



Turbo

Turbidity Smart Sensor
with Data Logging



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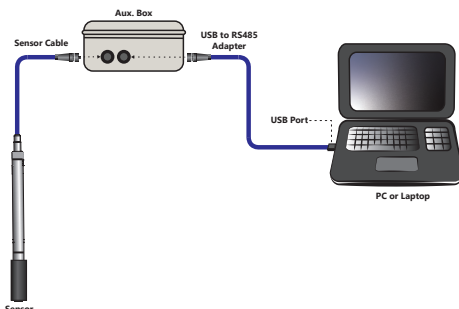
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The internal microprocessor runs on 12 VDC and automatically turns the turbidity sensing unit on and off, as needed, to conserve power. A built in wiper cleans the sensing eye each time power is applied to the sensing unit.

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Connecting the Turbo to a Computer

The Turbo cable is terminated with a weather-resistant connector. Connect the weather-resistant connector to your computer's USB port as shown below.



Installing the Aqua4Plus Software

The Turbo sensor comes with the Aqua4Plus host software that is installed on your PC or laptop. Use this software to program the datalogger, to retrieve data from the logger, to view collected data, and to export data to external files for use with spreadsheets or databases.

Refer to the Aqua4Plus software manual for details on installing and using Aqua4Plus.

Using the Sensor Without Aqua4Plus

Most users will use the sensor with Seametrics' Aqua4Plus software. However, this sensor is quite versatile, allowing you to do the following:

- Read via the Modbus® protocol using your own software.
- Read via SDI-12 protocol.
- Display readings on a panel meter.

If you want to use one of these methods, see Appendix C or contact Seametrics for further details.

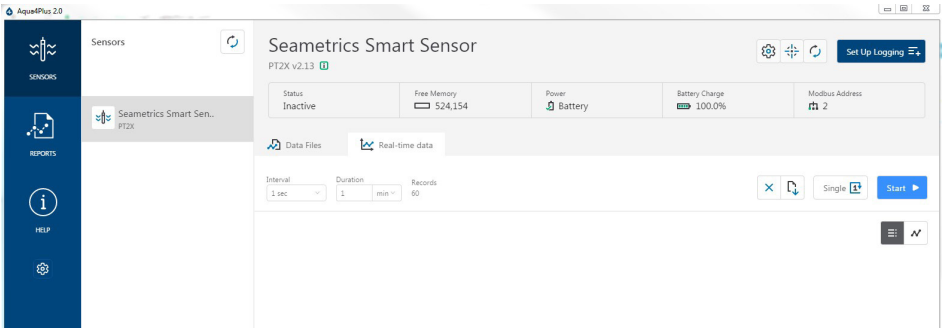
Installing the Sensor


Lower the sensor to the desired depth. Fasten the cable to the well head using tie wraps or a weather proof strain-relief system. When securing a vented cable, make sure not to pinch the cable too tightly or the vent tube inside the cable jacket may be sealed off. Take a measurement to insure the sensor is not installed below its maximum range.

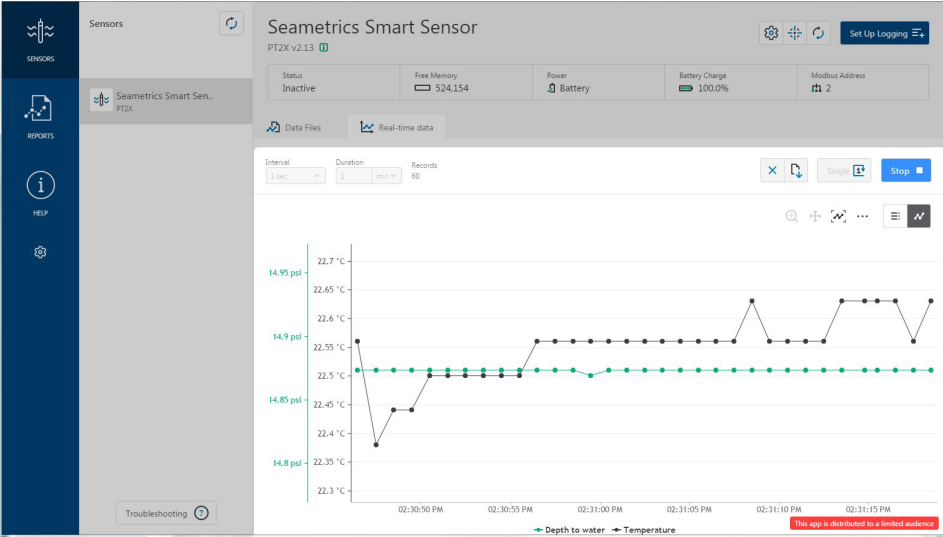
Be sure the supplied cap is securely placed on the weather-resistant connector at the top of the cable. Do not install such that the connector might become submerged with changing weather conditions. The connector can withstand incidental splashing but is not designed to be submerged.

Real-time Data



Connect to sensor and select the Real-time data tab




To start real-time readings click Start, readings default to table view. To switch to Real-time graphing view click the graph icon 



Real-time readings default to a 1 second interval for 1 minute, to adjust enter your desired settings here:

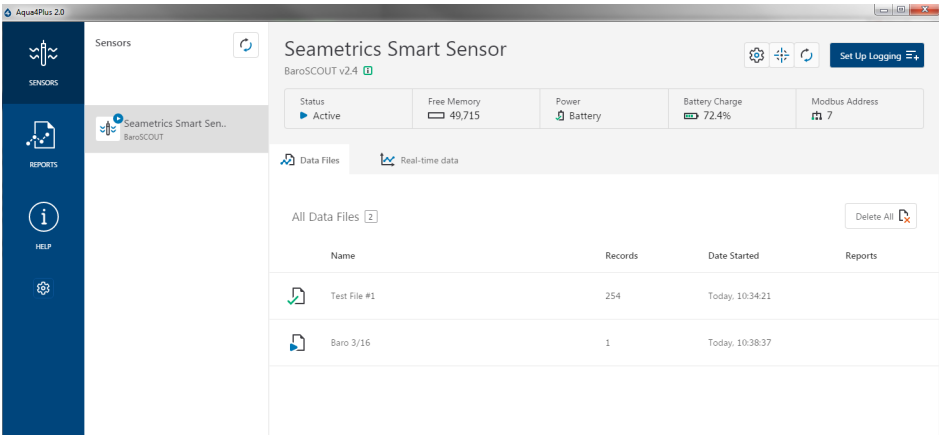
 Data Files  Real-time data

Interval: 1 sec Duration: 1 min Records: 60

To save this data to the Reports section click the  button located next to the Single button in the Real-Time tab. This will permanently save this real-time data set to your Reports database.

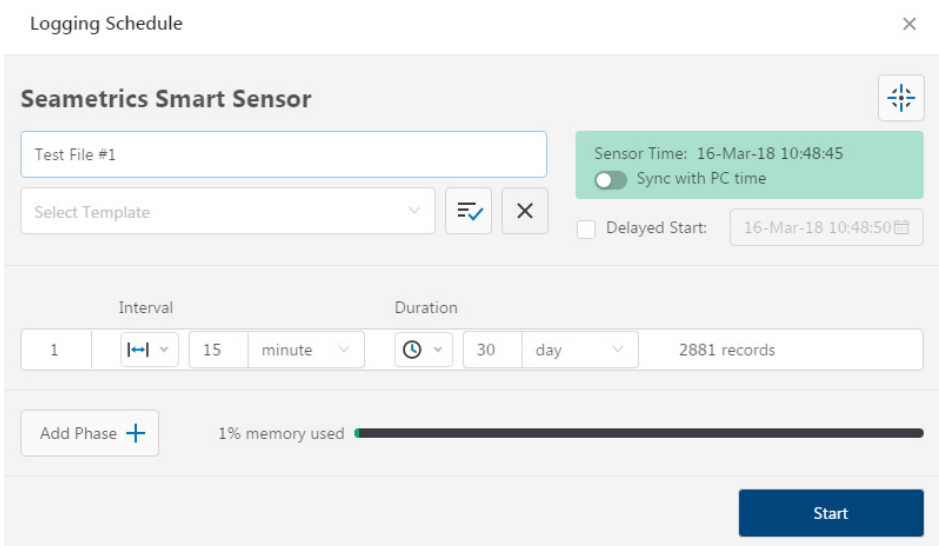
Data Logging

Select Set Up Logging from the sensor screen. If there are no files currently on the sensor you'll see the Set Up Logging button active under the Data Files tab as well as in the upper menu. Once files have been started/logged on the sensor they will be displayed under the Data Files tab.



Set Up Logging Window

Here you will name your data file and set up the recording interval and duration of each logging phase. Select your desired recording interval and duration for each phase, Aqua4Plus 2.0 will display the available memory at the bottom of the window.



Reports

Data downloaded from your sensor is stored in the Reports section of Aqua4Plus 2.0 for viewing and editing. The files will be saved to default data folder on your PC as well. See Program Settings for default data folder location.

All Reports

Delete All

Group by Date Size Name

Name	Date Modified	Records	Source	Created By
March, 2018				
Baro 3/16 Today, 10:38:37 - Today, 10:53:37	Today, 10:57:39	2	Downloaded	seanv
Baro 3-12 12-Mar 13:52:32 - Today, 10:14:32	Today, 10:15:32	5,543	Downloaded	seanv
Desk 3-12 12-Mar 14:02:55 - 13-Mar 15:10:55	13-Mar 15:20:14	1,509	Compensated	seanv
Desk 3-12 12-Mar 14:02:55 - 13-Mar 15:10:55	13-Mar 15:11:39	1,509	Downloaded	seanv
Desk CT2X 3-12 12-Mar 13:55:53 - 12-Mar 13:59:53	13-Mar 15:11:03	5	Downloaded	seanv
February, 2018				
300k test 21-Feb 15:30:09 - 22-Feb 07:40:51	22-Feb 12:02:29	232,971	Downloaded	seanv
Test File #2 21-Feb 15:19:36 - 21-Feb 15:22:55	21-Feb 15:30:43	400	Downloaded	seanv
Test File #1 21-Feb 14:21:48 - 21-Feb 14:22:37	21-Feb 15:20:04	100	Downloaded	seanv

In the main view you'll see a list of reports sorted by date, size, or file name as selected here:

All Reports

Group by Date Size Name

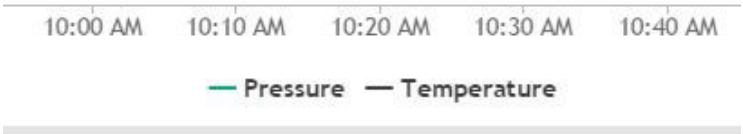
You can also search reports by keyword using the search box

Click on a report to bring up the report details.

Reports are displayed in graphing view by default. You can zoom to specific sections by selecting a section with you mouse or by adjusting the slider below the graph.



You may change the display units within the graph view by selecting the appropriate channel here:



Click to switch to full screen graphing view

Graph saving and export options are available here:

Print

Export PNG

☒ Show Warnings

☒ Show Phases

Click to view data as a table

Click to view data statistics

Report Details

Desk 3-12

Status
Incomplete

Records
1,509

Date Started
 12-Mar-18 14:02:55

Information

Data

Schedule

Name	Temperature °C	Conductivity µS/cm	Pressure psi	Salinity PSU	TDS mg/L
Sensor Range	150K ohm	0-300 mS/cm	500 psia	unknown	unknown
Min	21.02	337.8	14.535	0.1626	165.5
Max	23.45	360.0	14.700	0.1725	176.4
Mean	22.51	346.4	14.632	0.1664	169.7
Variance	0.54	38.4	0.002	0.0000	9.2
Deviation	0.74	6.2	0.045	0.0028	3.0
Calibration Date	unknown	19-Feb-18 12:48:12	21-Feb-18 14:22:57	unknown	unknown

The Information tab is a new feature allowing users to add metadata to their reports such as site location, field notes, or comments. The Schedule tab will display the logging setup details for the report.

Report Details

Desk 3-12

Status

Incomplete

Records

1,509

Date Started

12-Mar-18 14:02:55

Information

Data

Schedule

Report Name

Location(GPS or Job Site)

Comment

Sensor name

Seametrics Smart Sensor

Sensor type

CT2X

Serial number

0021746043

Last modified

13-Mar-18 15:11:39

Downloaded

13-Mar-18 15:11:39

Click Export to export the report as a .csv file or .a4d file for distribution or use in 3rd party software.

Click Delete to delete the report from Aqua4Plus 2.0

You can also import .a4d files from compatible sensors into Aqua4Plus 2.0 by clicking at the top of the Reports screen.

A Word About Units

Temperature readings from the sensor can be displayed in various units, such as degrees Celsius or degrees Fahrenheit for temperature. Select the units you want from the Sensor Settings menu. Turbidity is always in NTU.

Maintenance

Sensor: There are no user-serviceable parts. If problems develop with sensor stability or accuracy, contact Seametrics. If the unit has been exposed to hazardous materials, do not return without notification and authorization.

Cable: Cable can be damaged by abrasion, sharp objects, twisting, crimping, crushing, or pulling. Take care during installation and avoid cable damage.

End Connections: The contact areas (pins & sockets) of the connectors will wear out with extensive use. If your application requires repeated connections other types of connectors can be provided. The connectors used by Seametrics are

not submersible, but are designed to be splash-resistant.

Wiper Blades: The effectiveness of the wiper in maintaining a clean optical surface will eventually be compromised, the rate being dependent on the water under investigation and the number of wiping cycles carried out. We recommend periodic inspection of the wiper's silicon pad to determine if the wiper material is deteriorating or if there is an excessive buildup of material from bio-fouling. In addition, as a precaution we recommend changing the wiper prior to each long term deployment. The wiper is a consumable item. Wiper packs are available from Seametrics.

Erratic Readings

Erratic readings can be caused by a poor connection, damaged cable, moisture in the unit, or a damaged transmitter. In most cases, erratic readings are due to moisture getting into the system. The first thing to check is the connection. Look for moisture between contacts or a loose or broken wire. Next, check the cable for cracking or fraying. If the connections and cable appear OK, but the readings are still erratic, the transmitter may be damaged. Contact Seametrics for evaluation and repair. Erratic and erroneous readings can also occur due to improper grounding. See Grounding Issues, below.

Grounding Issues

It is commonly known that when using electronic equipment, both personnel and equipment need to be protected from high power spikes that may be caused by lightning, power line surges, or faulty equipment. Without a proper grounding system, a power spike will find the path of least resistance to earth ground – whether that path is through sensitive electronic equipment or the person operating the equipment. In order to ensure safety and prevent equipment damage, a grounding system must be used to provide a low resistance path to ground.

When using several pieces of interconnected equipment, each of which may have its own ground, problems with noise, signal interference, and erroneous readings may

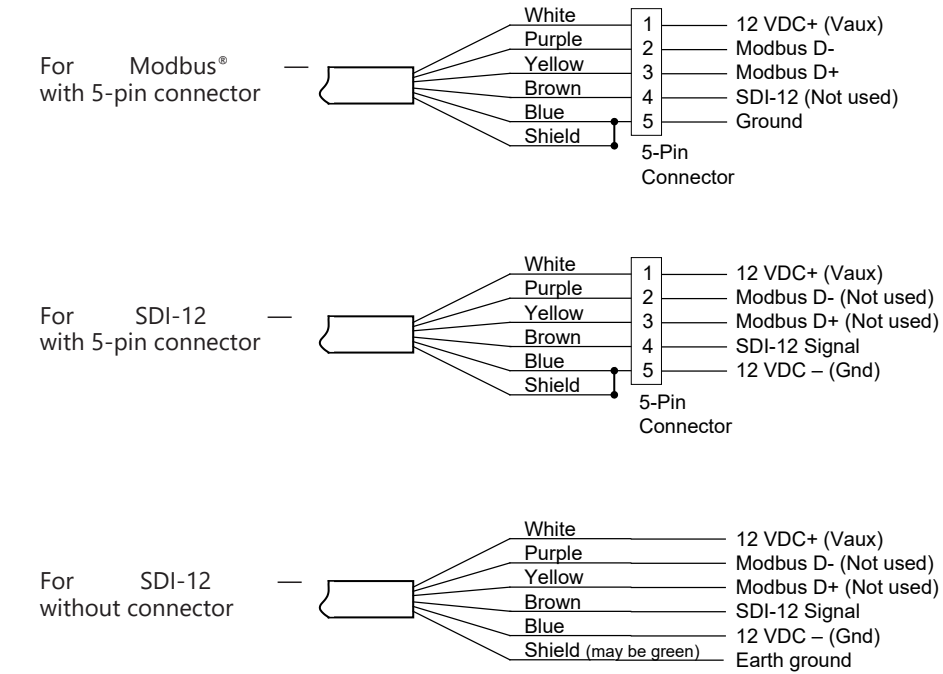
be noted. This is caused by a condition known as a *Ground Loop*. Because of natural resistance in the earth between the grounding points, current can flow between the points, creating an unexpected voltage difference and resulting erroneous readings.

The single most important step in minimizing a ground loop is to tie all equipment (sensors, dataloggers, external power sources and any other associated equipment) to a **single common grounding point**. Seametrics recommends connecting the shield to ground at the connector end.

General Specification

The Turbo sensor is a microprocessor based digital intelligent sensor designed to measure and record turbidity, temperature, and time.

Wiring



Cable

- OD 0.28" maximum
- Break Strength 138 lbs.
- Maximum Length 2000 feet
- Weight 4 lbs. per 100 feet

Input Power 12 Vdc nominal (9–15 Vdc)

Ranges 0 - 400 NTU
0 - 3000 NTU

Calibration can only be done when there are no sessions stored on the sensor. If there are any sessions stored on the sensor, upload any data you want and then erase the session before continuing.

Turbidity Calibration

The Turbo ships calibrated from Seametrics, however calibration should be checked after shipping as the 0 point may shift. Normal wear and tear of the optical window will also cause the 0 point to shift over time, the exact timing will depend on installation environment and wiper maintenance schedule. In most cases a 1 point calibration in a 0 standard (or DI water) is sufficient to re-zero the output.

Note: When using NTU standards ensure your standard is rated Amco Clear for ISO 7027 infrared turbidity sensors. The calibration container should be dark and non-reflective for the most accurate results. Make sure the bottom face of the turbidity probe is submerged about 0.5" (12mm) into the calibration standard, and at least 2" (50mm) from the bottom of the container to avoid interference with the infrared signal.

Generally we will use 0 NTU, or DI water, as the first calibration point or 1 point 0 offset adjustment point. If deploying in higher turbidity sites use your lower NTU standard for the first point and bracket your expected range with the 2nd point standard.

Place the Turbo in your first point standard and enter the standards value in the Ref. Point box, next click Measure.

Adjustments and Calibration for Seametrics Smart Sensor

Turbidity

Calibration Type

One Point Calibration

Input your reference point

Ref. Point

Units

NTU

Measure

Channel Label

Turbidity

Offset, NTU

-0.16341570019721985

Slope

1

Apply

Close

Aqua4Plus will take 10 readings and display the average. Watch for stability while Aqua4Plus is measuring to ensure an accurate calibration. To accept the first point reading click Ok.

If you've selected one point calibration next click Apply to apply the new offset value, Aqua4Plus will provide a real time reading to verify calibration was successful.

If you've selected a two point calibration thoroughly rinse and dry the first point standard from the probe, then place it in the 2nd point standard and click Next.

Adjustments and Calibration for Seametrics Smart Sensor

Turbidity

Calibration Type
Two Points Calibration

Input your first reference point

Ref. Point0UnitsNTU

Average: 0.9494 NTU

Next

Re-measure

Channel Label
Turbidity

Offset, NTU
-0.1634157001972198

Slope
1

Apply

Close

Enter the value of your 2nd point standard and click Measure

Adjustments and Calibration for Seametrics Smart Sensor

Turbidity

Calibration Type
Two Points Calibration

Input your second reference point

Ref. Point100UnitsNTU

Average: 112.9583 NTU

Ok

Re-measure

Channel Label
Turbidity

Offset, NTU
-0.8476226542845369

Slope
0.8927866476984289

Apply

Close

Aqua4Plus will take 10 readings and display the average. Watch for stability while Aqua4Plus is measuring to ensure an accurate calibration. To accept the second point reading click Ok. Your new offset and slope values will appear to the right, confirm other settings as needed and click Apply to confirm your new slope and offset values. Aqua4Plus will provide a real time reading to verify calibration was successful. You may now close the calibration window and proceed with deployment.

Adjustments and Calibration for Seametrics Smart Sensor

Turbidity

Calibration Type
Two Points Calibration

New Turbidity reading:
100.0000 NTU.

OK

Channel Label
Turbidity

Offset, NTU
-0.8476226542845369

Slope
0.8927866476984289

Apply

Close

Reading the Turbo Sensor via Direct Read

While the Turbo comes with Seametrics’ easy to use Aqua4Plus software, you can also use standard Modbus® RTU or SDI-12 equipment to easily take readings, so as to tie into your existing equipment or networks.

You may nee to use Aqua4Plus to set the baud rate. (You do not need to set the baud rate for SDI-12). For Modbus you must have Turbo firmware version 2.0 or higher. For SDI-12 you must have version 2.2 or higher.

Reading Via Modbus®

Setting Baud Rate

Your sensor comes configured to communicate at 38,400 baud, with 8 data bits, one stop bit, and no parity. The sensor can also be set to 19,200 or 9600 baud, if needed for your application.

See Sensor Settings.

Taking Measurements

Read measurements using Modbus function 03 – Read Holding Registers.

Readings are located in two registers each, starting at address 62592. (AquiStar® register addressing is zero based, i.e., starts at zero. If your equipment uses one based addressing, you will need to add one to the register addresses.)

Register addresses for Turbo Sensor		
	Zero Based	One Based
Temperature	62592	62593
Turbidity	62594	62595

Power On Function

In order to save power, the power to the sensing probe on the Turbo is normally off, even when the Turbo sensor itself is powered. The sensing probe requires a warm-up or stabilization time before returning valid readings. The sensing probe is turned on when a reading is requested or when a Power On command is written to the Turbo.

(Note: If you are recording sessions, reading with Aqua4Plus, or using SDI-12, you do not need to be concerned with the stabilization period. It is automatically taken care of in these situations. You only need to be concerned when using your own device to take Modbus readings.)

There is a “power on” register on the Turbo (register 62720 or 0xF500). When a positive value “n” is written to this register, the power is turned on to the sensing probe and remains on for n/4 seconds. When a reading is requested, the timer is reset and the sensing element remains on for another n/4 seconds. To force the power off immediately after a reading, for power savings, write a zero to the register. If the power to the entire Turbo sensor is turned off, this value defaults to 48 (or 12 seconds).

The recommended procedure to ensure proper warm-up/stabilization and to conserve power is:

- Write Power On value of 48 ($48/4 = 12$ seconds)
 - Power turns on
 - Starts sampling about two times per second
- Wait 10 seconds then request a reading
 - Returns most recent sample
 - Resets Power On value to 48 ($48/4 = 12$ seconds)
- Write Power On value of 0 (zero)
 - Turns power off
 - Retains last reading

If you Cannot Write to the Power On Register

If you are reading your device using a meter or other device that cannot write the Power On but simply takes readings on a specified schedule, be sure to set the polling interval to less than 12 seconds. This will ensure that the sensing probe is always powered up and readings should be fresh and stable. Note that the first reading when you turn on the sensor and meter will be old but will refresh within a second or two.

For further information and detailed Modbus examples, refer to our website at www.seametrics.com.

Data Format

The data is returned as 32-bit IEEE floating-point values, high word first, also referred to as big-endian or float inverse.

Wiper

Before each reading, the sensor will apply power to the turbidity sensing unit and run the wiper once. If your polling interval is 10 seconds or less, the sensing unit will remain on and will only wipe once when first started.

Reading Via SDI-12

Addressing

Default SDI-12 Address: 0

SDI-12 Command Nomenclature

<a> = Sensor address
 {crc} = SDI-12 compatible 3-character CRC
 <cr> = ASCII carriage return character
 <lf> = ASCII line feed character

highlighted values indicate variable data

SDI-12 Commands

//*** Sensor Identification

```
<a>!! <a>13 INWUSA ATurb2.2ssssssss<cr><lf>
// note: 2.2 will change to reflect current
// firmware revision
// ssssssssss = device serial #
```

//*** Acknowledge Active, Address Query

```
<a>! <a><cr><lf>
?! <a><cr><lf>
```

//*** Change Address

```
<a>A<b>! <b><cr><lf>
// change address from <a> to <b>
```

//*** Request measurement

```
<a>M! <a>0022<cr><lf>
// request all measurements
<a>D0! <a>+24.2412+458.73<cr><lf>
// read: temperature and turbidity
```

```
<a>M1! <a>0021<cr><lf>
// request measurements
<a>D0! <a>+24.2412<cr><lf>
// read: temperature
```

```
<a>M2! <a>0021<cr><lf>
// request measurements
<a>D0! <a>+458.73<cr><lf>
// read: turbidity
```

//*** Request measurement with CRC

```
<a>MC! <a>0022<cr><lf>
// request all measurements w/CRC
<a>D0! <a>+24.2412+458.73{crc}<cr><lf>
// read: temperature and turbidity
```

```
<a>MC1! <a>0021<cr><lf>
// request measurements w/CRC
<a>D0! <a>+24.2412{crc}<cr><lf>
// read: temperature
```

```
<a>MC2! <a>0021<cr><lf>
// request measurements w/CRC
<a>D0! <a>+458.73<cr><lf>
// read: turbidity
```

```

//*** Concurrent measurement
<a>C! <a>0022<cr><lf> // request all measurements
<a>D0! <a>+24.2412+458.73<cr><lf> // read: temperature and turbidity

<a>C1! <a>0021<cr><lf> // request measurements
<a>D0! <a>+24.2412<cr><lf> // read: temperature

<a>C2! <a>0021<cr><lf> // request measurements
<a>D0! <a>+458.73<cr><lf> // read: turbidity

//*** Concurrent measurement with CRC
<a>CC! <a>0022<cr><lf> // request all measurements w/CRC
<a>D0! <a>+24.2412+458.73{crc}<cr><lf> // read: temperature and turbidity

<a>CC1! <a>0021<cr><lf> // request measurements w/CRC
<a>D0! <a>+24.2412{crc}<cr><lf> // read: temperature

<a>CC2! <a>0021<cr><lf> // request measurements w/CRC
<a>D0! <a>+458.73<cr><lf> // read: turbidity
    
```

For further information and SDI-12 examples, see our website at www.seametrics.com.

SEAMETRICS LIMITED WARRANTY

TURBO INSTRUCTIONS

The limited warranty set forth below is given by Seametrics, with respect to Seametrics brand products purchased in the United States of America.

Seametrics warrants that products manufactured by Seametrics, when delivered to you in new condition in their original containers and properly installed, shall be free from defects in material and workmanship. **Seametrics products are warranted against defects for a period of two (2) years from date of installation, with proof of install date. If no proof of install date can be provided, warranty period will be two (2) years from date of shipment from Seametrics, as defined on Seametrics' invoice.** Seametrics' obligation under this warranty shall be limited to replacing or repairing the part or parts, or, at Seametrics' option, the products, which prove defective in material or workmanship. The following are the terms of Seametrics' limited warranty:

- a. Buyer must give Seametrics prompt notice of any defect or failure and satisfactory proof thereof.
- b. Any defective part or parts must be returned to Seametrics' factory or to an authorized service center for inspection.
- c. Buyer will prepay all freight charges to return any products to Seametrics' factory, or another repair facility, as designated by Seametrics.
- d. Defective products, or parts thereof, which are returned to Seametrics and proved to be defective upon inspection, will be repaired to factory specifications.
- e. Seametrics will deliver repaired products or replacements for defective products to the buyer (ground freight prepaid) to the destination provided in the original order.
- f. Products returned to Seametrics for which Seametrics provides replacement under this warranty shall become the property of Seametrics.
- g. This limited warranty covers all defects encountered in normal use of Seametrics products, and does not apply to the following cases:
 - i. Loss of or damage to Seametrics product due to abuse, mishandling, or improper packaging by buyer
 - ii. Failure to follow operating, maintenance, or environmental instructions prescribed in Seametrics' instruction manual
 - iii. Products not used for their intended purpose
 - iv. Alterations to the product, purposeful or accidental
 - v. Electrical current fluctuations
 - vi. Corrosion due to aggressive materials not approved for your specific product
 - vii. Mishandling, or misapplication of Seametrics products
 - viii. Products or parts that are typically consumed during normal operation
 - ix. Use of parts or supplies (other than those sold by Seametrics) which cause damage to the products, or cause abnormally frequent service calls or service problems
- h. A new warranty period shall not be established for repaired or replaced material, products, or supplied. Such items shall remain under warranty only for the remainder of the warranty period on the original materials, products, or supplies.
- i. In the event that equipment is altered or repaired by the buyer without prior written approval by Seametrics, all warranties are void. Damage caused by equipment or accessories not manufactured by Seametrics may void the product's warranty.
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 - ii. All title and intellectual rights to the software are owned by Seametrics.
 - iii. No copies may be made or distributed except as described above.
 - iv. The user may not modify or reverse-engineer the software.

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LT-14418r10 20190117
1/17/2019