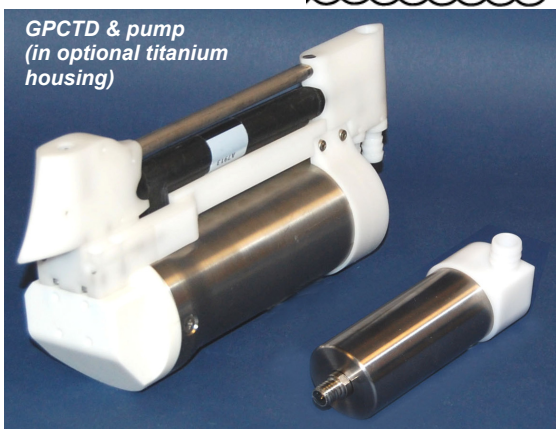
Glider Payload CTD

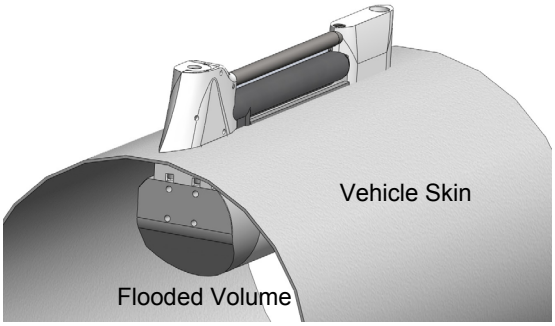
GPCTD

The Glider Payload CTD (GPCTD) measures conductivity, temperature, and pressure, and optionally, dissolved oxygen (with the modular SBE 43F DO sensor). It is a modular, low-power profiling instrument for autonomous gliders with the high accuracy necessary for research, inter-comparison with moored observatory sensors, updating circulation models, and leveraging data collection opportunities from operational vehicle missions. The pressure-proof module allows glider users to exchange CTDs (and DO sensors) in the field without opening the glider pressure hull.


GPCTD & pump (in optional titanium housing)

The GPCTD evolved from sensors and measurement methods used in Argo float CTDs. Their performance and reliability has been proven on more than 8,000 Argo floats to date. The constant pumped flow and ducted T & C sensors provide superior dynamic accuracy compared to free-flushed sensors. However, TS errors introduced by glider flight dynamics, boundary layers, and wakes are larger than those experienced by vertically ascending Argo floats, reducing the achievable dynamic accuracy on gliders.

Recent improvements in efficiency have yielded a continuously pumped CTD that consumes only 175 mw while recording at 1 Hz, or 190 mw when transmitting real-time data. To put this in perspective, the energy contained in one Alkaline D cell will operate the CTD continuously for 114 hours, or 9.5 days at 50% duty cycle (profiling continuously at 1 Hz on every glider upcast). One Lithium DD cell will provide 48 days profiling continuously on every upcast.



The T-C sensor assembly visible on the exterior of the vehicle consists of a streamlined T-C intake sail (with integral T-C duct and anti-foul device), a horizontal, internal field conductivity cell, and a downstream exhaust sail with pump connections. The intake sail allows measurements to be made outside of the vehicle's boundary flow where *old* water is thermally contaminated by the vehicle, producing TS errors. The pump pulls water into the duct at top of the intake sail and immediately past a temperature sensor. Water then flows through an anti-foulant cylinder, through the conductivity cell, and out the top of the exhaust sail to prevent exhaust re-circulation and Bernoulli pressure differences from changing the flow rate. The outside of the conductivity cell is free-flushed to minimize salinity errors. If the cell were located inside the flooded fairing, a *thermal mass* error resulting from temperature difference between the poorly-flushed volume inside the hull and the ambient ocean temperature measured by the CTD would produce salinity errors.

The connecting *neck*, electronics housing, modular pump, and DO sensor are meant to locate in a flooded space inside the glider hull. Pump tubing between the conductivity cell and the pump intake, and from the pump outlet to the exhaust fitting on the sail, are not shown. The locations of the pump and DO sensor within the flooded volume are not pre-determined, but tubing lengths should be short as possible and avoid sharp bends, and the pump (centrifugal impeller) and tubing orientation should avoid trapping air that will interfere with pump priming.

Four sampling modes are supported:

- **Continuous Sampling** - The pump runs continuously, and the CTD (or CTD / DO) samples once every 1, 2, 3, or 4 seconds (no power savings over 1 Hz sampling for other intervals, but less memory used). This produces a time series suitable for application of high-quality finish corrections (e.g., response filtering, alignment, thermal mass correction) for dynamic errors observed in the data.
- **Fast Interval Sampling** - When the interval between samples is 5 to 14 seconds, the pump runs continuously and CTD (or CTD / DO) measurements are made at the chosen interval, allowing users to conserve power (as compared to Continuous Sampling) by reducing the sample rate.
- **Slow Interval Sampling (CTD only)** - When the interval is 15 to 3600 seconds, the pump runs for 11.3 seconds before each CTD measurement, plus 2.1 seconds during the measurement (13.4 seconds total). Then the CTD turns off the pump and goes into a low-power state until the next measurement. (Sea-Bird cannot offer data processing support for data sets acquired in this mode.) The optional SBE 43F DO sensor is not powered in this mode.
- **Spot Sampling** – Single measurements and transmission of P, CTP, or CTP and DO can be commanded for testing, diagnostic, vehicle-control, or situational awareness purposes, but data is not stored in memory.

Data from Continuous or Interval Sampling are stored in memory for later upload. If desired, data can also be output in real-time (increasing power consumption slightly). A *Send Last Sample* command can be executed without interrupting Continuous or Interval Sampling; if the GPCTD is taking a sample in Interval Sampling mode when the command is sent, the reply is delayed slightly until the current sample is completed.

A file header (20 bytes) is created each time Continuous or Interval Sampling is initiated, and contains beginning and ending sample numbers, sample mode, time between samples, and cast starting date/time. A maximum of 1000 headers (casts) can be stored.

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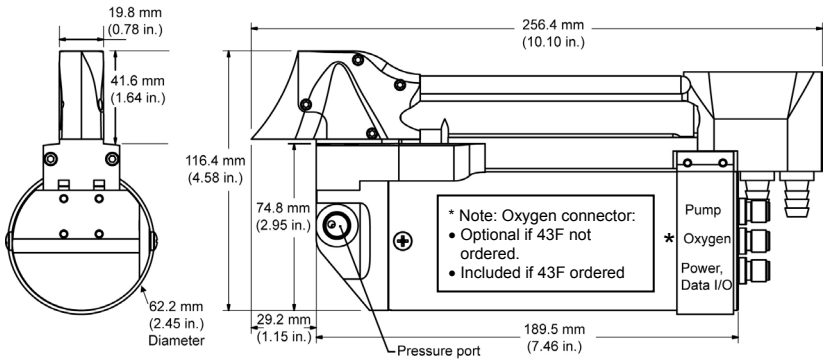
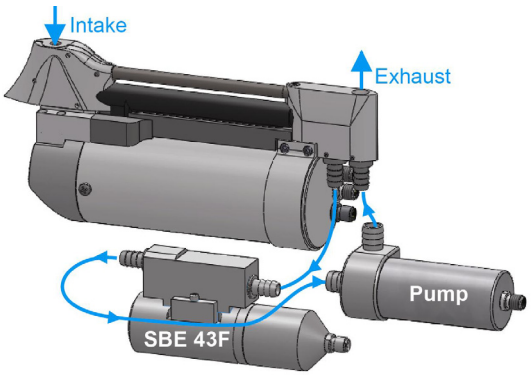
Glider Payload CTD GPCTD



Forward End View **Side View (connectors IE55)**



With Optional SBE 43F Oxygen Sensor
(plumbing approximate)

SPECIFICATIONS

	Measurement Range(s)	Calibration Range	Accuracy (within cal. range)	Accuracy (outside cal. range)	Resolution
Conductivity (S/m):	0 to 9	0 to 6	± 0.0003	better than ±0.0010 [1]	0.00001
(mS/cm):	0 to 90	0 to 60	± 0.003	better than ±0.010 [1]	0.0001
Temperature (°C):	-5 to +42	+1 to +32	± 0.002	better than ±0.004 [1]	0.001
Pressure (depth) (dbar):	0 to 100, 0 to 350, 0 to 1000, 0 to 2000	full scale	± 0.1% F.S.	--	0.002% F.S.

[1] Due to fit extrapolation errors.

Memory

8 Mbytes = 699,000 samples of CTP (194 hours at 1 Hz), or 559,000 samples of CTP & DO (155 hours at 1 Hz)

Data Formats

Real-time data and uploaded data are output (decimal or Hexadecimal characters) in units of Siemens/meter (conductivity), degrees C (temperature), decibars (pressure), and Dissolved Oxygen frequency.

Operating Power Requirements

Supply Voltage: 8 to 20 VDC nominal (power calculations below assume 10.0 V)

Quiescent current: 30 µA

Continuous Sampling CTP only: 175 mW if real-time = no, 190 mW if real-time = yes (2.10 – 2.28 Watt-hours/day @ 50% duty)
Continuous Sampling CTP & DO: 265 mW if real-time = no, 280 mW if real-time = yes (3.18 – 3.36 Watt-hours/day @ 50% duty)

Fast Interval Sampling (CTP only), real-time = no: 0.225 Joules/measurement + (interval in seconds * 0.068 W)
Fast Interval Sampling (CTP only), real-time = yes: 0.172 Joules/measurement + (interval in seconds * 0.108 W)
Fast Interval Sampling (CTP & DO), real-time = no: 0.320 Joules/measurement + (interval in seconds * 0.113 W)
Fast Interval Sampling (CTP & DO), real-time = yes: 0.267 Joules/measurement + (interval in seconds * 0.153 W)

Slow Interval Sampling (CTP only), real-time = no: 1.188 Joules/measurement + (interval in seconds * 0.002 W)
Slow Interval Sampling (CTP only), real-time = yes: 1.125 Joules/measurement + (interval in seconds * 0.043 W)
Slow Interval Sampling (CTP & DO, but not measuring DO*), real-time = no: 1.789 Joules/measurement + (interval in seconds * 0.002 W)
Slow Interval Sampling (CTP & DO, but not measuring DO*), real-time = yes: 1.757 Joules/measurement + (interval in seconds * 0.043 W)
**With DO sensor installed (so more pump power required to pump water through DO sensor), but DO not measured in this mode.*

Spot Sampling:
P = 0.7 sec * 0.124 W = 0.09 Joules/measurement (no pumping) + 0.043 W * seconds until next command (e.g., stop)
CTP = 1.73 Joules/measurement (with 13.4 sec pumping time) + 0.043 W * seconds until next command (e.g., stop)
CTP & DO = 3.03 Joules/measurement (minimum, using 15 sec pump time before sampling) + 0.043 W * seconds until next command (e.g., stop).
(Pump time before sampling is 7 DO sensor time constants or 15 seconds, whichever is longer, and is adaptively determined from T and P immediately prior to sampling. At 4 °C and 750 decibars, 7 time constants is approximately 25 sec pump time, consuming 4.66 Joules/measurement + 0.043 W * seconds until next command (e.g., stop).)

Battery Power Notes: Duracell D MN1300 - 20 Watt-hours or 72.0 Kjoules, nominal. Duracell C MN1400 - 9 Watt-hours or 32.4 Kjoules, nominal. Electrochem CSC93 DD (3B0036) – 368 Kjoules, nominal.

Mechanical

Weight, CTD & pump: 350 m version – 1.0 kg in air, 0.2 kg in water; 1500 m version – 1.2 kg in air, 0.4 kg in water
Weight, SBE 43F DO: 600 m version - 0.3 kg in air, 0.1 kg in water; 7000 m version – 0.4 kg in air, 0.2 kg in water

REFERENCES

Application Note 82: Guide to Specifying a CTD, and SBE 43/43F datasheet.

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