

# Instrumentation Northwest, Inc. (INW)

## APPLICATION NOTE

### MODBUS<sup>®</sup> DIRECT READ ON AN AQUISTAR<sup>®</sup> SMART SENSORS May 2010

#### Introduction

Instrumentation Northwest now offers an easy-to-read Modbus version for several of their popular Aquistar<sup>®</sup> Smart Sensors. These sensors communicate via Modbus RTU and directly return measurement readings, without any further math on the part of the host system.

Currently, this feature is available on the PT2X Pressure/Temperature Sensor, the CT2X Conductivity/Temperature/Pressure Sensor, and the T32 1Wire Temperature Logger.

The purpose of this document is to give details for communicating with these sensors for use by PLCs, SCADA systems, and any other applications that use Modbus RTU protocol.

#### Installing Aqua4Plus Software

INW Smart Sensors come with the Aqua4Plus host software to be installed on your PC or laptop. If you will mainly be reading your sensor with another control program, you may still want to install the Aqua4Plus software package. This software is used to set sensor options, such as the Modbus address, to program the datalogger for background recording, 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.

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## PT2X Pressure/Temperature Sensor

### Firmware Requirements for the PT2X

In order to use the direct read Modbus capability, your PT2X must have firmware version 1.5 or later. If you are unsure of your firmware version, you can determine the version as follows

- Connect your sensor directly to your computer. (Refer to the Aqua4Plus or PT2X Instruction manual for information on connecting your sensor to your computer.)
- Run Aqua4Plus and scan to locate your sensor. If more than one sensor is connected, be sure to highlight the correct one.
- Click on the button in the upper right corner of the sensor window. The firmware version will display in the drop down information box.

If your sensor does not have firmware version 1.5 or later, but has a version between 1.0 and 1.3, contact INW for information on downloading the correct firmware. If your firmware is earlier than 1.0, your sensor cannot be updated in the field, but must be returned to the factory for a new generation circuit board. Contact your INW representative for details.

### Communication Settings

Your PT2X 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.

#### Setting the Baud Rate in the PT2X (if needed)

If needed, set your PT2X to the desired baud rate as follows:

- Connect your sensor to your computer. (Refer to the Aqua4Plus or PT2X Instruction manual for information on connecting your sensor to your computer.)
- Run Aqua4Plus version 1.8.302 or later. .
- Scan for and click on your sensor.
- If your sensor contains any data you want to keep, upload that data now.
- Erase all sessions.
- Click on the Configure menu, and then select Advanced.
- From the flyout menu, select Sensor Baud Rate. (You may be asked for a password. The password is admin.) If you do not see the baud rate option, be sure your sensor is running version 1.5 or later firmware – see previous section.
- On the popup box, click the down-arrow and select the baud rate you need, and then click OK.

Once you have changed the baud rate on the sensor, you will not be able to talk to it with Aqua4Plus until you change the baud rate for Aqua4Plus, as follows:

- Click the Options menu, and then select Baud Rate.
- On the popup box, click the down-arrow, select the baud rate you need, and then click OK.

The current baud rate is displayed in the lower right corner of the main Aqua4Plus window.

## Reading Pressure and Temperature

### Reading Registers

Pressure and temperature readings can be read using Modbus function 03 – Read Holding Registers.

Pressure reading is located in two registers starting at address: 62592

Temperature reading is located in two registers starting at address: 62594

### Data Format

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

### Brief Explanation for Aquistar Register Addressing

The physical register addresses on Aquistar smart sensors start numbering from zero – the first address is 0, the second is 1, etc. On the other hand, Modbus protocol considers the first logical address to be 1, the second logical address to be 2, etc. For example, to take a pressure reading you have to read the physical address 62592.

Some programs and equipment when asked to read address 62592 will read that physical address. Others however will read that logical address, which is actually the physical address 62591. With these programs and equipment you must add a one to the address – thus in this example you would request a read at address 62593.

Still other programs and equipment require the addition of 400,000 to the address to indicate reading holding registers. These may or may not require the addition of one to the physical address. Check with your program and/or equipment documentation to determine what style of register addressing is required.

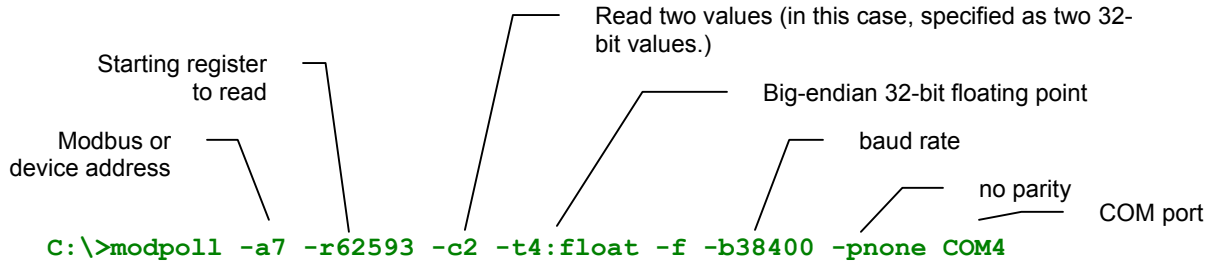
<b>Sample Addresses and Programs/Equipment</b>				
<b>To read:</b>	<b>Specified Address</b>	<b>+ 1</b>	<b>+ 400,000</b>	<b>+ 400,001</b>
Pressure	62592	62593	462592	462593
Temperature	62594	62955	462594	462595
Sample Programs or equipment	Visual Basic, Modbus Poll	Modpoll		Precision Digital meters

## Sample Readings from Modpoll

Modpoll is a free FieldTalk™ Modbus Polling Utility, Copyright (c) 2002-2006 FOCUS Software Engineering Pty Ltd. A copy can be downloaded from:

<http://www.modbusdriver.com>.

Following is the command line in Modpoll to take a pressure and temperature reading from a sensor on Modbus address seven. This sensor was connected to com port 4 on a PC.



Results:

```
Polling slave (Ctrl-C to stop) ...
[62593]: 0.123077  --Pressure value
[62595]: 23.137499 --Temperature value
```

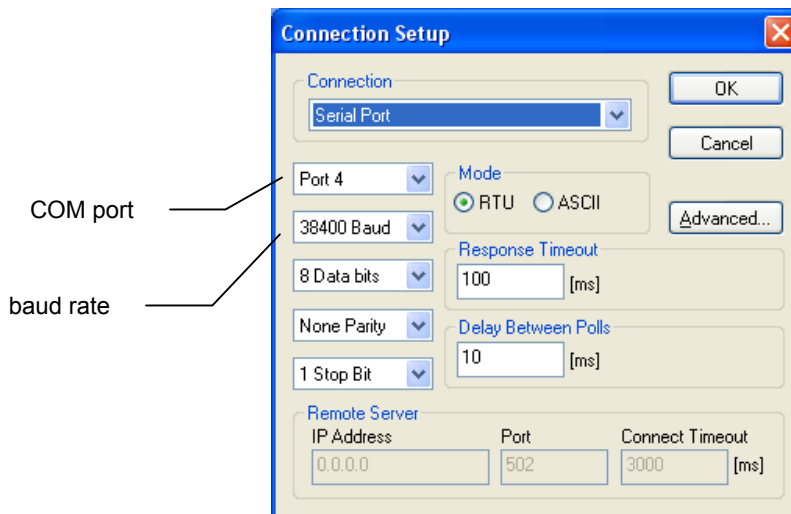
Note that the register address used is the specified address plus one. This command requested two floating point values. The program returned two 16-bit registers for pressure (62593-4) and two for temperature (62595-6), interpreting both sets as 32-bit floating point values.

## Sample Readings from Modbus Poll

Modbus Poll is a PC based polling program by Witte Software and is available from [www.modbustools.com](http://www.modbustools.com).

Below are the relevant windows from Modbus Poll, reading the same sensor as was read in the example above.

*Connection Setup Window*



### Read Request Window

Modbus or device address

Starting register to read – note this uses the specified address without adding 1.

Number of registers to read – in this case specified as four registers

Big-endian 32-bit float

Read/Write Definition

Slave ID: 7

Function: 03 Read Holding Registers (4x)

Address: 62592

Quantity: 4

Scan Rate: 1000 ms

Read/Write Enabled

View

Rows:  10  20  50  100

Display: Float inverse

Buttons: OK, Cancel, Apply, Read/Write Once

### Results Window

Mbpoll1

Tx = 4: Err = 0: ID = 7: F = 03: SR = 1000ms

	Alias	62590
0		
1		
2		0.123077
3		
4		23.074999
5		
6		
7		
8		
9		

Pressure value

Temperature value

## CT2X Conductivity/Temperature/Pressure Sensor

### Firmware Requirements for the CT2X

In order to use the direct read Modbus capability, your CT2X must have firmware version 1.5 or later. If you are unsure of your firmware version, you can determine the version as follows:

- Connect your sensor directly to your computer. (Refer to the Aqua4Plus or CT2X Instruction manual for information on connecting your sensor to your computer.)

- Run Aqua4Plus and scan to locate your sensor. If more than one sensor is connected, be sure to highlight the correct one.
- Click on the button in the upper right corner of the sensor window. The firmware version will display in the drop down information box.

If your firmware is earlier than 1.0, your sensor cannot be updated in the field, but must be returned to the factory for a new generation circuit board. Contact your INW representative for details.

## Communication Settings

Your CT2X 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.

### Setting the Baud Rate in the CT2X (if needed)

If needed, set your CT2X to the desired baud rate as follows:

- Connect your sensor to your computer. (Refer to the Aqua4Plus or CT2X Instruction manual for information on connecting your sensor to your computer.)
- Run Aqua4Plus version 1.8.402 or later.
- Scan for and click on your sensor.
- If your sensor contains any data you want to keep, upload that data now.
- Erase all sessions.
- Click on the Configure menu, and then select Advanced.
- From the flyout menu, select Sensor Baud Rate. (You may be asked for a password. The password is `admin`.) If you do not see the baud rate option, be sure your sensor is running version 1.5 or later firmware – see previous section.
- On the popup box, click the down-arrow and select the baud rate you need, and then click OK.

Once you have changed the baud rate on the sensor, you will not be able to talk to it with Aqua4Plus until you change the baud rate for Aqua4Plus, as follows:

- Click the Options menu, and then select Baud Rate.
- On the popup box, click the down-arrow, select the baud rate you need, and then click OK.

The current baud rate is displayed in the lower right corner of the main Aqua4Plus window.

## Reading Pressure and Temperature

### Reading Registers

Temperature, conductivity, and pressure readings can be read using Modbus function 03 – Read Holding Registers.

Temperature reading is located in two registers starting at address: 62592

Linear Conductivity reading is located in two registers starting at address: 62594

Non-linear Conductivity reading is located in two registers starting at address: 62596

Pressure reading is located in two registers starting at address: 62598

### Data Format

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

### Brief Explanation for AquiStar Register Addressing

The physical register addresses on AquiStar smart sensors start numbering from zero – the first address is 0, the second is 1, etc. On the other hand, Modbus protocol considers the first logical address to be 1, the second logical address to be 2, etc. For example, to take a pressure reading you have to read the physical address 62592.

Some programs and equipment when asked to read address 62592 will read that physical address. Others however will read that logical address, which is actually the physical address 62591. With these programs and equipment you must add a one to the address – thus in this example you would request a read at address 62593.

Still other programs and equipment require the addition of 400,000 to the address to indicate reading holding registers. These may or may not require the addition of one to the physical address.

Check with your program and/or equipment documentation to determine what style of register addressing is required.

### Register Addresses For CT2X

Sample Addresses and Programs/Equipment				
To read:	Specified Address	+ 1	+ 400,000	+ 400,001
Temperature	62592	62593	462592	462593
Conductivity - Linear	62594	62595	462594	462595
Conductivity - nLFn	62596	62597	462596	462597
Pressure	62598	62599	462598	462597
Sample Programs or equipment	Visual Basic, Modbus Poll	Modpoll		Precision Digital meters

## Sample Readings from Modpoll

Modpoll is a free FieldTalk™ Modbus Polling Utility, Copyright (c) 2002-2006 FOCUS Software Engineering Pty Ltd. A copy can be downloaded from:

<http://www.modbusdriver.com>.

Following is the command line in Modpoll to take temperature, conductivity, and pressure readings from a sensor on Modbus address two. This sensor was connected to com port 4 on a PC.

```
C:\>modpoll -a2 -r62593 -c4 -t4:float -f -b38400 -pnone COM4
```

Polling slave (Ctrl-C to stop) ...

[62593]: 39.096756	-- Temperature (degrees C)
[62595]: 2297.144775	-- Conductivity – Linear (uS/cm)
[62597]: 2274.558105	-- Conductivity – nLFn (uS/cm)
[62599]: 10.049695	-- Pressure (psi)

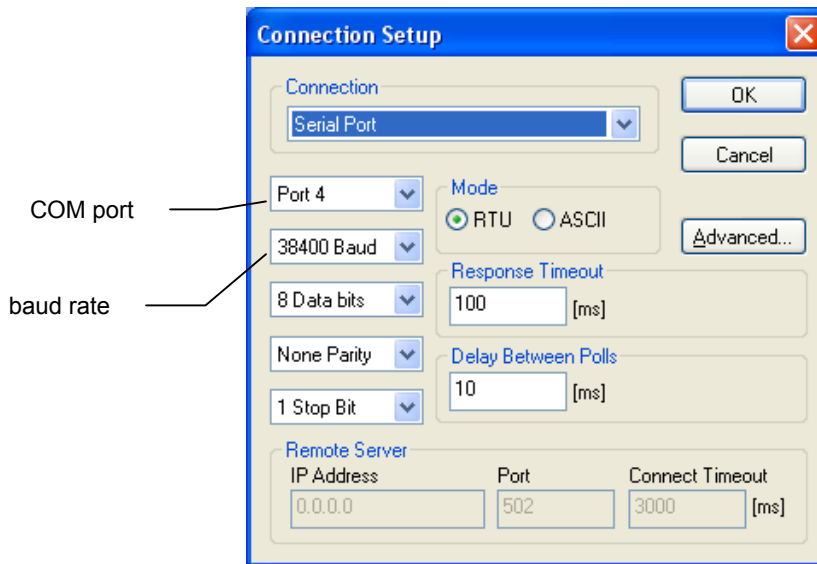
Note that the register address used is the specified address plus one. This command requested four floating point values. The program returned two 16-bit registers for temperature (62593-4), and two for linear conductivity (62595-6), two for non-linear conductivity (62597-8), and two for pressure (62599-600), interpreting each set as a 32-bit floating point value.

## Sample Readings from Modbus Poll

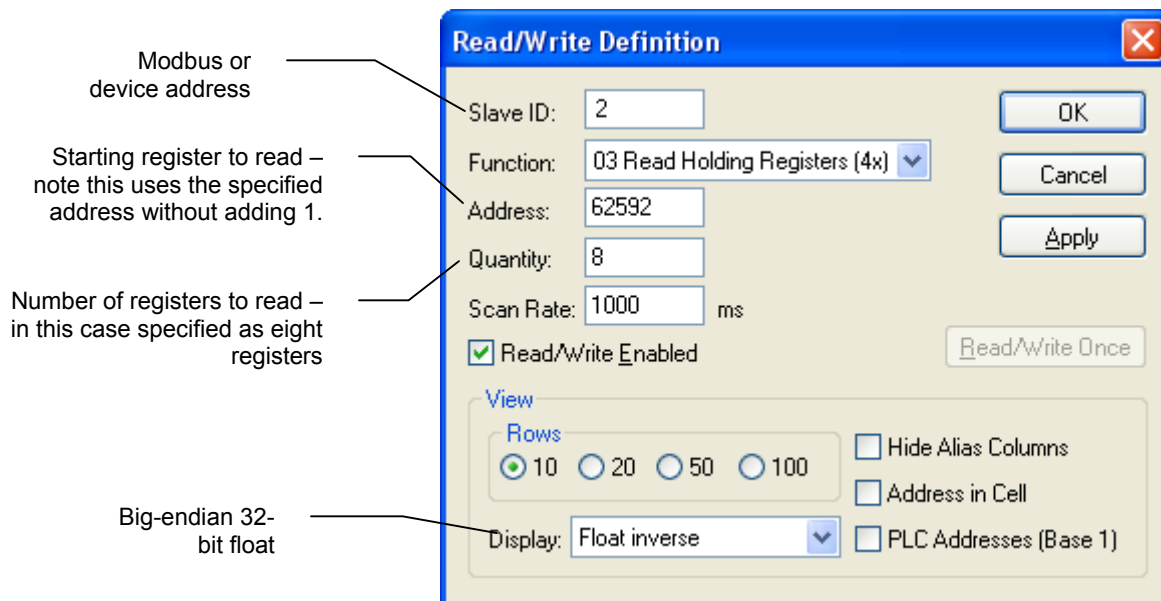
Modbus Poll is a PC based polling program by Witte Software and is available from [www.modbustools.com](http://www.modbustools.com).

Below are the relevant windows from Modbus Poll, reading the same sensor as was read in the example above.

### Connection Setup Window



### Read Request Window



*Results Window*

	Alias	62590
0		
1		
2	temperature - deg C	39.092087
3		
4	conductivity - uS Linear	2294.928711
5		
6	conductivity - uS nLFn	2272.375977
7		
8	pressure - psi	10.049695
9		

## T32 1Wire Temperature Logger

### Firmware Requirements for the T32

Direct read Modbus functionality is built into all versions of the T32.

### Communication Settings

Your T32 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.

#### Setting the Baud Rate in the T32 (if needed)

If needed, set your T32 to the desired baud rate as follows:

- Connect your sensor to your computer. (Refer to the Aqua4Plus or PT2X Instruction manual for information on connecting your sensor to your computer.)
- Run Aqua4Plus version 1.8.5 or later. .
- Scan for and click on your sensor.
- If your sensor contains any data you want to keep, upload that data now.
- Erase all sessions.
- Click on the Configure menu, and then select Advanced.
- From the flyout menu, select Sensor Baud Rate. (You may be asked for a password. The password is admin.)
- On the popup box, click the down-arrow and select the baud rate you need, and then click OK.

Once you have changed the baud rate on the sensor, you will not be able to talk to it with Aqua4Plus until you change the baud rate for Aqua4Plus, as follows:

- Click the Options menu, and then select Baud Rate.
- On the popup box, click the down-arrow, select the baud rate you need, and then click OK.

The current baud rate is displayed in the lower right corner of the main Aqua4Plus window.

### Reading Temperature

#### Reading Registers

Temperature readings can be read using Modbus function 03 – Read Holding Registers.

The T32 has 32 channels of temperature data. Temperature reading from the first channel is located in two registers starting at address 62594. The reading from the 2<sup>nd</sup> channel is located in two registers starting at address 62596. The addressing continues thus until the 32<sup>nd</sup> channel is read from two registers starting at address 62654.

## Data Format

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

## Brief Explanation for AquiVar Register Addressing

The physical register addresses on AquiVar smart sensors start numbering from zero – the first address is 0, the second is 1, etc. On the other hand, Modbus protocol considers the first logical address to be 1, the second logical address to be 2, etc. For example, to take a pressure reading you have to read the physical address 62592.

Some programs and equipment when asked to read address 62592 will read that physical address. Others however will read that logical address, which is actually the physical address 62591. With these programs and equipment you must add a one to the address – thus in this example you would request a read at address 62593.

Still other programs and equipment require the addition of 400,000 to the address to indicate reading holding registers. These may or may not require the addition of one to the physical address. Check with your program and/or equipment documentation to determine what style of register addressing is required.

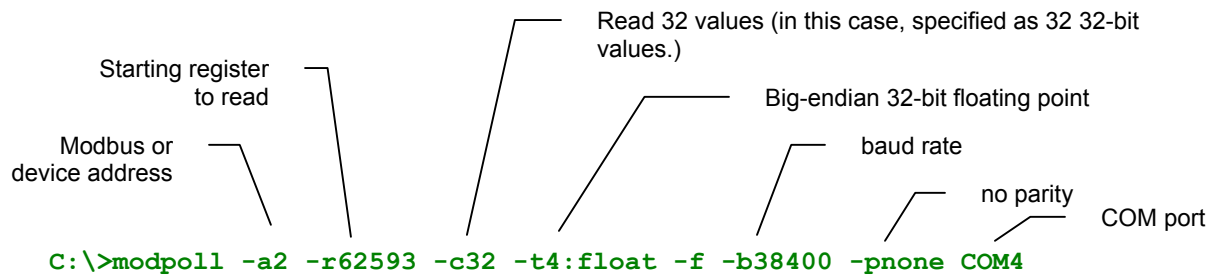
<b>Sample Addresses and Programs/Equipment</b>				
<b>To read:</b>	<b>Specified Address</b>	<b>+ 1</b>	<b>+ 400,000</b>	<b>+ 400,001</b>
Channel 1	62592	62593	462592	462593
Channel 2	62594	62955	462594	462595
↓	↓	↓	↓	↓
Channel 32	62654	62655	462654	426565
Sample Programs or equipment	Visual Basic, Modbus Poll	Modpoll		Precision Digital meters

## Sample Readings from Modpoll

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<http://www.modbusdriver.com>.

Following is the command line in Modpoll to take temperature readings from a sensor on Modbus address two. This sensor was connected to com port 4 on a PC.



### Results:

```
Polling slave (Ctrl-C to stop) ...
[62593]: 23.187500 - channel 1
[62595]: 23.437500 - channel 2
[62597]: 23.437500 - channel 3
[62599]: 23.437500 - channel 4
[62601]: 23.562500 - channel 5
[62603]: 23.452400 - channel 6
[62605]: 23.651000 - channel 7
[62607]: 23.187500 - channel 8
[62609]: 23.437500 - channel 9
[62611]: 23.437500 - channel 10
[62613]: 23.437500 - channel 11
[62615]: 23.562500 - channel 12
[62617]: 23.452400 - channel 13
[62619]: 23.651000 - channel 14
[62621]: 23.187500 - channel 15
[62623]: 23.437500 - channel 16
[62625]: 23.437500 - channel 17
[62627]: 23.437500 - channel 18
[62629]: 23.562500 - channel 19
[62631]: 23.452400 - channel 20
[62633]: 23.651000 - channel 21
[62635]: 23.187500 - channel 22
[62637]: 23.437500 - channel 23
[62639]: 23.437500 - channel 24
[62641]: 23.437500 - channel 25
[62643]: 23.562500 - channel 26
[62645]: 23.452400 - channel 27
[62647]: 23.651000 - channel 28
[62649]: 23.187500 - channel 29
[62651]: 23.437500 - channel 30
[62653]: 23.437500 - channel 31
[62655]: 23.437500 - channel 32
```

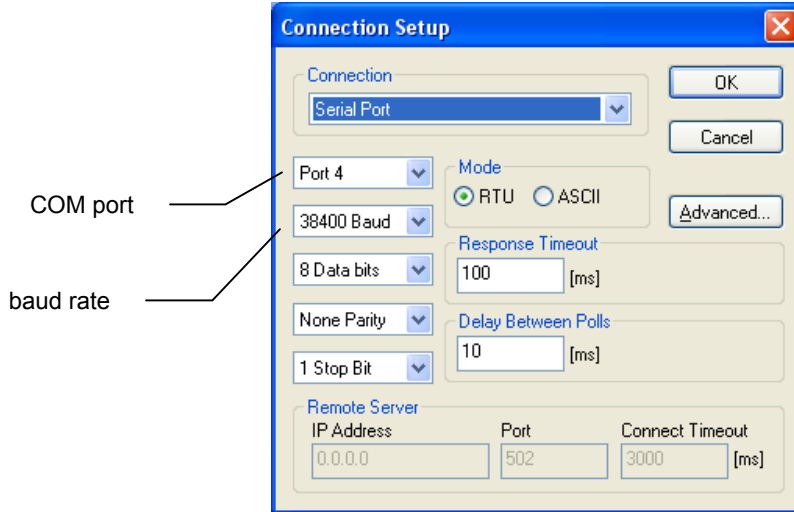
Note that the register address used is the specified address plus one. This command requested 32 floating point values. The program returned two 16-bit registers for each channel, interpreting each set as a 32-bit floating point value.

## Sample Readings from Modbus Poll

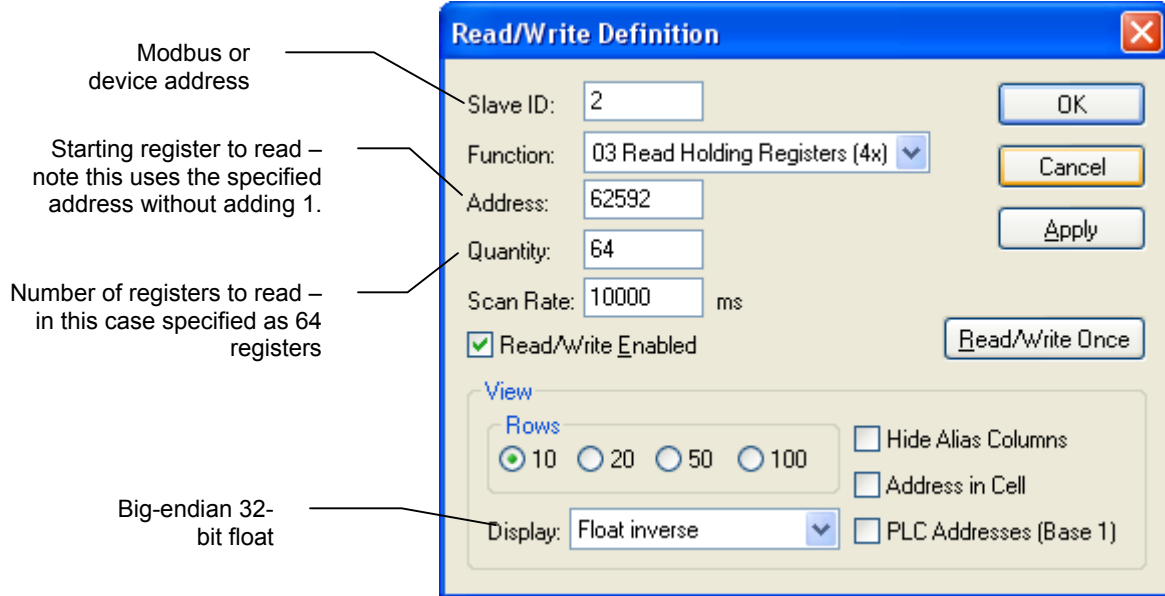
Modbus Poll is a PC based polling program by Witte Software and is available from [www.modbustools.com](http://www.modbustools.com).

Below are the relevant windows from Modbus Poll, reading the same sensor as was read in the example above.

### Connection Setup Window



### Read Request Window



## Results Window

	Alias	62590	Alias	62600	Alias	62610	Alias	62620	Alias	62630	Alias	62640	Alias	62650
0			Ch 5	24.062500	Ch 10	23.812500	Ch 15	24.062500	Ch 20	23.812500	Ch 25	24.062500	Ch 30	23.812500
1														
2	Ch 1	23.812500	Ch 6	23.812500	Ch 11	24.062500	Ch 16	23.812500	Ch 21	24.062500	Ch 26	23.812500	Ch 31	24.062500
3														
4	Ch 2	24.062500	Ch 7	24.062500	Ch 12	24.187500	Ch 17	24.062500	Ch 22	24.187500	Ch 27	24.062500	Ch 32	24.187500
5														
6	Ch 3	24.187500	Ch 8	24.187500	Ch 13	24.125000	Ch 18	24.187500	Ch 23	24.125000	Ch 28	24.187500		
7														
8	Ch 4	24.125000	Ch 9	24.125000	Ch 14	24.062500	Ch 19	24.125000	Ch 24	24.062500	Ch 29	24.125000		
9														

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AquiStar is a registered trademark of Instrumentation Northwest. Modbus is a registered trademark of Sneider Electric.

Instrumentation Northwest appreciates any comments you may have regarding this application note. Please contact:

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