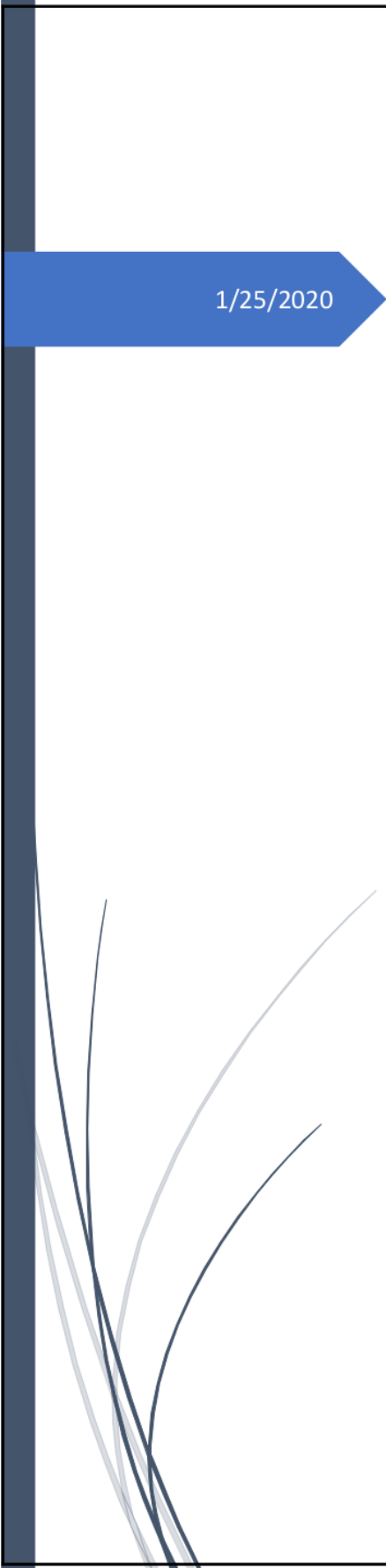


ESD Assignment 2

by John Davies

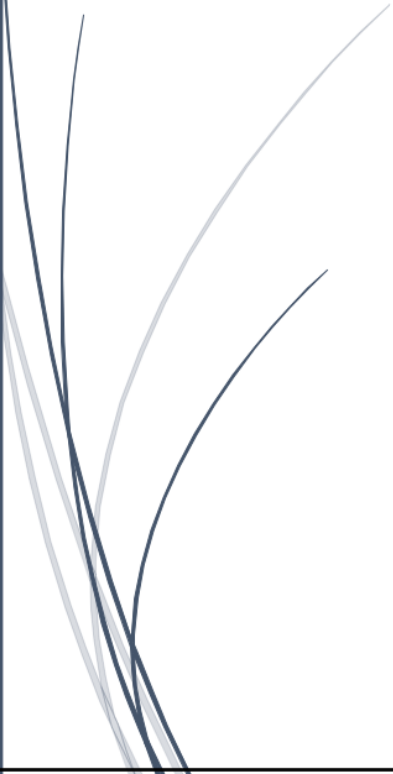
FILE	19506_JOHN_DAVIES_ESD_ASSIGNMENT_2_228202_150521184.DOCX (5.66M)		
TIME SUBMITTED	25-JAN-2020 06:17PM (UTC+0000)	WORD COUNT	2571
SUBMISSION ID	119103510	CHARACTER COUNT	13291

A thick dark blue vertical bar runs down the left side of the page. A blue arrow points to the right from this bar, containing the date 1/25/2020.

1/25/2020

Electronic Design Systems

Assignment 2

Several thin, light blue curved lines originate from the bottom left corner and sweep upwards and to the right, creating a sense of movement or a stylized signature.

John (Jack) Steven Davies
UNIVERSITY OF WALES TRINITY SAINT DAVID

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Introduction

This report is based upon designing an offshore portable weather monitoring system. The system will be measuring the following elements; temperature, humidity, wave height, wind speed, wind direction, sunlight brightness and will log the GPS. It will be housed within its own protective container/casing, with its own power source through a battery and will store data through its memory storage devices, i.e. micro SD card.

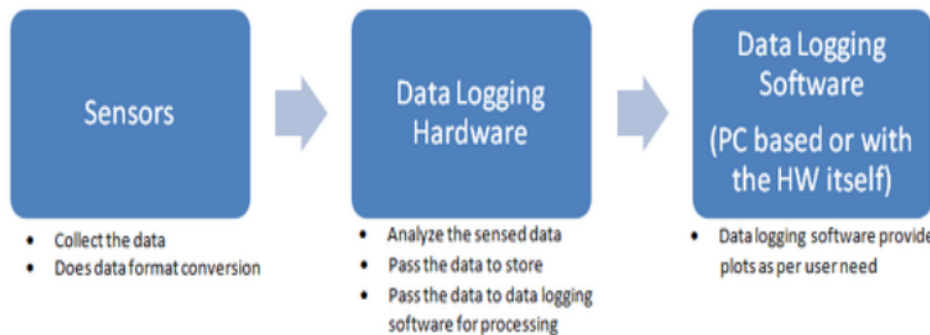
The system will be monitoring the elements listed above over a seven-day period and will be accessible via a USB port, to access the recorded data.

Literature Review & Sensor Selection

A literature review is a comprehensive summary of previous research on a topic. The literature review surveys scholarly articles, books, and other sources relevant to a particular area of research.

Data Loggers

Data Loggers are electronic instruments used to record various measurements at set intervals over a specific period of time. They vary from, air temperature, humidity, wind speed, AC and DC currents and many more storing all recorded reading of these devices. They are battery powered and use an internal microprocessor, data storage and one or more sensors. [1]



Type	Pros	Cons
Bluetooth Data Logger	. Wireless . No cables . Transmit data to wireless devices . 30-meter range	. Expensive . Training needed to use equipment . High battery usage
Web-Based Logging System	. Remotely access data using the internet . Send collected data to secure web servers	. Training needed to use equipment . Expensive
Stand-Alone Data Logger	. Portable . Simple . Small . Reusable . USB interface	. Training needed to use equipment . Possible data loss during malfunctions

Brand	Global Water			
Name/Type	GL500-2-1 Data Logger			
Memory	Non-volatile flash memory			
Classification	Two analogue and one digital			
Channels	2 Input channels + battery voltage monitor			
Output (Amps)	4 – 20 mA			
Operating Voltage	9(x2) VDC			
Storage Capacity	81,759 Recordings for all inputs plus time stamp			
Bluetooth	Yes			
Cost	£ 338.58			
Image				

Microcontroller (PIC)

Brand	Microchip			
Name/Type	PIC18F25K50			
Pin Count	28			
Program Memory Size	32 kB			
RAM Size	2.048 kB			
USB Channels	1			
Supply Voltage	2.3 5.5 V			
Timer Resolution	8-bit, 16-bit			
Operating Temp	-40 °C - +85 °C			
Cost	£1.73			
Image				

Temperature

Temperature sensors are used for weather forecasting by a process of which mariners and meteorologically organisations attempt to predict the weather, based upon the data gathered. It can be extremely useful when anticipating severe weather forecast. [2]

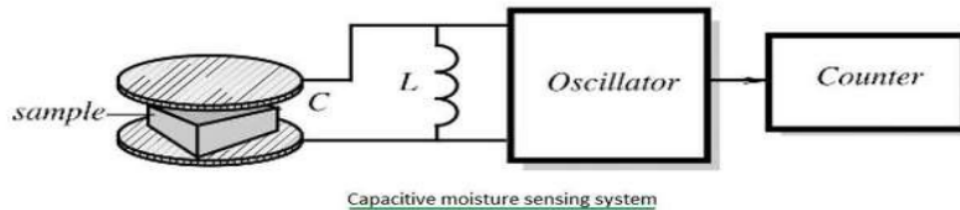
Type	Pros	Cons
Thermocouples		
Resistor temperature detectors		
Thermistors		
Infrared sensors		
Semiconductors		
Thermometers		

Brand	Global Water			
Name	WE700 Temperature Sensor			
Type	Resistance			
Classification	Analogue (RTD)			
Accuracy	$\pm 0.2^{\circ}\text{F}$ or $\pm 0.1^{\circ}\text{C}$			
Output (Amps)	4-20 mA			
Operating Voltage	10-36 VDC			
Range	-58 to $+122^{\circ}\text{F}$ (-50 to $+50^{\circ}\text{C}$)			
Operating Temp	-58 to $+212^{\circ}\text{F}$ (-50 to $+100^{\circ}\text{C}$)			
Warm up time	3 seconds			
Number of cables	2			
Cost	£297.94			
Image				

This sensor was chosen because it is reliable, durable and ideal for monitoring temperature.

Humidity

A humidity sensor is used for the measurement of moisture in the air, water vapours or gases. [3]



Type	Pros	Cons
Capacitance	. Can withstand temperatures below zero degrees Celsius . Flexibility . Low maintenance . Pressure independent	. Limited long-term stability . Sensitive to aggressive substances
Hygrometric	. Easy to clean . Simple . Cheap . Usable in contaminated areas	. Limited accuracy . Limited measurement range . Slow in measurement
Psychrometric	. Higher accuracy . Higher quality . Low maintenance	. Difficult to use below zero degrees Celsius . Limited long-term measurements

Brand	Global Water			
Name	WE600 Humidity Sensor			
Type	Capacitance			
Classification	Analogue			
Accuracy	±2% RH			
Output (Amps)	4 – 20 mA			
Operating Voltage	10 – 36 VDC			
Range	0 to 100% RH			
Warm up time	3 seconds			
Operating Temp	-40 to +131°F (-40 to +55°C)			
Number of cables	3			
Cost	£495.35			
Image				

This sensor was chosen because it is reliable, durable and ideal for monitoring humidity.

Wave height

Type	Pros	Cons
Accelerometer	. Most accurate . Low-frequency noise	. Less common measurement device . Low frequency signals
Wave Gauges	. Low maintenance . Accurate . Low current drain	. Expensive . Training needed to install
Radars	. High specification . Accurate . Reliable	. Expensive . Training needed to install

Brand	VEGA	Xylem		
Name	VEGAPULS 64	Wave and Tide Sensor 5218/5218R		
Type	Radar	Wave gauge		
Classification	Digital	Digital		
Accuracy	± 1 mm	±0.2°C/0.1°C 1)		
Output (Amps)	4 –20 mA	4 –20 mA		
Operating Voltage	10-36 VDC	10-36 VDC		
Range	30 m	30 m		
Sampling rate	2Hz, 5Hz	2Hz, 4Hz		
Operating Temp	-40 - 80°C	0 – 36°C		
Number of cables	2	2		
Cost	£1,930.28	£693.29		
Image				

Wind speed

Wind speed is an important measurement to record and monitor for various applications, formally known as Anemometers they can be used to measure; meteorology, shipping, construction, the list goes on. Common applications are used to determine safety elements of operating mechanical equipment such as cranes or lifts and estimating the efficiency of wind farm technology. It can be used for navigation, air craft safety, very effective for the industry and various construction sites. [4]

Type	Pros	Cons
Cup Anemometer	. Reliable . Digital readouts . Rugged . Doesn't need to point towards wind direction	. High starting velocity . Low measurements . Turbulent conditions can affect the readings . High maintenance
Hot Wire Anemometer	. Cheap . Small . Multi-component measurement . Low signal-to-noise ratio . Small sensor	. Easily damaged . Contamination . Probes are not sensitive to flow . Sensitive wires to temperature and velocity
Propeller (windmill) Anemometer	. Durable . Can handle high wind speeds	. Device must be pointing at wind direction . High starting speeds . High maintenance
Pitot Tubes Anemometer	. Can handle high temperatures . Can handle high wind speeds . No rotating parts . Quick response	. Device must be facing towards the wind . Not supported for very high wind fluctuations . Not supported for areas with low airspeed
Sonic Anemometer	. Measures temporal resolutions of 20 Hz or more . Weather Resistant . No rotating parts	. Expensive . Rare . Not portable . Animals can affect the readings

Brand	Global Water			
Name	WE550 Wind Speed Sensor			
Type	Propeller Anemometer			
Classification	Digital			
Accuracy	0.2 mph over the range 11 to 110 mph (0.09 m/s from 4.9 to 24.6 m/s)			
Output (Amps)	4 – 2- mA			
Operating Voltage	10 - 36 VDC			
Range	>= 4 mph to 110 mph (>= 1.8 to 50 m/s)			

Warm up time	3 Seconds			
Operating Temp	-40 to +131°F (-40 to +55°C)			
Number of cables	2			
Cost	£ 519.41			
Image				

Wind direction

Wind directional sensors are used to measure the air pressure between weather shifts, air moves in the direction of the recorded low pressure on the system. It is also determined by other factors including the Coriolis effect (the inertial or fictitious force that acts on objects that are in motion within a frame of reference, that rotates with respect to an internal frame), land topography and friction. [5]

Type	Pros	Cons
Pitot Tubes Anemometer	. Can handle high temperatures . Can handle high wind speeds . No rotating parts . Quick response	- Device must be facing towards the wind . Not supported for very high wind fluctuations . Not supported for areas with low airspeed
Laser Doppler Anemometer	. More accurate . Light . Easy to use . Fast measurements	. Expensive . Delicate . Only needed for high-end measuring
Ultrasonic Anemometer	. No moving parts . Accurate . Fast readings	. Certain material can affect the readings . Materials can absorb signals rather than reflect them

Brand				Global Water
Name				WE570 Wind Direction Sensor
Type				Pitot Tubes Anemometer
Classification				Digital
Accuracy				1% of full scale
Output (Amps)				4 – 20 mA
Operating Voltage				10 – 36 VDC

Range				0-360° (352° electrical, 8° open)
Sensitivity				1 m/s (2.2 mph)
Operating Temp				-40° to +131°F (-40° to +55°C)
Number of cables				2
Cost				£610.42
Image				

Sunlight brightness

Brief description

Type	Pros	Cons
Pyranometers	. Reliable . Accurate . Easy to install	. Expensive . Delicate . Average maintenance
Quantum (PAR)	. Fast readings . Can easily preform complex algorithms . Environmentally friendly	. Average maintenance . Training needed to operate . Can heat up

Brand	Global Water			
Name	WE300 Solar Radiation Sensor			
Type	Pyranometer			
Classification	Digital			
Accuracy	1% of full scale			
Output (Amps)	4 – 20 mA			
Operating Voltage	10 – 36 VDC			
Range	0 to 1500W/m²			
Warm up time	3 Seconds			
Operating Temp	-40° to +131°F (-40° to +55°C)			
Number of cables	2			
Cost	£793.35			
Image				

GPS position

Type	Pros	Cons
Satellite		

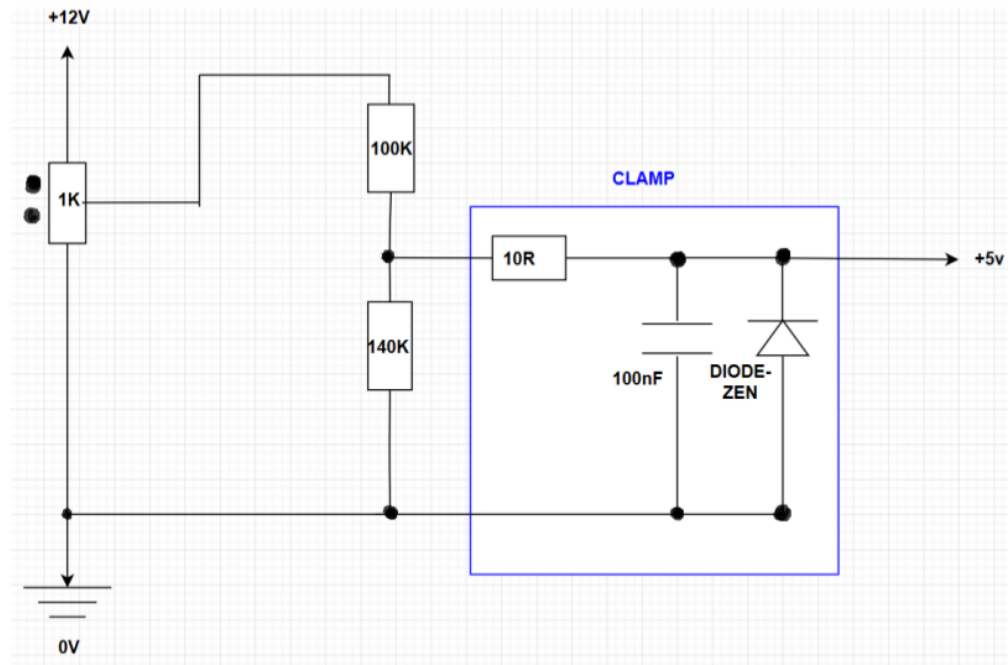
Brand		TriNav		
Name		GPS160 NMEA 0183		
Type		Satellite		
Classification		Digital		
Accuracy		1m		
Output (Amps)		4 – 20 mA		
Operating Voltage		10 - 30 VDC		
Output Rate		1, 10 and 18Hz		
Number of cables		2		
Cost		£150		
Image				

Highlight one sensor and explain why you chose it.

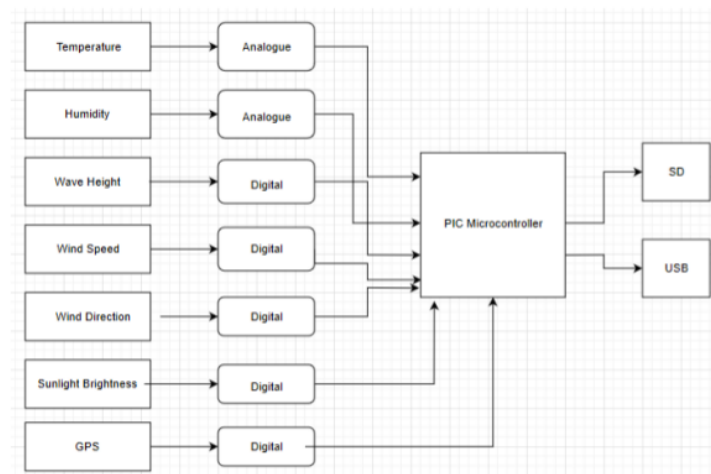
The Design

To lower the voltage from 10 - 36 VDC, a 12V input is used by the equation below, to achieve a 5V output. Seen in the diagram below. This step was used for all sensors as they all had a voltage output of 10 - 36 VDC.

$$V_{out} = V_{in} \left(\frac{R2}{R1 + R2} \right) = 12V \left(\frac{100k}{100k + 140k} \right) = 5V$$



Discuss the design features, what will be shown below. Flow charts, circuit diagrams, Prometheus diagrams, PCB stuff will be put into the diagrams section.



Here is a flow chart representation of how the system operation will commence.

Micro SD Card & USB

Micro SD cards at 32 GB are cheap and affordable, more than capable for storing the data for this circuit.

This micro SD card comes with the adapter for £4.99 on eBay, made in the UK. Samsung are also renown for making high quality and reliable SD cards.



Connectors

Table of connectors for each chosen component.

Brand	Zoro	RS	VELLEDQ	chestele
Name	3-wire, PNP-NO, M12 Connector	XMLE Electronic Sensor	M12 4 Pin Female Plug Screw Thread Shield Cable Connector	Waterproof Junction Box Outdoor Cable Connector
Connection Type	Inductive	M12 4-Pin	M12 4-Pin	2/3-Pin
Connection Gender	Male	Female	Female	Connector
Material	Brass-nickel	Plastic	Aluminium	Plastic
Pins	2	4	4	2/3-Pin
Operating Voltage	36 VDC	250 VAC	30 VDC	36 VDC
Current Rating	4 - 20 mA	Max of 16 A	4 - 20 mA	4 - 20 mA
Cost	£39.99	£3.28	£10.99	£7.49
Image				

The Chestele connector was chosen because it is cheap, durable, 2 and 3 wire connectable, waterproof, flame resistant and temperature resistant.

Memory Storage

Do a table listing the memory storage used like in the first assignment (this includes the LED).

Sensor	Accuracy	Range	States	Bits/Sample	Bytes/Sample	Logging Rates	No. 7 Logging Days	Total Bytes - 7 Logging Days
Temp	±0.2°F or ±0.1°C	-50 to +50°C	135	8	1	15min	336	336
Humidity	±2% RH	0 to 100% RH	100	8	1	15min	336	336
Wave Height	±0.2°C/0.1°C 1)	30 m	500	8	2	15min	336	670
Wave Speed	0.2 mph over the range 11 to 110 mph (0.09 m/s from 4.9 to 24.6 m/s)	>= 4 mph to 110 mph (>= 1.8 to 50 m/s)	100	10	2	15min	336	336
Wind Direction	1% of full scale	0-360° (352° electrical, 8° open)	360	8	1	15min	336	670
Solar	1% of full scale	0 to 1500 W/m²	1000	10	2	15min	336	670
GPS	1m	1, 10 and 18Hz	1	10	2	15min	336	

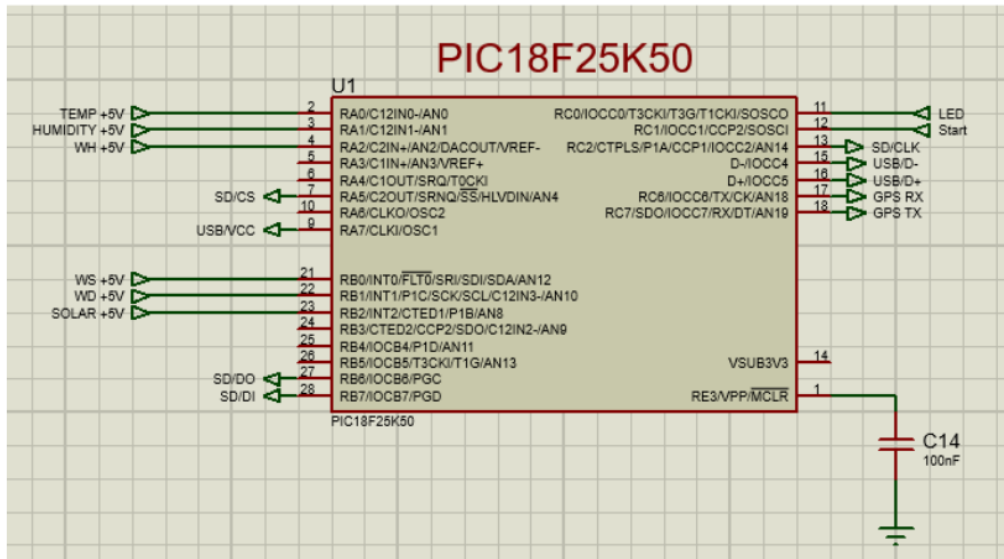
The Prototype

A brief discussion about the prototype, based on all the components you've chosen.

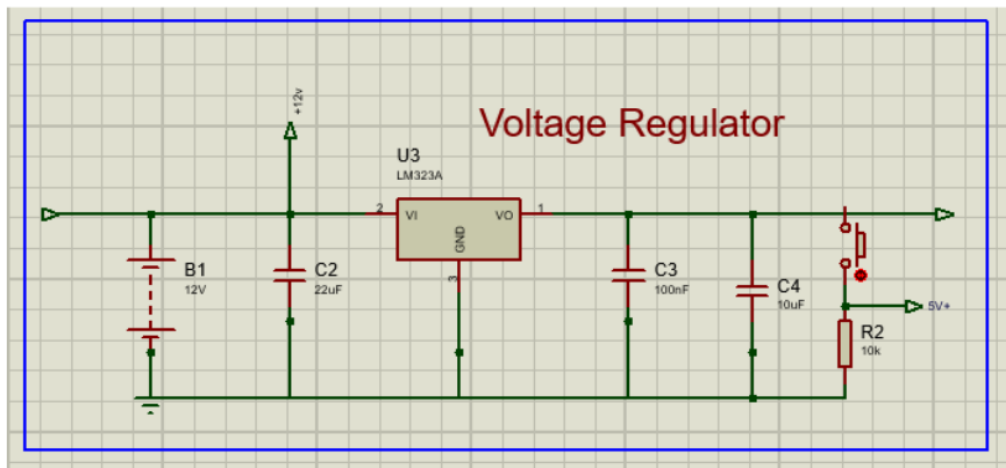
Prototype Design

The images below are the various sensors within the system, first designed in Proteus.

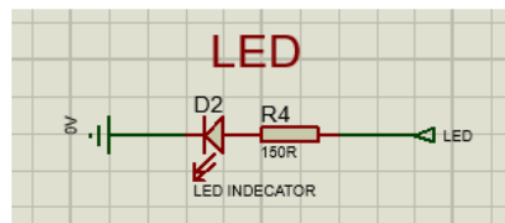
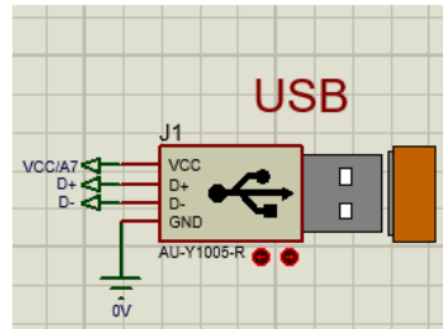
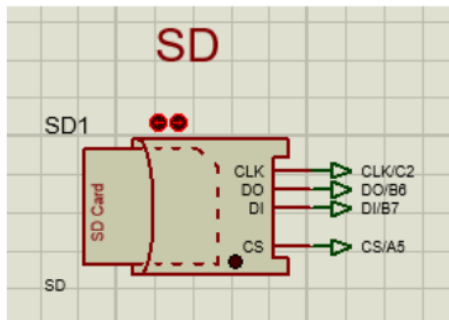
The first Image, is representing the microcontroller and all the connection pins for each sensor connected to it. This PIC allows pins to be altered between analogue and digital.



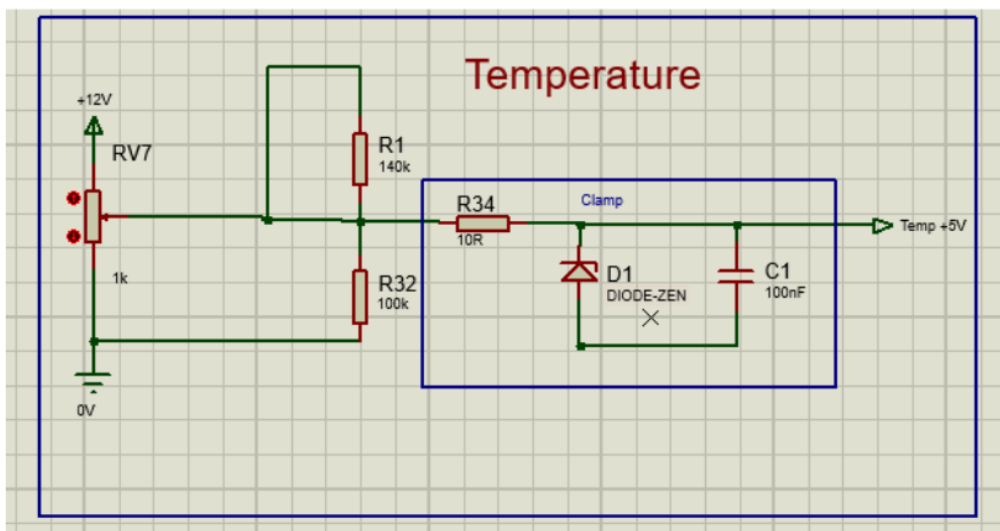
This image is of the voltage regulator, which does as the name suggests, regulates voltage



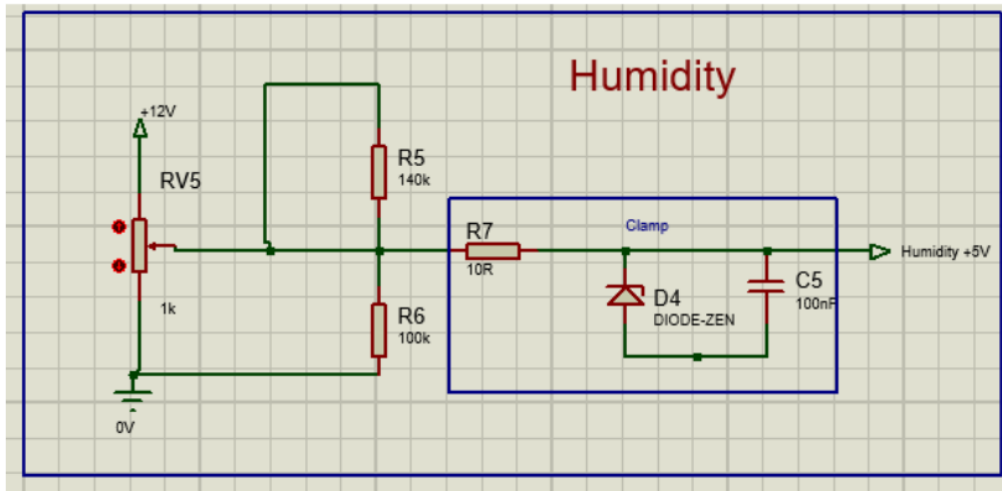
These two images, are of the micro SD card and the USB port. Each output can be seen connected to the microcontroller. The last image on this page is representing the flashing LED.



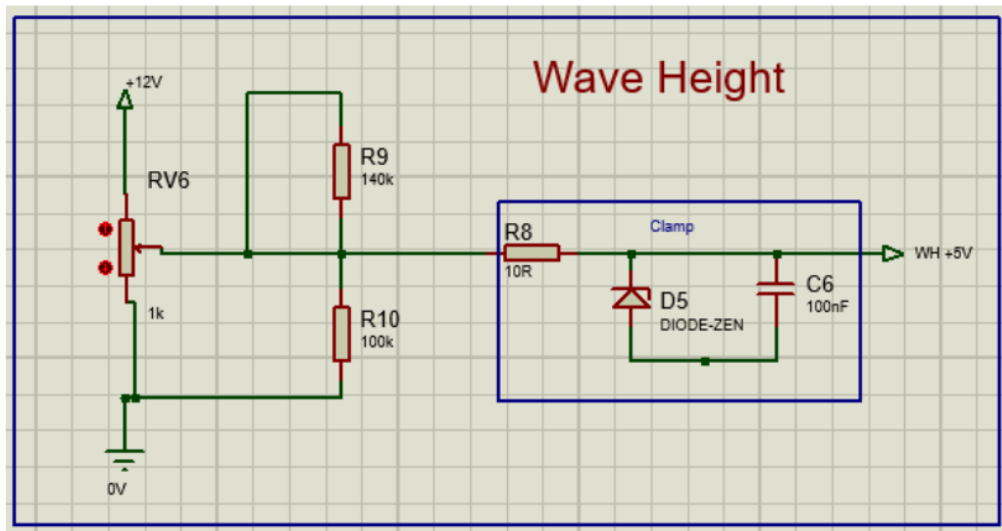
This image is the temperature sensor, designed as seen in design section, to lower the +12V input down to a +5V output. This sensor is connected to an analogue set pin.



The same process is used for the humidity sensor, also connected to an analogue pin.

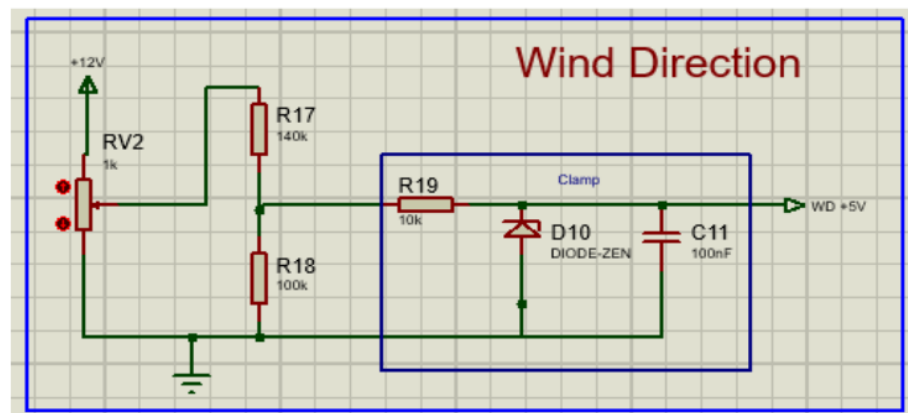
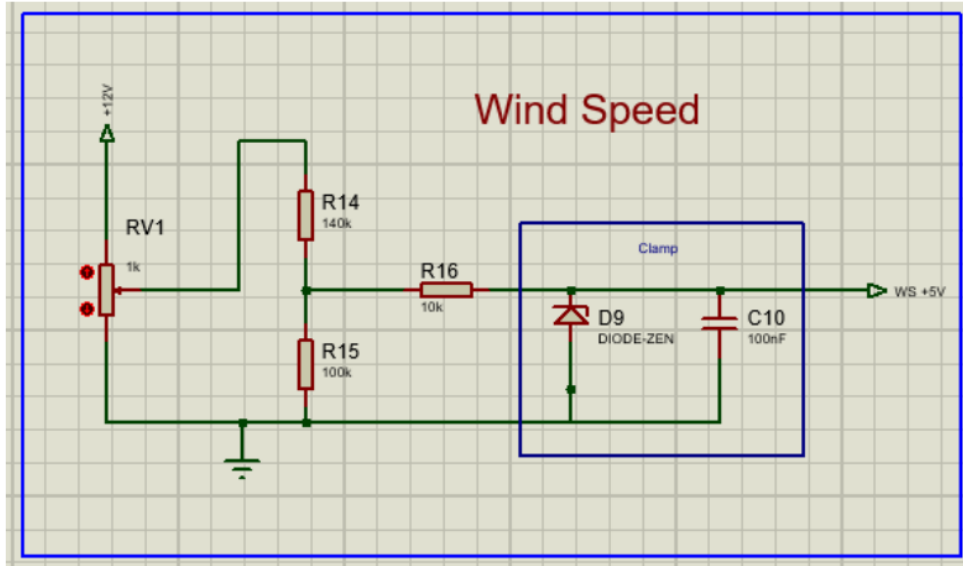


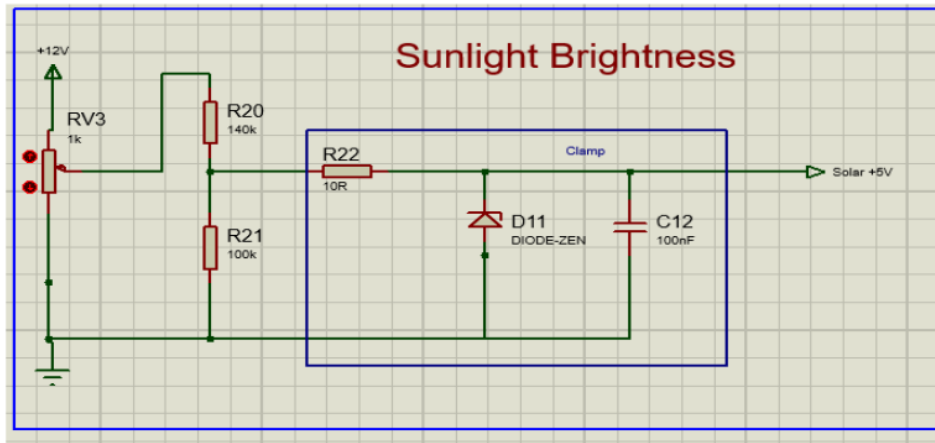
Although the wave height sensor is connected in the same way as the previous sensors, it is connected to a digital selected pin.



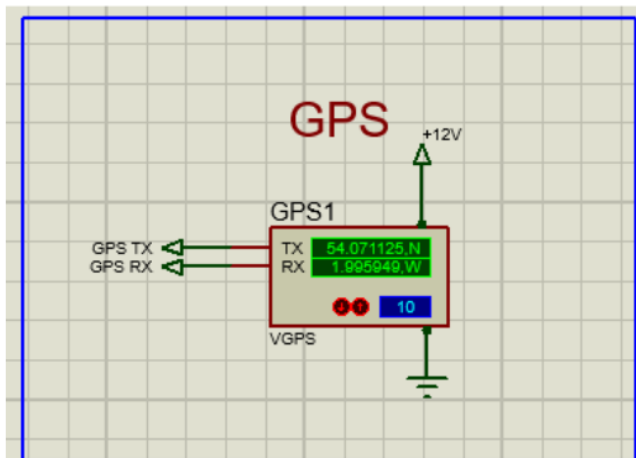
There is an error in the proteus in this section, a connection is not supposed to pass right through, it should be like the wind speed sensor seen below.

The following next three sensors are all connected to digital set pin and are all deigned to drop the voltage down from +12V to +5V.





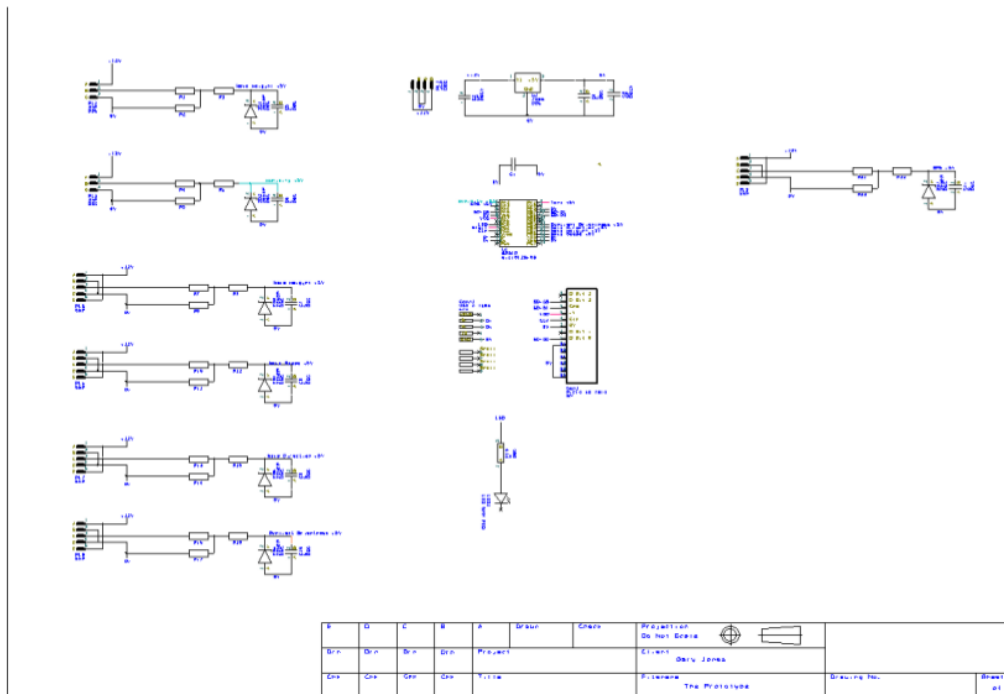
The final image from Proetus is representing the GPS.



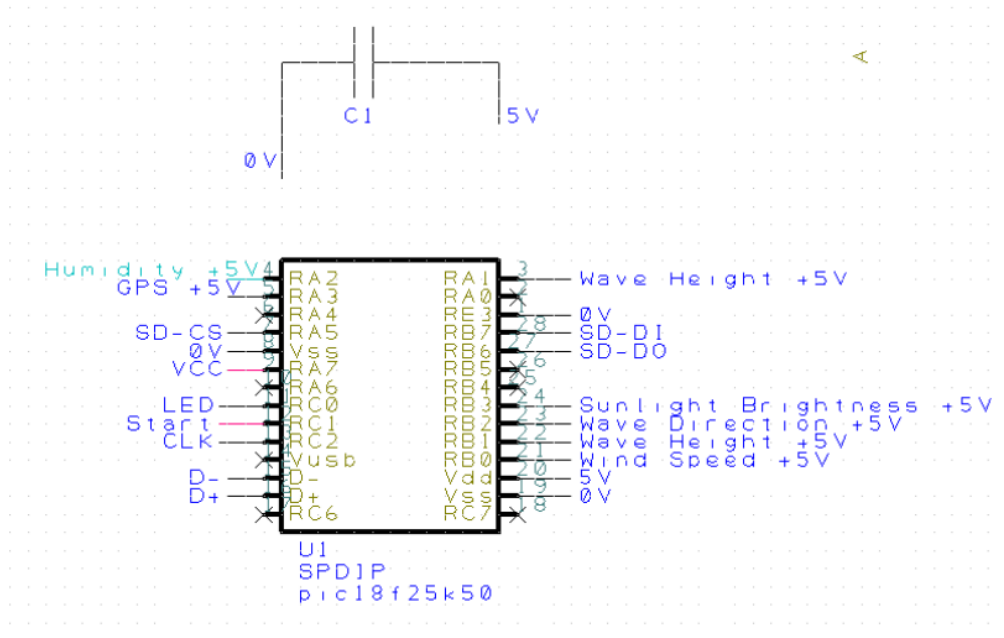
[Easy-PC Design](#)

Here are the schematics on Easy-PC just before adding them to the PCB board.

The design as a whole:



Starting with an image of the pic.



Conn1
usb c type
smd

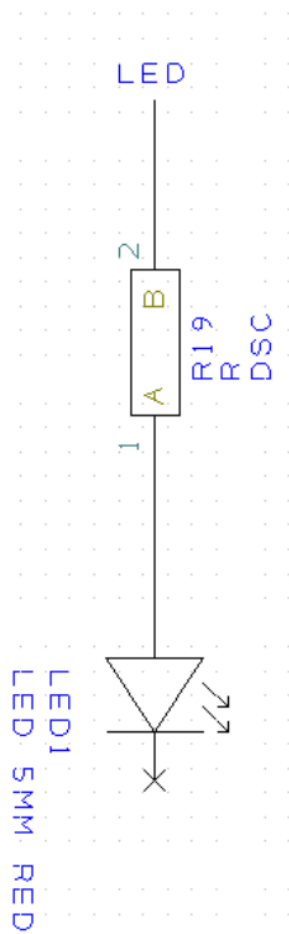
VBUS — 1
D- — 2 D-
D+ — 3 D+
ID — 4
GND — 5 0V

6 Shell
7 Shell
8 Shell
9 Shell

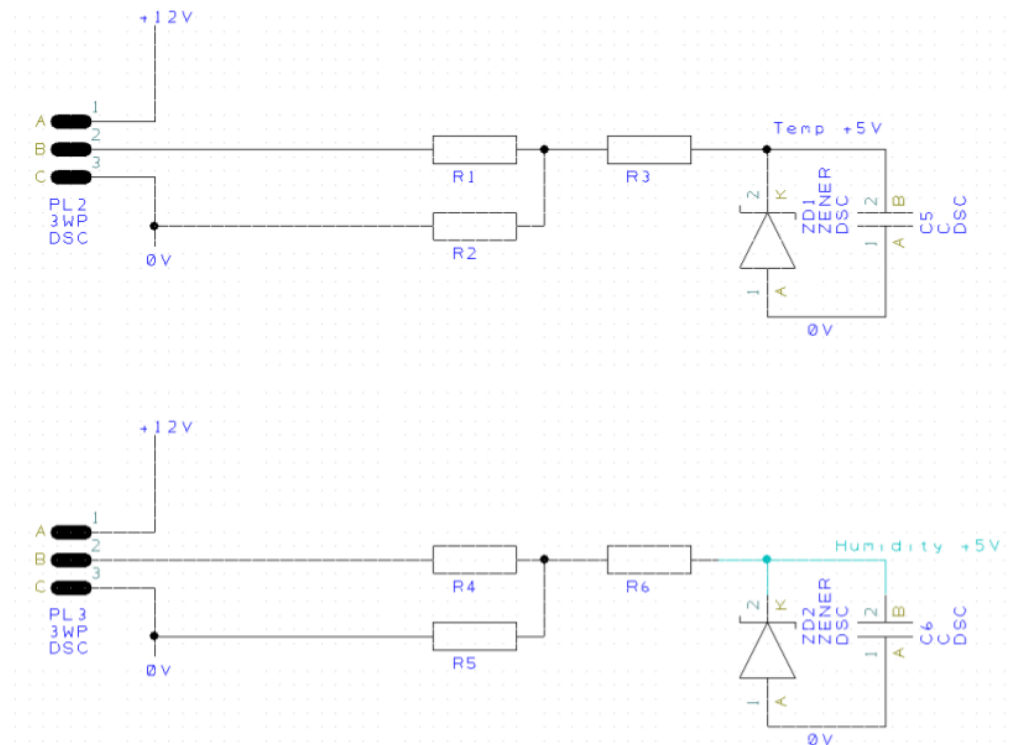
SD-DO — 1
0V — 2
0V — 3
CLK — 4
+V — 5
Cmd — 6
D Bit 3 — 7
D Bit 2 — 8

0V

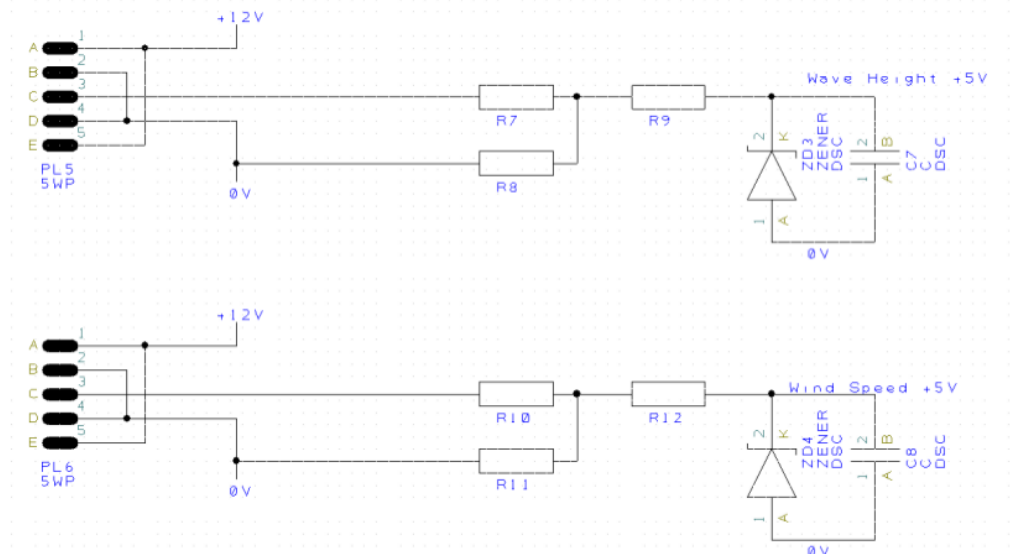
Conn1
Micro sd card
SMD



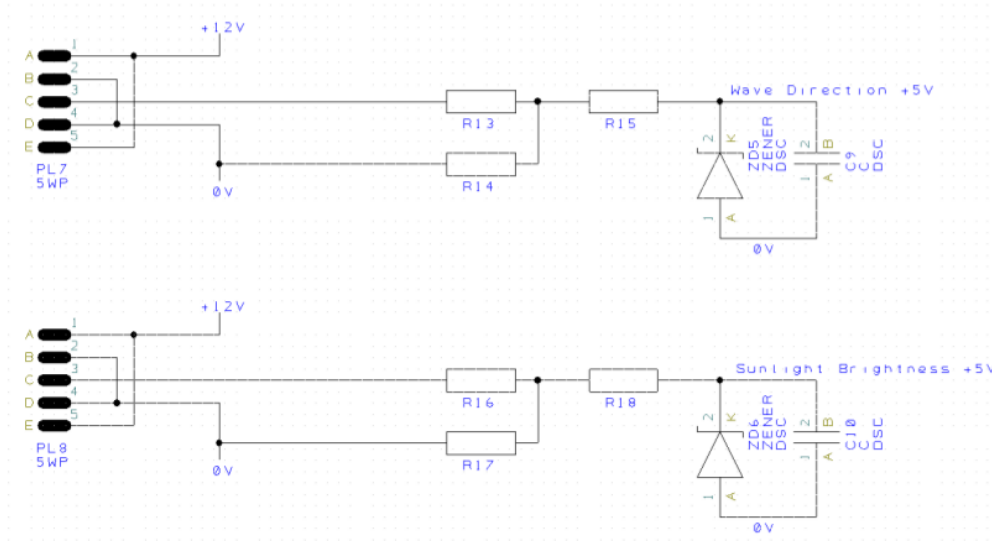
Images of the Temperature and Humidity sensors, both on an analogue input.



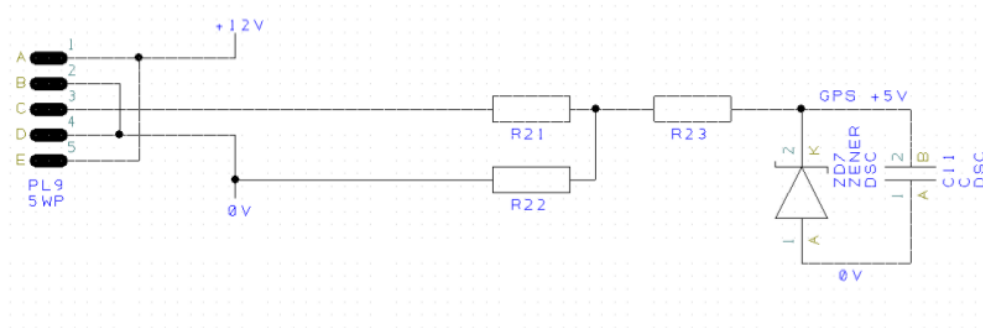
Now the wave height and wind speed on digital input schematics.



Followed by the Wind direction and sunlight brightness sensors, both digital.



Finally, the GPS sensor, also a digital input.



Battery & Casing

The battery required to operate the system would be 12 V, due to the maximum voltage being +12 VDC. The battery chosen for this, is an 12V 12.5Ah (C20) AGM Super Cycle Battery (Faston-tab 6.3x0.8mm), image seen below. [6]



Specifications:

Ah Rating	1-65Ah
Country of Manufacture	China
Dimensions (mm)	151 x 100 x 103
Material	AGM
SKU	BAT412012080
Voltage	12V
Weight (kgs)	4

The casing that will house the entire system and battery will be the Duratool Waterproof Case. It's lightweight, hard-wearing,



Costing

Item	Quantity	Price	Total
Resistor	22	£1.14	£23.14
Capacitor	12	£2.99	£35.88
Temp Sensor	1	£297.94	£297.94
Humidity Sensor	1	£495.35	£495.35
Wave Height Sensor	1	£693.29	£693.29
Wind Speed Sensor	1	£519.41	£ 519.41
Wind Direction Sensor	1	£610.42	£610.42
Solar Sensor	1	£793.35	£793.35
GPS Sensor	1	£150	£150
Battery	1	£28.00	£28.00
LED	1		
PCB Board	1		
Case	1		
			£3646.78

Improvements

- . Wireless sensors using Bluetooth.
- . Multichannel data loggers.
- . A whole kit of devices from the same manufacturer, to ensure full compatibility with al devise.

Appendix

Details of the sensors, data loggers, pics, everything backed with screenshots of the data sheets.

Global Water WE570 Wind Direction Sensor

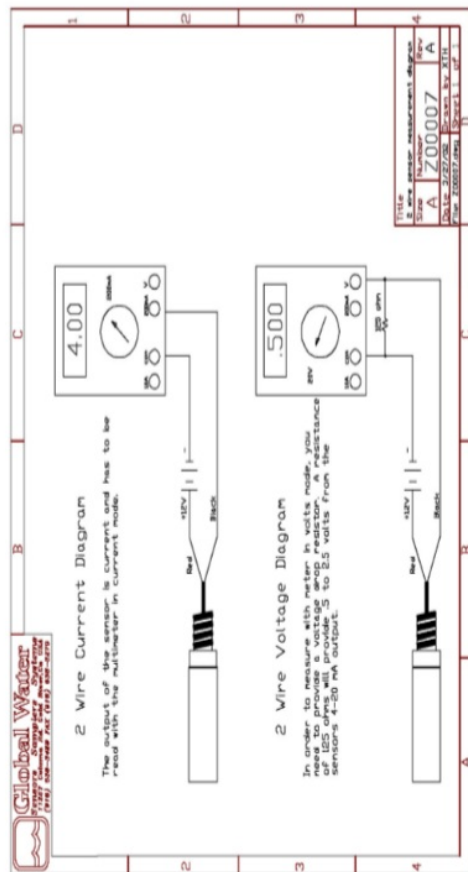


Global Water
800-876-1172 • globalw.com



Global Water
800-876-1172 • globalw.com

XV. Appendix B: 2 Wire Sensor Measurement Diagram



VII. Wind Direction Sensor

a. Wind Direction sensor specifications.

Output:	4-19 mA
Range:	0 to 360° (352° electrical, 8° open)
Accuracy:	1% of full scale
Operating Voltage:	10-36VDC
Current Draw:	Same as sensor output
Warm Up Time:	3 seconds minimum
Operating Temp:	-40° to +55°C
Size:	8 1/2" diameter x 10 1/2" long
Weight:	1 lb.

- The sensor is a two-wire sensor using the red wire for power and the black wire for the output signal. **Warning: Always connect the sensor with the power turned off.**
- The ridge on the fixed portion of the sensor represents the 0° direction of the sensor. The sensor comes with a stainless steel elbow that can be mounted on a 1" diameter tube. For best results ensure that the sensor is mounted parallel to the ground surface.
- A wind direction sensor produces a ratiometric voltage signal. That voltage signal is transformed into a 4-19 mA sensor output signal.

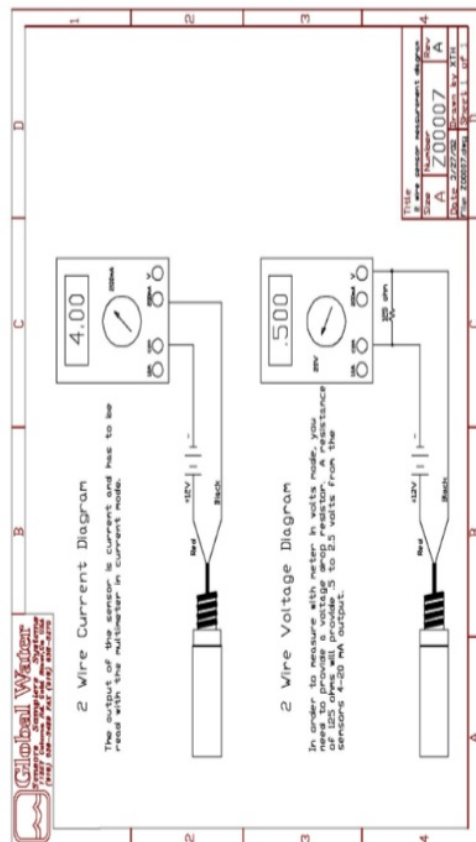
WE550 Wind Speed Sensor

Global Water
800-876-1172 • globalw.com



Global Water
800-876-1172 • globalw.com

XV. Appendix B: 2 Wire Sensor Measurement Diagram



VI. Wind Speed Sensor

a. Wind Speed sensor specifications.

Output: 4-20mA
 Range: 0-110 MPH
 Accuracy: .2 MPH over the range 11 to 55 MPH
 Operating Voltage: 10-36VDC
 Current Draw: Same as sensor output
 Warm Up Time: 3 seconds minimum
 Operating Temp: -40° to +55°C
 Size of Probe: 7" diameter x 8 1/2" long
 Weight: 1 lb.

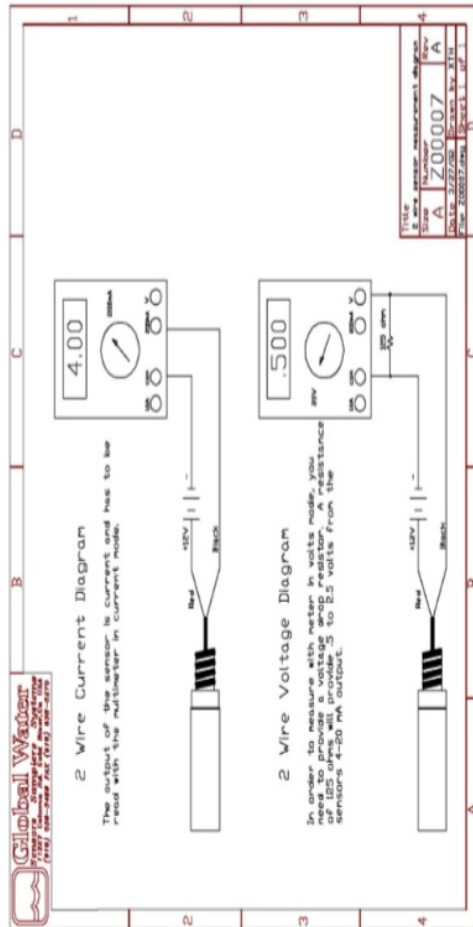
b. The sensor is a two-wire sensor using the red wire for power and the black wire for the output signal. **Warning:** Always connect the sensor with the power turned off.

c. The sensor comes with a stainless steel elbow that can be mounted on a 1" diameter tube. For best results ensure that the sensor is mounted parallel to the ground surface.

d. The wind speed sensor or anemometer produces a sine wave voltage signal with a frequency that changes linearly with the wind speed. The frequency is transformed into a 4-20 mA sensor signal output.

WE700 Temperature Sensor

XV. Appendix B: 2 Wire Sensor Measurement Diagram



IX. WE700 and WE710 Temperature Sensors

a. Temperature sensor specifications.

Output:	4-19mA
WE700 Range:	-50° C to + 50° C (-58F to +122F)
WE710 Range:	-50° C to + 85° C (-58F to +185F)
WE700 Accuracy:	±0.2° F or ±0.1° C
WE710 Accuracy:	±0.5° F or ±0.27° C
Operating Voltage:	10-36VDC
Current Draw:	Same as sensor output
Warm Up Time:	3 seconds recommended
Storage Temperature:	-50°C to +100°C
Size of Probe:	3/4" diameter x 4 1/2" long
Weight:	1/2 lb.

- b. The sensor is a two-wire sensor using the red wire for power and the black wire for the output signal. **Warning: Always connect the sensor with the power turned off.**

Do not install the temperature sensor in direct sunlight.

- c. To check the temperature sensor calibration you will need:

- 1 thermometer
- 1 insulated container of at least on gallon
- 1 power supply
- 1 current meter
- Connecting wires as necessary

Connect the sensor to the power supply and current meter in the following way. Attach the black wire to the positive input of the current meter. Connect the ground terminal of the power supply to the ground of the current meter. Attach the red wire to the positive terminal of the power supply. **Warning: Always connect the sensor with the power turned off.**

GL500-2-1 Data Logger

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XVII. Input Connections

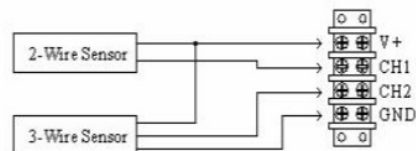
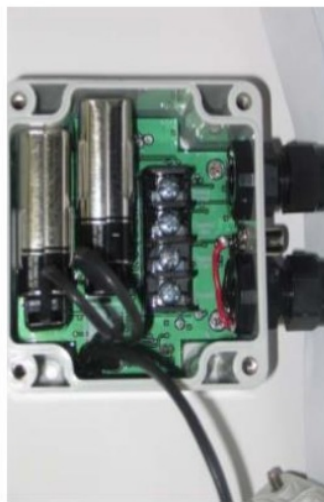
The digital input uses a standard RCA jack on the bottom of the case and 2 strain reliefs are provided for feeding sensor cables into the case where the analog input connector is.

To access the analog sensor connections inside the logger, loosen the four screws and remove the lid.

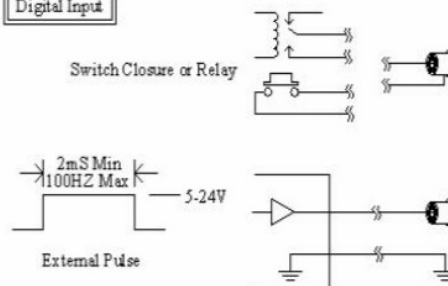


The "V+" or "Sensor Power" terminal provides power to the sensor. This is a switched power source which, to preserve power, is on only during the sensor warm-up time. The "Channel One" and "Channel Two" terminals are 4-20mA current loop inputs for the analog channels and "Ground" is circuit ground.

Analogue Inputs



Digital Input

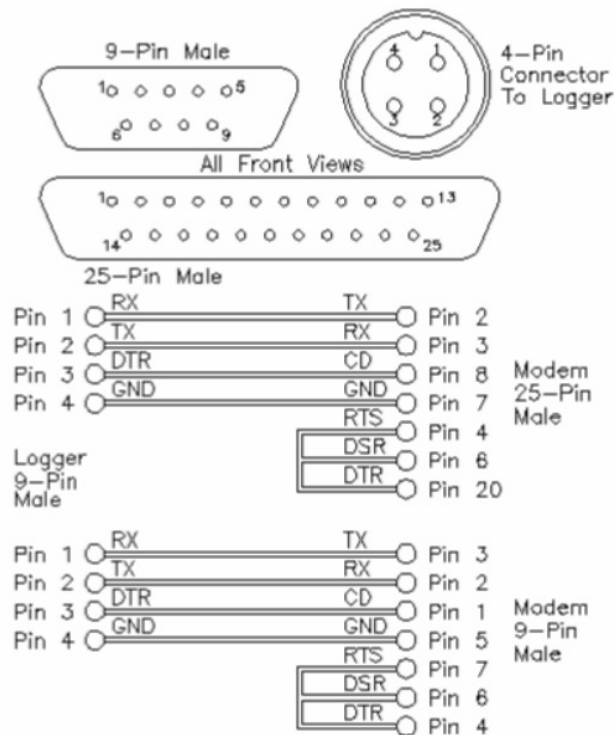




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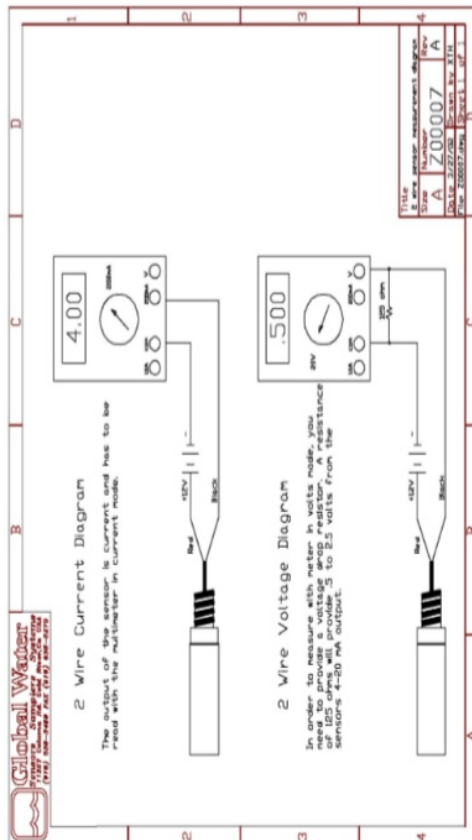
XVIII. Modem Cable Diagram (GL500S Only):

The following wiring diagram is used to make a cable to connect the GL500S Data Logger to an external modem. A Pre-wired cable is available from Global Water.



WE300 Solar Radiation Sensor

XV. Appendix B: 2 Wire Sensor Measurement Diagram



7. Solar Radiation Sensor

a. Solar Radiation sensor specifications.

Output:	4-20mA
Range:	0-1500 W/m ²
Accuracy:	1% of full scale
Operating Voltage:	10-36VDC
Current Draw:	Same as sensor output
Warm Up Time:	3 seconds minimum
Operating Temperature:	-40°C to +55°C
Size of Probe:	3" diameter x 1 1/2" high
Weight:	1/4 lb.

- b. The sensor is a two-wire sensor using the red wire for power and the black wire for the output signal. **Warning: Always connect the sensor with the power turned off.**
- c. Ensure that the sensor is placed on a level surface, use the alignment bolts to adjust the sensor until it is level. Remove the red cap to begin taking readings.
- d. The solar radiation sensor or pyranometer is an instrument for measuring solar radiation received from a whole hemisphere. It is suitable for measuring global sun plus sky radiation. Solar radiation varies significantly among regions. Season and time of day are major considerations, but surrounding terrain elevation, man-made obstructions, and surrounding trees can also cause large variations in locations with a small area. Often, the required measurement is, energy flux density of both direct beam and diffuse sky radiation passing through a horizontal plane of known unit area (i.e., global sun plus sky radiation).
- e. Calibration should be confirmed annually.

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ESD Assignment 2

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

51 / 100

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GRADING FORM: SMU GENERIC_GJ

JOHN DAVIES

50.65

RESEARCH-INFORMED LITERATURE



Poor literature review of available systems with no comparison table as only 1 system was put forward or

3

relevant information.25%

KNOWLEDGE AND UNDERSTANDING



Reasonable 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. The design show good practice in the use of clamps to limit damage to the pic from over voltage although the explanation of it shows the resistors the wrong way around although this has not been done in the design. Ensure that the component names are the same in all schematics. From the proteus schematic it can be seen that Wave Height, Humidity and Temperature signal have been taken straight to the pic and are reliant on the clamp to limit the voltage. I am assuming that this is an early mistake as you have not done this on other inputs. You have not included a PCB although you translated the proteus schematic to easy-pc. 55%

19.25

ANALYSIS



Good selection of microcontroller but no specification to show why it was selected. Reasonable selection of sensors showing details for each with a table showing a limited selection in some cases only one of sensors to be chosen from with an image or illustration of each. Good case selection. Good selection of connectors with comparison table..58%

17.4

PRACTICAL APPLICATION AND DEP.



Incomplete costings put forward as a table with price without manufacturer part numbers or supplier of component. Poor attempt at future enhancements. 55%

5.5

SKILLS FOR PROFESSIONAL PRAC.



The report is poorly presented with limited tabled data and diagrams. A poor selection of references. More time taken would have resulted in a better overall mark 55%

5.5