



Scuba and Scuba Trimeter water quality probes

User manual



This manual covers the Royal Eijkelkamp water quality probes Scuba and Scuba Trimeter. For simplicity the term “Scuba” is used collectively for all models.

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As this manual was written, these documents were on the flash drive next to the Scuba control software:


- 1 M-Calibrating Ion-Selective Electrodes
- 2 M-Calibrating the Scuba Turner fluorometers
- 3 M-Cleaning pH sensors
- 4 M-Eight ways to power a Scuba
- 5 M-Field calibration crude oil sensor
- 6 M-Four primary operating modes for Eijkelkamp multiprobes
- 7 M-Scuba cable wiring
- 8 M-Scuba integrated SDI-12 and MODBUS output operating instructions
- 9 M-Scuba logging with uninterrupted external power supply
- 10 M-Scuba MODBUS communication protocol
- 11 M-Scuba RS-232 communications protocol
- 12 M-Scuba SDI-12 adapter
- 13 M-Standardizing Eijkelkamp’s Turner fluorometers
- 14 M-Warranty Scuba water quality probes

Do you need help?

Royal Eijkelkamp has the best customer service in the multiprobe market, so there’s no reason to get bogged down with a problem. We welcome your call at +31 313 880 200, or email at sales@eijkelkamp.com

About this manual

 If the text follows a mark (as shown on the left), this means that an important instruction follows.

 If the text follows a mark (as shown on the left), this means that an important warning follows relating to danger to the user or damage to the apparatus. The user is always responsible for its own personal protection.

Text Italic indicated text indicates that the text concerned appears in writing on the display or must be typed.

1. Learning the Scuba in 30 minutes

1.1 See your Scuba



1. The Scuba multiprobe is configured with your choice of sensors, and with or without a battery pack.
2. The underwater cable connects the Scuba to a data display (PC, Amphibian, logger, telemetry device or, using the Bluetooth battery, a tablet or smart phone).
3. The storage/calibration cup protects the sensors when the Scuba is not in use (keep a few ounces of tap water in the storage/calibration cup when the Scuba is not being used). And with the lid removed, it holds your calibration solutions.
4. The Scuba flash drive contains the software for connecting your Scuba to your PC or other data display, plus a digital copy of this manual, several instructional videos, and several technical notes.
5. The optional data cable lets you communicate conveniently with your Scuba when an underwater cable is not needed, for instance, during calibration.
6. The USB adapter connects between your underwater cable (or data cable) and a USB port on your display device. The USB adapter can also connect an external power supply to your Scuba if USB power is not adequate (particularly with long underwater cables or large number of sensors).

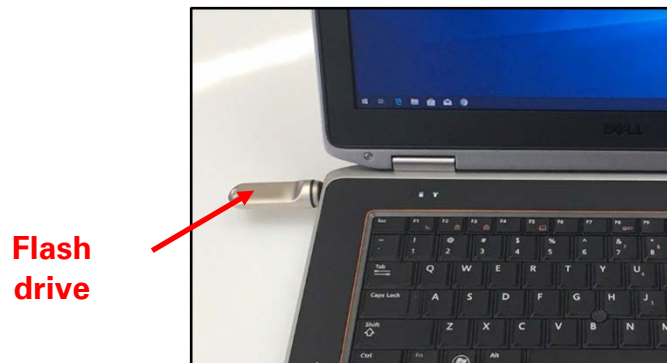
 **Do not use the USB adapter with anything but a USB port and a Scuba.**

7. The maintenance kit contains all the tools and maintenance items needed to keep your Scuba in top shape.
8. The weighted sensor guard replaces the storage/calibration cup to protect the sensors during deployment, and to help the Scuba sink.

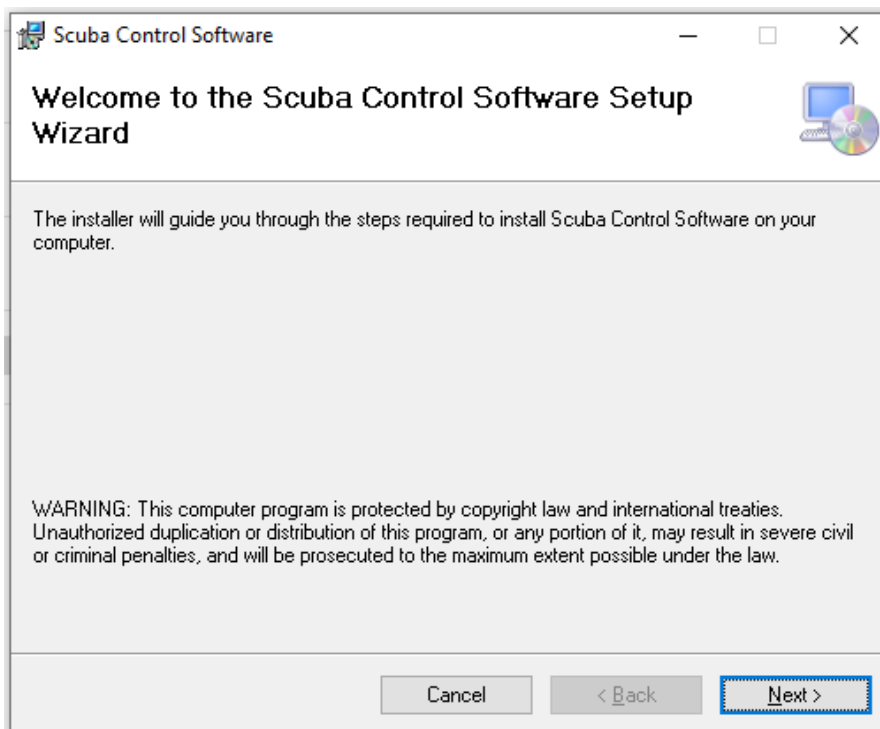
1.2 Talk to your Scuba

Please follow the steps below to install the Scuba software on your PC or laptop (collectively, PC).

- 1 Plug the Scuba flash drive into one of your PC's USB ports.



- 2 When the dialog box shown below opens, click *Install Scuba software* to upload the Scuba user interface software and the USB driver software onto your PC.



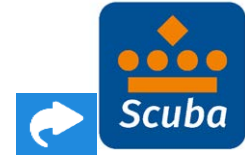
Depending on which version of Windows you are accustomed with, you might have to answer the usual questions about your intention to load new software on your PC. Once you're through with that, you'll be returned to the same screen that you started with, meaning that your Scuba software and USB driver are installed.

Click the X in the upper right corner of the dialog box to close the installation process.

- ☛ **This software installation process should take only a few minutes.**
Please call us (+31 313 880 200) if you have any problems.

Note that you can download the Scuba manual and various videos and technical documents that are stored on the flash drive.

- If your Windows did not create on your desktop a shortcut to the Scuba control software, and you would like to have one, click the *Start* button in the lower left of your screen, click *All Programs*, click the Scuba folder, right-click "*Scuba Control Software*", and drag it to your desktop.



- Now connect your Scuba to the USB adapter using either a Scuba data cable or underwater cable. Click the Scuba icon to connect your PC and Scuba. The home page will appear, showing the Scuba's real-time data and various menu options. You can close the program by clicking the X in the upper right corner.

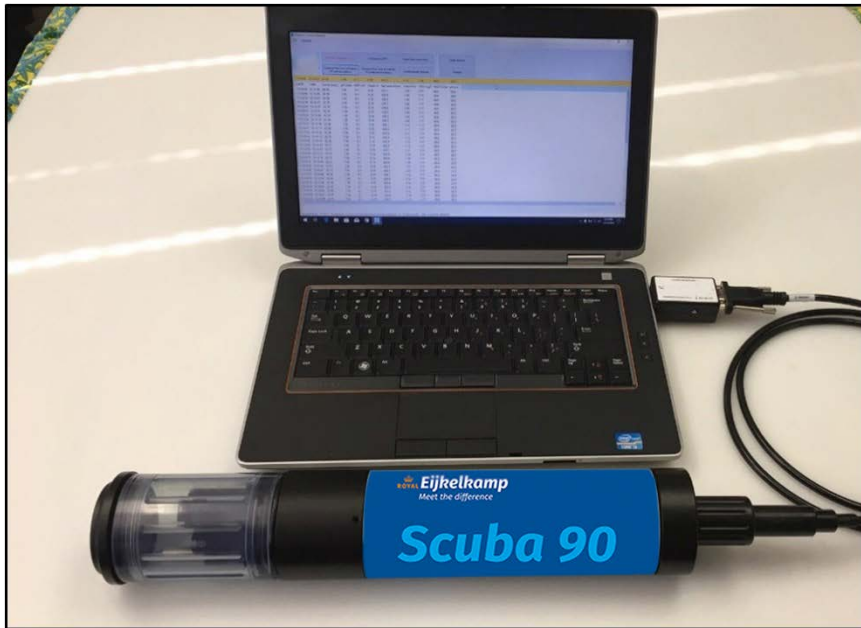
DATE	TIME	Temp deg C	pH units	SpCond uS/cm	Turb FNU	SpCond uS/cm	HDO %Sat	HDO mg/l	Chl u/l	bp ppb	NH4 mg/L-N	NH4 mV	NO3 mg/L-N	NO3 mV	pH mV	Int Batt V
07/06/22	14:33:37	25.065	7.31	427.2	-11.23	427.2	94.3	7.64	0.03	10.21	1.4	-0.4	2.1	129.8	-30.6	0.36
07/06/22	14:33:35	25.065	7.31	427.2	-11.24	427.2	94.3	7.64	0.04	10.23	1.4	0.2	2.1	129.8	-30.6	0.36
07/06/22	14:33:33	25.065	7.32	427.3	-11.24	427.3	94.3	7.64	0.03	10.11	1.4	0.4	2.1	129.9	-30.7	0.36
07/06/22	14:33:31	25.065	7.31	427.3	-11.25	427.3	94.3	7.64	0.02	10.05	1.4	-0.7	2.0	129.9	-30.6	0.36
07/06/22	14:33:29	25.065	7.31	427.3	-11.29	427.3	94.3	7.64	0.02	10.04	1.4	-0.4	2.0	130.0	-30.6	0.35
07/06/22	14:33:27	25.065	7.31	427.3	-11.30	427.3	94.3	7.64	0.02	10.04	1.3	-0.8	2.1	129.9	-30.6	0.35
07/06/22	14:33:25	25.065	7.32	427.3	-11.32	427.3	94.3	7.64	0.02	10.04	1.3	-1.0	2.1	129.9	-30.6	0.35
07/06/22	14:33:23	25.065	7.31	427.3	-11.33	427.3	94.3	7.64	0.02	10.06	1.4	-0.9	2.1	129.9	-30.6	0.36
07/06/22	14:33:21	25.065	7.31	427.3	-11.35	427.3	94.3	7.64	0.02	9.96	1.4	0.8	2.1	129.8	-30.6	0.36
07/06/22	14:33:19	25.065	7.31	427.4	-11.37	427.4	94.3	7.64	0.02	10.00	1.4	0.1	2.1	129.7	-30.5	0.35
07/06/22	14:33:17	25.065	7.31	427.3	-11.38	427.3	94.3	7.64	0.02	10.01	1.4	0.9	2.1	129.7	-30.6	0.36
07/06/22	14:33:15	25.065	7.32	427.3	-11.34	427.3	94.3	7.64	0.02	10.01	1.4	0.9	2.1	129.7	-30.6	0.36
07/06/22	14:33:13	25.045	7.31	427.4	-11.32	427.4	94.3	7.64	0.01	10.03	1.4	0.1	2.1	129.7	-30.6	0.36
07/06/22	14:33:11	25.045	7.31	427.4	-11.31	427.4	94.3	7.64	0.02	10.11	1.4	0.7	2.1	129.6	-30.6	0.36
07/06/22	14:33:09	25.045	7.31	427.4	-11.31	427.4	94.3	7.64	0.03	10.06	1.4	0.7	2.1	129.6	-30.6	0.36
07/06/22	14:33:07	25.045	7.31	427.5	-11.31	427.5	94.3	7.64	0.03	10.14	1.4	0.8	2.1	129.5	-30.6	0.33
07/06/22	14:33:05	25.045	7.31	427.4	-11.32	427.4	94.3	7.64	0.02	10.10	1.5	1.0	2.1	129.6	-30.6	0.35
07/06/22	14:33:03	25.045	7.31	427.4	-11.32	427.4	94.3	7.64	0.01	10.10	1.5	1.5	2.1	129.5	-30.6	0.35
07/06/22	14:33:01	25.035	7.31	427.4	-11.33	427.4	94.3	7.64	0.02	10.09	1.5	1.6	2.1	129.5	-30.6	0.36
07/06/22	14:32:59	25.035	7.31	427.5	-11.36	427.5	94.4	7.64	0.03	10.10	1.5	1.8	2.1	129.6	-30.6	0.35
07/06/22	14:32:57	25.035	7.31	427.5	-11.37	427.5	94.3	7.64	0.02	10.27	1.5	1.9	2.1	129.6	-30.6	0.33
07/06/22	14:32:55	25.035	7.31	427.5	-11.38	427.5	94.3	7.64	0.00	10.02	1.5	2.0	2.1	129.6	-30.6	0.35
07/06/22	14:32:53	25.035	7.31	427.5	-11.36	427.5	94.3	7.64	0.00	10.13	1.5	1.7	2.1	129.7	-30.5	0.35
07/06/22	14:32:51	25.035	7.31	427.5	-11.35	427.5	94.3	7.64	0.01	10.13	1.5	2.1	2.1	129.6	-30.5	0.36
07/06/22	14:32:49	25.025	7.31	427.5	-11.34	427.5	94.3	7.64	0.02	10.21	1.5	1.8	2.1	129.7	-30.6	0.31
07/06/22	14:32:47	25.025	7.31	427.5	-11.33	427.5	94.3	7.65	0.02	10.16	1.5	1.6	2.1	129.6	-30.6	0.35
07/06/22	14:32:45	25.025	7.31	427.5	-11.35	427.5	94.3	7.64	0.02	10.14	1.5	1.7	2.1	129.7	-30.6	0.35
07/06/22	14:32:43	25.025	7.31	427.6	-11.38	427.6	94.3	7.64	0.02	10.14	1.5	1.7	2.1	129.6	-30.6	0.31
07/06/22	14:32:41	25.025	7.31	427.6	-11.40	427.6	94.3	7.64	0.02	10.10	1.5	2.0	2.1	129.7	-30.6	0.33
07/06/22	14:32:39	25.025	7.31	427.7	-11.41	427.7	94.3	7.65	0.01	10.08	1.5	1.8	2.1	129.7	-30.5	0.31
07/06/22	14:32:37	25.025	7.31	427.7	-11.39	427.7	94.3	7.65	0.01	9.98	1.5	1.6	2.1	129.7	-30.6	0.35
07/06/22	14:32:35	25.025	7.31	427.6	-11.36	427.6	94.3	7.65	0.02	10.02	1.5	1.5	2.1	129.8	-30.5	0.35
07/06/22	14:32:33	25.015	7.31	427.7	-11.31	427.7	94.3	7.65	0.01	10.00	1.6	2.4	2.1	129.8	-30.6	0.35
07/06/22	14:32:31	25.015	7.31	427.7	-11.30	427.7	94.3	7.65	0.01	10.02	1.6	3.0	2.1	129.8	-30.5	0.35
07/06/22	14:32:29	25.015	7.31	427.7	-11.29	427.7	94.3	7.65	0.01	10.14	1.6	3.4	2.1	129.8	-30.5	0.36
07/06/22	14:32:15	25.005	7.31	427.8	-11.31	427.8	94.4	7.65	0.01	10.00	1.6	3.0	2.1	129.9	-30.4	0.36
07/06/22	14:32:13	25.005	7.31	427.8	-11.32	427.8	94.3	7.65	0.01	10.02	1.6	2.6	2.1	129.9	-30.5	0.33
07/06/22	14:32:11	25.005	7.31	427.9	-11.33	427.9	94.4	7.65	0.02	10.07	1.5	2.6	2.1	129.9	-30.4	0.33
07/06/22	14:32:09	25.005	7.31	427.9	-11.33	427.9	94.4	7.65	0.01	10.11	1.5	2.3	2.1	129.9	-30.5	0.35

👉 If your Scuba does not connect with your PC, it may be that your organization's network firewall prevented the installation of the USB driver. Consult your IT department if you do not see the Prolific USB driver listed in your device-driver menu (which is usually found in *Settings* after clicking the *Start* button in the lower-left screen).

1.3 A short exercise

Let's do a quick exercise to show how easy the Scuba is to use. We will connect the instrument to a PC, calibrate conductivity, and check the calibration log for the conductivity calibration information.

- 1 Connect your Scuba to your PC with the USB adapter and either a data cable or underwater cable.



- 2 Click the Scuba icon to launch the Scuba control software. Soon you will see the home page and the data being sent from your Scuba.
- 3 Fill the storage/calibration cup with tap water or conductivity standard and wait for the conductivity reading to stabilize.
- 4 Click the Scuba pull-down menu on the home page and click *Calibrate*, and then click *SpCond* on the next screen.
- 5 Type in the approximate conductivity of your tap water or the value of your conductivity standard and click *OK*.
- 6 Click on *OK* in the next screen to finalize the calibration and be returned to the home page. (D.5)
- 7 Click the Scuba pull-down menu on the home page then click *Cal Log* on the next screen. At the bottom of the list are the details of the calibration that you just did.
- 8 Click on *OK* to return to the home page.

Was that easy, or what? Don't you wish you had back all those frustrating, life-shortening, soul-crushing hours you spent trying to decipher those other multiprobe manufacturers' software?

2. Scuba basics



Royal Eijkelpamp is the only major multiprobe manufacturer that provides a three-year warranty that covers all sensors, including pH and DO.

2.1 Deployment specifications

The Scuba can be used in natural water up to 50 degrees C and 200 meters deep, except that ISE's are rated to 10 meters deep, and TDG sensors and low-range depth should go no deeper than 25 meters.

2.2 Scuba control software flow chart

Please see the first page in Section 3.

2.3 The Scuba has four basic applications

- 1 Manual data collection, also known as profiling, surveying, site-to-site measurements, etc., means that the user is present at the monitoring site and uses a data display for observing measurements. This allows the user to make data-based decisions in the field in real-time, and lets the user visit multiple monitoring sites in one day. The data display can be a laptop, Amphibian, or almost any tablet or smartphone. The user makes note of measurements either with pen and paper or, preferably, by using the Scuba's snapshot or automatic snapshot features. You might "snapshot" a series of measurements in one or more lakes or streams during the day, and then download the data to your desktop PC that evening (see 3.3, 5.1).
- 2 Unattended logging means that the user has set the multiprobe into its logging mode, deployed the multiprobe in the proper location in the water, and then left the site. The Scuba can run for weeks at a time with cable-supplied power or an optional Scuba integral battery pack. You can, for instance, set the instrument to take a set of readings every half-hour, anchor it in an estuary, and return after two weeks to retrieve the instrument and download the data to a PC, laptop, or Android device.
- 3 Telemetry relay means that the user has connected the multiprobe to a telemetry device, deployed the Scuba in the proper location in the water, and then left the site. A cable connects the multiprobe to the telemetry system. The telemetry device uses satellite or cell-phone communication to periodically report data collected by the multiprobe to the user's office PC or to a proprietary web page. In many telemetry systems, the user can also contact the multiprobe and request transmission of the most recent data. Telemetry relay allows the user to collect data all night and all day for weeks without being present at the monitoring site and allows the user remote access to those data at any time. Telemetry is helpful in deciding when a trip to the field for multiprobe calibration or maintenance is necessary. Telemetry is also ideal in locations for which access is dangerous or expensive.

On-line monitoring, also known as process-control monitoring, means that the multiprobe is connected to a PLC, SCADA system, etc. An example is monitoring the input to a water-treatment plant for salinity or chlorophyll. On-line monitoring allows the user to make water-quality-based decisions in real-time. The Scuba is particularly effective in this application when more than one parameter is used in the control loop.

2.4 Underwater cables

The Scuba underwater cables have a RS 232 connector (left) and a female Scuba probe connector (right).



Vented underwater cables (VUC), which are used with the optional vented level sensor, have a small tube within the VUC to connect the sensor to the surface of the water so that changes in barometric pressure do not affect level readings. That vent tube is connected to a desiccant pack at the top of the VUC to prevent water from condensing inside the vent tube. Later VUC's are fixed to the Scuba and cannot be removed.

2.5 Operating the Scuba with Eijkelkamp's Amphibian 3

(Please see 6.4.1 if you wish to connect to your Amphibian 3 via Bluetooth instead of a cable.)

- 1 Power on the Amphibian 3 data display.
- 2 On the start-up screen, select "Amp_2_2_X" to launch the Scuba control software.
- 3 Connect the Amphibian 3 to your Scuba cable's 9-pin connector and turn the Amphibian 3 on.
- 4 You should see scrolling data from the Scuba's sensors.

The Scuba control software loaded on the Amphibian 3 mirrors the version for the PC with some concessions for the small screen.

Section 5 has more information about small-screen data displays.



2.6 What do the LED lights mean?

The Scuba has three light-emitting diodes (LED's), mounted on the circuit board visible through the instrument housing, to help you understand what's happening, and to provide information when troubleshooting a failure.

The green light blinks every second when receiving adequate operating voltage via the cable; it does not blink when the Scuba operates under its own battery power.

The red light blinks five times upon power-up when logging is enabled.

The amber light blinks when the Scuba is receiving RS-232 communications from an external device (such as a PC or logger).

A sequence of red and amber LED flashes tell you the voltage of your battery pack if you have activated logging. When you first power-up your Scuba, the red LED will blink five times to indicate that logging is activated and to indicate the first 3.5 volts of battery power, and then one amber blink for each volt, and one red blink for each half volt.

For instance, five reds, five ambers, and a red means $3.5 + 5 + 0.5 = 9$ battery volts.

2.7 The USB converter

Eijkelpamp's USB converter converts your Scuba's data stream to a USB port. Newer models have a power port on the side that you can use to provide power to the Scuba if USB power is insufficient, or to protect your laptop's battery. The connector is fairly standard for power supplies, so you can plug in many third-party power supplies – but do not use a power supply providing over 14 VDC.

☞ **If you are using a power supply that plugs into the wall, please use a GFI-equipped circuit.**

2.8 Accessories

Eijkelpamp provides a number of accessories for the Scuba, including carrying cases, anti-fouling kits, SDI-12 converters, data displays, telemetry systems, cable reels, etc.

2.9 Flow cell



If it is more convenient to bring the water to the Scuba than the Scuba to the water, for instance when monitoring surface water which is heavily aerated (or use it in the lab), you can simply screw a flow cell onto the Scuba as you would normally screw on a sensor guard.

☞ The flow cell cannot be used in combination with low flow pumping.

2.10 Routine maintenance

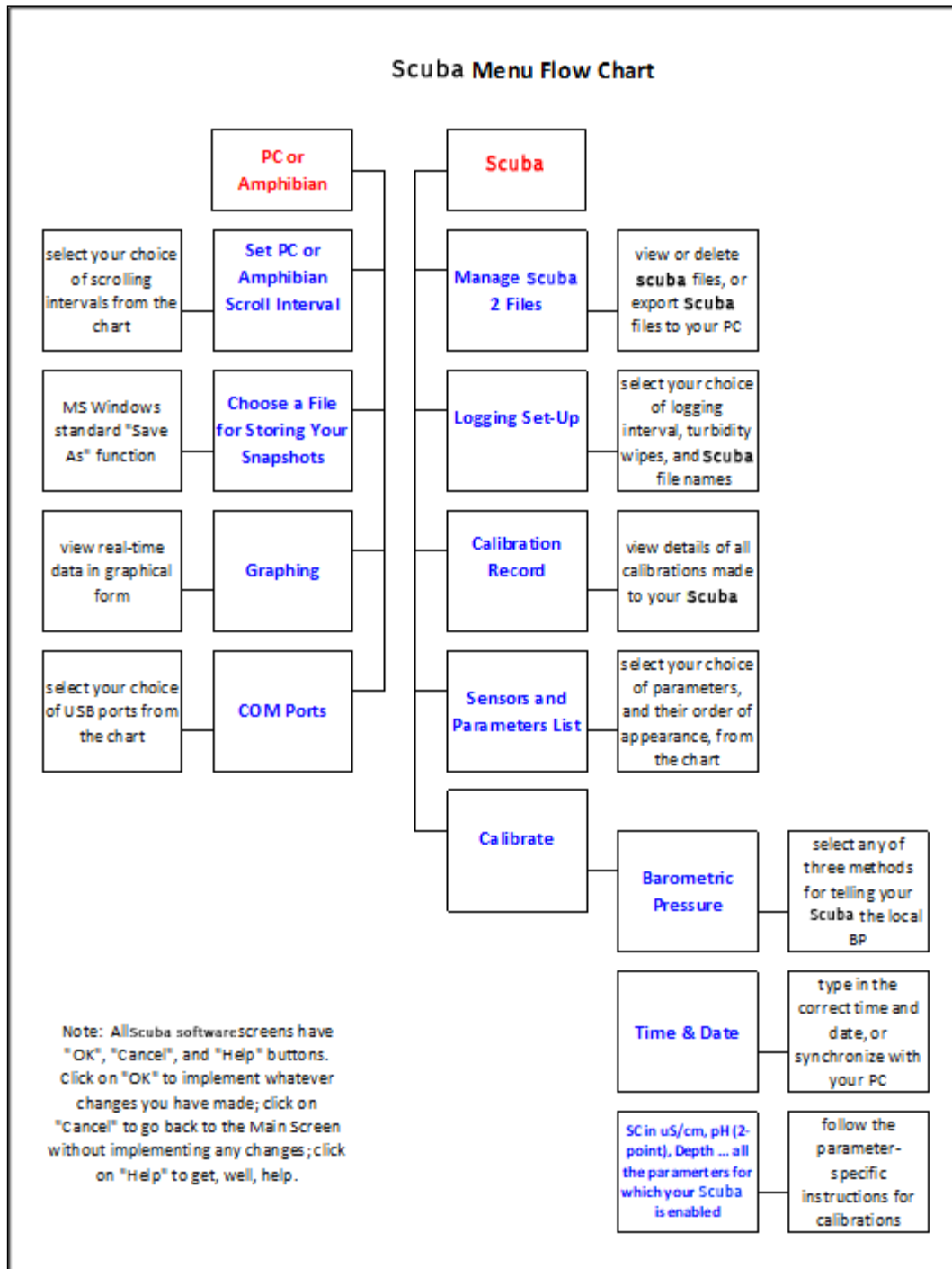


Clean your instrument periodically with warm soapy water. Liquid dishwashing soap is fine. Do not use abrasives. Do not use acetone. Do not clean with gasoline, kerosene, or industrial cleaners. Mild household cleaners work well. Clean sensor stems with a soft brush.

Rinse well with tap water, and store sensors with tap water in the storage cup. Replace any o-rings with visible cracks. Keep o-rings greased with silicon grease (found in your maintenance kit). Always remove batteries and clean your Scuba prior to storing it for prolonged periods.

3. The Scuba control software

3.1 Scuba control software map



3.2 Home page

We call the Scuba control software's home page the "home page" because you can access all the Scuba functions from this screen. The home page functions are:

The screenshot shows the Scuba control software interface. At the top, there are several status indicators: "Scuba Logging is OFF", "Circulator is OFF", "Wipe One Cycle Now", and "Clear Screen". Below these are buttons for "Capture One Line of Data to PC with Annotation", "Capture One Line of Data to PC without Annotation", "List Bluetooth Scubas", and "Restart". The main area is a data table with columns for DATE, TIME, Temp deg C, pH units, SpCond uS/cm, Diss O2 %, SpO2 %, DO sat, TCO mg/l, CH ug/l, bg ppb, NH4 mg/L-N, NH4 mV, NO3 mg/L-N, NO3 mV, pH mV, and Int Bat V. The most recent data row is highlighted in yellow. At the bottom, there is a status bar showing "Connected on COM4 | Snapshot | Log Interval: 15 min | Log File: ENATEST.LOG".

These two buttons are pull down menus

These eight buttons are "hot buttons"; short-cuts to important and often-used functions

The bottom line of the screen tabulates some information you might find handy.

This area is continuously updating, real-time data from your Scuba.

The line of data highlighted in yellow is the most recent line of data sent from the Scuba.

DATE	TIME	Temp deg C	pH units	SpCond uS/cm	Diss O2 %	SpO2 %	DO sat	TCO mg/l	CH ug/l	bg ppb	NH4 mg/L-N	NH4 mV	NO3 mg/L-N	NO3 mV	pH mV	Int Bat V
07/06/22	14:33:37	25.065	7.31	427.2	-11.23	427.2	94.3	7.64	0.03	10.21	1.4	-0.4	2.1	129.8	-30.6	0.36
07/06/22	14:33:35	25.065	7.31	427.2	-11.24	427.2	94.3	7.64	0.04	10.23	1.4	0.2	2.1	129.8	-30.6	0.36
07/06/22	14:33:33	25.065	7.32	427.3	-11.24	427.3	94.3	7.64	0.03	10.11	1.4	0.4	2.1	129.9	-30.7	0.36
07/06/22	14:33:31	25.065	7.31	427.3	-11.25	427.3	94.3	7.64	0.02	10.05	1.4	-0.7	2.0	129.9	-30.6	0.36
07/06/22	14:33:29	25.065	7.31	427.3	-11.29	427.3	94.3	7.64	0.02	10.04	1.4	-0.4	2.0	130.0	-30.6	0.35
07/06/22	14:33:27	25.065	7.31	427.3	-11.30	427.3	94.3	7.64	0.02	10.04	1.3	-0.8	2.1	129.9	-30.6	0.35
07/06/22	14:33:25	25.065	7.32	427.3	-11.32	427.3	94.3	7.64	0.02	10.04	1.3	-1.0	2.1	129.9	-30.6	0.35
07/06/22	14:33:23	25.065	7.31	427.3	-11.33	427.3	94.3	7.64	0.02	10.06	1.4	-0.9	2.1	129.9	-30.6	0.36
07/06/22	14:33:21	25.065	7.31	427.3	-11.35	427.3	94.3	7.64	0.02	9.96	1.4	0.8	2.1	129.8	-30.6	0.36
07/06/22	14:33:19	25.065	7.31	427.4	-11.37	427.4	94.3	7.64	0.02	10.00	1.4	0.1	2.1	129.7	-30.5	0.35
07/06/22	14:33:17	25.065	7.31	427.3	-11.38	427.3	94.3	7.64	0.02	10.01	1.4	0.9	2.1	129.7	-30.6	0.36
07/06/22	14:33:15	25.065	7.32	427.3	-11.34	427.3	94.3	7.64	0.02	10.01	1.4	0.9	2.1	129.7	-30.6	0.35
07/06/22	14:33:13	25.045	7.31	427.4	-11.32	427.4	94.3	7.64	0.01	10.03	1.4	0.1	2.1	129.7	-30.6	0.38
07/06/22	14:33:11	25.045	7.31	427.4	-11.31	427.4	94.3	7.64	0.02	10.11	1.4	0.7	2.1	129.6	-30.6	0.36
07/06/22	14:33:09	25.045	7.31	427.4	-11.31	427.4	94.3	7.64	0.03	10.06	1.4	0.7	2.1	129.6	-30.6	0.36
07/06/22	14:33:07	25.045	7.31	427.5	-11.31	427.5	94.3	7.64	0.03	10.14	1.4	0.8	2.1	129.5	-30.6	0.33
07/06/22	14:33:05	25.045	7.31	427.4	-11.32	427.4	94.3	7.64	0.02	10.10	1.5	1.0	2.1	129.6	-30.6	0.35
07/06/22	14:33:03	25.045	7.31	427.4	-11.32	427.4	94.3	7.64	0.01	10.10	1.5	1.5	2.1	129.5	-30.6	0.35
07/06/22	14:33:01	25.035	7.31	427.4	-11.33	427.4	94.3	7.64	0.02	10.09	1.5	1.6	2.1	129.5	-30.6	0.36
07/06/22	14:32:59	25.035	7.31	427.5	-11.36	427.5	94.4	7.64	0.03	10.10	1.5	1.8	2.1	129.6	-30.6	0.36
07/06/22	14:32:57	25.035	7.31	427.5	-11.37	427.5	94.3	7.64	0.02	10.27	1.5	1.9	2.1	129.6	-30.6	0.33
07/06/22	14:32:55	25.035	7.31	427.5	-11.38	427.5	94.3	7.64	0.00	10.02	1.5	2.0	2.1	129.6	-30.6	0.35
07/06/22	14:32:53	25.035	7.31	427.5	-11.36	427.5	94.3	7.64	0.00	10.13	1.5	1.7	2.1	129.7	-30.5	0.35
07/06/22	14:32:51	25.035	7.31	427.5	-11.35	427.5	94.3	7.64	0.01	10.13	1.5	2.1	2.1	129.6	-30.5	0.36
07/06/22	14:32:49	25.025	7.31	427.5	-11.34	427.5	94.3	7.64	0.02	10.21	1.5	2.1	2.1	129.7	-30.6	0.31
07/06/22	14:32:47	25.025	7.31	427.5	-11.33	427.5	94.3	7.65	0.02	10.16	1.5	2.1	2.1	129.6	-30.6	0.35
07/06/22	14:32:45	25.025	7.31	427.5	-11.35	427.5	94.3	7.64	0.02	10.14	1.5	2.1	2.1	129.7	-30.6	0.35
07/06/22	14:32:43	25.025	7.31	427.6	-11.38	427.6	94.3	7.64	0.02	10.14	1.5	2.1	2.1	129.6	-30.6	0.31
07/06/22	14:32:41	25.025	7.31	427.6	-11.40	427.6	94.3	7.64	0.02	10.10	1.5	2.1	2.1	129.7	-30.6	0.33
07/06/22	14:32:39	25.025	7.31	427.7	-11.41	427.7	94.3	7.65	0.01	10.08	1.5	2.1	2.1	129.7	-30.5	0.31
07/06/22	14:32:37	25.025	7.31	427.7	-11.39	427.7	94.3	7.65	0.01	9.98	1.5	2.1	2.1	129.7	-30.6	0.35
07/06/22	14:32:35	25.025	7.31	427.6	-11.36	427.6	94.3	7.65	0.02	10.02	1.5	2.1	2.1	129.8	-30.5	0.35
07/06/22	14:32:33	25.015	7.31	427.7	-11.31	427.7	94.3	7.65	0.01	10.00	1.6	2.1	2.1	129.8	-30.6	0.35
07/06/22	14:32:31	25.015	7.31	427.7	-11.30	427.7	94.3	7.65	0.01	10.02	1.6	3.1	2.1	129.8	-30.5	0.35
07/06/22	14:32:29	25.015	7.31	427.7	-11.29	427.7	94.3	7.65	0.01	10.14	1.6	3.1	2.1	129.8	-30.5	0.35
07/06/22	14:32:15	25.005	7.31	427.8	-11.31	427.8	94.4	7.65	0.01	10.00	1.6	3.1	2.1	129.9	-30.4	0.35
07/06/22	14:32:13	25.005	7.31	427.8	-11.32	427.8	94.3	7.65	0.01	10.02	1.6	2.1	2.1	129.9	-30.5	0.33
07/06/22	14:32:11	25.005	7.31	427.9	-11.33	427.9	94.4	7.65	0.02	10.07	1.5	2.1	2.1	129.9	-30.4	0.33
07/06/22	14:32:05	25.005	7.31	427.9	-11.33	427.9	94.4	7.65	0.01	10.11	1.5	2.1	2.1	129.9	-30.5	0.35

Connected on COM4 | Snapshot | Log Interval: 15 min | Log File: ENATEST.LOG

3.3 Hot buttons

“Hot buttons” are the little squares you can click on to do something important without leaving the home page. The hot buttons are:

If this button says “ON” click on it to turn Scuba logging “OFF”, click on it to turn Scuba logging on.

Click this button to toggle your circulator, if any, on and off.

Click this button to start one wipe cycle for your turbidity sensor, if any.

Click on this button to clear the data area.

When you click on this button, a comment screen appears (see below), and then one frame of data is sent to your PC snapshot file (along with the comment you typed in the box). The comment is called an annotation.

Click on this button to send one frame of data to your PC snapshot file without an annotation.

Click this button to list available Bluetooth Scubas.

Click this button to rebuild the data in this screen

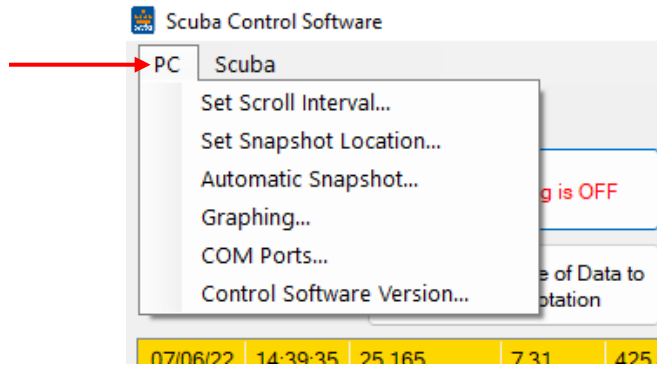
DATE	TIME	Temp dea C	pH units	SoCond uS/cm	Turb FNU	SoCond uS/cm	HDO %Sat	HDO ma/l	Chl ua/l	baobb	NH4 ma/L-N	NH4 mV
07/06/22	14:33:37	25.065	7.31	427.2	11.23	427.2	94.3	7.64	0.03	10.21	1.4	-0.4

- 1 Click the “*Scuba logging is OFF*” (or, “*Scuba logging is ON*”) hot button to enable or disable the Scuba’s logging function. It lets you tell the Scuba that you will be deploying it in the field for unattended logging. Clicking the hot button toggles the logging on and off. Generally, logging should be off – turn logging to *ON* only when you’re preparing for unattended deployment.
- 2 Click the “*Circulator is Off*” hot button to toggle your circulator, if any, on and off.
- 3 Click the “*Wipe one cycle now*” hot button to activate one cycle of the turbidity sensor’s wiper. If your Scuba doesn’t have turbidity, you can still click this button, but nothing will happen.
- 4 Click the “*Clear screen*” hot button to remove the data you see on the screen and start over with only the most recent data. Clicking this button does not close the program.
- 5 Click the “*Capture one line of data to PC with annotation*” hot button to save the most recent line of data (as shown in the yellow band on the home page) to your snapshot file, along with a brief note that you might wish to append to the data. Type that note in the annotation box. The note will be saved, along with the data, in your snapshot file. (see 3.3.2)
- 6 Click the “*Capture one line of data to PC without annotation*” hot button to save the most recent line of data (as shown in the yellow band on the home page) in your snapshot file. (see 3.3.2)

- 7 Click the “*List Bluetooth Scubas*” hot button to show a list of available Bluetooth Scubas.
- 8 Click the “Restart” hot button, data will be rebuild on the screen.

3.4 “PC” pull-down menu

The Scuba has two pull-down menus, called PC and Scuba. They’re called pull-downs because when you click on them, a bunch of hidden buttons appear. When you click on the “PC” pull-down menu, you get six buttons to choose from:



- 1 Click *Set Scroll Interval* if you wish to change the time for which lines of data on your data display screen are updated. You can click on a specific scroll interval or type in your own.
- 2 Click *Set Snapshot Location* if you wish to specify the file in which your snapshots are to be filed. This calls up the standard “*Save As*” (or equivalent) function of your data display’s operating system. Follow the instructions just as if you were saving, for instance, a new Word document.

A “Snapshot” is what happens when you choose to log, or store, one line of data. That line can be representative of, say, stabilized readings at 10 meters in a particular lake, or any other line of data you find interesting. (3.4, 5.1)

If you want to find those interesting lines of data later, it’s a good idea to put them in a file whose location you can actually remember.

Notice that the active snapshot file location is listed on the bottom line of the home page.

- 3 Click *Automatic Snapshot* if you wish log data automatically and quickly, for instance to catch a transient situation or if you are rapidly profiling a column of water. You can also use *Automatic Snapshot* to save data while you go to lunch. The data are stored in the snapshot file as determined by “*Set Snapshot Location*”. (3.4, 5.1)

In Automatic Snapshot, data are logged at the same interval as they are displayed on your data display screen when you’re not in Automatic Snapshot. For instance, if you have set your PC scroll interval to 10 seconds, automatic snapshot will record data at 10-second intervals.

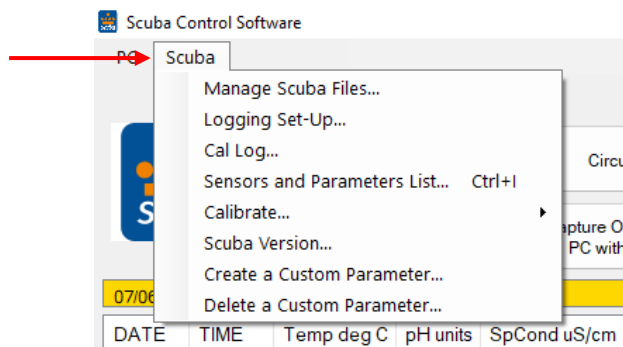
- 4 Click *Graphing* to see your Scuba real-time data in graphical form. The graph view is helpful when profiling to watch for sensor stability. For example, dissolved oxygen readings are temperature and salinity corrected, so when the probe goes through water with thermal or saline stratification, it’s important to wait for stable readings before recording a snapshot.
- 5 Click *COM Ports* to change the USB port that your Scuba control software uses to talk to your Scuba. Normally the Scuba control software searches all active USB ports until it finds a Scuba to talk to, and then it stops looking. But you might have more than one Scuba connected to your PC at one time, for instance if you are calibrating several Scuba’s at the same time or are using your PC to monitor several

Scuba's at the same time (like in a fish hatchery with multiple tanks). In that case, you can click *COM Ports* to see the list all the COM ports that your PC knows about and choose another COM port corresponding to another for the Scuba.

- 6 Click *Control Software Version* to get a screen that tells you the software version that your data display is using to talk to your Scuba.

3.5 “Scuba” pull-down menu

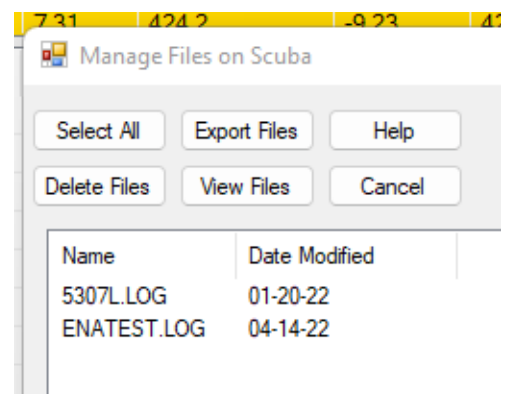
The Scuba has two pull-down menus, called PC and Scuba. They're called pull-downs because when you click on them, a bunch of hidden buttons appear. When you click on the “*Scuba*” pull-down menu, you get eight buttons to choose from:



3.5.1 Manage Scuba files

Click on *Manage Scuba Files* to see the names of all the data files that are stored in your Scuba. Highlight the file you're interested in by clicking on it. Then, with the other buttons on the screen, you can then view that file on your data display screen, delete that file, or export it to your data display (via the *Save As* function standard to Windows).

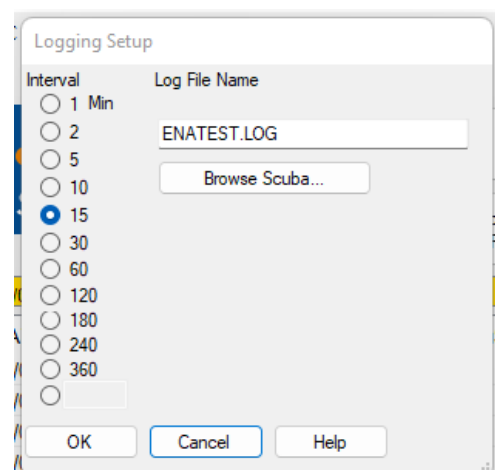
You may highlight multiple files to select for export.



3.5.2 Logging setup

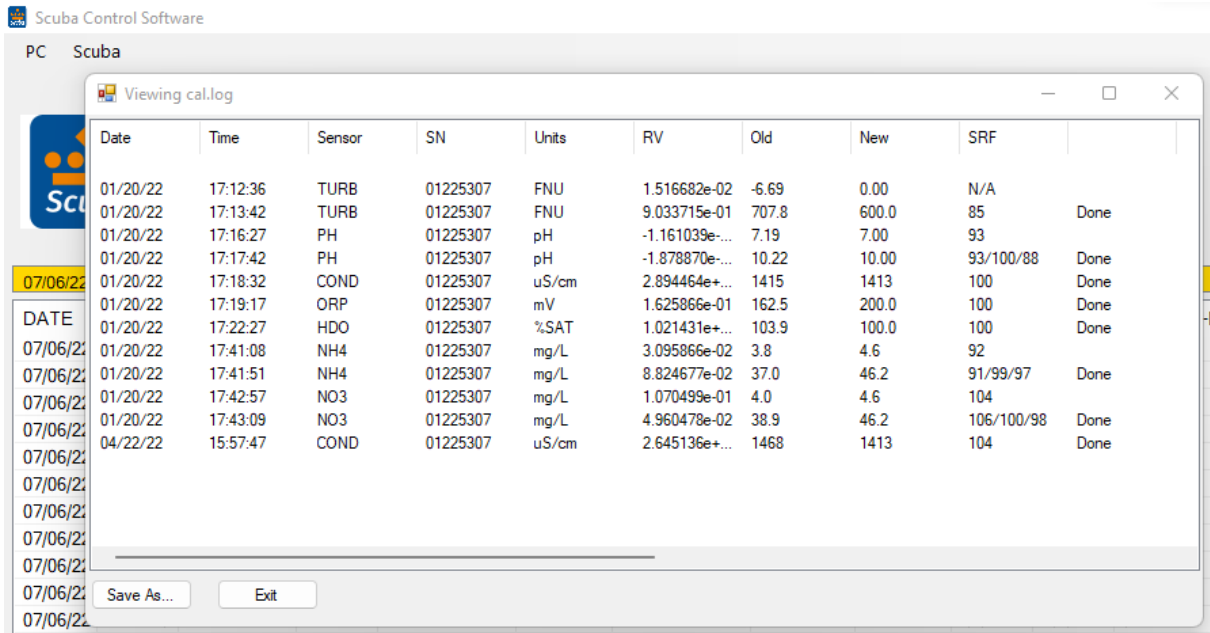
All Scubas include data memory and software that automatically logs (stores) a line of data any time you want. The logging set-up screen lets you change the instructions the Scuba will follow when logging. You can click on your preferred logging interval. You can also select to append any new data to a file that already exists in the Scuba by clicking “*Browse Scuba*”, then selecting a file and clicking on “*OK*”, or you can create a new Scuba logging file by typing the new file name under “*Log File Name*”.

For your convenience, the active logging file name is displayed in the bottom line of the home page.



3.5.3 Calibration log

Click on the *Cal Log* button to see, you guessed it, the calibration record. This is a lifetime, permanent record of all calibration changes for your Scuba (4.4).

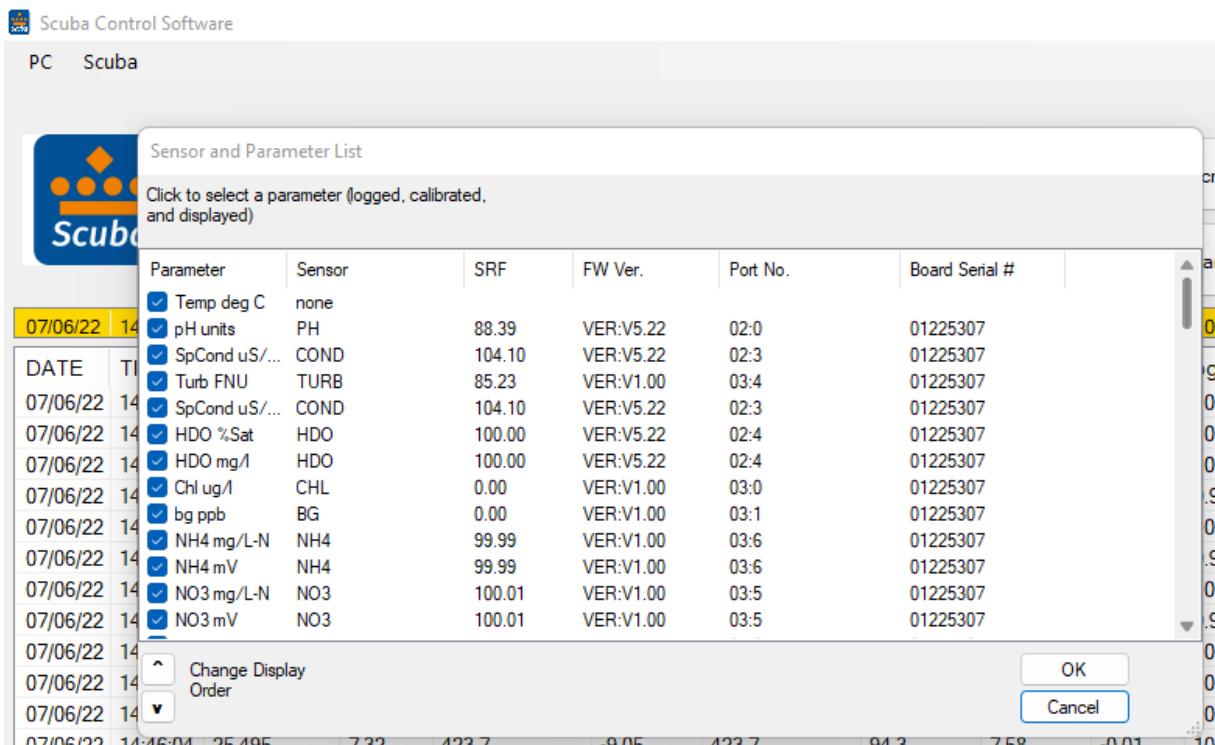


3.5.4 Sensors and parameters list

Click on the *Sensors and parameters list* button enables the parameters listed by clicking the box (to the left of the parameter name) to produce the check mark. Clicking on a box with a check mark removes the check mark and disables that parameter.

Note that if you enable a parameter but don't have a sensor for that parameter, it would be a huge coincidence if the data were accurate.

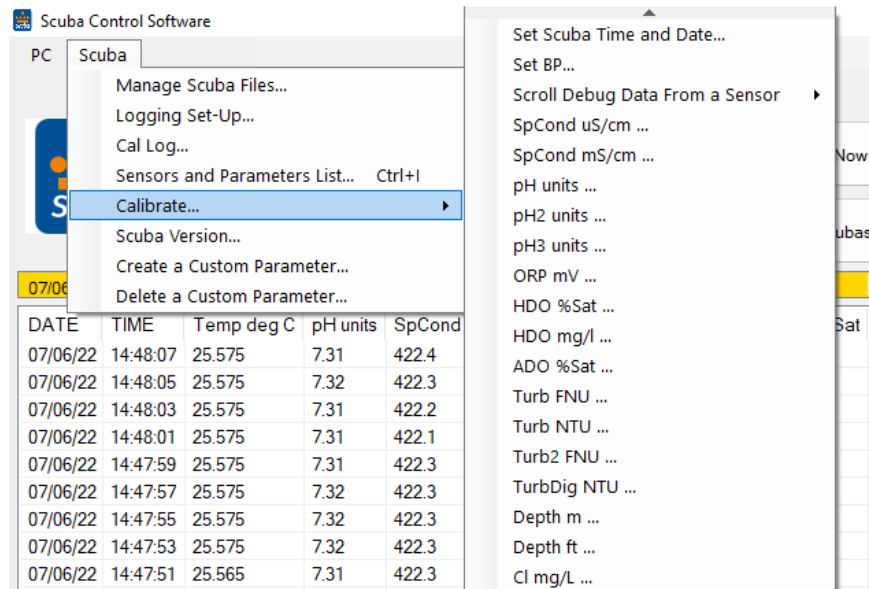
The order of the enabled parameters in this list is the order in which the parameters will appear in your data display home page, the order in which they will appear in logging files, and the order in which they will appear in snapshot files. You can change the parameter order by clicking on (i.e. highlighting) the parameter name and then moving the highlighted name up or down by clicking on the up- and down-arrows at the bottom of the screen.



3.5.5 Calibrate

Click on the *Calibrate* button in the Scuba pull-down menu to get a screen listing all the parameters that can be calibrated in a Scuba. Click on the parameter you wish to calibrate to see its calibrate screen. This screen has calibration instructions for the specific parameter and shows the current reading for that parameter.

If your calibration requires a calibration standard, type your calibration standard value where it says “*enter calibration value*”. When the parameter reading has stabilized in the calibration solution, click on the *OK* button. If your calibration has an acceptable SRF (Sensor Response Factor, an indication of the sensor condition (4.4); the calibration will be accepted, and you will be returned to the home page. If you click on “*OK*”, the calibration will be accepted despite a deviant SRF, and you will be returned to the home page). If you click on “*Cancel*”, you’ll go back to the calibrate screen.



👉 How do I know if I need to calibrate?

The simple answer is that frequent calibration will give you better data. The more meticulous you are with calibration, the better data you will gather. If you are uncertain whether you need to calibrate, check your sensors against a known sample. If the reading is within the accuracy specification and/or your accuracy expectations, there is no need to calibrate.

Experience and your program’s accuracy expectations will help determine calibration frequency for the various sensors. If, for instance, your reservoir discharge is hovering near the regulatory minimum for dissolved oxygen, you should pay special attention to DO calibration frequency and technique. On the other hand, if a conductivity accuracy of +/- 10% is OK, you needn’t calibrate conductivity very often.

3.5.6 Scuba version

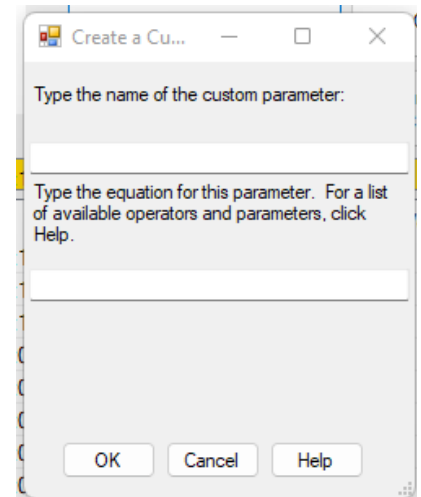
Click this button to see the version number for the software that your Scuba uses.

3.5.7 Create a custom parameter

Suppose you determined the relationship, specific to your waters, between conductivity and total dissolved solids (TDS). Or suppose you had an algorithm relating water level to flow for a certain site. With the Scuba, you can create new parameters – call them, for instance, My TDS and Site 4b Flow – that will show up on your home page and logged data just like temperature, pH, and all the other parameters.

To make this happen, click on the Scuba pull-down menu, and click on *Create Custom Parameter*. Follow the instructions to name your new parameter, specify the units that you wish the new parameter reported in (e.g. mg/l for TDS), and tell the Scuba how to calculate your new parameter (using mathematical operators as you would in Excel).

Note: Enclose the entire expression in parentheses. After creating or deleting a parameter, restart your CPU. Custom parameters cannot be created with the Amphibian2 Scuba control software.



3.5.8 Delete a custom parameter

Suppose you're having second thoughts about the customer parameter you created. Click on the Scuba pull-down menu and click on *Delete Custom Parameter*. Follow the instructions.

3.6 Software updates

A new Scuba software version (2.2.10), was implemented. The new software makes the following improvements to the turbidity parameter:

- 1) The *Sensors and Parameters List* now contains the parameter "*Turb_FNU*", which replaces "*Turb NTU*". *Turb_FNU* is the same measurement as *Turb NTU*, except altered slightly to make its true ISO 2027 response linear with formazin.
- 2) The *Sensors and Parameters List* now contains the parameter "*Turb_Mod*", which is the same measurement as *Turb_FNU*, except NOT altered to make its response linear with formazin. It is numerically equal to the earlier parameter *Turb NTU*.
- 3) The *Sensors and Parameters List* now contains the parameter "*Turb_NTU*". *Turb_NTU* is the same measurement as *Turb_FNU*, except with units of NTU instead of FNU if you prefer that your data are labeled NTU. Calibrating *Turb_NTU* also calibrates *Turb_FNU*, and vice-versa.
- 4) The *Sensors and Parameters List* now contains the parameter "*Turb2_FNU*". *Turb2_FNU* is the same measurement as *Turb_FNU* (or *Turb_NTU*, if you prefer NTU's), except multiplied by a Turbidity scale factor. *Turb2_FNU* is a unique parameter that helps you match Eijkelkamp turbidity readings with readings from other types of turbidity sensors for the sake of data continuity.

For instance, suppose you found that an Eijkelkamp turbidity sensor read 89 while another turbidity sensor read 78 in the same sample. The Turbidity Scale Factor is $78/89 = 0.88$. You can type that Turbidity Scale Factor into the Scuba when calibrating *Turb2_FNU*. Thereafter, all *Turb2_FNU* readings will be the Eijkelkamp turbidity readings multiplied by 0.88 to mimic the readings that you would get with the other turbidity sensor.

The software specific to turbidity has changed as well.

In most cases, you can update your Scuba's software with these new software if you wish to take advantage of the new features dealing with turbidity.

4. Sensors and calibrations

4.1 The difference between sensors and parameters

A sensor is a basic element, like a thermistor or a pH glass electrode. Each sensor has one or more parameters. For instance, we use a thermistor to measure both temperature °F and temperature °C – that’s one sensor with two parameters. A conductivity sensor can be read as specific conductance $\mu\text{S}/\text{cm}$, specific conductance mS/cm , total dissolved solids mg/l , and salinity (PSS) – that’s one sensor with four parameters.



4.2 Basics of parameter calibrations

The Scuba never guesses parameter values, so you have to calibrate it from time to time by simply telling the instrument what it should read in a calibration situation for which the correct parameter value is known. Here’s the general procedure; instructions for specific parameters will follow beginning with 4.5:

- 1 Clean the sensor and perform any necessary sensor-specific maintenance.
- 2 Select a calibration standard whose value is close to the values you expect to see in the field. For best results, use fresh calibration solutions, and discard once they have been used.
- 3 Rinse sensors thoroughly (more than once may be required) with DI (deionized) water, especially if you have been using other calibration solutions. Pour the water into the calibration cup, position the “stopper” side of the lid on top and shake the Scuba vigorously to remove traces of old calibration solutions – repeat if necessary.
- 4 Rinse the sensors twice with a small quantity of your calibration standard. Discard the used calibration standard.
- 5 Immerse the sensor in the calibration standard. This is usually accomplished by pouring the standard into the Scuba’s calibration cup once it has been screwed onto the Scuba housing. Secure your Scuba with the sensors pointing up and fill the calibration cup with your calibration standard. Make sure the standard covers the sensor entirely, and that it also covers the thermistor for those parameters that are temperature-compensated. For turbidity sensors and other fluorometers fill the cup to at least 1 ½ inches above the sensor’s lens surface.

Select the parameter to be calibrated by clicking on the Scuba pull-down menu in the home page, then clicking on *Calibrate*, and then clicking on the parameter you wish to calibrate. First, enter the calibration value and press enter; when the reading has stabilized, press enter to calibrate. The Scuba will report the resulting Sensor Response Factor (SRF); then press Y to accept the calibration, N to back up one step, or Exit to leave the sensor uncalibrated. (3.5.5)

4.3 Choosing calibration standards

For best results, choose a calibration standard whose value is close to what you expect to see in the field. For example, calibrate with a 1413 $\mu\text{S}/\text{cm}$ specific conductance standard if you expect to see specific conductance readings between 500 and 1000 $\mu\text{S}/\text{cm}$ in the field. Calibrating with a sea water standard or a very low standard would not be appropriate in that case. Similarly, if your waters tend toward the acidic, calibrate with a 4-buffer instead of a 10-buffer.

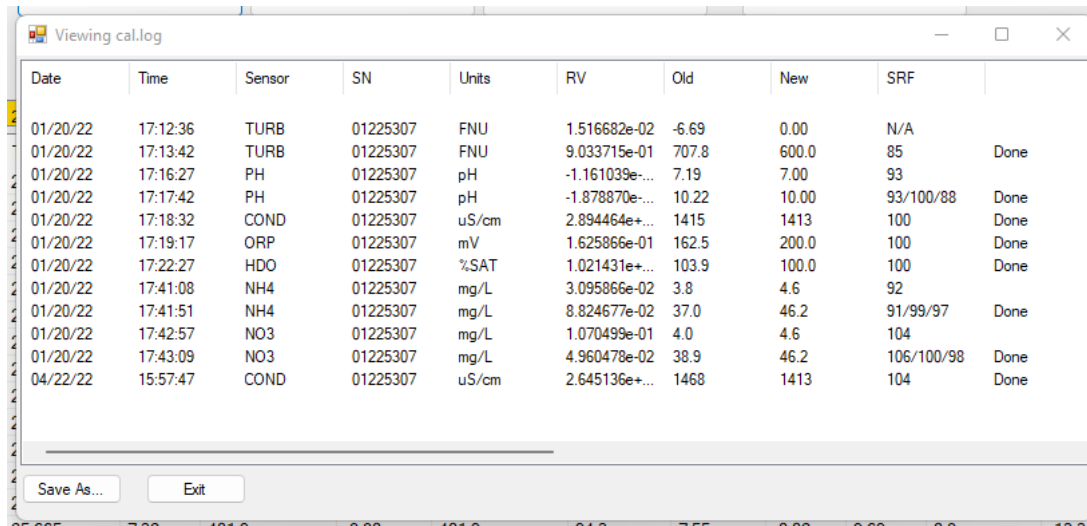
If you are moving your multiprobe across wide ranges of water conditions, you may wish to recalibrate to match the new situations. For instance, if you are measuring a clear lake during the morning and a high-sediment stream in the afternoon, you might consider recalibrating at noon with a high-range turbidity standard.

The table below shows common calibration practices.

Sensor	Standard method of calibration	Available calibration solutions	Comments
Temperature	never requires calibrating	N/A	
pH / pH reference	2 or 3 points	pH 4, pH 7, pH 10	pH 7, pH 10 most common
ORP	1 point	ORP Standard 200 mV	
Conductivity	1 point	CD Standard, 0.5 Molar, 58670 Micro S CD Standard, 0.1 Molar, 12856 Micro S CD Standard, 0.01 Molar, 1412 Micro S CD Standard, 0.001 Molar, 147 Micro S	brackish/saltwater borderline brackish typical freshwater very pure fresh/glacial
Reference Electrode	calibration not required	N/A	replace pH electrolyte solution at routine calibration
Depth	adjust for barometric pressure	N/A	recalibrate at deployment site for best accuracy
Turbidity	2 points	0 NTU, 10 NTU, 100 NTU, 400 NTU	calibrate near expected value
HDO (Optical DO)	calibrate at 100% saturated water	DI water -shake vigorously to oxygenate	set BP before calibrating, recal at deployment site for best accuracy
Chlorophyll	2 points	secondary solid or 40 $\mu\text{g}/\text{L}$ solution or lab sample	
Rhodamine	2 points	secondary solid standard or rhodamine	
Blue Green Algae	2 points	secondary solid standard or lab sample	
Ammonium (NH ₄ ⁺)	2 points	Lo 4.63 mg/l; Hi 46.3 mg/l	
Nitrate (NO ₃ ⁺)	2 points	Lo 4.62 mg/l; Hi 46.2 mg/l	
Chloride (CL ⁻)	2 points	CD Standard 147 Micro S CD Standard 1412 Micro S	enter 34.3 during calibration for low enter 319.3 mg/l for high

4.4 Calibration record (“Cal Log”)

Every Scuba has a dedicated data file called CAL.LOG. The CAL.LOG records every calibration that your instrument has accepted. In this file are the time and date of the calibration, the parameter calibrated, the reading before the calibration was accepted, the reading after the calibration was accepted, the SRF, and a few other details. If you wished to know, for instance, the last time that conductivity was calibrated, the calibration record would tell you when the most recent conductivity calibration was accepted, the value of the calibration standard, and the instrument’s reading in the standard before the calibration was made (to tell you exactly how much the instrument was changed during calibration). This data cannot be altered within the Scuba, so don’t try any funny business.



Date	Time	Sensor	SN	Units	RV	Old	New	SRF	
01/20/22	17:12:36	TURB	01225307	FNU	1.516682e-02	-6.69	0.00	N/A	
01/20/22	17:13:42	TURB	01225307	FNU	9.033715e-01	707.8	600.0	85	Done
01/20/22	17:16:27	PH	01225307	pH	-1.161039e...	7.19	7.00	93	
01/20/22	17:17:42	PH	01225307	pH	-1.878870e...	10.22	10.00	93/100/88	Done
01/20/22	17:18:32	COND	01225307	uS/cm	2.894464e...	1415	1413	100	Done
01/20/22	17:19:17	ORP	01225307	mV	1.625866e-01	162.5	200.0	100	Done
01/20/22	17:22:27	HDO	01225307	%SAT	1.021431e...	103.9	100.0	100	Done
01/20/22	17:41:08	NH4	01225307	mg/L	3.095866e-02	3.8	4.6	92	
01/20/22	17:41:51	NH4	01225307	mg/L	8.824677e-02	37.0	46.2	91/99/97	Done
01/20/22	17:42:57	NO3	01225307	mg/L	1.070499e-01	4.0	4.6	104	
01/20/22	17:43:09	NO3	01225307	mg/L	4.960478e-02	38.9	46.2	106/100/98	Done
04/22/22	15:57:47	COND	01225307	uS/cm	2.645136e...	1468	1413	104	Done

4.5 Sensor Response Factor (SRF)

Also included in the calibration record is each calibration’s Sensor Response Factor (SRF). Suppose that a typical conductivity sensor reports 100 μ A in a 1413 μ S/cm standard. If your conductivity sensor reports 100 μ A in that same calibration solution, then your SRF is 100% (some parameters, such as pH, have a more complex SRF calculation, but the effect is the same). If your response is 80 μ A, your SRF would be 80%. When you press the OK button to accept a calibration, the Scuba automatically accepts your calibration if the SRF is between 60% and 140%. If the SRF falls outside that range, you will be cautioned to check your standard value, make sure the sensor is clean, make sure the reading has stabilized, etc. But you can elect to accept any SRF.

4.6 Temperature

The temperature sensor is an electrical resistor (thermistor) whose resistance changes predictably with temperature. The sensor is protected by a stainless-steel tube. Thermistors are very stable with time, and so do not require calibration.



4.7 Dissolved oxygen

The optical dissolved-oxygen sensor comprises a blue-light source, a sensing surface, and a red-light receiver. The sensing surface is an oxygen-active compound stabilized in an oxygen-permeable polymer, usually silicone. When the sensing surface is exposed to water (or air, for that matter), oxygen diffuses into the sensing surface according to the amount (partial pressure) of oxygen in the water. The oxygen-active compound fluoresces – that is, it absorbs energy in the form of blue light and then emits energy as red light. In each measurement cycle, the blue light is first turned on, and then turned off. The red-light receiver measures the time it takes, after the blue light is turned off, for the fluorescence to die off. This value is proportional to dissolved oxygen.



The sensor output is corrected for the temperature and salinity of the water.

Eijkelkamp is an advocate of the “air-saturated water” calibration method – that’s different from the “water-saturated air” calibration commonly used in the past. Here are the steps to air-saturated water calibration:

- 1 Make sure your instrument’s barometric pressure setting is accurate. (4.18)
- 2 Put a half-litre of tap water in a litre jar, put on the lid and shake the jar vigorously for one minute. Take the lid off the jar and let the water stand for about five minutes to let the air bubbles float out.
- 3 Screw your calibration cup onto the Scuba housing. With the sensors pointed upward, fill the calibration cup until your aerated water covers the DO cap by a centimetre or so.
- 4 Wait a few minutes for the temperature to equilibrate.
- 5 Follow the Scuba control software calibration instructions – remember that you are calibrating % sat, not mg/l, so select % sat from the list.

☞ What’s the real story on optical DO sensitivity to fouling?

Glad you asked. Several years ago, there was rumour floating around that optical DO sensors were not affected by fouling. The rumour was only half true.

Suppose you put an optical DO sensor in a river. If you’re just downstream of a rendering plant or oil patch, your sensor might become coated with grease or oil. Unless that coating is impermeable to oxygen, your sensor will still give accurate readings (though it may be slow to respond to changes in oxygen). That’s because the coating is not oxygen-active, i.e. it doesn’t produce or consume oxygen.

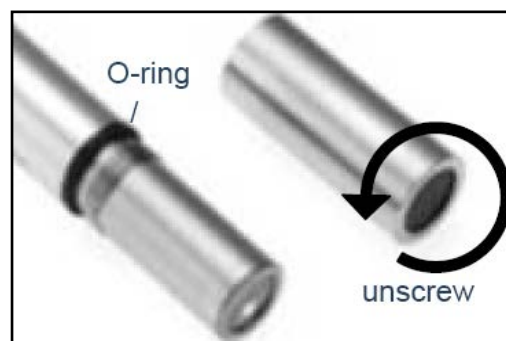
On the other hand, if your sensor picks up an oxygen-active coating, for instance of photosynthetic algae. The algae’s respiration can cause the sensor to report exaggerated swings in diurnal oxygen pressure because the algae have their own micro-environment of oxygen pressure – and the optical DO sensor thinks that the oxygen pressure immediately adjacent its membrane is representative of the rest of the world.

The manufacturers of optical-DO sensors recommend that you not calibrate the zero-DO point. However, we support zero-DO calibration in the Scuba software, and think it’s a good idea to check your sensor’s zero from time to time in either of three ways:

- 1 Dissolve a few grams of sodium sulfite and a pinch of cobalt chloride in a half-litre of tap water. You can buy this solution ready-to-use but be careful not to aerate the solution by pouring it numerous times.
- 2 If you’re like me and think the sodium-sulfite method is yesterday’s news, you can prepare zero-oxygen water by bubbling nitrogen through water. Use bottled gas and an aquarium-type airstone (If you’re using a high-pressure gas bottle, please use a two-stage regulator to prevent unnecessary excitement). After bubbling the gas through, say, a litre of water for, say, 10 minutes, you should have a good zero.
- 3 The simplest way to check zero response is with nitrogen gas. Wrap the sensor-end of your Scuba with a plastic bag, and feed nitrogen gas into the bag. Make sure there’s another hole at the opposite end of the bag for the air to escape, otherwise you won’t get a good zero and the exploding bag will cause excitement. (If you’re using a high-pressure gas bottle, please use a two-stage regulator.)

Optical dissolved-oxygen sensor maintenance is little more than occasionally cleaning the sensing surface (the black material; about a centimetre diameter) with a cloth and soapy water. Optical dissolved-oxygen sensors *usually* have very low drift rates (compared to the old Clark sensors), so practice will show you how often to calibrate your optical sensor. You might also find that one or other of the calibration points does not require calibration every time you set the other point.

The tip of the optical dissolved oxygen sensor (HDO) must be replaced periodically, typically once every 4 years. If your SRF reports less than 100% or if you notice that the sensor’s readings are getting noisy (i.e. jumpy), then it’s probably time to change the tip by unscrewing the old tip and replacing it with a new tip. Recalibrate and you’re ready to go.



4.8 Conductivity

Eijkelkamp uses the four-electrode method to determine water conductivity. Two pairs of graphite electrodes are situated in a stable geometry (you can barely see the electrodes; they look like two bull's eyes inside the slot on the conductivity sensor).

A constant voltage is applied to one of each electrode pair, and the amount of current required to maintain that voltage is measured. As the conductivity of the water increases, the current increases.



The zero point for the sensor is set electronically, so you need only set the "slope" point:

- 1 Fill the calibration cup with your conductivity standard to cover the conductivity sensor. Tap gently on the cup to make sure there aren't bubbles trapped in the conductivity sensor.
- 2 Follow the Scuba control software's calibration instructions.

The Scuba normally reports specific conductance – that's conductivity standardized to 25°C. Your reading is thus the conductivity of your water if that water were heated or cooled to exactly 25°C. Conductivity has several other forms, Total Dissolved Solids (TDS) and salinity. You can't calibrate TDS or salinity directly because they are calculated from conductivity. You can, however, "calibrate" TDS with a TDS standard by adjusting the conductivity calibration point up or down until the TDS standard produces the desired TDS reading. The same is true for salinity if you're using a standard qualified on the Practical Salinity Scale (PSS). "Enable" TDS and/or Salinity by checking the box next to those parameters in the "Sensors and Parameters" section.

4.9 pH

pH is measured as the voltage drop across the glass membrane of a pH electrode. A reference electrode is used to complete the voltage-measuring circuit. The pH glass is specially formulated to absorb water so that ions (particularly H⁺ and OH⁻) in the water are attracted to the glass to offset the ionic constituency of the pH electrode's internal electrolyte. As a result, there is a charge separation across the glass, and that's the voltage we measure. pH readings are automatically compensated for temperature.



pH electrode maintenance is nothing more than occasionally cleaning the glass surface with a soft cloth and soapy water. Do not use anything abrasive. The really important part of pH maintenance is refilling the reference electrode. (4.10) You can choose a two- or three-point pH calibration. The two-point calibration, a seven buffer and a second buffer whose value is near that of the waters you intend to monitor, is recommended. If you are measuring in waters whose pH might range above and below seven, you can increase your accuracy slightly by choosing a three-point calibration (the third buffer should be on the other side of seven). pH calibration is simple:

- 1 Rinse your sensors several times with the pH buffer you'll use for calibration.
- 2 Fill the calibration cup with enough buffer to cover both the pH and reference electrodes.
- 3 Follow the Scuba control software calibration instructions.
- 4 Repeat steps 1, 2, and 3 if you choose to calibrate with one or two more standards.

4.10 Reference electrode

The key to reliable pH, ORP, and ISE measurements is a well-maintained reference electrode. Recall that a reference electrode is required to complete voltage measurement for pH readings.

Reference electrode maintenance is simple:

- 1 Remove the reference cap by unscrewing it from the reference sleeve and discard old reference electrolyte.
- 2 Fill the sleeve completely with fresh pH reference electrolyte (KCl saturated with silver chloride). Tap the Scuba a few times to dislodge any bubbles.



- 3 Screw the reference cap back on to the sleeve. As you screw the sleeve into place, air and excess electrolyte is forced out of the sleeve through the reference electrode junction (the white, porous circle at the end of the sleeve). This not only purges bubbles from the electrolyte, but also cleans nasty stuff out of the junction.

👉 **Other manufacturers may tell you that their integral, or combination, reference electrode is better. This is not true**

First of all, every year or so you have to buy a new combination electrode for about € 275 and install the whole thing yourself. Second, combination electrodes usually employ “gelled” electrolyte, and are therefore inclined to calibrating easily in standard pH buffers but measure poorly in low-conductivity waters (like < 200 umhos). With the Eijkelkamp-style reference electrode you spend a few pennies and a few minutes every month or two refilling the electrolyte. And its “free-flowing” junction performs well in low-conductivity waters.

4.11 ORP

ORP is measured as the voltage drop across the platinum membrane of an ORP electrode.

The actual ORP sensor is the 1 mm silver-coloured dot you can see when looking down at the pH sensor – if your Scuba has ORP. A reference electrode is used to complete the voltage-measuring circuit. Because platinum does not react with ions in the water, it won’t give or take any electrons from those ions unless they are very persuasive. The potential (voltage) created by this refusal is what you’re actually measuring as ORP. ORP electrode maintenance is nothing more than occasionally cleaning the platinum surface with a soft cloth and soapy water. If the platinum is discoloured, you can polish the ORP electrode with very light abrasive, like 900-grit wet-and-dry sandpaper (please be careful not to polish the pH glass bulb). The important part of ORP maintenance is refilling the reference electrode (4.9).



ORP uses a one-point calibration:

- 1 Rinse your sensors several times with the ORP standard you’ll use for calibration.
- 2 Fill the calibration cup with enough ORP standard to cover both the ORP and reference electrodes.
- 3 Follow the Scuba control software calibration instructions after selecting ORP_mV to calibrate.

4.12 Depth and vented depth (stage)

Depth is measured by a strain-gauge transducer as hydrostatic water pressure. The deeper you go in the water, the higher the pressure.

Eijkelkamp’s depth sensors are usually inside the instrument, with a small pressure port that can be seen on the outside of the Scuba bottom cap. They require no regular maintenance, but you might check occasionally to make sure the pressure port is not clogged. If it is, use something soft, like a toothpick, to clear the port of obstruction.

Depth calibration is nothing more than “zeroing” the sensor in air, where one assumes the depth to be zero:

- 1 Make sure the Scuba is not in the water.
- 2 Follow the Scuba control software’s calibration instructions.

Notice that the depth sensor cannot distinguish between water pressure and the air pressure over that water (i.e. barometric pressure). After you have zeroed the sensor, any change in barometric pressure will be measured as a change in water pressure. Fortunately, water on earth is considerably heavier than air, so the error introduced by barometric pressure changes is small.

If that’s not good enough for you, there’s always vented depth, or stage. Vented depth uses the same transducer as does depth, except that there’s a tiny hole in the back of the transducer. If you have a vented cable (a cable that has a tube running through it), atmospheric pressure is sensed by the transducer via the little hole. Changes in barometric pressure will not affect the depth reading.

Vented depth cables have a desiccant-filled housing at their surface end. The desiccant keeps water from condensing in the vent tube by letting vapor escape through a small Gortex patch. Keep that housing clean and replace the desiccants every year or so.

4.13 Turbidity

Turbidity is measured as the fraction of an infrared light beam that is scattered at 90° to that beam. More particles in the water mean more of that light is scattered, so the turbidity reading is higher.

Any material that accumulates on the optical surfaces of the turbidity sensor is indistinguishable from material in the water, so most turbidity sensors have little wipers to clean the window(s).

Turbidity sensors require no regular maintenance, but you might check occasionally to make sure the optical window (i.e. the little glass port on the front of the sensor) has not been damaged by overzealous wiping. Turbidity uses a two-point calibration; one point is zero turbidity and the other point should be a standard approximating the turbidity of the water you intend to monitor.



For the zero calibration:

- 1 Make sure the turbidity sensor is fully immersed (i.e. at least 1 ½ inches of solution over the sensor) in zero-turbidity standard and has an unobstructed optical path.
- 2 Follow the Scuba control software’s calibration instructions.

For the other calibration point:

- 1 Rinse your sensors several times with the standard you’ll use for calibration.
- 2 Make sure the turbidity sensor is fully immersed (i.e. at least 1 ½ inches of solution over the sensor) in the standard and has an unobstructed optical path.
- 3 Follow the Scuba control software’s calibration instructions.

A clean wiper means better measurements. If the wiper pad has deteriorated or is clogged with debris from your water (algae, silt, etc.), you should change it. For best results, you might consider changing the wiper pad prior to each long-term deployment.

To change the wiper pad:

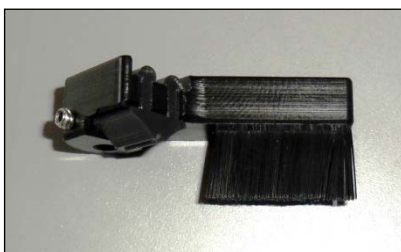
- 1 Make sure you have the 1.5 mm hex key and a new pad for the wiper. Loosen the small set screw on the wiper arm.
- 2 Remove the wiper pad from the wiper arm and replace the pad.
- 3 Place a new wiper arm on the motor shaft so that the set screw faces the flat spot on the motor shaft.
- 4 Gently press the wiper pad against the face of the probe until the pad is compressed to roughly three quarters of its original thickness. It is important that the wiper arm does not make contact with the probe face – only the pad should be in contact. A gap of 0.5 mm between the wiper arm and the probe face is typical when a new pad has been installed. Another way of setting the pad gap is to place the pad such that you can slide a small piece of paper under the pad, but snug enough that the pad will hold the paper.
- 5 Tighten the set screw.



Do not over-tighten the set screw on the little rotating arm that holds the wiper pad; that will strip the threads, and that will cause cursing once you realize what you did. And don't rotate the wiper arm manually; that will strip the gears and stick you with a big, hard-to-explain repair bill.

Your turbidity sensor may be equipped at the factory with an extended brush arm. For best results, change the brush frequently by pulling the old brush out of the brush arm body, and sliding a fresh brush into the brush slot as shown below.

Use the first Allen wrench from your wiper kit to remove the standard turbidity sensor wiper. Use the other Allen wrench to install the brush arm. Notice that the Allen set screw seats on the flat side of the wiper motor shaft.



The new Scuba software version adds several turbidity features for the hard-core turbidity people. Please see 3.6.

4.14 Fluorometers

Eijkelpamp's chlorophyll, rhodamine, blue-green algae, CDOM, fluorescein, and crude oil sensors are Turner designs fluorometric sensors, with each tuned to the slightly different wavelengths.

Fluorescence occurs when a molecule absorbs light at one wavelength and then emits that energy at a different wavelength. More molecules of analyte produce a higher level of that different-wavelength light.

Fluorometric sensors emit light at a certain wavelength, and look for a very specific, different wavelength in return. The magnitude of the return light is relatable to the amount of analyte present.

Note that there are two types of blue-green algae sensors – fresh-water and marine.

Note that CDOM, or Colored Dissolved Organic Matter, is also known as fDOM (fluorescent Dissolved Organic Matter), chromophoric dissolved organic matter, yellow substance, and Gelbstoff.

Note that there are many different types of crude oil, and each has a relatively unique fluorescence response.



We use Turner designs fluorometers because Turner is recognized as the world's leading manufacturer of miniature fluorescence sensors.

There are several conventional ways to calibrate fluorometers; those are explained in [Calibrating Eijkelpamp's Turner Fluorometers](#). Eijkelpamp also has a new method for "standardizing" fluorometers if you do not use a conventional calibration method; that is explained in [Standardizing Eijkelpamp's Turner Fluorometers](#). Both of these documents can be found on the flash drive.

The maintenance procedure is pretty much the same for all fluorometers:

- 1 Cleaning the sensor: Rinse the chlorophyll sensor in fresh water following each deployment, ideally until it is completely clean again. Do not let the chlorophyll sensor come in contact with any organic solvents, such as acetone and methanol, or strong acids and bases.
- 2 Cleaning the optics: Visually inspect the optical window after each deployment following a soaking in fresh water. Use optical tissue to clean the window with soapy water, if needed.

4.15 Ion-Selective Electrodes (ISE's)

ISE's are traditionally used in the laboratory at a constant, moderate temperature, with ionic strength adjusters added to each sample so that the sample and calibration solution have roughly the same ionic strength. ISE's can provide valuable information in the field, for instance in watching short-term trends, but their calibration requirements, stability, and accuracy are not nearly as simple and reliable as those for DO, conductivity, turbidity, etc. For field use, Eijkelpamp makes several theoretical and empirical corrections to elicit the best possible field performance.



ISE's operates much like a pH electrode except that the pH glass is replaced by a membrane that is selective for the analyte of interest (ammonium, chloride, nitrate, sodium). The electrode's filling solution contains a salt of the analyte, and the difference between that salt's concentration and the analyte concentration in your water produces a charge separation. That charge separation is measured, relative to the reference electrode, as a voltage that changes predictably with changes in the analyte concentration in the water adjacent the membrane.

It's best not to let your ISE dry out, so place a small amount of tap water in the storage cup to ensure 100% humidity. The sensing elements (tip) for nitrate and ammonium ISE's have lifetimes of about 90 days. Then, you must replace the tip by unscrewing it from the sensor body and screwing in a new tip.

Each sensor body is programmed for a specific ISE; the ISE is identified by a series of rings or dots. One ring or dot means the sensor body is programmed for a chloride ISE; two mean calcium, three mean nitrate, four mean ammonium, 5 mean bromide, and six mean sodium.

☞ **It's a good idea to limit the submersion of ISE's to about 10 meters. If you need to go deeper than that with the other sensors, you can use a plug for the ISE electrode.**

Note that the ammonium ISE senses ammonium, but at pH's higher than about 8 the ammonium (NH_4^+) is mostly converted into ammonia gas (NH_3). Eijkelpamp's software uses the pH, conductivity, and temperature of the sample water to calculate ammonia (as mg/L-N). You can also display total ammonia; the sum of ammonia and ammonium. Note that ammonium and nitrate ISE's suffer interference from positive ions, especially potassium and sodium, and sodium ISE's suffer interference from positive ions, especially potassium and ammonium. The chloride ISE does not normally suffer from interfering ions.

Note that Eijkelpamp's sodium ISE has a plastic membrane with a wider pH range (pH 3 – 10) and less pH interference than the traditional sodium ISE's (which are made with glass membranes). This sensor is specified to have a 10-second response time and a range of 0.05 – 2,300 mg/L Na^+ . The sodium ISE can be immersed to 15 meters of water without damage, but there may be a pressure effect on the reading. Although Eijkelpamp testing on a limited sample size showed this error to be within our $\pm 20\%$ accuracy specification, we recommend that users check the performance of their particular sensors under actual field conditions.

Note that the sodium ISE has a slow response to changes in temperature and may take many minutes to reach a final reading when the temperature changes significantly.

If your Scuba is equipped with more than one ISE, use care when replacing tips so that you don't put a tip on the wrong sensor (for example put a nitrate on the sodium sensor).

ISE calibration is more complex than calibrations for most other sensors, but we've made it as simple as possible in [Calibrating Ion-Selective Electrodes: The difference between activity and concentration](#). This document can be found on the Eijkelkamp flash drive.

4.16 Total Dissolved Gas (TDG)

The TDG sensor is a pressure transducer (the same one used for the 10-meter depth sensor) attached to a "membrane". This membrane is a long piece of thin-wall, silicone tubing whose job is matching gas partial pressures inside the tube with those of the surrounding water. The sum of those partial pressures is measured by the transducer, and that's the TDG of the water. Aside from keeping the membrane as clean as possible without tearing the tubing, the TDG sensor requires no maintenance. When the membrane is torn or is just too dirty, the membrane assembly must be replaced. Simply unscrew the old membrane and screw on a new membrane. Screw it on finger-tight, plus 1/4 turn.



Silicone rubber is chosen for the membrane material because gases pass through silicone readily. This means that response time for silicone is much faster than if the membrane were, say, Teflon. However, if the membrane is soaked in water for more than a few hours, the silicone absorbs just enough water to slow the gas transfer considerably. This is not usually a problem for unattended monitoring applications (the TDG doesn't change very quickly anyway) but can be annoying if you are doing daily spot-checks. In that case, it's best to dry out the membrane between stations by using only a few drops of water in the storage cup instead of a few ounces.

4.17 PAR

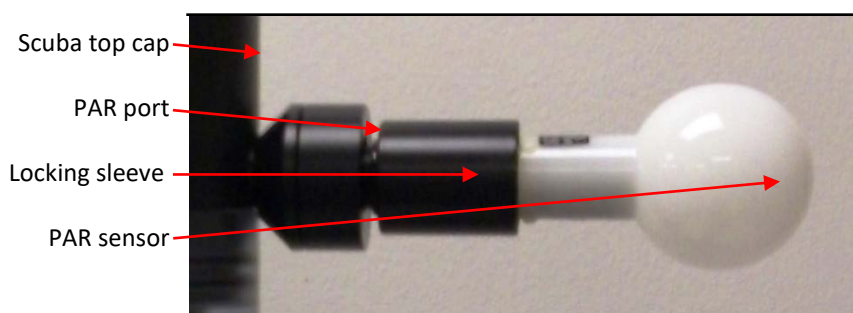
The PAR (Photosynthetically Active Radiation) sensor measures the amount of light available to biota for photosynthesis. Its units of measurement are micro-moles of photons per square meter per second, or photon $\mu\text{moles}/\text{m}^2$ second. This is also referred to as micro-Einsteins per square meter per second.

The sensor looks like a light bulb and receives light from all directions except the "blind spot" at its base. Eijkelkamp mounts the PAR sensor a few inches away from the multiprobe, facing away from the multiprobe, so that the multiprobe is in the blind spot.

PAR sensors are supplied with a dummy plug so that you can use the Scuba 2 without the PAR sensor attached.

PAR measurement is accessed for display through the menu structure just like all other sensors. The PAR sensor is calibrated at the LI-COR factory, and cannot be calibrated by the user. LI-COR recommends that the sensor be returned to the factory every couple of years to be re-calibrated.

PAR sensors are not attached to the multiprobe when shipped from Eijkelkamp; there is a dummy plug in the PAR port. To attach the PAR sensor, simply unscrew the dummy plug's locking sleeve (it's the same type locking sleeve used for Eijkelkamp cables) and pull the dummy plug out of the port. Slide the locking sleeve onto the non-light-bulb end of the PAR sensor and push the PAR sensor into the port as you tighten the locking sleeve. This may take a little bit of practice, as the locking sleeve's off-center hole has to shift slightly to center of the PAR sensor and its port.



There is no need to tighten the locking sleeve more than finger-tight.

Reverse the process to remove the PAR sensor if you wish to make calibration easier, or for cleaning, or for storage if you want extra protection for the PAR sensor. Simply unscrew the locking sleeve, pull the sensor away from the multiprobe, re-install the dummy plug, and re-install the locking sleeve. The dummy plug seals the PAR port, so you can submerge the multiprobe without the PAR sensor attached.

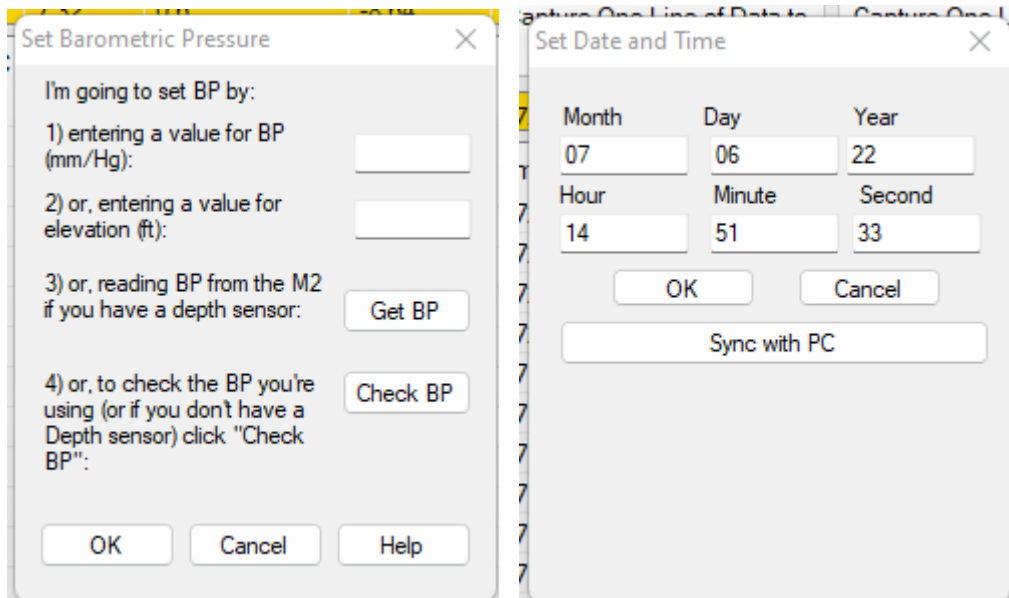
The PAR sensor is made of acrylic plastic for optical reasons. Acrylic is somewhat brittle, so don't step on the sensor. It's also rather soft, so clean the sensor only with soapy water and a soft, wet cloth.

A copy of LI-COR's PAR instruction manual is included with the PAR sensor; it's well-done and worth reading.

4.18 Set barometric pressure and set time and date

Your Scuba needs to know the local Barometric Pressure (BP) if you have a Clark or optical dissolved oxygen sensor, so click on the *Set Barometric Pressure* button (it's in the Calibrate menu). You can set the BP by typing the correct value (in mm Hg) in the first box of the Set BP screen (below, left). Or, you can set the approximate BP by typing your altitude (in feet) in the second box. Notice that if you type in BP, altitude is automatically calculated, and vice-versa. The third method for setting BP is asking your Scuba the value (if your Scuba is equipped with an un-vented depth sensor). If you choose this method, remove the calibration cup from the Scuba and make sure the depth sensor is exposed to air. The correct values will automatically appear in the BP and altitude boxes.

Click on the *Set Date and Time* button to see the Scuba's opinion on time and date. If you wish to change any of those values, just type the new value in the appropriate box or click the box at the bottom of the screen (above, right) to synchronize the Scuba time and date with that of the device you're using to read the Scuba, i.e. your PC or Amphibian.



5. Data logging



Batteries loaded backwards (reversed polarity) can damage any battery pack and may cause pressure to build up inside the battery pack. So please pay careful attention to the polarity markers found on all Eijkelkamp battery packs.

5.1 What's the difference between "Logging" and "Snapshot"?

"Logging" always refers to unattended data capture and storage in the Scuba. "Snapshot" refers to the manual capture of data into your data display (PC or small-screen device).

5.2 Why we do logging the way we do

Lesser manufacturers may require that you type in long strings of digits to specify start time, start date, end time, end date and logging interval. One wrong digit and you might get no data. The Scuba requires only that you click one hot button, install batteries, and (for Scuba 90 and 105 models) flip the battery-pack switch to "ON". No typing. Once this is done, the red LED will blink five times to confirm that logging is activated, and the green LED will blink briefly to confirm that the Scuba is receiving adequate voltage to start logging. It's fast and fool-proof.

Another user-friendly feature of the Scuba logging time uniformity. For instance, if your logging interval is 15 minutes and you turn logging on at five minutes past 10 AM, your first data will be logged at exactly 10:15, and then every 15 minutes thereafter. If your logging interval is one hour and you turn logging on at five minutes past 10 AM, your first data will be logged exactly at exactly 11 AM, and then every hour thereafter. Your data are cleaner, and it's easier to match times if you wish to merge data logs.

5.3 Sensor warm-up

Your Scuba knows the warm-up times required for all the sensors you have enabled. It figures out exactly when to turn the various sensors on so that a frame of data can be taken exactly at the correct time. For instance, the HDO dissolved oxygen sensor takes 20 seconds to warm up and the turbidity sensor takes 25 seconds to warm up. So, the Scuba turns on the DO sensor 20 seconds, and the turbidity sensor 25 seconds, ahead of the time data is required. This minimizes power consumption.

5.4 Setting up logging runs, logging file management, logging interval

These Scuba logging functions are software-driven and explained in Section 3.5.2.

5.5 Activating Scuba logging

To initiate logging, you must "activate" logging by clicking the "Scuba logging is OFF" hot button so that it changes to "Scuba Logging is ON".

DATE	TIME	Temp deg C	pH units	SpCond uS/cm	Turb ENI	SpCond uS/cm	HDO % Sat	HDO mg/l	Chl a/l	hpph	NH4 mg/L
07/06/22	14:33:37	25.065	7.31	427.2	-11.23	427.2	94.3	7.64	0.03	10.21	1.4

Then all you have to do to start logging for Trimeter and Scuba 50, 65, and 75 models is load batteries. For convenience, you may wish to take a data display to the field so that you can activate logging right before you place the Scuba in the water. Don't forget to activate logging.

All you have to do to start logging for Scuba 35 and 40 models is load batteries and, when you get to the field, turn the IBP switch on the top cap to "ON". Don't forget to activate logging.

Don't forget that the blinking green LED tells you that you have adequate voltage to begin logging, and the blinking red LED tells you that logging is indeed enabled.

5.6 Am I using battery pack power or cable power?

Most users log data using an Internal Battery Pack (IBP) or External Battery Pack (EBP). But you can also log using power from a secondary power source (such as a solar-recharged storage battery located above the water surface) via the underwater cable. If you have an IBP or EBP and a secondary power source attached, the Scuba will use power coming from the secondary power source as long as its voltage is sufficient. If the Scuba cannot find adequate voltage in the underwater cable, it will use the IBP or EBP. This scheme preserves your Scuba batteries when possible. Other manufacturers, for reasons unknown, use the power source with the highest voltage, meaning that your Scuba batteries may be consumed quickly. More information can be found in [M-Scuba logging with uninterrupted external power supply](#) and [M-Eight ways to power a Scuba](#).

5.7 Logging with an Internal Battery Pack

All Scubas may be ordered with an optional Internal Battery Pack (IBP), a watertight housing with a cassette for batteries that is permanently fixed to the Scuba. Most IBP's are used for logging, but they can also be used to power the Scuba while it is connected to a data display.

5.7.1 Changing IBP batteries in Scuba 50, 65, and Trimeters and activating logging

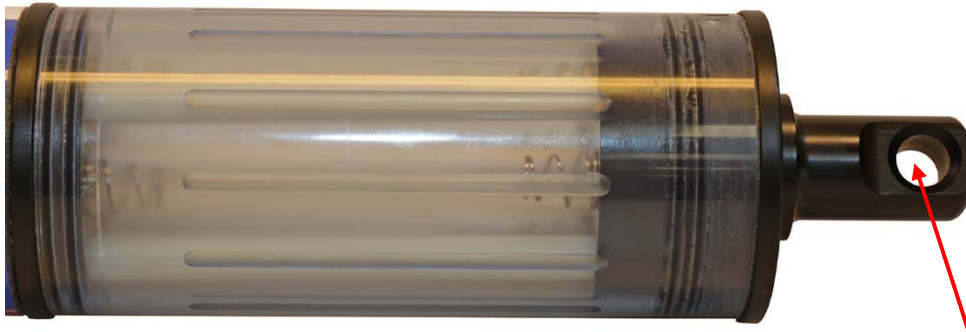
- 1 Replace all batteries at the same time and use the same brand of battery.
- 2 Clean all moisture, dirt, grit and any other debris off the Scuba because you are going to expose sealing surfaces as you change the batteries.



- 3 Grasp the clear battery sleeve that covers the battery housing and unscrew it until it detaches from the IBP body.
- 4 Remove the spent batteries and install the new ones carefully following the polarity diagram. Your Scuba is now logging, if you have activated logging. De-activate logging if you don't want to be logging now.
- 5 Clean all moisture, dirt, grit and any other debris off the exposed O-ring surfaces and the inside of the battery sleeve. Add a small amount of silicone grease to the O-rings and to the inside of the battery sleeve where the O-rings will seat.
- 6 Carefully screw the battery sleeve back into place. You don't have to tighten it closely to the IBP body; finger-tight is fine.
- 7 Remember that you must first activate Scuba logging by clicking the "Scuba Logging is OFF" hot button so that it changes to "Scuba Logging is ON" (3.3, 5.5).
- 8 Remember to look for the red LED to blink five times to confirm that logging is activated, and the green LED blink briefly to confirm that the Scuba is receiving adequate voltage to start logging.

5.7.2 Changing IBP batteries in Scuba 75 models and activating logging

- 1 Replace all batteries at the same time and use the same brand of battery.
- 2 Clean all moisture, dirt, grit and any other debris off the Scuba because you are going to expose sealing surfaces as you change the batteries.



- 3 Grasp the polymer “eyebolt” on the top of the battery housing and unscrew it until the top cap and clear housing detach from the Scuba body.
- 4 Remove the spent batteries and install eight C-cell batteries (or six D-cell batteries) carefully following the polarity diagram.
- 5 Clean all moisture, dirt, grit and any other debris off the exposed O-ring surfaces and the inside of the battery sleeve. Add a small amount of silicone grease to the O-rings and to the inside of the battery sleeve where the O-rings will seat.
- 6 Carefully place the top cap – clear housing back into place, and screw the eyebolt until the clear housing seats on the Scuba. You don’t have to tighten it closely to the IBP body; finger-tight is fine.
- 7 Remember that you must first activate Scuba logging by clicking the “*Scuba Logging is OFF*” hot button so that it changes to “*Scuba Logging is ON*” (3.3, 5.5).
- 8 Remember to look for the red LED to blink five times to confirm that Logging is activated, and the green LED blink briefly to confirm that the Scuba is receiving adequate voltage to start Logging.

5.7.3 Changing IBP batteries in Scuba 90 and 105 model and activating logging

- 1 Replace all batteries at the same time and use the same brand of battery.
- 2 Clean all moisture, dirt, grit and any other debris off the Scuba because you are going to expose sealing surfaces as you change the batteries.
- 3 Unscrew the eye-bolt until you are able to completely remove the battery plug.
- 4 Remove the spent batteries and install six C-cell batteries carefully following the polarity diagram.
- 5 Clean all moisture, dirt, grit and any other debris off the exposed O-ring surfaces and the inside of the battery tubes. Add a small amount of silicone grease to the O-rings and to the inside of the battery tubes where the O-rings will seat.
- 6 Re-attach the battery plug by turning the eye-bolt. You don't have to tighten it closely to the Scuba; finger-tight is fine.
- 7 Remember that you must first activate Scuba logging by clicking the "Scuba Logging is OFF" hot button so that it changes to "Scuba Logging is ON" (3.3, 5.5).
- 8 When you are ready to deploy the Scuba, turn the battery switch to "ON". (And turn the switch back to "OFF" when you retrieve the Scuba).
- 9 Remember to look for the red LED to blink five times to confirm that logging is activated, and the green LED blink briefly to confirm that the Scuba is receiving adequate voltage to start logging.
- 10 Your Scuba is now logging and will continue logging until you turn the battery switch to its "OFF" position, or your batteries are depleted.

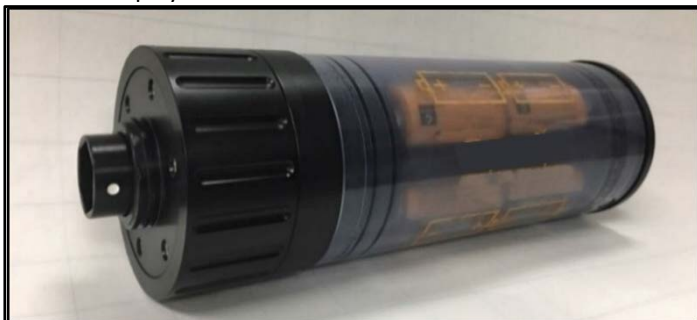


5.8 Logging with an external battery pack

5.8.1 The external battery pack

All Scuba models (except the Scuba 90 and 105 models with Internal Battery Packs) can utilize the optional External Battery Pack (EBP), a watertight housing with a cassette for batteries that can be removed from the Scuba. Most EBP's are used for logging, but they can also be used to power the Scuba while it is connected to a data display if the data display cannot provide sufficient power.

The EBP simply screws into the Scuba multiprobe where normally you would find the underwater cable and its locking sleeve. The EBP is installed immediately before a logging deployment, and later removed so your Scuba can upload data to a data display or be calibrated.



5.8.2 Changing EBP batteries and activating logging

- 1 Replace all batteries at the same time and use the same brand of battery.
- 2 Clean all moisture, dirt, grit and any other debris off the Scuba because you are going to expose sealing surfaces as you change the batteries.
- 3 Unscrew the black knob at the top of the EBP it until the battery sleeve detaches from the EBP body.

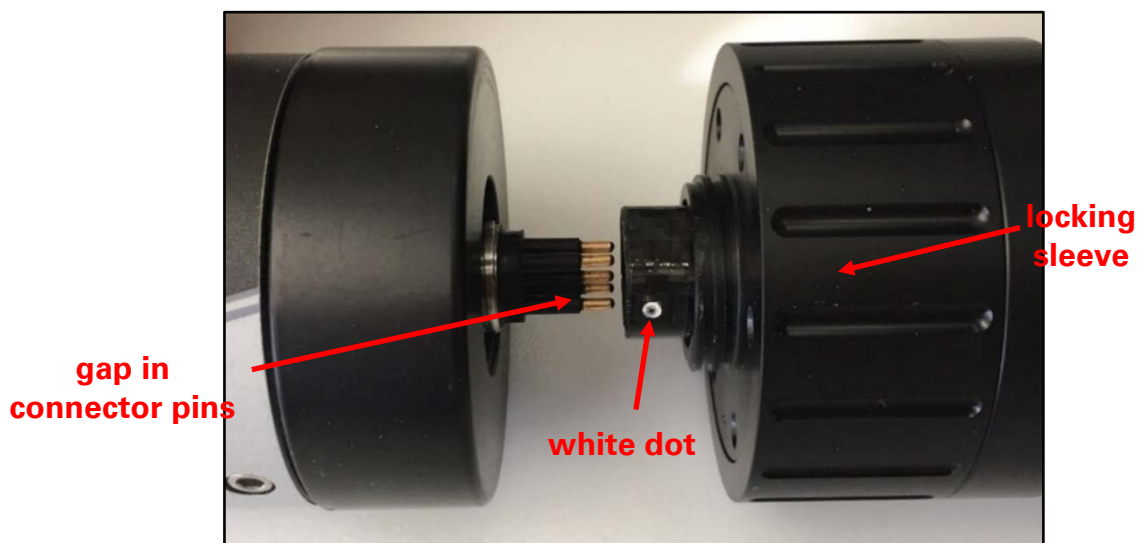


- 4 Remove the spent batteries and install eight C-cell batteries (or six D-cell batteries) carefully following the polarity diagram.
- 5 Clean all moisture, dirt, grit and any other debris off the exposed O-ring surfaces and the inside of the battery sleeve. Add a small amount of silicone grease to the O-rings and to the inside of the battery sleeve where the O-rings will seat.
- 6 Carefully screw the battery sleeve back into place. You don't have to tighten it closely to the EBP body; finger-tight is fine.
- 7 Remember that you must first activate Scuba logging by clicking the "Scuba Logging is OFF" hot button so that it changes to "Scuba Logging is ON" (3.3, 5.5).

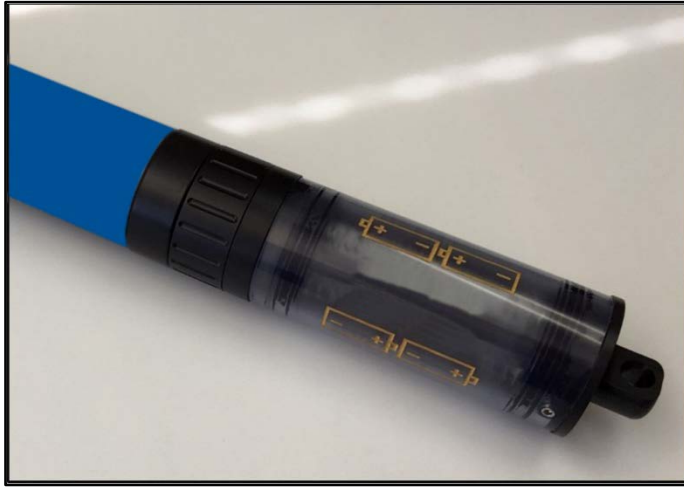
Remember to look for the red LED to blink five times to confirm that logging is activated, and the green LED blink briefly to confirm that the Scuba is receiving adequate voltage to start logging.

5.8.3 Installing and removing the EBP

- 1 Remove the marine connector protector or, if a cable is attached to your Scuba, remove the locking sleeve and then the cable.
- 2 Clean the connectors on the EBP and Scuba and add a little silicone grease to each.
- 3 Find the white dot on the hexagonal sleeve on the bottom of the EBP and note that the Scuba connector has six pins with a gap in the outer circle of pins.
- 4 Line up the white dot with the gap in the connector pins and slowly push them together. Very little force is needed.



- 5 Grasping only the Scuba and EBP locking sleeve (the portion of the lower EPB with the serrations), turn the EBP locking sleeve so that it screws into the threads where the underwater cable locking sleeve is normally fitted. You may have to jiggle the EBP a bit so that the hexagonal sleeve fits properly over the hexagonal base of the connector.



- 6 Tighten the EBP locking sleeve firmly, but not so tightly that you will have difficulty removing it later.
- 7 Remember that you must first activate Scuba logging by clicking the “*Scuba Logging is OFF*” hot button so that it changes to “*Scuba Logging is ON*” (3.3, 5.5).
- 8 Remember to look for the red LED to blink five times to confirm that logging is activated, and the green LED blink briefly to confirm that the Scuba is receiving adequate voltage to start logging.

Your Scuba is now logging, and will continue logging until you remove the EBP, or your batteries are depleted.

To remove the EBP, grasp the Scuba with one hand and the EBP locking sleeve with the other, and unscrew the EBP locking sleeve. Pull the Scuba and EBP apart.

☞ **Twist only the EBP locking sleeve - twisting the entire EBP body only creates unhappiness.**

5.9 Batteries and battery life

When the batteries in a Scuba battery pack are spent, logging simply ceases. It may begin again after a few hours if your batteries recover sufficiently during that time.

Unfortunately, there are so many different combinations of sensors, water temperature, logging intervals, types of batteries, etc. that estimation of battery life may not be very accurate. We recommend that you run the Scuba in the field to see how long the batteries will last in your specific application.

We recommend using the highest quality alkaline batteries available, such as Duracell Copper Tops. Rechargeable batteries can be used, but their battery life is typically only half that of non-rechargeable batteries.



We strongly recommend that you do not use lithium batteries in any Eijkelpomp battery pack. Lithium batteries don't like water and may cause a dangerous build-up of pressure if they get wet during a deployment. That pressure can damage the instrument and/or you.

It's a good idea to remove the batteries from the Scuba battery pack if the Scuba is not going to be used for a while. This helps prevent battery leakage.

5.10 Logging redundantly with telemetry

If you wish to add redundancy to your data collection, you can connect a Scuba to a third-party data logger, telemetry device, etc. to store data in the Scuba (using its standard logging function) and in the third-party device (according to its manufacturer's instructions).

Since you will be using an underwater cable, you can run power to the Scuba from a surface power supply to provide power to Scubas – you don't need a Scuba battery packs.

Or, the surface power supply can power Scubas with IBP's, thus saving your batteries for emergencies such as the failure of the surface power supply.

Either way, you will end up with data records in both the Scuba and the third-party device.

More information can be found in [M-Scuba logging with uninterrupted external power supply](#) and [M-Eight ways to power a Scuba](#).

5.11 Controlling sensor fouling

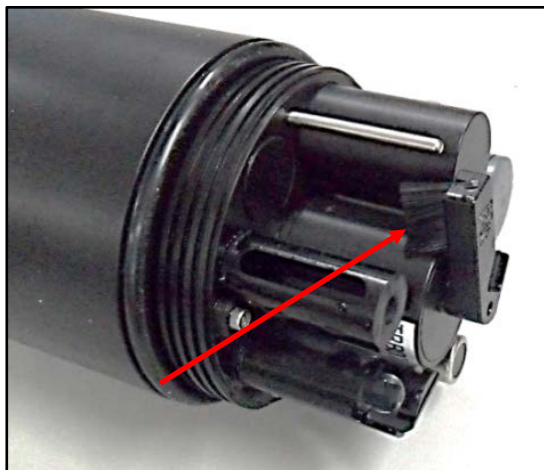
Fouling cannot be eliminated altogether, but Eijkelpamp offers three effective options to minimize sensor fouling and maximize data quality.

- 1 Eijkelpamp's unique copper gauze antifoulant is a double-wall sensor guard (below) envelops the sensors with copper gauze. Unlike copper screen, the copper gauze dissolves with time, killing or discouraging biota that would otherwise collect on the sensors. Available on all Scubas.



The copper-gauze method works better than copper screen or copper parts. Solid copper rapidly develops an oxide coating – stuff may not grow on the copper part, but the copper will not protect the sensors. The copper gauze dissolves slowly, bathing the sensors in copper ions that discourage biological growth.

- 2 The extended turbidity brush attaches to the turbidity sensor and cleans the measurement surfaces of several sensors, including the Turner fluorometers (chlorophyll, blue-green algae, etc.) and the dissolved oxygen sensor. Available on Scuba 75, 90, and 105 models with turbidity sensors.
- 3 Eijkelpamp's mini cleaner is used for sensor brushing when the Scuba does not have a turbidity sensor (and hence cannot have the extended turbidity brush). It can be programmed for frequency of brush cycles and number of sweeps per cycle.



5.12 Protective cover

For extra protection for your Scuba during deployments in areas with boat traffic, flooding, debris in the waterway, etc., you can use a protective cover. A protective cover, which come in several diameters, is a PVC pipe with a locking, sealed cap on the top end and water-passage slots at the bottom end.



6. Small screen data displays

6.1 Small-screen data displays

Small-screen data displays include the Amphibian 3, smart phones, and tablets. They run the same Scuba control software used for PC's, but with some concessions to make the small screens readable (especially in bright sunlight). Nonetheless, the small-screen menu structures are nearly identical to the screens you see when operating a Scuba with a PC (3.1).

6.2 Connecting the Amphibian 3 with a cable

(Please see 6.4.1 if you wish to connect to your Amphibian 3 via Bluetooth instead of a cable.)

- 1 Power-on the Amphibian 3 data display.
- 2 Connect the Scuba and underwater cable to the Amphibian 3 using the nine-pin connector on the bottom end of the Amphibian.
- 3 On the lower right corner of the start-up screen, select "*Amp_2_2_X or Scuba_2_2_X*" to launch the Scuba control software.
- 4 You should see scrolling data from the Scuba.

6.3 Bluetooth battery

The Amphibian2/3 connects directly to a Scuba via a data cable or underwater cable. But smart phones and tablets seldom have conventional USB ports, so we connect to them using Bluetooth.

Eijkelkamp's Bluetooth battery contains a Bluetooth transmitter and receiver, an on/off switch, and a rechargeable battery sized to get you through a full day of field work.

The Bluetooth battery's Bluetooth address is shown on a label on the back side.



6.4 Establish Bluetooth communication

Follow the directions below for establishing Bluetooth communication between your Bluetooth battery and data display; it should take just a few minutes to set up. However, anything having to do with Bluetooth can be tedious because of all the different versions of Bluetooth hardware and software floating around the world. If you run into a problem, don't give up. Call us at +31 313 880 200 or send us an email at sales@eijkelkamp.com.

6.4.1 Connecting the Amphibian 3 with Bluetooth for the first time

(Please see 6.2 if you wish to connect to your Amphibian 3 with a cable instead of via Bluetooth.)

- 1 Power-on the Amphibian 3 data display.
- 2 Turn on the Scuba Bluetooth battery by pushing the on/off button. You will see the LED begin flashing indicating that the unit is "*ON*" (if not, recharge the battery using the recharger provided).
- 3 Enable Bluetooth (BT) on the Amphibian 3 by pushing the BT ICON on the start-up screen. Make sure the BT ICON turns green and says "*Discoverable*".
- 4 On the Amphibian 3 home page select "*Settings*", then "*Connections*", and then select the "*Bluetooth*" ICON (not the BT COM ICON). Delete any BT devices listed by pressing and holding, then select delete.
- 5 Select "*Add New Device*", select the Bluetooth ID of your Scuba BT when it appears, then select "*Next*".


- 6 Enter the password “1234”, select ‘Next’, and the display will connect to your Scuba BT. Select the Scuba BT device, and put a checkmark on the serial port and then select “Save”.
- 7 Now select “COM Ports” at the top of the screen. Next select “New Outgoing Port”, then your Scuba BT will show up highlighted. Select “Next” from the bottom and use the pull-down menu to select an available COM port, such as COM5. Once selected, select “Finish” and then “OK”. Select “X” to return to home page.
- 8 On the home page, select “Amp_2_2_X” to launch the Scuba control software. Upon connection, the blinking light on the Scuba BT will turn solid. Once the software is running and the Amphibian2/3 is connected via the Scuba BT, you should see data scrolling.
- 9 From now on when the Amphian 3 is on, with Bluetooth enabled, and the Scuba BT Battery is switched “ON”, the Scuba will be found on the previously-selected COM port, unless you change the settings.

6.4.2 Connect to “classic Bluetooth” Android data displays

- 1 In the near future you can install the classic Bluetooth version of the software app Scuba control software™ from *Google Play Store*. The software can also be downloaded at www.royaleijkelkamp.com or ask our sales department Tel, +31 313 880 200 or send us an email at sales@eijkelkamp.com. See [Installing Scuba control software on an Android data display](#).
- 2 Power up the Bluetooth battery by pressing the *on/off* button.
- 3 For the initial pairing of the BT module to the data display, go to “MORE” (Smartphone), or “:” (tablet) and select “Android”, “Scan Filter”. Clear any settings in field, Select “OK”.
Go to the “Bluetooth SETTINGS” on the data display and select the Bluetooth ID of your Scuba Bluetooth battery. The device IDs for classic Bluetooth have normally had the format “Scubaxxx” or “ScubaEDRXXXX”.
Do not select the address with format *ScubaBLExxxx* for classic Bluetooth utilities, as the hardware and firmware of low energy bluetooth (discussed below) is NOT compatible with classic Bluetooth and will interfere with making this device connection.
- 4 Enter the password “1234”.

Once the password is accepted, the devices are paired, and you should now see scrolling data.

6.4.3 Connect to “Bluetooth Low-Energy” (BLE) data displays (including the iPhone)

- 1 Install the ScubaLink™ application from the Apple App Store. 
- 2 Click “Tap to Connect”.
- 3 On the *Nearby Devices* screen select your Scuba Bluetooth device, which normally has had a Bluetooth ID with format *ScubaBLEXXXX*. The home page will open with current data.

6.5 Example screens from small-screen data displays

6.5.1 Screens Amphibian 3

While the basic structure of the user-interface software (Scuba control software) on small-screen data displays (smart phones, Amphibian 3, some tablets) is the same as that of large-screen data displays (PC, laptop, some tablets), some modifications have been made to ensure that the various types and sizes of small-screen displays are easy to read and navigate.

Below are examples of small-screen displays from the Amphibian3 data display to help you understand the differences between the large and small screens. You can compare those of the small screen to those shown in Section C.

Home Page

Amphibiar 10:12

Snapshot SS & Annotate

Parameter	Value	Av
Temp deg C:	19.71	
pH units:	8.2	
Turb NTU:	1.7	
SpCond mS/...	4.338	
ODO %Sat:	36.0	
ODO mg/l:	3.18	

Snapshot Menu

Amphibiar 10:13

Snapshot SS & Annotate

Parameter	Value	Av
Temp deg C:	19.73	
pH units:	8.2	
Turb NTU:	8.1	
SpCond mS/...	4.338	
ODO %Sat:	35.8	
ODO mg/l:	3.16	

Snapshot Files

SS Locations 10:13 ok

Name	Date Modified
\My Documen...	6/6/2008 17:24
\My Documen...	6/6/2008 17:28
\My Documen...	7/15/2008 10:51
\My Documen...	6/6/2008 17:39
\My Documen...	7/15/2008 11:1
\My Documen...	11/12/2008 20:56
\My Documen...	7/17/2008 13:5

Create New Snapshot File

SS Locations 10:15

Save As

Name:

Folder:

Type:

Location:

View Snapshot File Contents

178.csv 10:17

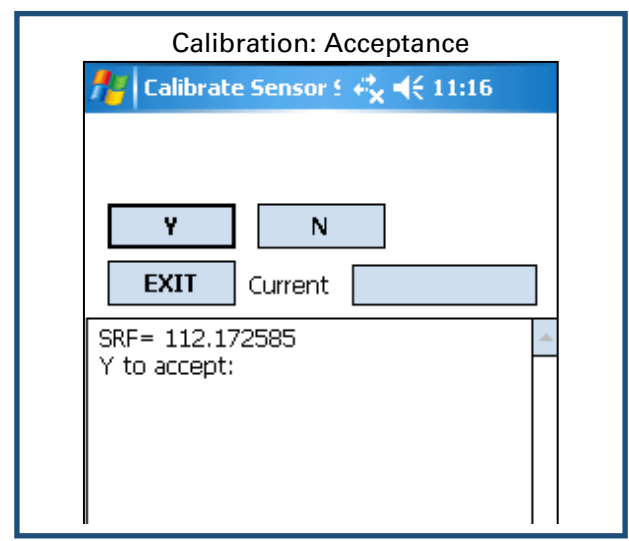
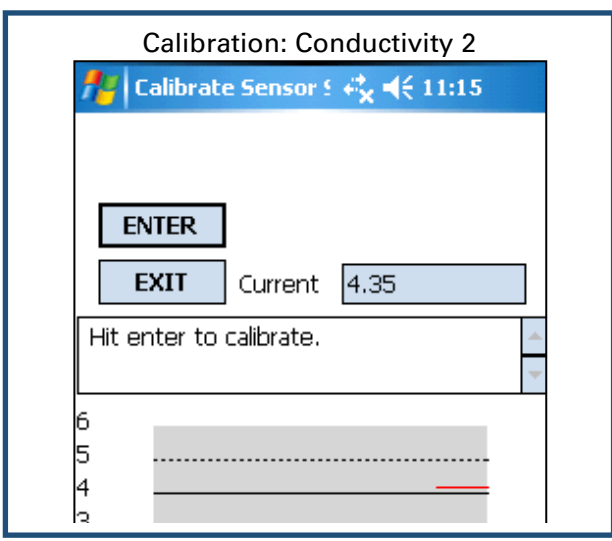
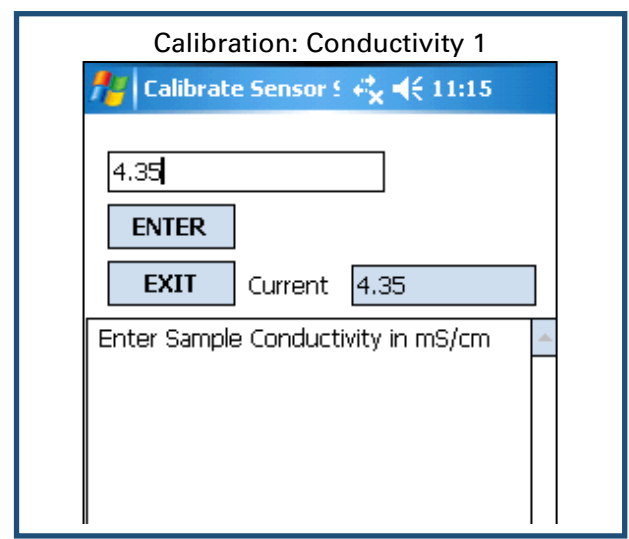
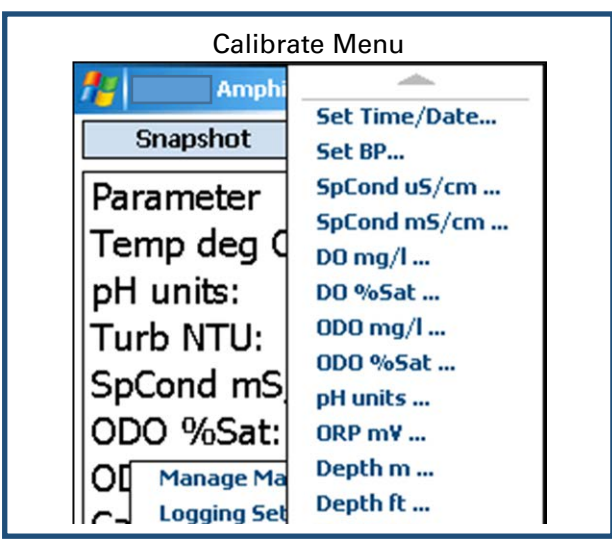
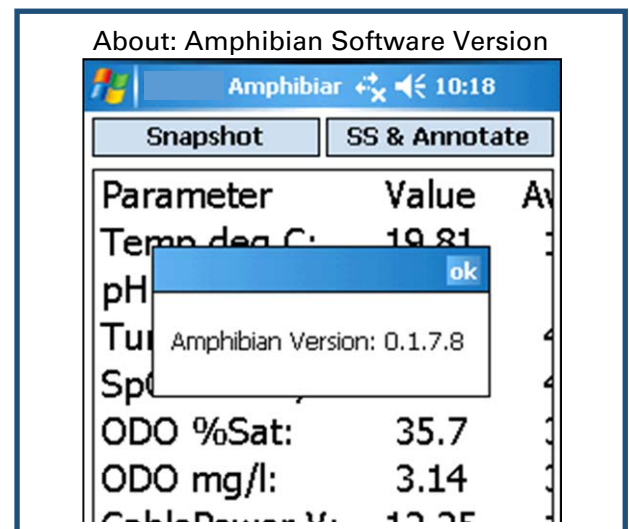
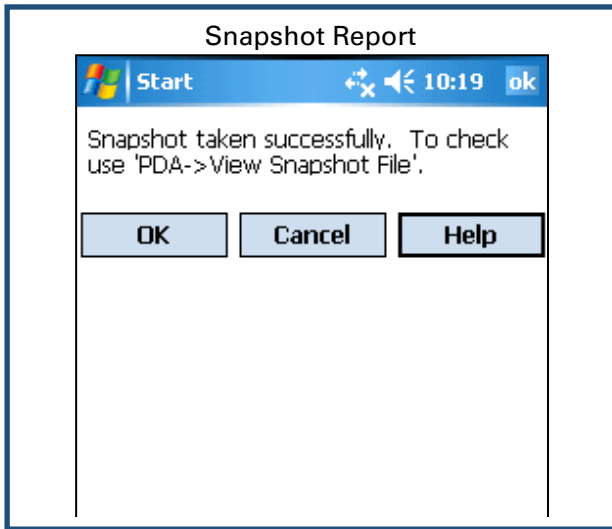
Save As...

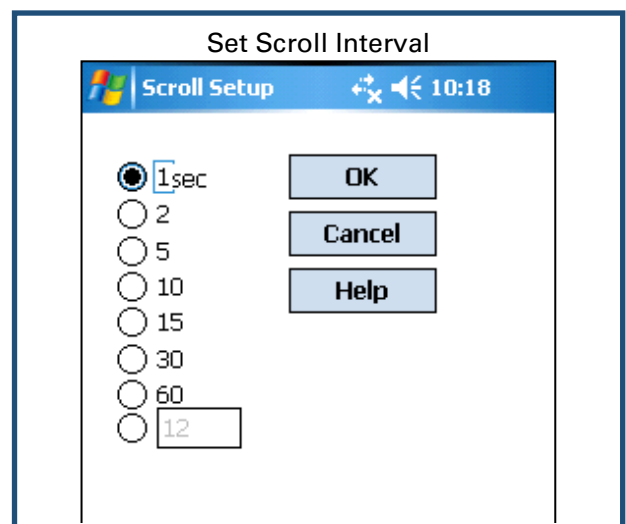
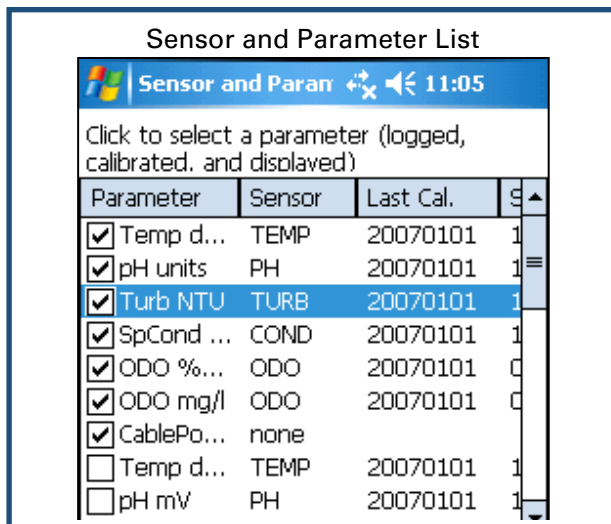
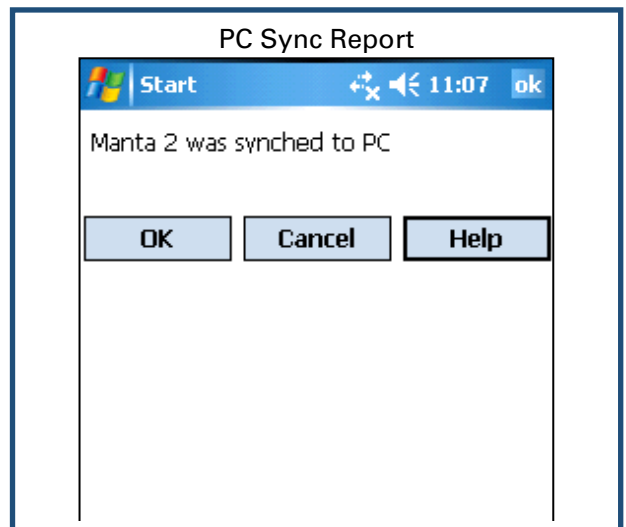
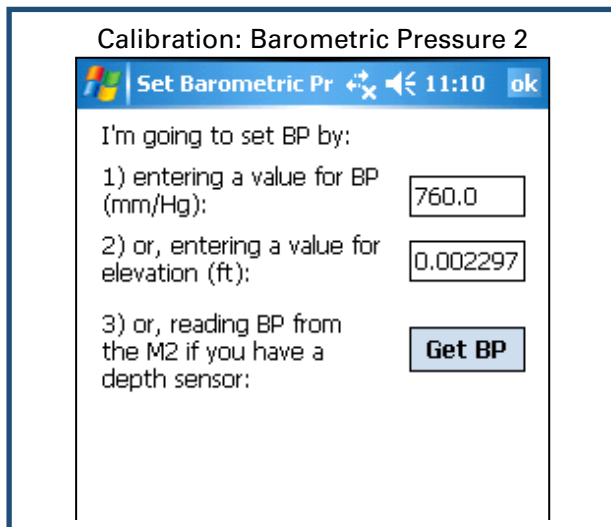
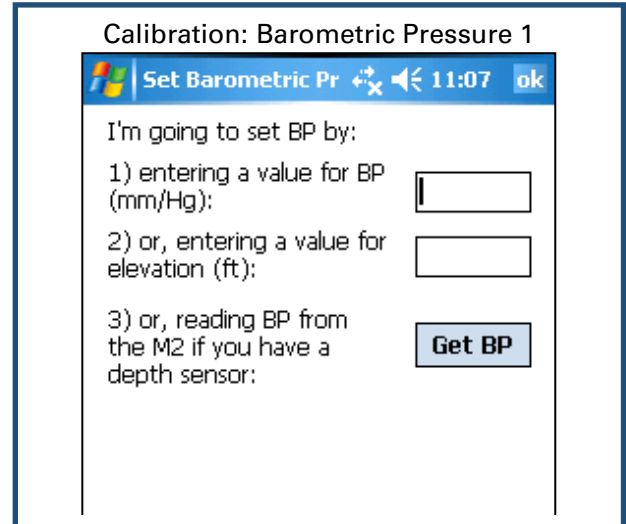
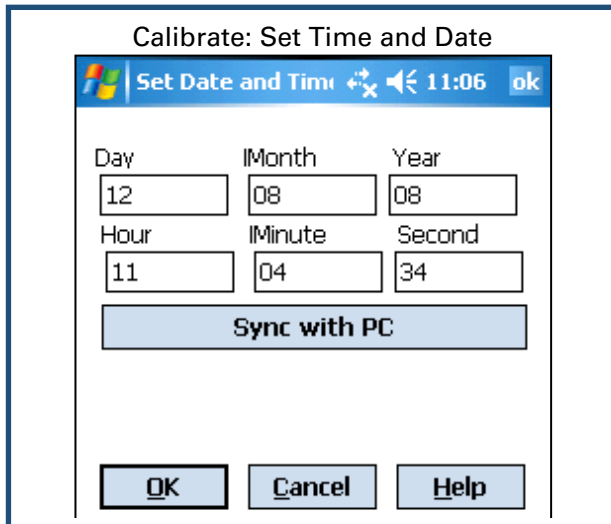
DATE	TIME	Temp ...	pH ut
12/08/08	10:14:...	19.78	8.2
12/08/08	10:14:...	19.78	8.2
□12/0...	10:14:...	19.78	8.2

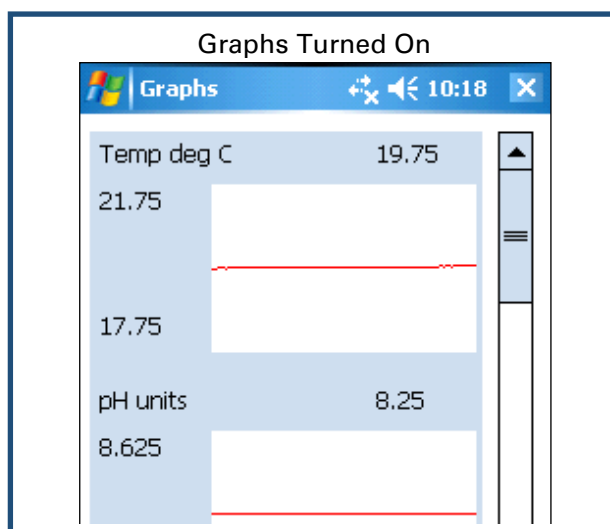
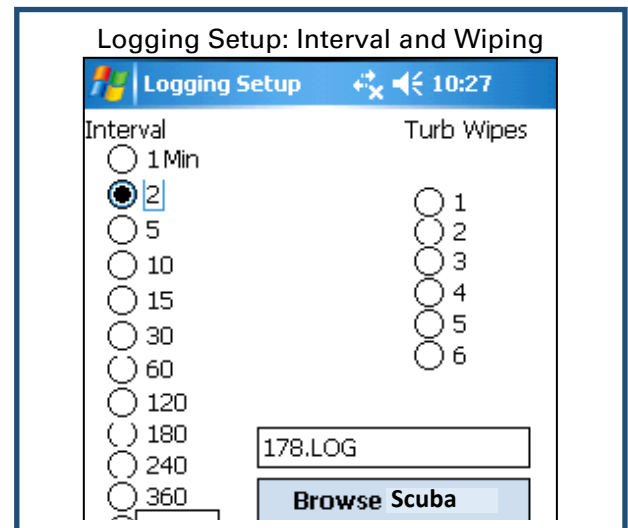
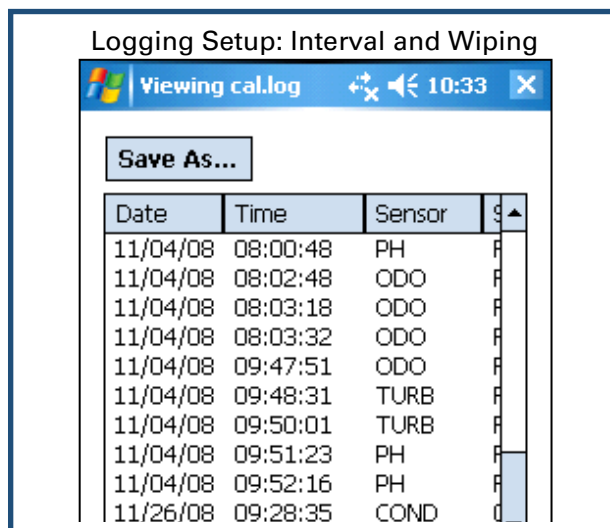
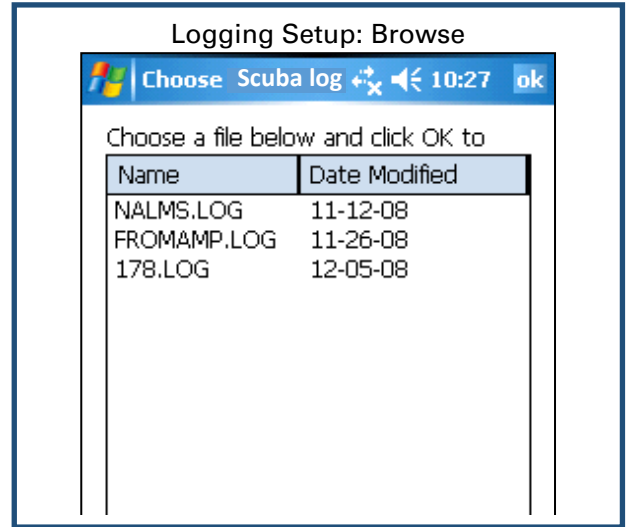
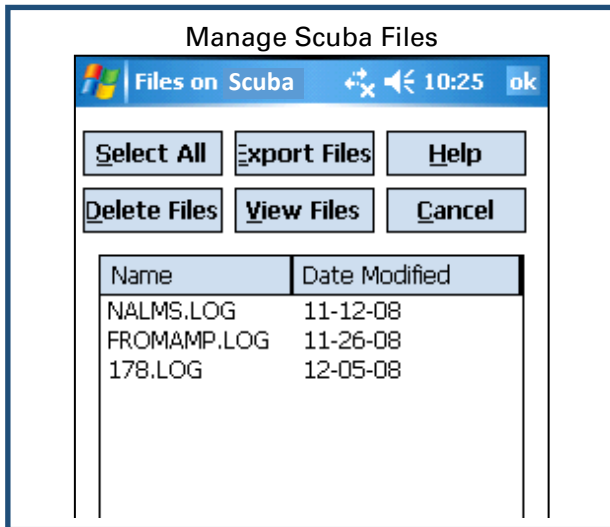
Snapshot Annotation

Annotate Snapshot 10:19 ok

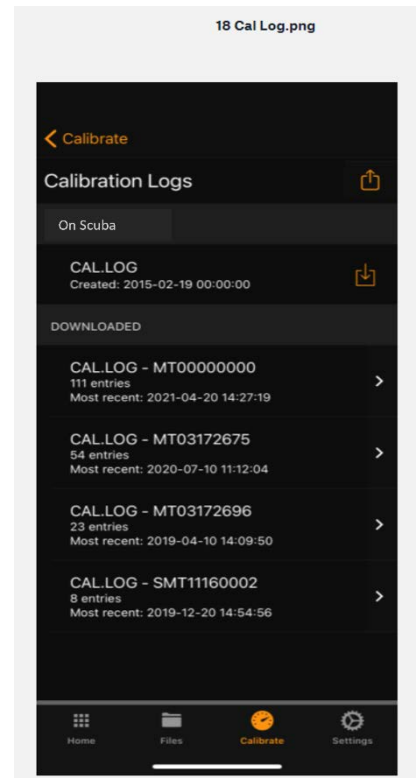
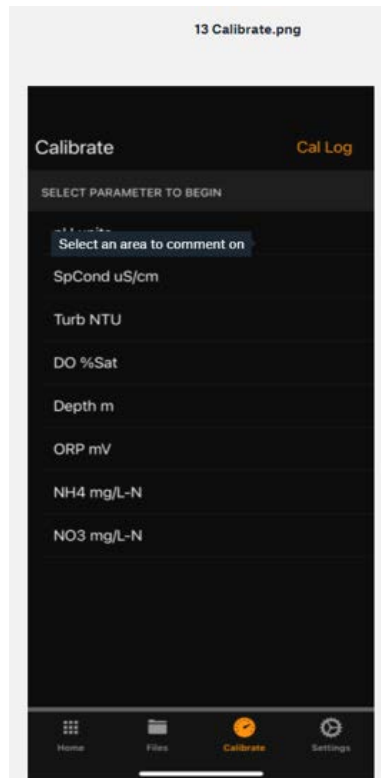
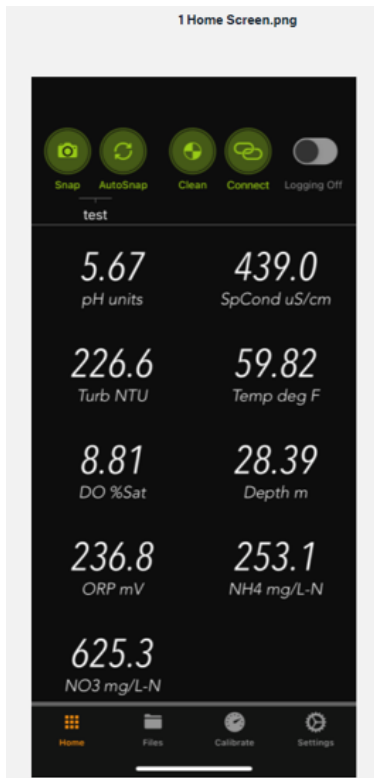
Type text to annotate







6.5.2 Screens ScubaLink App



7. Frequently asked questions

7.1 Our three most frequently asked questions

1 How does Eijkelkamp dare to offer a three-year warranty that includes the turbidity, optical dissolved-oxygen, and pH sensors?

I'm afraid it wasn't for altruistic purposes. We simply looked at our repair records and realized that a three-year warranty will cost us a trivial amount of money. It's a marketing edge, because the other multiprobe manufacturers can't warranty their pH and DO sensors for more than one or two years.

2 Are you guys really that good, or just a bunch of blowhards?

Our customers maintain that we are both.

3 You guys ever invent anything?

Glad you asked. In its continuing effort to make your life easier, Eijkelkamp developed the first multiprobes with:

- 1) USB power capability
- 2) LED status indicators
- 3) standard memory and logging functions
- 4) a permanent calibration log
- 5) snapshot and automatic snapshot functions
- 6) custom-parameter feature
- 7) optical DO caps that never need replacement
- 8) turbidity-mimicking software
- 9) PDA-based data display
- 10) Bluetooth connectivity
- 11) Cell phone as a data display
- 12) a digital instruction manual
- 13) smart sensors that were actually smart
- 14) fool-proof logging activation
- 15) a full, three-year warranty
- 16) a cell-phone-based telemetry system

7.2 Sensors

1 How do I know which sensor is which?

Please see 4.1.

2 How do I know when I need to maintain sensors?

Judgment gained from observing your field conditions and data requirements tells you when to maintain sensors. If you are logging data over long periods, the time when you collect your data from the Scuba is a good time for maintenance and calibration (2.10).

3 Why is it important to check SC reading in air? What should it be?

A well-dried SC sensor should produce a zero reading in air. This lets you know that a one-point calibration is adequate.

4 Can I see the slope calculation for pH?

Sure you can – just look at the mV readings in your calibration log. But there's no need to do that with your Eijkelkamp multiprobe because the reference electrode seldom need replacement, i.e. you need only monitor pH

slope for those manufacturer's whose reference electrodes are always moving toward the failure that requires replacement of the pH/reference sensor.

5 What is the range of millivolts for each pH solution?

You asked that question because you've been taught to worry about pH mV by another multiprobe manufacturer, didn't you? Because you have become used to worrying about mV's because that multiprobe requires frequent replacement of the pH/reference electrode? With a Scuba, just refill your reference electrode every two months or so and forget about mV's. You have more important things to do than worry about mV's.

6 How do I get the barometric pressure reading for the DO calibration? Do I need to check it to a certified barometer?

You can enter an exact BP from, say, your lab barometer (don't use the weather station's BP – it's corrected to sea level). Or, you can enter your elevation and the Scuba will estimate your BP. Or, if your Scuba has a depth sensor, the Scuba can use it to measure BP.

7 Will my Scuba also report TDS and/or Salinity?

Yes; please see Section 4.8.

8 How often should I change the pH electrolyte?

Electrolyte usually lasts two months or more. But if you are logging data, or monitoring in very low conductivity waters, change your electrolyte each time before you recalibrate pH to be safe. You may learn a better rule of thumb as you review your data. (4.10)

9 How long with my DO cap last?

You've been paying € 175 a year to replace DO caps, haven't you? It's OK; lots of people have been in the same boat. Now that you are a Scuba owner, you can expect your DO caps to last five years or more. You can see the condition of your cap when you calibrate DO. (4.7)

10 How often should I change my turbidity wipers?

Wipers usually last for years, but you should change yours if it gets stiff or has nicks in it. (4.13)

11 Can I customize the Scuba with different configurations of sensors?

We can fit up to 12 sensors in just about any combination you need. (4.1)

12 Can I replace the sensors myself, or do I have to ship the Scuba back to Eijkelkamp?

You have been led to believe that sensors need "wet-mateable connectors", haven't you? So that you can change failed sensors easily? Eijkelkamp sensors seldom need replacement – that's why they have a three-year warranty instead of the one-year warranty offered for lesser sensors. But if you have a problem, Scuba sensors are easy to replace. Contact Eijkelkamp customer service for assistance.

13 Why can your turbidity read negative?

We let the turbidity reading go negative to indicate a problem with the turbidity low calibration. If, for instance, you calibrate at zero with water that is actually 5 NTU, then any sample less than 5 NTU will read negative. Recalibration would be in order. Some manufacturers "clip" their turbidity readings at zero to avoid this question, but that's misleading and throwing away perfectly good information. (4.13)

14 How long do ISE tips last?

The usual rule is six weeks, but you may get more or less than that. Change tips often to be safe, but you may learn a better rule of thumb as you review your data. (4.15)

7.3 Calibration and maintenance

1 How do I know when I need to calibrate my sensors?

The simple answer is that frequent calibration will give you better data. The more meticulous you are with calibration, the better data you will gather. If you are uncertain whether you need to calibrate, check your sensors against a known sample. If the reading is within the accuracy specification and/or your accuracy expectations, there is no need to calibrate.

Experience and your program's accuracy expectations will help determine calibration frequency for the various sensors. If, for instance, your reservoir discharge is hovering near the regulatory minimum for dissolved oxygen, you should pay special attention to DO calibration frequency and technique. On the other hand, if a conductivity accuracy of +/- 10% is OK, you needn't calibrate conductivity very often. (4.2)

2 How often should you calibrate your multiprobe?

That depends on a number of factors, including the nature of the waters being monitored and your expectations for accuracy. We suggest that you start by calibrating once per week and shorten or lengthen that interval as the data suggest. (4.2)

3 How do I choose calibration standards?

For best results, choose a calibration standard whose value is close to what you expect to see in the field. For example, calibrate with a 1413 μS specific conductance standard if you expect to see specific conductances between 500 and 1000 μS in the field. Don't calibrate with a sea water standard. And if your waters tend toward the acidic, calibrate with a 4-buffer instead of a 10-buffer.

If you are moving your multiprobe across wide ranges of water conditions, you may wish to recalibrate to match the new situations. For instance, if you are measuring a clear lake during the morning and a high-sediment stream in the afternoon, you might consider recalibrating at noon with a high-range turbidity standard. (4.3)

4 What is an SRF?

Suppose that a typical conductivity sensor reports 100 μA in a 1413 $\mu\text{S}/\text{cm}$ standard. If your particular conductivity sensor reports 100 μA in that same calibration solution, then your SRF is 100% (some parameters, such as pH, have a more complex SRF calculation, but the effect is the same). If your response is 80 μA , your SRF would be 80%. When you click the *OK* button to accept a calibration, the Scuba automatically accepts your calibration if the SRF is between 60% and 140%. If the SRF falls outside that range, you will be cautioned to check your standard value, make sure the sensor is clean, make sure the reading has stabilized, etc. But you can elect to accept any SRF.

Each sensor calibration's Sensor Response Factor (SRF) is automatically logged into the *Cal Record* with the details of that calibration. (4.5)

5 Do I have to calibrate temperature?

No; the temperature sensor is so stable that it needs no calibration. (D.6)

6 What is the basic calibration procedure?

The Scuba never guesses parameter values, so you have to calibrate it from time to time by simply telling the instrument what it should read in a known calibration situation. The general procedure is shown below. (4.2)

- 1) Clean the sensor and perform any necessary sensor-specific maintenance.
- 2) Select a calibration standard whose value is close to the values you expect to see in the field.
- 3) Rinse sensors thoroughly (more than once may be required) with DI (deionized) water, especially if you have been using other calibration solutions. Shake the Scuba so the DI can vigorously remove traces of old calibration solutions and cleaning agents – repeat if necessary.
- 4) Rinse the sensors twice with a small quantity of your calibration standard. Discard the used calibration standard because it is probably contaminated with DI water.
- 5) Immerse the sensor in the calibration standard. This is usually accomplished by securing your Scuba with the sensors pointing up, screwing the cup onto the Scuba, and filling the cup with your calibration standard. Make

sure the standard covers the sensor entirely, and that it also covers the thermistor for those parameters that are temperature-compensated.

- 6) Watch the parameter readings until they have stabilized.
- 7) Select the parameter to be calibrated by clicking on the calibrations button in the Scuba manager home screen, then clicking on *Calibrate*, and then clicking on the parameter you wish to calibrate. For parameters that have two calibration points, you will specify which you wish to calibrate (usually high or low). Enter the calibration value and click on *OK*. The Scuba will report the resulting Sensor Response Factor (SRF); then click on *OK* to accept the calibration or *Quit* to leave the sensor uncalibrated. (4.5)
- 8) Each sensor calibration's Sensor Response Factor (SRF) is automatically logged into the *Cal Record* with the details of that calibration.

7 Can I use calibration solutions more than once?

If your QC protocol requires fresh calibration solutions for every calibration, then you might as well discard the once-used solutions. If not, then your sensitivity cost and accuracy will determine whether you can re-use calibration solutions. If, for instance, you really want your field conductivity readings to be within 1% of reading, then fresh conductivity calibration solution, which is not very expensive, should be used for each calibration. If you are not so keen on turbidity accuracy, then you can probably reuse your turbidity calibration solution once or twice because it's pretty expensive. (4.3)

8 What standard should I use to calibrate SC? What type?

For any parameter, use a calibration standard that is near the highest reading you anticipate in the field. For instance, if your lake usually runs about 1000 $\mu\text{S}/\text{cm}$, then calibrate with the readily available 1413 $\mu\text{S}/\text{cm}$ KCl standard. Note that some sensors (not SC) have two calibration points; the second point should be set at a convenient low point, usually zero. (4.3)

9 What is the different between calibrating % sat or milligrams per liter for DO?

Percent saturation tells you how much oxygen you have compared to how much you would have if the water were saturated with oxygen. Milligrams per litre tells you just that: how many milligrams of oxygen are dissolved in one litre of water. For instance, if your Scuba was reading 6.0 mg/l and the saturation tables told you that at that temperature, salinity, and barometric pressure the saturation value was 8.0 mg/l, then your % sat would be $6/8 = 75\%$. You can use either measurement, or both, but % sat is helpful during DO calibration because it should always be 100%. (4.7)

10 What is the different between the Amco Clear turbidly standard and StablCal?

Amoco Clear is made of polymer beads while StablCal is a formazin compound. Most people want their turbidity measurements referenced to formazin, and so use formazin or StablCal for calibrations. The polymer beads are cheaper and more stable, BUT you must know the equivalent formazin value for any polymer bead standard. You cannot rely on what's written on the polymer-bead label; you must check it with your own instrument after it has been calibrated with formazin or StablCal. (4.13)

11 How do I calibrate blue green algae?

There are several ways to calibrate fluorometers. Please read [Standardizing Eijkelkamp's Turner Fluorometers](#) and please read [Calibrating Eijkelkamp's Turner Fluorometers](#); they can be found on the Eijkelkamp flash drive. (4.14)

12 What is a good SRF?

Generally, and SRF between 80 and 120 is good, and 60 to 140 is acceptable. If your SRF is outside those limits, you should check your standard value and the maintenance condition of your sensor. (4.5)

13 How often should I change the pH electrolyte?

To be safe, change your electrolyte every month or so. That's probably overkill, but changing electrolyte takes only a minute and is basically free. (4.10)

14 Where do I buy calibration solutions for the various sensors?

You can buy most calibration solutions from Eijkelkamp, lab supply companies, or most catalogue houses (4.2, 4.3).

7.4 Communication and software

1 What is the range of the Bluetooth?

Hard to say because of the differences in Bluetooth technology over the years, variations in data display Bluetooth implementations, and because Bluetooth is different for Android and Apple applications. You can estimate Bluetooth range of your Bluetooth by connecting your Scuba to your Bluetooth Battery, pairing with a data display, and then walking away with the data display until the connection breaks. (6.3, 6.4)

2 How long does the Bluetooth battery take to charge?

We recommend charging overnight, but you can get a partial charge in an hour or two. (6.3)

3 How does the Scuba communicate (SDI-12, etc.)?

Scubas speak RS-232 as their native language, but Eijkelkamp provides converters for SDI-12 and MODBUS if you prefer. ([Scuba Comm Protocol](#), [Scuba SDI-12 Adapter](#), and [MODBUS Communications](#))

4 What com port should I use?

Most people should never have to worry about choosing a COM port; just let the PC do the work. (3.4)

5 Is the coloured top line an average of the values or the latest readings?

No; the data in the coloured band is the most recent line of data obtained from your Scuba. (3.2)

7.5 Deployment and applications

1 How long can I expect my batteries to last?

Battery life is difficult to predict because it varies with logging interval, quality of batteries, number and type of sensors, and water temperature. Battery life is best determined by experimenting with your specific Scuba in your specific applications. (5.9)

2 For my battery pack when looking in the log file at battery voltage, at what point will the Scuba stop logging?

The Scuba can show the voltage provided via the cable and the voltage provided by an Internal Battery Pack. The voltage provided by an External Battery Pack is shown as cable voltage. There is no fixed cut-off point, but any time the battery pack or cable voltage drops below about 5 VDC, the voltage may not be adequate for the Scuba to boot properly. (5.9)

3 How do I deploy my sonde when there is no bail hook? Is it OK to hang by the cable? How much weight will the cable hold?

When properly attached, the Scuba underwater cable can support well over 50 pounds without using a bail kit. You can hang the Scuba by the underwater cable if the load is not likely to exceed 50 pounds. (2.4)

4 How do I attach the underwater cable to the sonde?

Please see 2.4.

5 What anti-fouling products to you offer?

We offer three anti-fouling aids, including the uniquely effective copper-gauze method. (5.11)

6 Can I use re-chargeable or Lithium batteries in the Internal Battery Pack or External Battery Pack?

We strongly discourage use of lithium batteries in enclosed housings if there is any chance the batteries could get wet – such as in the IBP or EBP. (5.9)

7 Why is it important to check water temperature in a range of temperatures in the lab before deployment? How often?

It's not really that important; the Scuba design has been checked many times to make sure it accounts for water temperature everywhere necessary, such as when calculating DO saturation. However, it might be instructive to check the performance of your Scuba in cold water if you often operate in cold waters.

7.6 General FAQ's

1 What do the LED's mean?

Please see 2.6.

2 Is your sonde approved by the EPA, USGS, or has it been tested at ACT (Alliance for Coastal Technologies)?

Yes, and you can see the test reports, including ACT's [Performance verification statement for the Eijkelkamp Scuba pH sensor \(2015\)](#), [Evaluation of the Eijkelkamp Scuba water quality multiprobe sonde \(USGS, 2017\)](#), and [Eijkelkamp outperforms the competition](#).

2 Can I add sensors to my Scuba?

The Scuba can handle as many as 12 sensors. If you have fewer than 12 and wish to add one or more sensors, we can do it.

3 Why do you build the Scuba the way you do?

Unlike the products of lesser manufacturers, the Scuba uses the same basic electronic and mechanical components regardless of how many sensors you order. Most importantly, we have a no-cramming rule that prevents our stuffing too many sensors into an artificially small instrument diameter. Yes, we know that you like small instruments, but cramming sensors together results in sensors whose performance, reliability, reparability, and/or maintenance ease is compromised. We choose the best sensors available on the world market for your needs and build the Scuba around them.

So, when you ordered your Scuba, one of the Eijkelkamp product specialists determined the optimum housing diameter for the sensors you selected. The Scuba sizes (outside diameters) are 50 mm, 65, 75, 90 and 105 mm.

Anytime you wish to add or subtract sensors, we can use all of your Scuba's circuit boards and sensors in a larger or smaller housing. Cost is minimized, and you still have a conventional Scuba instead of having to change to a different instrument model.

We know that stuff - bad stuff - happens in the field, so we designed the Scuba so you don't need a factory expert for troubleshooting if something goes wrong. If the multiprobe turns on and reads any of its parameters correctly, then the basic communication circuitry is OK - if not, you need a new CPU board. If the multiprobe reads temperature, but not, say, conductivity, then you need a new conductivity sensor. You call Eijkelkamp, we send you the replacement component, and you install it yourself in a few minutes. There's no labor charge, and only one day of down-time. It really is that easy.

And, of course, the Scuba continues Eijkelkamp's tradition of user software that is so easy that most users rarely read this instruction manual. In fact, you are the only person who has ever read this far.