusion

To conclude, the design of the vehicle data logger was a success, even for the improvements that could be made to the design, as the current design meets the design brief set out.

The integration of a 10-bit IC18F45K50 microcontroller, with its high-performance RISC architecture, proves instrumental in handling the complexities of real-time data processing. The inclusion of an analog-to-digital converter, USB 2.0 interface, and versatile peripheral options enhances the logger's adaptability to various automotive applications.

The use of Proteus and Easy PC design software aided in the development of this vehicle data logger. Proteus being used to initially sketch a prototype circuit diagram, whilst easy PC was used to develop the final design and to get a manufacturing quote of the PCB Board.

References

- [1] "2d-datarecording," 9 November 2023. [Online]. Available: <http://2d-datarecording.com/Downloads/Datasheets/Logger/Pdf/LG-L9-000.pdf>.
- [2] "Vector," [Online]. Available: https://cdn.vector.com/cms/content/products/gl_logger/Docs/GL_Logger_ProductInformation_EN.pdf. [Accessed 9 November 2023].
- [3] "Teoresi Group," [Online]. Available: <https://www.teoresigroup.com/products/vehicle-data-loggers/>. [Accessed 9 November 2023].
- [4] "Microchip," [Online]. Available: <https://www.microchip.com/en-us/product/PIC18F45K50#document-table>. [Accessed 21 11 2023].
- [5] "Microchip," [Online]. Available: <https://www.microchip.com/en-us/product/PIC24FJ64GB004>. [Accessed 21 11 2023].
- [6] "Microchip," [Online]. Available: <https://www.microchip.com/en-us/product/PIC24FJ64GU205>. [Accessed 21 11 2023].
- [7] "2D Date Recording," [Online]. Available: <http://2d-datarecording.com/Downloads/Datasheets/Sensors-dynamic/Pdf/SA-GYxxxV4-000-DINA4.pdf>. [Accessed 20 11 2023].
- [8] "RS Components," [Online]. Available: <https://uk.rs-online.com/web/p/sensor-development-tools/2678055?gb=s>. [Accessed 20 11 2023].
- [9] "RS Components," [Online]. Available: <https://docs.rs-online.com/fb82/A700000008916411.pdf>. [Accessed 20 11 2023].
- [10] "The Sensor Connection," [Online]. Available: https://thesensorconnection.com/sites/default/files/2023-02/LPPS-22%20Linear%20Potentiometer_Data%20Sheet_Rev25.pdf. [Accessed 20 11 2023].
- [11] "RS Components," [Online]. Available: <https://uk.rs-online.com/web/p/laser-modules/2107351?gb=s>. [Accessed 20 11 2023].
- [12] "Active Sensors," [Online]. Available: <https://www.activesensors.com/products/linear-position-sensors/general-purpose-linear-potentiometers>. [Accessed 20 11 2023].
- [13] "RS Components," [Online]. Available: <https://uk.rs-online.com/web/p/motion-control-sensors/2013642?gb=s>. [Accessed 21 11 2023].
- [14] "RS Components," [Online]. Available: <https://uk.rs-online.com/web/p/photoelectric-sensors/2122997?gb=s>. [Accessed 21 11 2023].

- [15 "RS Components," [Online]. Available: <https://uk.rs-online.com/web/p/optical-rotary-encoders/7967806?gb=s>. [Accessed 21 11 2023].
]
- [16 "RS Components," [Online]. Available: <https://uk.rs-online.com/web/p/rtd-sensors/2601071?gb=s>.
] [Accessed 21 11 2023].
- [17 "RS Components," [Online]. Available: <https://uk.rs-online.com/web/p/infrared-temperature-sensors/0553349?gb=s>. [Accessed 21 11 2023].
]
- [18 "RS Components," [Online]. Available: <https://uk.rs-online.com/web/p/thermocouples/8722512?gb=s>. [Accessed 21 11 2023].
]
- [19 "JLC PCB," [Online]. Available: <https://jlcpcb.com/>. [Accessed 23 11 2023].
]
- [20 "Amazon," [Online]. Available: https://www.amazon.com/Molex-Receptacle-Terminal-sockets-Micro-Fit/dp/B07HDM897L/ref=sr_1_3?keywords=3+pin+molex+connector&qid=1700816792&sr=8-3.
] [Accessed 24 11 2023].
- [21 "Molex," [Online]. Available: <https://www.molex.com/en-us/products/part-detail/1727040031>.
] [Accessed 24 11 2023].
- [22 "Farnell," [Online]. Available: <https://cpc.farnell.com/wago/231-203-026-000/terminal-block-pluggable-3pos/dp/CN20530?st=3%20pin%20connectors>. [Accessed 24 11 2023].
]
- [23 "Farnell UK," [Online]. Available: <https://uk.farnell.com/binder/09-9789-71-05/circular-connector-plug-5-way/dp/1122803?st=binder%20719,%205pf>. [Accessed 24 11 2023].
]
- [24 "Amazon UK," [Online]. Available: <https://www.amazon.com/Molex-Micro-Fit-Receptacle-Terminal-sockets/dp/B07H8V1BWJ>. [Accessed 24 11 2023].
]
- [25 "Poly Case," [Online]. Available: <https://www.polycase.com/sa-39>. [Accessed 24 11 2023].
]
- [26 "Poly Case," [Online]. Available: <https://www.polycase.com/sb-39>. [Accessed 24 11 2023].
]
- [27 "Polycase," [Online]. Available: <https://www.polycase.com/an-16f>. [Accessed 24 11 2023].
]

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PAGE 1



Comment 1

Confidential?

PAGE 2

PAGE 3

PAGE 4

PAGE 5



Comment 2

do you mean housed?

"stored in" implies you take it out of the box to use it

PAGE 6

PAGE 7



Comment 3

You have chosen a 16 bit PIC. This does not meet the assignment brief:

"Microcontroller
selection from the 8bit PIC range"



Comment 4

All PICs use RISC



Comment 5

All these points apply to all the PICs in the table above. What *specifically* makes this PIC more suitable than the others?



Comment 6

How does a beam break sensor measure distance?



Comment 7

Good justification.



Comment 8

Some engines will rotate faster than this. How will this be mechanically connected to the engine?



Comment 9

Good justification for selecting this, but how will it mount to the engine?



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 10

Where is the PCB design? You haven't shown it yet. Should this bit come after your PCB design?

PAGE 14



Comment 11

Where in the system will these connectors be?

Are they to go between the PCB and another connector on the outside of the box, or are they to go on the box?

If they are to go on the box, they are not panel mounting connectors and nor do they have a suitable IP rating.

PAGE 15

PAGE 16



Comment 12

The processor can only do one thing at a time. Which of the 5 boxes on the 3rd row does it do first?



Comment 13

Not the first figure.

PAGE 17



Comment 14

The output from most of your sensors (suspension, engine and road speed) is connected straight to ground. I suspect you intended them to be connected like the gyroscope?

This will not work.

PAGE 18



Comment 15

But the sensor cannot rotate that quickly. Will it be geared? How does it connect?



Comment 16

This sample rate is not quick enough.

Also, when designing an anti-aliasing filter, such as this, the filter cutoff should be at half the sample rate.

PAGE 19



Comment 17

Better, there are no signal to ground shorts on here, although I am concerned:

1. There is no power supply
2. The anodes of the zener diodes may not be connected together - there is no obvious link between them like a ground symbol, or a wire connecting them.

Your SD card connector also needs power to it.

PAGE 20



Comment 18

The diagonal tracks leaving pins 17 & 18 are a bit close to the adjacent pads for my liking.

PAGE 21

PAGE 22



Comment 19

You have not considered how this design will be powered. This will not work without batteries in it!!

PAGE 23



Comment 20

Why such a broad range of prices? Surely you have decided which part from the range you need to use and can get a price for that?



Comment 21

What about the resistors, capacitors, diodes, power supply components, batteries, CD card & connector, USB connector? There are a lot of bits missing from this list.

PAGE 24



Comment 22

If you had a single connector for all the sensors, then you would need to produce a breakout box or lead to allow the user to connect all of their sensors to the DAQ. This would add more

cost, and complexity to the design.



Comment 23

Good hardware improvements, but no improvements to functionality or operation?
e.g. sample rate selection.

PAGE 25



Comment 24

It was supposed to be an 8-bit PIC

PAGE 26

PAGE 27

GRADING FORM: SMU GENERIC_SMOSEY

RYAN STAPLETON

47.60

ENGAGEMENT WITH LITERATURE

including reading, referencing, academic conventions and academic honesty



Inclusion of a range of research-informed literature, including sources retrieved independently. Referencing conventions mostly consistently applied.
More research was needed.

5.4

KNOWLEDGE & UNDERSTANDING

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



Minor omissions in the design of the data storage - no power connections to the SD card, no SD card connector.
No power supply included in design. No batteries specified.

11

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.



No memory sizing calculations done.
Packaging is suitable.
Connectors chosen are not suitable due to mounting arrangements and IP rating.
Most sensors are ok, although thought needs to be given to how they will interface with the vehicle under test. You need to look carefully at how each sensor mounts and what the condition of the vehicle would be when your system is removed.
PIC chosen from wrong range of parts. You chose a 16-bit PIC when an 8-bit one was specifically asked for in the brief.

15.4

PRACTICAL APPLICATION SKILLS

Different approaches to solving problems in particular contexts.



Costing is missing most of the board mounted components, along with the memory and batteries

10

(and associated components) which were not specified at all.

Suggested improvements generally 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.

Mostly coherent work. Could be structured better.

5.8