



# DO2

## Dissolved Oxygen Smart Sensor and Datalogger Instructions





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## What is the DO2 Sensor?

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The Seametrics DO2 Smart Sensor is the next generation in trouble-free oxygen sensing design. Utilizing fluorescence of a stable, immobilized ruthenium-based film matrix, the sensor provides precision optical transmission and detection to measure oxygen concentration in the fluid outside of the sensor.

This industry standard digital RS485 interface device records over 250,000 records of dissolved oxygen, temperature, and power supply voltage data, operates with low power, and features easy-to-use software with powerful features.

The unit is programmed using the easy-to-use Aqua4Plus control software. Once programmed the unit will measure and collect data on a variety of time intervals.

The internal microprocessor runs on 12 VDC and automatically turns the sensing unit on and off, as needed, to conserve power.

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## Initial Inspection and Handling

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Upon receipt of your smart sensor, inspect the shipping package for damage. If any damage is apparent, note the signs of damage on the appropriate shipping form. After opening the carton, look for concealed damage, such as a cut cable. If concealed damage is found, immediately file a claim with the carrier.

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## Do's and Don'ts

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**Do** handle the device with care.

**Do** store the device in a dry, inside area when not in use.

**Do** install the device so that the connector end is kept dry.

**Don't** scratch the sensing window.

**Don't** support the device with the connector. Use a strain relief device to take the tension off the connectors.

**Don't** allow the device to free-fall down a well as impact damage can occur.

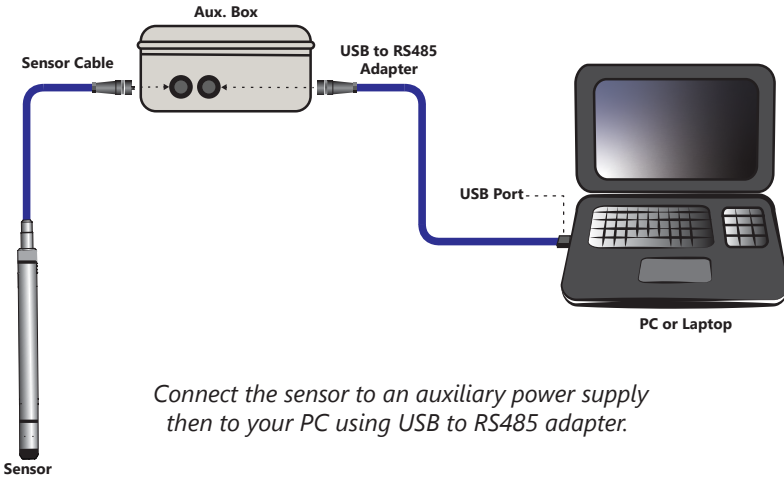
**Don't** bang or drop the device on hard objects.

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## Connecting the DO2 to a Computer

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The DO2 cable is terminated with a weather-resistant connector. Connect the weather-resistant connector to your computer's USB port as shown below.



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## Installing the Aqua4Plus Software

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The Seametrics DO2 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.

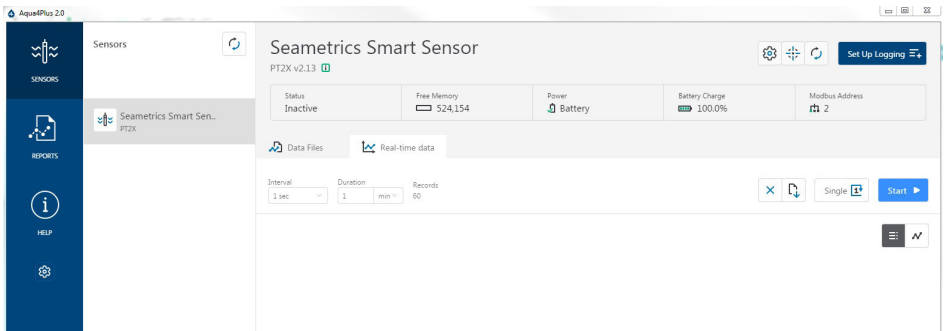
### Installing the Sensor

Lower the sensor to the desired depth. Fasten the cable to the well head using tie wraps or a weather proof strain-relief system. Take a measurement to insure the sensor is not installed below its maximum range.

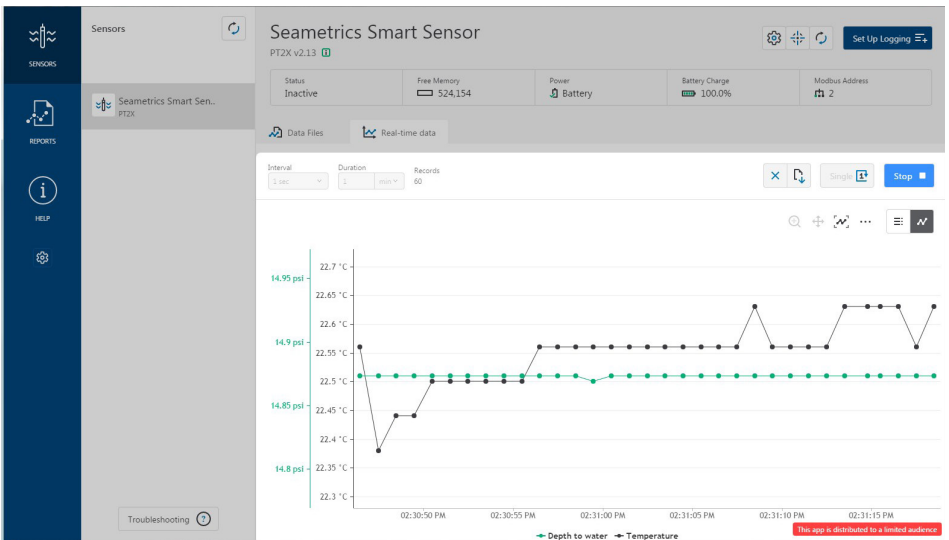
Be sure the supplied cap is securely placed on the weather-resistant connector at the top of the cable. Do not install such that the connector might become submerged with changing weather conditions. The connector can withstand incidental splashing but is not designed to be submerged.

### Real-time Data

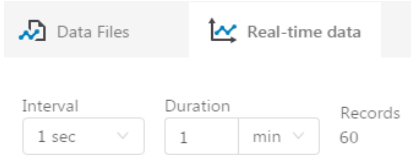
Connect to sensor and select the Real-time data tab




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



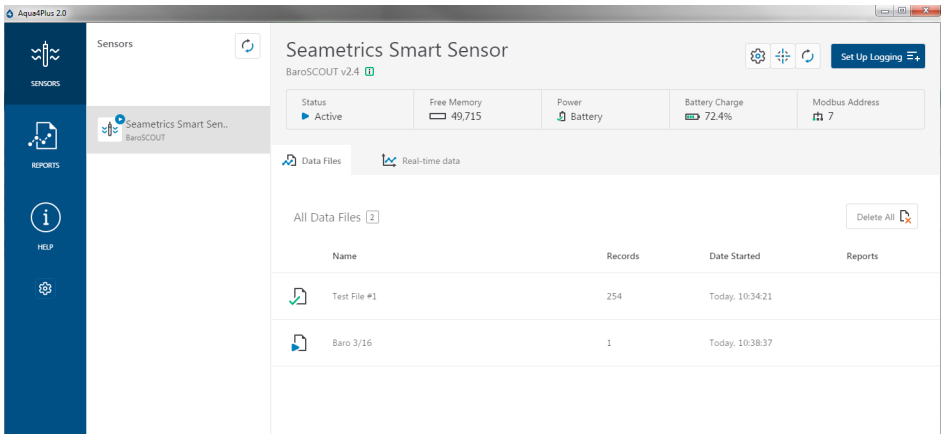
Real-time readings default to a 1 second interval for 1 minute, to adjust enter your desired settings here:



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.

Logging Schedule ×

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**Seametrics Smart Sensor** ⌵

Test File #1

Select Template ⌵ ☰ ×

Sensor Time: 16-Mar-18 10:48:45  
 Sync with PC time

Delayed Start: 16-Mar-18 10:48:50 📅

Interval: 1 ⏪ 15 minute ⏩ Duration: 30 day 🕒 2881 records

Add Phase + 1% memory used ▬

**Start**



## 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.

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 14:22:17	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:

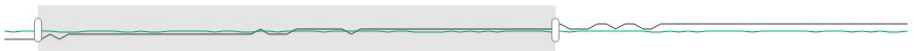
All Reports [Download Icon] [Search Bar]

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:

Click to view data as a table

Click to view data statistics

Report Details

Desk 3-12

Status	Records	Date Started
Incomplete	1,509	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
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① Information

Data

Schedule

Report Name

Location(GPS or Job Site)

Comment

Sensor name  
Seametrics Smart Sensor

Sensor type  
CT2X

Serial number  
0021746043

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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**

Readings from the Multi-Parameter 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 button.

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**Maintenance**

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**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 use to 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.

**DO Window Cleaning:** During deployment the sensing window on the DO2 may collect debris or growth. Heavy debris/growth can affect the accuracy of the DO readings over time. Periodically check the window and clean if necessary. Note: the DO window is very sensitive and prone to scratching, DO NOT use abrasive cleaners. We recommend using a wash bottle and DI water to remove the loose debris. If there is a stubborn growth over the window you may clean it with a very soft cloth or Q-tip and a very light touch. Take care not to exert too much pressure or scratch the window surface during cleaning. A mild detergent may be used if necessary, such as Alconox. The main body of the unit may be cleaned with a mild detergent as well.

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## Erratic Readings

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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.

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## Grounding Issues

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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.

The Seametrics DO2 Smart Sensor is a microprocessor based digital intelligent sensor designed to measure dissolved oxygen, utilizing fluorescence of a stable, immobilized ruthenium-based film matrix.

### **GENERAL**

Probe Diameter	1.66" (4.22 cm)
Tube Material	Acetal & 316 stainless steel or titanium
Probe Material	Epoxy, polyurethane, and PVC
Wire Seal Material	Fluoropolymer and PTFE
Submersible Cable	Polyurethane, polyethylene, or ETFE available
Terminating Connector	Available
Communication	RS485 Modbus® RTU
Direct Modbus Read Output	32-bit IEEE floating point
Internal Math	32-bit floating point
Operating Temp. Range	0° C to 55° C
Storage Temp. Range	-40° C to 80° C

### **LOGGING**

Memory	260,000+ records
Log Types	Variable, user-defined, step logarithmic, profiled
Programmable Baud Rate	9600, 19200, 38400
Logging Rate	8x/sec maximum
Software	Complimentary Aqua4Plus
Networking	32 available addresses per junction w/batching capabilities (up to 255)

### **SENSOR**

File Formats	.xls / .csv / .a4d
Measuring Range	0 - 25 ppm
Accuracy	1% of reading or 0.02 ppm — whichever is greater
Sensitivity / Resolution	0.01 ppm below 4.00, 0.1 ppm above 4.0
Stability	0.01 ppm
Repeatability	0.01 ppm
Sensor Drift	Less than 1% per year
Temperature Range	0° C to 55° C
Response Time	95% in less than 60 seconds
Maximum Pressure	100 PSI

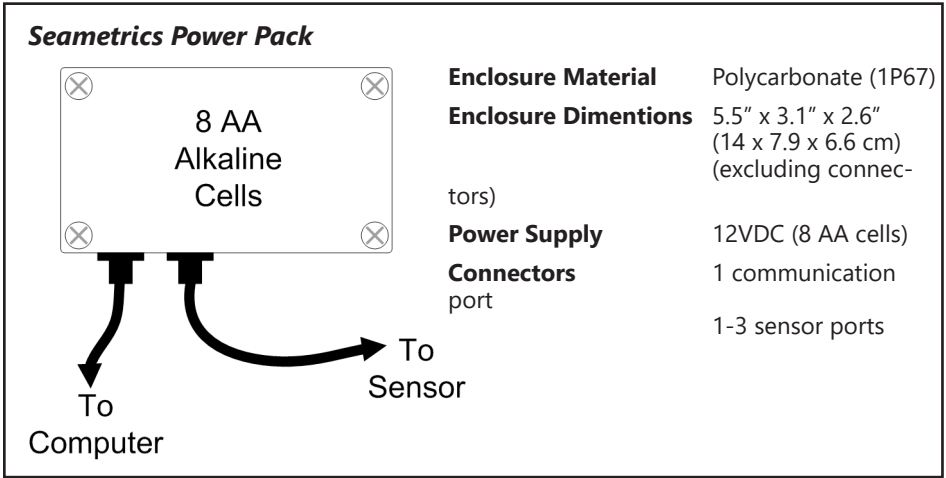
**POWER**

External Power Pack Required (9-15VDC)

Seametrics Power Pack described below.

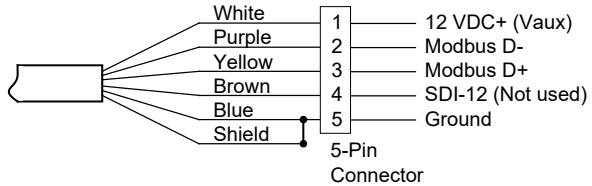
Other power options available.

Contact Seametrics for details.

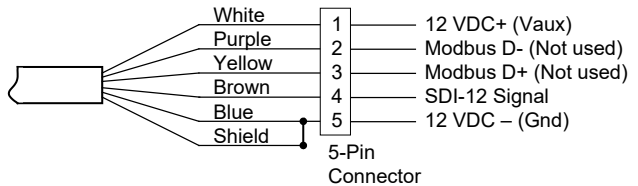


**WIRING**

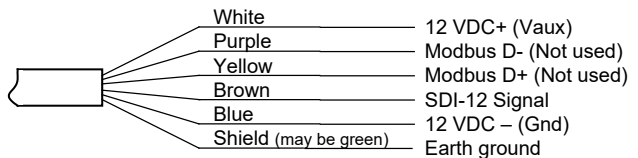
For Modbus® — with 5-pin connector



For SDI-12 — with 5-pin connector



For SDI-12 — without connector



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.

**DO Calibration**

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

Place the DO2 sensor in your reference solution, allow a few minutes for temperature to stabilize.

Obtain the DO saturation using an alternate method, then select the calibration button.

Enter the saturation in the reference box, next click Calibrate.

Adjustments and Calibration for Seametrics Smart Sensor

**DO2: INW Smart Sensor**

This function calibrates the actual DO probe.

- 1 Place DO2 probe in reference solution and allow temperature to fully stabilize.
- 2 Using alternate method, determine DO saturation in ppm.
- 3 Enter this value in the box below.
- 4 Click the Calibrate button. This will trigger the DO probe's internal calibration.

Reference value:  ppm **Calibrate**

Close

While the DO2 is calibrating you'll see this:

Once complete close the calibration window and check readings in the real-time data section.



**Reading Via Modbus®**

While the DO2 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 need to use Aqua4Plus to set the baud rate. (You do not need to set the baud rate for SDI-12).

<b>Register addresses for DO2 Sensor</b>		
	Zero Based	One Based
Temp (on board)	62592	62593
Pressure	62594	62595
Power	62596	62597
DO	62598	62599
Temp (on probe)	62600	62601

**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. Change using Sensor Settings.

**Taking Measurements**

Read measurements using Modbus function 03 – Read Holding Registers. Readings are located in two registers each, starting at address 62592. (Sensor 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.)

**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.

**Power On Function**

In order to save power, the power to the sensing probe on the DO2 is normally off, even when the DO2 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 DO2.

*(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 DO2 (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 DO2 sensor is turned off, this value defaults to 30 (or 7.5 seconds).

Recommendations to ensure proper warm-up/stabilization and to conserve power:

- Write Power On value of 30 (30/4 = 7.5 seconds)
  - Power turns on
  - Starts sampling about two times per second
- Wait 7 seconds then request a reading
  - Returns most recent sample
  - Resets Power On value to 30 (30/4 = 7.5 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 7.5 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, see Seametrics application note, "*Modbus Direct Read on Smart Sensors*" available from our web site at [www.seametrics.com](http://www.seametrics.com).

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## Reading Via SDI-12

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### 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 SMDO2.01ssssssss<cr><lf>
```

```
// note: 2.01 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>0045<cr><lf> // request all measurements
<a>D0! <a>+23.1374+14.9829+12.1616+3.9829<cr><lf> // read: temperature (on board),
// pressure
// power
// DO
```

```
<a>D1! <a>+19.1374<cr><lf> // read: temperature (on probe)
```

```
//*** Request measurement with CRC
<a>MC! <a>0045<cr><lf> // request all measurements w/CRC
<a>D0! <a>+23.1374+14.9829+12.1616+3.9829{crc}<cr><lf> // read: temperature (on board),
// pressure
// power
// DO
```

```
<a>D0! <a>+19.1374{crc}<cr><lf> // read: temperature (on probe)
```

```
//*** Concurrent measurement
<a>C! <a>0045<cr><lf> // request all measurements
<a>D0! <a>+23.1374+14.9829+12.1616+3.9829<cr><lf> // read: temperature (on board),
// pressure
// power
// DO
```

```
<a>D0! <a>+19.1374<cr><lf> // read: temperature (on probe)
```

```
//*** Concurrent measurement with CRC
<a>CC! <a>0045<cr><lf> // request all measurements w/CRC
<a>D0! <a>+23.1374+14.9829+12.1616+3.9829{crc}<cr><lf> // read: temperature (on board),
// pressure
// power
// DO
```

```
<a>D0! <a>+19.1374{crc}<cr><lf> // read: temperature (on probe)
```

For further information and SDI-12 examples, see the Seametrics application note, "DO2 Interface Specification (SDI-12 and Modbus)" available from our web site at: [www.seametrics.com](http://www.seametrics.com)

Any reading over 1000 indicates an error, as detailed in the chart below. To use this chart, look up the 1000+ reading from your sensor and note the Sensor Error code in the second column. Then note the Errors 0 – 5. See error descriptions after chart.

		<b>Errors</b>					
<b>Aqua4Plus Reading</b>	<b>Sensor Error Code</b>	5	4	3	2	1	0
1001	01						√
1002	02					√	
1003	03					√	√
1004	04				√		
1005	05				√		√
1006	06				√	√	
1007	07				√	√	√
1008	08			√			
1009	09			√			√
1010	10			√		√	
1011	11			√		√	√
1012	12			√	√		
1013	13			√	√		√
1014	14			√	√	√	
1015	15			√	√	√	√
1016	16		√				
1017	17		√				√
1018	18		√			√	
1019	19		√			√	√
1020	20		√		√		
1021	21		√		√		√
1022	22		√		√	√	
1023	23		√		√	√	√
1024	24		√	√			
1025	25		√	√			√
1026	26		√	√		√	
1027	27		√	√		√	√
1028	28		√	√	√		
1029	29		√	√	√		√
1030	30		√	√	√	√	
		<b>Errors</b>					

<b>Aqua4Plus Reading</b>	<b>Sensor Error Code</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>0</b>
1031	31		√	√	√	√	√
1032	32	√					
1033	33	√					√
1034	34	√				√	
1035	35	√				√	√
1036	36	√			√		
1037	37	√			√		√
1038	38	√			√	√	
1039	39	√			√	√	√
1040	40	√		√			
1041	41	√		√			√
1042	42	√		√		√	
1043	43	√		√		√	√
1044	44	√		√	√		
1045	45	√		√	√		√
1046	46	√		√	√	√	
1047	47	√		√	√	√	√
1048	48	√	√				
1049	49	√	√				√
1050	50	√	√			√	
1051	51	√	√			√	√
1052	52	√	√		√		
1053	53	√	√		√		√
1054	54	√	√		√	√	
1055	55	√	√		√	√	√
1056	56	√	√	√			
1057	57	√	√	√			√
1058	58	√	√	√		√	
1059	59	√	√	√		√	√
1060	60	√	√	√	√		
1061	61	√	√	√	√		√
1062	62	√	√	√	√	√	
1063	63	√	√	√	√	√	√
1128	Unable to communicate with sensor						

**ERROR DESCRIPTION**

- 0 = Main photodiode saturated (circuit or sensor coating damage)
- 1 = Main photodiode negative (excessive electrical noise or damage)
- 2 = Reference photodiode saturated (circuit or sensor coating damage)
- 3 = Reference photodiode negative (excessive electrical noise or damage)
- 4 = Temperature error (thermistor is damaged)
- 5 = Temperature error (temperature is out of range)

**LIMITED WARRANTY/DISCLAIMER - SEAMETRICS DO2 DIS-SOLVED OXYGEN SENSOR**

A. Seller warrants that products manufactured by Seller when properly installed, used, and maintained, shall be free from defects in material and workmanship. Seller's obligation under this warranty shall be limited to replacing or repairing the part or parts or, at Seller's option, the products which prove defective in material or workmanship within TWO (2) years from the date of delivery, provided that Buyer gives Seller prompt notice of any defect or failure and satisfactory proof thereof. Any defective part or parts must be returned to Seller's factory or to an authorized service center for inspection. Buyer will prepay all freight charges to return any products to Seller's factory, or any other repair facility designated by Seller. Seller will deliver replacements for defective products to Buyer (ground freight prepaid) to the destination provided in the original order. Products returned to Seller for which Seller provides replacement under this warranty shall become the property of Seller.

This limited warranty does not apply to lack of performance caused by abrasive materials, corrosion due to aggressive fluids, mishandling or misapplication. Seller's obligations under this warranty shall not apply to any product which (a) is normally consumed in operation, or (b) has a normal life inherently shorter than the warranty period stated herein.

In the event that equipment is altered or repaired by the Buyer without prior written approval by the Seller, all warranties are void. Equipment and accessories not manufactured by the Seller are warranted only to the extent of and by the original manufacturer's warranty.

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, WHETHER ORAL, WRITTEN, EXPRESSED, IMPLIED OR STATUTORY. IMPLIED WARRANTIES OF FITNESS AND MERCHANTABILITY SHALL NOT APPLY. SELLER'S WARRANTY OBLIGATIONS AND BUYER'S REMEDIES THEREUNDER (EXCEPT AS TO TITLE) ARE SOLELY AND EXCLUSIVELY AS STATED HEREIN. IN NO CASE WILL SELLER BE LIABLE FOR CONSEQUENTIAL DAMAGES, LABOR PERFORMED IN CONNECTION WITH REMOVAL AND REPLACEMENT OF THE SENSOR SYSTEM, LOSS OF PRODUCTION OR ANY OTHER LOSS INCURRED BECAUSE OF INTERRUPTION OF SERVICE. A NEW WARRANTY PERIOD SHALL NOT BE ESTABLISHED FOR REPAIRED OR REPLACED MATERIAL, PRODUCTS OR SUPPLIES. SUCH ITEMS SHALL REMAIN UNDER WARRANTY ONLY FOR THE REMAINDER OF THE WARRANTY PERIOD ON THE ORIGINAL MATERIALS, PRODUCTS OR SUPPLIES.

B. With respect to products purchased by consumers in the United States for personal use, the implied warranties including but not limited to the warranties of merchantability and fitness for a particular purpose, are limited to twenty four (24) months from the date of delivery.

Some states do not allow limitations on the duration of an implied warranty, so the above limitation may not apply to you. Similarly, some states do not allow the exclusion or limitation of consequential damages, so the above limitation or exclusion may not apply to you. This limited warranty gives you specific legal rights; however, you may also have other rights which may vary from state to state.



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