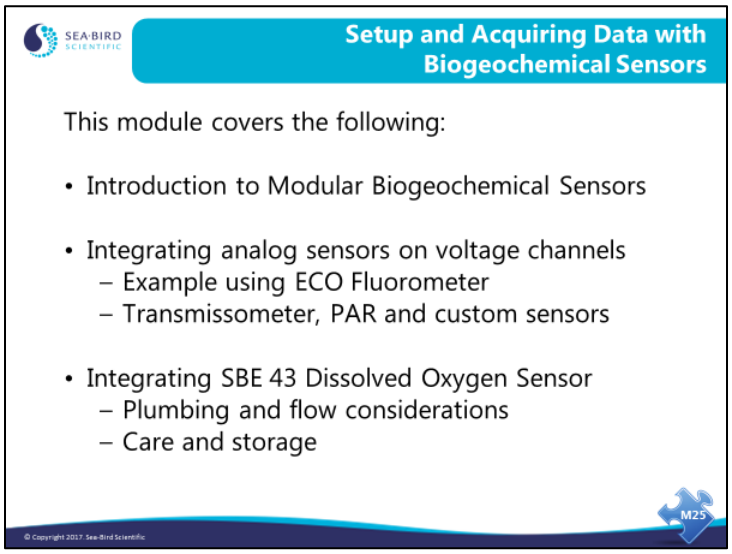
SEA-BIRD SCIENTIFIC

Setup and Acquiring Data with Biogeochemical Sensors

Sea-Bird Scientific University Module 25

Overview


SEA-BIRD SCIENTIFIC
Setup and Acquiring Data with Biogeochemical Sensors
This module covers the following:
• Introduction to Modular Biogeochemical Sensors
• Integrating analog sensors on voltage channels
– Example using ECO Fluorometer
– Transmissometer, PAR and custom sensors
• Integrating SBE 43 Dissolved Oxygen Sensor
– Plumbing and flow considerations
– Care and storage
M25
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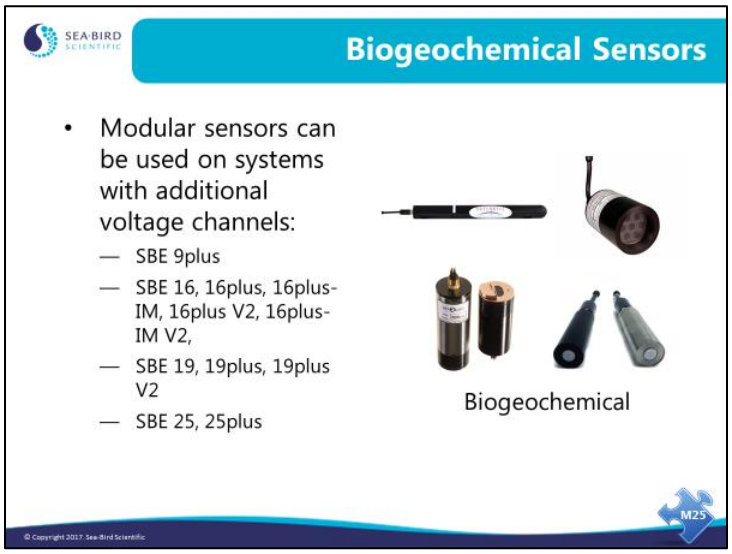
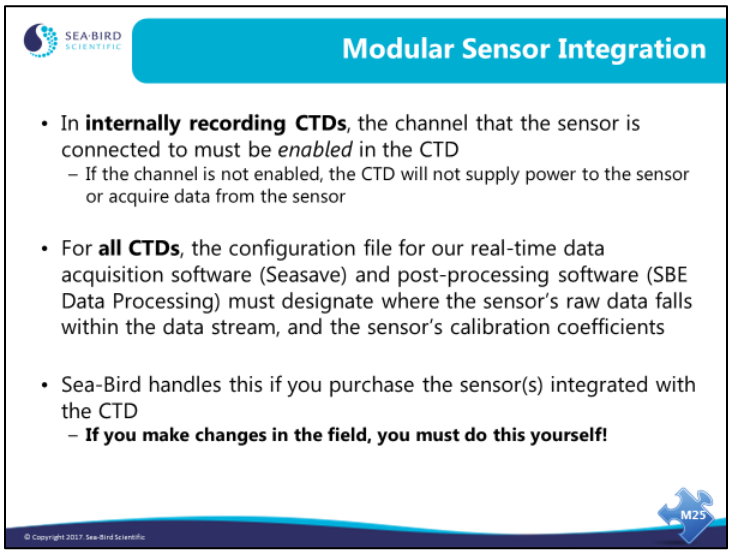
Introduction to Modular Sensors



Integrating Modular Sensors

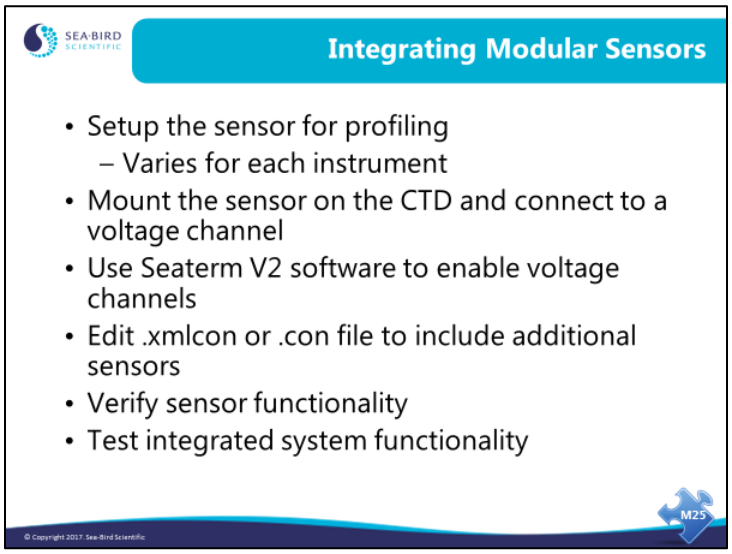


We will cover this in more detail in Modules 24 and 25.

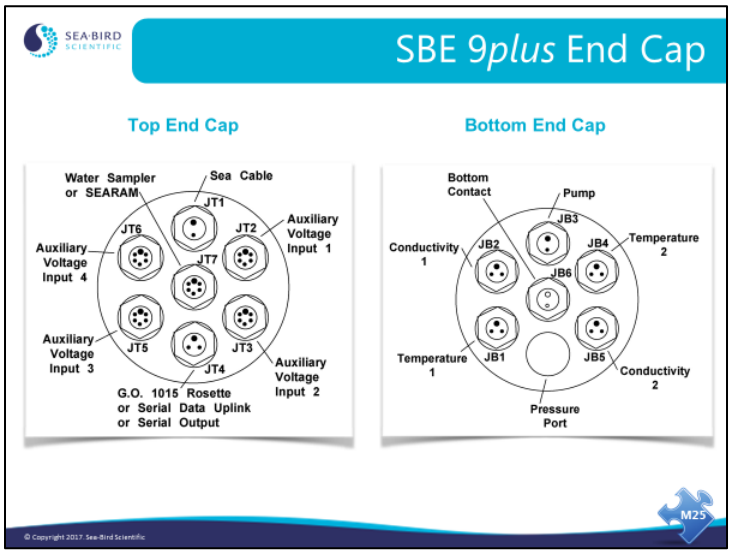
Sea-Bird's website includes a number of Application Notes providing details on setting up the CTD to work with auxiliary sensors and calculating calibration coefficients to enter in our software (see www.seabird.com/application-notes). Following is a list of the application notes and their associated sensors:

- 7: Sea Tech and Chelsea (Alphatracka) Transmissometers
- 9: Sea Tech Fluorometer and WET Labs Flash Lamp Fluorometer (FLF)
- 11General: PAR Light Sensors
- 11Chelsea: Chelsea PAR Light Sensor *with* Built-In Log Amplifier
- 11Licor: Licor Underwater Type SA PAR Light Sensor *without* Built-In Log Amplifier
- 11QSP-L: Biospherical PAR Sensor *with* Built-In Log Amplifier
- 11QSP-PD: Biospherical PAR Sensor *without* Built-In Log Amplifier
- 11S: Biospherical Surface PAR Light Sensor with SBE 11*plus* Deck Unit
- 16: D&A Instruments OBS-3 Optical Backscatter Sensor
- 39: Chelsea Aquatracka Fluorometer
- 41: WET Labs WETStar Fluorometer
- 48: Seapoint Turbidity Meter
- 54: Seapoint Fluorometer
- 61: Chelsea Minitracka Fluorometer
- 62: WET Labs ECO-AFL and ECO-FL Fluorometer, ECO-NTU Turbidity Meter, and ECO-FL-NTU Fluorometer/Turbidity Meter
- 63: Turner SCUFA (I, II, or III) Fluorometer/OBS
- 72: WET Labs ECO-FL Fluorometer with Bio-Wiper™
- 74: Turner Cyclops-7 Fluorometer or Turbidity Sensor
- 77: Seapoint *Ultraviolet* Fluorometer
- 81: Campbell Scientific/D&A OBS-3+ Optical Backscatter Sensor
- 87: Wet Labs ECO-BB Scattering / Turbidity Meter
- 91: WET Labs C-Star Transmissometer
- 95: Teledyne Benthos Altimeter

Integrating Modular Sensors *(continued)*



Integrating Modular Sensors *(continued)*

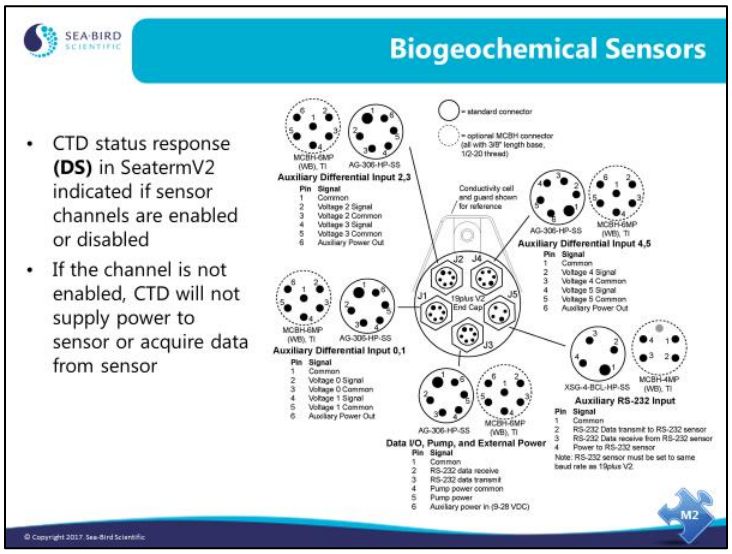


The **top end cap** of the 9*plus* has bulkhead connectors for all auxiliary sensors. Auxiliary sensors are those that are not temperature, conductivity, or pressure. Each auxiliary bulkhead has inputs for two 0 – 5V differential input channels. In addition, there is a 2-pin connector for the sea cable and a 3-pin connector for a GO 1015 rosette sampler. The center connector connects to the SBE 17*plus* (a memory module), a remote instrument, or an SBE 32 Carousel Water Sampler.

The **bottom end cap** has connectors for pairs of temperature and conductivity sensors, pump power, and a bottom contact switch. The bottom contact switch is mechanical, with a weight that hangs below the instrument package. When the weight contacts the ocean bottom, a bit is set in the data stream and an alarm in the SBE 11*plus* deck unit sounds.

WARNING! Do not plug the sea cable into the pump or bottom contact connector; this could cause serious damage to the CTD. In 2007, Sea-Bird changed the bottom contact connector to a female connector to reduce the possibility of this error; older units can be retrofitted if desired.

Integrating Modular Sensors *(continued)*

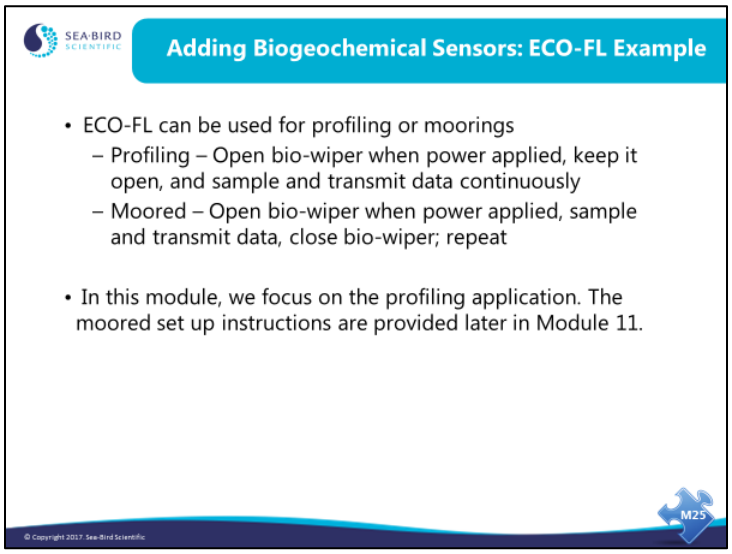


Sea-Bird CTDs can be configured with a wide range of auxiliary sensors. For example, the SBE 19*plus* V2 has three 6-pin bulkhead connectors for voltage output (0-5 volt) auxiliary sensors, each of which can accommodate two sensors (using a Y-cable). It also has one 4-pin bulkhead connector for an RS-232 output sensor. The connectors provide power to and acquire data from the auxiliary sensors.

Sea-Bird CTDs can accommodate almost any voltage output (0-5 volt) sensor whose response can be described with a polynomial equation. However, the 19*plus* V2 is currently limited to one of the following RS-232 sensors: SBE 63 optical DO sensor; SBE 38 secondary temperature sensor; WET Labs sensor (single, dual, or triple channel ECO sensor; WETStar; or C-Star); Pro-Oceanus Gas Tension Device; Aanderaa Oxygen Optode 4330 or 4835.
Note: Several WET Labs sensors are available as either voltage or RS-232 sensors.

As mentioned in Module 1, if you purchase auxiliary sensors from Sea-Bird along with the CTD, we handle the sensor integration – enabling the channel in the CTD, modifying the configuration file to describe where the data falls within the data stream and provide the calibration coefficients, and doing any required setup of the auxiliary sensor itself. If you add or remove a sensor in the field, you must do this work yourself.

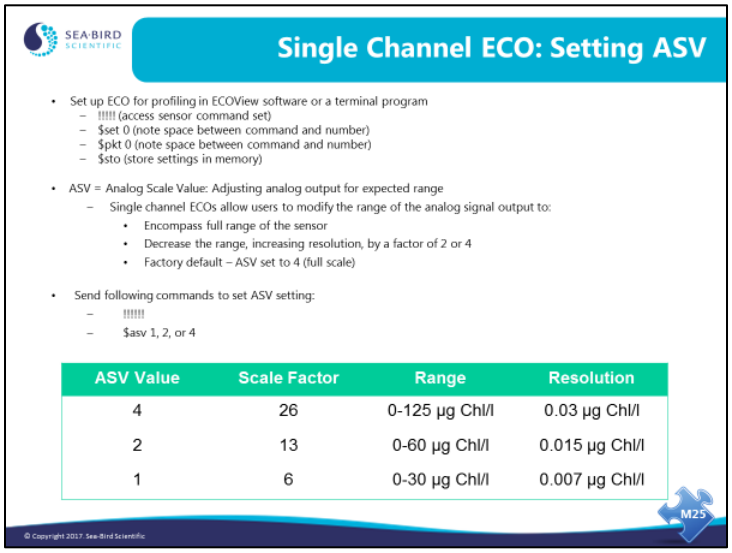
Biogeochemical Sensors: WET Labs ECO Example



We will run through one example of setting up a CTD for use with an auxiliary sensor, using the WET Labs ECO-FL fluorometer sensor. Application Note 72 provides details on the setup of this sensor.

The ECO can be used as a profiling sensor or a moored sensor. For this example, we will be using the SBE 19*plus* V2 in profiling mode, so we must first plug the ECO directly into the computer and set it up to work in profiling mode. We will do another example in Module 11 on setting up the system for operating in moored mode.

Biogeochemical Sensors: WET Labs ECO Example *(continued)*



ASV is the Analog Scale Value. **Single channel ECOs** allow users to modify the range of the analog signal output to:

- Encompass the full range of the sensor.
- Decrease the range, increasing resolution, by a factor of 2 or 4.

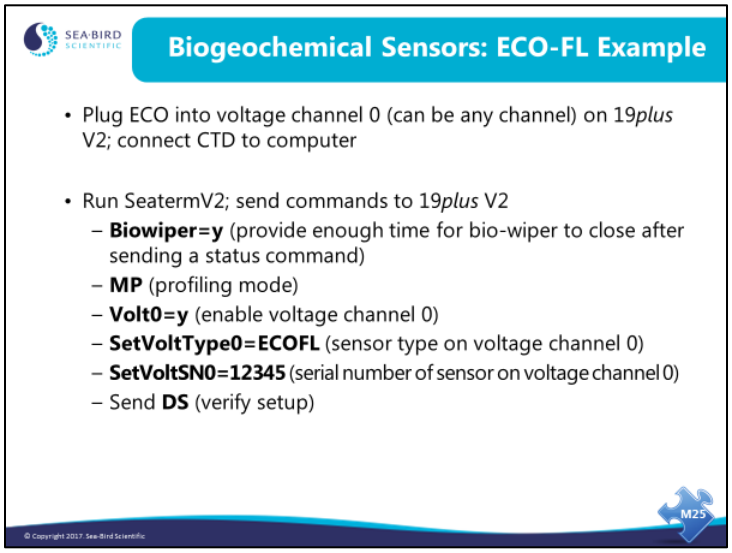
The factory default ASV is set to 4 (full scale).

The table above shows the ASVs and scale factors needed for your expected range of values for Chlorophyll a for the ECO-FL.

While still connected directly to the ECO sensor, set the ASV.

Note: The ASV cannot be modified in dual-channel ECOs (such as ECO-FLNTU, which has both fluorometer and turbidity channels) or triple-channel ECOs (such as the ECO Triplet, which has a user-defined combination of fluorometer and scattering channels).

Biogeochemical Sensors: WET Labs ECO Example *(continued)*

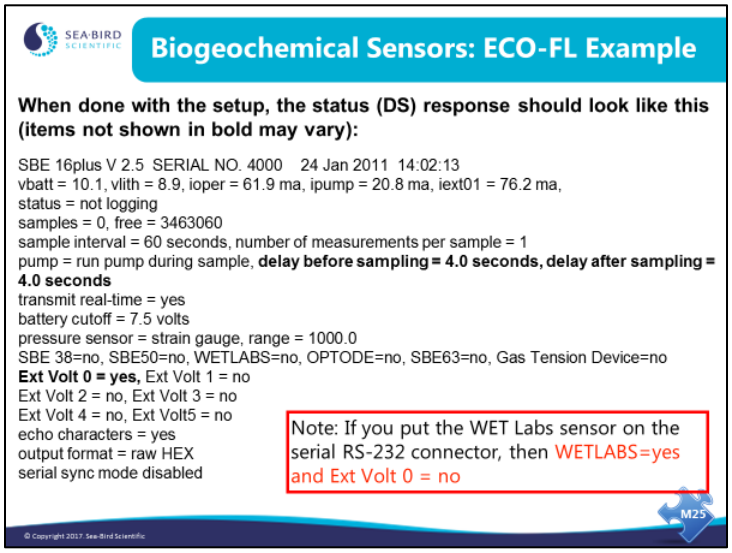


As mentioned earlier, when enabling/disabling a parameter, y and 1 are equivalent, and n and 0 are equivalent (i.e., **Volt0=y** and **Volt0=1** both enable voltage channel 0). The commands for enabling/disabling each voltage channel are **Volt0=** through **Volt5=**.

The **SetVoltType0=** and **SetVoltSN0=** commands record the user-input sensor types and serial numbers, and are informational only; the **GetHD** status response displays these, which may be useful for record keeping. The commands for each voltage channel are **SetVoltType0=** through **SetVoltType5=** and **SetVoltSN0=** through **SetVoltSN5=**.

Note: For this example, we are using a voltage output version of the ECO-FL. It is also available as an RS-232 sensor. If using the RS-232 version, the command to enable the RS-232 channel in the 19*plus* V2 is **WetLabs=y**. And the informational commands to record the serial instrument type and serial number are **SetSerialType=** and **SetSerialSN=**.

Biogeochemical Sensors: WET Labs ECO Example *(continued)*



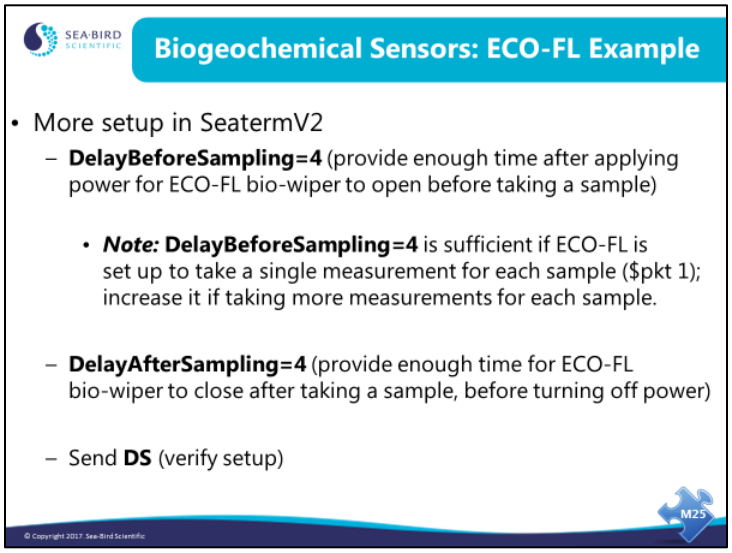
When the setup is complete, the **DS** response should show **mode = profile** (the CTD will operate in profiling mode) and **Ext Volt0 = yes** (you enabled voltage channel 0, so the CTD will supply power to that channel and incorporate data from that channel into the CTD data stream).

Additionally, because we set **Biowiper=y**, the response shows

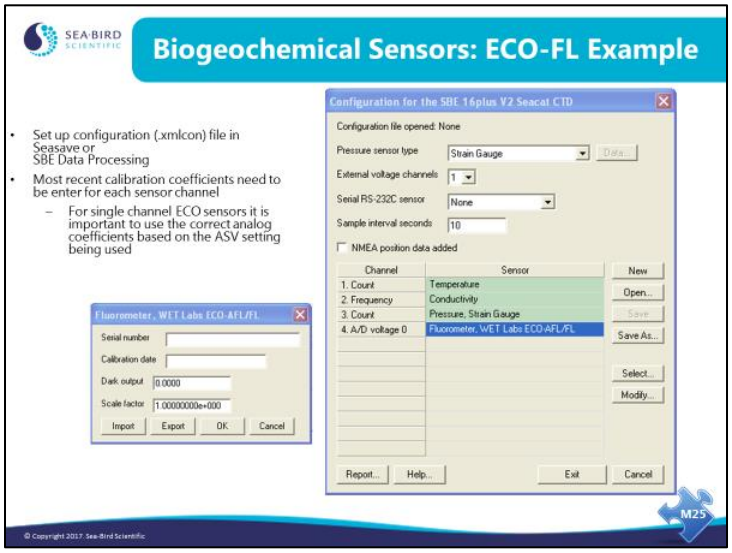
```
wait 4 seconds for biowiper to close
```

before it measures the enabled external voltage currents.

Biogeochemical Sensors: WET Labs ECO Example *(continued)*



Biogeochemical Sensors: WET Labs ECO Example *(continued)*



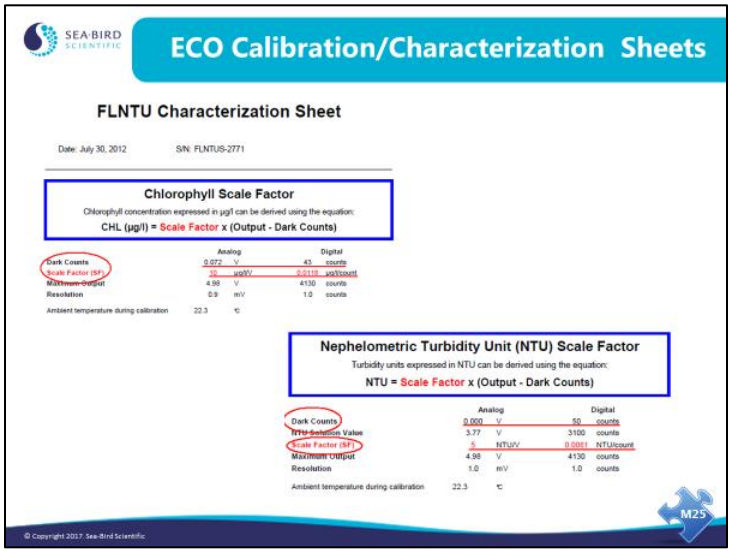
If using Seasave (real-time data acquisition), you must modify/create the configuration file before deploying. Select *1* for *External voltage channels*. *A/D voltage 0* appears in the table, labeled *Free*. Double click to get a list of supported voltage sensors; click the + sign by Fluorometers, and select WET Labs ECO-AFL/FL. A dialog box appears; enter calibration coefficients for the sensor.

What if you have multiple auxiliary sensors, and they are not using sequential channels (for example, sensors plugged into channels 0 and 4)? In SeatermV2, enable channels 0 and 4 in the CTD, so the CTD provides power to and receives data from those channels. In Seasave, select *2* for *External voltage channels*. *A/D voltage 0* and *A/D voltage 1* then appear in the table. In the configuration file, voltage 0 corresponds to the first auxiliary sensor voltage in the data stream, and voltage 1 corresponds to the second.

If not doing real-time data acquisition (i.e., deploying on non-conducting cable, and uploading data later), create/modify the configuration file when you run SBE Data Processing (post-processing software). Seasave and SBE Data Processing use the same configuration file.

Note: For a dual-channel voltage-output ECO-FLNTU, you must enable two voltage channels in both CTD and configuration file. For a Triplet (available only as a RS-232 sensor), you must enable the RS-232 channel in the CTD (**WetLabs=y**) and select WET Labs as the RS-232 sensor in the configuration file; the software automatically creates 3 RS-232 channels in the configuration file.

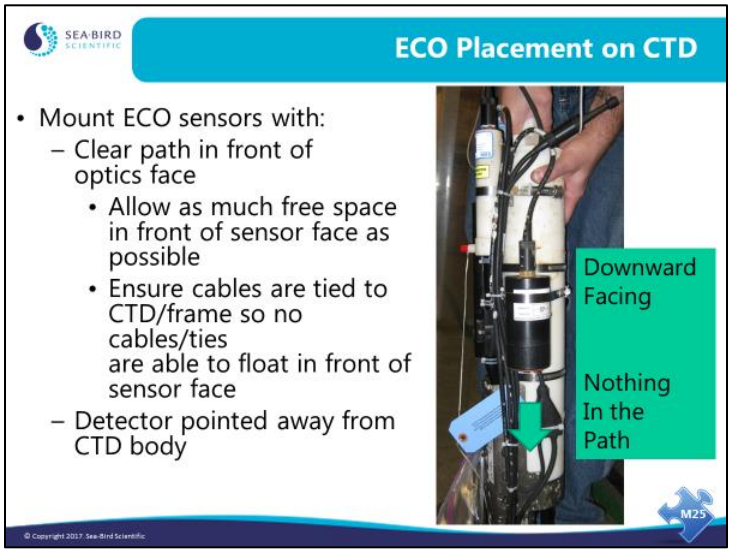
Biogeochemical Sensors: WET Labs ECO Example *(continued)*



These are calibration sheets for an ECO-FLNTU; one calibration sheet is for the fluorometer (FL) channel while the other is for the turbidity (NTU) channel. Both show the Dark Counts and Scale Factor to input in the Sea-Bird configuration file

The ECO-FLNTU is a dual-channel voltage-output instrument. You must enable two voltage channels in both the CTD and configuration file when using this sensor.

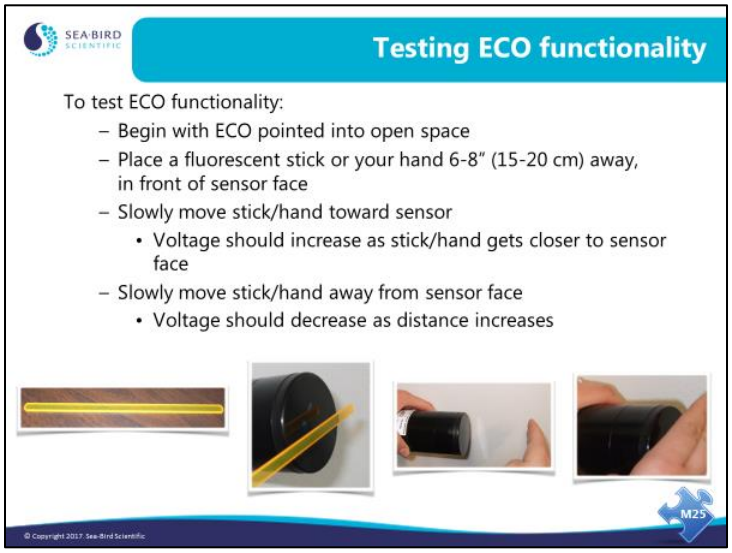
Biogeochemical Sensors: WET Labs ECO Example *(continued)*



Attach the ECO on the CTD cage or to the CTD housing, with the optical window facing in the direction you are profiling…preferred down. Be sure nothing is in the direct path of the optical window, and that nothing can reflect light back towards the sensor.

Remove the protective cap before deployment!

Biogeochemical Sensors: WET Labs ECO Example *(continued)*

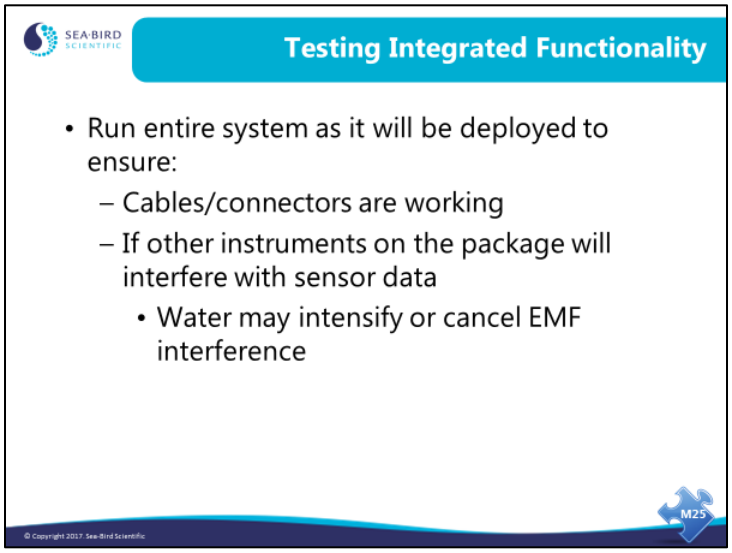


It is always good to be sure that all sensors are outputting data once they are installed. Sea-Bird does this by placing the assembled CTD with all auxiliary sensors into a test bath overnight and examining the recorded data the following day, prior to shipping to customers. If you install your own sensors, you may want to do something similar, or perform a bench test to ensure all sensor channels that are enabled are outputting data the way you think they should, and that you do not have something plugged into the wrong channel or enabled incorrectly in the CTD.

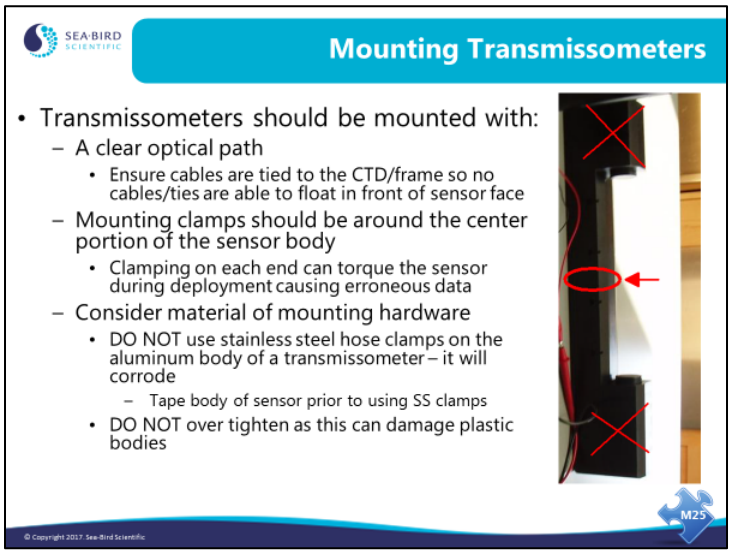
Easy checks for functionality include:

- The ECO-FL test described above. The fluorescent stick is shipped with the sensor.
- Conductivity check - Zero conductivity test with a dry conductivity cell and in air (should output a frequency very close to the zero conductivity calibration frequency on the conductivity sensor calibration sheet that came with your CTD).
- Temperature check.
- Pressure check - At a known elevation (quick check) or against a barometer (more precise).
- Scan output rate check.

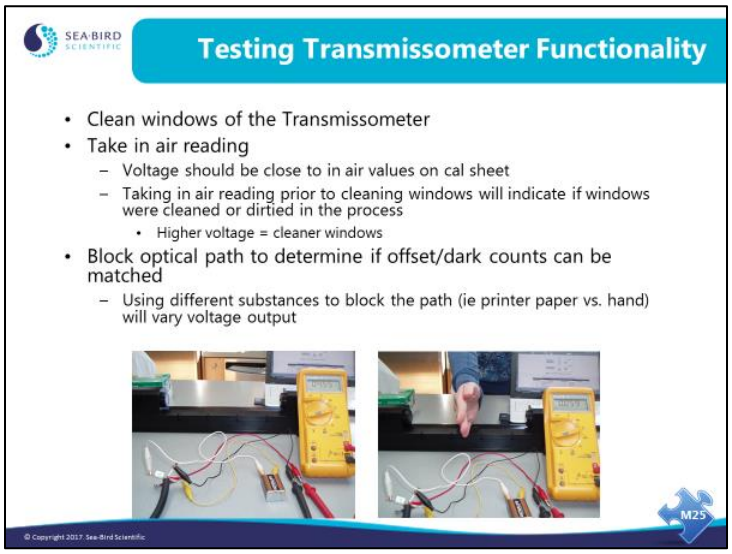
Biogeochemical Sensors: WET Labs ECO Example *(continued)*



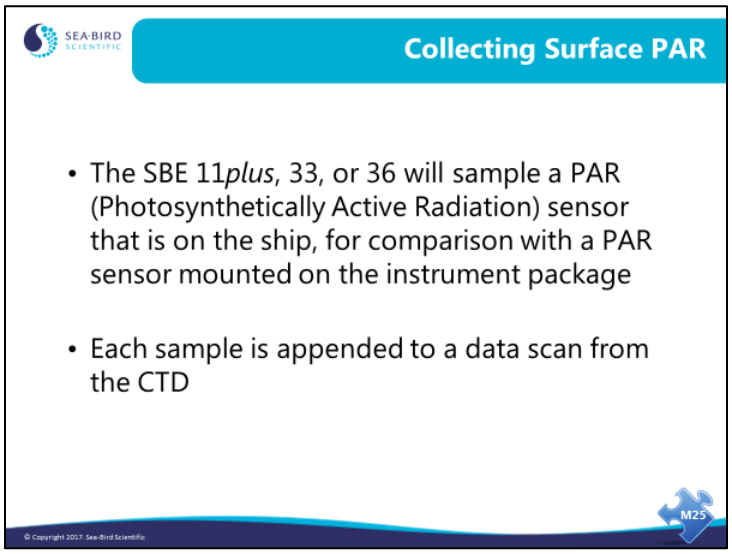
Integrating Transmissometers



Integrating Transmissometers *(continued)*



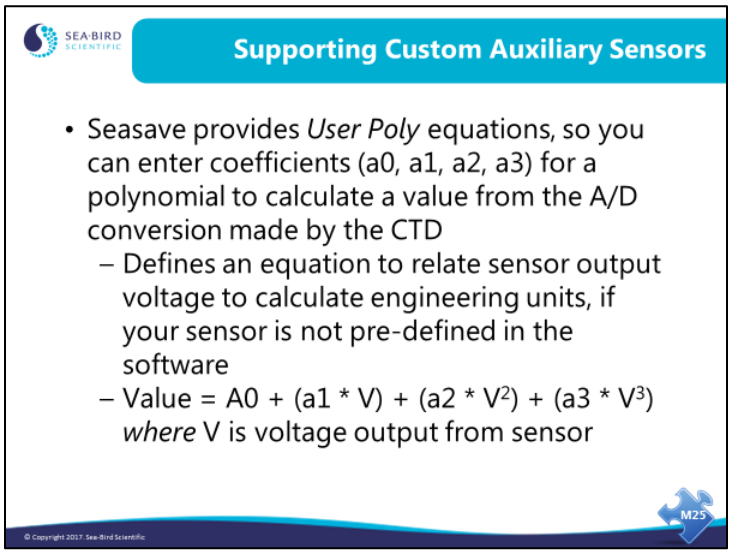
Adding Surface PAR



Sea-Bird deck units may be equipped with an A/D interface intended to digitize the signal from a deck-mounted PAR sensor. This is standard equipment for the SBE 11*plus* and optional for the SBE 33 and 36. In Seasave, Surface PAR data is appended to real-time data if you select *Surface PAR voltage added* in the instrument configuration (*.con* or *.xmlcon*) file dialog box.

Mount the Surface PAR sensor where it will not be shadowed by anything overhead. The Surface PAR sensor is used in conjunction with a PAR sensor mounted on the instrument package.

Supporting Custom Auxiliary Sensors



For instruments that are not supported in Seasave, a meaningful display of data can be made by specifying a *user polynomial* to be applied to the 0 – 5V data. The user polynomial can be up to 3rd order:

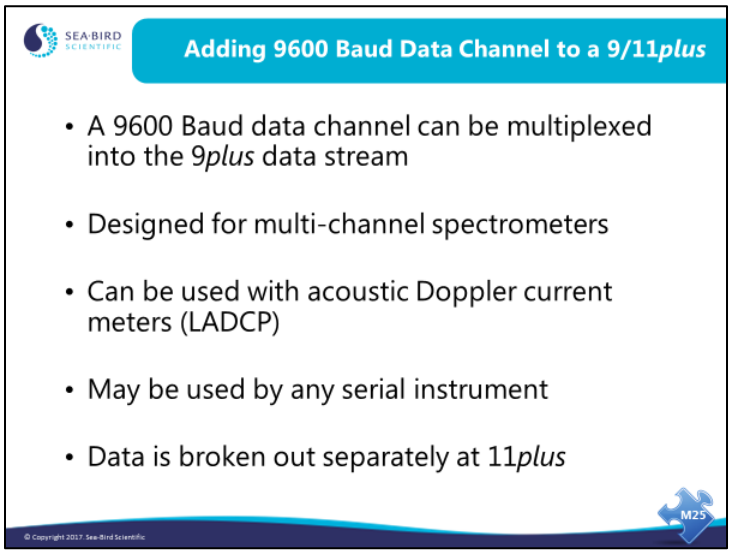
$$\text{Value (in engineering units)} = a0 + (a1 * V) + (a2 * V^2) + (a3 * V^3)$$

where:

V = voltage from sensor

a0, a1, a2, and a3 = user-defined sensor polynomial coefficients, specified in the instrument configuration (*.con* or *.xmlcon*) file

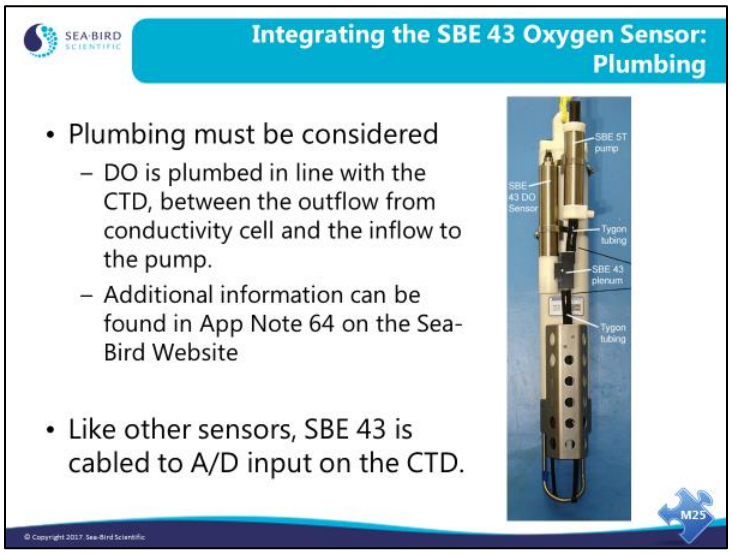
Adding 9600 Baud Data Channel to 911*plus*



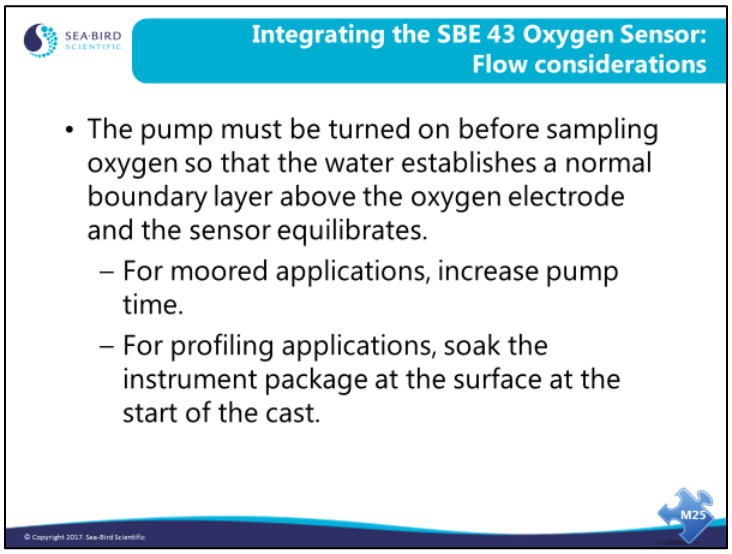
As optional equipment, a 9600-baud serial channel can be multiplexed into the 9*plus* data stream, allowing external instruments that transmit serial data at 9600 baud or less to send their data up the sea cable. This data channel was designed for multi-channel spectrometers; however, it has also been used with acoustic Doppler current meters.

The 9600 baud channel can also be used with an instrument that transmits at 19200 baud in *burst* mode, so that the overall rate of transmission does not exceed 9600 baud.

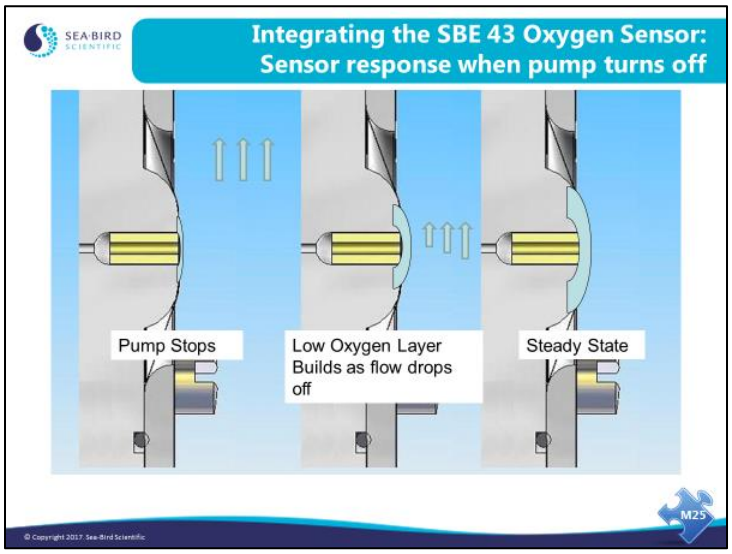
Integrating Dissolved Oxygen



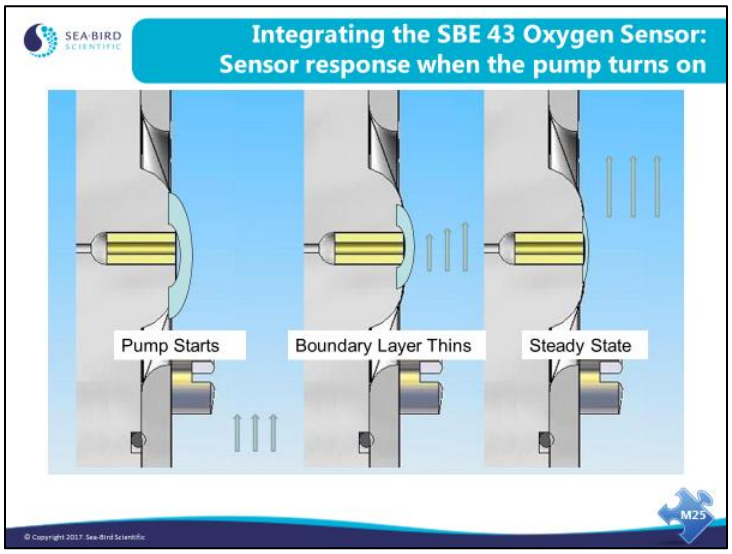
Integrating Dissolved Oxygen *(continued)*



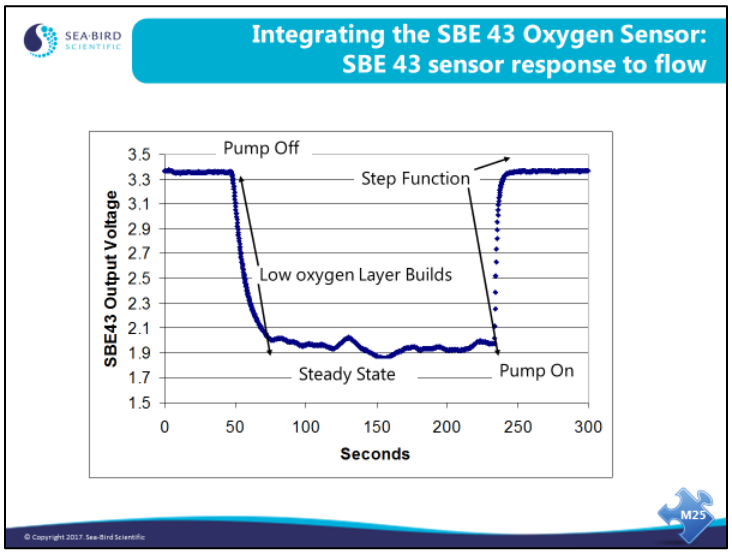
Integrating Dissolved Oxygen *(continued)*



Integrating Dissolved Oxygen *(continued)*



Integrating Dissolved Oxygen *(continued)*



Preparing for Moored Deployment