Universal Water Content Sonde
UWC2 Series

User Manual

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Introduction

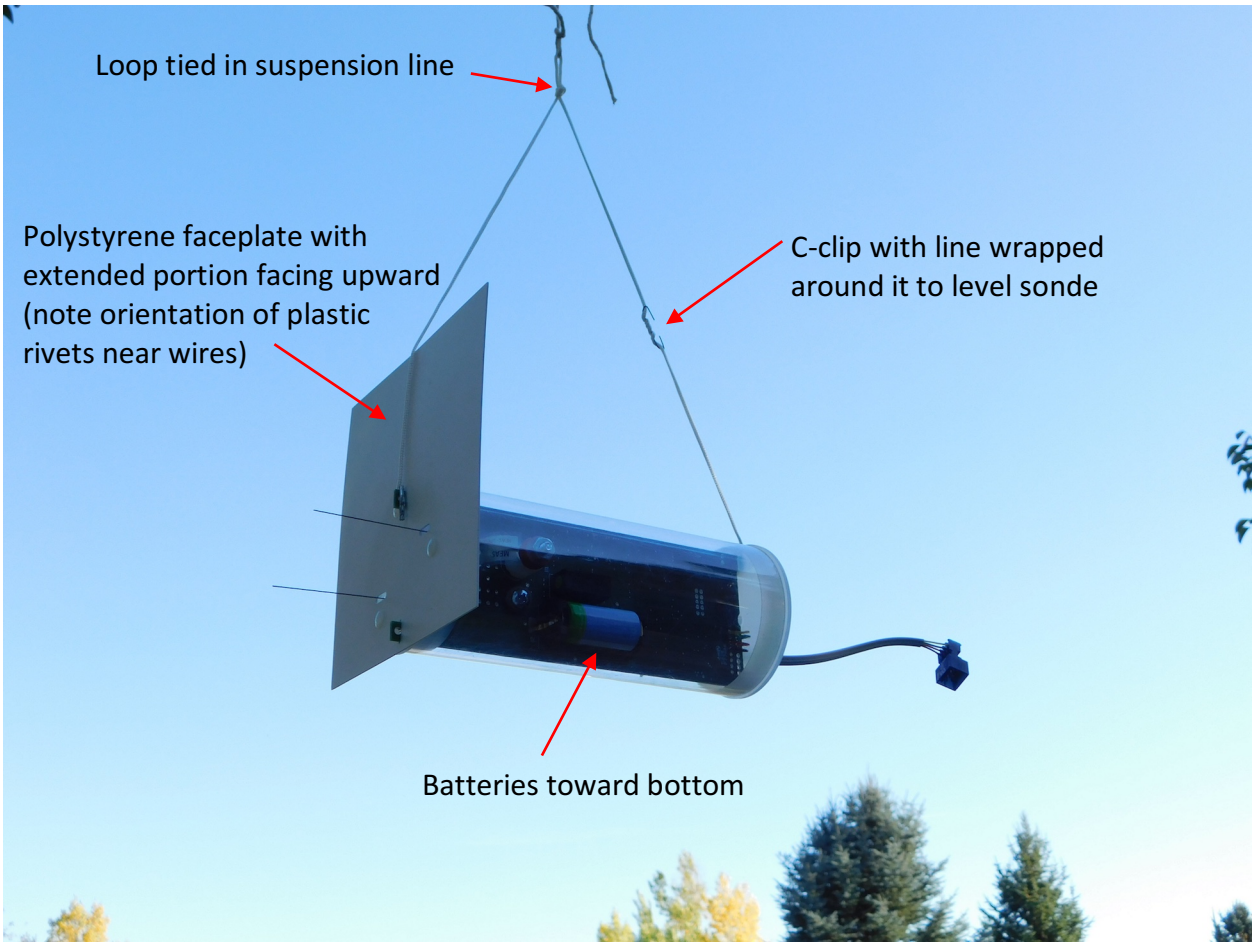
Anasphere's Universal Water Content (UWC) sonde series of balloon-borne instruments are built to quantify and identify the speciation of condensed-phase water in clouds. Depending on the instrument configuration, it will measure supercooled liquid water content (SLWC), total water content (TWC) without speciation, or both. In the latter case, combining both data sets with temperature data enables the measurement and speciation of all condensed phases of water. The UWC2 sensor family includes three subtypes:

- a dual-wire sensor with both SLWC and TWC wires (UWC2)
- a single-wire sensor for SLWC only (UWC2-S)
- a single-wire sensor for TWC only (UWC2-T)

The following instructions are for all three types.

Instrument Overview

The UWC2 sonde consists of a circuit board installed in a tube with two endcaps. An accessory bag containing a faceplate, fasteners, suspension line, and metal C-clip is provided with each sonde; the faceplate must be installed for flight. A data cable specified by the user will interface with common radiosonde types (a 4-pin male XDATA connector is standard). A red power button at one end turns the sonde on and off. At the other end, the sensing wire(s) protrude through the front endcap and through an endplate which attaches to the front endcap. In flight, the sonde is suspended such that the circuit board is vertical with the batteries at the bottom. The following photograph, using a see-through housing, illustrates this configuration with key elements labeled for reference.



LEDs provide status information for the instrument. A main red/green status LED is located near the power button and is visible through the translucent endcap. Green means that all wires are seeing valid signals and the sonde is ready for launch. Red means that one (or more) wires have a problem (either not vibrating or poor signal quality). In the case of 2-wire sondes, LEDs by each wire indicate individual wire status. The most likely reason for a red indication is that the wire has been bumped and is rubbing against the edge of the slot. Other reasons can include a misplaced sensor tab or the wire being bent up or down to the extent it is not being properly plucked. These issues can all be fixed by the user.

The sonde label includes an abbreviated instruction set as a reminder for use during setup. It also includes checkboxes as part of a short checklist at the bottom to ensure the sonde is ready for launch.

Accessory bags provided with the sondes include spare wires, spare faceplate fasteners, and may include a gauge for checking dimensions when replacing wires. An additional bag provided with UWC2 and UWC2-T sondes that use the gel-coated wires includes extra practice wires to gain experience with applying the gel to the coated total water content wire.

Battery Installation

UWC2 sondes may be shipped with or without batteries installed, depending on user request. To install or replace batteries, follow these instructions.

1. Remove the front endcap (the one the wires go through) from the tube. These caps can be very difficult to remove from the cardboard tubes; try not to crush the tube. It can help to hold the tube on either side of the circuit board so the support of the circuit board prevents the tube from being crushed.

2. Remove the rear endcap (the one with the power switch and data cable) from the tube. The circuit board will come out with it.

3. Install two CR123A batteries in the black battery holders. Polarity is indicated in the holders.

4. **The sonde will automatically turn on when batteries are first inserted. Turn off the sonde using the red button.**

Note: this is a good time to check the operation of the sonde. Turn the sonde on and ensure that both wires are being plucked and all LEDs are green. Red means that the wire has a poor signal due to too few vibrations being detected. If an LED is red, try these two things first; if they don't work, go to the Wire Alignment section.

- **If the wire is not being plucked, pressing down on it near its base by the red silicone washers to move it closer to the magnet is a quick fix.**

- **Nudging the flexible piezoelectric tab side to side can help if it is being plucked but has a red LED indication – and be sure the tab is physically touching the base of the wire.**

5. Ensure the circuit board is seated in the rear endcap and reinsert the assembly into the tube partway.

6. Align the front endcap with the wires, being sure to observe orientation (see notes below). Insert it partway into the tube as well. If the wires have enough clearance side-to-side in their slots (that is, room either side with regard to the narrow axis of the slot), press both endcaps fully into the tube. If a wire is bumping the side of a slot, remove the circuit board and realign the wire(s).

Both endcaps have UP and DOWN orientations. The slots will help you to align the boards as you replace the endcaps. The photograph at the beginning of this manual will help with orientation. The batteries are on the bottom of the sonde as we talk about up and down directions.

The front endcap is properly oriented with the circuit board tab hole with an adjacent 1/8-inch hole for mounting the faceplate toward the top of the sonde. Reference the photo at the beginning of this manual for orientation. If you left this endcap installed in the tube, just be careful to not dislocate the wires as you do this – otherwise you will need to realign the wires (which should be very quick to do if necessary).

Preflight Actions

1. Install the 5-inch by 5-inch polystyrene faceplate over the wire endcap using the three provided push-in plastic rivets. Its holes will match the endcap once it is properly oriented. The free end of the plate should be in the up direction (into the airflow). If it is not, the front endcap may have been installed upside down. Reference the photograph at the beginning of these instructions for the orientation.

Be sure that the wires are centered across the short axis of the slots. If a wire is not centered, it can be adjusted from the outside of the sonde using your fingers – just push it in the direction it needs to go. You may need to slightly angle the wire between your fingers to get enough torque on the wire as it (and the washers that hold it) pivots around the mounting screw.

2. Install the provided suspension line into the two upper suspension holes found on the circuit board tabs. Poke each metal part (aglet) through the hole and then pull so that the aglet seats against the circuit board. As a reminder, the polystyrene plate free end should be up, and the red power button will also be on the upper part of the sonde. The weight of the batteries at the bottom helps the sonde to hang in the correct orientation.

3. Tie a small loop in the approximate middle of this string so that it hangs approximately level when suspended from this loop.

4. To level the sonde, a wire C-clip has been provided. Wrap excess string from the longer string leg around this clip until the sonde is level when hanging by the loop.

Note: it is important that the sonde hang level for flight. This extends to rotation as well: rotation around the axis of the cylinder should be avoided, and the batteries are at the bottom when the sonde is in the proper orientation. This is why radiosondes are not attached directly to the cylinder, because they could change the center of gravity and how it hangs. Radiosondes may be located either above or below the sonde, which is why additional suspension tabs with holes are provided at the bottom of the circuit board.

5. Attach the UWC sonde to the radiosonde with a short length of string (or two, if using the bottom suspension tabs) such that the UWC sonde will hang either above or below the radiosonde. Be sure the data cable can reach the radiosonde. Generally, we have placed the radiosonde above the UWC sonde and used a single line from the radiosonde to the loop in the attachment line to suspend the UWC sonde.

Immediately Before Flight

1. (Sondes with coated TWC wires only) Apply the hydrophilic water collection gel to the wire. Insert the TWC wire all the way into the tube (until the tube is against the faceplate). Squeeze the tube until gel begins to come out of the end, at which point the whole wire has been coated. Remove the tube and ***very*** gently wipe off any excess gel. Wiping too hard can remove some of the coating that holds the gel. You should not see any lumps of gel along the wire; if you do, wipe the wire again.

2. Turn the sonde on with the red power button and verify that the wires are freely vibrating. The wires do not continuously vibrate, but are plucked once every few seconds.

3. Connect the XDATA cable to the radiosonde (this is usually done after the radiosonde has been turned on).

4. Confirm that the sonde is still hanging level when the radiosonde and UWC sonde are freely hanging from the line. Adjust the UWC sonde lines as needed if the data cable causes any problems with the sonde being level.

Note: At this point, and through launch, it can be very easy to snag the sensing wires on balloon lines, and that can cause them to be pushed out of position and fail to operate. It is recommended that two people conduct the launch, with one person focused on holding the UWC sonde and radiosonde and protecting the wires.

5. Confirm that XDATA data is being received by your software (if possible).

6. Last minute prelaunch checks (these are listed on the sonde label for reference as well):

Is the sonde level?

Was gel applied to the coated TWC wire? (TWC and 2-wire sondes only)

Are all LEDs green?

7. The sonde is now ready for launch.

Sonde Stickers for Reference

These are the stickers placed on each sonde. Normal operation DIP switch settings for each configuration are in bold.

Universal Water Content Sensor - 2-wire

Setup

1. Install the faceplate with 3 push-in fasteners.
2. Install the suspension line in the upper mounting holes (red power button will be up). Tie a small loop in the middle of the line so it can be attached with a line from the loop to the radiosonde.
3. Ensure the cylinder hangs horizontally by shortening one leg of the suspension line by wrapping the line around a metal C-clip.

Immediately before flight:

1. Apply gel to the coated total water content wire and wipe excess away.
2. Turn the sonde on with the red power button.
3. Connect the XDATA cable to the radiosonde (this is usually done after the radiosonde is turned on).
4. Confirm the sonde is still hanging level with the data cable connected.
5. Both wires should be vibrating freely and all status LEDs should be green. If not, a) ensure the wires are not touching anything when vibrating, and b) follow wire adjustment instructions if necessary.

Mode switch reference:

1: serial mode: **up** XDATA / down invert (serial)
2: magnet power: up off / **down** on
3: 1/2-wire operation: **up** 2 / down 1
4: 1-wire type: up TWC / down SLWC
5: run/test: **up** run / down test
6: unused

This is a harmless meteorological sensor. ***Model UWC2***

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☐ Yes **Gel Applied to UWC Wire?** ☐ Yes **Sonde leveled?**

SLWC Sensor - 1-wire

Setup

1. Install the faceplate with 3 push-in fasteners.
2. Install the suspension line in the upper mounting holes (red power button will be up). Tie a small loop in the middle of the line so it can be attached with a line from the loop to the radiosonde.
3. Ensure the cylinder hangs horizontally by shortening one leg of the suspension line by wrapping the line around a metal C-clip.

Immediately before flight: .

1. Turn the sonde on with the red power button.
2. Connect the XDATA cable to the radiosonde (this is usually done after the radiosonde is turned on).
3. Confirm the sonde is still hanging level with the data cable connected.
4. The wire should be vibrating freely and the status LED should be green. If not, a) ensure the wire is not touching anything when vibrating, and b) follow wire adjustment instructions if necessary.

Mode switch reference:

1: serial mode: **up** XDATA / down invert (serial)
2: magnet power: up off / **down** on
3: 1/2-wire operation: up 2 / **down** 1
4: 1-wire type: up TWC / **down** SLWC
5: run/test: **up** run / down test
6: unused

This is a harmless meteorological sensor.

www.anasphere.com

☐ Yes **Sonde leveled?**

Wire Alignment

These instructions should rarely if ever be needed. These are for reference if 1) wires are visibly pushed out of position during shipping, 2) wires are dislocated or pulled out during launch activities, or 3) the signal is poor as indicated by a red LED.

A properly centered wire will follow a straight line from the center of the steel screw that mounts the wire, across the center of the magnet, and through the center of the slot in the endcap.

With regard to centering in the slot, a wire should be close to centered with regard to the short axis of the slot. With regard to the long axis of the slot, it is not as critical. The wire can be (and often will be) offset along the long slot axis as long as it has room to vibrate when plucked by the electromagnet.

With regard to tools, you can do all of the below steps with fingers only (though tightening the nut can be a little hard). A #2 Phillips screwdriver and a 11/32" nutdriver will help; a small wrench may be used instead of a nutdriver. A brass gauge for checking measurements may be provided.

1. Remove the circuit board from the tube following the instructions under Battery Installation above. This can be very difficult once the endcaps have been fully pushed in. Note that any suspension line attachments must be undone before the circuit board can be removed from the tube.

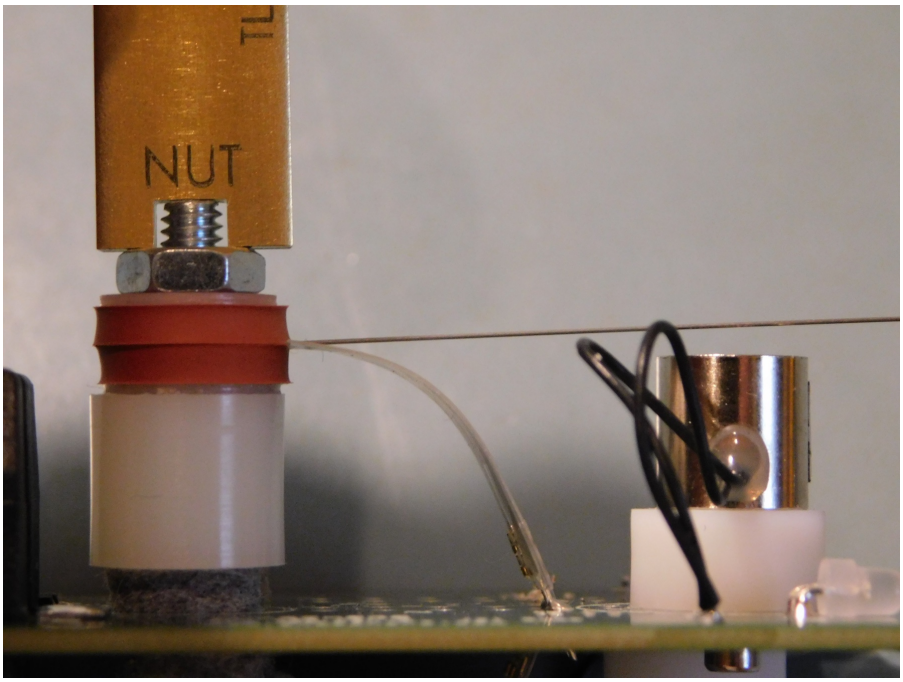
Note: Skip to step 6 or 8 as appropriate if you just need to align the wire. If the wire has fallen out, or is giving a red LED indication for no obvious reason even after ensuring the wire is being plucked and shifting the flexible piezoelectric tab, try a complete reinstallation starting at step 2.

2. Loosen the metal nut at the top of the sensor stack until you can push the wire in between the two red washers.

3. To make the following steps easier, you can push the flexible piezo tab down so that it is trapped by the lower part of the washer stack on the screw – this will keep it out of your way. Don't bend the leads (but if you inadverently do, they can be bent back).

4. Insert the wire between the two red washers. Keeping the wire fairly straight between the center of the metal screw and the center of the electromagnet, tighten the metal nut. **This is most easily done by holding the nut still (with a nutdriver) and tightening the screw with a screwdriver. So turn the screw, not the nut.** The factory setting is 0.122" down from the screw end to the top of the nut. 1/8" will be plenty close in the field. A brass gauge may be

provided in your spare parts bag to make this measurement easier. The following photo illustrates the measurement to be made:



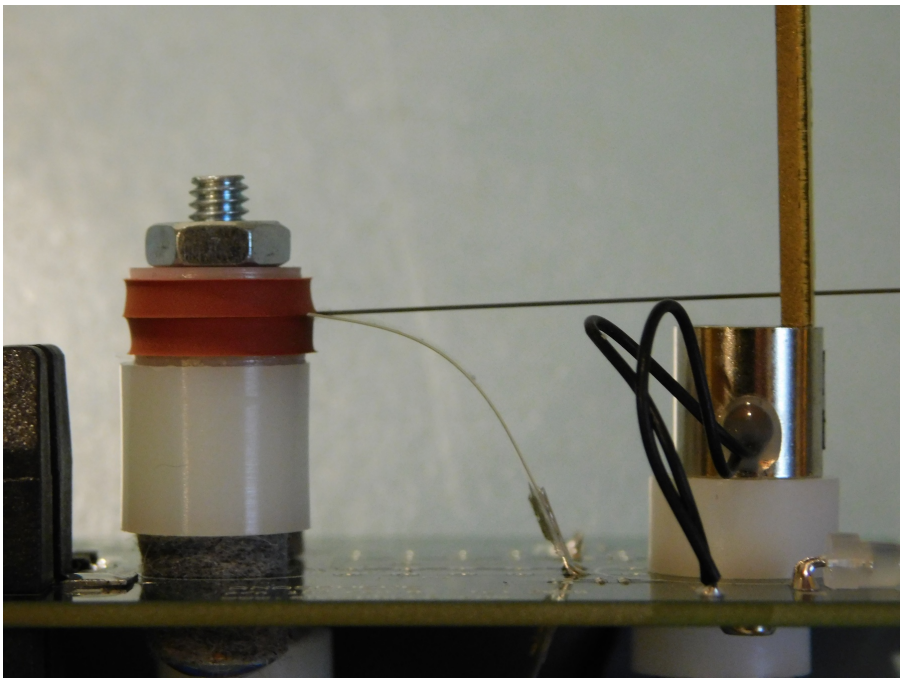
5. Release the piezo sensor tab from where it was pushed out of the way (if you did that) so it is pushing up against the base of the wire.

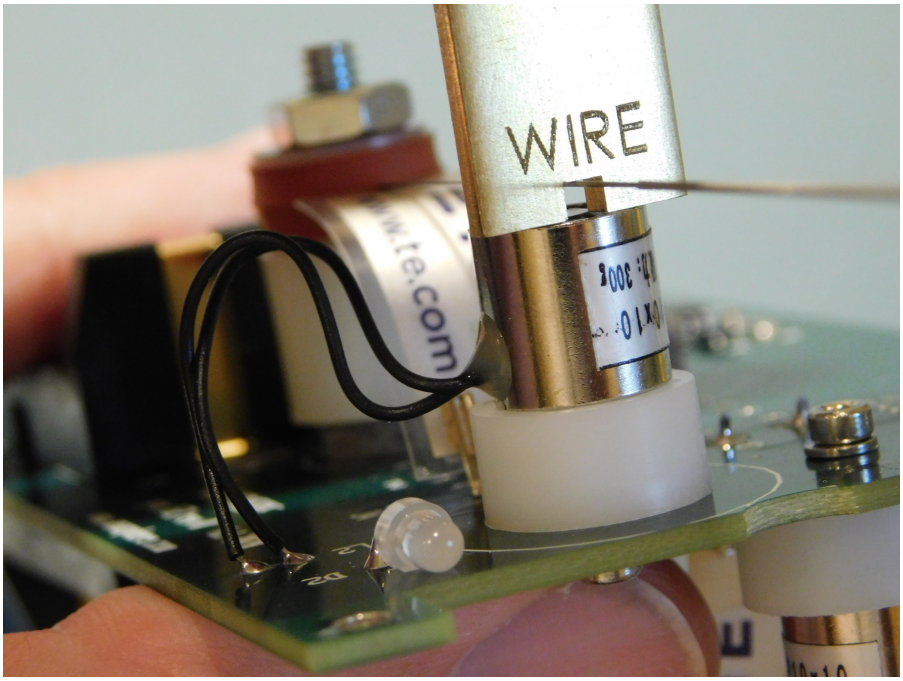
6. Now adjust the height of the wire above the electromagnet. The target measurement (something measured using a gauge or calipers) is 0.080" from the top of the wire to the top metal surfaces of the electromagnet when measuring at the end of the electromagnet closest to the endcap. A brass gauge may be provided in your spare parts bag to make this measurement easier. This measurement can vary along the electromagnet due to the tilt of the wire, so a little less than 0.080" is acceptable as one moves inward along the wire. Close counts – what really matters is that the wire has enough amplitude in its vibration to get a good signal.

To do this, you can push up or down on the base of the wire with your fingertip or a screwdriver where it meets the screw/washer stack. You are not actually trying to bend the wire very much – just an imperceptible amount.

If the wire is just not getting low enough, it may be that one end is stuck on the threads of the screw. Rotating the screw can help with this (it can be rotated easily from the bottom of the board using a screwdriver), or even better just slide the wire a tiny amount out from the screw so it no longer interferes with the threads (sliding the wire back and forth will easily let you feel the contact between the wire and screw).

The following photographs illustrate the use of the gauge and the measurement to be made.



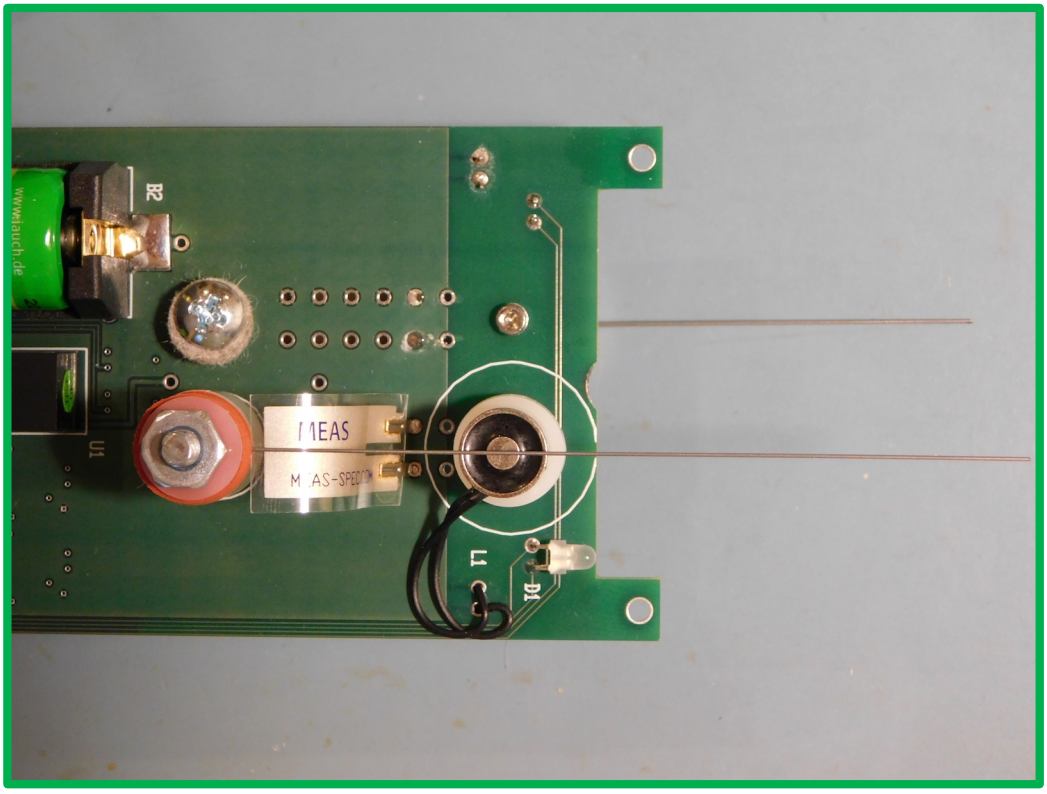


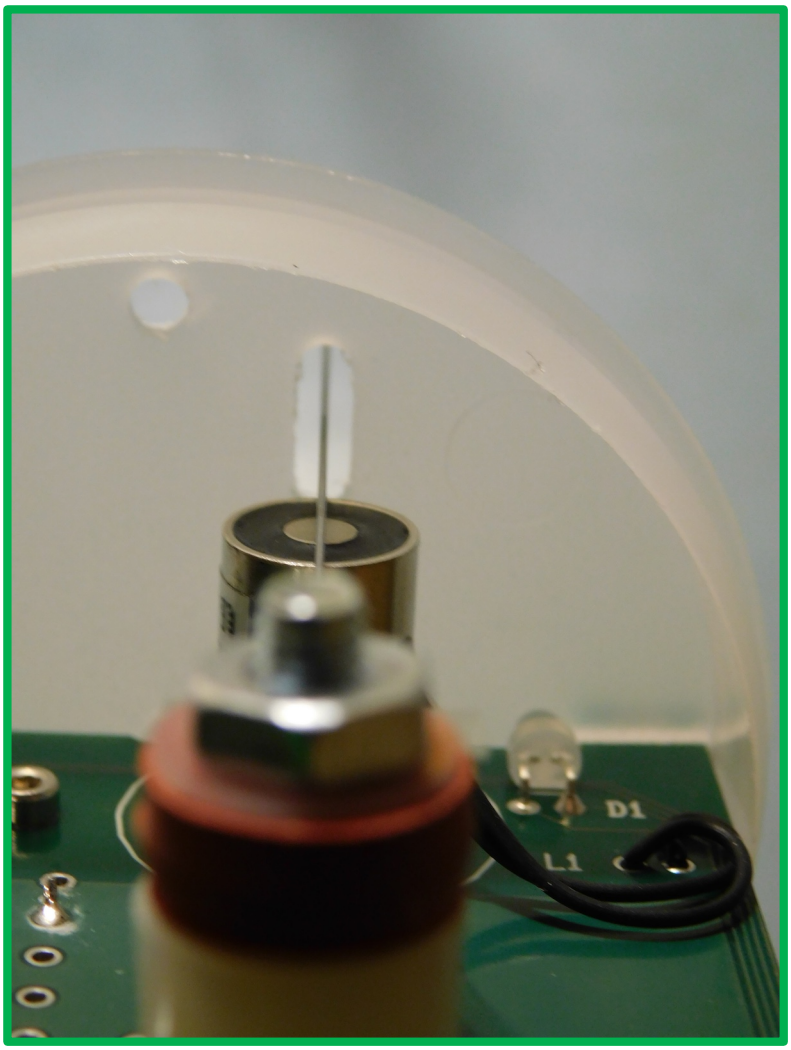
An express way to adjust the height is as follows: turn the sonde on and see if the wire is being plucked. Is it? If yes, and you have a green LED, you are all set. If no, push the wire closer to the magnet by pressing at the base of the wire near the red silicone washers. If the wire is being plucked but you get a red LED, try lifting the wire up a bit to increase amplitude. If that doesn't result in a green LED, reinstall the wire.

7. Place the front endcap over the wires, again being very careful to observe proper orientation. Reference the photograph at the beginning of these instructions for correct orientation.

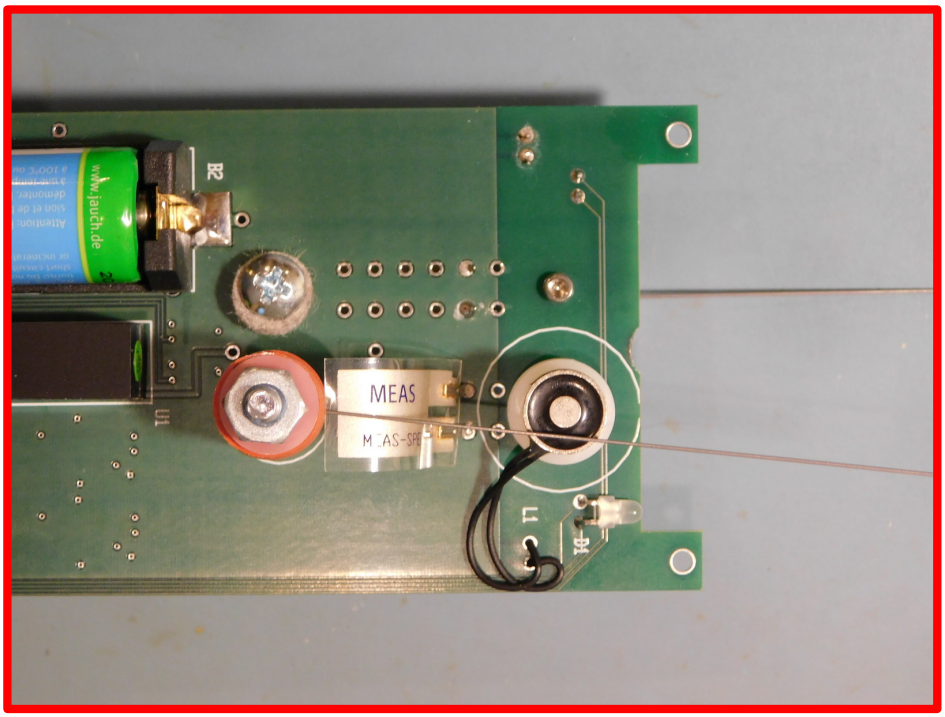
8. Now align the wire horizontally. Reference the four following photos when following the instructions after the photos. The first two show a correct installation; the last two show common installation misalignments.

Correctly aligned wire:

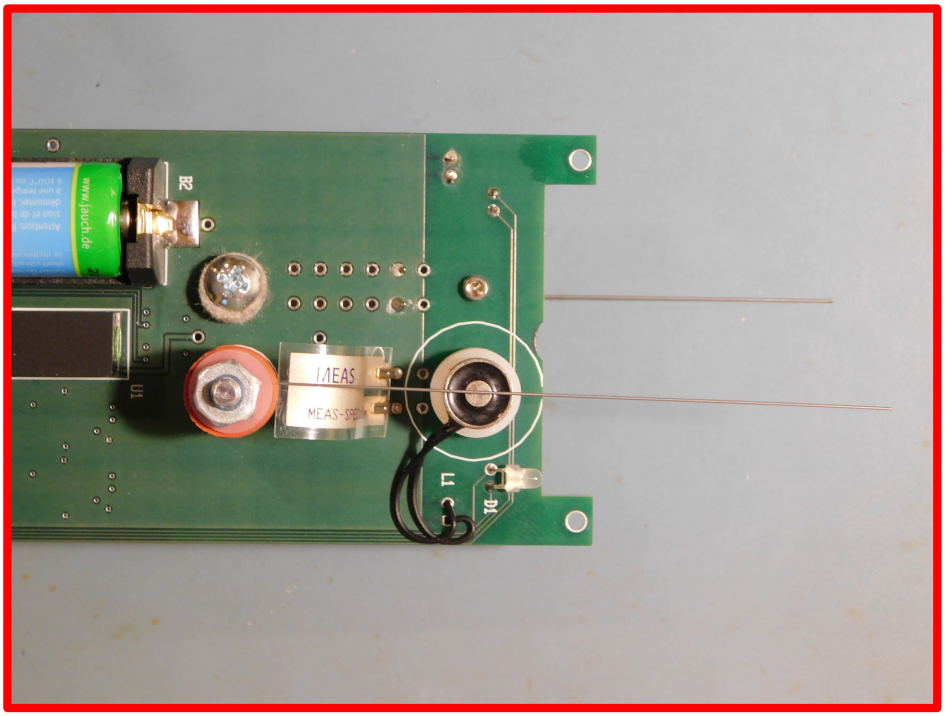



D1
L1

Incorrectly aligned examples:



Above: centered on screw, not centered on magnet
Below: not centered on screw, but centered on magnet



First, be sure the sensor stack (metal screw plus spacer and washers) is centered in the circle on the circuit board.

Next, the goal is to have the wire follow a straight line from the center of the screw, over the center of the electromagnet, and through the center of the short axis of the slot. See the second photo in the good examples above. Ensure that the wire has room to vibrate along the long slot axis – it may not necessarily be centered along the long axis.

You may need to rotate the stack and push the wire around to do this.

Be certain that the wire does not come loose while doing this – that can happen. Just pinch the wires with your finger and push it back toward the screw periodically as you are adjusting it. If it does come loose, go to step 2 above.

9. Finally, be sure the plastic sensor tab is pressing against the wire. Sometimes it can look like it is but is instead caught on the plastic outer layer of the red washer right next to the wire, leaving an imperceptible but significant gap.

10. Reinstall the circuit board in the housing following steps given under Battery Installation above.

Physical specifications

Mass with accessories (faceplate, fasteners, suspension line): 137 grams
Mass of two CR123A batteries: 32-33 grams

Wire specifications

Inner section:
diameter 0.013”
free length 42 mm +/- 0.3 mm (this is the number used for calculations)
(note: total length of inner uncoated/unplated section is 46 mm)

Outer sensing section, SLWC (metal plated):
diameter 0.023”
length 62 mm*

Outer sensing section, TWC (coated for gel application):
diameter 0.028” +/- 0.002”
length 62 mm*

Note: Calipers or a micrometer may be gently used (do not compress the coating) to obtain an exact diameter value for each coated TWC wire.

**** - Some sondes use shorter 44 mm coated or plated sections. Longer wires are recommended for free-flying balloons, and shorter wires are recommended for tethered applications. Be certain to use the correct length installed on your sondes.***

Tools and Batteries

#2 Phillips screwdriver
11/32” nutdriver or wrench

Two CR123A batteries

Hydrophilic Gel

UWC2 (dual wire) and UWC2-T (total water content wire only) sondes are supplied with a tube of hydrophilic gel that is used to coat the wires so that they can collect water droplets and ice particles. This is a nontoxic glycerin-based gel.

Over time (several months), large globular crystal masses may form within the gel. The gel may be reconditioned by heating it to approximately 70°C in a hot water bath and kneading the tube. Additional fresh gel may also be obtained from Anasphere.

Data Format

The XDATA packet structure is as follows:

xdata=2901aabbbbccccdeff

29 = Anasphere water content sonde
01 = daisy chain index
aa = packet type
    03: single-wire SLWC wire in UWC2 sonde (uses channel 2)
    04: single-wire TWC wire in UWC2 sonde (uses channel 1)
    05: two-wire UWC2 sonde with both wires (TWC channel 1, SLWC channel 2)
bbbb = channel 1 wire frequency * 1000 (hexadecimal, 4 digits)
cccc = channel 2 wire frequency * 1000 (hexadecimal, 4 digits)
d = number of valid measurement cycles on channel 1 wire (hexadecimal, 1 digit)
e = number of valid measurement cycles on channel 2 wire (hexadecimal, 1 digit)
ff = battery voltage in 25 mV increments (hexadecimal, 2 digits)

All fields are present in all UWC2 sondes. Unused fields will contain random data.

Example data packet:

xdata=29010593E6A1AEFCEC

29 = Anasphere water content sonde
01 = daisy chain index
05 = packet type: two-wire UWC2 sonde with both wires (TWC channel 1, SLWC channel 2)
93E6 = TWC wire frequency = 37862/1000 = 37.862 Hz
A1AE = SLWC wire frequency = 41390/1000 = 41.390 Hz
F = number of valid measurement cycles on TWC wire = 15 decimal*
C = number of valid measurement cycles on SLWC wire = 12 decimal
EC = battery voltage in 25 mV increments (hexadecimal, 2 digits) = 236 * 25 = 5900 mV

Processing of frequency data to yield cloud water content values is addressed in separate publications. Wire specification data given above is used in that processing.

* - a value of F in the valid cycles field may indicate 15 or more valid cycles.