

JJP Assignment 2

by Joshua Port

Submission date: 09-Dec-2024 11:35AM (UTC+0000)

Submission ID: 245196129

File name: 32728_Joshua_Port_JJP_Assignment_2_523685_1061858430.docx (4.17M)

Word count: 4499

Character count: 24847

14 Day Weather and Air Quality Measurement and Logging System

Joshua J Port 2114468
BEng Embedded Electronic Systems
University of Wales Trinity St David's
Electronic System Design (ESD)
(ACDA6002)

Contents

Introduction	4
Task 1	5
Literature Review	5
Task 2	6
Micro-Controller	6
Choice of Micro-Controller	6
USB Pin Identification on the PIC18F24K50	6
SD Pin Identification on the PIC18F24K50	7
SD Card Memory limitations	7
Task 3	9
Hardware	9
Suitable Casing	9
Sensors	10
Task 4	17
Electrical Designs	17
Easy PC Circuit Design	17
PCB Circuit Design	19
PCB Design	20
Task 5	21
Prototype Designs	21
Circuit Block Diagram	21
Software Flowchart	22
Task 6	24
Costs	24
Full Prototype Build Costs (including connectors)	24
Task 7	26
Connectors and Final Case Design	26
Required Connectors	26
Prototype Case Design	26
Task 8	27
Summary Elements	27
Improvements And reasoning	27
Conclusion	27
References	28
Appendix	32

Figure 1 - PIC18F24K50 Proteus Set Up.....	6
Figure 2 - PIC18F24K50 I/O Datasheet Pin Diagram [1]	6
Figure 3 - Easy - PC Main Chip Schematic	17
Figure 4 - Sensor Easy - PC Sensor Diagram	18
Figure 5 - Sensor Easy - PC Sensor Diagram and Led Tell.....	18
Figure 6 - Easy - PC PCB Circuit Diagram	19
Figure 7 - 3D PCB Board Design.....	20
Figure 8 - PIC18F24K50 Proteus Diagram	21
Figure 9 - Station Proteus Diagram pt.2	21
Figure 10 - Sensor Proteus Circuit Diagram	21
Figure 11 - Prototype Main Program Flowchart	22
Figure 12 - Prototype Sub Routine Flowchart.....	23
Figure 13 - Final Prototype Case Design.....	26
Figure 14 - Microcontroller Selection Page.....	32

Table 1 - Market Weather Stations Comparison Against the Report Station.....	5
Table 2 - Weather Station Total Data Required for 14 Days	7
Table 3 - SD Card Comparison Table.....	8
Table 4 - Sensor Types for Temperature and Humidity	10
Table 5 - Temperature and Humidity Sensor Choice.....	10
Table 6 - Sensor Types for Wind Speed and Direction`	11
Table 7 - Wind Speed and Direction Sensor Choice.....	12
Table 8 - Sensor Types for Light and UV Intensity	13
Table 9 - Light and UV intensity Sensor Choice.....	13
Table 10 - Sensor Types for VOC	14
Table 11 - VOC Sensor Choice	14
Table 12 - Sensor Types for the Airbourne Particle Count	15
Table 13 - Airbourne Particle Count Sensor Choice.....	15
Table 14 - Sensor Types for GPS.....	16
Table 15 - GPS Sensor Choice	16
Table 16 - Final Prototype Costing.....	25
Table 17 - Final Prototype Case Design Key	26

Introduction

The aim of this project is to use the internet to gain sources for electronic components, in order to design and price a fully functioning portable weather station, to capture multiple areas of the environment over a period of 14 days. The station will be designed and controlled using a specified microcontroller which will be capable enough to run the required sensors. The design will also use a SD card with enough space to store the information collected as well as, a usb device to allow transferral of data onto a laptop or other computational device.

The weather station, due to its portability, needs to be powered off of an external power source such as a battery pack with the capability to keep the device running for 14 days without fail. The device will be used to obtain data from 9 different elements at varying capture times ranging from 1 capture every 15 seconds to 1 capture per minute. The captured elements are as follows:

- Temperature
- Humidity
- Wind Speed
- Wind Direction
- Airbourne Particle Count
- Sunlight Brightness
- Ultraviolet Levels
- Volatile Organic Compounds (VOC) Particles
- GPS

The report below will detail the outlines of the device, the sensors required for the data collection as well as, the overall cost of the model to be fully functional.

Task 1

Literature Review

A weather station is made from multiple different sensors designed to calculate environmental factors such as wind speed, wind directions and the volatile organic compounds within the atmosphere. Weather stations are needed to constantly monitor the environmental changes in specific areas to check for any deviations from the standardised measurements. It is also used as a protection system to show habitability within certain areas, such as those at altitude.

Most weather stations on the current market are comprised of 5 main sensors. These sensors are, temperature, humidity, wind speed, wind direction and rainfall. The most common of these sensors being the temperature and humidity sensors which are deployed more due to concerns with conditional weather conditions in a selective area and risk to property damage [1]. Usual weather stations are connected directly to a power source such as a socket or generator. This generally means that the device cannot be portable and is stuck in place. Due to them being in a fixed point, they usually last for between 10 and 20 years, providing they are professionally made and not tapered with too often [2].

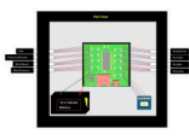
Weather Station Image			
Name of the station	Davis Wireless Vantage Vue Weather Station with Weather Console 6242UK [3]	HOBO Cellular Weather Station Kit – Intermediate [4]	ESD Project Weather Station Prototype
Power supply	230 V adapter to plug with a battery backup. Solar Powered	Solar Powered of 17 V external power supply	12 V 100ah LiFePo4 battery
Sensors used	Wind speed, Wind direction, Temperature, Humidity, Rainfall	Temperature, Humidity, Wind speed, Wind direction, Rainfall	Temperature, Humidity, Wind speed, Wind direction, Sunlight brightness, UV index, VOC, Airbourne particles, GPS
Portable	Yes	Yes	Yes
Data Storage	Bluetooth link to external PC/Phone	Cellular remote link to external PC/Phone	SD Card and Usb plug for external connection
Size (L*W*H)	340*329*146mm	186*181*118mm	550*269*185mm
Price	£544.96	£3,579.24	£1,817.85

Table 1 - Market Weather Stations Comparison Against the Report Station

Both of the on the market products are designed with 5 sensors and can be portable. They are both considerably larger and require external poles for mounting the specific devices on. The market designs also use a Bluetooth and Wi-Fi link to the user's phone to be operated. This can cause many problems as it requires the phone to be close and have a signal to connect. The design in this paper also uses a specific battery instead of relying on sunlight for its operations.

Task 2

Micro-Controller

Choice of Micro-Controller

The weather station prototype requires a microcontroller processor on order to operate the sensor circuits. Using the chip identifier, it was determined that the PIC18F24K50 was the perfect choice for this project due to its multiple capabilities including USB connectivity ports and SD card ports [1]. This specific microcontroller has an already pre-selected integrated clock known as the SCK (Serial Clock). This serial clock is used to run the chip at a specific frequency to avoid any timing delays or interruptions in the program or design structure. This Programmable Integrated Chip setup is shown below in figure 1.

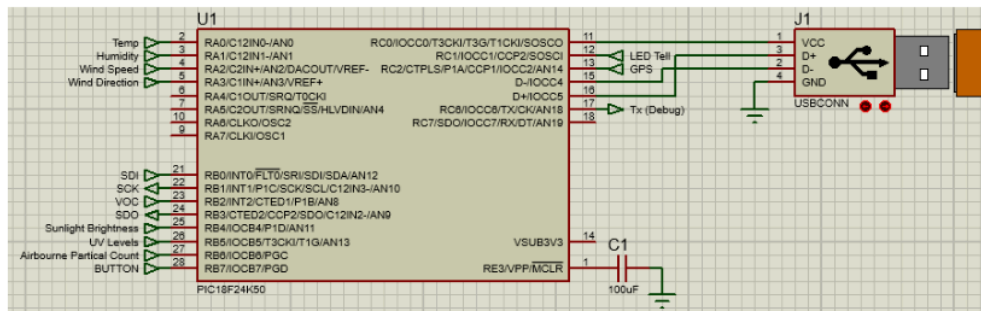


Figure 1 - PIC18F24K50 Proteus Set Up

USB Pin Identification on the PIC18F24K50

The PIC18F24K50 chip has been selected due to its capabilities in connecting and operating a USB device. This is vital to the project as the usb connection will be the only way to transfer the data from the SD cards drive onto an external computer system to be displayed or shown to the user/operators. The usb device is operated by enabling a high input direct to the D+ pin (pin 16) and having the return D- pin (pin15) as a low output all shown below in figure 2. A power input is also used from pin 11 to power the usb connector. The usb connector requires a stable serial clock, either internal or external, in order to operate in its respective manner. Due to the PIC18F24K50 having an internal oscillator, the chip provides the necessary oscillations and clock speed for the usb module to work [2].

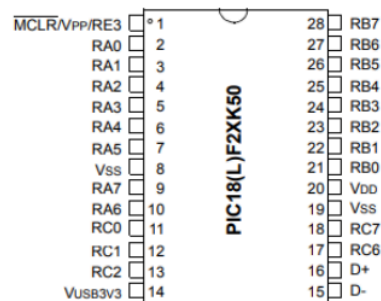


Figure 2 - PIC18F24K50 I/O Datasheet Pin Diagram [1]

SD Pin Identification on the PIC18F24K50

The SD card is known as a peripheral device which requires a Serial Peripheral Interface in order to allow the data transferral off of the chip. One perk of the PIC18F24K50 is that there is already an inbuilt SPI protocol which comes standard with this chip which means that, no additional connection SPI modules would be required for the SD card to operate nominally. The SD card reader connects to the PIC by using 3 ports. These three ports are the Serial data Input (SDI), the Serial Clock (SCK) and the Serial Data Output (SDO) [3]. The SDI controls the input data signals to the SD card from the PIC and the SCK is used to keep the same oscillations and clock cycle as the chip in order for easy transmission of the data through the SDI port. The SDO port is the only output port for the SD card which allows the SD card to transmit some of the data to the chip.

SD Card Memory limitations

The SD card selected will be based on the sensors bit requirements to operate and calculated with the timeframe required for operation. Shown below in table x is the minimum size requirement for the SD card to continue collection for 14 days. This is done by taking the bit value per test and multiplying it by the total test time required for an accurate result. This total came out to be 2.66 MBs. A 2 GB SD card would be ideal to allow for any extra data storage required however the price of a 16 GB opposed to the 2 GB was the same, and so the 16 GB SD, shown in blue in table 2, was purchased.

Measuring	Sensor Type	Mechanism	Bits	Bytes Per Reading	Rep Time (s)	Bit per min	per hour	per day	per 14 days
Temperature	Hygrometer	Analog	14	2	15	8	480	11520	161280
Humidity	Hygrometer	Analog	14	2	15	8	480	11520	161280
Wind Speed	Anemometer	Analog	10 bit min	2	60	2	120	7200	100800
Wind Direction	Anemometer combined	Analog	10 bit min	2	60	2	120	7200	100800
Airborne Partical Count	Optical	Analog	10 bit	2	60	2	120	7200	100800
Sunlight Brightness	Radiometer	Analog	24 bit	3	30	6	360	8640	120960
UV Levels	Radiometer	Analog	24 bit	3	30	6	360	8640	120960
GPS Position	Transistor	Digital	672 bits	84	60	84	5040	120960	1693440
VOC Levels	Optical	Digital I2C	10 bit	2	60	2	120	720	100800
Totals							7200	183600	2661120
Total in MBs									2.66 MBs

Table 2 - Weather Station Total Data Required for 14 Days

Sensor Image				
Name of Component	Integral Memory 16 GB SDHC SD Card, Class 10, UHS-1 U1	Transcend 16 GB SDHC SD Card, Class 10	Transcend 2 GB SD SD Card, Class 1	Inno Disk 2 GB Industrial SD SD Card, Class 6
Supplier	RS	RS	RS	RS
Supplier Number	180-5811	187-1627	758-2552	144-8088
Manufacturer	Integral Memory	Transcend	Transcend	InnoDisk
Manufacturer Number	INSDH16G10-80U1	TS16GSDC300S	TS2GSDC	DS2A-02GI81W1B
Size in GBs	16 GBs	16 GBs	2 GBs	2 GBs
Cost (Per 1 Unit) (exc.vat)	£6.38	£12.46	£14.34	£61.15

Table 3 - SD Card Comparison Table

Task 3

Hardware

Suitable Casing

The case for the design had to be strategically chosen to ensure the battery, GPS and PCB would fit in to be waterproofed. The size of the battery chosen was 260mm by 210mm by 17mm meaning the pelican case would have to be larger than this as a minimum. Shown below is the battery which will be used and the chosen case which will allow enough space for the connectors, battery and PCB to sit comfortably within.



[4]



[5]

The case above is the pelican case used with the dimensions of 505mm by 269mm by 185mm (L*W*H). This case also comes with wheels for easy portability as well as, a key lock so other people cannot take the internal equipment.

Sensors

Temperature and humidity

Sensor Image Temperature and Humidity			
Sensor Type	Resistive	Thermo	NTC / Thermistor
Can be used. (Green = yes) (Red = no)	Green	Red	Red

Table 4 - Sensor Types for Temperature and Humidity

Sensor Image				
Name of Component	Amphenol Advanced Sensors Temperature and Humidity Sensor, Analogue, Digital Output, Cable Mount, I2C, ±2%	TE Connectivity Temperature & Humidity Sensor, Voltage Output, Through Hole Mount, Analogue, ±5%RH	TE Connectivity Temperature & Humidity Sensor, Voltage Output, Analogue, ±2%	TE Connectivity Humidity Sensor, Voltage Output, Through Hole Mount, Analogue, ±5%RH, 3 Pins
Supplier	RS	RS	RS	RS
Supplier Number	257-9568	893-7373	221-7342	161-4580
Manufacturer	Amphenol	TE Connectivity	TE Connectivity	TE Connectivity
Manufacturer Number	T96032-5-A	HPP809A031	HPP809A033	HPP805A031
Input Voltage	5 V	5 V	5 V	5 V
Output Voltage	3 V	1 to 4 V	2.48 V	3.6 V
Range of Measurement	Humidity 0 - 100%, Temperature -20 - 70 Degrees Celsius	Humidity 0 - 100%, Temperature -40 - 85 Degrees Celsius	Humidity 0 - 100%, Temperature -40 - 60 Degrees Celsius	Humidity 0 - 100%, Temperature -40 - 60 Degrees Celsius
Calibration	Calibrated ±2%	Calibrated ±2%	Calibrated ±2%	Calibrated ±2%
Dimensions (L*W*H)	1028 x 4 x 4mm (length including Cable)	76.3 x 11.6 x 11.6 mm	76.3 x 11.6 x 11.6 mm	67.9 x 11.4 x 11.4 mm
Pins	4	5	5	3
IP Rating	67	No IP Rating	No IP Rating	No IP Rating
Cost (Per 1 Unit) (exc.vat)	£35.87	£99.23	£114.87	£57.57

Table 5 - Temperature and Humidity Sensor Choice

Wind Speed and Direction

Sensor Image Wind Speed			
Sensor Type	Sonic	Anemometer / Rotating Cups	
Can be used. (Green = yes) (Red = no)			
Sensor Image Wind Direction			
Sensor Type	Windsock / Optical	Weathervane	Anemoscope
Can be used. (Green = yes) (Red = no)			

Table 6 - Sensor Types for Wind Speed and Direction

Sensor Image				
Name of Component	Carlo Gavazzi DWS Series Cup Anemometer, 5m Cable Length	MeteoWind Compact	Wind Speed & Direction Sensor AV-WS	WindUltra Ultrasonic Heated Anemometer
Supplier	RS	MeteoWind	ECP	Omni Instruments
Supplier Number	256-5064	MeteoWind Compact	AV-WSD-UKCA	1416-PK-210-11
Manufacturer	Carlo Gavazzi	Barani	AV	Wind Ultra
Manufacturer Number	DWS-V-DBC05	Barani	AV-WSD	Wind Ultra
Input Voltage	10 V to 28 V	3.2 V to 15 V	10 V	10 V to 30 V
Output Voltage	5 V	0 V to 2.5 V	5 V	5 V to 30 V
Range of Measurement	1.5 to 75 m/s	80 m/s and	0.5 m/s	0.5 to 75 m/s
Calibration	3 to 30 m/s; +10%	+5%	± 2%	± 2%
Dimensions (L*W*H)	183 x 145 x 45 mm	111 x 82 x 272 mm	280 mm x Unspecified	189 x 84 x 84 mm
Pins	4 or 1 x m28 Screw	5pa	6	8 or m12 8 way Screw
IP Rating	54	67	65	66
Cost (Per 1 Unit) (exc.vat)	£430.46	£350.00	£1,250.00	£1,271.00

Table 7 - Wind Speed and Direction Sensor Choice

Light and UV Intensity

Sensor Image			
Sensor Type	Optical	Solar	Radiometer
Can be used. (Green = yes) (Red = no)			

Table 8 - Sensor Types for Light and UV Intensity

Sensor Image				
Name of Component	SICK Light Intensity Sensors 12.5 mm, Ultraviolet LED IO-Link, PNP, 50 mA, 12 → 24 V dc, IP67	RM-12 radiometer: inexpensive measurement of irradiance and illuminance	Low Power, High Sensitivity, I2C Ambient Light Sensor	RS PRO Retroreflective Photoelectric Sensor, Barrel Sensor, 50 mm → 7 m Detection Range
Supplier	RS	Opsytec Dr. Gorbel	Digikey	RS
Supplier Number	134-7831	RM-12	751-VEML3235SLTR	729-5117
Manufacturer	Sick	Opsytec Dr. Gorbel	Vishay	RS Pro
Manufacturer Number	LUTM-UP817A2P	RM-12	VEML3235SL	7295101
Input Voltage	12 V to 24 V	5 V	1.7 V to 3.6 V	10 V to 30 V
Output Voltage	5 V	1 V to 3 V	0.4 V	1.4 V
Range of Measurement	8 mm to 20 mm	200 to 280 nm UV, 380 to 780 nm Lux	0.0021 to 17867 (lux)	0.05 m to 7 m distance
Calibration	± 2%	± 1%	± 2%	± 5%
Dimensions (L*W*H)	31.5 x 12 x 21 mm	40 x 35 x 35 mm	2.95 x 1.5 x 1.5 mm	62.5 x 16.6 x 16.6 mm
Pins	4	4	4	4
IP Rating	67	65	N/A	67
Cost (Per 1 Unit) (exc.vat)	£345.29	Inquiry Estimated at £350.00	£1.10	£73.93

Table 9 - Light and UV intensity Sensor Choice

Volatile Organic Compounds (VOC)

Sensor Image			
Sensor Type	PID	Optical	MOS
Can be used. (Green = yes) (Red = no)			Best Option

Table 10 - Sensor Types for VOC

Sensor Image				
Name of Component	TVOC sensor IP65 enclosure, PoM	Outdoor air quality sensor	CDD4B4 Carbon Dioxide Sensor, Dual Beam, Outside, Analog Op, Unheated	Sensirion SEN54-SDN-T, PM, RH, T, VOC Environment Sensor for Particulate Matter, Relative Humidity, Temperature, VOC
Supplier	Sentera Controls	Senva	MSL	RS
Supplier Number	ODVCM-R	AQ20-AA2VAAD	CDD4B4	238-9413P
Manufacturer	Sentera Controls	Senva	Greystone	Sensirion
Manufacturer Number	ODVCM-R	AQ20-AA2VAAD	PS-CDD43-01	SEN54-SDN-T
Input Voltage	24 V	16 V to 30 V	20 V to 28 V	5V
Output Voltage	0 V to 10 V	0 V to 10 V	0 V to 10 V	0 V to 4 V
Range of Measurement	0 to 60 PPM	20 to 500 PPM	0 to 1000 PPM	0 to 1000 PPM
Calibration	± 15%	± 2%	± 5%	± 5%
Dimensions (L*W*H)	80 x 40 x 100 mm	190 x 115 x 54 mm	110 x 180 x 89 mm	52.3 x 43.3 x 22.3 mm
Pins	4	3	8	5
IP Rating	65	43	65	65
Cost (Per 1 Unit) (exc.vat)	Enquiry Estimated £900.00	£717.00	£566.00	£76.20

Table 11 - VOC Sensor Choice

Airbourne Particle Count

Sensor Image			
Sensor Type	Optical	Photodetector	Aerodynamic Particle Sizer
Can be used. (Green = yes) (Red = no)			

Table 12 - Sensor Types for the Airbourne Particle Count

Sensor Image				
Name of Component	Airbourne Particulate Matter sensor	Outdoor air quality sensor	HPM Series Particulate Matter Sensor	On-wall fine dust sensor/particulate matter sensor AERASGARD APS-SD-U
Supplier	MSL	Senva	TTI	S+S REGELTECHNIK
Supplier Number	PMOSXX	AQ20-AA2VAAD	HMPA115S0-008	1501-7130-1001-000
Manufacturer	Analog Model	Senva	Honeywell	S+S REGELTECHNIK
Manufacturer Number	Analog Model	AQ20-AA2VAAD	32322550	APS-SD-U
Input Voltage	24 V	16 V to 30 V	5 V	24 V
Output Voltage	0 V to 10 V	0 V to 10 V	0 V to 3 V	0 V to 10 V
Range of Measurement	0 to 1000 $\mu\text{g}/\text{m}^3$	20 to 500 PPB	0 to 1000 $\mu\text{g}/\text{m}^3$	0 to 500 $\mu\text{g}/\text{m}^3$
Calibration	$\pm 10\%$	$\pm 2\%$	$\pm 15\%$	$\pm 10\%$
Dimensions (L*W*H)	130 x 130 x 75 mm	190 x 115 x 54 mm	43 x 36 x 29 mm	126 x 90 x 50 mm
Pins	4	3	4	3
IP Rating	65	43	65	30
Cost (Per 1 Unit) (exc.vat)	£513.00	£717.00	£73.22	£355.38

Table 13 - Airbourne Particle Count Sensor Choice

Global Positioning System (GPS)

Sensor Image		
Sensor Type	GNSS	Galileo
Can be used. (Green = yes) (Red = no)		

Table 14 - Sensor Types for GPS

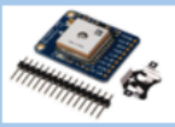
Sensor Image				
Name of Component	Quectel L80-M39 GPS Receiver	ADAFRUIT INDUSTRIES 746 GPS Module	Garmin 16x GPS Sensor	M5Stack COM.GPS EO-M8N GPS Board for M5Stack UART M031-G
Supplier	RS	RS	RS	RS
Supplier Number	908-4085	905-4630	703-2950	230-5121
Manufacturer	Quectel	Adafruit INDUSTRIES	Garmin	M5Stack
Manufacturer Number	L80-M39	746	010-00258-63	M031-G
Input Voltage	3.3 V	5 V	3.3 V	3.3 V
Output Voltage	0 V – 3 V	0 V – 3 V	0 V – 3 V	0 V – 3 V
Range of Measurement	Tracking: -165dBm	Tracking: -165dBm	Tracking: -185dBm	Tracking: -167dBm
Calibration	N/A	N/A	N/A	N/A
Dimensions (L*W*H)	16 mm x 16 mm x 6.45 mm	35 mm x 25.5 mm x 6.5 mm	91 mm Diameter x 42 mm Height	54 mm x 54 mm x 13.2 mm
Pins	9	5	5	1 x SMA Connector
IP Rating	N/A on board chip	N/A on board chip	IPx7 – 1 Meter submersion for 30 minutes	N/A on board Chip
Cost (Per 1 Unit) (exc.vat)	£10.58	£40.61	£121.62	£30.39

Table 15 - GPS Sensor Choice

Task 4

Electrical Designs

Easy PC Circuit Design

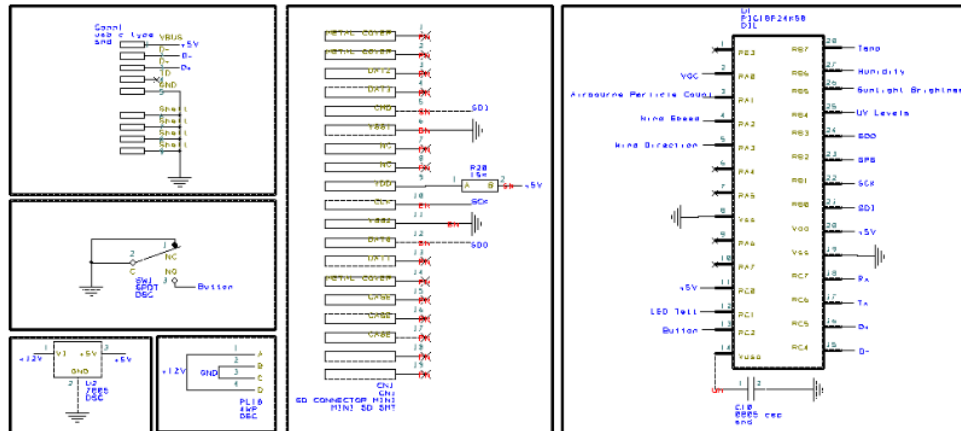


Figure 3 - Easy - PC Main Chip Schematic

Shown above in figure 3 is the first elements of the PCB design schematic designed within the Easy-PC simulation software. The right hand side shows the PIC18F24K50 chip which was used in this product as the command chip for the station. This chip runs of 5 volt power supply which is conditioned from the 12 v battery using a signal conditioning chip (7805). In the middle is the SD card reader. This design needed an SD card reader to allow the data collected from the 9 individual sensors to be stored until the data could be removed via USB to an external standalone as shown on the top left hand side. The last elements are the battery connection and a switch to allow the device to be turned on at the start of the 14 days and switched off at the end.

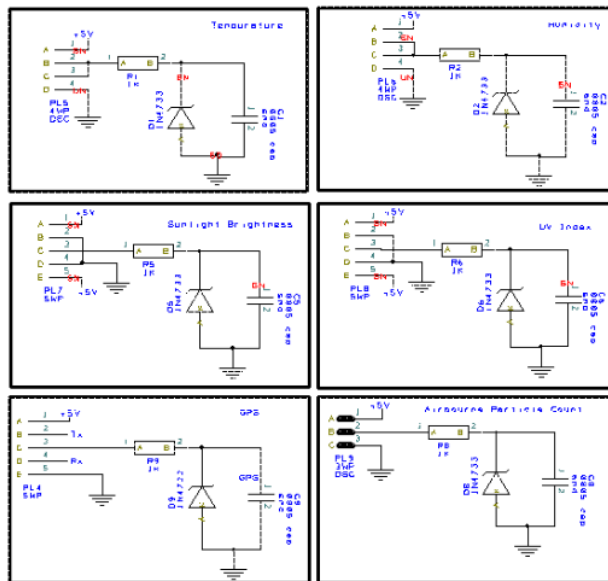


Figure 4 - Sensor Easy - PC Sensor Diagram

The second part of the design element was to use the datasheets from the sensors to establish the connectors they would require to be connected to the PCB board. The clamp then allows the sensor to operate without any compromise of heat dissipation and with risk of the sensor blowing itself up. This stage is extremely important as without creating a design first the components could be connected wrong on the PCB board and the whole design will not function or be a hazard to the users.

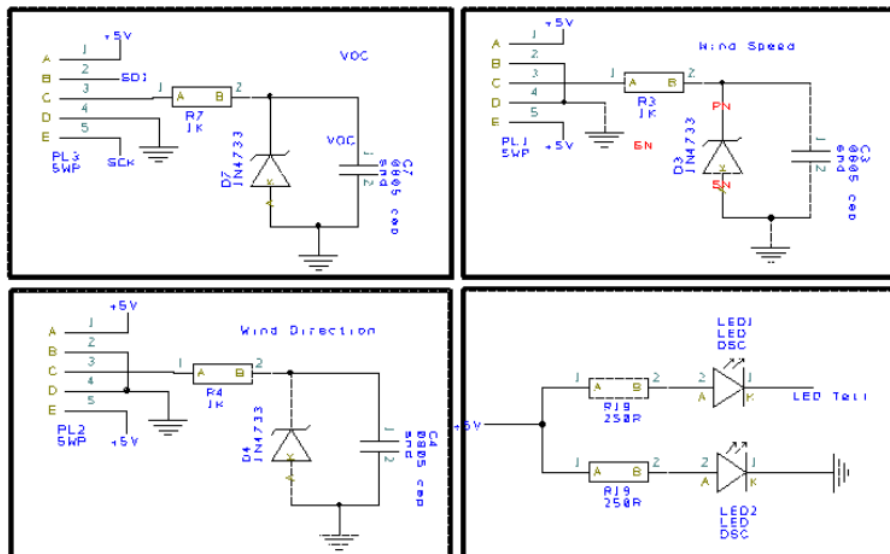


Figure 5 - Sensor Easy - PC Sensor Diagram and Led Tell

PCB Circuit Design

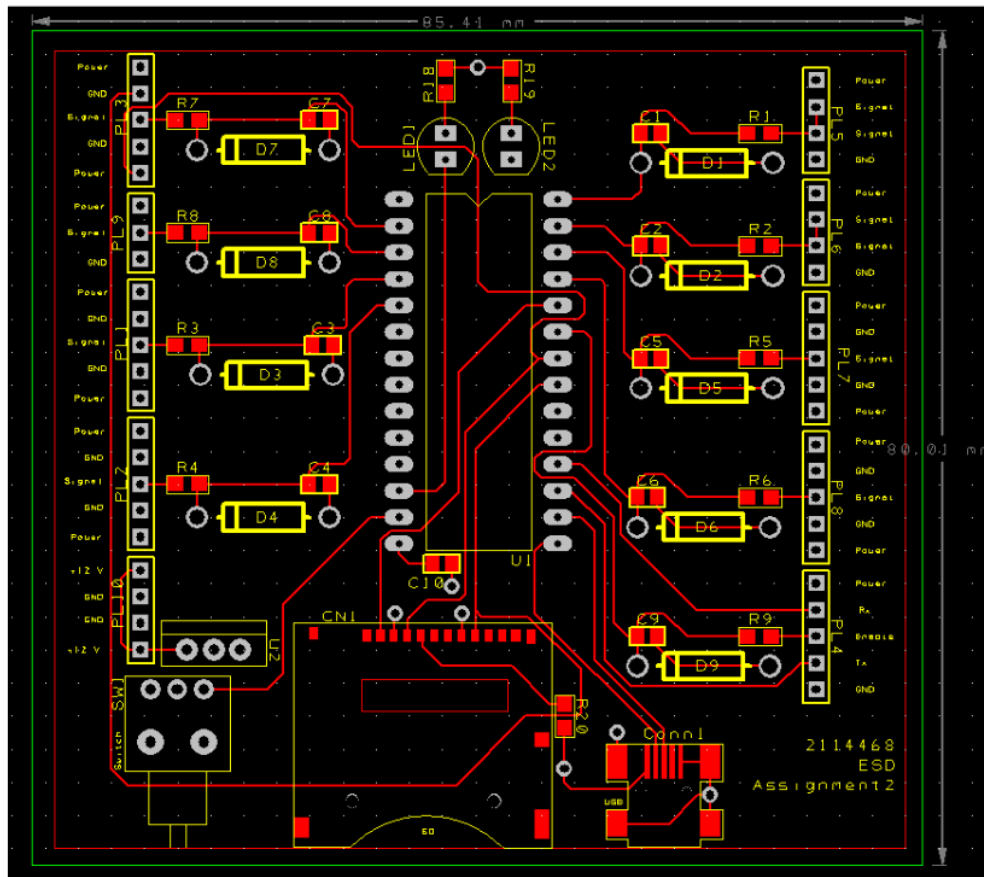


Figure 6 - Easy - PC PCB Circuit Diagram

Shown above in figure 6 is the finalised PCB design which includes all of the sensors required to run a weather station for 14 days without fail. The design has been made to be as small as possible to reduce the space needed as well as the cost. The PIC chip lies in the centre of the board with the connectors for the sensors lying on the edge to the left and right to allow for easy connections. Due to the design constraints explaining the design must be portable, the PCB has been produced to slot into a hard pelican case to allow the product to be fully waterproof to an IP rating of 67. The product will be run by a 12 volts 100 AH battery to ensure the station stays active over the test period. The overall product design size is 85.41 mm by 80.01 mm as shown above.

PCB Design

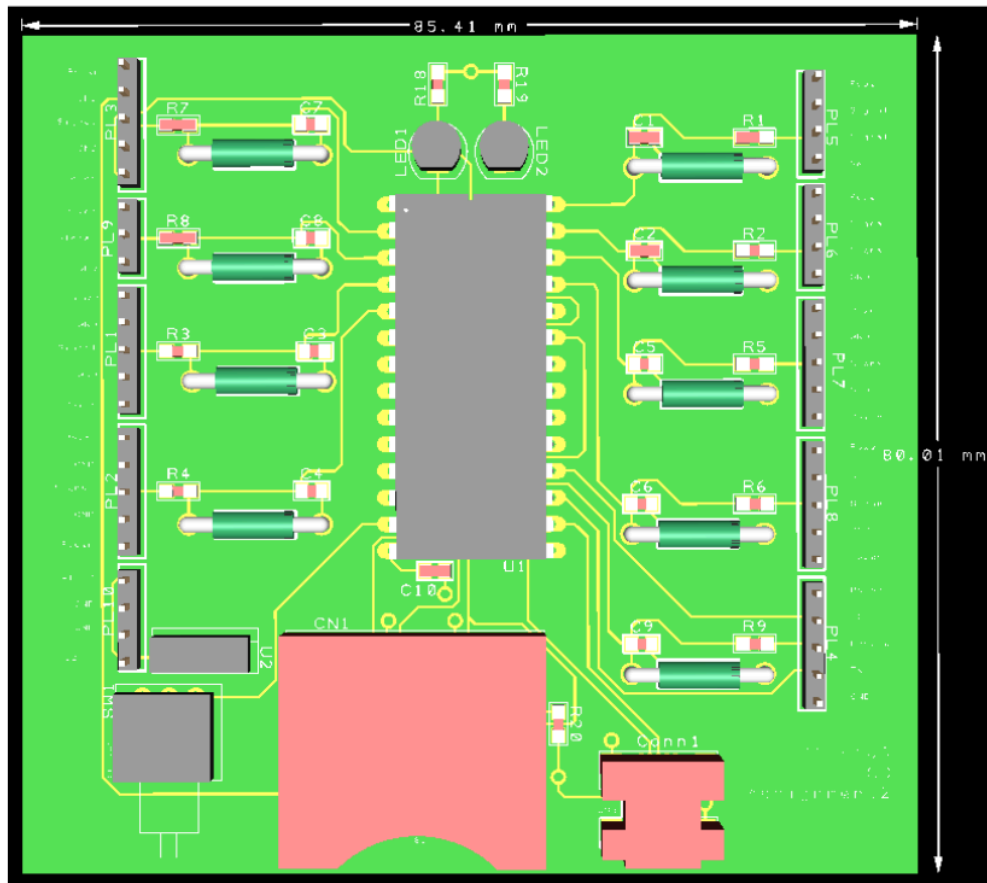


Figure 7 - 3D PCB Board Design

Shown above in figure 7 is the 3D design of the PCB as described in Task 4 PCB Circuit Design.

Task 5

Prototype Designs

Circuit Block Diagram



Figure 8 - PIC18F24K50 Proteus Diagram

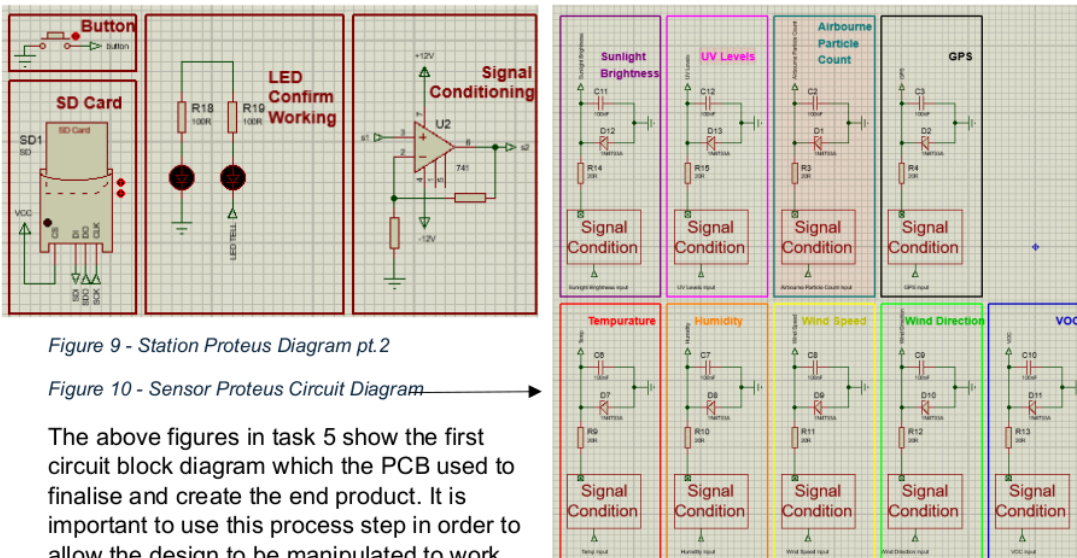


Figure 9 - Station Proteus Diagram pt.2

Figure 10 - Sensor Proteus Circuit Diagram

The above figures in task 5 show the first circuit block diagram which the PCB used to finalise and create the end product. It is important to use this process step in order to allow the design to be manipulated to work with the required design constraints specified. Without this process there would be a high chance that the product would not work. This step is also used for the creators to design each aspect and how it will fit together when translated to a functioning PCB.

Software Flowchart

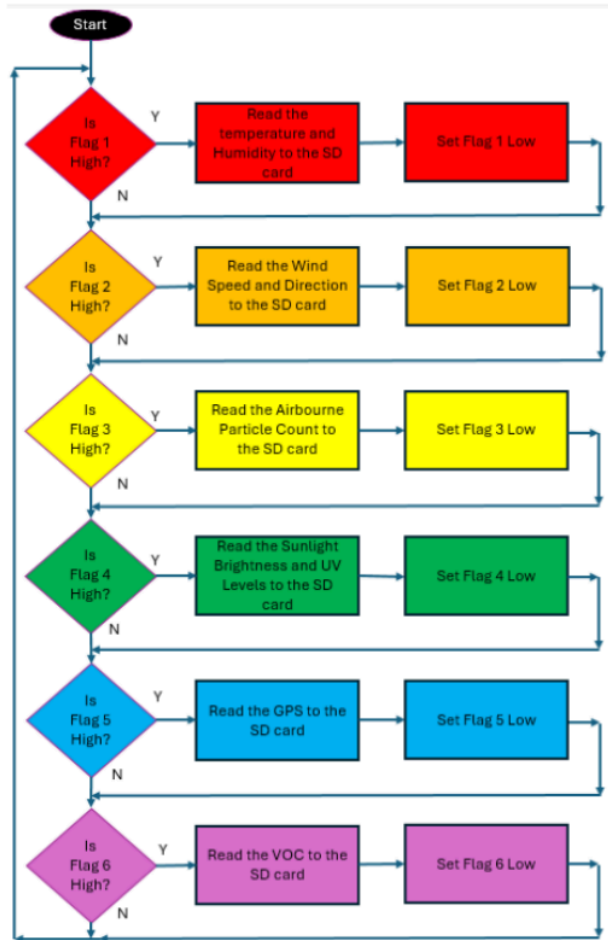


Figure 11 - Prototype Main Program Flowchart

The main flow program above demonstrates how the background functionality of the weather station PCB prototype works in conjunction with the required sensors. The program continuously looks for any flag state changes by using an infinite loop whilst the system is active. Once the main program picks up a change in the flag status, the chip will read the selective data and transfer the findings to the SD card waiting for data removal. After the process has been completed the flag status is set back to 0/low in order to wait for a change again.

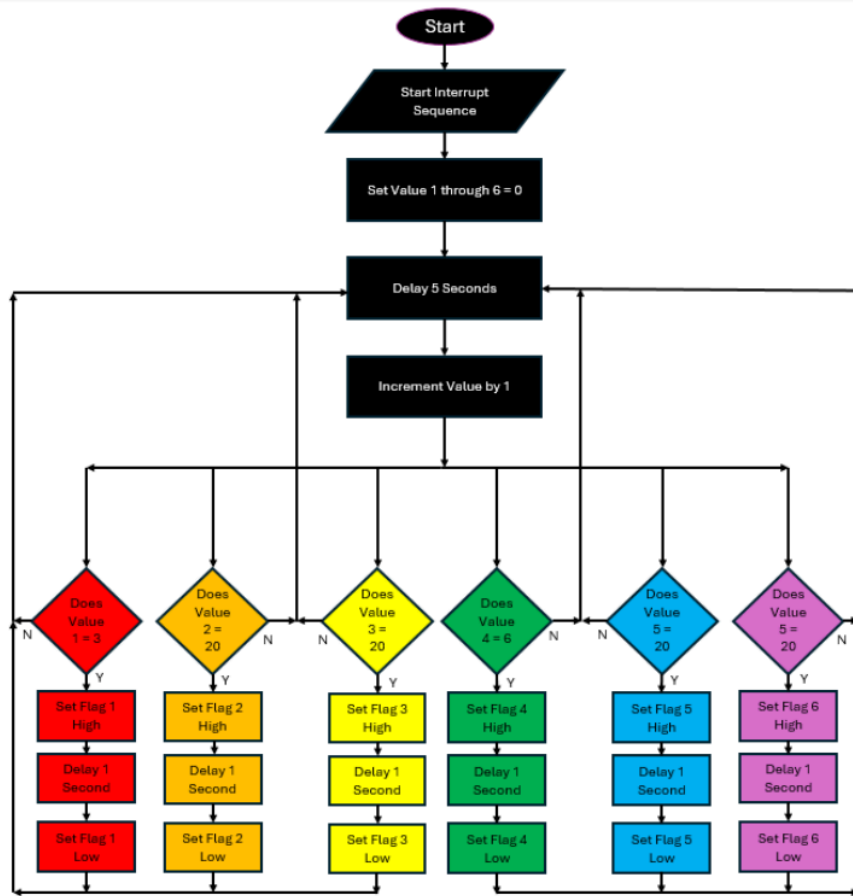


Figure 12 - Prototype Sub Routine Flowchart

The flowchart in figure 12 shows the interrupt program which runs in alignment with the main program. This program is designed in accordance with the timing required to capture the data from the sensors. All 9 sensors are collecting the data in either 15, 30 or 60 second intervals and so the delay is set much higher between the increments to facilitate this. If the program runs and the value, multiplied by 5, does not match the interval, the program will re-run and increment the value by 1 to show another 5 second interval has been applied.

Task 6

Costs

Full Prototype Build Costs (including connectors)

No.	Product	Component Amount Required	Units	Price per unit (£)	Total price (£)
1	Amphenol Advanced Sensors Temperature and Humidity Sensor, Analogue, Digital Output, Cable Mount, I2C, $\pm 2\%$ [4]	2	2	£35.87	£71.74
2	MeteoWind Compact [5]	1	1	£350.00	£350.00
3	RM-12 radiometer: inexpensive measurement of irradiance and illuminance [6]	1	1	£350.00	£350.00
4	Sensirion SEN54-SDN-T, PM, RH, T, VOC Environment Sensor for Particulate Matter, Relative Humidity, Temperature, VOC [7]	1	1	£76.20	£76.20
5	HPM Series Particulate Matter Sensor [8]	1	1	£73.22	£73.22
6	ADAFRUIT INDUSTRIES 746 GPS Module [9]	1	1	£40.61	£40.61
7	Microchip PIC18F24K50-I/SP [10]	1	1	£2.71	£2.71
8	TE Connectivity 1k Ω Metal Film Resistor 0.25W $\pm 0.1\%$ H81K0BYA – Pack of 10 [11]	9	1	£9.80	£9.80
9	Rubycon 470 μ F Aluminium Electrolytic Capacitor 25V dc, Radial, Through Hole - 25YXF470MEFCT810X16 – Pack of 10 [12]	10	1	£5.87	£5.87
10	onsemi, 5.1V Zener Diode 5% 1 W Through Hole 2-Pin DO-41 – Pack of 100 [13]	9	1	£6.30	£6.30
11	RS PRO 15k Ω Carbon Film Resistor 0.25W $\pm 5\%$ - Pack of 10 [14]	1	1	£1.06	£1.06
12	Vishay 250 Ω 0.5W Metal Foil Resistor $\pm 0.01\%$ $\pm 2\text{ppm}/^\circ\text{C}$ RCKO2 250R 0.01% [15]	2	2	£25.90	£51.80
13	STMicroelectronics L7805ACV, 1 Linear Voltage, Voltage Regulator 1A, 5 V 3-Pin, TO-220 [16]	1	1	£0.57	£0.57
14	RS PRO Straight, Panel Mount, Socket- Single Port Type A 3.0 IP68 Type A USB Connector [17]	1	1	£50.48	£50.48
16	Hirose 9 Way Right Angle SD Card Memory Card Connector [18]	1	1	£3.28	£3.28
17	RS PRO Toggle Switch, Panel Mount, On-Off-On, SPDT, Solder Terminal [19]	1	1	£2.12	£2.12
18	Kingbright 2.25 V Red LED 5mm Through Hole, L-53HD [20]	2	1	£1.51	£1.51

19	Molex C-Grid III Series Straight Through Hole Pin Header, 3 Contact(s), 2.54mm Pitch, 1 Row(s), Unshrouded – Pack of 5 [21]	1	1	£4.98	£4.98
20	RS PRO Straight Through Hole Pin Header, 4 Contact(s), 2.54mm Pitch, 1 Row(s), Unshrouded – Pack of 25 [22]	3	1	£4.38	£4.38
21	HARWIN M20 Series Straight Through Hole Pin Header, 5 Contact(s), 2.54mm Pitch, 1 Row(s), Unshrouded – Pack of 25 [23]	6	1	£21.75	£21.75
22	SPP-150, 150mm Insulated Tinned Copper Breadboard Jumper Wire in Black, Blue, Red, White, Yellow – Pack of 10 [24]	45 minimum	5	£4.65	£23.25
23	RS PRO Circular Connector, 5 Contacts, Cable Mount, Plug and Socket, Male and Female Contacts, IP68 [25]	5	5	£36.00	£180.00
24	RS PRO Circular Connector, 3 Contacts, Cable Mount, Plug and Socket, Male and Female Contacts, IP68 [26]	1	1	£31.27	£31.27
25	RS PRO Circular Connector, 4 Contacts, Cable Mount, Plug and Socket, Male and Female Contacts, IP68 [28]	2	2	£31.27	£62.54
26	12V 100Ah LiFePO4 Lithium Battery [4]	1	1	£199.99	£199.99
27	V525C Vault Equipment Case by pelican [8]	1	1	£192.42	£192.42
Total					£1,817.85

Table 16 - Final Prototype Costing

Task 7

Connectors and Final Case Design

Required Connectors

The prototype will require 6*5 pin connectors, 3*4 pin connectors and 1, 3 pin connector. The connections will be done by using a socket and plug connection through the pelican case to ensure the case remains water resistant. These connectors are included within the final pricing in task 6.

Prototype Case Design

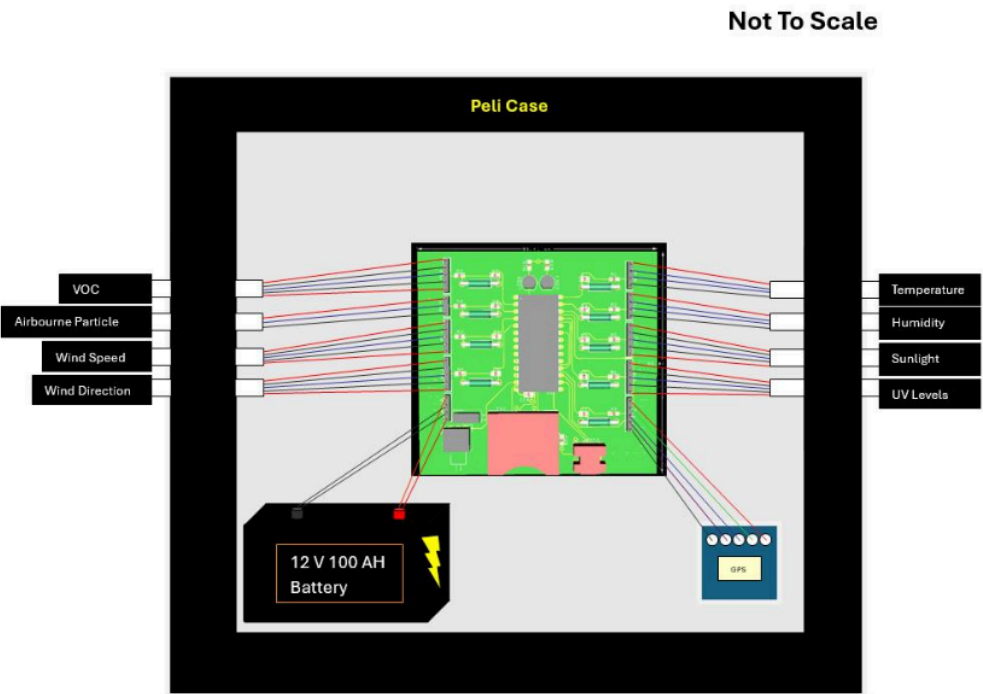


Figure 13 - Final Prototype Case Design

	Power
	Ground
	Signal
	Tx
	Rx
	Male to Female Connector Through Peli Case

Table 17 - Final Prototype Case Design Key

The figure above shows a bird's eye view of how the PCB will sit within the pelican case to keep the system

waterproof. There will be 8 connectors through the peli case to keep the box watertight, but still operate all of the sensors to a normal capacity. The second figure is the key to the coloured connectors.

Task 8

Summary Elements

Improvements And reasoning

One aspect which will need further development would be the GPS capability within this prototype. The GPS chosen for this station sits within the case connected to the board directly. By having the GPS in the case, there is a chance that the signal can be distorted or lost whilst communicating. This is due to all of the electronic components and circuitry having a reflective nature. Having an external GPS would benefit the model more and allow for a more accurate read on the positional location of the prototype.

Another improvement could be to add an additional screen within the design to show the user the progress of the stations reporting without having to externally read the data. This would allow the user to quickly go and check the system for any dangerous changes in the atmosphere to allow for safe systems of operation for all users in the area.

Conclusion

Overall, the project went as planned with the allocated sensors which could capture the desired data to an accurate level. The prototype which was built in this project was kept to a reasonable cost which is in alignment with the intermediate levels of weather stations on the market. This design was tailored to the user required specifications by creating proteus and easy pc designs, which allowed adaptations to be made to create a sustainable design which is small and accurate. In summary, by using these simulation software's, the prototype could be designed and made to be both low cost as well as, contain all the relative sensors required by the users task requirements.

References

- [AEM, "Weather Station Sensors: Types, Use Cases, & Selection Criteria," AEM, 2024.
1 [Online]. Available: <https://blog.aem.eco/weather-station-sensors#:~:text=Temperature%20and%20humidity%20sensors%20are,work%20in%20a%20given%20area..> [Accessed 3 December 2024].
- [Niubol, "What is the lifespan of a weather station?," Niubol, 28 August 2024. [Online].
2 Available: <https://www.niubol.com/Product-knowledge/What-is-the-lifespan-of-a-weather-station.html#:~:text=%2D%20Professional%20Grade%20Weather%20Stations%3A%20Can,to%2020%20years%20or%20more..> [Accessed 3 December 2024].
- [Weather Shop, "Davis Wireless Vantage Vue Weather Station with WeatherLink Console 6242UK," Weather Shop, 2024. [Online]. Available: <https://www.weathershop.co.uk/davis-vantage-vue-weather-station-with-weatherlink-console-6242uk>. [Accessed 3 December 2024].
- [HOBO, Enviromonitors, "HOBO Cellular Weather Station Kit - Intermediate,"
4 Enviromonitors, 2024. [Online]. Available: <https://www.enviromonitors.co.uk/rx3000-sys-kit-int-bundle>. [Accessed 3 December 2024].
- [Microchip Technology, "28/40/44-Pin, Low-Power, High-Performance Microcontrollers with XLP Technology," Microchip Technology Inc., 2014. [Online]. Available:
5 https://ww1.microchip.com/downloads/aemDocuments/documents/OTH/ProductDocuments/DataSheets/PIC18F2X_45K50-30000684B.pdf. [Accessed 18 November 2024].
- [Microcontrollerslab, "USB Interfacing Circuit with PIC Microcontroller,"
6 Microcontrollerslab, 2024. [Online]. Available: <https://microcontrollerslab.com/usb-interfacing-pic-microcontroller-code/#:~:text=USB%20Interfacing%20Circuit%20with%20PIC%20Microcontroller&text=It%20communicates%20with%20the%20computer,signal%20for%20the%20USB%20module..> [Accessed 18 November 2024].
- [D. H. Sarah L. Harris, "Embedded I/O Systems," *Digital Design and Computer*
7 *Architecture*, vol. II, no. 2, p. 542, 2022.
]
- [ECO-WORTHY, "12V 100Ah LiFePO4 Lithium Battery," Eco-Worthy, 2024. [Online].
8 Available: https://uk.eco-worthy.com/products/lifepo4-12v-100ah-lithium-iron-phosphate-battery?gad_source=1&gclid=CjwKCAiA9bq6BhAKEiwAH6bqOot9L6sOAqkIXSJmmlBvWdp6EkaDpGvIOeARZe-nseavAEI3bm3LRoCHIMQAvD_BwE. [Accessed 3 December 2024].
- [Peli, "V525C Vault Equipment Case," Peli, 2024. [Online]. Available:
9 <https://www.peli.com/gb/en/product/cases/equipment-case/vault/v525c/>. [Accessed 3
] December 2024].
- [RS, "Amphenol Advanced Sensors Temperature and Humidity Sensor, Analogue, Digital
1 Output, Cable Mount, I2C, $\pm 2\%$," RS, 2024. [Online]. Available: <https://uk.rs->

0 online.com/web/p/temperature-humidity-sensor-ics/2579568?searchId=0c588be2-ddf2-
] 44da-9bf5-bacbd85c5bc9&gb=s. [Accessed 3 December 2024].

[Barani Designs, "WMO conforming compact anemometer with a wind vane," Barani,
 1 2018. [Online]. Available: <https://www.baranidesign.com/meteowind-compact>. [Accessed
 1 3 December 2024].
]

[Opsytec Dr Grobel , Stefan Pieke, "RM-12 radiometer: inexpensive measurement of
 1 irradiance and illuminance," Opsytec, 2024. [Online]. Available:
 2 [https://www.opsytec.com/products/uv-meter/rm-
 \] 12?_gl=1*c1krvc*_up*MQ..&gclid=CjwKCAjw9p24BhB_EiwA8ID5BpQO4eM09qwPh0gWUPRfv88lapAkbQR3_uasaT0u3QWhWjep_vWVoxoCf2EQAvD_BwE](https://www.opsytec.com/products/uv-meter/rm-12?_gl=1*c1krvc*_up*MQ..&gclid=CjwKCAjw9p24BhB_EiwA8ID5BpQO4eM09qwPh0gWUPRfv88lapAkbQR3_uasaT0u3QWhWjep_vWVoxoCf2EQAvD_BwE). [Accessed 3
 December 2024].

[RS, "Sensirion SEN54-SDN-T, PM, RH, T, VOC Environment Sensor for Particulate
 1 Matter, Relative Humidity, Temperature, VOC," RS, 2024. [Online]. Available:
 3 [https://uk.rs-online.com/web/p/environmental-sensor-ics/2389413P?searchId=6016b305-
 \] 7a07-4928-941d-3bef5c6e8240](https://uk.rs-online.com/web/p/environmental-sensor-ics/2389413P?searchId=6016b305-7a07-4928-941d-3bef5c6e8240). [Accessed 3 December 2024].

[Honeywell, "HPMA115S0-008," TTI, 2024. [Online]. Available:
 1 [https://www.tti.com/content/ttiinc/en/apps/part-detail.html?partsNumber=HPMA115S0-
 4 008&mfgShortname=HON&productId=2026632444](https://www.tti.com/content/ttiinc/en/apps/part-detail.html?partsNumber=HPMA115S0-008&mfgShortname=HON&productId=2026632444). [Accessed 3 December 2024].
]

[Adafruit, RS, "ADAFRUIT INDUSTRIES 746 GPS Module," RS, 2024. [Online]. Available:
 1 <https://uk.rs-online.com/web/p/gnss-gps-modules/9054630?gb=s>. [Accessed 3
 5 December 2024].
]

[Farnell, "PIC18F24K50-I/SP," Farnell, 2024. [Online]. Available:
 1 [https://uk.farnell.com/microchip/pic18f24k50-i-sp/mcu-8bit-pic18-48mhz-spdip-
 6 28/dp/2305828](https://uk.farnell.com/microchip/pic18f24k50-i-sp/mcu-8bit-pic18-48mhz-spdip-628/dp/2305828). [Accessed 3 December 2024].
]

[TE Connectivity, RS, "TE Connectivity 1kΩ Metal Film Resistor 0.25W ±0.1%
 1 H81K0BYA," RS, 2024. [Online]. Available: [https://uk.rs-online.com/web/p/through-hole-
 7 resistors/1251196?gb=a](https://uk.rs-online.com/web/p/through-hole-resistors/1251196?gb=a). [Accessed 3 December 2024].
]

[Rubycon, RS, "Rubycon 470µF Aluminium Electrolytic Capacitor 25V dc, Radial, Through
 1 Hole - 25YXF470MEFCT810X16," RS, 2024. [Online]. Available: [https://uk.rs-
 8 online.com/web/p/aluminium-capacitors/7038122](https://uk.rs-online.com/web/p/aluminium-capacitors/7038122). [Accessed 3 December 2024].
]

[onsemi, RS, "onsemi, 5.1V Zener Diode 5% 1 W Through Hole 2-Pin DO-41," RS, 2024.
 1 [Online]. Available: <https://uk.rs-online.com/web/p/zener-diodes/8050047>. [Accessed 3
 9 December 2024].
]

[RS, "RS PRO 15k Ω Carbon Film Resistor 0.25W $\pm$ 5%," RS, 2024. [Online]. Available:
2 <https://uk.rs-online.com/web/p/through-hole-resistors/7077760>. [Accessed 3 December
0 2024].
]

[Vishay, RS, "Vishay 250 Ω 0.5W Metal Foil Resistor $\pm$ 0.01% $\pm$ 2ppm/ $^{\circ}$ C RCKO2 250R
2 0.01%," RS, 2024. [Online]. Available: <https://uk.rs-online.com/web/p/through-hole-1-resistors/2019854>. [Accessed 3 December 2024].
]

[Texas Instruments, RS, "STMicroelectronics L7805ACV, 1 Linear Voltage, Voltage
2 Regulator 1A, 5 V 3-Pin, TO-220," RS, 2024. [Online]. Available: <https://uk.rs-online.com/web/p/voltage-regulators/2988508>. [Accessed 3 December 2024].
]

[RS, "RS PRO Straight, Panel Mount, Socket- Single Port Type A 3.0 IP68 Type A USB
2 Connector," RS, 2024. [Online]. Available: <https://uk.rs-online.com/web/p/usb-3-connectors/2317944>. [Accessed 3 December 2024].
]

[Hirose, RS, "Hirose 9 Way Right Angle SD Card Memory Card Connector," RS, 2024.
2 [Online]. Available: <https://uk.rs-online.com/web/p/memory-card-connectors/8281872>.
4 [Accessed 3 December 2024].
]

[RS, "RS PRO Toggle Switch, Panel Mount, On-Off-On, SPDT, Solder Terminal," RS,
2 2024. [Online]. Available: <https://uk.rs-online.com/web/p/toggle-switches/7347233>.
5 [Accessed 3 December 2024].
]

[Kingbright, RS, "Kingbright 2.25 V Red LED 5mm Through Hole, L-53HD," RS, 2024.
2 [Online]. Available: <https://uk.rs-online.com/web/p/leds/2285988>. [Accessed 3 December
6 2024].
]

[Molex, RS, "Molex C-Grid III Series Straight Through Hole Pin Header, 3 Contact(s),
2 2.54mm Pitch, 1 Row(s), Unshrouded," RS, 2024. [Online]. Available: <https://uk.rs-online.com/web/p/pcb-headers/3606320>. [Accessed 3 December 2024].
]

[RS, "RS PRO Straight Through Hole Pin Header, 4 Contact(s), 2.54mm Pitch, 1 Row(s),
2 Unshrouded," RS, 2024. [Online]. Available: <https://uk.rs-online.com/web/p/pcb-8-headers/2518115>. [Accessed 3 December 2024].
]

[Harwin, RS, "HARWIN M20 Series Straight Through Hole Pin Header, 5 Contact(s),
2 2.54mm Pitch, 1 Row(s), Unshrouded," Rs, 2024. [Online]. Available: <https://uk.rs-online.com/web/p/pcb-headers/6812981P>. [Accessed 3 December 2024].
]

[SSP-150, RS, "SPP-150, 150mm Insulated Tinned Copper Breadboard Jumper Wire in
3 Black, Blue, Red, White, Yellow," RS, 2024. [Online]. Available: [https://uk.rs-
0 online.com/web/p/breadboard-jumper-wires/5053380](https://uk.rs-online.com/web/p/breadboard-jumper-wires/5053380). [Accessed 3 December 2024].
]

[RS, "RS PRO Circular Connector, 5 Contacts, Cable Mount, Plug and Socket, Male and
3 Female Contacts, IP68," RS, 2024. [Online]. Available: [https://uk.rs-
1 online.com/web/p/industrial-circular-connectors/1246694](https://uk.rs-online.com/web/p/industrial-circular-connectors/1246694). [Accessed 3 December 2024].
]

[RS, "RS PRO Circular Connector, 3 Contacts, Cable Mount, Plug and Socket, Male and
3 Female Contacts, IP68," RS, 2024. [Online]. Available: [https://uk.rs-
2 online.com/web/p/industrial-circular-connectors/2070680](https://uk.rs-online.com/web/p/industrial-circular-connectors/2070680). [Accessed 3 December 2024].
]

[RS, "RS PRO Circular Connector, 4 Contacts, Cable Mount, Plug and Socket, Male and
3 Female Contacts, IP68," RS, 2024. [Online]. Available: [https://uk.rs-
3 online.com/web/p/industrial-circular-connectors/2070684](https://uk.rs-online.com/web/p/industrial-circular-connectors/2070684). [Accessed 3 December 2024].
]

Appendix



MICROCHIP ADVANCED PART SELECTOR

Match ALL (AND)

Match ANY (OR)

Advanced

Search Results

3 MCHP parts found

Family

AB

Part Family

PIC18F24K50

CPU Type

AB

Max CPU Speed (MHz)

AB

CPU Speed (MIPS/DMIPS)

AB

☐ ARM Neon
 ☐ Math Accelerator

6-bit

16-bit

32-bit

Current

Future

Mature

Product Status

☐ Current
 ☐ Future
 ☐ Mature

Voltage

Operation Voltage

5

AB

Temperature

Temp Range

AB

AB

Packages

Pin Count

24

AB

Max I/O Pins

AB

AB

Memory Data

Program Memory Size (KB)

AB

AB

Program Memory Size (KWords)

AB

AB

Auxiliary Flash (KB)

AB

AB

SRAM (KB)

AB

AB

L1 Cache Memory (Instructions) (KB)

AB

AB

L1 Cache Memory (Data) (KB)

AB

AB

Data EEPROM/HEF (Bytes)

AB

AB

Internal DRAM

AB

AB

Internal DRAM Type

AB

External Memory Bus Interface

AB

☐ Multiple Flash Panels
 ☐ Error Correction Code Program Flash

☐ Emulated EEPROM in Flash
 ☐ NAND Interface

Search

Reset Search

Sort Results by

Memory Size

To add MCHP part to side-by-side

Add PIC18F24K50

Go to side-by-side

Automotive Capable

☐

PIC18F24K50

Specifications

Dev Tools

Technical Docs

Budgetary Pricing

Family

8-bit MCU

CPU Type

8-bit PIC MCU

Max CPU Speed (MHz)

48 MHz

MPU

None

Operation Voltage

(1.8V-5.5V)

Temp Range

(-40 to +125)

Pin Count

24

Program Memory Size (KB)

16

Error Correction Code Program Flash

2 KB

SRAM

256

Data EEPROM/HEF (bytes)

1024

Internal DRAM Type

None

Internal DRAM Access (ns)

100

Low Power

Yes

ADC Input

14

Max ADC Resolution (Bits)

10

DAC Output

1

Number of Op Amps

1

Hardware Touch Peripheral

1

UART

1

SP

1

I2C

1

I2S

1

FS

1

Analog

Interface

Memory

MCUs & MPUs

Wireless

Not sure of complete part number?

Global Part Search

Selection Tools Home

Have a suggestion?

Send email

More Links

Select a part in the search results, press one of the buttons below to view.

PIC18F24K50

Figure 14 - Microcontroller Selection Page



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

JJP Assignment 2

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

75/100

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14

PAGE 15

PAGE 16

PAGE 17

PAGE 18

PAGE 19

PAGE 20

PAGE 21

PAGE 22

PAGE 23

PAGE 24

PAGE 25

PAGE 26

PAGE 27

PAGE 28

PAGE 29

PAGE 30

PAGE 31

PAGE 32

GRADING FORM: SMU GENERIC_GJ

JOSHUA PORT

74.85

RESEARCH-INFORMED LITERATURE



Reasonable literature review of a number of available systems with a good comparison table of

relevant information but a few more devices would have improved it. 68%

6.8

KNOWLEDGE AND UNDERSTANDING

 Good overall schematic design but a things to be kept in mind. When designing a complex board it is beneficial, from a understanding point of view, to limit the number of lines travelling around and instead use net names which you have done. Your PCB has a small number of error that should have been corrected. When using 7805 voltage regulators, you need a tank cap on the input and the output, you should be looking at the switch mode types to limit temperature issues. 75%

18.75

ANALYSIS

 Good selection of microcontroller. Good selection of components very well described and selected via the tables.. Good case selection. Good selection of connectors .78%

27.3

PRACTICAL APPLICATION AND DEP.

 Costings were included in a table without an image but with the supplier's name and part number. Interesting attempt at future enhancements. 72%

14.4

SKILLS FOR PROFESSIONAL PRAC.



The report is well presented with a very good selection of references. 76%

7.6