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D-2 INCORPORATED

Ocean Conductivity & Temperature Sensor

OC-CT-DL-1-000-0

OPERATION MANUAL
REVISION 2.0
P/N 309-010
Firmware Version 0.62

Revision History:

Rev	Date	Description	
0	20APR20	Written	**DLF**
1	29JUL21	Changed procurement numbers	**SWS**
2	02DEC24	Removed RS-485 and editorial changes	**DLF**

This manual covers the operational aspects of the D-2 Ocean Conductivity (Salinity) and Temperature Sensor. D-2 continuously strives to meet the full expectations of our customers, and we welcome comments on the structure, content and the ability of this manual to answer your questions regarding our products. If you have any suggestions or comments, please contact us at sales@D-2inc.com. This document is provided with the understanding that future versions of this instrument may have additional commands, and the function of the commands shown in this document may vary from the present operation. D-2 believes that this manual is accurate at the time of writing, but its contents are subject to change. D-2 accepts no liability for errors and omissions in this document. If you have any questions or comments regarding the manual content, contact D-2.

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Notes for User:

WARNING!

There is a danger to life and limb or a risk of serious injury if the notes on safety are disregarded!

CAUTION!

There is a risk of injury and damage to property if the notes on safety are disregarded!

ATTENTION!

There is a risk of damage to property if the notes on safety are disregarded!

! IMPORTANT

Notes on working procedures.

Read the instructions in this manual carefully before installing or starting the system. Note throughout this manual the term “OC-CT” & or “CT” applies to all models of the Ocean Conductivity & Temperature instrument, unless specific individual model numbers are detailed.

D-2 Incorporated will accept no liability for damages due to non-observance of this manual.

ATTENTION!

If the instructions in the operating manual are not adhered to or are inadequately adhered to, there shall be no entitlement to services under the warranty.

Information in this manual is subject to change without notice and does not represent a commitment on the part of D-2 Incorporated.

Where manuals are written in several languages, the text it was created in is considered the original.

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1.0 GENERAL DESCRIPTION

The OC-CT Sensors are a new low-cost alternative for upper ocean conductivity and temperature measurements. The sensor uses a traditional inductive conductivity sensor, with high stability glass tube which defines the sensitive measurement region to improve measurement accuracy. These CT sensors are ideal for use on coastal monitoring platforms. Data is available in serial form in various communication formats to allow ease of integration to a wide range of data collection platforms. Available data conductivity, temperature, and salinity (Salinity is computed from instrument Conductivity, Temperature data, and a fixed depth input and stored in the unit by the user). Unit is calibrated by trained technicians in our ISO 9001 Certified Manufacturing Facility.

2.0 SPECIFICATIONS

Conductivity:
2.1 Range: 0 to 60 mS/cm
2.2 Accuracy: 0.02 mS/cm
2.3 Resolution: .005 mS/cm
2.4 Sampling Rate: 2.5 Hz Max
2.5 Stability 0.005 mS/cm per Month
Temperature:
2.6 Range: -5 to 40 Deg ℃
2.7 Accuracy: 0.02 ℃
2.8 Resolution: .001 ℃
2.9 Stability: 0.005 ℃ per Month
Power:
2.10 Input Voltage: 7 – 14 VDC
2.11 Input Current: 14 mA (Average)
2.12 Power: 106 mW @ 6VDC Input
Communications:
2.13 Hardware Protocol: RS-232
2.14 Baud Rate: 19200 BAUD
2.15 Data Bits: 8
2.16 Stop Bits: 1
2.17 Parity: None
2.18 Handshaking: None
2.19 Data Format: ASCII
2.20 Data Units mS/cm, ℃, IPSS
2.21 Data Filtered: Box Car Average, User Defined Box Car 2 – 10
2.22 Data Frame Rate:

1. 2.5 Hz (+/- 0.1 Hz)
2. 1.25 Hz (+/- 0.1 Hz)
3. 0.83 Hz (+/- 0.05 Hz)
4. 0.62 Hz (+/- 0.05 Hz)
5. 0.48 Hz (+/- 0.05 Hz)

Connector:
2.23 Manufacturer: Macartney®
2.24 Series: MCBH5MSS
2.25 Pins: 5 PIN

Hydrostatic:
2.26 Pressure Rating: 500 Meters

3.0 USAGE

This OC-CT is perfect for shallow Ocean conductivity, temperature and salinity measurements on platforms such as AUV's, UUV's, buoys, floats and moorings.

The use of the OC-CT is to determine the conductivity, temperature and salinity of shallow ocean water up to 500m deep. This unit is our economically designed shallow water unit. Perfect for the integration into the ocean of things platforms.

4.0 THEORY OF OPERATION

The inductive conductivity cell measures the electrical conductance of ocean water. It does this by using traditional inductive conductivity measurement circuitry featuring an external field cell and a high stability glass tube that improves accuracy. Users should take care when placing or using the sensor to not affect the external field. A radius of 8" (20 cm) free of other structures is recommended (see section 5).

The sensor can be coated with an antifoulant protection. Whereas the antifouling protection changes the physical properties of the conductivity cell, recalibration will be necessary. Consult the calibration section of the manual for instructions on how to recalibrate the conductivity.

5.0 OPERATION INSTRUCTIONS

1. Connect the cable/pigtail to a suitable power supply, see specifications for power supply.

2. Connect the data in and data out connections to your device input and output. See section 7 for wiring definitions.

3. Apply power to the device, you should receive the wake-up serial banner from the sensor.
   "D-2 INC."
   "C-T SENSOR"
   Verify you have received the wake-up banner with your client.

4. Remove power. Securely mount the sensor so the conductivity sensor can be freely flushed. Also clear other structures that could interfere with the conductivity sensor external field, a radius of 8" (20 cm) is recommended.

6.0 FIELD VERIFICATION PROCEDURE

The sensor can be verified in the laboratory:

1. Connect as in section 7.0
2. Pass the sensor a <CR> it will respond with a line of data.
3. Read that the temperature report is near the laboratory temperature.
4. Conductivity reading should be near zero.
5. Connect a 100-ohm resistor through the conductivity sensor, again read data, the value of conductivity should have risen, and a corresponding change in computed salinity.

7.0 SERIAL DATA INTERFACE

The OC-CT has a standard RS-232 Interface. The CT-Sensor utilizes the Macartney® MCBH5MSS pin bulkhead connector. The pinout is as follows:

	RS-232
Pin 1	Ground
Pin 2	Receive Data In
Pin 3	Power +
Pin 4	Transmit Data Out
Pin 5	No Connect

Use of a USB to RS-232 Serial cable is an acceptable alternative for newer computers that no longer offer RS-232 computer ports. The proper drivers for the specific cable must be loaded and are the responsibility of the end user.

The CT-Sensor can output continuous data to the serial port. To have the unit send data continuously, send the **"SC"**<CR> command. The unit will commence sending data at the data rate. To stop continuous data, resend the **"SC"**<CR> command. To achieve this immediately on power up, send the **"SP"**<CR> command and then the **"ST"**<CR> command. To have this data include raw A/D counts send the **"RW"**<CR> command.

7.1 Port Settings

When using a terminal program such as Hyperterminal®, the following settings must be used.

19200 Baud
8 Data Bits
No Parity
1 Stop Bit
No Handshaking

7.2 Command Structure

All commands are two letter commands, case insensitive. Blank spaces are not allowed in a command. Each command must be followed with a carriage return. (<CR> enter key of the computer keyboard.) If a command does not have the proper structure, it will respond with: "BAD COMMAND". Commands are immediately implemented but will not be saved to nonvolatile memory until the Store command has been sent. Once a Store command has been issued, all parameters will be present after the sensor has been turned off and repowered.

7.3 Available Commands (with responses)

(Commands do not include the "")

"F1"<CR> - Displays a list of commands available to the user.
"LI"<CR> - Displays the list of the calibration constants
"MD"<CR> - lists the pressure, in dBars, used to Calculate Salinity; defaults to 1.0
"N1"<CR> - lists the filter number used to smooth the output response; defaults to 10
"OR"<CR> - Displays the data output rate; defaults to 1 (fastest output rate)
"RW"<CR> - toggles the output to include or not include the raw data (this cannot be saved in memory)
"SC"<CR> - toggles the output to display or not display a steady stream of data
"SP"<CR> - same as "SC" but if stored, the senor will automatically power with a steady stream of output
"ST"<CR> - Store command to save all parameters into memory – will respond with "Saving Complete" when finished.
"VR"<CR> - responds with the firmware revision
<CR> - a single carriage return will respond with the last available set of data.
Note: see Calibration section for calibration constants commands. Please be aware changing calibration constants can render the instrument innacurate.

7.4 Available Commands (set values)

(no blank spaces are allowed in a command)

"MD=XXXX"<CR> - where XXXX represents any real number representing the pressure, in dBars, used to Calculate Salinity. The value is not limited to four positions, nor must it be four positions, any of the following are valid commands.
MD=6.4<CR>
MD = 100.83332<CR>
MD = 2<CR>

"N1=DD"<CR> - where DD represents any whole number between 2 and 99.
N1=10<CR>
N1=2<CR>

"OR=X"<CR> - Where X is a single digit, between the values 1 and 5 (inclusive); defaults to 1
OR=1<CR> fastest output rate
OR=5<CR> slowest output rate

7.5 Data Output Format

TT.TTT, CC.CCCC, SS.SSS<CR><LF>

Where TT.TTT = Temperature (IPTS-90 C)
CC.CCCC = Conductivity (S/M)
SS.SSS = Salinity (PSU)
<CR> = Carriage Return
<LF> = Line Feed

7.6 Raw Data Output Format

Following the issue of the "RW" command the unit will report raw sensor counts along with the physical units of measurement. Each time the 'RW' command is sent the output switches between the addition of raw data or only physical units:

The data format in Raw is as follows:

XXXXX, TT.TTT, YYYYY, CC.CCCC, SS.SSS<CR><LF>

Where XXXXX = Temperature Raw Counts
TT.TTT = Temperature (°C)
YYYYY = Conductivity Raw Counts
CC.CCCC = Conductivity (S/M)
SS.SSS = Salinity (PSU)
<CR> = Carriage Return
<LF> = Line Feed

8.0 CT SENSOR CALIBRATION PROCEDURE

8.1 Purpose

The purpose of this procedure is to ensure that CT Sensor is calibrated. This procedure is designed to produce the highest calibration accuracy for the CT Sensor. Persons conducting this calibration procedure should have a working knowledge of the CT-Sensor and are generally familiar with calibration procedures. Please read, follow and understand the procedure before performing the calibration.

8.2 Calibration

The CT Sensor measures conductivity and temperature. It also computes salinity based on those two measurements and a user's input depth. The CT Sensor electronics must be calibrated before the CT Sensor can measure these parameters. Each parameter is calibrated using a unique calibration sequence designed specifically for the individual sensor.

8.3 Equipment

Software:	HyperTerminal (Microsoft ® Free Ware)
Fresh Water Bath:	Hart Scientific Model 7015 or equivalent
Temperature:	EXTECH Model 421305 Thermometer
Conductivity:	Auto Sal Salinometer or Conductivity Sensor with +/- .005 S/M Accuracy or Better
Salt Bath High	Salt Bath High Value ~ 42 PSU, dimensions no smaller than 18" Diameter by 18" Height, with means to hold the CT Sensor submerged on center.
Data Test Cable:	D-2

You must ensure standard equipment has been recently calibrated.

8.4 Temperature

The Temperature Calibration is performed using the EXTECH Thermometer and the Hart Scientific Temperature controlled baths. The CT Sensors are calibrated at two temperature points, 0.6 and 30 C. The CT Sensor is fully immersed in the well stirred temperature-controlled bath for 20 minutes before a temperature sample is taken. The EXTECH Thermometer measures the temperature of the bath. Using HyperTerminal and the "RW" command the raw sensor counts for the temperature channel are collected at both calibration temperatures along with collection of the standard temperature of the bath. From the average of the raw data and the reference temperature a straight line computation of slope and offset are determined. NOTE: Average of CT Raw Counts should be taken from between 5 – 10 scans.

T1 = Standard Temperature #1
avg1 = Average of CT Raw Counts at T1 Standard Point
T2 = Standard Temperature #2
avg2 = Average of CT Raw Counts at T2 Standard Point

MT = (T2 – T1)/ (avg2 – avg1)

BT = T1 – (avg1*MT)
After MT and BT are entered into the CT Sensor, and stored using the ST command, we recommend that a test data point be taken around 15°C to check that the CT Sensor reads with the specification as given in Section 2.2.

8.5 Conductivity

The conductivity calibration is performed using the one high salt bath with known conductivity and air. If the salinity sensor is used as the standard then the bath must be thermally stable and secondary precision sensor is used through which the salinity values are transformed through temperature to a value of conductivity using IPS-78.

The CT Sensor is fully immersed in the well stirred salinity high bath for 20 minutes before a conductivity sample is taken. The salinity standard or conductivity standard sensor is used to measure the conductivity of the bath. Using HyperTerminal and the "RW" command the raw sensor counts for the conductivity channel are collected in the first bath, this process is repeated in the air. The user should make sure the data is repeatable (air bubbles inside the sensor are removed), by repeating the measures. For the average of the raw data and the reference conductivity a straight-line computation of slope and offset are determined. NOTE: Average of CT Raw Counts should be taken from between 5 – 10 scans.

C1 = Standard Conductivity #1 – Air (use 0.0 mS/cm)
avg1 = Average of CT Raw Counts for C1 Standard Point
C2 = Standard Conductivity #2
avg2 = Average of CT Raw Counts for C2 Standard Point.

MC = (C2 – C1)/ (avg2 - avg1)

BC = C1 – (avg1*MC)

After "MC" and "BC" are entered into the CT Sensor, and stored using the "ST" command, we recommend that a test data point be taken in the salt bath and in air to check that the CT Sensor reads within the specification as given in Section 2.2.

8.6 Pressure

If the deployment depth is known this value should be entered in bars using the "MD =" command; and then stored.

8.7 Store All Data

Upon completion all values should be stored in instrument EEPROM using the "ST" command. Power down the unit and power on to verify constants have been saved.

9.0 MAINTENANCE

NOTE: There are no user-serviceable components inside the D-2 OC-CT Sensor. There are NO Electronic adjustments inside the sensor. Opening the instrument will damage the cover and will void the instrument warranty.

DO NOT ATTEMPT TO OPEN THE SENSOR IN THE FIELD.

APPENDIX A: LIMITED WARRANTY

One year from date of shipment, D-2 Incorporated, guarantees its products to be free of defects in materials and workmanship. In the event a product malfunctions during this period, the company obligation is limited to repair of the defective item at our factory, or the defective item may be replaced at our option. Instruments found defective should be returned to the factory prepaid and carefully packed, as customer will be responsible for freight damage. D-2 will pay return shipping on any warranty repairs.

Repairs or replacements under warranty will be at no cost to the customer for parts, labor, or return shipment from our factory to the customer. This warranty is void if in our opinion the instrument has been damaged by accident, mishandled, altered or repaired by the customer where such treatment has affected its performance or reliability. In the event of such abuse by the customer, all costs for repairs plus freight costs will be borne by the customer. All equipment supplied by D-2 that is designed for use under hydrostatic loading has been certified by actual pressure testing prior to shipment.

The customer will be charged a diagnostic fee plus all shipping costs if an instrument is returned for warranty repair and no defect is found by the factory. Incidental or consequential damages or costs incurred as a result of product malfunction are not the responsibility of D-2 Incorporated.

Equipment not manufactured by D-2 Incorporated, is supported only to the extent of the original manufacturer's original warranties. All OEM sensors which utilize electrodes (oxygen cartridges, pH, ORP, etc.) is warranted at the time of shipment, and shall perform upon initial installation within stated specifications. If the product proves to be defective within the OEM's warranty we will replace the product or defective part with a similar model, product or part, but only to the extent that the OEM will warrant.

All returned products must be accompanied by a Returned Material Authorization (RMA) number issued by D-2 Incorporated. Shipments will not be accepted without the RMA number. An RMA number can be obtained by calling Customer Service Department at 508-329-2046 or by emailing sales@D-2inc.com.

The following information should accompany any instrument being returned to the factory:

Return Merchandise Authorization Number
Model/Serial Number
Brief Description of the Problem
Customer Contact/Telephone Number

CALIBRATION SERVICE POLICY

A calibration only service is available for OC-CT Sensors.

The service is limited to instruments requiring only calibration and minor adjustment. Instruments that are not operating properly and require repair or replacement parts will not be covered. If repair is necessary the customer will be contacted and apprised of the additional cost. The customer will be charged the standard repair cost, which includes repair and calibration. In the event that the customer does not approve repair, the unit will be returned in "as received" condition and the teardown and inspection charge will be invoked.

The customer will be required to obtain a return merchandise authorization number from Customer Service at D-2 Incorporated prior to the return of the instrument. This number should be displayed on the outside of the container, preferably on the shipping label, and included on the shipping documentation sent with the instrument.

If possible, the following information should accompany the instrument:

Return Merchandise Authorization Number
Model/Serial Number
Customer Contact/Telephone Number