SEA-BIRD SCIENTIFIC

User manual

Spectral absorption and attenuation sensor (ac-s)

Document No.	ac-s
Release Date:	2023-03-22
Version:	N

425-643-9866
seabird.com

Table of Contents

Section 1 Safety information

Please read this entire manual before this equipment is unpacked, set up, or operated. Pay attention to all danger, warning, and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

⚠DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to equipment. Information that requires special emphasis.

1.1 Hazard information

NOTICE

The manufacturer is not responsible for any damages due to misapplication of misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect process during a possible equipment malfunction.

1.2 Equipment labels

Read all labels and tags attached to the equipment. Personal injury or damage to the equipment could occur if not observed. A symbol on the equipment is referenced in the manual with a precautionary statement.

⚠WARNING

Sensors that use ultraviolet light sources (< 400 nm): Do not look directly at a UV light source when it is on. It can cause damage to the eyes. Keep products that have UV light sources away from children, pets, and other living organisms. Wear polycarbonate UV-resistant safety glasses to protect the eyes when a UV light is on.

Electrical equipment marked with this symbol may not be disposed of in European domestic or public disposal systems. Return old or end-of-life equipment to the manufacturer at no charge to the user.

EFUP: Hazardous material exists over the threshold of GB/T 26572.2011. The number in the center of the symbol is the Environmentally Friendly Use Period as specified by SJ/T 11364-2014, China's marking for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products. This product should be recycled after its environmentally friendly use period.

Section 2 ac-s quick start guide

This quick start guide and user manual applies to the ac-s spectrophotometer.
What's in the box:

- SBE 5T pump with patch cable and hardware to attach to ac-s
- Spare parts kit
- 2 dummy connectors with lock collars
- 3 m test cable
- Plumbing kit
- Sensor-specific calibration page
- CD or USB drive, with software, calibration files, documentation.

1. Install the manufacturer-supplied software on a PC. Refer to Install software on page 9 for details.
2. Make sure that the flow tubes and the flow sleeves are attached to the sensor correctly. Refer to Verify function on page 10 for details.
3. Connect the sensor to the PC and start the WETView software. Refer to Verify function on page 10 for details.
4. Make sure that the sensor, pump, and tubing are attached to the deployment frame correctly. Refer to Pre-deployment setup on page 12 for details.
5. Deploy the sensor. Refer to Deployment on page 15 for details.
6. Immediately after the sensor is recovered from a deployment:
   a. Turn off the sensor.
   b. Flush the sensor and the plumbing with fresh water.
   c. Keep the sensor out of direct sunlight between deployments.
7. To store the ac-s:
   a. Make sure the optical windows are clean. Refer to Air calibration on page 22 for details.
   b. Make sure the flow tubes and sleeves are clean and dry.
   c. Attach the flow sleeves and tubes.
   d. Install the black plastic protective caps on the flow sleeve nozzles.
   e. Make sure the bulkhead connectors are clean and lubricated. Refer to Clean bulkhead connectors on page 23 for details.
   f. Attach the dummy plugs and lock collars.

Section 3 Specifications

3.1 Mechanical

Temperature range, operation	0–30 °C
Temperature range, storage	-2–40 °C
Rated depth	500 m (std); 5000 m (deep)
Diameter	10.5 cm (std); 9.9 cm (deep)
Length	77.0 cm (std); 75.8 cm (deep)
Weight in air, water	5.9 kg, 0.80 kg (std); 10.3 kg, 5.3 kg (deep)

Table 1 Power and communications

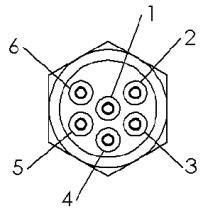
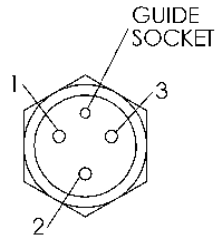
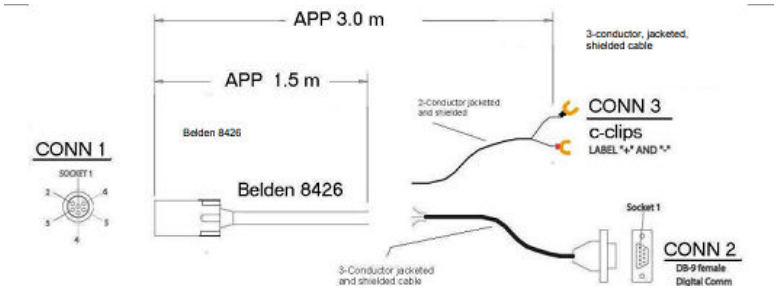
Contact	Function	MCBH6MP
1	Ground	
2	RS232 RX	
3	Reserved	
4	Voltage in	
5	RS232 TX	
6	Reserved	

Table 2 Pump

Contact	Function	MCBH3FS connector
1	Ground	
2	Voltage in	
3	No connect	



3.2 Electrical

Input	10–35 VDC
Current draw	0.37 A @ 12V nominal
Linearity	99%

3.3 Optical

Spectral range	400–730 nm
Bandpass	15 nm/channel
Pathlength	10 or 25 cm
Beam cross-section	8 mm diameter, nominal
Linearity	>/= 99% R^2
Output wavelengths	nominal 80, ± 5
Resolution	4 nm
Precision, 400–449 nm	±0.003 m^{-1} typical, 0.006 m^{-1} max @ 1Hz; ±0.005 m^{-1} typical, 0.012 m^{-1} max @ 4Hz
Precision, 450–730 nm	±0.0005 m^{-1} typical, 0.0015 m^{-1} max @ 1Hz; ±0.001 m^{-1} typical, 0.003 m^{-1} max @ 4Hz
Accuracy	±0.01 m^{-1}
Dynamic range	0.001–10 m^{-1}

Section 4 Set up sensor and verify operation

⚠WARNING

If the user thinks that a sensor has water in the pressure housing: Disconnect the sensor from any power supply. Put on safety glasses and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, use the purge port (if the sensor is so equipped), or very SLOWLY loosen the bulkhead connector to let the pressure release.

⚠WARNING

Sensors that use ultraviolet light sources (< 400 nm): Do not look directly at a UV light source when it is on. It can cause damage to the eyes. Keep products that have UV light sources away from children, pets, and other living organisms. Wear polycarbonate UV-resistant safety glasses to protect the eyes when a UV light is on.

NOTICE

Do not use acetone or other solvents to clean any part of the sensor.

The sensor is usually deployed as part of a system but the user can install the manufacturer-supplied software and do a functional check of the sensor alone to make sure it is ready to deploy.

System requirements

Pump—Use a pump that will meet the necessary flow rates, the required depth of operation, the power available, and other hardware on the system.

Communication cable—Use an RS232 cable with the system.

Power supply—Use a 10–35 VDC power supply that supplies a minimum of 10 watts. More power is necessary to operate a pump from the same power supply.

PC or data logger—Use a PC or data logger with a serial interface that can accept data that is transferred at 115,200 baud.

Software—Use WETView software to monitor the data collected. The software automatically applies calibration coefficients, temperature corrections and makes tab-delimited files to move into MS Excel® or MatLab®.

4.1 Install software

Use the WETView software to look at the data from the sensor to make sure it is ready to deploy.

1. Put the manufacturer-supplied CD in the connected PC.
2. Open the "setup.exe" file.
   The "setup.exe" file guides the user through the software installation. The installed files are "wetview.exe" and "wetview.uir."
3. Change the file names or move any calibration or device files that are on the PC so that they will be not be over-written.
4. Copy the calibration and device files from the CD.
   a. Copy the "air*xxyyy*.cal" air calibration file.
   b. Copy the "acs*yyy*.dev" device file.
      xx is the calibration number. *yyy* is the serial number of the sensor.
5. Make a backup copy of the manufacturer-supplied ".cal" and ".dev" files as a safety measure.

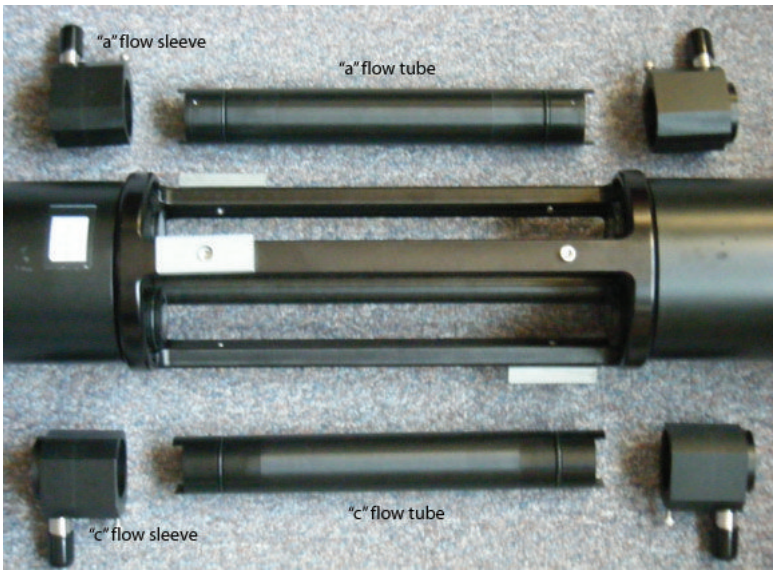
4.2 Verify function

Look at the data with the air calibration and the water calibration applied to make sure the sensor operates correctly. The items below are necessary to do a functional check on the sensor.

- A clean work area and table
- The sensor and the manufacturer-supplied test cable
- A 10–35 V power supply
- A PC with the manufacturer-supplied software and the device file installed.

1. Make sure that the flow tubes and the flow sleeves are attached to the sensor correctly.
2. If necessary, attach the flow tubes and the flow sleeves to the pressure housing of the sensor.

Figure 1 Flow sleeves and tubes for ac sensor



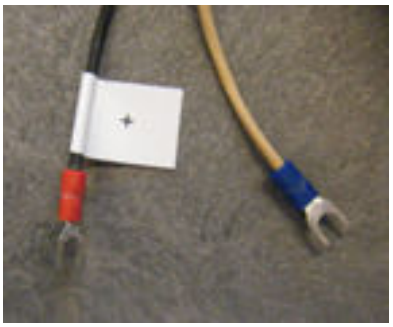
The "a" flow tube has a smaller inside diameter than the "c" flow tube.

Figure 2 Flow sleeves and sensor windows

The "a" detector window is white. The other windows are clear.

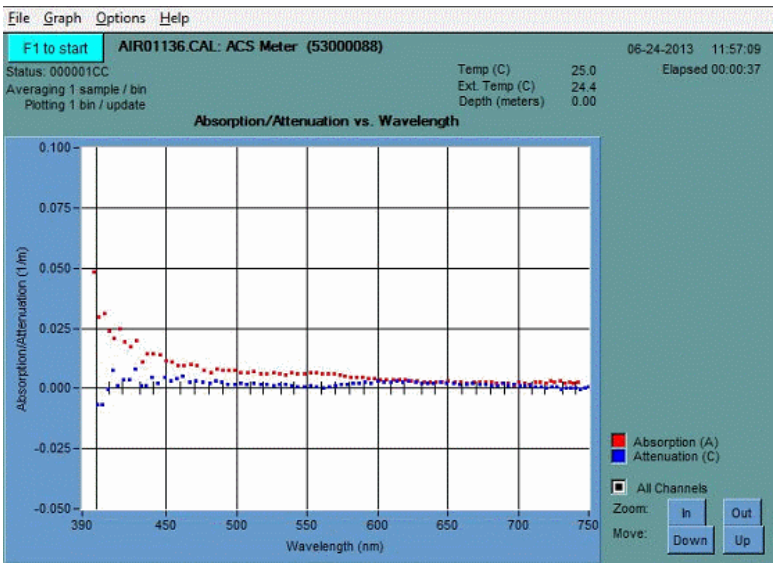
3. Make sure that the flow sleeves are tight against the top and the bottom pressure housings.
4. Hand-tighten the screws in the flow sleeves with a 9/64 driver.
5. Connect the test cable to the host PC.
6. Connect the power leads on the test cable to the power supply.

Figure 3 Test cable terminals

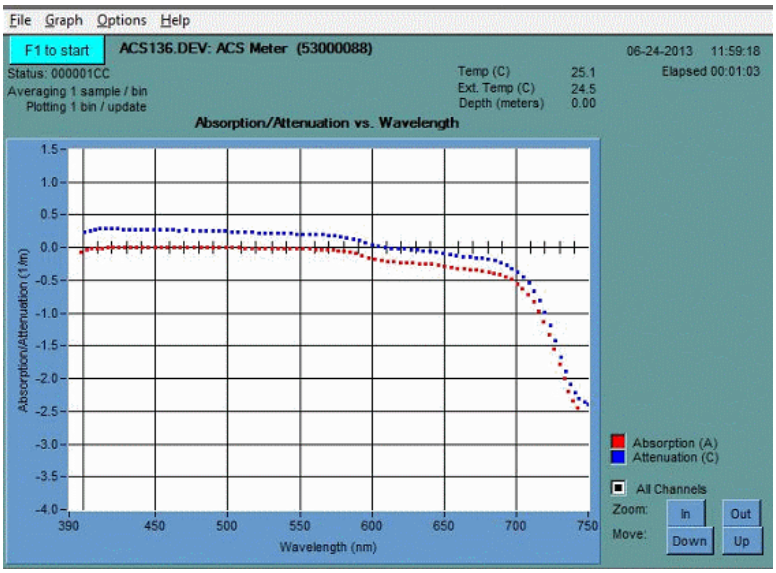


Make sure to connect the red (positive) terminal on the cable to the red (positive) terminal on the power supply.

7. Connect the test cable to the sensor.
8. Turn on the power supply.
9. Start the software.
10. Push **^O to Open**.
11. Select the air calibration (.cal) file to open.
12. Select the COM port of the PC.
13. Push **F1 to start** to show the data that the sensor collects. Data shows in 5–10 seconds.



14. Select the "All Channels" box.
15. Operate the sensor for several minutes.
16. Push **F2 to stop** to stop data collection.
17. To save the data that is collected:
    a. Enter a file name.
    b. Select the location on the PC to save the file to.
    c. Push **OK**.
    d. Push **Cancel** and the collected data will not be saved.
18. Go to the **File** menu and then *Open Device File*.
19. Select the water calibration (.dev) file.
20. Select the COM port if necessary.
21. Push **F1 to start** to show the data that the sensor collects. Data shows in 5–10 seconds.



22. Push **F2 to stop** to stop data collection.
23. Save or discard the data that was collected.

4.3 Pre-deployment setup

The manufacturer recommends that the user attach the sensor and the pump to a deployment frame vertically. The sensor can be attached to a cage at 45 degrees off-vertical if necessary. The operation of the pump is better and the flow tubes are less likely to trap air bubbles if the sensor and the pump are attached vertically to a frame.

1. Make sure that the flow tubes, pump tubing and screens are clean. Refer to Clean the sensor on page 21 for details on how to clean the sensor.
2. Make sure that the flow tubes are installed correctly on the appropriate absorption and attenuation locations. Refer to the Verify function on page 10 for details.
3. Remove the four black plastic caps from the flow sleeves. Keep the caps.
4. Attach the Norprene tubing as shown below.

Figure 4 acs with plumbing tubes and pump attached

5. Use the manufacturer-supplied size 104 hose clamp and the spacer saddle to attach the pump to the sensor as shown below.
   a. Attach a layer of tape to the hose clamp to give protection to the sensor from scratches.
   b. Put the hose clamp over the sensor.
   c. Put the spacer saddle between the pump and the sensor.
   d. Use a slotted screwdriver or 9/32" driver to tighten the hose clamp.

6. Use a dielectric isolator such as a rubber sheet or thick tape to prevent the sensor from touching the cage or hose clamp when the sensor is attached to a cage.
7. If the sensor is attached to a cage, attach the sensor to the cage at the top pressure housing only. Put the bottom of the sensor in the manufacturer-supplied cup and bracket assembly.

Make sure there is no torsional stress applied to the sensor when it is attached to the cage. The beam alignment can be altered, which will make the quality of the data defective.

8. Attach the power and communication cable.

Section 5 Deployment and recovery

5.1 Deployment

1. Lower the sensor to just below the surface of the water.
2. Turn on the sensor and the pump.
3. Make sure the pump operates correctly.
4. Lower the sensor to a depth of 10–20 m.
5. Operate the sensor at this depth for 3–5 minutes so that the sensor is stable, and the flow tubes are free of bubbles.
6. Lift the sensor to just below the surface of the water and start data collection.
7. Slowly lower the sensor through the water column.
8. Lift the sensor through the water column immediately after it has reached the necessary depth.
9. Stop the data collection and turn off the pump when the sensor is just below the surface of the water.
10. Remove the sensor from the water and make sure it is secure.
11. Flush the sensor or system with fresh water if possible. If this is not possible, flush the sensor at the end of each day of data collection.
12. If the sensor will be out of the water for more than a few minutes, cover it with a tarp so that it does not get too hot.
13. At the end of a day of data collection, remove the flow tubes and clean and dry the tubes and the optical windows.

5.2 Recommended procedures for best data

- Use a sturdy container to transport the ac-s to the field. The optics are extremely sensitive.
- Air bubbles, dirt, or grease in the flow path will cause bad data. Make sure the flow tubes, pump tubing, screens, and windows are all very clean. Use ethanol or warm soapy water to clean, and flush with distilled or tap water.
- Make sure that the flow tubes are installed correctly and in the correct locations.
- Attach the ac-s to a frame so that it will not hit anything. Use rubber sheets or thick electrical tape to isolate the pressure housing from the frame.
- Make sure there is no torsional stress on the ac-s when it is attached to a frame, especially on the 'c' side.
- Collect a data file at regular intervals to monitor any sensor drift.
- To deploy: lower the ac-s to just below the surface of the water, then turn on the sensor and pump and make sure the pump is primed and operates correctly. Then lower the sensor to 10–20 m. Operate the sensor for 3–5 minutes so it can stabilize and equilibrate with the water temperature.
- After the sensor is stable, raise it to just below the surface and start data collection. The surface conditions will have an effect on the initial depth.
- When the deployment is complete, carefully bring the frame on deck and make sure it is safely attached to the deck. If possible, flush the sensor and frame with fresh water after every cast. use low pressure fresh water to flush the tubing and flow tubes. Use a tarp to cover the frame if it will be on deck for more than a few minutes so that the sensor does not get too hot.

Section 6 Process data

The ac-s collects data in binary and the WETView software converts the data into uncorrected engineering units. The basic steps in WETView:

1. Calculates the uncorrected engineering units in inverse meters from the signal and reference values.
2. Applies a linear temperature correction for the sensor's internal temperature with constants supplied in the device file of the sensor.
3. Applies clean water offsets supplied in the device file of the sensor.

Refer to Section 5 of the *ac Protocol Manual* for details about WETView calculations and the corrections applied for time lag, water temperature, drift, scattering, salinity, and attenuation acceptance angle.

The table below is a snapshot of binary data from the ac-s. The "row offset" column on the left is for reference only and does not show in the data from the sensor.

row offset	0	1	2	3	4	5	6	7	8	9	a	b	c	d	e	f
000:	53	d0	03	01	53	00	00	02	4e	1e	01	ba	21	29	35	ff
010:	00	ff	00	02	d0	05	01	53	00	00	02	4e	1a	01	ba	02
020:	a1	7a	e4	b9	d7	01	d5	02	b0	00	07	1b	02	01	56	04
030:	05	03	63	04	f4	03	10	04	98	03	da	05	ab	03	ac	05
040:	3b	04	69	06	7c	04	77	05	f5	04	fe	07	67	05	52	06
050:	c6	05	ae	08	69	06	4a	07	9f	06	66	09	88	07	3a	08
060:	96	07	33	0a	c9	08	47	09	ab	08	1b	0c	32	09	6a	0a
070:	dc	09	0e	0d	c7	0a	a8	0c	2f	0a	2f	0f	84	0c	0f	0d
080:	9a	0b	5c	11	63	0d	9a	0f	23	0c	9d	13	69	0f	3a	10
090:	c5	0d	f8	15	8d	11	01	12	70	0f	5b	17	c9	12	d8	14
0a0:	32	10	ce	1a	25	14	d2	16	17	12	61	1c	b5	16	e8	18
0b0:	20	14	08	1f	85	19	2b	1a	5b	15	e7	22	8e	1b	ad	1c
0c0:	be	17	d8	25	c7	1e	5d	1f	3d	19	ef	29	33	21	3b	21
0d0:	e4	1c	17	2c	d5	24	48	24	b4	1e	6f	30	ad	27	7f	27
0e0:	9f	20	de	34	b9	2a	f7	2a	b6	23	65	38	f3	2e	8e	2d
0f0:	e7	26	0b	3d	4e	32	5d	31	29	28	c6	41	d1	36	49	34
100:	84	2b	82	46	63	3a	4f	37	d9	2e	49	4a	f4	3e	6a	3b
110:	3b	31	17	4f	b2	42	96	3e	bc	34	09	54	a0	46	f8	42
120:	6a	37	22	59	d2	4b	90	46	4e	3a	6c	5f	5a	50	7d	4a
130:	75	3d	ea	65	44	55	ba	4e	f0	41	b3	6b	9a	5b	67	53
140:	a2	45	b5	72	35	61	6f	58	73	49	be	78	df	67	9b	5d
150:	41	4d	cb	7f	79	6d	d1	61	e2	51	ab	85	d7	73	ed	66
160:	64	55	77	8c	10	79	f4	6a	be	59	19	92	12	7f	cd	6e
170:	ef	5c	a0	97	d4	85	7d	72	eb	60	01	9d	63	8b	00	76
180:	c2	63	41	a2	bd	90	5e	7a	22	67	e0	a7	92	98	2f	7d
190:	b7	6a	c6	ac	8c	9d	1a	81	13	6d	75	b1	37	a1	cc	84
1a0:	35	70	05	b5	aa	a6	4f	87	25	72	54	b9	bf	aa	85	89

1b0:	cd	74	63	bd	75	ae	5d	8c	20	76	2b	c0	b9	b1	d0	8e
1c0:	1e	77	95	c3	6e	b4	ce	8f	aa	78	9c	c5	93	b7	3c	90
1d0:	c0	79	3e	c7	05	b9	11	91	5e	79	8e	c7	e6	ba	63	91
1e0:	9c	79	82	c8	2d	bb	23	91	5d	79	13	c7	d9	bb	56	90
1f0:	b5	78	5b	c7	00	bb	07	8f	ac	77	2f	c5	83	ba	1e	8e
200:	28	75	c6	c3	76	b8	ab	8c	52	74	0d	c0	f8	b6	c8	8a
210:	1e	72	00	bd	e6	b4	5c	87	8e	6f	ad	ba	60	b1	6e	84
220:	a9	6d	0a	b6	5c	ad	f9	81	58	6a	07	b1	b7	a9	ee	7d
230:	9c	66	a8	ac	6e	a5	37	79	72	62	eb	a6	8b	9f	e9	74
240:	e3	5e	ec	a0	25	9a	16	70	00	5a	c2	99	56	93	db	6a
250:	ef	56	69	92	46	8d	4f	65	ba	52	0f	8b	15	86	9e	60
260:	82	4d	b2	83	db	7f	d9	5b	53	49	5e	7c	b2	79	16	56
270:	25	45	14	75	86	72	54	51	06	40	e1	6e	75	6b	b1	4c
280:	13	3c	d0	67	9d	65	3a	47	3a	38	d5	60	f1	5e	de	42
290:	89	35	02	5a	82	58	b8	3e	05	31	52	54	47	52	bf	39
2a0:	9c	2d	be	4e	3c	4c	fc	35	79	2a	70	48	9a	47	85	31
2b0:	8c	27	36	43	35	42	52	2d	c8	24	33	3e	15	3d	5c	2a
2c0:	3b	21	5a	39	39	38	a5	26	da	1e	9d	34	98	34	30	23
2d0:	b3	1c	1c	30	50	30	03	20	bb	19	bf	2c	49	2c	1c	22
2e0:	44	00	ff	00	ff	00	02	d0	03	01	53	00	00	02	4e	1e

The table below is the detail of each field in the data record. Make sure that the data collection program you use can read binary.

Byte Offset	Num Bytes	Data	Description
00f	4	ff00ff00	packet registration
013	2	02D0	record length of full packet (without chksum) = 720
015	1	05	packet type 03 and above is an ac-s sensor
016	1	01	reserved
017	1	53	sensor type-53 is an ac-s
018	3	000002	serial number
01b	2	4e1a	"a" reference dark counts (diagnostic)
01d	2	01ba	pressure counts (ignore)
01f	2	02a1	"a" signal dark counts
021	2	7ae4	raw external temp counts = 22.14 °C
023	2	b9d7	raw internal temp counts = 17.91 °C
025	2	01d5	"c" reference dark counts (diagnostic)
027	2	02b0	"c" signal dark counts (diagnostic)
029	4	00071b02	time in milliseconds since power on (465666 = 7.761 mins)
02d	1	01	reserved

02e	1	56	number of output wavelengths = 86 decimal
02f	2	0405	raw cref $_1$ counts
031	2	0363	raw aref $_1$ counts
033	2	04f4	raw csig $_1$ counts
035	2	0310	raw asig $_1$ counts
037	2	0498	raw cref $_2$ counts
…			
2d7	2	20bb	raw cref $_{86}$ counts
2d9	2	19bf	raw aref $_{86}$ counts
2db	2	2c49	raw csig $_{86}$ counts
2dd	2	2c1c	raw asig $_{86}$ counts
2df	2	2244	checksum
2e1	1	00	pad byte
2e2	4	ff00ff00	start of next packet

⚠WARNING

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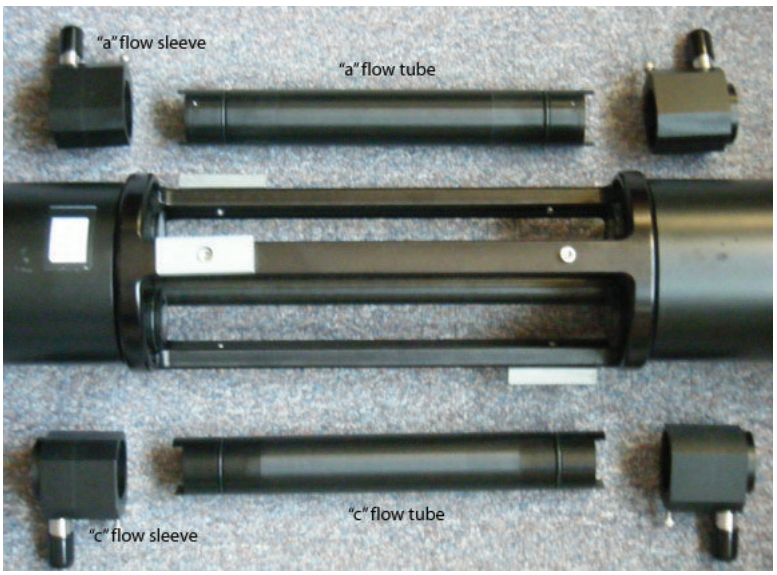
7.1 Clean the sensor

Clean the flow tubes, sleeves, optical windows and remove and replace any O-rings that are damaged before the air calibration.

1. Attach the dummy plugs to the sensor and tighten the lock collars. Refer to Clean bulkhead connectors on page 23 for details on how to care for bulkhead connectors.
2. Remove the plumbing tubing for the pump and the intake screens.
3. Flush the plumbing tubing and the intake screens with DI or fresh water.
4. Put the protective black plastic caps on the flow sleeves.
5. Remove the flow tubes and the flow sleeves from the sensor: hold the metal nozzles with the black plastic caps and move them approximately ½" toward the middle of the flow tube.



The flow tubes lift out of the sensor.

6. Remove the seven size 122 O-rings from the flow tubes and optical windows.
7. Remove the size 025 O-ring from the "a" detector window.
8. Rinse the sensor and the flow tubes and flow sleeves with fresh water.
9. Use Kimwipes® or other lint-free tissue and a mild detergent that is diluted with distilled or de-ionized (DI) water to wash the optical windows and the flow tubes.
10. Rinse the windows and the flow tubes. Refer to Air calibration on page 22 for specific steps to clean the optical windows.
    Make sure there is no soap residue on the windows or in the flow tubes.
11. Examine the O-rings for any damage.
    Use new O-rings if necessary.
12. Install the O-rings on the flow tubes and the optical windows again.
13. Clean the flow tubes:
    a. Put some methanol or ethanol on a lint-free tissue.

b. Use a ±¼"-thick rod to carefully push the dampened lint-free tissue through the flow tube.
c. Make sure there are no streaks or lint inside the flow tube.
d. Do these steps again for the second flow tube.

14. Dry the sensor.

a. Blow dry nitrogen over the sensor to remove water from the O-ring grooves.
b. Put the sensor in a place where it can dry fully for 12 hours or overnight.
c. Use a small heater to blow warm air over the sensor.

15. Attach the flow tubes and sleeves to the sensor again.
16. Make sure that the metal nozzles on the flow sleeves are covered with the manufacturer-supplied black plastic caps or with electrical tape.

7.2 Air calibration

The manufacturer makes an air calibration file and a water calibration file with each ac-s. Refer to Clean the sensor on page 21 for details on how to clean flow tubes and other hardware.

- The air calibration file (.cal) has the offsets that show 0.0 values for in-air measurements when the sensor is clean and dry. Air calibration is useful to see sensor drift, the age of the filter, or has not been cleaned sufficiently.
- The water calibration file (.dev) has the clean water offsets to show 0.0 (or close) values for clean, fresh water measurements on all channels.

If the air values collected in the field are different from the values on the calibration page that ships with the ac-s, that difference can be applied as a correction factor to the initial water calibration values in the .dev file:

$a'_{clean} = a_{clean} + (a'_{air} - a_{air})$

Where:

a_{clean} = clean water offset value supplied with the sensor

a'_{clean} = corrected clean water offset

a_{air} = air value supplied with the sensor

a'_{air} = air values collected in the field.

A good air calibration requires that:

- The optical path is clean and dry
- The optical path is completely protected from ambient light
- The internal temperature of the sensor stays withing the calibration range
- The sensor is permitted to sit open for an hour or two to make sure it is completely dry
- The sensor is permitted to warm up for approximately 5 minutes.

1. Remove the flow tubes and clean and dry them completely.
2. Remove the flow sleeves to make sure there is no moisture inside.
3. Let the flow tubes and flow sleeves sit in a dry environment with good air flow.
4. Assemble the flow tubes and sleeves again and attach to the sensor.
5. Clean the optical windows:

a. Use a mild solution of detergent and distilled water, then rinse and wipe dry with lint-free tissues.
b. Put some methanol or ethanol on a lint-free tissue.
c. Use this tissue to clean the window. Swipe the tissue straight across the window, not in a circular motion.

d. Use a lint-free tissue to dry the window.
e. Use nitrogen or canned air to blow any lint or dust off of the window.
f. Do these steps to clean each optical window.
g. Make sure that the optical windows are dry.

6. Operate the sensor for approximately 15 minutes to make sure that the optical components are very clean and that the data that is collected is within 0.005 m^{-1} for each wavelength. Refer to the section on Verify function on page 10 for details.
7. If the ambient air temperature is more than 25 °C, put the lower pressure housing in a pan of water to help keep it cool. Monitor the internal temperature to make sure it is within specification.
8. If necessary, do steps **13 and 14** until the data value is within 0.002 m^{-1} for each wavelength.
9. Do the air calibration again at the end of a deployment to monitor the performance of the ac-s over time.

7.3 Monitor sensor performance

Do operational checks at regular intervals to monitor the performance of the sensor over time.

1. Make sure that the optical components of the sensor, the flow tubes and optical windows, are very clean and dry. Refer to the section on Clean the sensor on page 21 for details on how to clean the sensor.
   The data output from the sensor is within 0.005 m^{-1} of 0.00.
2. Make sure that the metal nozzles are fully covered with the manufacturer-supplied black plastic caps or with electrical tape.
   No ambient light gets into the optical components.
3. Operate the sensor for approximately 15 minutes to let it stabilize.
4. Collect data for approximately 5 minutes.
5. Open the file of data in an Excel® spreadsheet and calculate if the standard deviation is 0.002 m^{-1} or less. This means that the sensor output is stable.

7.4 Clean bulkhead connectors

NOTICE

Do not use WD-40® or petroleum-based lubricant on bulkhead connectors. It will cause damage to the rubber.
Damaged connectors can cause a loss of data and additional costs for service.

Damaged connectors can cause damage to the sensor and make it unserviceable.

Use silicone-based lubricants only.

Examine, clean, and lubricate bulkhead connectors at regular intervals. Connectors that are not lubricated increase the damage to the rubber that seals the connector contacts. The incorrect lubricant will cause the failure of the bulkhead connector.

1. Apply isopropyl alcohol (IPA) as a spray or with a nylon brush or lint-free swab or wipes to clean the contacts.
2. Flush with additional IPA.
3. Shake the socket ends and wipe the pins of the connectors to remove the IPA.
4. Blow air into the sockets and on the pins to make sure they are dry.
5. Use a flashlight and a magnifying glass to look for:

Any corrosion.		
Cracks, scratches, or other damage on the rubber pins or in the sockets.		
Separation of the rubber from the pins.		
Swelled or bulging rubber pins.		

6. Use a silicone-based lubricant on each of the contacts of the bulkhead connector. The manufacturer recommends any of the products listed below.

   - 3M™ Spray Silicone Lubricant (3M ID# 62-4678-4930-3). Make sure to let it dry.
   - Dow Corning Molykote® III Compound (DC III)
   - Dow Corning High Vacuum Grease® (DC 976 V)
   - Dow Corning 4 Electrical Insulating Compound® (DC 4)
   - Dow Corning Molykote 44 High Temperature Grease® (DC 44)

   Use a finger to put a small quantity (approximately 1 cm in diameter) of silicone grease on the socket end of the connector and push as much of the lubricant as possible into each socket. Do not use too much lubricant, as that will prevent a good seal.

7. Connect the connectors.
8. Use a lint-free wipe to clean any unwanted lubricant from the sides of the connectors.

Section 8 General information

⚠WARNING

This product can expose the user to chemicals with silica, crystalline (airborne particles of respirable size), which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, go to www.P65Warnings.ca.gov.

Revised editions of this user manual are on the manufacturer's website.

8.1 Warranty

Refer to the manufacturer's website for warranty information (seabird.com/warranty).

8.2 Service and support

The manufacturer recommends that sensors be sent back to the manufacturer annually to be cleaned, calibrated, and for standard maintenance.
Refer to the website for FAQs and technical notes, or contact the manufacturer for support at support@seabird.com. Do the steps below to send a sensor back to the manufacturer.

1. Complete the online Return Merchandise Authorization (RMA) form or contact the manufacturer.
   Note: *The manufacturer is not responsible for damage to the sensor during return shipment.*
2. Remove all anti-fouling treatments and devices.
   Note: *The manufacturer will not accept sensors that have been treated with anti-fouling compounds for service or repair. This includes AF 24173 devices, tri-butyl tin, marine anti-fouling paint, ablative coatings, etc.*
3. Use the sensor's original ruggedized shipping case to send the sensor back to the manufacturer.
4. Write the RMA number on the outside of the shipping case and on the packing list.
5. Use 3rd-day air to ship the sensor back to the manufacturer. Do not use ground shipping.
6. The manufacturer will supply all replacement parts and labor and pay to send the sensor back to the user via 3rd-day air shipping.

8.3 China RoHS disclosure table

Name of Part	Hazardous substance or element in product					
	Pb	Hg	Cd	Cr(VI)	PBB	PBDE
PCBs	X	O	O	O	O	O
Cables	X	O	O	O	O	O
Housing	O	O	O	O	O	O
Plumbing	O	O	O	O	O	O
Frame	O	O	O	O	O	O
Mounting hardware	O	O	O	O	O	O
Accessories	O	O	O	O	O	O
This table is compiled to the SJ/T 11364 standard.						
O: This hazardous substance is below the specified limits as described in GB/T 26572. X: This hazardous substance is above the specified limits as described in GB/T 26572.						

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