

EES ACDA6002 Weather monitoring system assignment 2 Robbie Young 2111907

by Robbie Young

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Weather monitoring system
ACDA6002

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Electronic system design Weather monitoring system ACDA6002

Robbie Young 2111907

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Types of sensors

Temperature and Humidity

There are two options for temperature sensors these being contact and non-contact, both have the capability to output both digital and analogue readings [1]. However, due to application being a weather station a non-contact temperature sensor wouldn't work as intended.

Type	Viability	Market option	Price
Analogue	An analogue temperature and humidity sensor can be very cheap and basic if done right making them a good option to use to cover both options.	1. https://uk.rs-online.com/web/p/temperature-humidity-sensor-ics/8937373 Basic temperature and humidity Sensor, doesn't get effected by water, can use 5v , tolerance of -40C to 85C and accuracy of 5%. 2. https://uk.rs-online.com/web/p/temperature-humidity-sensor-ics/2217342 Basic temperature and humidity Sensor, doesn't get effected by water, can use 5v , tolerance of -40C to 85C and accuracy of 2%	1. £119.08 With the better price and similar degree of accuracy it makes more sense to get the cheaper option. 2. £137.84

Digital	A digital temperature and humidity sensor are also a fine option, as they can be made cheaply will communicate with most if not all devices. However, they would have to be mounted on a PCB and wouldn't do very well in extreme weather conditions making an analogue a better option for an outdoor application.	1. https://uk.rs-online.com/web/p/multi-function-sensors/2877268 uses Bluetooth to communicate the information, making it a bad option for the design, as a Bluetooth model would have to be incorporated costing more. 2. https://uk.rs-online.com/web/p/temperature-humidity-sensor-ics/2465631 although a solid choice at an extremely good price, with a slightly better tolerance than analogue options. It is designed for indoor applications, as if it was put outdoors it would suffer from the weather, in less in caged, making it less effective as the box would protect it from the very elements it is trying to capture, making its calibration useless.	1. £168.60 2. £2.23 Being just £2.23 it would make it the cheapest and most cost effective however, as previously comments say it wouldn't work very well
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Wind direction and Speed

Wind speed and direction sensors can be found and most have good price ranges, there are both digital and analogue options to chose from as well just getting direction and speed separately. Using one sensor would be the best option as it saves in costs and setup time.

Type	Viability	Market option	Price
Digital	Digital is the best option for the application, as it is the easiest way to implement both. It also is the cheaper of the two options found, making it better than the analogue option.	Being only ~£18 it is very cheap sensor. The sensor found uses RS485 which can be easily integrated with most microcontrollers, this alone with decent range for both speed and direction. Speed being 0 to 30M/S which gives leeway to an average wind speed of 10 to 20M/S. with a good resolution of 0.1M/S. Wind Direction has 8 directions of measurement. The downside to choosing this product is that it uses 10 to 30V power supply. Making it slight inconvenient when building for a circuit design as a 5V output from the microcontroller won't provide the correct voltage therefore having to uses a external power supply to power the two sensors.	£17.79
Analogue	option 2 is using an analogue sensor this is just as practical as using a digital one however, designing the system would	The analogue sensor that could be used, cost a lot more and is designed only to work with a system that it was built for. thus, the data sheet doesn't show the voltage range in which it operates at, making getting the system to operate correctly could be rather difficult.	£235

	require more analogue pins, possible changing the microchip selection making it a worse alternative.	however, where it is an analogue system, it would have better accuracy.	
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<https://www.aliexpress.com/item/1005005500304078.html?src=google>

<https://www.weathershop.co.uk/davis-6410-anemometer-vantage-pro2?srsId=AfmBOoqcpljmECRsLXJIPZlqE3Auhe9JnFJbwrcafcB0TjrND>

Air borne particle count

Air borne particle count sensors are hard to find just for the one purpose. however, finding one that also does air quality is rather easy, and the data collected from the quality can be disregarded. Making air quality sensors the best option for an air borne particle count sensor. Due to the way they work they can only be digital thus making it the only option.

Type	Viability	Market option	Price
Digital	A digital option is the only option there for it comes down to which communication protocol they counter use.	The options to connect to a microcontrollers is RS232, RS485 and I2C. as the wind speed and direction already use RS485 it makes sense to continue using that. however, it is impractical to use it for two reasons, firstly and the bigger issues finding an approved RS485 sensor is rather difficult. The second is it is better just to leave the RS485 connectors with just the two readings on due to speed concerns. Therefore, choosing an I2C is a better option. The option listed is at a reasonable price, has a reasonable data sheet and has a good range for particle measurements.	£42.60

https://thepihut.com/products/adafruit-pmsa003i-air-quality-breakout-stemma-qt-qwiic?variant=42951823458499&country=GB¤cy=GBP&utm_medium=product_sync&utm_source=google&utm_content=sag_organic&utm_campaign=sag_organic&gad_source=1&gclid=EAlaIqOBChMI6KCwhLvVigMVZpRQBh1WeDzYEAQYBiABEgJZRfD_BwE

Sunlight brightness/ UV Levels

Combine light sensors and UV sensors is rather common depending on the application. As a weather monitoring station requires both, combining them makes sense. Both can be digital or analogue this makes finding sensor easy but finding the correct one more difficult as there are multiple options to chose from.

Type	Viability	Market option	Price
LDR Analogue	A LDR is an analogue sensor that changes it resistance depending on the light level. combine this with a voltage divider you can make an analogue light sensor for a very cheap price. This makes it very effective for this application. However, as	https://uk.rs-online.com/web/p/colour-light-sensor-ics/9146710 above is an ambient light sensor that when made into a voltage divider would work on an analogue pin of the microcontroller. It is a viable option and is very cheap to make	£1

	many different digital sensors can also do UV it makes more sense to combine both.	However, would be hard to mount making it less practical.	
both	Combing both makes the most practical sense as it saves space on a microcontroller allowing for a smaller controller with less pin. being a digital option rather than an analogue, it can combine along already made communication networks such as the I2C one for the air bone practical counter	https://thepihut.com/products/grove-sunlight-sensor?srltid=AfmBOooLLGhikk eGVISXpXEi5kquz3QgVwblgnwS X86dBkaezeKgXxZo the sunlight sensor is the cheapest practical device found. It can read UV levels and measure sunlight, it uses I2C to communicate allowing it to be used in a preexisting network it also works of 5V	£10.30
UV Digital	A digital UV light sensors are very common and could use I2C, a digital UV light sensor would be used if just UV levels were required.	https://uk.rs-online.com/web/p/colour-light-sensor-ics/2724082?srltid=AfmBOooz6FWt9zeV9HifauNCXAE786tqe_WVB-J0L4NVgKAb1QeN8mv6 out of the multiple options to choose from this was the cheapest I2C model that could be incorporated into a microchip design. It does have a better sample rate and a higher definition, however, can't measure ambient light forms as well.	£3.73

GPS

A GPS for a weather monitoring station can be very cheap and doesn't need to capture updates very regularly. A weather station also won't be moved very often, this allows for it to be turned on get a reading and very occasional, get an update, and turn back off saving power. Allowing for a slow cheap GPS monitor, as it will work for the application provided.

Type	Viability	Market option	Price
5V GPS	A 5V option that take a slow data rate, draws little power and interfaces with I2C will be the most practical. It will be cheap easy to set up and doesn't require to much power to run.	https://www.adafruit.com/product/4415 the option chosen as it fits the bill perfectly. It has a Wake pin making its power consumption very low. it easy to mount with preexisting holes, uses I2c and operates at 5V.	£30

VOC Level

Volatile organic compound sensors are used to detect harmful emissions, such as CO2, making the useful in detecting things like fire. for a weather monitoring system, it would allow it to detect a forest fire for example. VOC also ensure that the air is a good quality, breathable and not harmful to humans.

Type	Viability	Market option	Price
Digital	A digital VOC is really the only viable option for a VOC. Most are printed on there own circuit boards and require 4 pin connectors to work, I2C one is common and have good detection ranges	It operates at 5V uses I2C, meaning all but one digital component can communicate along the same bus can making the circuit board design relatively simple .	£16.20

https://thepihut.com/products/digital-sgp40-voc-volatile-organic-compounds-gas-sensor?variant=40842320642243&country=GB¤cy=GBP&utm_medium=product_syn&utm_source=google&utm_content=sag_organic&utm_campaign=sag_organic&gad_source=1&gclid=EAlalQobChMIm7OQwtbVigMVQYBQBh3irCTREAQYAYABEgLCKfD_BwE

Connectors

Product chosen	connector	Price
Light/UV and VOC	https://thepihut.com/products/jst-ph-4-pin-to-female-socket-cable-i2c-stemma-cable-200mm	£1.30 each £2.60 total
GPS	https://www.adafruit.com/product/4210	£1
Wind	Preexisting connector will work and can solder to board.	£0
particle count	https://thepihut.com/products/thepihuts-jumper-bumper-pack-120pcs-dupont-wire	£6

Other parameters

Package

The outer casing/ package should be portable and sustainable packaging, all the electronics fit inside, stay water proof and has a high durability, so that nothing brakes whist in transit or being used in bad weather. A very good option to keep the package affordable and have all the above features, is 3d printing. 3D printing fits the sustainable part, as there is reduced waste less water and energy used and most of the material can be recycled and used again, other benefits can be found in [X] which shows that using 3D printing is better than plastic. 3D printing is also cheap to do has a high durability and with the right sealant will stay waterproof.

<https://www.sustainableplastics.com/news/how-sustainable-3d-printing>

Storage Size

DATA	Bits	How many readings	Total per day
Temperature	8	1 per min	1.2Kb
humidity	8	1 per min	1.2Kb

Wind speed	8	1 per second	700Kb
Wind direction	8	1 per second	700Kb
Particle count	8	1 per second	700Kb
Light levels	8	1 per min	1.2Kb
UV levels	8	1 per min	1.2Kb
GPS	24	1 per hour	700Kb
VOC	8	1 per min	1.2Kb
	42Mb	14*3	~3Mb

Ruffly 42Mb of data will be stored across the 14-day time period therefore a 32Gb SD card will more than suffice and cost less than £10 making them the ideal fit.

Costings

A three-to-four-layer board will cost less than £10. With this a total rough estimate on how much the whole system will cost excluding the labour time. The total cost for a 14-day weather monitoring system is around ~£265, this is rather cheap compared to other systems with the same features. However, there are some on the market that will do most of the same things at a cheaper price and come with everything preinstalled and no building to be done. with this information an improvement could be trying to decrease the price.

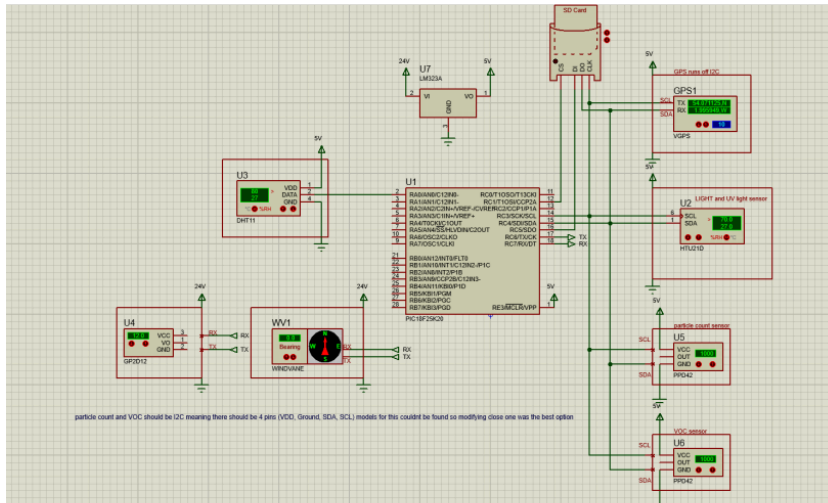
Circuit Design

For the circuit to work one analogue pin is needed, RX and TX pins are required for RS485 and SCL and SDA pins for I2C communication. I have chosen I2C as most sensor chosen can work with it. By using I2C one bus line is needed to connect half the sensors saving space on a PCB, it also requires less pins to be used on both the microcontroller and board itself. I2C is also has a fast enough data rate when only reading small amounts of data as 100kbit/s is more than enough to read the data.

Microcontroller of choose

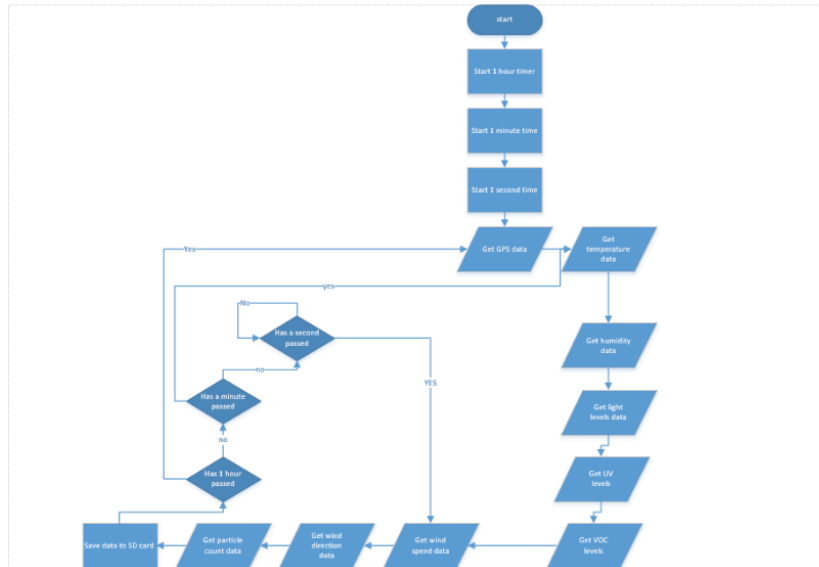
PIC18F25K20 has all features required to make I2C and RS485 work it also can have at least one analogue pin and can use an SD card.

Protus circuit design



Using PIC18F25K20 at the centre then add all the sensors around it. The model of the GPS module is slightly incorrect, it should be a I2C not an RS232. however, an I2C model wasn't in the library, so the model changes the RX and TX to SCL and SDA. The light and UV sensors have been changed to a temperature and humidity sensor, this is so that they would model as I2C. The Particle count and VOC sensors are both incorrect as well but again appropriate models weren't found. Therefore, the package has been changed to represent how they would function if they were built correctly rather than modelled. These changes were done to show that the model would look like, rather than be incorrect making the model accurate, to what it would look like if built. The two correct features are the wind direction (although it has 16 readable directions rather than 8) and the analogue temperature and humidity sensor which is connected to an analogue pin, allowing for the information to be read. The analogue temperature and humidity sensor should have two output pins to simulate temperature and humidity. 5 out of the 7 sensors use 5V the other two use 24V therefore the input to the system must be 24V, this can be done via a battery or just ran off a mains supply. There is a voltage regulator that takes the 24V down to 5V this is so that the microcontroller and the sensor that require 5V to work can run.

Software flow chart



After starting, 3 timers are set, one hour, one minute and one second. After the timers start the GPS data is collected, followed by temperature, humidity, light levels, UV levels, VOC, wind speed and direction, and finally particle count. Once that has happened it checks to see if 1 hour has passed, if not it goes to the next question of has a minute passed, and again if not, it checks if a second has passed. If only a second has passed it will only collect the data on wind speed and direction as well as particle count. If one minute has passed it checks temperature, humidity, light levels and UV levels then checks everything in the one second category. Finally, after one hour has passed it will check GPS data then everything else. The most important step is to save the data to the SD card which should happen once all the data is read.

Improvements

After designing the product there are a few improvements that can be made. These being for example the price at around £265, it is rather expensive. One way to decrease this is to not use the analogue temperature and humidity sensor at £119 and get a cheaper option. A good alternative is the grove temperature and humidity sensor [x]. This alone would save £100 making the build cost a lot less. it reads the same data but can be used in the I2C communication bus. Therefore, not using the analogue pin. Other Improvements could be made with the sampling rate on all the data, this would be limited to the I2C protocol speed however would still be faster than what is already being used. By doing this a better representation of the data and a more accurate result. The best example of this is reading light levels every minute this causes wild results. As clouds go over the sensor changing the light levels drastically. Reading the sensor more often would help in this but getting a full read of the cloud cover would make it disappear.

Title: Electronic System Desing Name: Robbie Young Student number: 2111907
Weather monitoring system
ACDA6002
https://store.arduino.cc/products/grove-temperature-humidity-sensor-sht31?pr_prod_strat=e5_desc&pr_rec_id=7a07850fe&pr_rec_pid=5518374797463&pr_ref_pid=5518373355671&pr_seq=uniform

apdeix

[1] [https://atlas-scientific.com/blog/types-of-temperature-sensors/#:~:text=There%20are%20four%20main%20temperature,based%20integrated%20\(IC\)%20sensors](https://atlas-scientific.com/blog/types-of-temperature-sensors/#:~:text=There%20are%20four%20main%20temperature,based%20integrated%20(IC)%20sensors)

EES ACDA6002 Weather monitoring system assignment 2

Robbie Young 2111907

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

52/100

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GRADING FORM: SMU GENERIC_GJ

ROBBIE YOUNG

51.90

RESEARCH-INFORMED LITERATURE

No literature review submitted 0%



0

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. You have used a gp2d12, which is a distance measuring device for what purpose?. 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. The ppd42 device is a diugital output device with 2 outputs 1 for small particles ad the other for large particles, it is not anI2C device. You have not submitted a PCB design. 45%

11.25

ANALYSIS



Good selection of microcontroller. Good selection of components selected via the tables but with no images. Case selection is strange, printing a case when there are so many good sturdy cases in the market would seem to be an expensive option. Reasonable selection of connectors .65%

22.75

PRACTICAL APPLICATION AND DEP.



Costings were included but spread out through out the document they should have been included in a table with an image and the manufacturers part number along with the supplier's name and part number. Poor attempt at future enhancements.62%

12.4

SKILLS FOR PROFESSIONAL PRAC.



The report is strangely presented with a very poor and limited selection of references. Better time management would have seen a much better submission 55%

5.5