

Marine Weather Monitoring Station



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Introduction

Within this technical report a requirement to design a simple microcontroller based marine weather monitor/logger.

The data logger shall be suitable for amateur marine weather forecasting to aid in weather predictions.

There are some key design criteria in which the design must meet;

- Temperature Measurement
- Humidity
- Wave Height
- Wind Speed
- Wind Direction
- Sunlight Brightness
- GPS Position
- Data obtained over 7 day periods
- Internal memory
- USB connectivity
- Battery operated
- IP Rated
- Ease of transport & set up
- L.E.D signal flash every 10s

This technical document contains the background research, design and construction information.

The unit will require individual sensors suitable by specification to capture real world conditions specific to the design requirement, and be connected back to a central command centre and data processed via a microcontroller, and information stored internally on non-volatile memory.

The units housing will be of rugged design and high IP rated to ensure components sensitive to moisture ingress are fully protected from the marine environment, the pre-wired connections linking the field monitors shall have individual pin connectors where required.

Clarification, within this document the system being designed will be a self-floating buoy, which will be designed to be situated within the confines of a marina, it must be noted this unit will not be designed to handle open sea conditions.

Research into Existing weather monitoring systems

Within the market place there are a number of existing systems available to purchase with a number of applications uses, below are three systems and their applications and benefits and comparisons;

1. Davis instruments 6322 wireless integrated sensor suite

The standard version of the ISS contains a rain collector, temperature sensor, humidity sensor and anemometer. In addition to the standard weather features, the ISS Plus adds a pre-installed solar radiation sensor and a ultra-violet (UV) radiation sensor. Temperature and humidity sensors are mounted in a passive radiation shield to minimize the impact of solar radiation on sensor readings. The anemometer measures wind speed and direction and can be installed adjacent to the ISS or apart from it.

On an ISS Plus, the additional solar and UV sensors are mounted next to the rain collector cone. Separate solar and UV sensors are available to upgrade a standard ISS.

The Sensor Interface Module (SIM) contains the “brains” of the ISS and the radio transmitter.
[1]



Figure 1 – Davis Instruments

Web Link

https://www.coleparmer.co.uk/i/davis-instruments-6322-wireless-integrated-sensor-suite/8640355?PubID=UY&persist=true&ip=no&keyword=&&gclid=CjwKCAiAluLvBRASEiwAAbX3GVc6mrqv7OOGxu-WVSQv_1YRqhptjWCIW0QYj5XAUp-Qw86M16nM6xoCVmYQAvD_BwE&gclsrc=aw.ds

2. WS-GP1 Compact Weather Station

Rapid installation

The WS-GP1 Automatic Weather Station is supplied pre-wired and pre-programmed and can be set up on-site in minutes. The system is delivered in two suitcase-style carry cases that can be used to store or transport the system. The cases are light enough for one person to carry.



Figure 2 - WS-GP1

Tough and dependable

Despite the low system cost, the sensors are dependable and suitable for use in demanding environments. The galvanised steel tripod and white painted stainless steel cross-arm ensure excellent physical strength. The system requires minimal maintenance.

The internal battery provides 6 month's operation (typical).

Easy data collection

Recorded weather data can be collected directly with a notebook PC, or remotely by optional cellular modem. In addition to the standard logging options, the WS-GP1 can log and display wind rose, gusts, averages (including vector average) and maximum and minimum readings, with times of occurrence. The GP1 Data Logger can store >600,000 readings.

[2]

Web Link

<https://www.delta-t.co.uk/product/ws-gp1/#overview>

A Bresser weather station featuring a large, black LCD display with a white border. The display shows various weather metrics: temperature (30.8°C), humidity (63%), wind speed (19.8 km/h), wind direction (NE), pressure (1013 hPa), and a 5-day forecast. To the right of the display is a white outdoor sensor unit with a black anemometer cup and a black wind vane. The sensor unit is connected to the display by a black cable. The Bresser logo is visible on both the display and the sensor unit.

Figure 3 - Bresser Unit

- ### Web Link

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Existing weather station system's review

Within this review the existing systems will be compared on a short brief comparable table (below).

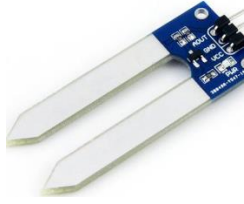
Its noted that there is a vast amount of weathering monitoring systems available in the market, most do not vary in terms of what they can and can not monitor, where the real differences come is when considering the environmental conditions and accuracy levels required for your specific requirements.

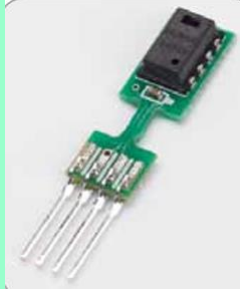
Product Name	Davis instruments 6322 wireless integrated sensor suite	WS-GP1 Compact Weather Station	Bresser complete wifi weather station with UV monitoring & weather alerts
Product Image			
Supplier Web	www.coleparmer.co.uk	www.delta-t.co.uk	www.weathershop.co.uk
Unit Cost	£481.85	£458.98	£249.99
What it monitors	• Wind Speed • Temperature • Wind direction • Humidity • Solar radiation	• Wind Speed • Temperature • Wind direction	• Wind Speed • Temperature • Wind direction
Out Puts / connectivity	• bluetooth	• GPS • Wifi	• GPS • Wifi
Pro's	• Simple to use • Simple installation requirements •	• Easy set up • Simple installation requirements •	• Digital information display • Huge information • Simple installation requirements
Con's	• Light use applications only • Limited for water type monitoring	• Moderate use applications • Limited for water type monitoring	• Limited for water type monitoring

Sensor selection & comparison

Below tables show the back-ground research into the most appropriate sensor for the given application, highlighted sensors are the sensors which will be used in the construction of the monitoring unit.

Temperature & Humidity Sensor's

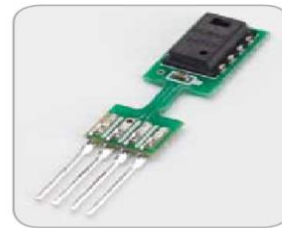
Technology Name	Hydrometer	Thermistor	Temp & Humidity Combined
Image			
Pro's	Accurate / compact / cost effective / simple installation	Accurate / compact / cost effective / simple installation	Accurate / Compact / cost effective / simple installation / 2 x sample measurements within the one device
Con's	One measurement range only	One measurement range only	If the device fails you loose 2 x measurement applications

Sensor Name	HX300 – Temp & Humidity Sensor	Temperature & Humidity Sensor (CC2D25-5P)	Pt100 Humidity & temperature probe
Image			
Portability	Very Good	Excellent	Very Good
Power Supply	12-40 V dc	2.3-5.5 Vdc	5-30 v DC
Power Supply Connection Type	Hard Wired	Hard Wired	Hard Wired

Data Signal Out Put	4 – 20Ma	0-5V DC	4 – 20Ma
Power Consumption	40mA	0.075Ma	25mA
Manufacture Web Link	https://www.omega.co.uk/pptst/HX300GB.html	https://www.seeedstudio.com	file:///C:/Users/cston/AppData/Local/Package

TELAIRE®

ChipCap® 2-SIP Humidity and Temperature Sensor



Description

ChipCap 2-SIP by Telaire is a Single In-Line Package type of ChipCap with ready installed V-Core capacitor for easy and convenient application.

ChipCap offers the most advanced and cost effective humidity and temperature sensing solution for virtually any type of applications. Capacitive polymer sensor chip developed and fabricated in-house and CMOS integrated circuit with EEPROM are integrated into one embedded system.

Individually calibrated and tested, ChipCap 2-SIP performs $\pm 2\%$ from 20% to 80%RH ($\pm 3\%$ over entire humidity range), and yet is simple and ready to use without further calibration or temperature compensation.

ChipCap 2-SIP offers another sensible sensing solution for excellent reliability, high accuracy, and cost effective sensing applications.

Features

- Fully Calibrated & Temperature Compensated
- Digital ($^{\circ}\text{C}$) Output
- Precision and Accuracy ($\pm 2\% \text{RH}$, $\pm 0.3^{\circ}\text{C}$, 14 bit)
- Free Operating Voltage (min 2.3V to max 5.5V)
- Low Current Consumption
- SIP (Single-In-line-Package)
- Reliable in Harsh Environment
- Eliminates the reconditioning procedure needed for surface mount RH sensors
- Field replaceable.
- Allows better air circulation and response time

Applications

- Energy Saving HVAC Control: Air Conditioning, Refrigeration, IAQ monitoring, Vent Fans, Home Appliances, Humi/Dehumidifiers
- Process Control and Instrumentation: Sensor Performance
- Medical Instruments, Handheld Devices, Weather Stations, Food Processing, Printers, RFIDs
- Automobile & Transportation Cabin Climate Control, Defogging Control, Condensing Preventive Device
- Mass Quantity Application: OEM custom specification available

Amphenol
Advanced Sensors

Figure 4Humidity & temp sensor data sheet 1

Sensor Performance

Relative Humidity (RH%)

* Custom Accuracy Tolerance Available

Resolution	14 bit (0.0166%)
Accuracy*	±2.0%RH (10-90%RH)
Repeatability	±2.0%RH
Hysteresis	±2.0%RH
Linearity	±2.0%RH
Response time†	7.0 sec (63%)
Temp. Coefficient	Max (0.13 %/°C) (at 10-60°C, 10-90%RH)
Operating range	0 - 100 %RH (Non-Condensing)
Long term drift	<0.5 %RH/yr (Normal condition)

Temperature (°C)

Resolution	14 bit (0.01°C)
Accuracy*	±0.3°C (Figure 2)
Repeatability	±0.1°C
Response time	5.0 sec (63%)
Operating range	-40 - 125°C
Long term drift	<0.05 °C/yr (Normal condition)

1. Accuracies measured at 25°C, 5.0V
2. Measured at 25°C, 1mspec. allow for achieving 65% of step from ±3%RH to 90%RH
3. Accuracies measured at 25, 5.0V
4. Min 5.0 sec, Max 20 sec

Figure 1. Typical RH% Accuracy at 25°C

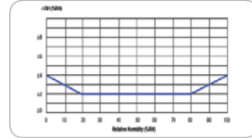
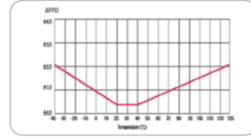
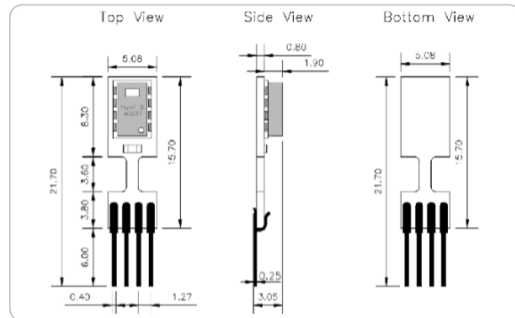


Figure 2. Typical Temperature Accuracy



Dimensions

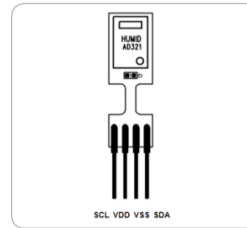


Electrical Specification

Supply Voltage*	1 min 2.3V - max 5.5V
Supply Current (I _{cc})	750 µA (typical)
Sleep Current (I _{sleep})†	0.6 µA (typical)

*1. Lower than 2.3V supply voltage may increase the accuracy tolerance of the temperature.
†2. At -40 - +85°C

Pin Connection



*Chip on board is 100 nF capacitor for VDD.

Environmental

Operating Temperature	-40 - 125°C
Operating Humidity	0-100%RH (non condensing)

Absolute Maximum Rating

Parameter	Min	Max
Supply Voltage (VDD)	-0.3V	6.0V
Storage Temp	-50°C	150°C
Junction Temp	-50°C	150°C

Soldering Information

Standard or IR Solder Reflow.

Tp: 260°C, tp: 40 sec. (qualify Pb free profile) For manual soldering, contact time should not exceed 4 seconds at up to 350°C.

Shipping

Tray :	100 ea
Inner Box :	500 ea
Out Box :	5,000 ea

Standard Digital (I²C) Output :
Factory setting is Sleep Mode and calibrated at 3.3V.

Package Contents

ChipCap 2-SIP consists of a ChipCap 2 and a V-core capacitor soldered on the top of a FR4 substrate. Lead Pins are made of Cu, Sn, P alloy and all parts are fully RoHS and REACH compliant.

Ordering Information

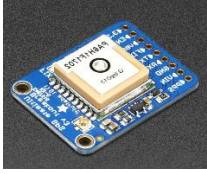
Output	Accuracy	VDD	Mode	Part Number
10C	2%	3.3 V	Update	CC2013-SIP
10C	2%	5 V	Update	CC2025-SIP
10C	2%	3.3 V	Sleep	CC2035-SIP
10C	2%	5 V	Sleep	CC2055-SIP
10C	3%	3.3 V	Update	CC2013-SIP
10C	3%	5 V	Update	CC2035-SIP
10C	3%	3.3 V	Sleep	CC2035-SIP
10C	3%	5 V	Sleep	CC2055-SIP

Figure 5 Humidity & Temp Sensor Data Sheet 2

GPS Sensor Selection

GPS Sensor's

Technology Name		GPS	
Image			
Pro's		Very accurate location positioning / global use no limitations on location / enclosed IP rated sensor housing	
Con's		None	

Sensor Name	MikroElektronika GPS	Garmin GPS Sensor 16X-HVS	Adufruit GPS
Image			
Portability	Excellent	Excellent	Excellent
Power Supply	3.3v DC	12 V dc	3.3-5.5v DC
Power Supply Connection Type	Hard Wired	Hard Wired	Hard Wired
Data Signal Output	RS-232	RS-232	RS-232
Power Consumption	38mA	45mA	25Ma
Manufacturer Web Link	https://uk.rs-online.com/web/p/radio-frequency-development	https://www.campbellsci.co.uk/gps16x	https://shop.pimoroni.com

6. Installation

6.1 Wiring

The GPS16X-HVS connects directly to a CR300-series, CR1000X-series, CR6-series, CR800-series, CR1000, or CR3000 datalogger (see TABLE 6-1). However, if PPS is required, the A300 Power and Signal Converter may be required for use with the CR800 series, CR1000, and CR3000. See Section 6.1.1, *Using with an A300 (p. 8)*. The CR6 series, CR1000X series, and CR300 series do not require the use of an A300.

The CR9000X only supports the GPS16X-HVS on the RS-232 port of the CPU card. The recommended interface is pn #28841. See TABLE 6-2.

If the GPS16X-HVS is to be connected to a computer to change the default settings, an A200 or pn #28840 interface is needed (see Appendix A, *Changing GPS16X-HVS Settings (p. A-ii)*).

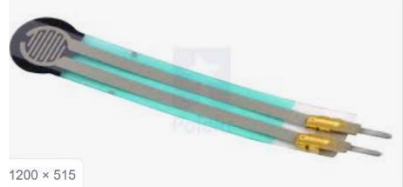
TABLE 6-1. Datalogger Wiring		
GPS16X-HVS	Datalogger	Function
Red	12V	Power In
Black	Ground	Power Ground
Yellow	Ground or Control Port for On/Off control	Power Switch
White	Control Port (Rx)	TXD
Grey	Control Port (Tx)	PPS
Blue	Ground or Control Port (Tx) for datalogger-based configuration	R _x data
Shield	Ground	Shield

Figure 6 - GPS Data Sheet 1

RS-232 Connection clarification for sensors

PIN	NAME	DIRECTION	DESCRIPTION
1	GND	-	Shield Ground
2	TXD	—»	Transmit Data
3	RXD	«—	Receive Data

Sunlight Sensor Selection

Technology Name	Photo-resistor	Photodiode	***CHANGE TO PHOTOVOLTAIC~*****
Image			
Pro's	Hight accuracy levels / compact / simple installation / cost effective	Hight accuracy levels / compact / simple installation / cost effective	Hight accuracy levels / compact / simple installation / cost effective
Con's	Subset able to damage	Subset able to damage	Subset able to damage

Sensor Name	GMX 101 Radiation sensor	Grove Sunlight Sensor – Si1145	LL-E-V light sensor
Image			
Portability	Very Good	Excellent	Very Good
Power Supply	5-30 V dc	3 – 5.5 V dc	24V DC
Power Supply Connection Type	Hard Wired	Hard Wired	Hard Wired
Data Signal Output	RS-232	4-20Ma	0-10v
Power Consumption	6mA	3.5mA	1Ma
Manufacturer Web Link	https://www.omniinstruments.co.uk/weather-stations-and-instruments/light-level-sensors/gmx101-weather-station.html	https://thepihut.com/products/grove-sunlight-sensor	file:///C:/Users/cston/AppData/Local/Packages/MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/File-1494325887%20(1).pdf

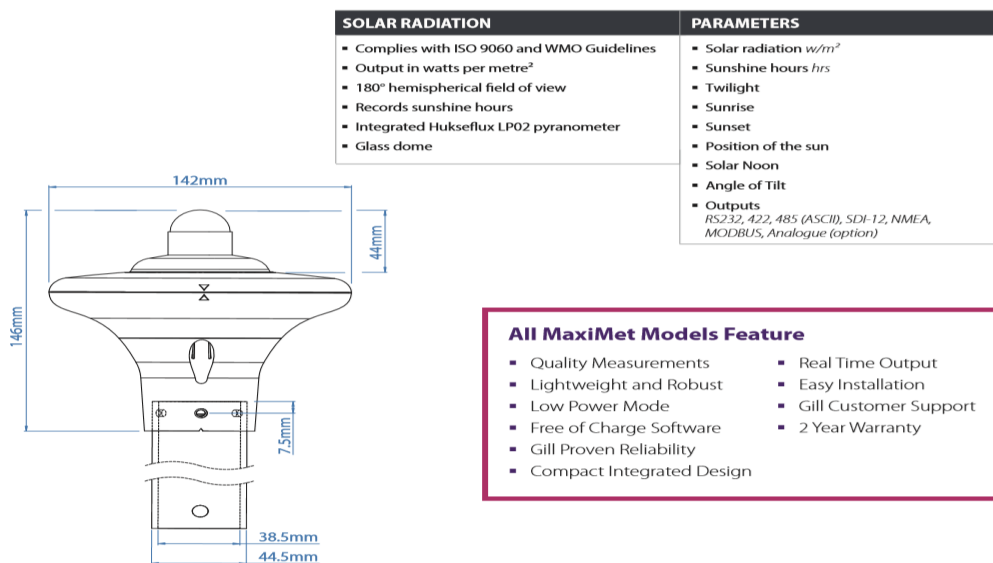
MaxiMet

GMX101 Compact Weather Station

The MaxiMet range of compact weather stations is designed and manufactured by Gill Instruments. MaxiMet products use reliable, high quality instruments to provide accurate meteorological information in a wide variety of applications.

GMX101 Features

Solar radiation. An integrated solar radiation sensor/pyranometer. This highly accurate instrument uses a thermal sensor mounted at its base and protected by a single glass dome to record the amount of light in watts per metre². It is widely used in agro-meteorological applications and for monitoring the performance of solar panels. An inclinometer is fitted to provide the angle of tilt to aid correct vertical and angled mounting.



For pricing or any further information, please contact Omni Instruments Ltd.



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Figure 7 GMX 101 Data Sheet 1

Applications

- Building and Industrial Controls
- Authorities
- Transport
- Coastal
- Agricultural
- Safety
- Educational
- Commercial
- Energy

GLOBAL SOLAR RADIATION	
Wavelength Sensitivity	300 to 3000 nm
Output Range	0 to 1600 w/m ²
Resolution	1 w/m ²
DIN Standard	ISO 9060 Second Class
Sampling Rate	1 Hz
Units	w/m ²

INCLINOMETER	
Range	± 90°
Accuracy	± 3°
Resolution	1°

OUTPUTS	
Output rate	1/s, 1/min, 1/hr
Digital Comms Modes	Serial RS232, RS422, RS485, SDI-12, NMEA, MODBUS, ASCII
Analogue Outputs	Available via separate optional device

POWER	
Power Supply	5 to 30 Vdc
Power (Nominal) 12 Vdc	6 mA continuous high mode. 0.7 mA eco-power mode (1 hour polled)

ENVIRONMENTAL CONDITIONS	
IP Rating	66
Operational Temperature Range:	-40°C to +70°C
EMC Standard:	BS EN 61326 : 2013 FCC CFR47 parts 15.109
CE Marking	YES
RoHS compliant	YES
Weight	0.4 Kg
Origin	UK

* Please see the manual for a full list of derived parameters

Specifications may be subject to change without prior notice



Whilst every effort has been made to ensure the accuracy of this specification, we cannot accept responsibility for damage, injury, loss or expense from errors or omissions. In the interest of technical improvement, this specification may be altered without notice.

For pricing or any further information, please contact Omni Instruments Ltd.

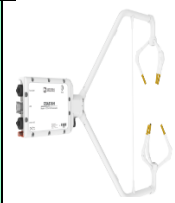


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Mid Craigie Trading Estate, Mid Craigie Road,
Dundee, DD4 7RH, UK

Wind Speed & Direction Sensor Selection

Technology Name	Anemometer	Wind Vane Sensor	Combined Wind speed & direction sensor
Image			
Pro's	Very Accurate / industry standard for measuring wind speed / simple installation	Very Accurate / industry standard for measuring wind speed / simple installation	Very Accurate / industry standard for measuring wind speed / simple installation / measures 2 x application in one instrument
Con's	Can be easily damaged in rough conditions	Can be easily damaged in rough conditions	Can be damaged in rough conditions

Sensor Name	05106 weather monitor	Wind-sonic 1	CSAT3BH 3-D anemometer
Image			
Portability	Very Good	Very Good	Very Good
Power Supply	15-28v DC	9-30 V DC	9.5-32V DC
Power Supply Connection Type	Hard Wired	Hard Wired	Hard Wired
Data Signal Out Put	4-20Ma	RS-232	RS-485
Power Consumption	30Ma	15mA	26mA

Manufacture Web Link	https://s.campbellsci.com/documents/eu/manuals/05103_wind_monitors.pdf	https://www.campbellsci.eu/windsonic1	https://www.campbellsci.eu/csats3bh
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Specifications

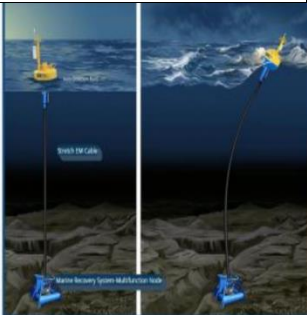
Input Voltage	9 to 30 Vdc
Typical Current Drain	~15 mA (continuous)
Operating Humidity Range	< 5% to 100% RH
Operating Temperature Range	-35° to +70°C
Storage Temperature Range	-40° to +80°C
Measurement Frequency	40 Hz block averaged to a 1 Hz output frequency
Outputs Parameters	Polar (direction and speed) or orthogonal (U _x and U _y wind)
Output Signal	RS-232
Maximum Cable Capacitance	2500 pF
Maximum Cable Length	15.24 m (50 ft) For configurations requiring longer cable lengths, contact Campbell Scientific.
Diameter	14.2 cm (5.6 in.)
Length	16.0 cm (16.3 in.)

Weight 0.5 kg (4.4 lb)

Wind Direction	
Range	0° to 359° (no dead band)
Accuracy	±3°
Resolution	1°
Wind Speed	
Range	0 to 60 m/s
Accuracy	±2% (@ 12 m s ⁻¹)
Resolution	0.01 m/s

Figure 9 Wind Sonic 1 Data Sheet 1

Wave height Sensor

Technology Name	Pressure Sensor	Stretch EM cable mooring system	Ultra-Sonic Sensor
Image			
Pro's	Bespoke instrument made to measure tidal variants / very robust / RS 232 out put	Bespoke instrument made to measure tidal variants / very robust	Modified to be used for tidal measurements / susceptible to high moisture damage
Con's	None	None	Will require suitable housing but ensure no to limit the sensor application

Sensor Name	Vented Tide 4428	Grove – Ultra Sonic Ranger	Stretch EM cable mooring sensor
Image			
Portability	Very Good	Very Good	Good
Power Supply	5-14 VDC	5 VDC	30-50 VDC
Power Supply Connection Type	Hard Wired	Hard Wired	Hard Wired
Data Signal Out Put	RS-232	PWM connection shown below image	4-20ma

Power Consumption	50mA	8Ma	100mA
Manufacturer Web Link	https://www.aanderaa.com/media/pdfs/Vented-Pressure-Tide-Wave-Sensor.pdf	https://www.seeedstudio.com/Grove-Ultrasonic-Distance-Sensor.html	https://www.eomoffshore.com/stretchemcable



Accurate monitoring of pressure, tide, water level and waves in ports, coastal and inland waters, rivers and boreholes is of great importance to many practical projects. This series of sensors measures the hydrostatic pressure caused by the head of water above them. The influence of barometric pressure on the sensors is compensated for by applying air pressure to one side of the transducer through an air pipe and compensating unit. The sensors contain, in addition to the sensing element, a temperature compensating and a range reducing network. The sensor is based on a silicon pressure sensor. The pressure measurements are sampled and temperature compensated by an advanced Digital Signal Processor.

The sensor application areas are in fixed installations, either deployed in a seabed installation in shallow waters, or mounted onto a fixed structure in the upper water column. Typical applications for the sensor are measurements of wave and tide in

Vented Pressure 4425/4426/4427 Vented Tide 4445/4446 Vented Wave 4428/4429

are compact fully integrated sensors for measuring pressure, tide or wave conditions, based on measuring the hydrostatic pressure and water temperature in a fixed submerged position. The pressure transducer is vented to facilitate automatic correction for atmospheric pressure fluctuations.

The sensor package consists of:

- Vented Sensor with Thermistor
- Cable with Airpipe
- Compensating Unit

Advantages:

- Smart Sensor technology - plug and play
- Sensor calibration coefficients are stored internally
- Low maintenance needs
- Low current drain
- Short update interval: 1 second to 255 minutes
- 2Hz and 4Hz sampling frequency
- 256, 512, 1024 and 2048 samples
- New updated wave parameters every 1 second
- Output parameters: see overleaf
- Output format: AiCaP CANbus, RS-232 or RS-422
- Real-time XML output

ports and harbors, marine operations, weather forecast, and climate studies.

The tide measurement is an average of the hydrostatic pressure measured over a time period of 10 seconds to 8 minutes (integration time configurable by the user). The update interval is between 1 second and 255 minutes.

The wave measurements are based on the pressure time series measured over a time period of 64 seconds to 17 minutes (configurable by the user). The update interval is between 1 second and 255 minutes.

All calibration and temperature compensation data are stored inside the sensor, the parameters are by default presented directly in engineering units without any external calculation. The sensor also provides raw data of the pressure and the temperature measurements.

D402 - Jan 2013

Figure 10 Vented Wave 4428 Data Sheet 1



PIN CONFIGURATION RS-422, R-version

Receptacle, exterior view; pin = • bushing = °

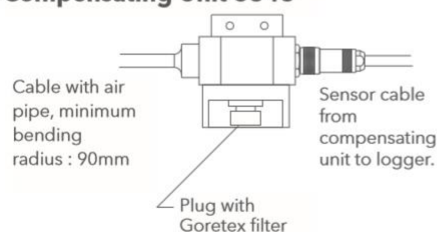
RS-422 TXD+	4	5	DNC
DNC	3	6	AIR PIPE
DNC	9	10	RS-422 RXD-
Gnd	2	7	RS-422 RXD+
Positive supply	1	8	RS-422 TXD-

PIN CONFIGURATION RS-232 and AiCaP

Receptacle, exterior view; pin = • bushing = °

CAN_H	4	5	NCE
NCG	3	6	AIR PIPE
NCR	9	10	CAN_L
Gnd	2	7	RS-232 RXD
Positive supply	1	8	RS-232 TXD

Compensating Unit 3848



All specifications are for the stand-alone sensor only, not the installation it is utilized with.
Specifications subject to change without prior notice.

Range:
4425,4428,4445: 0 - 50kPa (14 psia) ~ 5m depth
4426,4429,4446: 0 - 100kPa (14 psia) ~ 10m depth
4427,4447: 0 - 200kPa (29 psia) ~ 20m depth

Pressure:
Resolution: <0.0001% FSO
Accuracy: ±0.04% FSO

Tide:
Sampling rate: 2Hz, 4Hz
Integration time: 10 sec - 8 min

Wave:
Sampling rate: 2 Hz, 4 Hz
Number of samples: 256, 512, 1024, or 2048

Output parameters:
All versions: Pressure, temperature, rawdata pressure and rawdata temperature.
Wave & Tide only: Tide pressure, tide level, significant wave height, maximum wave height, mean period, peak period, mean zero-crossing period, energy period, steepness, cut-off frequency, irregularity of sea-state, pressure series, last pressure sample index, wave spectrum

Temperature:
Range: 0 - 36°C (32 - 96.8°F)
Resolution: <0.001°C (0.0018°F)
Accuracy: ±0.4°C / 0.2°C⁽¹⁾ (±0.72°F/0.36°F⁽¹⁾)
Response time (63%): 2 min

Output format: AiCaP CANbus, RS-232(Standard version)⁽²⁾
RS-422 (R-version)⁽²⁾

Output interval: RS-232/RS-422: 1 sec - 255 min
AiCaP: Controlled by SmartGuard

Supply voltage: 5 to 14Vdc
Current drain(@ 9V)⁽³⁾: Maximum: 50 mA
Quiescent: RS-232: 0.25 mA
RS-422: 1.0 mA

Average (1024 samples, 40seconds tidal average):

Output Interval	2 sec	1 min	10 min	30 min
2 Hz: AiCaP	7.9 mA	4.8 mA	4.2 mA	1.6 mA
RS-232	19.5 mA	6.0 mA	4.7 mA	1.7 mA
RS-422	19.5 mA	6.0 mA	5.2 mA	2.4 mA
4 Hz: AiCaP	11.7 mA	9.3 mA	4.2 mA	1.6 mA
RS-232	24 mA	10.5 mA	4.7 mA	1.7 mA
RS-422	24 mA	10.5 mA	5.2 mA	2.4 mA

Operating temp.: -5 - +40°C (23 - 104°F)
Operating depth: Within pressure range
Electrical connection: 10-pin receptacle mating plug CSP
Pressure connection: Swagelok™ 1/8 inch
Dimensions: OD: 36 x 108mm (OD:1.4"x4.3")
Weight: 189g (6.67oz)

Materials: Titanium, POM, epoxycoating

⁽¹⁾ Wave and Tide disabled and output interval ≥ 2 seconds
⁽²⁾ 9600 baud, 8 data bits, 1 stop bit, no parity, Xon/Xoff Flow control
⁽³⁾ Current drain based on wave enabled, for pressure and tide see D381 and D382



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www.aanderaa.no

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Figure 11 Vented Wave 4428 Data Sheet 2

Microcontroller Specification & Selection

The microcontroller for this marine weather application will need to be selected with the key requirement of the instrument's connection preferences and the processing power required for the whole operation.

Table below shows the overview of the specification required, from these points below it should be a minimum guidance for the selection of the microcontroller.

Sensor	Signal	Pins	Logging Rate	Bits
Wind Speed & Direction	Digital	2 (RS-232)		10
Wave Height	Digital	2 (RS-232)		10
Light Levels	Digital	2 (RS-232)		10
Temperature & Humidity	Analogue	2 (0-5V)		10
GPS	Digital	2 (RS-232)		10
RS232	digital	2		
SD Card	digital	3		
USB	digital	2		
SPI		1		

For the selection of the chip, utilisation of microchip.com's (<https://www.microchip.com>) selector tool was used to narrow down and precisely highlight the correct microcontroller for the application.

The microcontroller selected was the (ATSAMA5D27-WLSOM1) - <https://www.microchip.com/maps/Microcontroller.aspx>

The overview technical specification of the microcontroller can be seen in the below image (xxxx).



Figure 12 Micro Chip 25K50

FIGURE 1: 28-PIN SPDIP (300 MIL), SOIC, SSOP

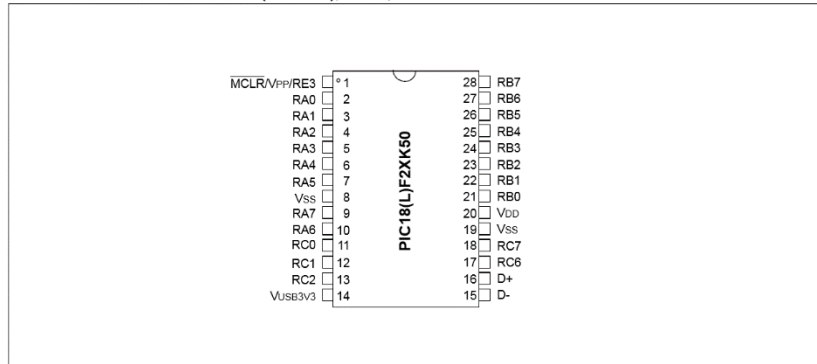


Figure 13 Micro Chip 25K50 GA

TABLE 1: PIC18(L)F2X/45K50 PIN SUMMARY

I/O	28-Pin SPDIP/SOIC/SSOP	28-Pin QFN	40-Pin PDIP	40-Pin UQFN	44-Pin TOFP	Analog	Comparator	CTMU	SR Latch	Reference	USB	(E)CCP	EUSART	MSSP	Timers	Interrupts	Pull-up	Basic	ICD
RA0	2	27	2	17	19	AN0	C12IN0-	—	—	—	—	—	—	—	—	—	—	—	—
RA1	3	28	3	18	20	AN1	C12IN1-	CTCMP	—	—	—	—	—	—	—	—	—	—	—
RA2	4	1	4	19	21	AN2	C2IN+	—	—	VREF- DACOUT	—	—	—	—	—	—	—	—	—
RA3	5	2	5	20	22	AN3	C1IN+	—	—	VREF+	—	—	—	—	—	—	—	—	—
RA4	6	3	6	21	23	—	C1OUT	—	SRQ	—	—	—	—	—	T0CKI	—	—	—	—
RA5	7	4	7	22	24	AN4	C2OUT	—	SRNQ	HLVDIN	—	—	—	SS	—	—	—	—	—
RA6	10	7	14	29	31	—	—	—	—	—	—	—	—	—	—	—	—	OSC2 CLKO	—
RA7	9	6	13	28	30	—	—	—	—	—	—	—	—	—	—	—	—	OSC1 CLKI	—
RB0	21	18	33	8	8	AN12	—	—	SRI	—	—	FLT0	—	SDI SDA	—	INT0	Y	—	—
RB1	22	19	34	9	9	AN10	C12IN3-	—	—	—	—	P1C ⁽⁵⁾	—	SCK SCL	—	INT1	Y	—	—
RB2	23	20	35	10	10	AN8	—	CTED1	—	—	—	P1B ⁽⁶⁾	—	—	—	INT2	Y	—	—
RB3	24	21	36	11	11	AN9	C12IN2-	CTED2	—	—	—	CCP2 ⁽¹⁾	—	SDO	—	—	—	—	—
RB4	25	22	37	12	14	AN11	—	—	—	—	—	P1D ⁽⁵⁾	—	—	—	IOCB4	Y	—	—
RB5	26	23	38	13	15	AN13	—	—	—	—	—	—	—	—	T1G T3CKI ⁽²⁾	IOCB5	—	—	—
RB6	27	24	39	14	16	—	—	—	—	—	—	—	—	—	—	IOCB6	Y	PGC	—

Note 1: Alternate CCP2 pin location based on Configuration bit.
 2: Alternate T3CKI pin location based on Configuration bits.
 3: Pins are enabled when ICPRT = 1, otherwise, they are disabled.
 4: Location on 40/44-Pin parts (PIC18(L)F45K50). Function not on this pin on 28-Pin parts (PIC18(L)F25K50).
 5: Location on 28-Pin parts (PIC18(L)F25K50). Function not on this pin on 40/44-Pin parts (PIC18(L)F45K50).
 6: Alternate SDO pin location based on Configuration bits.

Figure 14 Micro Chip Data Sheet 1

PIC Data sheet - http://ww1.microchip.com/downloads/en/DeviceDoc/PIC18F2X_45K50-30000684B.pdf

due to the overall set criteria in which I was choosing the final results were in one device selection as above, the PIC18F25K50.

Given that the research into the devices and specific criteria has yielded one offering I am happy to continue with this selection as the selection tool from microchip.com

PIC18F25K50-I/SO - 8 Bit MCU, Flash, PIC18 Family PIC18F K5x Series Microcontrollers, 48 MHz, 32 KB, 2 KB, 28 Pins



Image is for illustrative purposes only. Please refer to product description.

MICROCHIP

Manufacturer: MICROCHIP

Manufacturer Part No: PIC18F25K50-I/SO

Order Code: 2305831

Product Range: PIC18 Family PIC18F K5x Series Microcontrollers

Technical Datasheet: PIC18F25K50-I/SO Datasheet

See all Technical Docs

[Add to compare](#) [Write a Review](#) [Ask a Question](#)

642 In stock

291 in stock for next day delivery (Liege stock)
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£2.08 (£2.496 Inc. VAT)
 Price for: Each
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Quantity	Price
1+	£2.08 (£2.496)
10+	£1.95 (£2.340)
25+	£1.88 (£2.256)
100+	£1.72 (£2.064)

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Figure 15- Micro Chip Cost

Non-Volatile Memory Storage

System memory logging required for the rig, which would be required to store acquired data over a seven-day period.

On the table below shows a quick overview of the required memory storage for the acquisition system can operate.

Measurement	Signal Type	Bytes	Logging Rate	Total Bytes
Wind Speed & Direction	Digital	2	500ms	1000
Wave Height	Digital	1	500ms	1000
Light Sensor	Digital	1	500ms	1000
Humidity & Temperature	Analogue	4	500ms	4000
GPS	Digital	1	500ms	1000

From the above table this is the data acquired during a 7-day 24hrs a day logging of bytes is 8,000 Bytes, which totals 8KB.

Total memory for the 24hrs per day over 7 day is shown in the below calculation;

Calculated Values rounded to the nearest 100.

- $8\text{KB/s} \times 60 = 0.48\text{MB/min}$
- $0.48\text{MB} \times 60 = 28.8\text{MB/hour}$
- $28.8\text{MB} \times 24 = 691.2\text{MB}$ but round to nearest 100 = 700MB / 24hrs
- $700\text{MB} \times 7 = 4.9\text{GB}$ rounded to nearest 100 = 5GB total Requirement

For the removable SD card, any size from 5GB and up will have sufficient memory for the application.

Due to the low cost of the SD cards I have selected the below, SD card which is 64GB well over specified but at £12 per unit its well within allocated budget cost.



Figure 16 Sandisk
Memeory Card

**Figure 12 –
Sandisk SD card**

SanDisk Ultra UHS-I, Class 10, SDXC Card, up to
80MB/s Read Speed, 64GB

£12.24

Free standard delivery over £50
[View delivery options](#)

★★★★★ (2 reviews)

[View product description](#)

Power Supply (Rechargeable Battery)

On the below table is the power requirements for the data logging system;

Sensor	Max Current mA
Wind Direction & Speed	50mA
Humidity & Temperature	1mA
Light Sensor	6mA
Wave Height Sensor	50mA
GPS	45mA
LED	20mA

Total mA Current	172 mA
------------------	--------

From the above table the total maximum current is calculated at 172mA, from this we can work out the battery requirement as follows;

- Capacity (Amp Hour) = Total Current (Amps) x Time (Hours)
- Capacity = 0.172 (Amps) x 24 (Hours) = 4.12mAh
- Capacity = 4.12mAh x 7 Days = 28Ah

Li30-12, 12v 30Ah Lithium Iron Phosphate, LiFePO4 High Capacity Deep Cycle Battery, Charger Included. L(Mm) W(Mm) H(Mm) 175 166 125

HOME / LITHIUM PHOSPHATE LIFEPO4 / LI30-12, 12V 30AH LITHIUM IRON...



Li30-12, 12v 30Ah Lithium Iron Phosphate, LiFePO4 High Capacity Deep Cycle Battery, Charger Included. L(mm) W(mm) H(mm) 175 166 125

< >

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SKU: SLAUMXLI30-12

Li30-12, 12v 30Ah Lithium Iron Phosphate, LiFePO4 Battery for Mobility Scooter, Electric Vehicles, Golf Trolley, Wheelchairs, Lawn mowers, Lights, Toy cars, Sprayers, Photovoltaics, Robots, Communications, Electric tools, Pumps, Measuring instruments, AGV (Automatic guided vehicle), Magnetic lifts. A high end replacement for heavy users of Sealed lead acid batteries. Dimensions: L(mm) W(mm) H(mm) 175 166 125

Product Code : SLAUMXLI30-12

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~~£297.72~~ **£267.95**

Brand See other products by Ultra Max

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Figure 17 Li30 Battery

<https://www.batterymasters.co.uk/lithium-phosphate-batteries/li30-12-12v-30ah-lithium-iron-phosphate-lifepo4-high-capacity-deep-cycle-battery-charger-included-l-mm-w-mm-h-mm-175-166-125.html>

Below image and information dictating the chosen LED for the operational LED indicator.

Figure 18 LED Specification & Cost

Page 25 of 36

Connector Selection

Connector	SD 16, 5pin	Hi-rose connector	XLR Connectors	CDI connectors
Image				
Cost	£3.49	£10.40	£18.56	£2.34
Durability	Very Good	Very Good	Good	Poor
Product Range (pins/sizes etc)	High Product Range Available in good variety of pin configure ranges	High product range available in good variety.	High product range available in good variety	Limited range
Positives	High IP rating and good pin selection, Economical cost	Good build quality and durable	Product range	Cheap
Negatives	None	Low IP rating higher cost	High cost value	Poor build quality, limited on connector sizes

For the connector selection I have gone with the SD range of connectors they were second cheapest on my review table and overall best quality and value for money.

Below figure shows the available product range and different pin connectors, this is extremely important where we may have different voltages or currents operating using different connects will emitting the errors in wrong connects and potentially damaging equipment.

Figure 14 – Multi Pin Connector

</

Figure 19 Connector Pin Data Sheet

PCB / Battery & other associated equipment Housing



HYLEC IP65 ABS ENCLOSURE 300 X 220 X 400MM (6608G)

★★★★★ [View reviews \(3\)](#) [View all Q&A](#)

Lockable, IP65 rated, blank door enclosure produced from UL approved ABS-HB (UV) plastic. Supplied complete with galvanised steel back plate and mounting brackets.

- IP65 Rated
- Flame Retardant to UL94V-HB
- Temperature Range -20°C to +85°C
- Lockable with Steel Back Plate
- Suitable for Sea Salt Air Conditions
- Suitable for Dry Dust Environments
- Suitable for Sea Salt Air Conditions
- Suitable for Dry Dust Environments

[More Info](#)

View all: [Hylec 3 Phase & Industrial Controls](#)

£56.85
INC VAT

QTY

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 **Click & Collect**

[Check stock in your local store](#)

Add to saved list...

Save

Figure 20 Enclosure Cost

SPECIFICATION	
Brand	Hylec
Colour	Grey RAL 7035
External Depth	300 mm
External Height	430 mm
External Width	220 mm
Fixings Supplied	Brackets & Fixings Supplied
IK Rating	IK10
Internal Depth	220 mm
Internal Height	400 mm
Internal Width	300 mm
IP Rating	IP65
Manufacturer Guarantee	1 Year Guarantee
Model No	DED005/S
Pack Size	1
Parent Colour	Grey
Pieces in Pack/Case	1
Product Depth	220 mm
Product Height	400 mm
Product Type	Enclosure
Product Width	300 mm
Total Product Weight	3.04 kg

Figure 21 Enclosure Data Sheet

Part Description	Cost £	Quantity	Total
IP rated Enclosure	£56.85	1 (Hylec IP65 ABS Enclosure)	£56.85
Humidity & Temperature Sensor	£15.00	1 (CC2D25-5P)	£15.00
Wind Speed & Direction Sensor	£565.95	1 (Wind Sonic 1)	£565.95
GPS Sensor	£178.56	1 (GPS16X-HVS)	£178.56
Wave Height Sensor	£2,156.36	1 (Vented Pressure 4428)	£2,156.36
Battery	£267.95	1 (Li30 Lithium Battery)	£11.85
5core Flex (0.5mm2)	£0.34 per Mtr	50Mtrs	£17.00
Sun Light Sensor	£991.00	1 (GMX101 Sensor)	£991.00
Multipin Connectors	£8.56	6 (SD20/Q4 Con)	£51.36
LED'S	£1.72	2 (MCL053HGD)	£3.44
PIC	£2.06	1 (PIC18F25K50)	£2.06
Floating Buoy	£1,850.00	1 (Dawson/oem)	£1,850.00
PCB	£67.55	1	£67.55
SD Card	£12.00	1 (San-disc 72Mb)	£12.00
USB cable	£14.99	1	£14.99

Table of Cost

Total initial cost for our prototype built.....£5,993.97 Ex VAT

Proteus Design

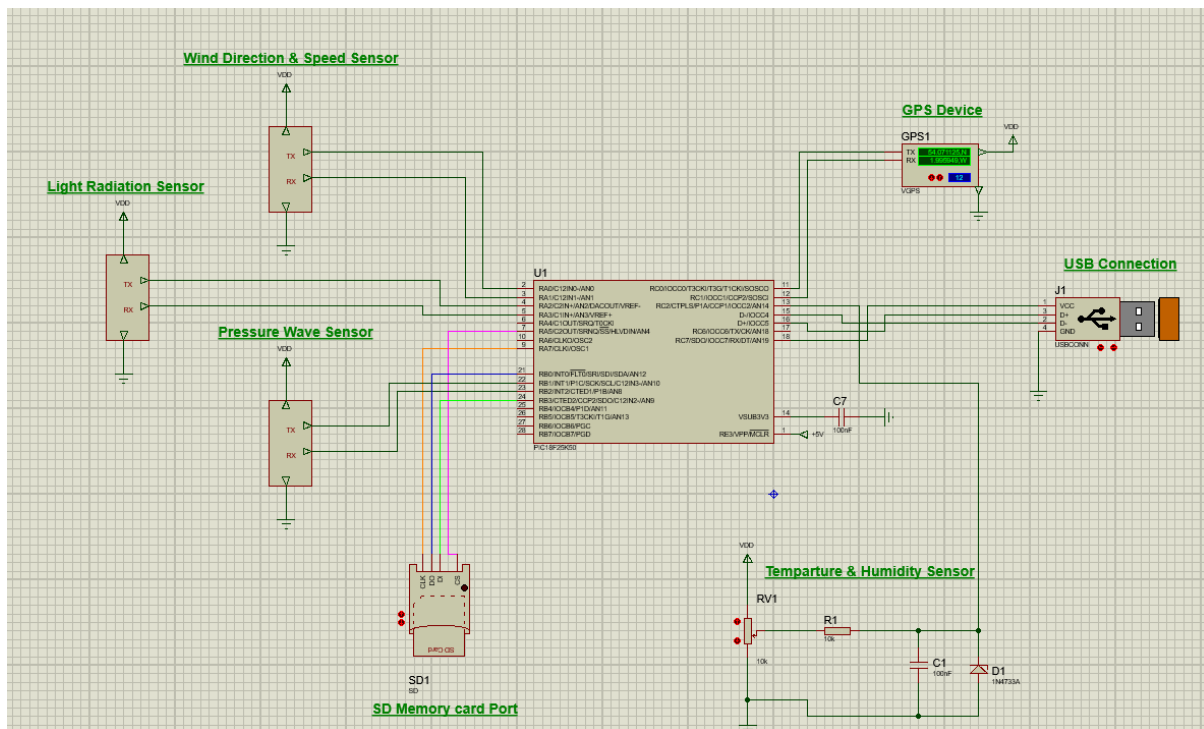


Figure 22- Proteus Design 1

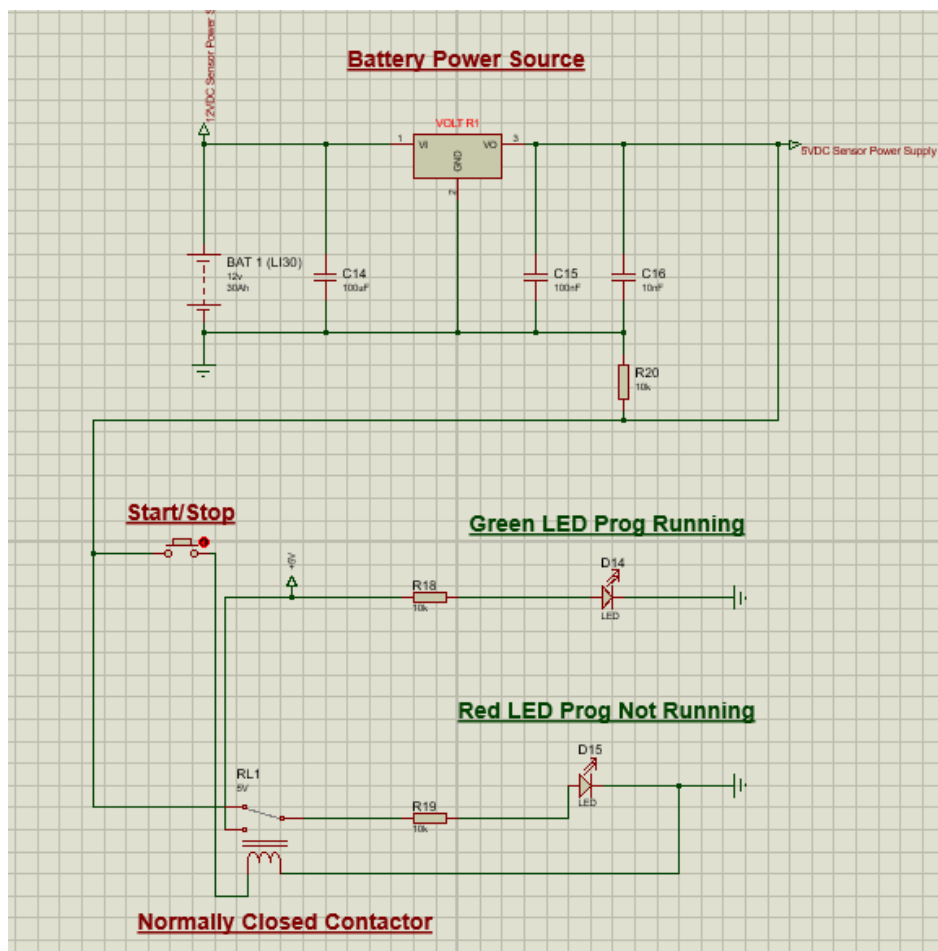


Figure 23 - Proteus Battery Configuration

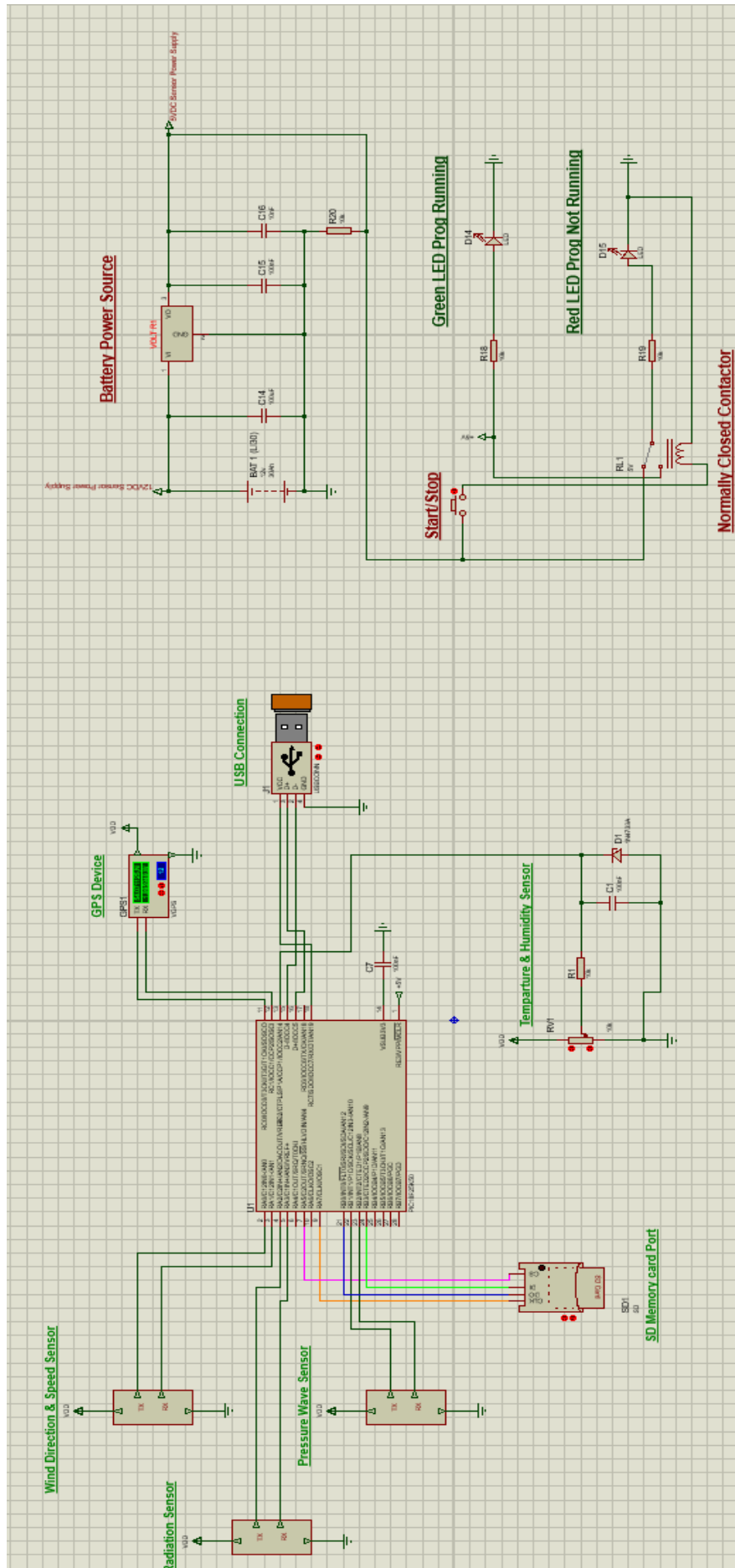


Figure 24 - Proteus whole design

Easy PC Schematic

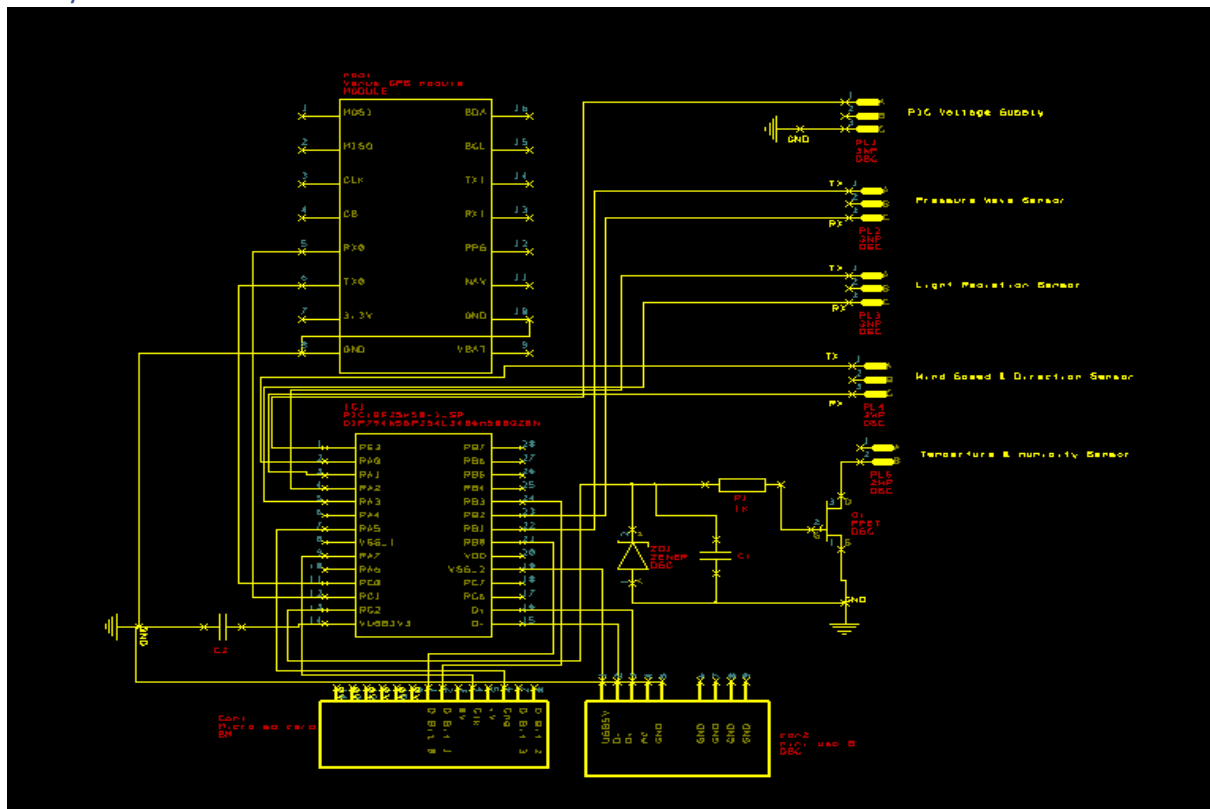


Figure 25- Easy PC Schematic with Lines

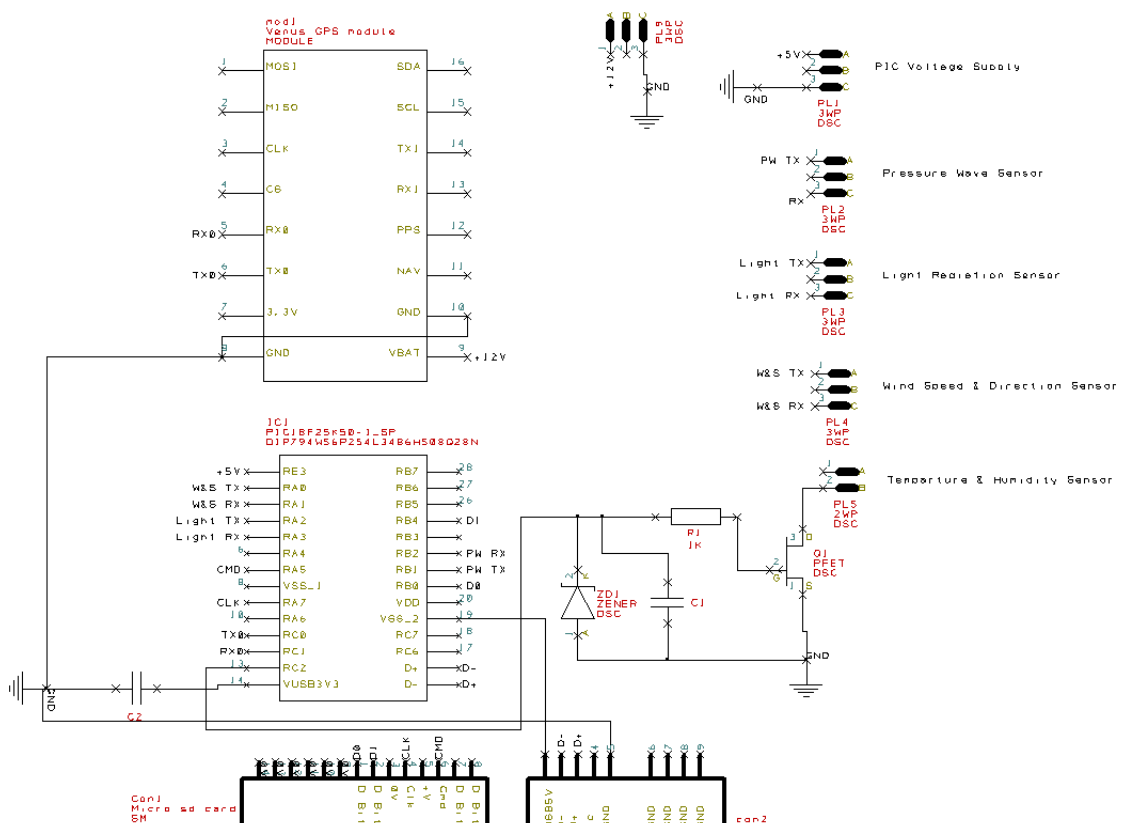


Figure 26 - Easy PC schematic

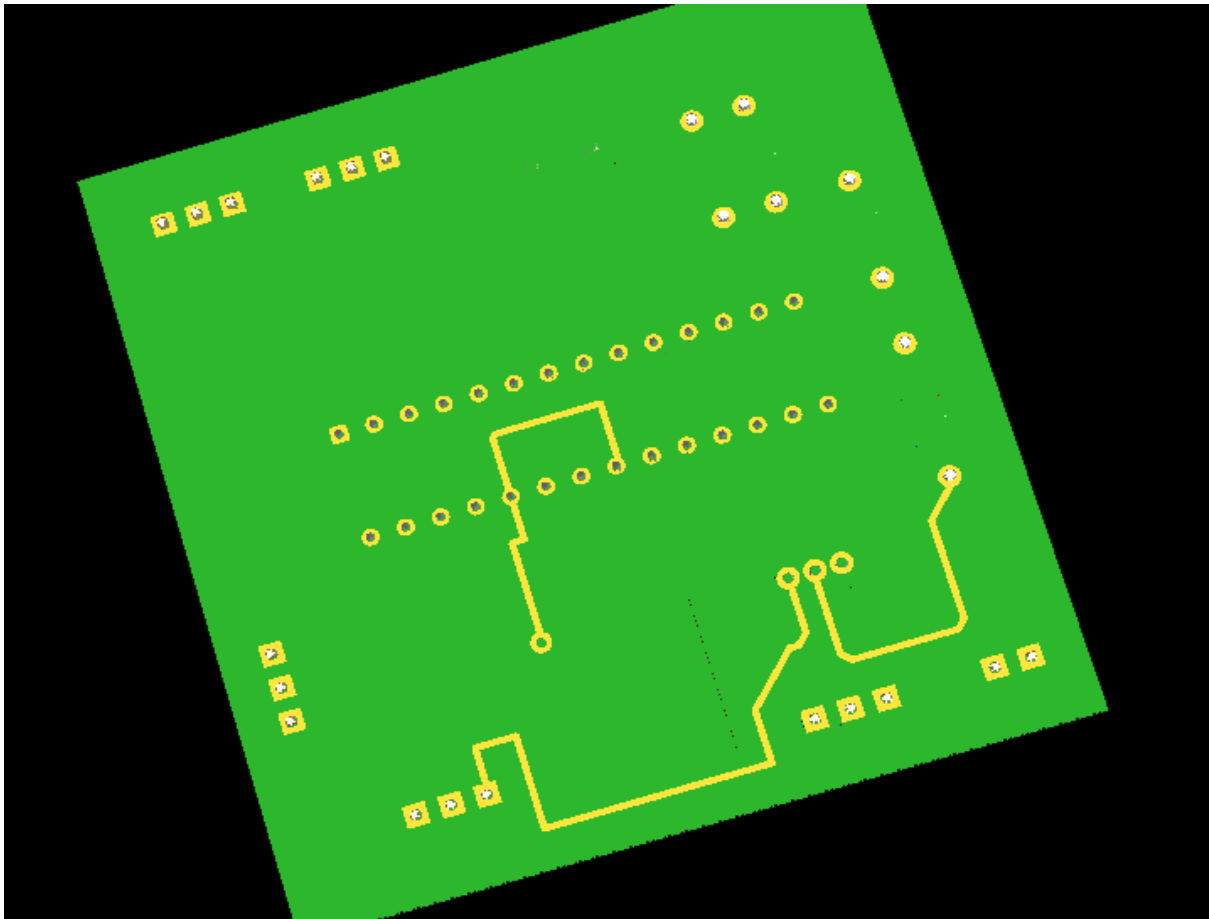


Figure 30 - Easy PC PCB 3D Back View

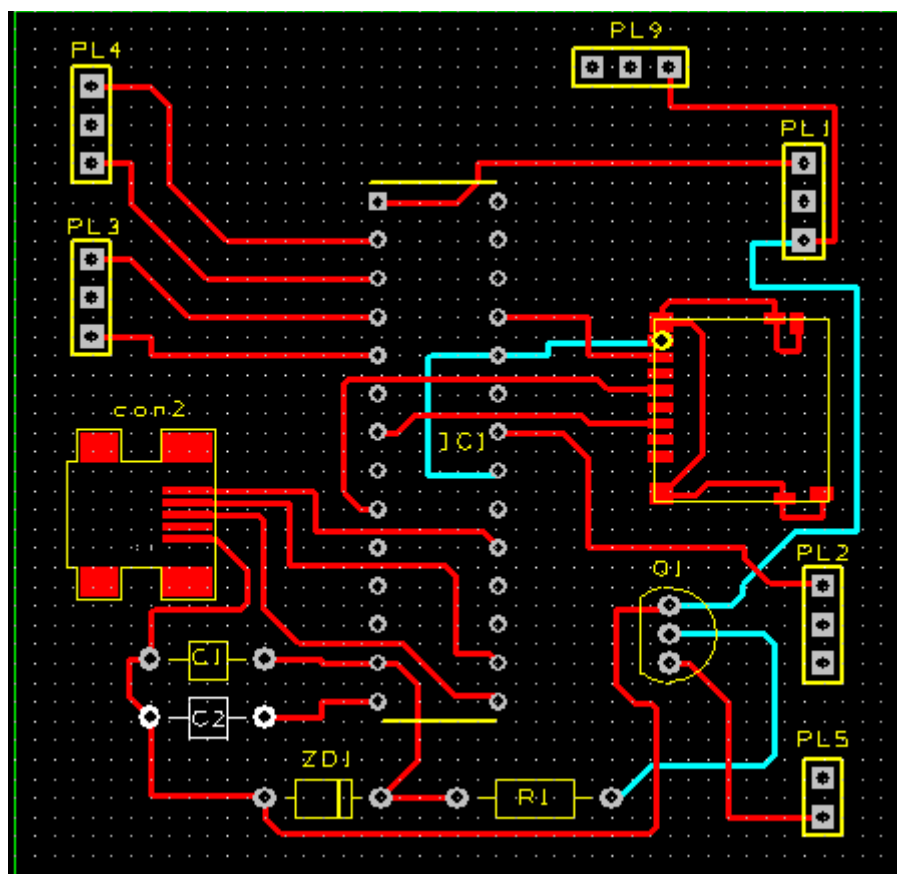


Figure 29 - Easy PC PCB Configured Lines

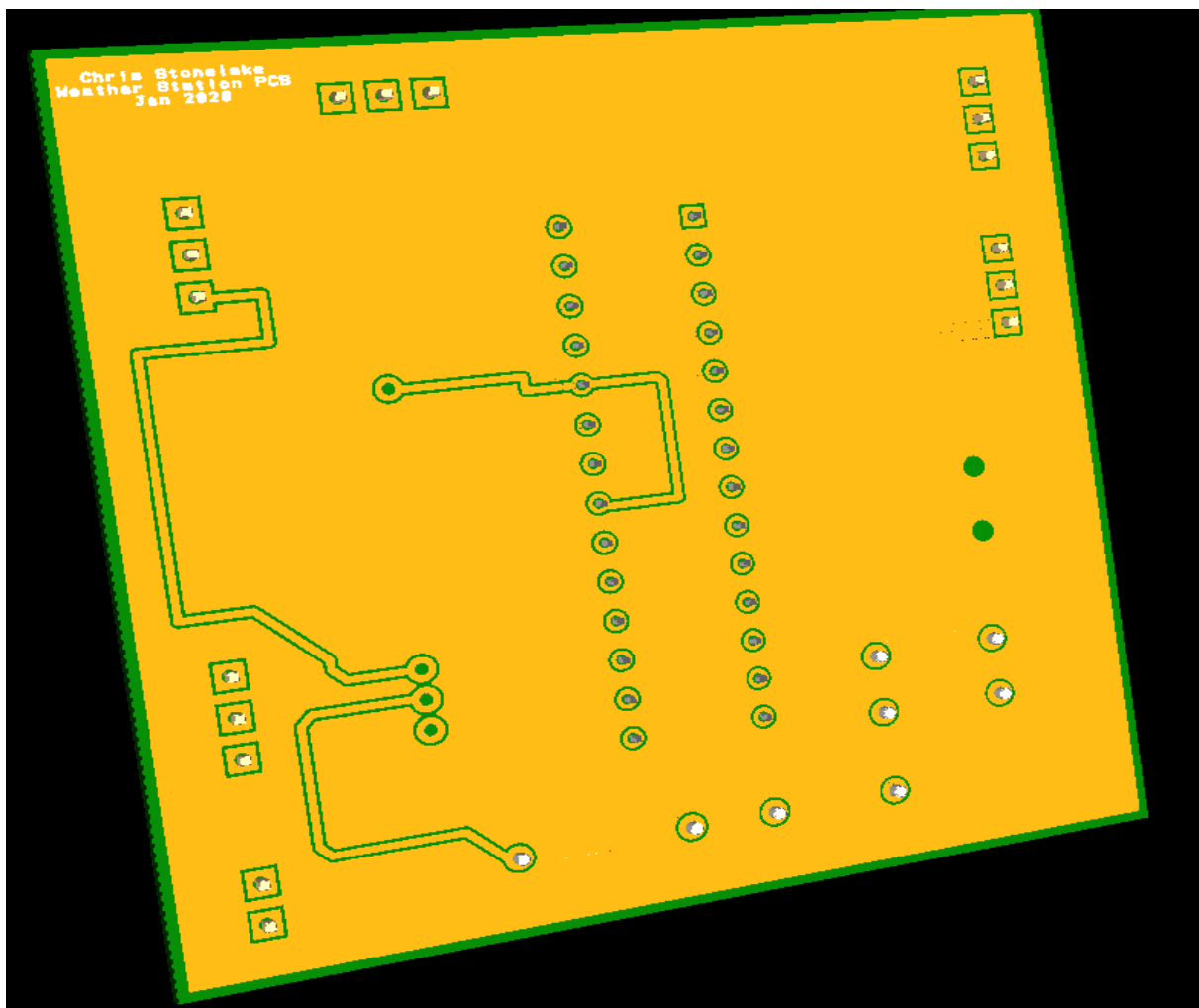


Figure 31 - Easy PC PCB 3D Copper Pour

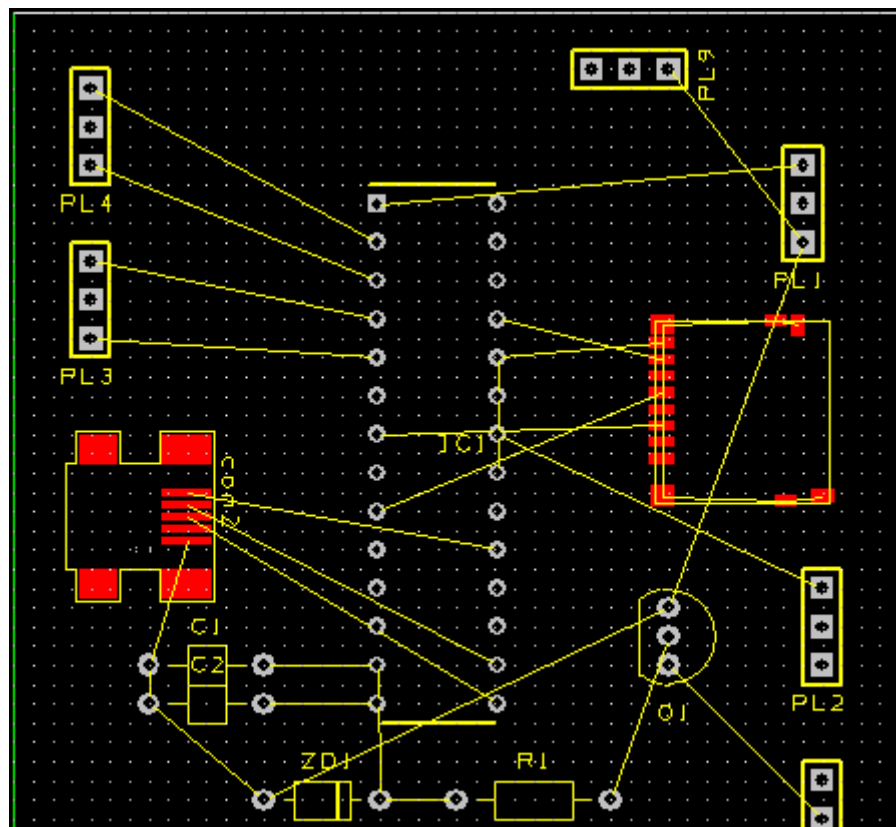


Figure 32- Easy PCB Component Position

Conclusion

This review into the above marine dock / marina weather station, is to establish the potential upgrades in later development of the above designed system.

As the above system has stated the mounting and system provided is a self-floating marine bouye, the next system application would need to be suitable to freely mount onto a moving vessel, for this the housing would need to be more of a portable IP rated wheeled case, certain instruments can be then installed on the case directly and others have strong magnet or electromagnets to mount to the ship surface or clamping arrangements depending on available steel surfaces.

One of the largest changes would be the wave monitoring system as the current pressure sensor for wave monitoring fitted to the bouye is designed more for a stationary station, so would not be suitable for a moving vessel, the upgrade choice would be to use radar, which is not effected by wind, water or other environmental factors these can be mounted over board of a vessel with minimal engineering and produce very accurate readings.

Introduction of a LED display screen to the case would be a great advantage when setting up the monitoring station when in the field, this will give the technician visual conformation when each instrument is installed and powered up that there is a positive signal coming back and the reading in which those signals represent i.e (wind speed MPH), this would not an interactive display purely a visual aid and minimum IP 66.

The final improvement wold be to introduce comms communication via ship either net or an independent satellite communication system, the advantages of this is that the real time data can be viewed at a remote location, and the stored data can be downloaded at intervals of no greater than 24hrs, this maybe be significantly advantageous due to vessels length of time at sea.

There are some minor improvements along with some major improvements which if developed correctly will make the monitoring station a market contender in line with other market proven systems already available

Referencing

- [1] <https://www.coleparmer.co.uk/i/davis-instruments-6322-wireless-integrated-sensor-suite>
- [2] <https://www.delta-t.co.uk/product/ws-gp1/#overview>
- [3] <https://www.weathershop.co.uk/shop/6-in-1-bresser-colour-wifi-weather-station>