

ESD assignment 2

by Connor Daniel

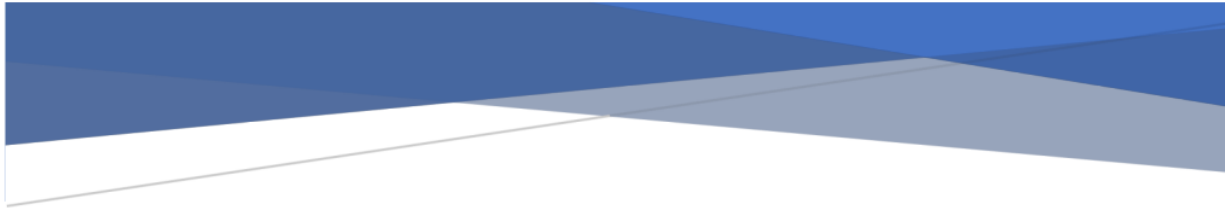
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ELECTRONIC SYSTEMS DESIGN

Assignment 2

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Table of Contents

Task 1	3
Portable weather measurement systems	3
Current weather measurement systems	3
Task 2	4
Microcontroller selection	4
Task 3	5
Enclosure and design	5
Enclosure box	5
Wheels	5
Pole for mounting external sensors	6
Bracket to panel mount pole	6
Inspection window	6
Panel vent	7
Switch	7
LED	8
Non-volatile memory	8
Parameters	8
Increments for parameters	9
Memory calculation	10
SD card	10
USB	11
Sensor selection	12
Temperature and Humidity	12
Wind speed and direction	12
Airborne particle count	13
Sunlight brightness	14
UV level	14
GPS	15
VOC levels	16
Voltage regulator	16
Connector specification	17
Sunlight Brightness	17
Wind speed and direction sensor	17
Connecting from enclosure to PCB	18
Battery selection	18
Current draw	18
Battery comparison	19
Task 4	20
PCB	20
Before copper pour	20
After copper pour	21
PCB price	22
Task 5	22
Structure diagram	22

Task 6	22
Build cost	22
Task 7	23
Task 8	24
Schematic diagram.....	24
Full schematic.....	24
Voltage regulation.....	24
Pull up resistors.....	25
LED	25
SD card	26
PM sensor	26
USB	27
VOC sensor & sunlight brightness sensor	27
Wind speed and direction	28
Temperature and humidity sensor	29
UV sensor	30
Software flow chart	30
Mode selection	30
Data upload mode.....	31
Data acquisition mode	32
Bibliography	36

Task 1

Portable weather measurement systems

A portable weather measurement system will measure record and transmit data that has been collected from its surroundings. The weather measurement systems typically measure the following parameters:

- Temperature
- Wind Speed
- Wind Direction
- Precipitation
- Humidity
- Solar Radiation
- Atmospheric Pressure
- Visibility. [1]

This measurement system will typically use various sensors to collect the data needed. For example, the temperature could be measured using a thermometer and a hygrometer could be used to measure the humidity. To measure the wind speed and direction an anemometer and a wind vane could be used. [2]

Current weather measurement systems

			
Supplier	[3] Weather shop	[4] CPC Farnell	[5] Vantage
Model	Accur8	W-8681-PRO	Watchdog 3250
Temperature range	-40 to 60 °C	-30 to 65 °C	-40 to 125 °C
Humidity range	1 to 99%	1 to 99%	0 to 100%
Wind speed range	0 to 112 mph	0 to 100 mph	0 to 200 mph
Rainfall range	0 to 9999 mm	0 to 9999 mm	0.245 mm resolution

Barometric pressure range	300 to 1100 hPa	300 to 1100 hPa	
Battery life			14 days without solar power
Data capacity			312 days at 15-minute intervals (30,000 records)
Price	£109.99	£262.80	£2,125.00
Other features	• Weather forecast • Wind direction • Wi-Fi and phone compatibility • Calendar and time functions • Programmable alarms • Dew point • Memory records	• Lux meter – 0 to 400 lux • Wind direction • Time display • Dew point • Wi-Fi connection • MicroSD memory card slot	• Solar radiation measurement – 0 to 1500 W/m² • Operating temperature range – -30 to 65°C • Wi-Fi and phone compatibility • One available sensor port • Wind direction – 0 to 359°

Task 2

Microcontroller selection

For the microcontroller the PIC18F27J53 will be used.

	
Supplier	[28] Farnell
Microchip	PIC18F27J53
Pin count	28
Supply voltage	3.3 V
Program memory	128 (Kbytes)
Data memory	3.8 (Kbytes)
ADC input	10
Max ADC resolution	12
UART	2

SPI	2
I2C	2
Number of USB modules	1
Price	£4.52

This microcontroller was chosen as it has 28 pins and has a good program memory of 128 KB. The microcontroller also has ports for UART, SPI and I2C meaning it will give a range of options when picking sensors. The low cost of £4.53 was also a factor when selecting this microchip. These factors should fit the specifications set out for the weather station.

Task 3

Enclosure and design

Enclosure box

The enclosure box below has been chosen as it's dimensions will fit the battery and PCB board inside. The enclosure is also IP66 rated meaning that it will be suitable for a variety of different weather conditions.

	
Supplier	[29] CEF
Model	Schneider Sarel
Dimensions	600mm x 400mm x 250mm
IP rating	IP 66
Weight	11.644 kg
Price	£127.20

Wheels

The wheels below have been chosen in order to improve the portability of the weather station, there will be a wheel on each corner of the box.

	
Supplier	[30] RS

Model	RS PRO Braked Swivel Castor Wheel
Load capacity	70 kg
Wheel diameter	100mm
Wheel width	27 mm
Price	£15.13

Pole for mounting external sensors

The conduit below has been selected to mount the external sensors due to its lightweight and low cost.

	
Supplier	[31] CEF
Model	Metal Pre-Galvanised Steel Conduit
Pole diameter	25mm
weight	0.688 kg
Price	£16.92

Bracket to panel mount pole

This bracket will be mounted to the side of the panel and has been chosen as it is a good diameter to hold the pole in place.

	
Supplier	[32] CPC
Model	Pressed Caravan Facia Bracket with Clamp
Diameter	1 inch (25.4mm)
Price	£3.00

Inspection window

The inspection window below will be used to allow sunlight to the UV sensor. It has been chosen as it is IP67 rated.

	
Supplier	[33] Essential supplies
Model	INSPECTION WINDOW 4 MODULE
IP rating	IP 67
Price	£14.21

Panel vent

This is the panel vent that will be used to allow airflow into the enclosure for the sensors that require it.

	
Supplier	[34] Farnell
Model	HAMMOND XPFA120BK
IP rating	IP 54
Price	£23.72

Switch

	
Supplier	[52] RS

Model	Schneider Electric Knob Selector Switch
IP rating	IP67
Price	£29.17

LED

	
Supplier	[49] RS
Optimum voltage	3.2 V
Current rating	20 mA
IP rating	IP 67
Price	£16.12

Non-volatile memory

Parameters

To work out how much memory is needed, first a suitable range and frequency of sample rate must be worked out for each parameter. This can then be used to calculate the number of bytes that will be used over the 14-day period.

Temperature and humidity

For the temperature and humidity, a sensor that can measure a wide range is desirable so the weather station can be set up in a variety of different environments. From completing research into temperatures that have been recorded, source [20] states that the highest temperature recorded was 58°C and the lowest was -88°C. Due to this an appropriate range for the application of the weather station being built is -40 to 60°C. The humidity should range from 0 to 100% relative humidity.

Wind speed and direction

The highest wind speed ever recorded according to source [35] is 253 mph however, due to the structural design of the weather station and the application an acceptable range would be between 0 and 120 MPH. The wind direction should cover a full 360°.

Airborne particle count

According to source [36] the particles size PM2.5 and PM10 are the ranges typically measured. These measure between 2.5 µm and 10 µm respectively therefore, a good range that the sensor will need to be able to detect particles would be 1 µm to 10 µm in order to detect all particles. Source [36] also states the average concentration of PM2.5 in Delhi is 130.1 µg/m³ therefore, a suitable concentration range for the airborne particle count would be 0 to 500 µg/m³.

Sunlight brightness

Source [37] states that typical lux levels range from less than 0.01 at night and up to 100,000 with direct sunlight. As these are typical values a suitable range to gather a good range of readings would be 0 to 120,000 lux.

UV levels

For UV levels it will have to gather readings from the entire ultraviolet spectrum. According to source [38] this ranges between 100 and 400 nm. UVC being between 100 and 280 nm, UVB being between 280 and 315 nm and UVC being between 315 and 400 nm.

GPS

The GPS will always remain on.  2

VOC levels

The VOC levels will be measured on a scale of 0 to 1000 ppm

Parameter	Measurement range
Temperature	-40 to 60°C
Humidity	0 to 100%
Wind speed	0 to 120 mph
Wind direction	0 to 360°
Airborne particle count	0 to 500 µg/m3
Sunlight brightness	0 to 120,000 lux
UV levels	100 to 400 nm
GPS position	N/A
VOC levels	0 to 1000 ppm

Increments for parameters.

Parameter	Increment	Number of possible Values	Number of bits	Bytes needed	Sampling rate
Temperature	1°C	100	7	1	1 minute
Humidity	1%	100	7	1	1 minute
Wind speed	1 mph	120	7	1	10 seconds
Wind direction	1°	360	9	2	10 seconds
Airborne particle count	1 µg/m3	500	9	2	1 minute
Sunlight brightness	100 lux	1200	11	4	1 minute
UV levels	1 nm	300	9	2	1 minute
GPS position	N/A	N/A	9600	14	5 minutes
VOC levels	10 ppm	100	7	1	1 minute

Memory calculation

Sensors sampling at 1 minute.

$$\begin{aligned} &11 \text{ bytes a minute} \\ &11 \times 60 = 660 \text{ bytes per hour} \\ &660 \times 24 = 15,840 \text{ bytes per day} \\ &15,840 \times 14 = 221,760 \text{ bytes over a 14 day period} \\ &221,760 \text{ bytes} = 0.22176 \text{ MB} \end{aligned}$$

Wind speed and direction

$$\begin{aligned} &3 \text{ bytes every 10 seconds} \\ &3 \times 6 = 18 \text{ bytes per minute} \\ &18 \times 60 = 1080 \text{ bytes per hour} \\ &1080 \times 24 = 25,920 \text{ bytes per day} \\ &25,920 \times 14 = 362,880 \text{ bytes over a 14 day period} \\ &362,880 \text{ bytes} = 0.36288 \text{ MB} \end{aligned}$$

GPS

$$\begin{aligned} &14 \text{ bytes every 5 minutes} \\ &14 \times 12 = 168 \text{ bytes per hour} \\ &168 \times 24 = 4,032 \text{ bytes per day} \\ &4,032 \times 14 = 56,448 \text{ bytes over a 14 day period} \\ &56,448 \text{ bytes} = 0.056448 \text{ MB} \end{aligned}$$

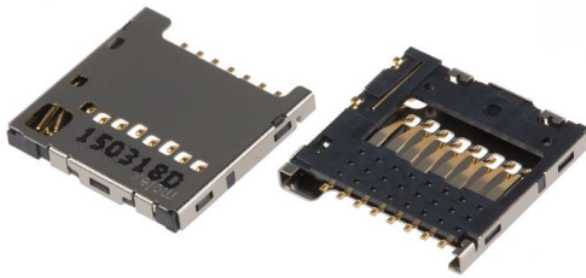
Total memory needed.

$$\begin{aligned} &0.22176 + 0.36288 + 0.056448 = 0.641088 \text{ MB} \\ &0.641088 \text{ MB needed over the 14 day period.} \end{aligned}$$

SD card

	
Supplier	[39] RS
Model	Kingston
Capacity	32 GB
Temperature range	-25 to 85°C
Voltage	3.3 V
Dimensions	24mm x 32mm x 2.1mm
Price	£10.99

To mount the SD card to the PCB the 8-way connector shown below will be used.



This has been chosen as it has a low cost of £2.166 and it has an operating temperature of 25 to 85°C. [40]

USB

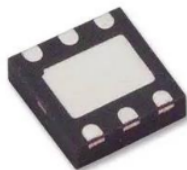
	
Supplier	[41] RS
Model	Kingston
Capacity	32 GB
Temperature range	0 to 65°C
Dimensions	39mm x 12.6mm x 4.9mm
Price	£12.36

To connect the USB to the PCB the connector below will be used. [42]



Sensor selection

Temperature and Humidity

			
Supplier	[6] Digikey	[7] RS	[8] Farnell
Model	LM75BIM-5+	PT100 RTD sensor	TE connectivity HTU21D
Sensor Type	Digital	PT100 (open collector)	Digital
Output type	I ² C		I ² C
Temperature measurement range	-55 to 125 °C	-50 to 250 °C	-40 to 125 °C
Humidity range			0 to 100% rh
Supply voltage	3.3V to 5V		3.6V
Operating supply current	250µA		500µA
Price	£2.55	£33.73	£6.852
IP rating		IP 68	IP 67

For the temperature and humidity sensor the TE connectivity HTU21D has been chosen. This is due to it having a good temperature range compared with the other sensors I have found and compared to my research with source [20]. It also measures the humidity which the other sensors I have selected do not. This will reduce the number of connections required as I will not need a separate sensor for the humidity. It is also reasonably priced at £6.852 which will help the cost of the weather station with the more expensive components.

Wind speed and direction

			
Supplier	[9] QUARK-ELEC	[10] Farnell	[11] Prodata weather systems
Manufacturer	QK-AS06	Omega	Davis

Sensor type	Anemometer	Open collector anemometer	Anemometer (RJ-11 connector)
Supply voltage	10 to 15 VDC	12 Vac or dc	
Measuring range	0 to 55 m/s (123 mph)	0 TO 100 MPH	1 TO 200 MPH
Wind direction operating range	0 to 359°	0 to 360°	0 to 360°
Operating temperature	-35 to 65°C	-20 to 50°C	-40 to 65°C
IP rating	IP 66		
Power consumption	27mA		
Output		Dual 4 – 20mA	
Price	£250.68	£1058.00	£225.00

The_QK-AS06 will be used to measure both the wind speed and direction. This is because it has a low power consumption of 27mA and is also IP66 rated whilst having good measurement ranges in wind speed and direction.

Airborne particle count

			
Supplier	[12] RS	[13] Farnell	[14] RS
Manufacturer	Seinsirion	Honeywell	Tera
Sensor type	PM sensor	PM sensor	PM sensor
Supply voltage	4.5 to 5.5V	5V	5V
Operating current		50mA	
Operating temperature	-10 to 60°C	-20 to 60°C	-20 to 70°C
Mass concentration range	0 to 1000 µg/m3	0 to 1000 µg/m3	0 to 1000 µg/m3
Particle size detection range	0.3 to 10µm	0.3 to 10µm	0.3 to 10µm
Output type	I2C, UART	I2C, UART	UART/Modbus(RS485)
Price	£47.92	£31.09	£93.16

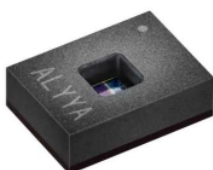
For my airborne particle count the Honeywell Particle matter sensor will be used. This is due to it having a good operating temperature and is the cheaper of the two sensors that are I2C compatible.

Sunlight brightness

			
Supplier	[15] Omni instruments	[16] Farnell	[27] Farnell
Model	CSD3 sunshine sensor	SEEED STUDIO photoresistor light sensor	SEEED STUDIO 314990740
Spectral range	400 to 1100 nm	Max 540 nm	
Measurement range			0 to 200,000 LUX
Operating temperature	-40 to 70°C		-40 to 85°C
Power supply	12 Vdc	3 to 5V	3.9 to 30 VDC
Signal	Analog(1mV/Wm ²)	Analog	Analog
Operating current		0.5 to 3 mA	7 mA at 24VDC
IP rating			IP 66
Price	£2166.00	£3.31	£67.10

To measure sunlight brightness the SEEED STUDIO 314990740 will be used as it has a good measurement range and is IP 66 rated. It also has a good operating temperature meaning it will be suitable for any conditions that it may need to operate in.

UV level

			
Supplier	[17] MSL	[18] Fruugo	[19] RS
Sensor type	Pyranometer	Pyranometer	UV Light sensor
Power supply		12 to 30V	3.3 V
Current consumption			1.42 mA
Standby current			970 µA

Measurement parameters	0 to 1280 W/m ²	0 to 2000 W/m ²	
Spectral range	300 to 1100 nm	400 to 1100 nm	UVA, UVB, UVC
Operating temperature	-40 to 75°C	-40 to 85°C	-40 to 85°C
IP Rating		IP 66	
Output		Analog 4 to 20mA	I2C
Price	£368.40	£139.00	£9.84

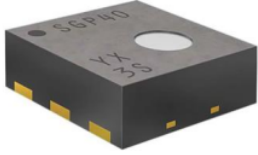
To measure the UV levels the UV light sensor from RS will be used due to it being the cheapest option.

GPS

			
Supplier	[21] RS	[22] Farnell	[23] RS
Model	TESEO-VIC3DA	LANTRONIX A2200A	Wurth Elektronik 2614021137000
Supply voltage	3.3V	3 to 3.6V	1.8 V
Operating temperature	-40 to 85°C	-40 to 85°C	-40 to 85°C
Standby current	17 µA	25 µA	30 µA
Current consumption	48.8 mA	52 mA	55 mA
Bus interfaces	I2C, UART	I2C, UART, SPI	I2C, UART
Position accuracy	1.5 m		
Price	£20.41	£14.24	£26.318

For GPS the TESEO-VIC3DA has been selected as the operating temperature and supply voltage are suitable for the application it will be used for. However, when compared to the other GPS Modules it has a lower standby current and current consumption which will help lower the battery size needed considering this will be monitored over a 14-day period.

VOC levels

			
Supplier	[24] RS	[25] RS	[26] Farnell
Model	Sensirion SGP40-D-R4	SGX PS4	AMPHENOL ADVANCED SENSORS MICS-VZ-89TE
Supply voltage	3.3 V	0 V (solid polymer electrolyte)	3.3 VDC
Operating temperature	-10 to 50°C	-40 to 50°C	0 to 50°C
Operating current/power	2.6 mA	0 A (+/- 100 nA)	125 mW
Measurement range	0 to 1000 ppm	0 to 1000 ppm	400 to 2000 ppm
Price	£6.89	£88.32	£19.85

For the VOC level sensor, the Sensirion SGP40-D-R4 will be used as it has an ideal measurement range and is the only sensor from the three above that is I2C compatible. It is also the cheapest of the three types of sensors I have researched.

Voltage regulator

Due to the majority of the sensors having a supply voltage of 3.3 V and having a 12 V battery a voltage regulator is required. The voltage regulator below has been chosen as it has a max input voltage of 15 V and an output voltage of 3.3 V therefore it is ideal for the specifications of this weather station.

	
Supplier	[43] Mouser
Model	LM1117MPX-3.3
Input voltage	15 V (max)
Output voltage	3.3 V
Operating temperature	-40 to 125°C
Price	£0.86

Connector specification

Sunlight Brightness

To connect the sensor to the enclosure the Male and Female connectors will be used. These connectors have been chosen as they are IP 67 rated and have a good operating temperature range. This allows the weather station to be placed in a variety of different weather conditions.

		
Supplier	RS	
Type	[44] 3 Contact Female circular connector	[45] 3 Contact Male circular connector
IP rating	IP 67	
Operating temperature	-25 to 75°C	
Current rating	3A	
Voltage rating	30 V	
Price	£22.24	£19.81

Wind speed and direction sensor 4

To connect the sensor this RS232 Female socket will be used as it has a good operating temperature range and is IP 67 rated. This means it is suitable for the weather conditions it may be placed in and will not have an impact of the integrity of the enclosure.

	
Supplier	[46] RS
Type	Female 9-way panel mount connector socket
IP rating	IP 67
Operating temperature	-40 to 105°C
Price	£26.00

Connecting from enclosure to PCB

To connect from the enclosure to the PCB board the Molex kk connector and crimp will be used as they are cheap and have a good operating temperature.

		
Supplier	RS	
Type	[47] Molex kk Female connector housing	[48] Molex kk crimp contact
Operating temperature	-40 to 105°C	-40 to 80°C
Price	£0.27	£0.134

Battery selection

Current draw

To work out the size of the battery needed, the total current draw over a 14-day period must be calculated for the sensors chosen.

Parameter	Current draw from sensor
Temperature and humidity	500 μ A
Wind speed and wind direction	27 mA
Airborne particle count	50 mA
Sunlight brightness	7 mA
UV level	1.42 mA
GPS	48.8 mA
VOC level	2.6 mA
TOTAL CURRENT DRAW	137.32 mA

$$137.32 \text{ mA} \times 24 = 3295.65 \text{ mA}$$

$$3295.65 \text{ mA} = 3.3 \text{ A}$$

$$3.3 \text{ A} \times 14 = 46.2 \text{ A}$$

$$\text{Total AH needed by battery over the 14 day period} = 46.2 \text{ AH}$$

Battery comparison

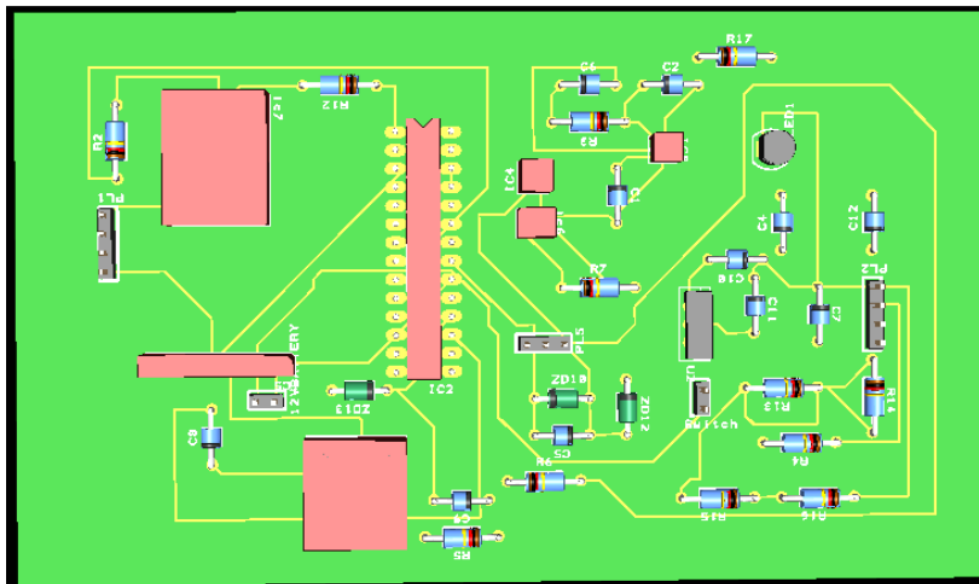
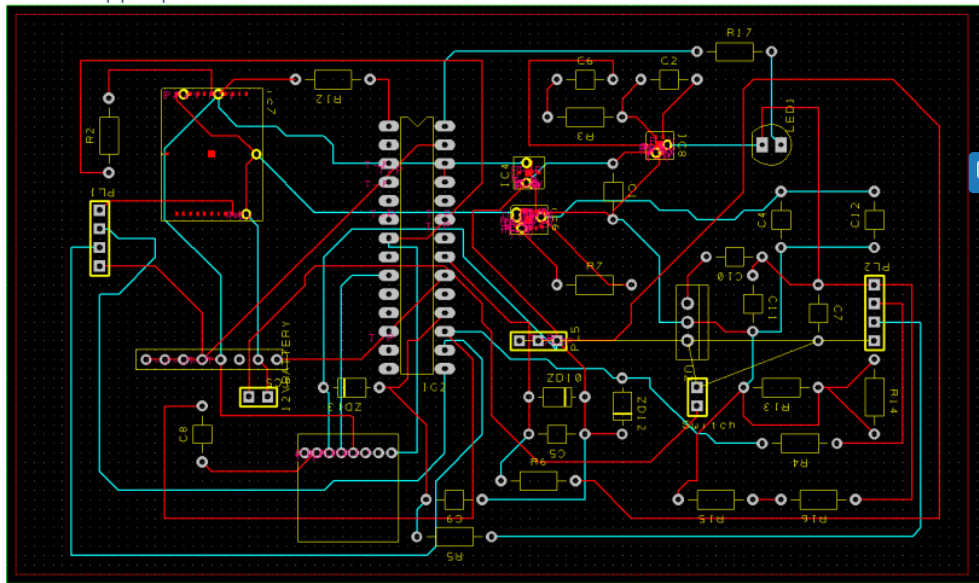
		
Supplier	[50] BBL Batteries	[51] RS
Model	Avon Deep Cycle AGM GEL	Yuasa 12V M5 Sealed Lead Acid Battery
Voltage	12 V	12 V
Number of AH	50 AH	50 AH
Connected in	Parallel	Single unit
Total weight	12 kg	15.3 kg
Total dimensions	360 x 154 x 340 mm	197 x 165 x 175 mm
Total cost	£95.96	£291.64

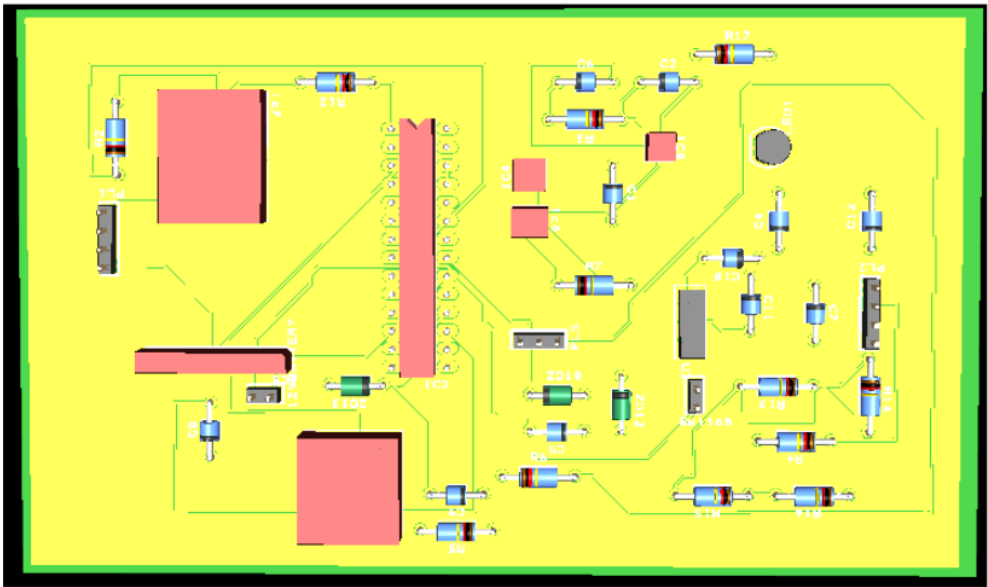
For the battery the Yuasa 12V M5 Sealed Lead Acid Battery will be used giving 50 AH which is more than is needed to meet the 46.2 AH calculated previously. Although this is the heavier and more expensive option, this battery will reduce the cost and weight of the enclosure due to its smaller dimensions, which will help increase the portability of the weather station.

Task 4

PCB

Before copper pour





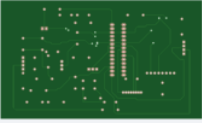
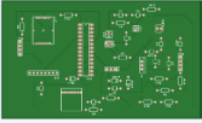
PCB price

Standard PCB/PCBA

Advanced PCB/PCBA

SMT-Stencil

3D/CNC



[Back to Upload File](#) Detected 2 layer board of 78.74x133.35mm(3.1x5.25 inches). [Gerber Viewer](#)

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

Charge Details

Engineering fee

\$4.00

Via Covering

\$0.00

Surface Finish

\$0.00

Board

\$4.00

Build Time

PCB:

3-4 days

2 days

24 hours

24 hours

\$0.00

\$0.00

\$7.20

\$0.00

PCBA Only

Calculated Price

Additional charges may apply for special cases

\$8.00

SAVE TO CART

Task 5

Structure diagram

```
graph LR;
    MC[MICROCONTROLLER] --> AS[Analog signals];
    MC --> RS232[RS232];
    MC --> LED[LED];
    MC --> I2C[I2C];
    AS --> SB[Sunlight brightness];
    RS232 --> WSD[Wind speed and direction];
    I2C --> TH[Temperature and humidity];
    I2C --> GPS[GPS];
    I2C --> UV[UV levels];
    I2C --> VOC[VOC levels];
    I2C --> PM[PM sensor];
```

Task 6

Build cost

Component	Cost
TE connectivity HTU21D	£6.58
QK-AS06	£250.68
Honeywell PM sensor	£31.09
SEED STUDIO 314990740	£67.10
UV Light sensor	£9.84

TESEO-VIC3DA	£20.41
Sensirion SGP40-D-R4	£6.89
Avon Deep Cycle AGM GEL	£95.96
PIC18F27J53	£4.52
Schneider Sarel	£127.20
RS PRO Braked Swivel Castor Wheel x4	£60.52
Metal Pre-Galvanised Steel Conduit	£16.92
Pressed Caravan Facia Bracket with Clamp	£3.00
INSPECTION WINDOW 4 MODULE	£14.21
HAMMOND XPFA120BK	£23.72
Schneider Electric Knob Selector Switch	£29.17
Kingston SD card	£10.99
SD card connector	£2.166
USB	£12.36
USB connector	£2.47
LM1117MPX-3.3	£0.86
3 Contact Female circular connector	£22.24
3 Contact Male circular connector	£19.81
9-way socket	£26.00
Molex kk Female connector housing	£0.27
Molex kk crimp	£0.402
LED	£16.12
PCB	£6.88 (\$8)
Total cost	£888.38



Task 7

To improve on the weather station for the next iteration a solar system would be incorporated, this would extend the battery life of the current system. Solar panels would be used to generate electricity through sunlight and recharge the battery. This would be an improvement on the current design as it would allow for a smaller battery therefore reducing cost and increasing the portability of the design.

The second improvement that could be made to the current weather station would be to program the sensors to enter sleep mode when not taking readings. This would substantially lower the total current draw again allowing for a smaller battery therefore reducing cost and improving the portability of the weather station.

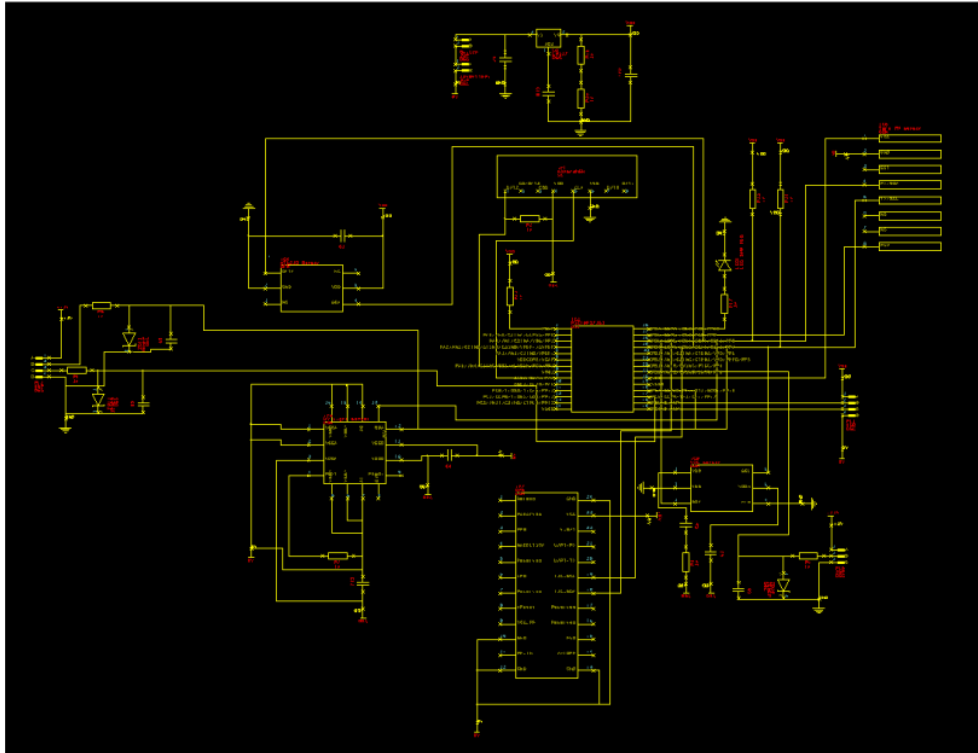
The third improvement that could be made to improve the weather station would be to change the airborne particle sensor to an external sensor. This is due to the airborne particle

sensor requiring airflow, which as it is currently directly connected to the PCB compromises the IP rating of the enclosure.

Task 8

Schematic diagram

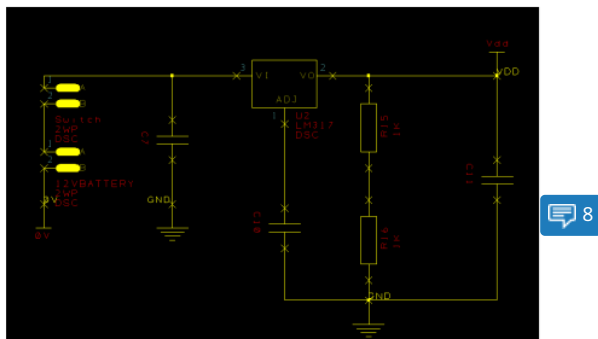
Full schematic



7

Voltage regulation

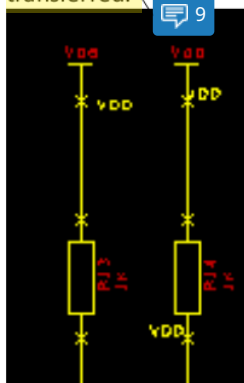
The circuit below shows the voltage regulation circuit. The circuit shows how the 12 V supply from the battery to the switch and gets taken down to the 3.3v supply for the microcontroller and the sensors that have a supply voltage of 3.3v. The value of capacitor C7 is 10 μ F. The value of the resistor R15 is 121 Ω and the value of R16 is 1k. Capacitor C11 has a value of 100 μ F. Capacitor C10 has been put in place to improve ripple rejection.



Pull up resistors

These pull up resistors have been put in place on the SDA and SCL lines of the I2C circuits.

The resistors have been put in place to keep the lines high when data is not being transferred.



LED

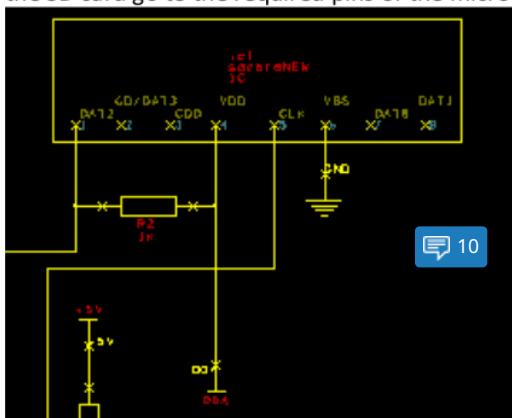
The circuitry below shows the LED that is connected to the microcontroller as it must be programmed to flash every 10 seconds. The resistor has been put in place to limit the current going to the LED.

$$\begin{aligned}
 &\text{Value of resistor } R17 \\
 R17 &= \frac{V_{supply} - V_{LED}}{I_{LED}} \\
 R17 &= \frac{3.3v - 3.2v}{0.02A} \\
 R17 &= \frac{0.1v}{0.02A} \\
 R17 &= 5\Omega
 \end{aligned}$$



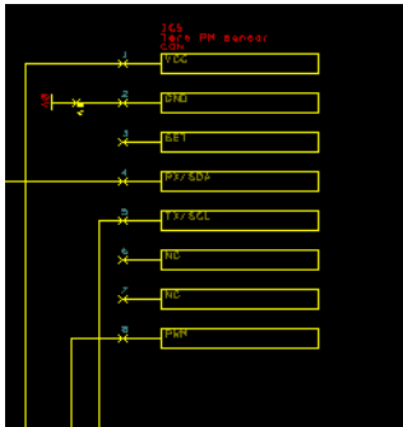
SD card

The circuit below shows how the SD card is connected. A shown VBS is connected to ground and VDD is connected to VDD for the power supply to for the SD card. There is also a resistor between the Data and VDD line as shown in the data sheet for the SD card, the purpose of this resistor is for noise reduction and signal integrity. The clock line and the data line from the SD card go to the required pins of the microcontroller.



PM sensor

The circuit below shows how the particle matter sensor is connected. The VDD line goes to the VDD line of the microcontroller and the ground line from the sensor is connected to ground. The SCL line is connected to the SCL pin of the microcontroller and the SDA line from the sensor goes to the SDA pin on the microcontroller. The PWM line from the sensor goes to pin 28 of the microcontroller which the data sheet specifies is suitable for PWM input/output.



USB

The USB connector is connected to ground and VDD. Pins 2 and 3 are connected to the D+ and D- pins of the microcontroller respectively.



VOC sensor & sunlight brightness sensor

The VOC sensor has been wired-up as the data sheet specified, with VDD from the sensor having a $1\mu\text{F}$ capacitor and a 4.7 Ohm resistor in place before connecting it to VDD. The VSS and n/a lines from the sensor are connected directly to ground. The VDDH line also has a $1\mu\text{F}$ capacitor which is then connected to VDD. The SCL and SDA lines from the sensor go to their pins on the microcontroller, with the pull up resistor required from the data sheet already in place on both lines.

The sunlight brightness sensor is a 3-pin connector with a 12v being fed straight of the battery. Pin 2 from the connector is the analog out from the sensor and is connected to the

pin 21 on the microcontroller which is suitable for analog input. The third pin is connected to ground. The circuit for the sunlight brightness sensor also has over voltage protection in the form of a Zener diode and a low pass filter which includes a resistor and capacitor. As the microcontroller has a supply voltage of 3.3 V the Zener diode will have a voltage of 3.4 V to ensure proper over voltage protection.

Calculating the resistor and capacitor value of the low pass filter

$$\text{Frequency (Hz)} = \frac{\text{sample rate}}{\text{Time (s)}}$$

$$\text{Frequency} = \frac{1}{60 \text{ s}}$$

$$\text{Frequency} = 0.0167 \text{ Hz}$$

$$\text{Cutoff frequency} = \frac{0.0167}{2}$$

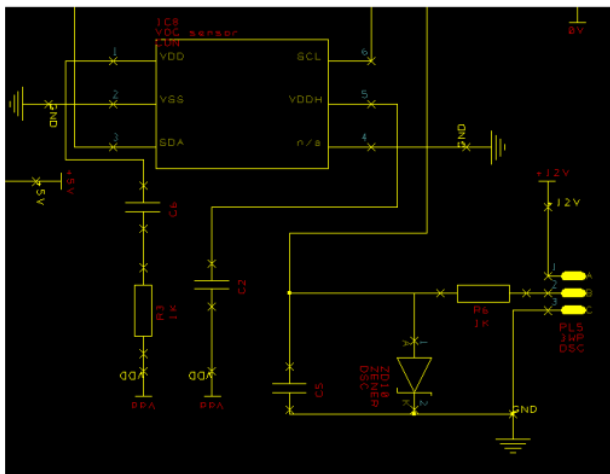
$$\text{Cutoff frequency} = 0.00835 \text{ Hz}$$

$$F_c = \frac{1}{2\pi RC}$$

$$C = \frac{1}{2\pi \times 0.00835 \times 9.1 \times 10^3}$$

$$C5 = 2.1 \text{ mF}$$

$$R6 = 9.1 \text{ k}\Omega$$



Wind speed and direction

The wind speed and direction sensor are connected by rs232 straight from the 12v batteries for a supply. Pins 2 and 3 are connected to the receive (RX) and transmit (TX) lines respectively. Both these lines have low pass filters and a Zener diode for over voltage protection. The Zener diode will be 3.4 V as the microcontroller has a supply voltage of 3.3 V.

Calculating the resistor and capacitor value of the low pass filter

$$\text{Frequency (Hz)} = \frac{\text{sample rate}}{\text{Time (s)}}$$

$$Frequency = \frac{1}{10\ s}$$

$$Frequency = 0.1\ Hz$$

$$Cutoff\ frequency = \frac{0.1}{2}$$

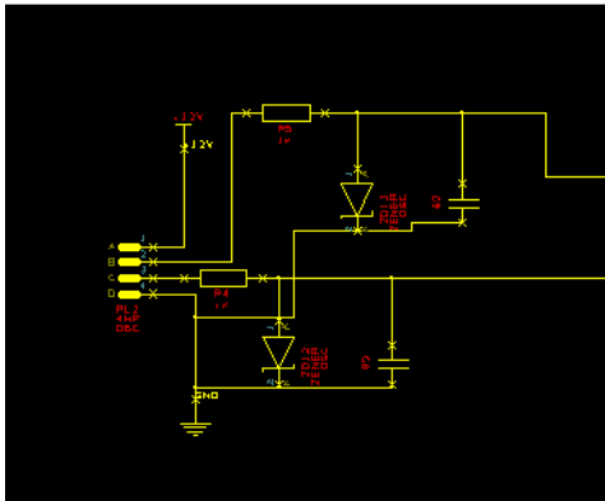
$$Cutoff\ frequency = 0.05\ Hz$$

$$Fc = \frac{1}{2\pi RC}$$

$$C = \frac{1}{2\pi \times 0.05 \times 10 \times 10^3}$$

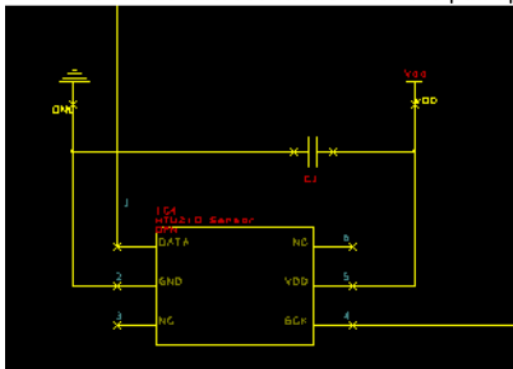
$$C8 \ \& \ C9 = 0.16F$$

$$R4 \ \& \ R5 = 10k\Omega$$



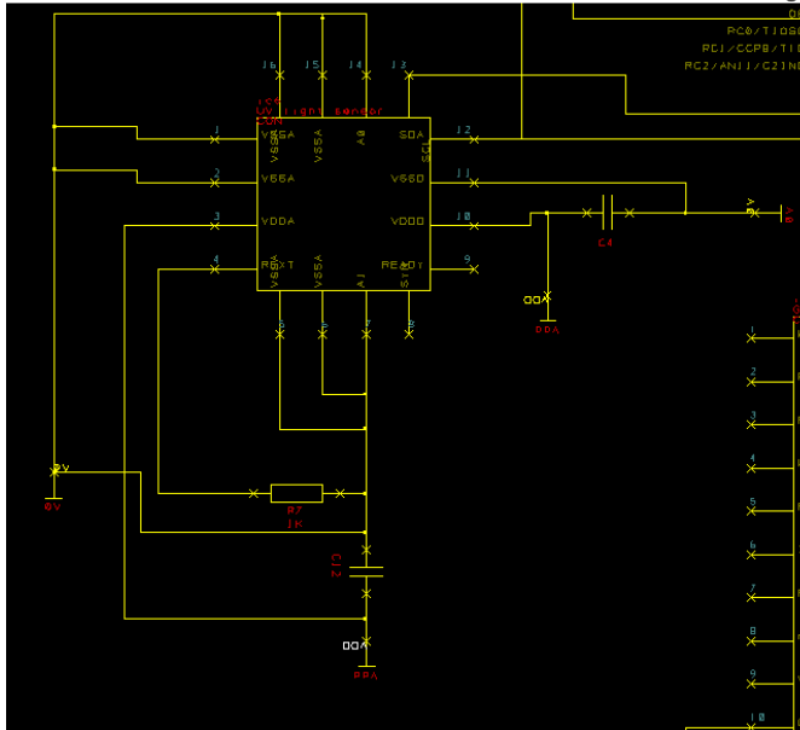
Temperature and humidity sensor

The temperature and humidity sensor has been wired up as the data sheet suggested, with the VDD and ground pins from the sensor going to VDD and ground respectively. These lines have a capacitor between them rated at 100 nF. The SCL and SDA lines got to the SCL and SDA lines on the microcontroller with the pull up resistors needed already in place.



UV sensor

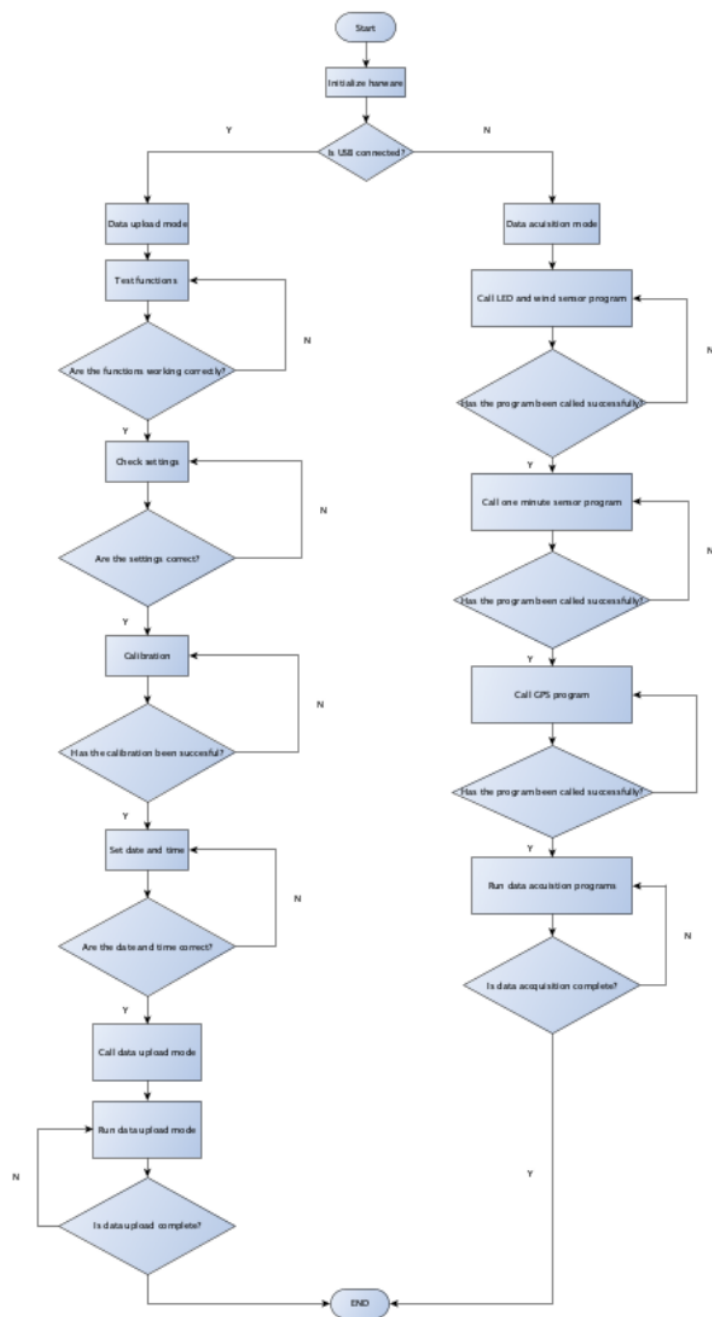
The UV sensor has been connected as specified by the data sheet with the VSSD and VDDD pins from the sensor connected to VDD with a capacitor rated at 100 nF. The VDDA pin is connected to VDD with a 100 nF capacitor and the REXT pin has a 3.3 M Ω resistor connected to it before it is connected to the VDD line. All the VSSA are connected to ground.



Software flow chart

Mode selection

This shows the first part of the software where the system decides if it is acquiring or uploading data. The first step is to initialize the hardware and check if the USB is connected, if the USB is connected it the program will enter data upload mode. This is where the data will be uploaded from the SD card to the USB. The program will check and test the software before setting the time and calling the data upload program. Once the data upload the program is complete it will end the program. If the USB is not connected it will enter data acquisition mode where data from the sensors is being collected and stored on to the SD card. The program will call each program individually and check that it has successfully been called. When the data acquisition is complete the program will end.

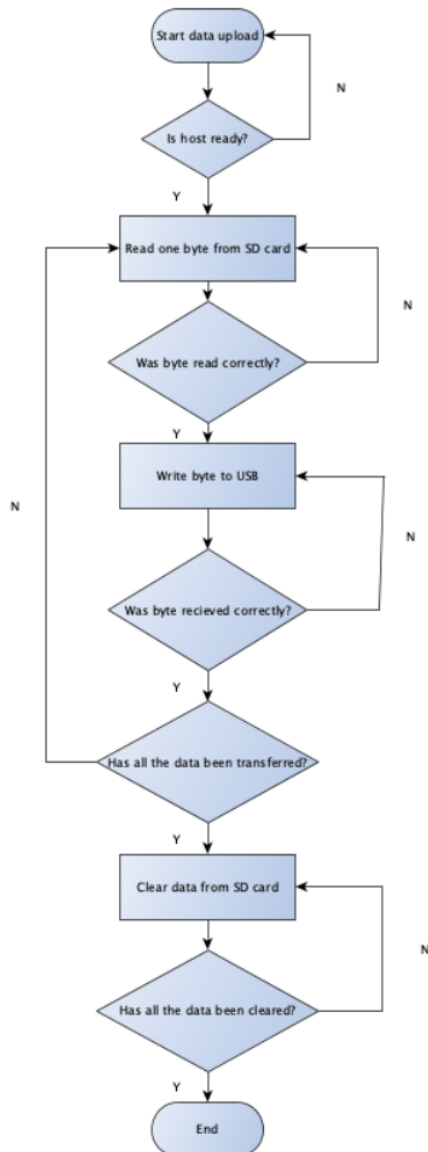


11

Data upload mode

The flow chart below shows how the program will read data from the SD card and write it to the USB. The first step is to check the host is ready then read a byte from the SD card, if the byte was read correctly, it will write it to the USB. If the read or write are not correct it will re-read or rewrite the byte. Once a byte has been written the program will check if all the

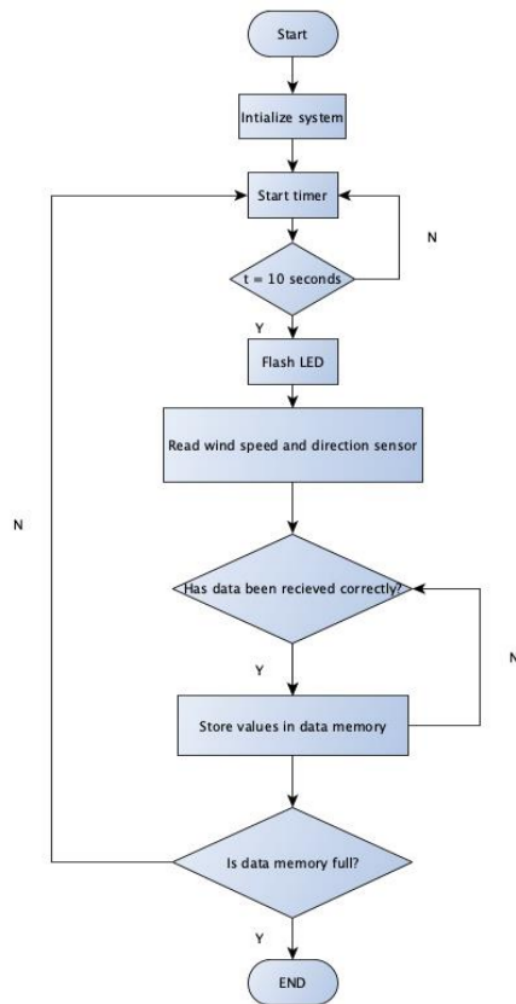
data has been transferred if it has it will clear the SD card of its data and end the program. If all the data has not been transferred the program will continue to read and write bytes.



Data acquisition mode

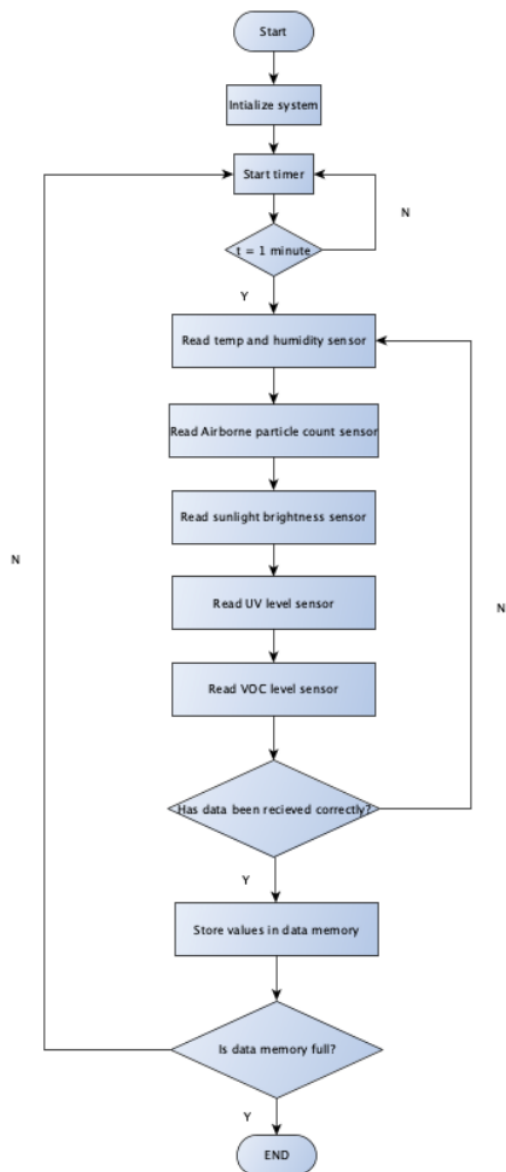
LED and wind sensor

The flow chart below shows how the system will flash the LED and read the wind sensor. The first step is to initialize the system and start the timer, when the timer is equal to 10 seconds it will flash the LED and read the wind sensor. If the data is correct for wind speed and direction data is correct, then it will store the value in the data memory. If the data is incorrect, it will re-read the sensor. If the data memory is not full it will re-start the timer and continue to acquire readings, if the data memory is full, it will end the program.



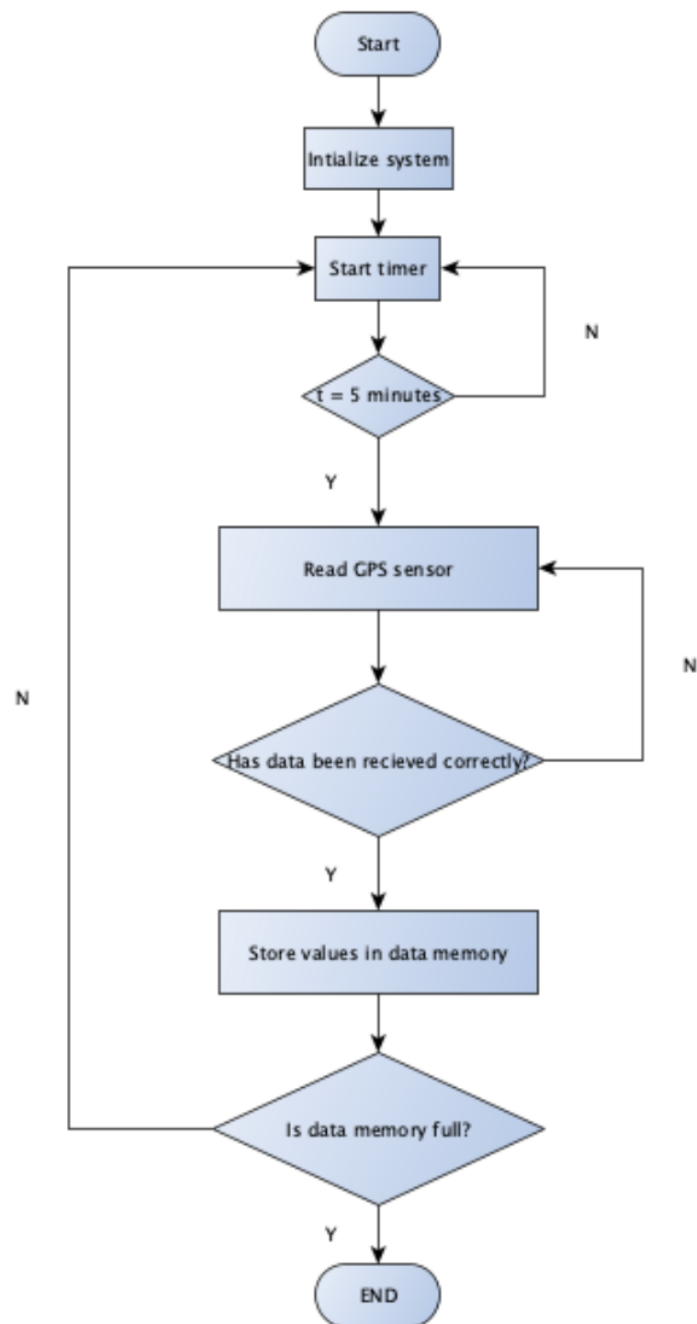
Sensors reading at one minute.

The flow chart below shows how the system will read the sensors that have a sample rate of 1 minute. The first step is to initialize the system and start the timer, when the timer is equal to one minute it will read the sensors. If the data is correct the system will store the data in the data memory. If the data is not correct it will re-read the sensors, then store the correct values in the data memory. If the data memory is full the program will end, if not it will restart the timer and take more readings.



GPS

The flow chart below shows how the system will collect data from the GPS sensor. The first step is to initialize the system and start the timer. When the timer is equal to 5 minutes the system will read the GPS sensor and if the data is correct, it will store the data in the data memory. If the data is incorrect, then then the system will re-read the sensor and store the correct data in the data memory. If the data memory is full then the program will end, if there is still space on the data memory it will restart the timer and collect more readings from the sensor.



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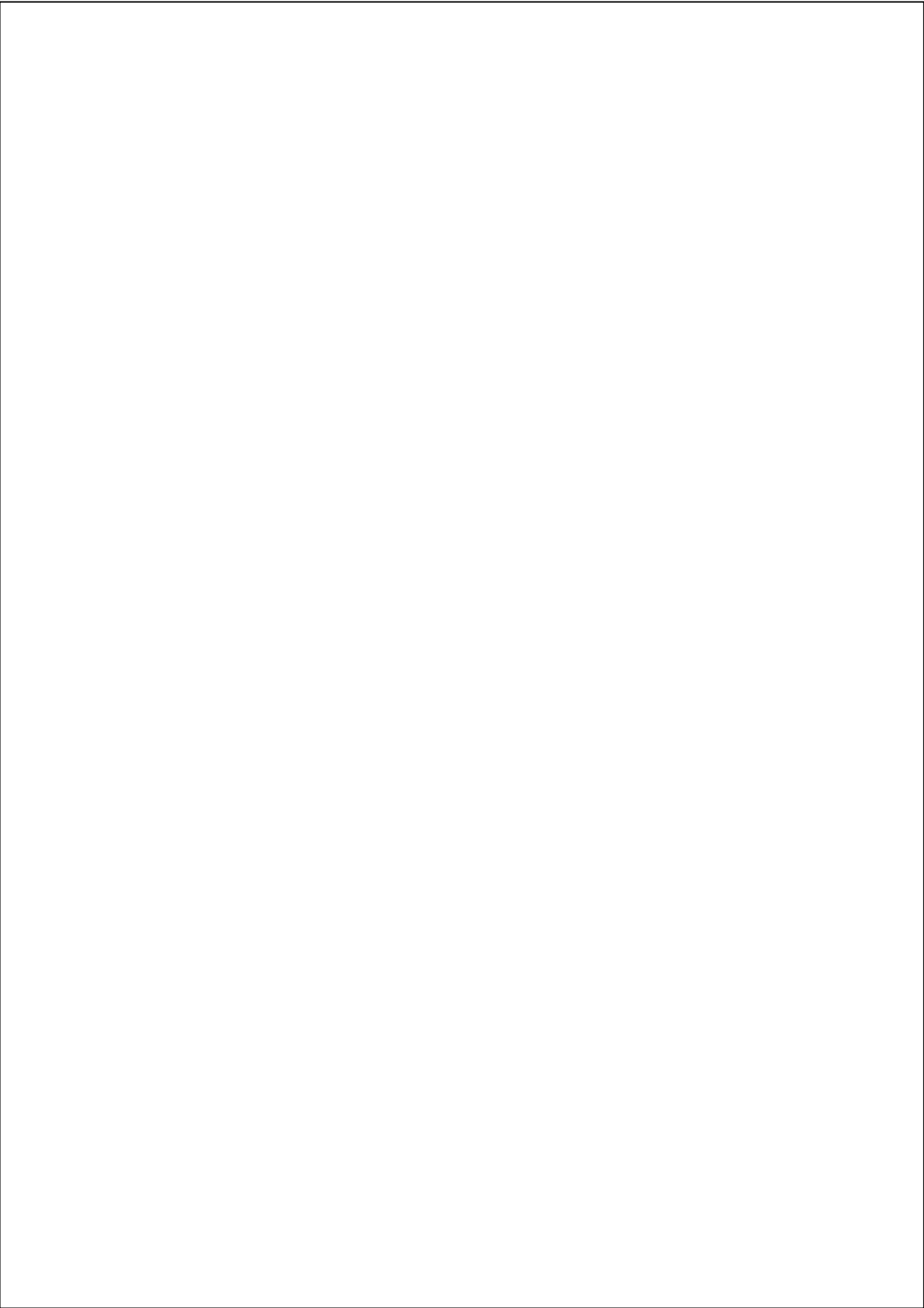
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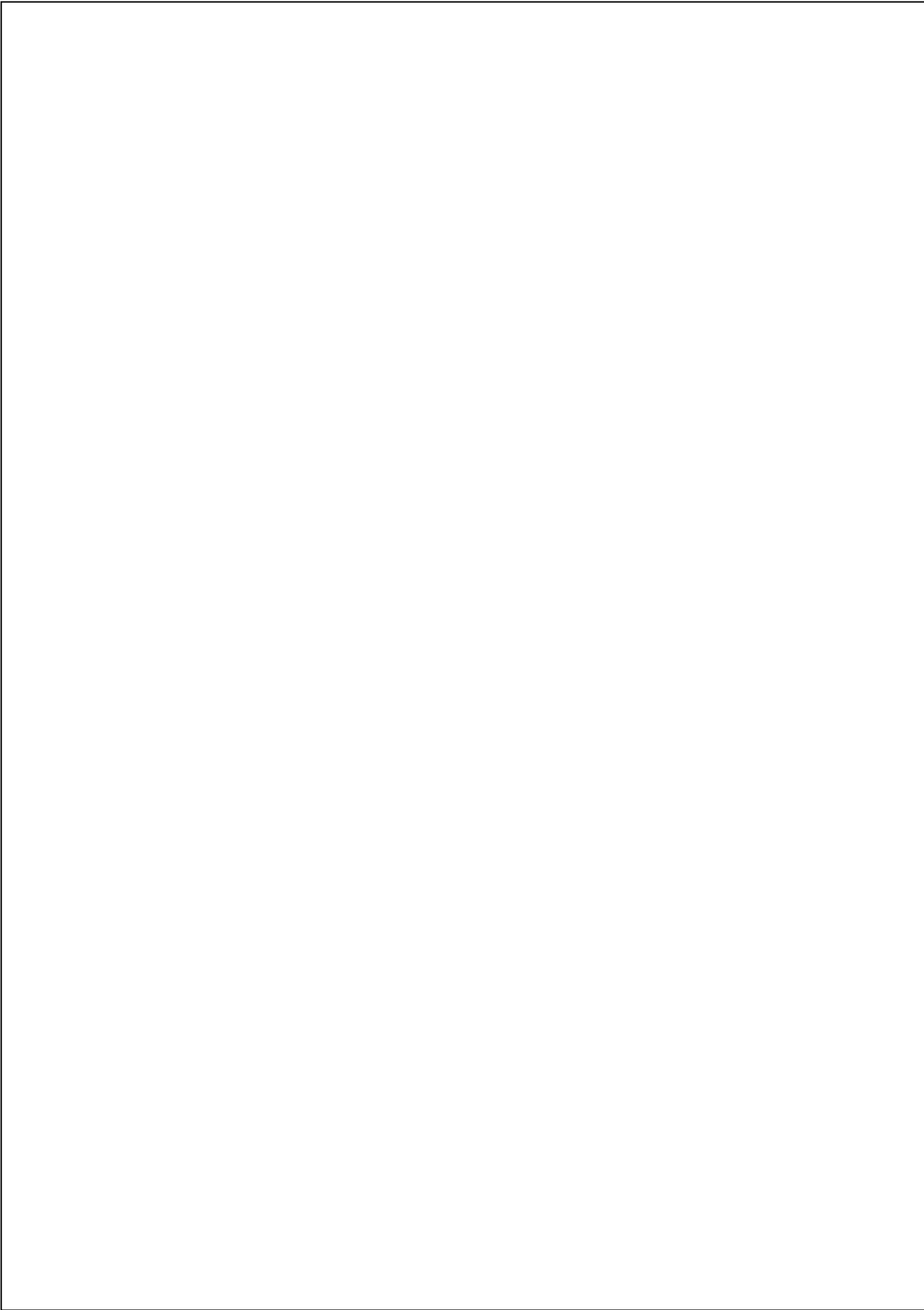
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ESD assignment 2

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

65/100

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6



Comment 1

Did you compare it to any others? Why is there no evidence of the comparison?

PAGE 7

PAGE 8

PAGE 9

PAGE 10



Comment 2

Won't that drain the battery?

PAGE 11

PAGE 12



Comment 3

These look like USB-C connectors. The USB stick has a male USB A connector

PAGE 13

PAGE 14

PAGE 15

PAGE 16

PAGE 17

PAGE 18



Comment 4

RS232 is a communications protocol, not a connector standard.

This is a 9 way D type connector

PAGE 19

PAGE 20

PAGE 21



Comment 5

There are a number of issues with this PCB.

1. Vias under surface mount device pads. These are bridging pads creating short circuits. IC3, IC4, IC6, IC7,
2. Un-routed track between PL5, U2, switch, C7 and PL2
3. R13 and R14 both pins are connected together
4. Tracks running through pads they shouldn't - IC2, pins 3,4, 6, 12, 20, 22
5. No mounting holes
6. Better component positioning would have made routing tracks easier - Battery connection to switch connection; these two connectors should be next to each other, not on opposite sides of the board.
7. Surface mount components only need pads on the top layer. Some of your surface mount components have pads on the bottom. e.g. IC7, IC3, IC4 etc.
8. LED1 is panel mount, not PCB mount, so it requires a connector.

PAGE 22



Comment 6

No PCB components apart from PIC in your costing. i.e. no resistors, capacitors, diodes etc.



Comment 7

Text is too small to read



Comment 8

This will not work as the ADJ pin needs to be taken to ground through a resistor, not a capacitor



Comment 9

They are there as I2C drivers are open drain, meaning the output can only be pulled to ground, or left floating. The resistors allow the lines to go high when not being pulled low. That way bus contention will not destroy the drivers, it will only corrupt the data.



Comment 10

Text is too blurry.



Comment 11

Too blurry to see text

PAGE 35

PAGE 36

PAGE 37

PAGE 38

PAGE 39

PAGE 40

PAGE 41

PAGE 42

PAGE 43

PAGE 44

GRADING FORM: SMU GENERIC_SMOSEY

CONNOR DANIEL

65

ENGAGEMENT WITH LITERATURE

including reading, referencing, academic conventions and academic honesty



"Inclusion of a wide range of research-informed literature, including sources retrieved independently.
Selection of relevant and credible sources. Very good use of referencing conventions, consistently applied.

6.5

KNOWLEDGE & UNDERSTANDING

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



Hardware design seems ok
Some issues with PCB. See comments on task 4
images. Cannot assess overall software structure
as unable to read the text, but two subroutines
seem ok. Some diagrams are poor quality and are
too blurry to see.

14.5

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.



Component selection and justifications are
generally ok. memory sizing is ok.

24.5

PRACTICAL APPLICATION SKILLS

Different approaches to solving problems in particular contexts.



Costing is missing most of the PCB mounted
components.
Suggestions for improvement are good.

13

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 well, confidently and consistently in a suitable format.

Work is coherent and fluent and is well structured and organised.

6.5