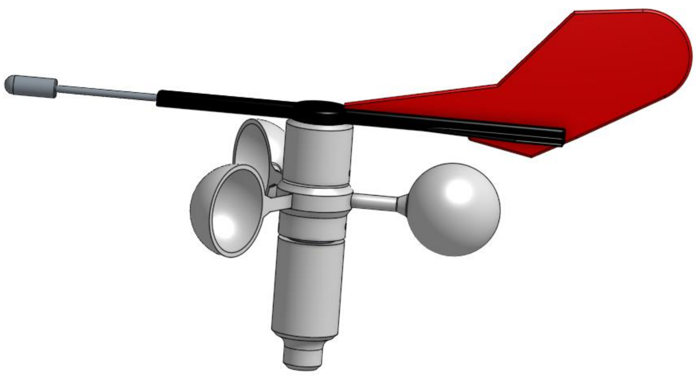
a

Assembly Instructions

Windsensor WiFi 1000



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Inhalt

1 Windsensor WiFi 1000

1.1 Preparation

The wind sensor WiFi 1000 consists of 45 individual parts which must be assembled. Before starting to assemble, all parts should be checked for completeness and the necessary tools and accessories should be available. It makes sense to use a suitable workplace where small individual parts such as grub screws cannot roll down. Alternatively, a white cotton cloth or a towel can be used. Small bowls for storing the respective parts are also very helpful.

Many parts are glued to the wind sensor. There are two reasons for this. One reason is that the 3D plastic parts cannot be printed in arbitrarily complex structures and can be dismantled into individual parts suitable for production and then subsequently assembled. On the other hand, to achieve a sufficient water tightness of the electronics. For this reason, all plastic parts are also painted, as the layered 3D printed parts made of PLA are not waterproof. After curing, the adhesive used should have a certain residual elasticity to compensate for the different coefficients of expansion of the materials used. In particular, the contact between metal and plastic are critical, as heavy stress can occur between the components at high temperature differences. The recommended 2-component glue Weikon RK-1300 is particularly easy to process. The activator previously applied to the plastic parts can be used for several days. Curing only begins when the actual glue gets in contact with the activator. This allows the bonding to be well prepared and only in the last step the parts finally are bonded. Of course, any other elastic glue can also be used.

Basically, you should ensure that the individual parts function well before gluing. A later disassembly is usually not possible without damaging the parts.

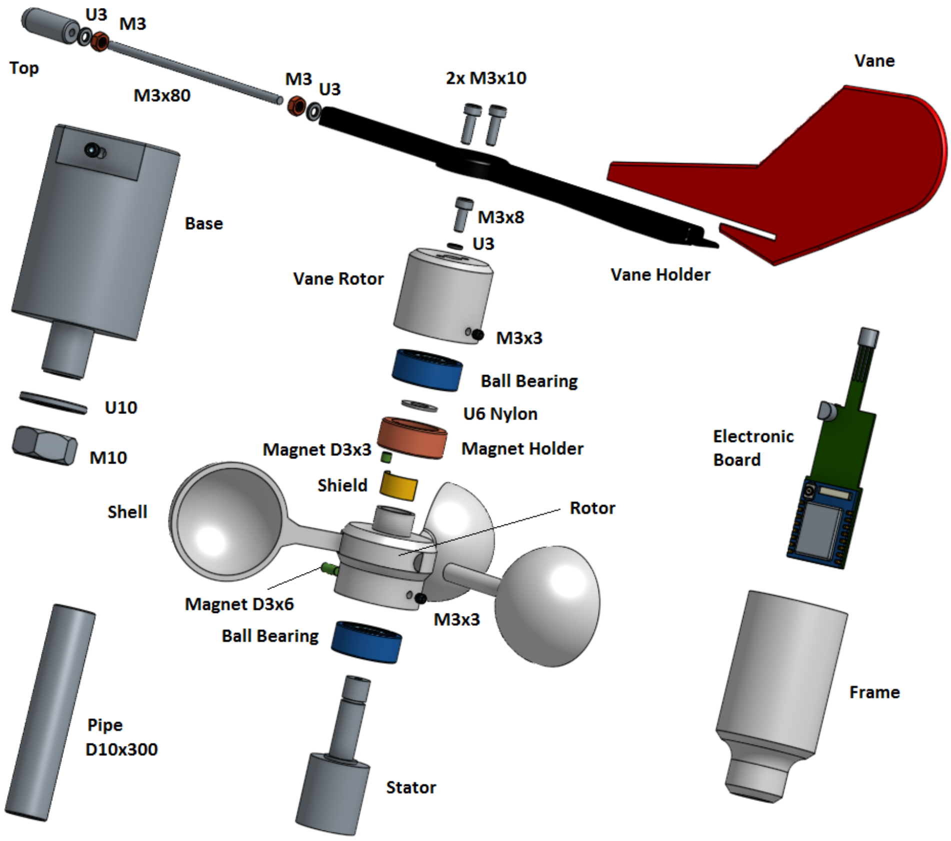
When setting the correct switching threshold for the wind direction sensor, a little more effort is necessary to find the correct setting point. The firmware can be used for this purpose. In difficult cases, it is helpful if one or two digital voltmeters are available to check the switching status of the Hall sensors during operation. Alternatively, test leads can be soldered to the circuit board, which greatly simplify handling. To support testing the open and non-installed electronics with parts of the mechanics, a mechanical substructure is required which holds the wind sensor securely in a vertical position during operation. A third hand or screw clamp can be very helpful. To simulate wind, a hairdryer set to cold can be used.

The white plastic parts are very sensitive to dirt. Especially glue residues should be removed immediately. Always work with clean hands. Not hardened Weikon glue residues can easily be removed with alcohol.

The time required for the pure assembly of the wind sensor is approximately 4 to 6 hours working time, depending on the respective abilities. The curing time of the glue of 24 hours is not included.

1.2 Check Completeness of Parts

First all parts should be checked for completeness. You can tick off the respective items in the parts list.



1.3 Checking the Accuracy of fit of the Parts

The next step is to check whether all parts can be joined as desired according to the design drawing. The threads in the plastic parts are already pre-cut. Especially the connections stator frame and frame tube should be able to be pushed together tightly to the intended end and have little play. If they are too tight, the plastic parts can be processed with a scalpel with a round blade or sandpaper. Basically, you should only rework the plastic parts, because they can be processed with less effort.

1.4 Cleaning the Ball Bearings for smooth running

As ball bearings, encapsulated industrial bearings of quality class ABEC7 are used. They are very accurate and have little clearance. A lower grade should not be used, nor should higher grades. Although they have a lower clearance, they are more difficult to move. ABEC7 is a good compromise between smooth running and low clearance. As standard, the ball bearings are lubricated with heavy rolling grease. Smooth running is only possible after cleaning. For this purpose, the ball bearings are submerged in cleaning alcohol and moved until the rolling grease has dissolved. The ball bearings should not lie overnight in cleaning alcohol, as additives in cleaning alcohol stimulate rusting of the stainless-steel parts. After the ball bearings have been freed from rolling grease and methylated spirits, they should be dried with kitchen paper. The final smooth running is not achieved until later in operation, when the rotor has rotated over a longer period. The ball bearings are well prepared if they run smoothly all around and do not rub against other ball bearing parts at any point. Some ball bearings are offered on the Internet that do not meet the specification. The ball bearing seal has a small air gap to the inner rotor and must not rub against the inner rotor. Otherwise the ball bearing is unusable and does not comply with the ABEC7 standard. Alternatively, open ball bearings can also be used.

1.5 Preparing the Wind Vane for Painting

For painting the vane is pushed into the groove on the vane holder and the vane holder is attached to the vane rotor with 2 M3x10 socket cap (Allen) screws. The vane rotor with wind vane is then fixed on a rod.

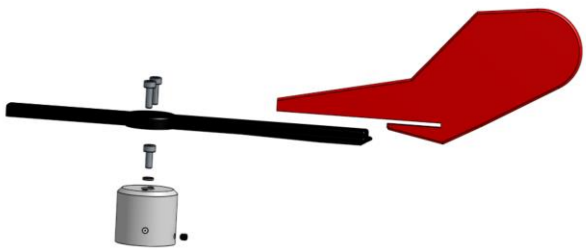


Fig.: Wind vane

1.6 Preparing the Shell Wheel for Painting

To paint the shell wheel, the shell bar ends are pushed into the rotor until they align with the inside. Alternatively, you can insert the ball bearing and then push the rod ends into the mounting holes until they touch the ball bearing. The rod ends do not have to be glued in yet. This can be done later. Then the shell wheel is fixed on a wooden rod for painting.

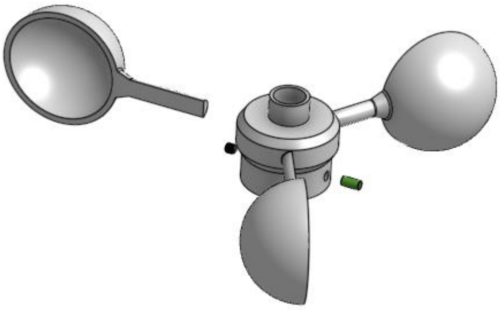


Fig.: Shell wheel

1.7 Preparing the Frame for Painting

The frame is fixed to a wooden rod from the large opening.

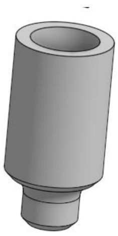


Fig.: Frame

Fig.: Prepared frame for painting

1.8 Painting

PLA is a plastic which cannot be painted directly due to its surface properties. A special pre-treatment of the substrate is required. However, there are special paints which can be applied directly to PLA without priming or pre-treatment. The recommended transparent paint "Aerosol Art" from Dupli-Color (matt or glossy) is a polymer paint with acetone and n-butyl acetate in a 400ml spray can. It can be applied directly to PLA in several coats without drying time.

Painting can be done in two ways. Either by painting with a brush or with a spray can. In principle, 3 layers of paint should be applied. Apply a correspondingly thinner layer to the fits. The layer structure should be thin and have no running drops. Running drops should be removed when damp.

If possible, spray painting should take place outdoors, as more paint is sprayed than is applied to the component. A cardboard should be placed in the background to take up excess paint. According to paint manufacturer recommendations, a minimum distance of 30cm should be observed when painting the component. Otherwise you apply too much varnish and running drops will appear. The parts are continuously turned or moved slowly during spraying so that all surfaces can be reached. Painting the inside of the bowl is a bit more difficult, because you can't see how much paint is applied. Here one should be more reserved, since one tends to apply too much. The correct layer thickness is reached when the wet paint starts to shine.

The varnish is hand dry after a short time and dry after 24 hours.

By using a filler before painting, the uneven surface of the 3D components can be significantly improved. The components will look much better. Before varnishing the actual parts, you should practice on test parts until the desired varnishing result is achieved.

1.9 Bending the Shield

The shield consists of a small piece of tin plate 20 x 7 mm to shield the magnetic field. The thickness of the tinplate is insignificant and can range between 0.15...0.3 mm. The bending of the tinplate is carried out around an M8 screw with a long smooth shaft and is rolled out on a wooden base. This ensures a good position and optimum alignment of the sheet. Then pull the metal sheet off the screw and repeat the same procedure with an M10 screw. Then the shield is perfectly bent. It is still a bit too small. At the plastic part, you may slightly bend up the panel. So, the screen fits absolutely perfect without gap to the plastic part. Fix the screen with a piece of transparent adhesive tape so that the function test can be carried out. The aperture should be glued just after sucessfully passing the function test

Fig.: Shield

1.10 Assembling the Wind Vane

First the bottom side of the vane holder is covered with the reflective foil. Cut the width and length of the foil so it corresponds to the maximum dimensions of the vane arm. The protective film must be removed from the reflective film cut in this way. It is helpful to hold the end of the foil with tweezers or a cutter knife. The film must now be aligned so that the complete bottom of the vane arm is covered. Starting from the end, the foil is applied step by step by pressing lightly with the finger to the tip of the vane arm. Enclosed air bubbles can be pushed out sideways. It is not possible to remove the film later, as the film will be destroyed. The film must therefore be applied cleanly in the first attempt.

In the second step, the remaining film is removed with a sharp cutter knife. For this purpose, the vane holder with the foil side is placed on a firm base and the protruding foil is cut along the edge with the cutter knife. A thicker cardboard or a wooden board can be used as an ideal base.

Fig.: Vane holder bottom view (red reflective foil)

Then vane and the vane arm are glued together. For this purpose, the small groove and the lower part of the vane are coated with activator. A thin glue seam can then be placed in the groove and the vane pushed into the vane arm. Remove excess glue with a cloth moistened with cleaning alcohol.

The ball bearing is glued into the rotor in the same way. Make sure that only the edge of the ball bearing and the inner part of the rotor are coated with activator and glue. Under no circumstances should glue get into the inside of the ball bearing.

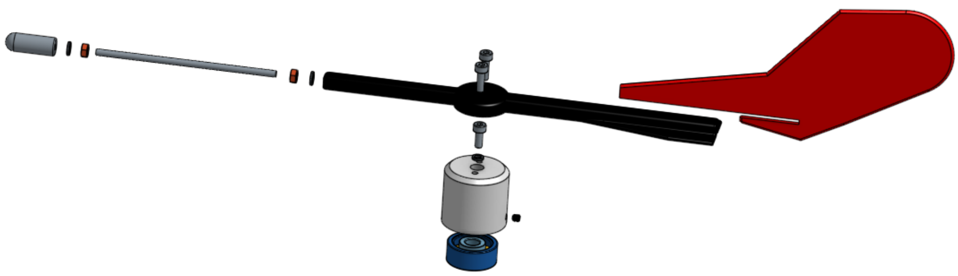


Fig.: Wind vane parts

After the glue has hardened, the wind vane can be screwed onto the vane rotor using the two M3x10 socket cap (Allen) screws.

The next step is to glue the silver reflective foil onto the tip. The foil is cut to size XX x XX mm and attached to the tip. The tip is then mounted on to the threaded rod and secured with a snap ring and a nut. At the opposite end, first a nut and then a locking washer are fitted and then the threaded rod is screwed into the vane holder as far as it will go.

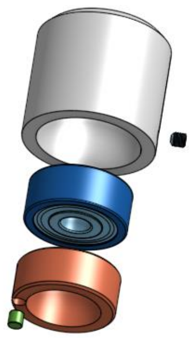


Fig.: Wind vane magnet

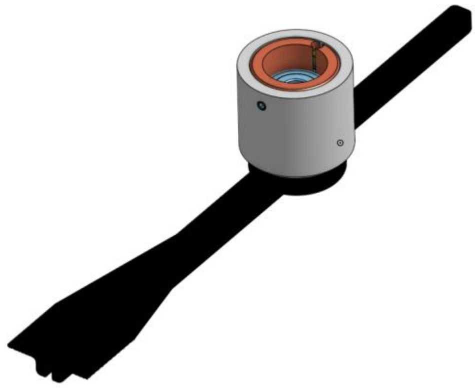


Fig.: Inserted magnetic holder with magnet

At the end the magnet is pushed into the magnet holder and the magnet holder is then inserted into the vane rotor. The magnet holder then rests on the edge of the ball bearing and aligns to with the bottom side of the vane holder. The magnet must be aligned on the opposite side of the grub screw so that it lies on the center line of the wind vane holder. The grub screw can be used to apply tension to the magnet holder so that the magnet is clamped in the slot.

1.11 Balancing the Wind Vane

Balancing is extremely important to get a smooth-running wind vane that aligns well in the wind. If the vane is not well balanced, bearing friction and premature wear will occur.

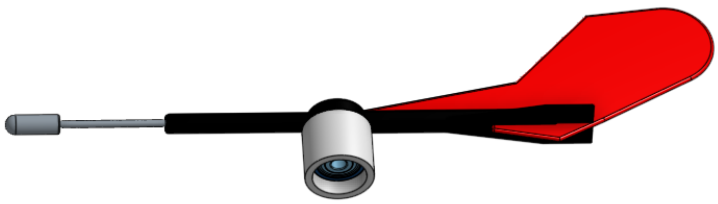


Fig.: Balancing the wind vane

To balance the vane, the vane rotor is pushed onto the stator and brought into a horizontal position. The result is a rocker which must be balanced with the help of the tip. If the tip lowers, the tip must be brought closer to the pivot point. If the tip rises, proceed in the opposite direction. The arm should be balanced as precisely as possible. Once you have found this position, tighten the lock nuts and check the balance again.

Kommentar [MS1]:

Kommentar [MS2R1]: rocker passt irgendwie nicht, aber mir fällt nix Passendes ein!

1.12 Assembling the Cup Anemometer

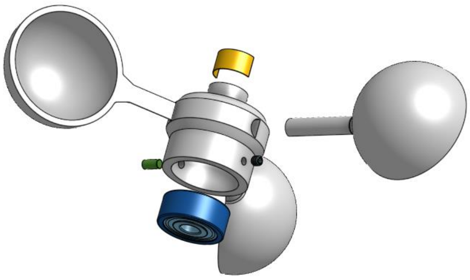


Fig.: Cup Anemometer

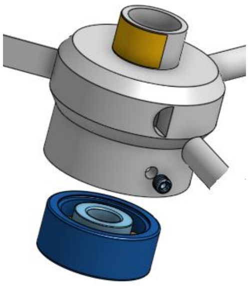


Fig.: Correct position of shield

To assemble the cup wheel, the ball bearing is glued in first, thereafter the cup rods. The activator is first applied to the outer ring of the ball bearing and the corresponding counter surface in the rotor. The glue is then applied to the rotor and evenly distributed with a Q-tip. Then both parts are joined together and excess glue is removed with a Q-tip. The ends of the cup rods can then be glued in the same way. Insert the ends of the rods as far as they will go so that they touch the ball bearing. The whole unit then requires 24 hours to cure the glue. The cover is still just fixed with adhesive tape and will be glued after the final test.

1.13 Wiring the Electronics

For wiring the electronics, the two cable ends of the CAT5e cable are stripped 50 mm and the individual wires are tinned to approx. 5 mm at the end. The 6 cable ends are then soldered from the underside of the circuit board according to the wiring diagram. Make sure not to introduce short circuits to the board connectors. If necessary, remove excess solder with the desoldering wire. Finally, remove the welding flux from the solder joints using a Q-tip soaked in alcohol. If the programming cables (cables 2, 3, 4, 5) are not required on the opposite connection side of the cable, they can be cut off with an electronic side cutter. Make sure that there are no short circuits between the cut cable ends. The cables can be cut off slightly offset. The red and black cables (cables 1 and 6) are the power supply connections for the wind sensor.

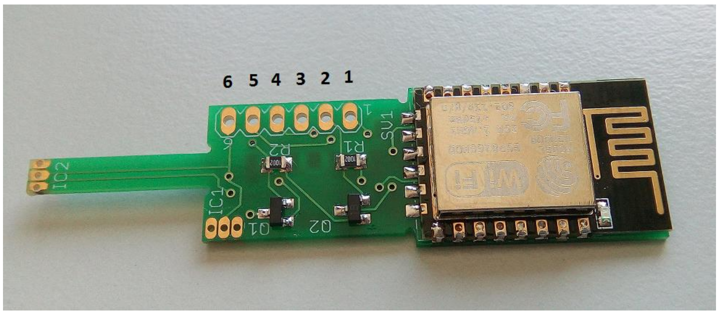


Fig.: Circuit board with solder connections

Pad	Wire Color	Short Name	Meaning
1	red	+5V	Power supply 5V
2	blue	DTR	Programming
3	yellow	RTS	Programming
4	withe	RXD	Receive data
5	broun	TXD	Send data
6	black	GND	Ground

Tab.: Terminal assignment of the cables

1.14 Setting the Output Voltage of the DC/DC Converters

To adjust the two DC/DC converters, a voltage of ~12V is applied on the input side (In-, In+). The required output voltage is then set with a small screwdriver at the adjusting screw of the blue adjusting potentiometer according to the following table values. The output voltage is measured with a digital voltmeter at Out+ and Out-. Make sure that the input voltage is not connected with the wrong polarity. In+ means 12V and In- is GND. Otherwise the DC/DC converter can be destroyed. If the polarity is correct, the small SMD LED on the board lights up.

Abb.: DC/DC Converter

A test circuit with a 9V block battery to set the output voltage is shown below.

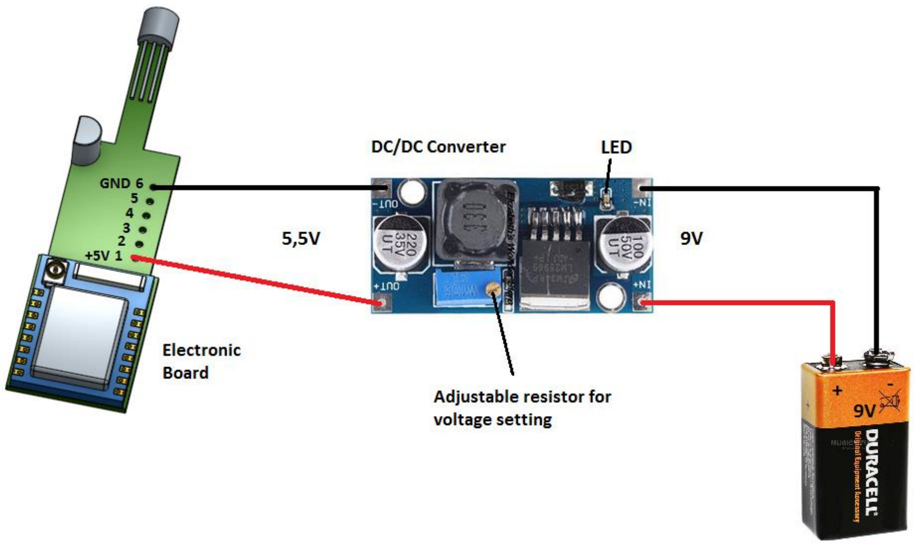


Fig.: Test circuit

Using	Input voltage [V]	Output voltage [V]
Power supply of wind sensor	12	5,5 +/-0,1
Feeding into the top light line	12	7 +/-0,1

Tab.: DC/DC Converter output voltages

1.15 Testing the Electronics and Connecting to Application Software

To test the function of the electronics, connect the red (+5V) and black (GND) cables to the output of the 5.5V DC/DC converter (Out+, Out-). The input of the DC/DC converter (In+, In-) is connected to the 12V source. A DC plug-in power supply for 12V, a car battery or an adjustable laboratory power supply can be used as source. After the voltage has been switched on, the LED of the DC/DC converter lights up. At the same time the blue LED of the wind sensor board lights up. It remains lit until the wind sensor has successfully logged into a WLAN network. By default, fixed values for the WLAN parameters are specified on delivery.

Designation	Default values on delivery
Connection type	Client
WLAN	11 bgn
SSID	MyBoat
Password	S6587rr94P
Port	6666 TCP

Tab.: Default values on delivery

For testing purposes, an Internet router or mobile phone with hotspot function can be set to the WLAN parameters. If the parameters have been set correctly, the wind sensor should log into the WLAN and the blue LED on the wind sensor circuit board turns off. In the connection status overview of the router or mobile phone, the wind sensor should now be visible as a registered device.

OpenPlotter V0.8.0 can be set to the WLAN connection parameters in preparation for the final check under Chapter 1.21. In the configuration program OpenPlotter the settings can be made. To activate the WiFi access point, the checkbox [Enable access point] must be checked.

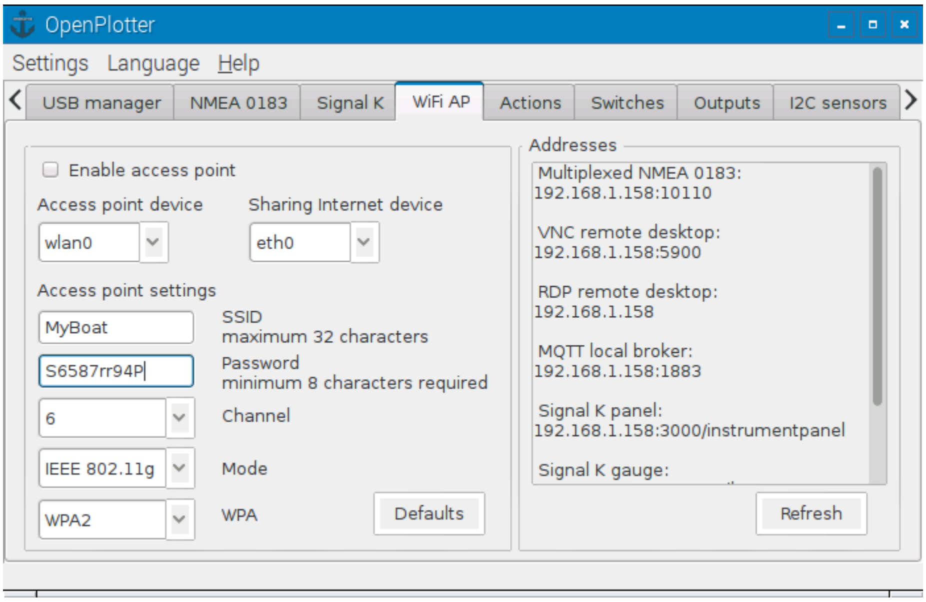


Fig.: OpenPlotter WiFi Network configuration

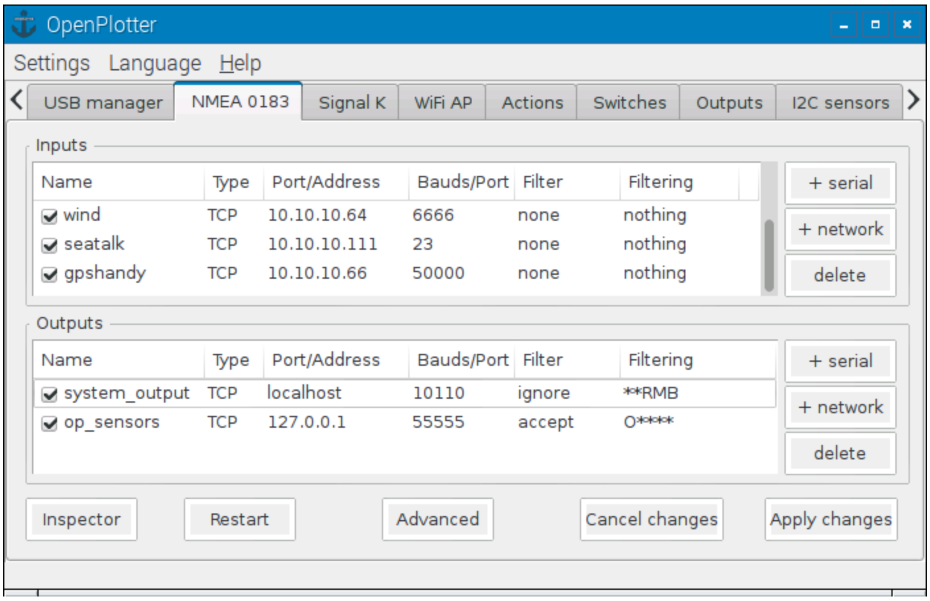


Fig.: Sensor configuration on OpenPlotter

The tab [NMEA0183] can be used to add new sensors in the Inputs area, so-called Devices, by selecting [+network]. The IP address of the wind sensor must be determined first. As a precondition, the wind sensor must already be registered within WLAN MyBoat of OpenPlotter and the blue LED of the board must be off. A Linux terminal window can be opened under [Menu] -> [Accessories] -> [Terminal]. The command arp -a is entered in the command line. The line containing ESP_XXXXXX displays the corresponding IP address. In our case this is IP 10.10.10.143.

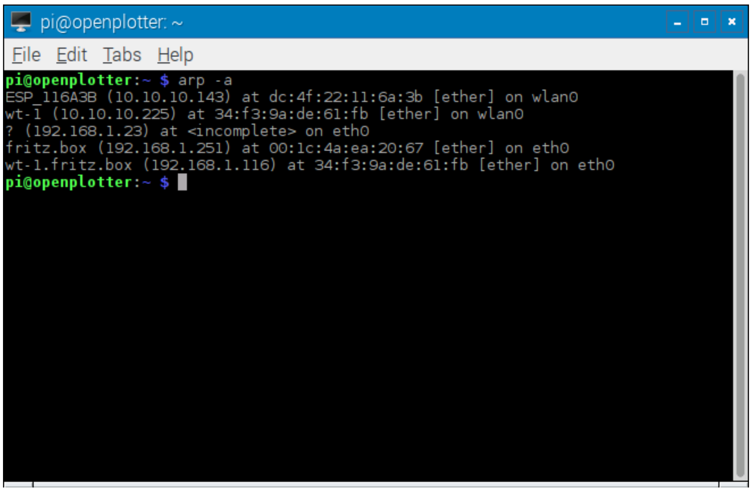


Fig.: Terminal window with IP address output

The wind sensor can now be added via [+network]. Confirm input with [OK].

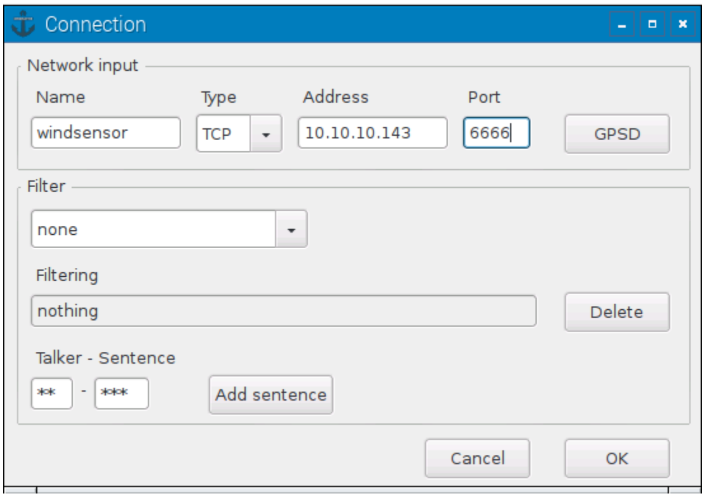


Abb.: Configuration page to set wind sensor IP adress

To accept the settings, press the [Apply Changes] button at the end of the entries in the [NMEA0183] window. Otherwise the settings will not be accepted and will be lost.

To be able to publish the wind sensor data via OpenPlotter, the NMEA0183 server must be restarted via the [Restart] button. A successful connection is visible in the Diagnostic Monitor Inspector. Data packets from the wind sensor should then arrive every 2 seconds and be displayed as values for wind speed and wind direction.

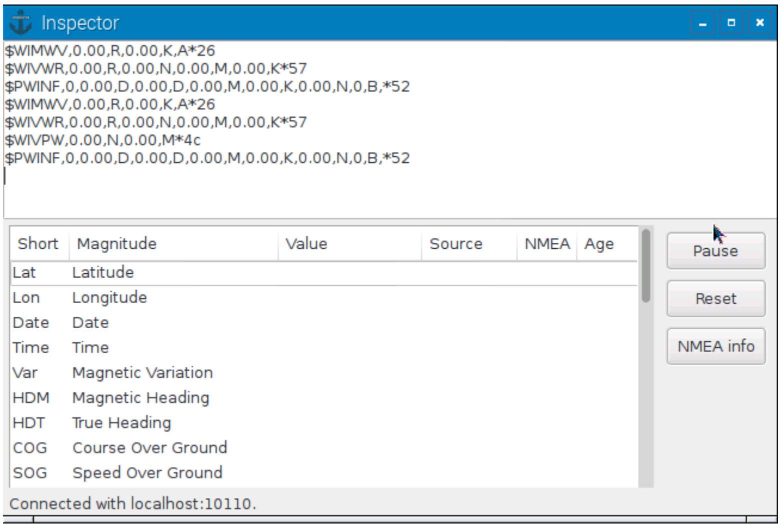


Fig.: NMEA inspector

Under certain circumstances, other telegrams may also arrive which are transmitted by other sensors. Each time a telegram is sent from the wind sensor, the blue LED of the electronic board lights up briefly as confirmation. Now, however, the values are still zero, as the hall sensors do not yet receive any signals from the magnets. If the LED is permanently lit, the wind sensor could not log into the WLAN network. If the LED is permanently off, a connection to the WLAN network has been established. However, OpenPlotter does not request any data from the wind sensor.

To display the NMEA data from the wind sensor, the OpenPlotter instrument panel can be accessed using an Internet browser. The following address must be called up for this purpose:

http://10.10.10.1:3000

Then the instrument panel can be started and the display elements can be arranged freely.

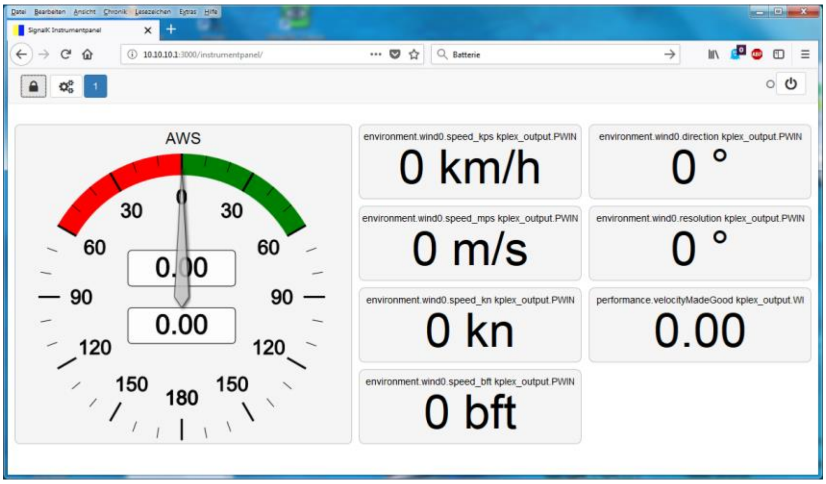


Fig.: Instrument Panel in OpenPlotter

Please note that only one data connection can be established at a time between a given application software and the wind sensor. If the sensor is already connected (this does not mean the WLAN), no data request can be made by another application software.

Similarily, a connection can also be established with other application software. Depending on the functionality of the software, the diagnostic options are partly restricted or not available at all. OpenCPN is also very well suited as test software since a diagnostic monitor is also available for the NMEA data packets.

1.16 Assembling the Frame with Base

When assembling the frame, the first step is to glue the tube to the frame. Brush both the tube and the frame with activator. After the drying time of the activator, the glue is evenly distributed with a Q-tip in the tube holder of the frame. The tube is then pushed into the frame as far as it will go. After the glue has cured, the base can be attached to the tube.

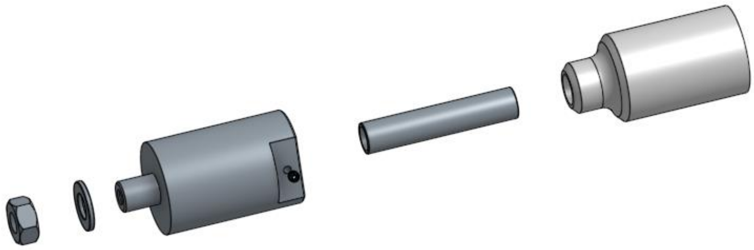


Fig.: Frame with standpipe and base

1.17 Adjusting the Wind Speed Magnet

The adjustment of the wind speed magnet is quite simple. The magnet D3x6 must be inserted into the 3mm hole of the cup rotor. The magnet is inserted so deeply that it does not touch the stator in any operating position when the shell wheel is mounted. There should be a gap of 0.3...0.5 mm. The function can be checked with a digital voltmeter or in OpenPlotter. If no measured value is visible with a rotating shell wheel, the polarity of the magnet is wrong and the magnet must be installed the other way around. If the correct function is given, the magnet can be fixed with a drop of superglue.

1.18 Adjusting the Wind Direction Magnet

The adjustment of the wind direction magnet is somewhat more complex, since a safe switching threshold must be found for all wind directions while the shell wheel rotates.

In the first step, the vane and the shell wheel are placed on the stator. The magnet D3x3 must first be inserted into the small slot of the vane rotor up to the middle. Then, with the wind vane fixed, the shell wheel is turned through 360° and the switching status of the Hall sensor is checked with a digital voltmeter. The signal must be on for about half a turn and off for the rest of the turn. For each revolution, the Hall sensor may be 1x on and 1x off. The following figure shows the correct switching behavior of the two Hall sensors in the oscilloscope.

Kommentar [MS3]: Hier fehlt (auch im Deutschen, da hänge ich gerade!) die Anleitung, wie das Messen mit Voltmeter/Oszi konkret erfolgen soll!

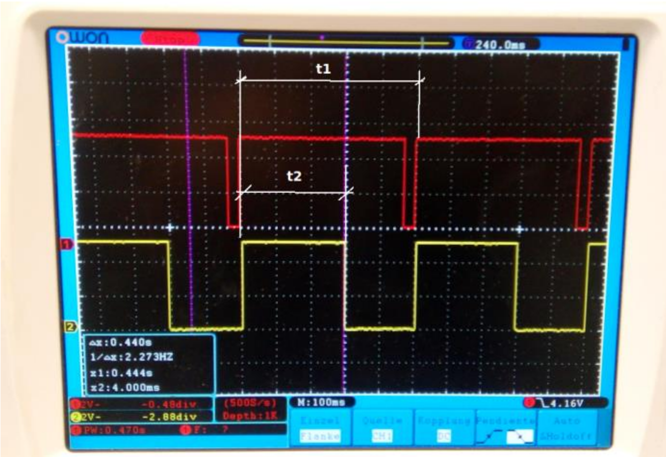


Fig.: Time signal characteristics of the Hall sensors (red wind speed, yellow wind direction)

If the Hall sensor does not switch at all, continuously or several times, the position of the magnet must be varied and the result checked. Once a correct position has been found, the angle of the wind vane must now be changed for all further wind directions and the correct switching behavior must also be checked. The problem is that the Hall sensor’s sensitivity varies at different angle directions, so the switching threshold changes depending on the direction of the magnetic field. The reduction of the magnetic field by the shield must be sufficiently large to produce correct switching behavior. The following diagram visualises the behavior of the Hall sensor.

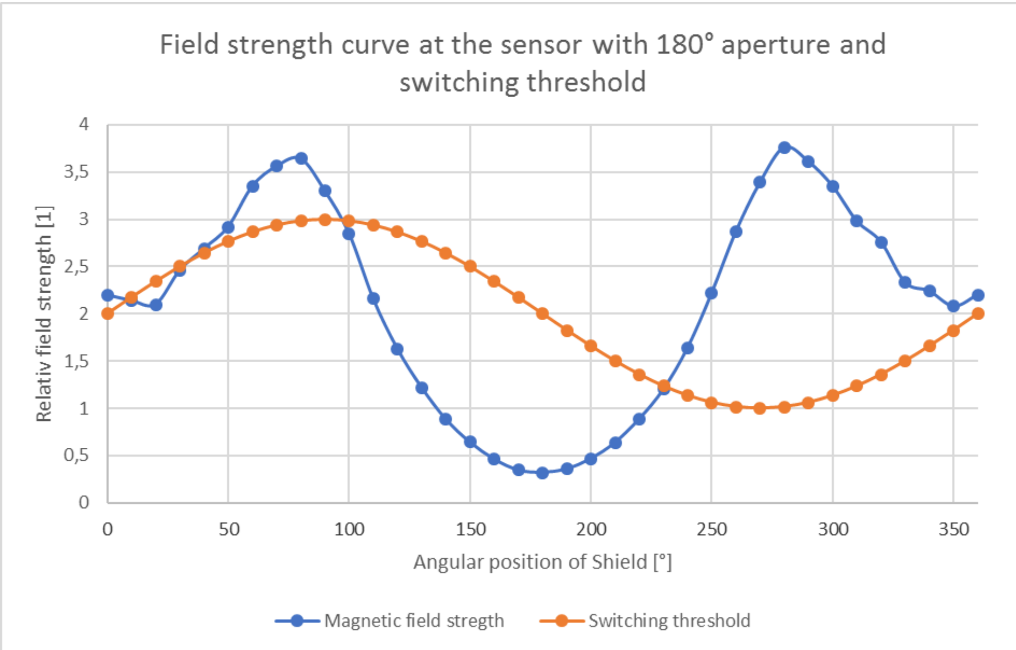


Fig.: Switching behavior of the Hall sensor for the wind direction

The Hall sensor always switches when the blue curve (magnetic field strength) is above the orange curve (switching threshold). The diagram shows 2 switched on and 2 switched off states. The magnetic field at the sensor must be raised to achieve exactly one switched-on and one switched-off state. The magnetic field strength can be changed by changing the magnet position along the groove. The blue line in the diagram then moves up or down. If the wind vane is twisted, the blue line shifts sideways depending on the direction of rotation. As can be seen in the diagram, the aperture does not generate a clean rectangularly reduced magnetic field during the passage through the shield. This is mainly because the half-open shield draws the magnetic field into the semicircle. The magnetic field inside the shield tends to run along the least magnetic resistance.

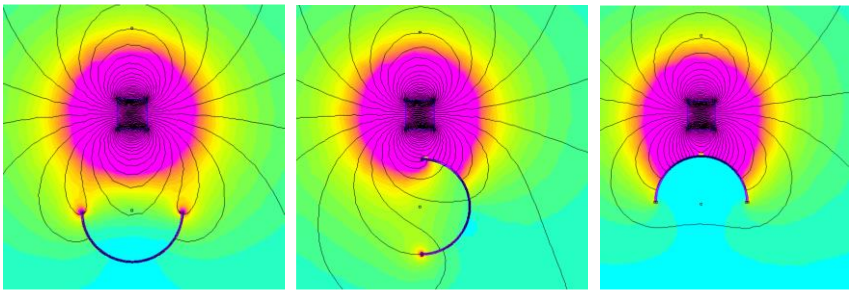


Fig.: Magnetic field characteristics at different shield positions

1.19 Function Test

In the functional test, all parts are assembled as they should be in their final state, with the exception that the parts are not yet glued together. The connecting cable is pulled through the frame, the standpipe and the mounting foot. Before the circuit board is inserted into the stator, the Hall sensor at the tip of the narrow bar must be protected against short circuits. A piece of transparent tape is wrapped around the outside of the Hall sensor and the circuit board so that the connection pins and the connection legs of the Hall sensor are protected. The board can then be pushed into the stator as far as it will go. Next, the stator is connected to the frame and then the shell wheel and the vane are mounted.

The function test is now carried out as described under 1.15. The correct function can then be checked in the application software. It is helpful if a pointer instrument is used for this purpose. This makes it easier to visually compare the angular positions with the position of the wind vane. If the wind vane is turned slowly by 360°, no jumps may occur in the angle display. If jumps are present, this indicates a faulty switching behavior and the magnet of the wind direction sensor must be readjusted. Then you should test the complementary wind directions 0°-180° and 90° -270° and check whether the display values of the angles are correct.

Finally, lightly oil the ball bearings of the vane and the shell wheel. Any excess oil must be removed. It should be oiled very sparingly so that the oil cannot leak out afterwards.

1.20 Glueing the Stator

After all preliminary work and tests have been successfully completed, the stator can be glued into the frame. However, you should be sure that the wind sensor works properly, as it is not possible to open it later without destroying the frame. Before you glue the parts together, you should check whether the board is stuck in the assembled state of stator and frame and has no clearance along the main axis.

This can be checked by gently pulling and pushing the connection cable. Otherwise the Hall sensor of the wind direction measurement could slip during operation and change the switching thresholds of the sensor. If there is a small clearance, a small piece of foam rubber can be inserted into the recess of the frame, which pushes the circuit board towards the stator.

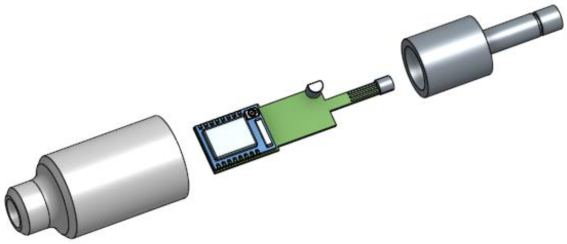


Fig.: Frame, circuit board and stator

Fig.: Board pushed into stator

Alternatively, the inserted circuit board in the stator can be filled with silicone up to the edge of the stator.

The bonding takes place as usual on the contact surface between stator and frame. Any excess glue should be removed with a cloth so that a clean joint is formed at the transition between the stator and frame. The joint must be completely filled with glue in order to achieve a sufficient tightness against humidity.

1.21 Final Inspection

In the final test, the same tests as in the functional test under 1.19 are performed. Possible switching or angular errors can now be corrected if the position of the board has changed again after the stator and frame have been glued together.

Finally, you should make a mark on the frame to mark the midship position (0° position). This way the wind sensor can easily be aligned to the correct position on the mast and the values are displayed correctly in the application software.

1.22 Glue the Shield and Magnet

Finally, the shield is glued in place and the magnet of the vane rotor is secured.

If possible, the shield should be glued aligned to the outer edge of the rotor without canting and without air gap. A suitable cable tie can be used to temporarily fix the cover.

The magnet of the vane rotor is secured by carefully tightening the opposite grub screw and securing the magnet with a drop of superglue. The grub screw should not be tightened too much, as the vane rotor could tear due to the high forces. Even small forces are sufficient to clamp the magnet securely in the gap.

1.23 Further Information

1) OpenPlotter: http://www.sailoog.com/openplotter
2) OpenPlotter Video: https://www.youtube.com/watch?v=LJyOYgIw6L4
3) OpenCPN: https://opencpn.org/
4) Weikon RK-1300:https://www.weicon.de/anwendungsbereiche/kleben-und-abdichten/grosse-teile-verbinden/schnellhaertend-schlagzaeh/243/rk-1300-acrylat-strukturklebstoff
5) Weikon video: https://www.youtube.com/watch?v=JJsYCqT3pSQ
6) Tips for soldering: https://www.sciencebuddies.org/science-fair-projects/references/how-to-solder#overview
7) Soldering video: https://www.youtube.com/watch?v=Qps9woUGkvI
8) Digital voltmeter video: https://www.youtube.com/watch?v=rUkvHeXsPWs