Integrating Wipered ECO Sensors with SeaCAT*plus* V2 CTDs

This application note applies to SBE 16*plus* V2, 16*plus*-IM V2, 19*plus* V2 when integrated with an ECO-FLNTUS, ECO-FLS, or ECO-FLCDS.

The manufacturer recommends that the user update the CTD firmware as necessary to accommodate the **DelayAfterSampling=** commands.

- SBE 16plus V2 and SBE 19plus V2 firmware 2.5
- SBE 16plus-IM V2 firmware 2.5.2.

The ECO sensor can be configured to operate in Profiling or Moored mode:

- **Profiling mode** – The ECO opens the Bio-wiper when power is applied and keeps it open continuously, even when power is removed. It samples continuously when powered. The output is a voltage that changes as the data changes.
- **Moored mode** – The ECO opens the Bio-wiper when power is applied and takes one or more samples, then closes the Bio-wiper. The output is a voltage that is held until power is removed.

When the manufacturer integrates the ECO with a CTD, it is set up so the ECO operates in the mode appropriate for the CTD. However, you may want to change the mode in the future, if:

- You purchased the ECO for use with an SBE 19*plus* V2, which can be field-configured to operate in either profiling or moored mode.
- You want to use the ECO in the future with another CTD; for example, you purchased the ECO for use with an SBE 25*plus* profiling CTD and now want to use it with an SBE 16*plus* V2 moored CTD.

Definitions

ECO Setup

- `$pkt` is the number of packets sent by ECO per set (defines ECO sampling duration).
- `$set` is the number of sets of packets sent by ECO before shutting down (0 = continuous).
- `$int` is the interval between sets of ECO packets.

SeaCAT*plus* V2 Setup

- **BioWiper=Y** defines that the CTD is integrated with a sensor equipped with a Bio-wiper. It affects length of time that the CTD is powered for the status command (**DS** or **GetSD**), to allow time for Bio-Wiper to close.
- **NCycles=** measurements for SeaCAT*plus* V2 to average per sample (requires 0.25 sec/measurement). Applies to SBE 16*plus* V2, 16*plus*-IM V2, and moored mode for 19*plus* V2.
- **DelayBeforeSampling=** seconds to wait after applying power to auxiliary sensors and pump before sampling begins.
- **DelayAfterSampling=** seconds to wait after sampling is completed, before powering down auxiliary sensors and pump.
- **ParosIntegration=** seconds to integrate (optional) Paroscientific Digiquartz pressure sensor readings per sample. Not applicable to 19*plus* V2.

Set Up and Use CTD in Moored Mode

Make sure to use the **#ii** prefix (ii = instrument ID) when sending commands to the SBE 16*plus*-IM V2. For example, **#01BioWiper=Y** sends **BioWiper=Y** to the 16*plus*-IM V2 with ID=01.

Moored Mode Setup - General

Enabling the Bio-wiper command ensures that the Bio-Wiper automatically closes after sending a status command.

Command	Response Description
BioWiper=x	**x=N** (default): Configuration does not include a sensor with Bio-wiper. **x=Y**: Configuration includes sensor with Bio-wiper. CTD is powered longer (total of 8 sec) for status command (**DS** or **GetSD**), providing 4 sec for Bio-wiper to open and then close again if in Moored mode. Note that 4 sec for the Bio-Wiper to open and shut is sufficient for the typical application, with the ECO set up to take a single measurement for each sample. However, the ECO can be user-programmed to take and average a number of measurements for each sample. If averaging multiple measurements, 4 sec may not provide sufficient time for the Bio-wiper to close. For those applications, use the **TV**, **TVR**, or **TS** command after the status command, and then wait at least 10 sec to cycle the Bio-wiper open/close. verify that the Bio-Wiper has closed before deploying.

Delay before sampling (**DelayBeforeSampling=**) sets the amount of time to wait after turning on external voltages before sampling. The ECO requires approximately 2 to 4 sec to provide time for the sensor to open the Bio-wiper before sampling. Refer to the ECO user manual for the specific time requirements.
Set delay before sampling as follows:

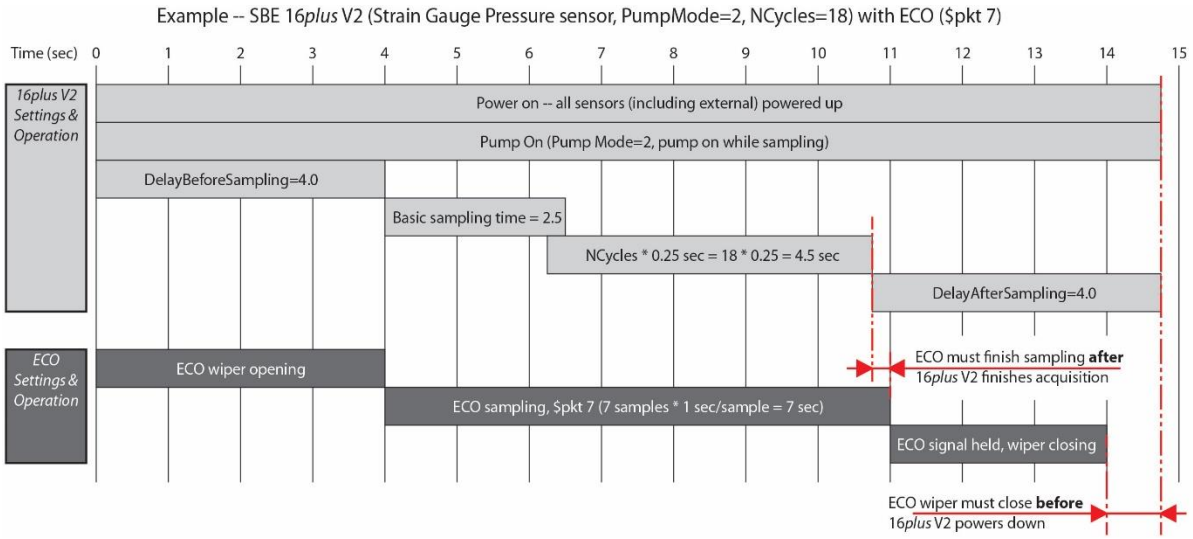
- If `$pkt` is set to 1: **DelayBeforeSampling=4**
- If `$pkt` is set to >1: See *Moored Mode Setup when Multiple ECO samples are Desired* below.

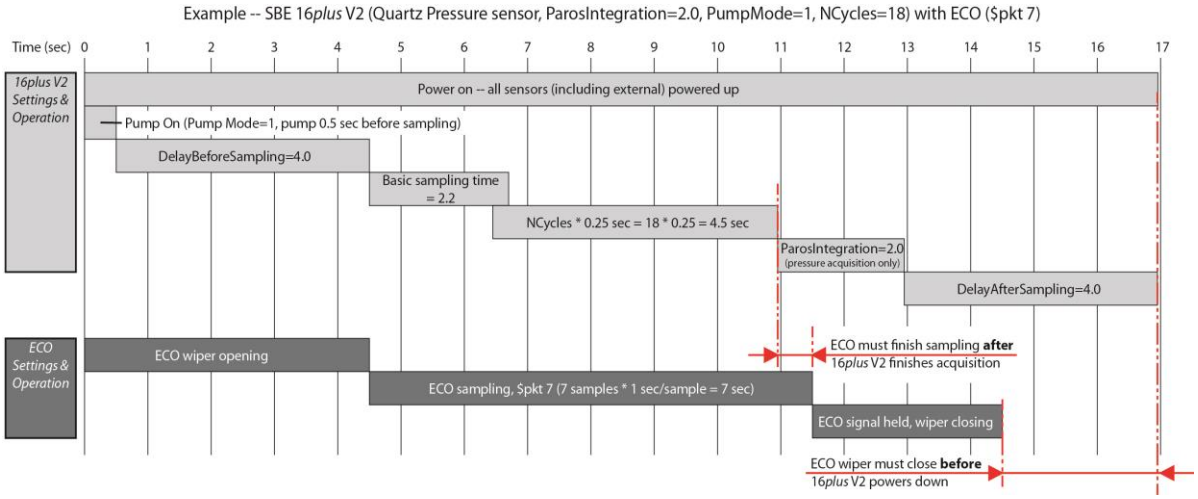
Delay after sampling (**DelayAfterSampling=**) sets the amount of time to wait after sampling is completed, before turning off power to external sensors. The ECO requires approximately 2 to 4 sec to provide time to close the Bio-wiper after sampling is complete. Therefore, set **DelayAfterSampling=4**.

Moored Mode Setup when Multiple ECO Samples are Desired

As described above, `$pkt` is the number of samples sent by the ECO per interval cycle (set). The ECO provides a sample at 1 Hz (1 sample /sec), and then holds the final output until power is removed. The SeaCAT*plus* V2 averages all of the ECO data received during its own sampling cycle. Consequently, if the SeaCAT*plus* V2 is still sampling when the ECO has finished, the final ECO voltage (which is held until power is removed) will bias the average toward the value of the last ECO sample. Therefore, if `$pkt` > 1, a careful timing analysis is required to ensure that the ECO sampling length extends beyond the end of the SeaCAT*plus* V2 acquisition. Modify **NCycles=** (number of A/D/ acquisition cycles, each at 0.25 sec) in the SeaCAT*plus* V2.

The examples below assume that the ECO wiper takes 4 sec to open or close. If estimating shorter open/close time, increase the number of ECO samples accordingly. For example, use the setting $pkt 9 for a 2-sec wiper open/close time. For most ECOs, the wiper typically takes 2 sec to open/close in the air and at the ocean surface. The wiper motion cycle time can also be impacted by pressure at depth. Provide a margin of safety for the wiper to close completely prior to powering down the SeaCAT*plus* V2 between samples (**DelayAfterSampling** ≥ 4 sec).


Example -- SBE 16plus V2 (Strain Gauge Pressure sensor, PumpMode=2, NCycles=18) with ECO ($pkt 7)
Time (sec) 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16plus V2 Settings & Operation
Power on -- all sensors (including external) powered up
Pump On (Pump Mode=2, pump on while sampling)
DelayBeforeSampling=4.0
Basic sampling time = 2.5
NCycles * 0.25 sec = 18 * 0.25 = 4.5 sec
DelayAfterSampling=4.0
ECO Settings & Operation
ECO wiper opening
ECO must finish sampling after 16plus V2 finishes acquisition
ECO sampling, $pkt 7 (7 samples * 1 sec/sample = 7 sec)
ECO signal held, wiper closing
ECO wiper must close before 16plus V2 powers down


Example -- SBE 16plus V2 (Quartz Pressure sensor, ParosIntegration=2.0, PumpMode=1, NCycles=18) with ECO ($pkt 7)
Time (sec) 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
16plus V2 Settings & Operation
Power on -- all sensors (including external) powered up
Pump On (Pump Mode=1, pump 0.5 sec before sampling)
DelayBeforeSampling=4.0
Basic sampling time = 2.2
NCycles * 0.25 sec = 18 * 0.25 = 4.5 sec
ParosIntegration=2.0
(pressure acquisition only)
DelayAfterSampling=4.0
ECO Settings & Operation
ECO wiper opening
ECO must finish sampling after 16plus V2 finishes acquisition
ECO sampling, $pkt 7 (7 samples * 1 sec/sample = 7 sec)
ECO signal held, wiper closing
ECO wiper must close before 16plus V2 powers down