Modbus Installation and Instruction Manual

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www.hydroinstruments.com

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Modbus Communication Set-up and Installation

I. Background

Modbus, developed in 1979, is a serial communications protocol to be used with programmable logic controllers (PLCs) to read or write digital messages sent over the network. It is perhaps one of the most widely used communication protocols as it is free to use, easy to program and maintain, and was developed specifically for industrial use. Using a master/slave network, it can transmit data in real time giving it an advantage over other networks. Modbus can support up to 247 devices and is used to define both the physical layer (electrical connections) and the application layer (way in which to communicate). All devices on the network must have the same physical configuration consisting of the data format and baud rate.

Before setting up/installing the Modbus communication network onto Hydro Instruments equipment, familiarize yourself with the information contained in this packet. If you have any questions please contact Hydro Instruments.

Electrical Warning: Programming these devices does include electrical shock risk. Take care to avoid electrical shocks and do not touch any part of the power line unless you are certain the power has been disconnected.

II. Definitions

Physical Layer: The physical layer is the actual hardware and electrical termination set-up used to connect the master and slaves together for Modbus communication. All Hydro Instruments equipment outlined in this document supports "Modbus RTU" on a 2-wire RS-485 network.

Baud Rate: The baud rate is the modulation of the signal between devices.

Node: The node is the programmed number given to the slave so that the master can communicate specifically with that unit when requested. Thus, each unit should have its own unique node number.

Application Layer: This is the layer closest to the end user. It interacts with the software application to display information in a human-recognizable format.

Master: The master is the main controller of the network (some programmers may be more familiar with the "server"). There can only be one master per network which is the only device that can read and write information to the other devices (or slaves). The master may be a computer or any type of SCADA system.

Slave: The slave, or "client", is any PLC connected to the master. Each slave will have a specific node which will be used by the master to communicate to that specific PLC.

Function Code: The function code tells the slave what type of information is being requested by the master. This information may either be to read or write bits, or to read or write registers. The function code is an integer from 1 to 127 and that number is interpreted by the slave as to what information is requested. Thus, the same function code may serve two different purposes on two different instruments.

Data Address: The data address in decimal format is an indexing integer uniquely identifying each variable stored by the selected device.

Data Quantity: The data quantity tells the slave how many bits or registers of data are going to the data address.

III. Support Types (Physical/Electrical Standards)

1. *RS-485*

The RS-485 network is supported by Hydro Instruments equipment and is the most commonly used physical layer. It allows for connection to multiple slaves (up to 247), has excellent noise immunity, high speed (up to 35Mbps), and cables can be used up to 4,000 feet. The RS-485 version of Modbus is commonly referred to as Modbus RTU. Aside from the physical connections, the user must define the baud rate and the data format so that both the master and the slave have the same format. The data formats and baud rates that are supported can be seen in Table 1.

2. **Address Data Format** - The published Modbus addresses are decimal addresses and use the standard notation prefix for decimal (no prefix).

Table 1. Data Formats and Baud Rates Supported by Hydro Instruments

Data Format	Baud Rates
8/N/1	2400
8/N/2	4800
8/E/1	9600
8/O/1	19200
	38400
	57600
	115200
	250000

Hydro Instruments uses a half-duplex (2 wire) interface type. Hydro Instruments also recommends that the slaves be "daisy chained" together so that only one connection to the master is required. Cat 5 cable is the recommended cable to use and the wiring should be installed according to Table 2.

Table 2. Wiring connections for Modbus RTU

CAT 5 Cable	RS-485 Terminal	Equipment Terminal
Brown & white	V+	
Blue &white	A	A
Blue	B	B
Brown	V-(GND)	GND

The RS-485 network requires a "termination resistor" installed at either end of the network when using very long cable runs (>300 feet) at high baud rates (> 19200). Contact Hydro Instruments for more information.

3. *TCP/IP*

This network architectural model can be used to communicate through Ethernet or WiFi and has the advantage of being able to control Modbus devices over the internet. This version is referred to as Modbus TCP/IP. Hydro Instruments does not currently sell the devices for this communication and recommends using an intermediate hub which can connect to the RS-485 terminal. The user can then communicate to the hub using the configuration outlined in Section III.1, and then communicate to this hub over the internet. Contact your supplier for installation information.

IV. Programming Equipment onto the Network:

1. Programing Omni-Valves (OV-110 and OV-1000)

Programming Omni-valves (slaves) should be performed after the physical layer has been installed (Section III). Omni-valves purchased after October 2013 will be standard equipped to communicate with Modbus. If purchased before said date, contact Hydro Instruments.

I. Determine the baud rate and data format of the master controller.
II. From the main screen, press the "down" key until the password screen appears. Enter the password, "110" (OV-110) or "1000" (OV-1000) using the "plus" and "minus" keys.
III. Once the correct password appears on the screen, continue to press the down key until the text "ADCAL" is blinking, then press the plus key.
IV. Press the down key once so that "Yes" is blinking. Press and hold the "down" key for approximately 5-10 seconds.
V. A new set of screens should appear. Go down two screens using the "down" key until the "Modbus" screen appears.
VI. Use the "plus" key to select the baud rate.
VII. Press the "down" key once. Then enter the node number using the "plus" key. Save this number to program the master controller and to ensure the same number is not given to two units.
VIII. Press the "down" key once. Then enter the data format using the "plus" key.
IX. Cycle the power to save the information.

2. Programming Vaporizers (VPH-10000)

Programming Vaporizers should be performed after the physical layer has been installed (Section III). Refer to the steps below to configure the VPH-10000 vaporizer baud rate, node number and data format to communicate with the network.

I. Determine the baud rate and data format of the master controller.
II. From the main screen, press the "down" key until the password screen appears. Enter the password "100" using the "plus" and "minus" keys.
III. Once the correct password is blinking continue to press the down key until the Modbus screen appears.
IV. Using the "plus" and "minus" keys, enter the baud rate that matches the master/server.
V. Press the "down" key so that the node number is blinking and enter the node number using the "plus" and "minus" keys. Save this number and make sure it does not match with any other equipment on the network.
VI. Press the "down" key so that the data format is blinking. Enter the data format that matches the master/server.
VII. Cycle the power to save the information.

3. Programming GA-180 Gas Leak Detectors

Programming the GA-180 Gas Detectors should be performed after the physical layer has been installed (Section III). Refer to steps below (and GA-180 O&M Manual Figure 8) to configure the GA-180 baud rate, node number, and data format to communicate with the network.

I. Determine the baud rate and data format of the master controller.
II. From the main screen, press the "down" key until the password screen appears. Enter the password "180" using the "plus" and "minus" keys.
III. Once the correct password is blinking press the down arrow key. Then with "Sensor" blinking, press and hold the "minus" key until the Modbus setup screen appears.
IV. Using the "plus" and "minus" keys, enter the baud rate that matches the master/server.
V. Press the "down" key so that the node number is blinking and enter the node number using the "plus" and "minus" keys. Save this number and make sure it does not match with any other equipment on the network.
VI. Press the "down" key so that the data format is blinking. Enter the data format that matches the master/server.
VII. Cycle the power to save the information.

4. Programming CS-110 Automatic Changeover Controller

Programming the CS-110 Automatic Changeover controllers should be performed after the physical layer has been installed (Section III). Refer to steps below (and CS-110 O&M Manual) to configure the CS-110 baud rate, node number, and data format to communicate with the network.

I. Determine the baud rate and data format of the master controller.
II. From the main screen, press the "down" key until the password screen appears. Enter the password "110" using the "plus" and "minus" keys.
III. Once the correct password is blinking press the down arrow key. Then continue to press the "down" key until the Modbus setup screen appears.
IV. Using the "plus" and "minus" keys, enter the baud rate that matches the master/server.
V. Press the "down" key so that the node number is blinking and enter the node number using the "plus" and "minus" keys. Save this number and make sure it does not match with any other equipment on the network.
VI. Press the "down" key so that the data format is blinking. Enter the data format that matches the master/server.
VII. Cycle the power to save the information.

5. Programming RAH-210, RPH-250, RPH-260, RAH-280, and WQM-100 Analyzers

Programming the Residual Analyzers should be performed after the physical layer has been installed (Section III). Refer to steps below (and O&M Manuals) to configure the residual analyzer baud rate, node number, and data format to communicate with the network.

I. Determine the baud rate and data format of the master controller.
II. From the main screen, press and hold the "down" key for at least 5 seconds until the first hidden screen appears. Use the "down" key to navigate to the 12th hidden screen which is the Modbus setup screen.
III. Using the "plus" and "minus" keys, enter the baud rate that matches the master/server.
IV. Press the "down" key so that the node number is blinking and enter the node number using the "plus" and "minus" keys. Save this number and make sure it does not match with any other equipment on the network.
V. Press the "down" key so that the data format is blinking. Enter the data format that matches the master/server.
VI. Cycle the power to save the information.

6. Programming TH-4000 Turbidimeter, GA-171 Gas Detector, HC-220 PID Controller

Programming the TH-4000 Turbidimeter, GA-171 Gas Detector, or HC-220 PID Controller should be performed after the physical layer has been installed (Section III). Refer to steps below to configure the baud rate, node number, and data format to communicate with the network.

I. Determine the baud rate and data format of the master controller.
II. From the main screen, press and hold the "down" key for at least 5 seconds until the Modbus setup screen appears.
III. Using the "plus" and "minus" keys, enter the baud rate that matches the master/server.
IV. Press the "down" key so that the node number is blinking and enter the node number using the "plus" and "minus" keys. Save this number and make sure it does not match with any other equipment on the network.
V. Press the "down" key so that the data format is blinking. Enter the data format that matches the master/server.
VI. Cycle the power to save the information.

V. Programming Masters:

Be sure that the electrical terminations are complete and accurate. Also confirm that the baud rate and data format are the same on the master as they are on the slaves. Different software may have different ways of displaying and programming information on the device, however the function code and addresses for the specified equipment will be the same regardless of the software being used. Refer to the tables below for setting the equipment parameters on the master/server.

Function Code Designations:

Table 3. Description of Function Codes for Hydro Instruments Equipment

Function Code	Function Name	Description	Request Packet Size	Response Packet Size
01	read coils	read 1 to 2000 bits	8	5 or 6 + N/8
02	read discrete inputs	read 1 to 2000 bits	8	5 or 6 + N/8
03	read hold registers	read 1 to 125 registers	8	5 + 2N
04	read input registers	read 1 to 125 registers	8	5 + 2N
05	write a single coil	write 1 bit	8	8
06	write a single register	write 1 register	8	8
15	write multiple coils	write 1 to 2000 bits	9 or 10 + N/8	8
16	write multiple registers	write 1 to 123 registers	9 + 2N	8

VARIABLE ADDRESSES AND REGISTER VALUES

*Values are read only and cannot be edited by the user.
**The decimal positions can be read but should not be written over Modbus since they can only be changed on the display.

The variable type defines whether or not the data stored in the register is a real time value/number (float/floating point) or if the number will correspond to a feature or command (integer). In the case of integers, values have been developed so that the Omni-valve can change and display features like units, the control type, or control alarms and relays over the Modbus network. The following definitions for integer type values can be seen in table 5.

The Omni-valve integer type values correspond to Modbus registers. The Omni-valve float values correspond to two Modbus registers in which the float data is in the IEEE 754 format (32 bit). Using this format the first address reads/writes the most significant 16 bits, whereas the second address reads/writes the least significant 16 bits.

Table 4. Modbus OV-110 and OV-1000 Omni-valve Variable Addresses, Register Values, and Features

Name	Type	Address	Register Value	Feature
Run Mode	Integer	0	0	Automatic
			1	Manual
			2	Check Valve Position
Alarm Status	Integer	1	0	Normal
			1	Flow Signal Loss
			2	Low Flow
			3	Res/ORP Loss
			4	Low Residual
			5	High Residual
			6	Flow + Resl Loss
			7	Dose Signal Loss
Control Method	Integer	2	0	Flow Pacing
			1	Residual/ORP
			2	Compound Loop
			3	Step Feed
			4	Dual Input Feed Fwd
Process Variable 1 Units	Integer	3	0	%
			1	GPM
			2	MGD
			3	LPM
			4	MLD
			5	GPD
			6	m^3/hr
Process Variable 2 Units	Integer	4	0	ppm
			1	mg/l
			2	mV

			3	pH
			4	GPD
Process Output 1 Units	Integer	5	0	%
			1	PPD
			2	g/hr
			3	kg/hr
			4	GPH
			5	GPM
			6	GPD
			7	LPM
			8	LPH
*PV1	Float	6/7		
PV1 Dosage	Float	8/9		
PV1 Span	Float	10/11		
PV1 Low Set	Float	12/13		
*PV2	Float	14/15		
PV2 Set Point	Float	16/17		
PV2 Span	Float	18/19		
PV2 Integral	Float	20/21		
PV2 Low Set	Float	22/23		
PV2 High set	Float	24/25		
*PO1	Float	26/27		
PO1 Span	Float	28/29		
PO1 Manual	Float	30/31		
*PV3	Float	32/33		
PV3 Set Point	Float	34/35		
PV3 Span	Float	36/37		
PV3 Integral	Float	38/39		
PV1 Enable	Integer	51	0 = Modbus, 1 = 4-20mA input	
PV2 Enable	Integer	52	0 = Modbus, 1 = 4-20mA input	
PV3 Enable	Integer	53	0 = Modbus, 1 = 4-20mA input	
PV2 Lag Time Mode	Integer	54	0 = fixed, 1 = single point, 2 = 2 point	
PV2 F1	Integer	55		
PV2 T1	Integer	56	Time in Seconds	
PV2 F2	Integer	57		
PV2 T2	Integer	58	Time in Seconds	
PV3 Lag Time Mode	Integer	59	0 = fixed, 1 = single point, 2 = 2 point	
PV3 F1	Integer	60		
PV3 T1	Integer	61	Time in Seconds	
PV3 F2	Integer	62		
PV3 T2	Integer	63	Time in Seconds	
PO1 GFM	Integer	64	In PO1 Units	
PO1 GFM Span	Integer	65	In PO1 Units	
PO1 GFM Error	Integer	66	10% to 100%	

***Values are read only and cannot be edited by the user. However, PV1, PV2, and PV3 can each be selected to either be read at the analog input channels or set over Modbus.

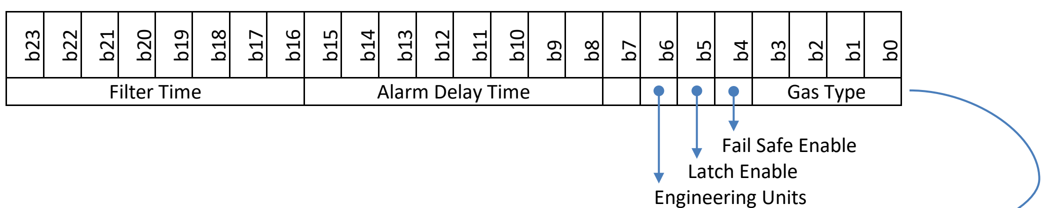
Table 5. Modbus VPH-10000 Vaporizer
Variable Addresses, Register Values, and Features

Name	Type	Address	Register Value	Feature
*Gas Temperature	Integer	1		
*Gas Pressure	Integer	2		
Gas Pressure Span	Integer	3		
High Pressure Alarm Level	Integer	4		
*Superheat Temperature	Integer	5		
Superheat Alarm Set Point	Integer	6		
*Control Water Temperature	Integer	7		
Water Temperature Set Point	Integer	8		
High Temperature Alarm Set Point	Integer	9		
Low Temperature Alarm Set Point	Integer	10		
*Aux Water Temperature	Integer	11		
*Water Level	Integer	12	0	Normal
			1	High
			2	Low
			3	Low Low
*Heater Power Output (kW)	Integer	13		
*Heater Power Output (%)	Integer	14		
*Heater Element Temperature	Integer	15		
Temperature Units	Integer	16	0	Celsius
			1	Fahrenheit
Pressure Units	Integer	17	0	PSI
			1	Bar
*Alarm Status	Integer	18	0	Normal
			2	Low Water Temperature
			3	High Water Temperature
			4	Heater Over Temperature
			5	Superheat Alarm
			6	High Water Alarm
			7	Low Water Alarm
			8	PRV Burst Disc
			9	EXP Burst Disc High Pressure
			10	High Pressure

*****Values are read only and cannot be edited by the user.

Table 6. Modbus GA-180 Gas Detector
Variable Addresses, Register Values, and Features

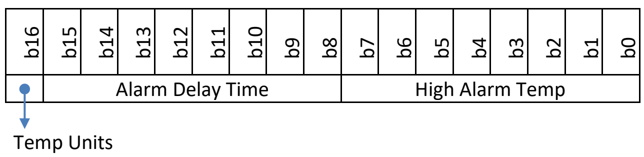
Name	Type	Address	Description	
*SensorLive(1 through 16)	Array of Integers	1 through 16	Array holds all 16 live sensor values (ppm or %)	For example 75 = 7.5ppm
SensorType(1 through 16)	Array of Integer Bit Fields	17 through 32	Array holds the sensor configuration for all 16 sensors. Each integer value is a bit field, with the following fields: b23-b16 = Filter Time b15-b8 = Alarm Delay Time b6 = Engineering Units (0=ppm, 1=%) b5 = Latch Enable b4 = Fail Safe Enable b3-b0 = Gas Type	



Gas Type							
b3	b2	b1	b0		Integer		
0	0	0	0	=	0	→	Sensor Off
0	0	0	1	=	1	→	NH_3 (Ammonia)
0	0	1	0	=	2	→	O_2 (Oxygen)
0	0	1	1	=	3	→	O_3 (Ozone)
0	1	0	0	=	4	→	SO_2 (Sulfur dioxide)
0	1	0	1	=	5	→	Cl_2 (Chlorine)
0	1	1	0	=	6	→	ClO_2 (Chlorine dioxide)
0	1	1	1	=	7	→	CO (Carbon monoxide)
1	0	0	0	=	8	→	H_2 (Hydrogen)
1	0	0	1	=	9	→	H_2S (Hydrogen sulfide)

Name	Type	Address	Description	
SensorSpan(1 through 16)	Array of Integers	33 through 48	Array holds all 16 sensor span values	For example 100 = 10.0ppm
*SensorStatus(1 through 16)	Array of Integers	49 through 64	Array holds all 16 sensor status values	*Integer Value* / *Status* 0 = Off 1 = Normal 2 = Danger 3 = Alarm 4 = Error
LowAlarm(1 through 16)	Array of Integers	65 through 80	Array holds all 16 sensor low alarm values	For example 10 = 1.0ppm
HighAlarm(1 through 16)	Array of	81	Array holds all 16	For example

<table>
<tr><td></td><td>Integers</td><td>through 96</td><td colspan="2">sensor high alarm values</td><td>20 = 2.0ppm</td></tr>
<tr><td>*Temperature</td><td>Integer</td><td>97</td><td colspan="2">Live temperature from thermocouple (C or F)</td><td>For example 75 = 75F</td></tr>
<tr><td rowspan="4">*TempStatus</td><td rowspan="4">Integer</td><td rowspan="4">98</td><td rowspan="4">Temperature status</td><td>Integer Value</td><td>Status</td></tr>
<tr><td>0</td><td>Normal</td></tr>
<tr><td>1</td><td>High Temp</td></tr>
<tr><td>2</td><td>Error</td></tr>
<tr><td>TempSetup</td><td>Integer Bit Field</td><td>99, 100, 101</td><td colspan="3">A bit field which holds the temperature configuration:
b16 = Temp Units (0=C, 1=F)
b15-b8 = Alarm Delay Time
b7-b0 = High Alarm Temp (C or F)</td></tr>
</table>



<table>
<tr><td>RemoteAck</td><td>Integer</td><td>102</td><td colspan="2">Remote acknowledge</td><td>Set to 1 to remote acknowledge alarm</td></tr>
<tr><td rowspan="3">*AnyLowAlarm</td><td rowspan="3">Integer</td><td rowspan="3">103</td><td rowspan="3">Indicates any sensor low alarm</td><td>Integer Value</td><td>Status</td></tr>
<tr><td>0</td><td>No Alarm</td></tr>
<tr><td>1</td><td>Any Alarm</td></tr>
<tr><td rowspan="3">*AnyHighAlarm</td><td rowspan="3">Integer</td><td rowspan="3">104</td><td rowspan="3">Indicates any sensor high alarm</td><td>Integer Value</td><td>Status</td></tr>
<tr><td>0</td><td>No Alarm</td></tr>
<tr><td>1</td><td>Any Alarm</td></tr>
<tr><td rowspan="3">*AnyFailAlarm</td><td rowspan="3">Integer</td><td rowspan="3">105</td><td rowspan="3">Indicates any sensor fail alarm</td><td>Integer Value</td><td>Status</td></tr>
<tr><td>0</td><td>No Alarm</td></tr>
<tr><td>1</td><td>Any Alarm</td></tr>
</table>

*****Values are read only and cannot be edited by the user.

Table 7. Modbus CS-110 Automatic Changeover Controller Variable Addresses, Register Values, and Features

<table>
<tr><th>Name</th><th>Type</th><th>Address</th><th colspan="2">Description</th></tr>
<tr><td rowspan="4">*V1State</td><td rowspan="4">Integer</td><td rowspan="4">1</td><td>Integer Value</td><td>State</td></tr>
<tr><td>0</td><td>Off</td></tr>
<tr><td>1</td><td>On</td></tr>
<tr><td>2</td><td>Empty</td></tr>
<tr><td>V1RunMins</td><td>Integer</td><td>2</td><td colspan="2">Run time in minutes</td></tr>
<tr><td>*V1Scale</td><td>Float</td><td>3,4</td><td colspan="2">Scale reading (e.g., 868 kg)</td></tr>
<tr><td>V1ScaleSpan</td><td>Float</td><td>5,6</td><td colspan="2">Scale span value (e.g., 1,000 kg)</td></tr>
<tr><td rowspan="4">*V2State</td><td rowspan="4">Integer</td><td rowspan="4">11</td><td>Integer Value</td><td>State</td></tr>
<tr><td>0</td><td>Off</td></tr>
<tr><td>1</td><td>On</td></tr>
<tr><td>2</td><td>Empty</td></tr>
<tr><td>V2RunMins</td><td>Integer</td><td>12</td><td colspan="2">Run time in minutes</td></tr>
<tr><td>*V2Scale</td><td>Float</td><td>13,14</td><td colspan="2">Scale reading (e.g., 868 kg)</td></tr>
</table>

<table>
<tr><td>V2ScaleSpan</td><td>Float</td><td>15,16</td><td colspan="3">Scale span value (e.g., 1,000 kg)</td></tr>
<tr><td rowspan="4">ScaleUnits
(Enable / Scale Units)</td><td rowspan="4">Integer</td><td rowspan="4">20</td><td colspan="2">Integer Value</td><td>Setting</td></tr>
<tr><td colspan="2">0</td><td>Off</td></tr>
<tr><td colspan="2">1</td><td>Kg (kilograms)</td></tr>
<tr><td colspan="2">2</td><td>Pd (pounds)</td></tr>
<tr><td>OnDelayTime</td><td>Integer</td><td>21</td><td colspan="3">Valve turn on delay time in seconds</td></tr>
<tr><td>RemoteAck</td><td>Integer</td><td>22</td><td colspan="2">Remote acknowledge</td><td>Set to 1 to remote acknowledge alarm</td></tr>
<tr><td rowspan="4">***RemoteCtrl</td><td rowspan="4">Integer</td><td rowspan="4">23</td><td rowspan="4">Remote control for valves</td><td>Integer Value</td><td>Behavior</td></tr>
<tr><td>0</td><td>Turn OFF both valves</td></tr>
<tr><td>1</td><td>Turn ON valve 1</td></tr>
<tr><td>2</td><td>Turn ON valve 2</td></tr>
</table>

*****Values are read only and cannot be edited by the user.
*******Value is not persistent, and the command is ignored when tanks are empty.

Table 8. Modbus RAH-210 and RPH-250 Residual Analyzers Variable Addresses, Register Values, and Features

<table>
<tr><th>Name</th><th>Type</th><th>Address</th><th colspan="2">Description</th></tr>
<tr><td>*Temp</td><td>Integer</td><td>1</td><td>Temperature live displayed
(C or F)</td><td>For example
74 = 74F</td></tr>
<tr><td>TempManual</td><td>Integer</td><td>2</td><td>Temp manual
(Kelvin x 10)</td><td>For example
2555 = 255.5K, display still shows C or F</td></tr>
</table>

<table>
<tr><td rowspan="3">TempMode</td><td rowspan="3">Integer</td><td rowspan="3">3</td><td rowspan="3">Temp mode</td><td>Integer Value</td><td>Setting</td></tr>
<tr><td>0</td><td>Auto</td></tr>
<tr><td>1</td><td>Manual</td></tr>
<tr><td rowspan="3">TempUnits</td><td rowspan="3">Integer</td><td rowspan="3">4</td><td rowspan="3">Temp units</td><td>Integer Value</td><td>Setting</td></tr>
<tr><td>0</td><td>C (Celsius)</td></tr>
<tr><td>1</td><td>F (Fahrenheit)</td></tr>
<tr><td>*Ph</td><td>Integer</td><td>10</td><td>pH live calibrated value
(pH x 100)</td><td colspan="2">For example
425 = 4.25 pH</td></tr>
<tr><td rowspan="5">PhMode</td><td rowspan="5">Integer</td><td rowspan="5">11</td><td rowspan="5">pH mode</td><td>Integer Value</td><td>Setting</td></tr>
<tr><td>0</td><td>Auto</td></tr>
<tr><td>1</td><td>Manual</td></tr>
<tr><td>2</td><td>Monitor</td></tr>
<tr><td>3</td><td>None</td></tr>
<tr><td>PhFilterTime</td><td>Integer</td><td>12</td><td colspan="3">pH average filter time in seconds</td></tr>
<tr><td>PhManual</td><td>Integer</td><td>13</td><td>pH manual value
(pH x 100)</td><td colspan="2">For example
425 = 4.25 pH</td></tr>
<tr><td>PhLow</td><td>Integer</td><td>14</td><td>pH low alarm value
(pH x 100)</td><td colspan="2">For example
425 = 4.25 pH</td></tr>
<tr><td>PhHigh</td><td>Integer</td><td>15</td><td>pH high alarm value
(pH x 100)</td><td colspan="2">For example
425 = 4.25 pH</td></tr>
<tr><td rowspan="5">**FlowDP</td><td rowspan="5">Hex</td><td rowspan="5">20</td><td rowspan="5">Flow decimal position</td><td>Hexadecimal Value</td><td>Float Scale Factor</td></tr>
<tr><td>0x50</td><td>x 1</td></tr>
<tr><td>0x31</td><td>x 10</td></tr>
<tr><td>0x22</td><td>x 100</td></tr>
<tr><td>0x13</td><td>x 1000</td></tr>
</table>

Flow	Integer	21	Flow live		
FlowSpan	Integer	22	Flow span		
FlowThreshold	Integer	23	Flow threshold for PO1Flow		
FlowMinCLC	Integer	24	Flow min to stop Resl in CLC mode		
FlowStop	Integer	25	Percent of FlowSpan below which stop		For example 10 = 10% of span
FlowLow	Integer	26	Flow low alarm value (0=Off)		
FlowUnits	Integer	27		*Integer Value*	*Setting*
				0	%
				1	GPM
				2	MGD
				3	LPM
				4	MLD
				5	GPD
				6	m^3/hour
FlowDosage	Integer	28	Flow dosage value (% x 100)		For example 125 = 1.25%
FlowFilterTime	Integer	29	Flow average filter time in seconds		
**Turb1DP	Hex	30	Turb1 decimal position	*Hexadecimal Value*	*Float Scale Factor*
				0x50	x 1
				0x31	x 10
				0x22	x 100
				0x13	x 1000
*Turb1	Integer	31	Turb1 live (turbidity)		
Turb1Mode	Integer	32	Turb1 mode	*Integer Value*	*Setting*
				0	Off
				1	On
Turb1Span	Integer	33	Turb1 span		
Turb1High	Integer	34	Turb1 high alarm value		
**Turb2DP	Hex	40	Turb2 decimal position	*Hexadecimal Value*	*Float Scale Factor*
				0x50	x 1
				0x31	x 10
				0x22	x 100
				0x13	x 1000
*Turb2	Integer	41	Turb2 live (turbidity)		
Turb2Mode	Integer	42	Turb2 mode	*Integer Value*	*Setting*
				0	Off
				1	On
Turb2Span	Integer	43	Turb2 span		
Turb2High	Integer	44	Turb2 high alarm value		
**ReslDP	Hex	50	Residual decimal position	*Hexadecimal Value*	*Float Scale Factor*
				0x50	x 1
				0x31	x 10
				0x22	x 100
				0x13	x 1000
*Resl	Integer	51	Residual final calibrated value		
ReslSetPoint	Integer	52	Residual set point for PID ctrl		
ReslLow	Integer	53	Residual low alarm value (0=Off)		
ReslHigh	Integer	54	Residual high alarm value		
ReslSpan	Integer	55	Residual span		
ReslMode	Integer	56	Residual sensor	*Integer Value*	*Setting*

			mode	0	mV cell
				1	4/20mA sensor
ReslUnits	Integer	57	Residual units	*Integer Value*	*Setting*
				0	PPM
				1	MG/L
ReslIntegral	Integer	58	Residual integral value (% x 10)	For example 225 = 22.5%	
ReslFilterTime	Integer	59	Residual average filter time in seconds		
**PO1DP	Hex	60	PO1 decimal position	*Hexadecimal Value*	*Float Scale Factor*
				0x50	x 1
				0x31	x 10
				0x22	x 100
				0x13	x 1000
PO1	Integer	61	PO1 final calibrated value		
PO1Manual	Integer	62	PO1 manual		
PO1Span	Integer	63	PO1 span		
PO1Units	Integer	64	PO1 units	*Integer Value*	*Setting*
				0	%
				1	PPD
				2	GR/H
				3	KG/H
				4	GPH
				5	GPM
				6	GPD
PO1GasType	Integer	65	PO1 gas type	*Integer Value*	*Setting*
				1	Cl_2
				-1	SO_2
AlarmStatus	Integer	70	Alarm status flag bits	*Flag Bit*	*Alarm Condition*
				b0	High Turbidity 1
				b1	High Turbidity 2
				b2	Turbid 1 Signal Loss
				b3	Turbid 2 Signal Loss
				b4	Low Flow
				b5	Flow Signal Loss
				b6	Data Log Error
				b7	Thermistor Failure
				b8	High Residual
				b9	Low Residual
				b10	Res/ORP Signal Loss
				b11	High pH
				b12	Low pH
				b13	I/O Node COM Error
AlarmMode	Integer	71	Alarm mode setting	*Integer Value*	*Setting*
				0	No Latch
				1	Latch
AlarmTime	Integer	72	Alarm delay time in seconds		
Relay1Mode	Integer	80	Relay mode setting	*Integer Value*	*Setting*
				0	Resl High Alarm
				1	Resl Low Alarm
				2	Turbid 1 High Alarm
				3	Turbid 2 High Alarm

				4	pH High/Low Alarm
				5	Any Alarm
Relay2Mode	Integer	81	Relay mode setting	*Integer Value*	*Setting*
				0	Resl High Alarm
				1	Resl Low Alarm
				2	Turbid 1 High Alarm
				3	Turbid 2 High Alarm
				4	pH High/Low Alarm
				5	Any Alarm
Relay3Mode	Integer	82	Relay mode setting	*Integer Value*	*Setting*
				0	Resl High Alarm
				1	Resl Low Alarm
				2	Turbid 1 High Alarm
				3	Turbid 2 High Alarm
				4	pH High/Low Alarm
				5	Any Alarm
Relay4Mode	Integer	83	Relay mode setting	*Integer Value*	*Setting*
				0	Resl High Alarm
				1	Resl Low Alarm
				2	Turbid 1 High Alarm
				3	Turbid 2 High Alarm
				4	pH High/Low Alarm
				5	Any Alarm
Relay1	Integer	84	Relay 1 state		
Relay2	Integer	85	Relay 2 state		
Relay3	Integer	86	Relay 3 state		
Relay4	Integer	87	Relay 4 state		
DataLogEnb	Integer	90	Data log enable		
DataLogTime	Integer	91	Data log time interval in seconds		
AO1Mode	Integer	100	AO1 mode setting	*Integer Value*	*Setting*
				0	Resl
				1	Temp
				2	pH
				3	Turb 1
				4	Turb 2
				5	PO1
AO2Mode	Integer	101	AO2 mode setting	*Integer Value*	*Setting*
				0	Resl
				1	Temp
				2	pH
				3	Turb 1
				4	Turb 2
				5	PO1
AO3Mode	Integer	102	AO3 mode setting	*Integer Value*	*Setting*
				0	Resl
				1	Temp
				2	pH
				3	Turb 1
				4	Turb 2
				5	PO1
AO4Mode	Integer	103	AO4 mode	*Integer Value*	*Setting*

			setting	0	Resl
				1	Temp
				2	pH
				3	Turb 1
				4	Turb 2
				5	PO1
RunMode	Integer	110	Run mode setting	*Integer Value*	*Setting*
				0	Auto
				1	Manual
CtrlMode	Integer	111	Control mode	*Integer Value*	*Setting*
				0	Off
				1	Flow
				2	Resl
				3	Compound

*****Values are read only and cannot be edited by the user.
******The decimal positions can be read but should not be written over Modbus since they can only be changed on the display.

Table 9. Modbus TH-4000 Turbidimeter
Variable Addresses, Register Values, and Features

Name	Type	Address	Description		
**Turb1DP	Hex	1	Turb1 decimal position	*Hexadecimal Value*	*Float Scale Factor*
				0x50	x 1
				0x31	x 10
				0x22	x 100
				0x13	x 1000
*Turb1	Integer	2	Turb1 live		
Turb1Mode	Integer	3	Turb1 mode (on or off)		
Turb1Span	Integer	4	Turb1 span level		
Turb1High	Integer	5	Turb1 high alarm level		
Turb1AvgTime	Integer	6	Turb1 average filter time in seconds		
**Turb2DP	Hex	11	Turb2 decimal position	*Hexadecimal Value*	*Float Scale Factor*
				0x50	x 1
				0x31	x 10
				0x22	x 100
				0x13	x 1000
*Turb2	Integer	12	Turb2 live		
Turb2Mode	Integer	13	Turb2 mode (on or off)		
Turb2Span	Integer	14	Turb2 span level		
Turb2High	Integer	15	Turb2 high alarm level		
Turb2AvgTime	Integer	16	Turb2 average filter time in seconds		
AlarmStatus	Integer	20	Alarm status flag bits	*Flag Bit*	*Alarm Condition*
				b0	High Turbidity 1
				b1	High Turbidity 2
				b2	Turbid 1 Signal Loss
				b3	Turbid 2 Signal Loss
				b4	Data Log Error
				b5	I/O Node COM Error
AlarmMode	Integer	21	Alarm mode setting	*Integer Value*	*Setting*

				0	No Latch
				1	Latch
AlarmTime	Integer	22	Alarm delay time in seconds (set by user)		
Relay1	Integer	30	Relay 1 state		
Relay2	Integer	31	Relay 2 state		
DataLogEnb	Integer	40	Data log enable		
DataLogTime	Integer	41	Data log time interval in seconds		

*Values are read only and cannot be edited by the user.
** The decimal positions can be read but should not be written over Modbus since they can only be changed on the display.

Table 10. Modbus GA-171 Gas Detector
Variable Addresses, Register Values, and Features

Name	Type	Address	Description			
*S1	Integer	1	S1 live (ppm x 10)	For example 32 = 3.2ppm		
S1Span	Integer	2	S1 span (ppm x 10)	For example 32 = 3.2ppm		
S1GasType	Integer	3	S1 gas type	*Integer Value*	*Setting*	
				0	Channel OFF	-
				1	NH_3	Ammonia
				2	O_2	Oxygen
				3	O_3	Ozone
				4	SO_2	Sulfur dioxide
				5	Cl_2	Chlorine
				6	ClO_2	Chlorine dioxide
				7	CO	Carbon monoxide
				8	H_2	Hydrogen
				9	H_2S	Hydrogen sulfide
S1AlarmMode	Integer	4	S1 alarm mode	*Integer Value*	*Setting*	
				0	No Latch	
				1	Latch	
S1HighLevel	Integer	5	S1 high alarm level (ppm x 10)	For example 32 = 3.2ppm		
S1AlarmTime	Integer	6	S1 alarm delay time in seconds			
S1FilterTime	Integer	7	S1 averaging filter time in seconds			
*S2	Integer	11	S2 live (ppm x 10)	For example 32 = 3.2ppm		
S2Span	Integer	12	S2 span (ppm x 10)	For example 32 = 3.2ppm		
S2GasType	Integer	13	S2 gas type	*Integer Value*	*Setting*	
				0	Channel OFF	-
				1	NH_3	Ammonia
				2	O_2	Oxygen
				3	O_3	Ozone
				4	SO_2	Sulfur dioxide
				5	Cl_2	Chlorine
				6	ClO_2	Chlorine dioxide
				7	CO	Carbon monoxide

				8	H_2	Hydrogen
				9	H_2S	Hydrogen sulfide

S2AlarmMode	Integer	14	S2 alarm mode	*Integer Value*	*Setting*
				0	No Latch
				1	Latch
S2HighLevel	Integer	15	S2 high alarm level (ppm x 10)	For example 32 = 3.2ppm	
S2AlarmTime	Integer	16	S2 alarm delay time in seconds		
S2FilterTime	Integer	17	S2 averaging filter time in seconds		
AlarmStatus	Integer	20	Alarm status flag bits	*Flag Bit*	*Alarm Condition*
				b0	S1 High Alarm
				b1	S2 High Alarm
				b2	S1 Loss Alarm
				b3	S2 Loss Alarm
				b4	I/O Node COM Error

***Values are read only and cannot be edited by the user.**

Table 11. Modbus HC-220 PID Controller Variable Addresses, Register Values, and Features

Name	Type	Address	Description		
**PV1DP	Hex	1	PV1 decimal position	*Hexadecimal Value*	*Float Scale Factor*
				0x50	x 1
				0x31	x 10
				0x22	x 100
				0x13	x 1000
PV1	Integer	2	PV1 live		
PV1Select	Integer	3	PV1 input selection (0=Modbus, 1=AI1, 2=AI2, 3=AI3, 4=AI4)		
PV1Name	Integer	4	PV1 name	*Integer Value*	*Setting*
				0	PV1
				1	H2O
				2	PRO
				3	FLO
PV1Units	Integer	5	PV1 units	*Integer Value*	*Setting*
				0	%
				1	GPM
				2	MGD
				3	LPM
				4	MLD
				5	GPD
				6	m^3/hour
PV1Dosage	Integer	6	PV1 dosage (dosage x 100)	For example 125 = 1.25	
PV1Span	Integer	7	PV1 span		
PV1MinCLC	Integer	8	PV1 flow min in compound loop control mode		
PV1Stop	Integer	9	PV1 percent of span below which	For example 3025 = 30.25%	

			stop (% x 100)		
PV1Threshold	Integer	10	PV1 threshold		
PV1FilterTime	Integer	11	PV1 averaging filter time in seconds		
PV1Low	Integer	12	PV1 low alarm level		
PV1VarLagTimeK1	Integer	13	PV1 Flow at variable lag time for PV1/PV2		
PV1VarLagTimeK2	Integer	14	PV1 Flow at variable lag time for PV3		
MaxLagTime1	Integer	15	PV1 max calculated lag time		
LagTimeK1	Integer	16	PV1 user set lag time		
MaxLagTime2	Integer	17	PV2 max calculated lag time		
LagTimeK2	Integer	18	PV2 user set lag time		
PV2DP	Integer	20	PV2 Decimal position		
PV2	Integer	21	PV2 live = residual		
PV2Select	Integer	22	PV2 input selection (0=Modbus, 1=AI1, 2=AI2, 3=AI3, 4=AI4)		
PV2Name	Integer	23	PV2 name	0 = PV2, 1=RES, 2 =ORP, 3=pH, 4=Ch1, 5=SCM, 6=TDS, 7=DO, 8=CON, 9=TUR	
PV2Units	Integer	24	PV1 units	*Integer Value*	*Setting*
				0	PPM
				1	MG/L
				2	mV
				3	pH
				4	NTU
				5	%
PV2SetPoint	Integer	25	PV2 set point for example 225 = 22.5%		
PV2Span	Integer	26	PV2 span		
PV2Zero	Integer	27	PV2 zero		
PV2FilterTime	Integer	28	PV2 averaging filter time in seconds		
PV2DeadBand	Integer	29	PV2 set point dead band		
PV2Integral	Integer	30	PV2 integral (% x 10)		
PV2Low	Integer	31	PV2 low alarm level		
PV2High	Integer	32	PV2 high alarm level		
PV2LagTimeMode	Integer	33	PV2 Lag time mode (0=fixed, 1=slope, 2=point)		
PV3	Integer	40	PV3 filtered and scaled		
PV3 Select	Integer	41	PV3 input selection (0=Modbus, 1=AI1, 2=AI2, 3=AI3, 4=AI4)		
PV3SetPoint	Integer	42	PV3 set point used when PV3Mode = 3		
PV3Span	Integer	43	PV3 span		
PV3Integral	Integer	44	PV3 integral (% x 10)		
PV3Mode	Integer	45	PV3 Mode (0=Flow, 1=Res, 2=CLC, 3=Feed forward)		
PV3LagTimeMode	Integer	46	PV3 Lag time mode (0=fixed, 1=slope, 2=point)		
PO1DP	Integer	60	PO1 decimal position		
PO1	Integer	61	PO1 live		
PO1Manual	Integer	62	PO1 value in manual mode		
PO1Units	Integer	63	PO1 units	0	%
				1	PPD

				2	GR/H
				3	KG/H
				4	GPH
				5	GPM
				6	GPD
				7	LPM
				8	LPH
PO1Span	Integer	64	PO1 Span		
PO1GasType	Integer	65	PO1 gas type	1	Cl_2
				0	SO_2
AlarmStatus	Integer	66	Alarm status flag bits	b1	PV1 low alarm
				b2	PV1 loss alarm
				b3	PV2 low alarm
				b4	PV2 loss alarm
				b5	PV2 high alarm
				B6	PV3 loss alarm
				B7	Node 1 comm error
				B8	Node 2 comm error
AlarmTime	Integer	67	Alarm delay time (secs) – delay time set by user		
CtrlMode	Integer	68	control mode	0	Flow
				1	Resl
				2	Compound
				3	Feed forward
RunMode	Integer	69	run mode	0	Auto
				1	Manual
PVxLoss	Integer	70	PV1/PV2 input loss action	0	Maintain Valve
				1	Close Valve

Table 12. Modbus WQM-100 Water Quality Monitor Variable Addresses, Register Values, and Features

Name	Type	Address	Description		
**FlowDP	Hex	20	Flow decimal position	*Hexadecimal Value*	*Float Scale Factor*
				0x50	x 1
				0x31	x 10
				0x22	x 100
				0x13	x 1000
Flow	Integer	21	Flow live		
FlowSpan	Integer	22	Flow span		
FlowThreshold	Integer	23	Flow threshold for PO1Flow		
FlowMinCLC	Integer	24	Flow min to stop Resl in CLC mode		
FlowStop	Integer	25	Percent of FlowSpan below which stop	For example 10 = 10% of span	
FlowLow	Integer	26	Flow low alarm value (0=Off)		
FlowUnits	Integer	27	*Integer Value*	*Setting*	
			0	%	
			1	GPM	
			2	MGD	

			3	LPM	
			4	MLD	
			5	GPD	
			6	m^3/hour	
FlowDosage	Integer	28	Flow dosage value (% x 100)	For example 125 = 1.25%	
FlowFilterTime	Integer	29	Flow average filter time in seconds		
Pb1PhInt	Integer	30	pH live calibrated value (pH x 100)	For example 725 = 7.25 pH	
Pb1Volts	Integer	31	mV live value	For example 535 = 53.5 mV	
Pb1CondInt	Integer	32	Cond Live Calibrated Value	For example 3035 = 30.35 mS/cm	
Pb1ProbeType	Integer	33	Probe Type	*Integer Value*	*Setting*
				0	*Off*
				1	*pH*
				2	*ORP*
				3	*Conductivity*
Pb1FilterTime	Integer	34	pH average filter time in seconds		
Pb1Low	Integer	35	pH low alarm value (pH x 100)	For example 425 = 4.25 pH	
Pb1High	Integer	36	pH high alarm value (pH x 100)	For example 925 = 9.25 pH	
Pb2PhInt	Integer	40	pH live calibrated value (pH x 100)	For example 725 = 7.25 pH	
Pb2Volts	Integer	41	mV live value	For example 535 = 53.5 mV	
Pb2CondInt	Integer	42	Cond Live Calibrated Value	For example 3035 = 30.35 mS/cm	
Pb2ProbeType	Integer	43	Probe Type	*Integer Value*	*Setting*
				0	*Off*
				1	*pH*
				2	*ORP*
				3	*Conductivity*
Pb2FilterTime	Integer	44	pH average filter time in seconds		
Pb2Low	Integer	45	pH low alarm value (pH x 100)	For example 425 = 4.25 pH	
Pb2High	Integer	46	pH high alarm value (pH x 100)	For example 925 = 9.25 pH	
Pb3PhInt	Integer	50	pH live calibrated value (pH x 100)	For example 725 = 7.25 pH	
Pb3Volts	Integer	51	mV live value	For example 535 = 53.5 mV	
Pb3CondInt	Integer	52	Cond Live Calibrated Value	For example 3035 = 30.35 mS/cm	
Pb3ProbeType	Integer	53	Probe Type	*Integer Value*	*Setting*

				0	*Off*
				1	*pH*
				2	*ORP*
				3	*Conductivity*
Pb3FilterTime	Integer	54	pH average filter time in seconds		
Pb3Low	Integer	55	pH low alarm value (pH x 100)	For example 425 = 4.25 pH	
Pb3High	Integer	56	pH high alarm value (pH x 100)	For example 925 = 9.25 pH	
Pb4PhInt	Integer	60	pH live calibrated value (pH x 100)	For example 725 = 7.25 pH	
Pb4Volts	Integer	61	mV live value	For example 535 = 53.5 mV	
Pb4CondInt	Integer	62	Cond Live Calibrated Value	For example 3035 = 30.35 mS/cm	
Pb4ProbeType	Integer	63	Probe Type	*Integer Value*	*Setting*
				0	*Off*
				1	*pH*
				2	*ORP*
				3	*Conductivity*
Pb4FilterTime	Integer	64	pH average filter time in seconds		
Pb4Low	Integer	65	pH low alarm value (pH x 100)	For example 425 = 4.25 pH	
Pb4High	Integer	66	pH high alarm value (pH x 100)	For example 925 = 9.25 pH	
Temp	Integer	70	Temperature (Kelvin x 10)	For example 2555 = 255.5K, display still shows C or F	
Temp Node	Integer	71	Temp active sensor node number (where to read T)	1, 2, 3, or 4	
TempMode	Integer	72	Temp mode	*Integer Value*	*Setting*
				0	Auto
				1	Manual
TempUnits	Integer	73	Temp units	*Integer Value*	*Setting*
				0	C (Celsius)
				1	F (Fahrenheit)
PO1	Integer	90	PO1 final calibrated value		
PO1Span	Integer	91	PO1 span	Full scale value for display	
PO1Units	Integer	92	PO1 units	% etc…	
PO1RunMode	Integer	93	Run Mode	*Integer Value*	*Setting*
				0	Manual
				1	Auto
PO1Manual	Integer	94	Manual Value	User adjustable	
PIDCtrlMode	Integer	95	PID Control mode	Integer Value	Setting

				0	Off
				1	Flow
				2	Set Point
				3	Compound Loop
PIDChannel	Integer	96	PID set point based on which channel	Select 1, 2, 3, or 4	
PIDSetPoint	Integer	97	PID Set Point	User selected value	
PIDDeadBand	Integer	98	PID Dead Band	User selected value	
PIDIntegral	Integer	99	PID Integral Value	Ex. 200 = 20.0 %	
AO1Mode	Integer	100	AO1 Mode	0=PO1, 1=Probe 1, 2=Probe 2, 3=Probe 3, 4=Probe 4, 5=Temp	
AO2Mode	Integer	101	AO2 Mode		
AO3Mode	Integer	102	AO3 Mode		
AO4Mode	Integer	103	AO4 Mode		
AlarmStatus	Integer	104	Alarm Status	b0:DataLogAlm, b1:Pb1LowAlm, b2:Pb1HighAlm, b3:Pb2LowAlm, b4:Pb2HighAlm, b5:Pb3LowAlm,b6:Pb3HighAlm, b7:Pb4LowAlm,b8:Pb4HighAlm, b9:TempAlm, b10:FlowLowAlm, b11:FlowLossAlm, b12:ComError	
AlarmMode	Integer	105	Alarm Mode	0=nonlatching, 1 = latching	
Relay1Mode	Integer	110	Relay 1 mode	0=Ch1 Low, 1=Ch1 High, 2=Ch2 Low, 3=Ch2 High, 4=Ch3 Low, 5=Ch3 High, 6=Ch4 Low, 7=Ch4 High, 8=Flow Low, 9=Any Alarm	
Relay2Mode	Integer	111	Relay 2 mode		
Relay3Mode	Integer	112	Relay 3 mode		
Relay4Mode	Integer	113	Relay 4 mode		
Relay1	Integer	114	Relay 1 State	0 = OFF, 1 = ON	
Relay2	Integer	115	Relay 2 State		
Relay3	Integer	116	Relay 3 State		
Relay4	Integer	117	Relay 4 State		

Table 13. Modbus RPH-260 Residual Analyzer
Variable Addresses, Register Values, and Features

Name	Type	Address	Description
Res1DP	Integer	10	Resl 1 decimal position
Res1	Integer	11	Resl 1 final calibrated value
Res1Low	Integer	12	Resl 1 low alarm value (0=off)
Resl1High	Integer	13	Resl 1 High Alarm value
Resl1FlowStopEnb	Integer	14	Resl 1 sample water flow stop alarm enable
Res1Span	Integer	15	Resl 1 span
Resl1Units	Integer	16	Resl 1 engineering units (0=PPM, 1=mg/l)
Resl1FilterTime	Integer	17	Resl 1 Avg filter time (seconds)
Resl1ProbeType	Integer	18	Resl 1 probe type (0=off, 1=F1, 2=F2, 3=T1, 4=F3)
Resl1pHProbe	Integer	19	Resl 1 pH probe used for compensation (1 or 2)

Resl1FlowStop	Integer	92	Resl 1 sample water flow (0=ok, 1=stopped)		
Res2DP	Integer	20	Resl 2 decimal position		
Res2	Integer	21	Resl 2 final calibrated value		
Res2Low	Integer	22	Resl 2 low alarm value (0=off)		
Resl2High	Integer	23	Resl 2 High Alarm value		
Resl2FlowStopEnb	Integer	24	Resl 2 sample water flow stop alarm enable		
Res2Span	Integer	25	Resl 2 span		
Resl2Units	Integer	26	Resl 2 engineering units (0=PPM, 1=mg/l)		
Resl2FilterTime	Integer	27	Resl 2 Avg filter time (seconds)		
Resl2ProbeType	Integer	28	Resl 2 probe type (0=off, 1=F1, 2=F2, 3=T1, 4=F3)		
Resl2pHProbe	Integer	29	Resl 2 pH probe used for compensation (1 or 2)		
Resl2FlowStop	Integer	93	Resl 2 sample water flow (0=ok, 1=stopped)		
Ph1PhInt	Integer	30	pH 1 live calibrated value (pH x 100)	For example 725 = 7.25 pH	
Ph1ProbeType	Integer	31	Probe 1 Type	*Integer Value*	*Setting*
				0	*Off*
				1	*pH*
				2	*ORP*
pH1CompMode	Integer	32	pH 1 Comp mode	0=off, 1=auto, 2=manual	
PH1FilterTime	Integer	33	pH 1 average filter time in seconds		
pH1Manual	Integer	34	pH 1 manual value		
pH1Low	Integer	35	pH 1 low alarm value		
pH1High	Integer	36	pH 1 High Alarm Value		
Ph2PhInt	Integer	40	pH 2 live calibrated value (pH x 100)	For example 725 = 7.25 pH	
Ph2ProbeType	Integer	41	Probe 2 Type	*Integer Value*	*Setting*
				0	*Off*
				1	*pH*
				2	*ORP*
pH2CompMode	Integer	42	pH 2 Comp mode	0=off, 1=auto, 2=manual	
PH2FilterTime	Integer	43	pH 2 average filter time in seconds		
pH2Manual	Integer	44	pH 2 manual value		
pH2Low	Integer	45	pH 2 low alarm value		
pH2High	Integer	46	pH 2 High Alarm Value		
Temp1Show	Integer	50	Temperature 1 (Kelvin x 10)	For example 2555 = 255.5K, display still shows C or F	
Temp1Mode	Integer	51	Temp 1 mode	*Integer Value*	*Setting*
				0	Off
				1	Auto
				2	Manual
Temp1Units	Integer	52	Temp 1 units	*Integer Value*	*Setting*

				0	C (Celsius)
				1	F (Fahrenheit)
Temp2Show	Integer	53	Temperature 2 (Kelvin x 10)		For example 2555 = 255.5K, display still shows C or F
Temp2Mode	Integer	54	Temp 2 mode	*Integer Value*	*Setting*
				0	Off
				1	Auto
				2	Manual
Temp2Units	Integer	55	Temp 2 units	*Integer Value*	*Setting*
				0	C (Celsius)
				1	F (Fahrenheit)
AO1Mode	Integer	60	AO1 Mode	0=Res1, 1=Res2, 2=pH/ORP1, 3=pH/ORP2, 4=Temp1, 5=Temp2, 6=Cond, 7=Press, 8=PO1, 9=PO2	
AO2Mode	Integer	61	AO2 Mode		
AO3Mode	Integer	62	AO3 Mode		
AO4Mode	Integer	63	AO4 Mode		
AlarmStatus	Integer	70	alarm status flag bits (b0:DataLogAlm, b1:Res1LowAlm, b2:Res1HighAlm, b3:Res1LossAlm, b4:Res2LowAlm, b5:Res2HighAlm, b6:Res2LossAlm, b7:pH1LowAlm, b8:pH1HighAlm, b9:pH2LowAlm, b10:pH2HighAlm, b11:Temp1Alm, b12:Temp2Alm, b13:Res1FlowStopAlm, b14:Res2FlowStopAlm, b15:CondHighAlm, b16:CondLowAlm, b17:PressHighAlm, b18:PressLowAlm, b19:PressLossAlm, b20:ComErrorAlm)		
AlarmMode	Integer	71	Alarm Mode	0=nonlatching, 1 = latching	
AlarmTime	Integer	72	Alarm Delay Time	seconds	
Relay1Mode	Integer	80	Relay 1 mode	0=Res 1 Low Alm, 1=Res 1 High Alm, 2=Res 2 Low Alm, 3=Res 2 High Alm, 4=pH/ORP 1 Alarm, 5=pH/ORP 2 Alarm, 6=Any Alarm, 7=Flow 1 Stop Alarm, 8=Flow 2 Stop Alarm, 9=Cond Low Alm, 10=Cond High Alm, 11=Press Low Alm, 12=Press High Alm	
Relay2Mode	Integer	81	Relay 2 mode		
Relay3Mode	Integer	82	Relay 3 mode		
Relay4Mode	Integer	83	Relay 4 mode		
Relay1	Integer	84	Relay 1 State	0 = OFF, 1 = ON	
Relay2	Integer	85	Relay 2 State		
Relay3	Integer	86	Relay 3 State		
Relay4	Integer	87	Relay 4 State		
DataLogEnb	Integer	90	Data Log Enable	0=off, 1=enable	
DataLogTime	Integer	91	Data Log Time Interval	Seconds	
CondEnb	Integer	100	Conductivity Enable		
Cond	Integer	101	Conductivity Live	(mS x 100, ex. 125 = 1.25mS)	
CondLow	Integer	102	Conductivity Low alarm value		
CondHigh	Integer	103	Conductivity high alarm value		

PressEnb	Integer	110	Pressure enable	
Press	Integer	111	Pressure live	(0x30 = psi, 0x21=bar)
PressMa	Integer	112	Pressure live	(mA x 100, ex. 425 = 4.25mA)
PressSpan	Integer	113	Pressure Span	
PressLow	Integer	114	Pressure low alarm value	
PressHigh	Integer	115	Pressure high alarm value	
PressUnits	Integer	116	Pressure units	(0=psi, 1=bar)
FlowDP	Integer	120	Flow decimal position	
Flow	Integer	121	Flow Live	
Flow Span	Integer	122	Flow Span	
Flow Threshold	Integer	123	Flow threshold for PO1Flow	
FlowMinCLC	Integer	124	Flow min to stop the Resl in CLC mode	
FlowStop	Integer	125	Flow percent of FlowSpan below which stop	
Flow Low	Integer	126	Flow low alarm value (0=off)	
Flow Units	Integer	127	Flow engineering units (0=%, 1=GPM, 2=MGD, 3=LPM, 4=MLD, 5=GPD, 6=M3/H)	
Flow Dosage	Integer	128	Flow dosage value (%)	
Flow Filter Time	Integer	129	Flow filter time (seconds)	
PID1CtrlMode	Integer	130	PID1 Ctrl mode (0=Off, 1=Flow, 2=SP, 3=Compound)	
PID1Channel	Integer	131	PID1 Channel (0=Residual, 1=pH1, 2=ORP1, 3=Cond)	
PID1SetPOint	Integer	132	PID1 set point (Res or pH or ORP or Cond)	
PID1DeadBand	Integer	133	PID1 dead band (Res, pH, ORP, or Cond)	
PID1 Integral	Integer	134	PID1 integral value (%)	
PID2CtrlMode	Integer	135	PID2 Ctrl mode (0=Off, 1=Flow, 2=SP, 3=Compound)	
PID2Channel	Integer	136	PID2 Channel (0=Residual, 1=pH1, 2=ORP1, 3=Cond)	
PID2SetPOint	Integer	137	PID2 set point (Res or pH or ORP or Cond)	
PID2DeadBand	Integer	138	PID2 dead band (Res, pH, ORP, or Cond)	
PID2 Integral	Integer	139	PID2 integral value (%)	
PO1	Integral	140	PO1 final calibrated value	
PO1Span	Integral	141	PO1 span	
PO1Units	Integral	142	PO1 engineering units (0=%, 1=PPD, 2= GR/h, 3=KG/H, 4=GPH, 5=GPM, 6=GPD)	
PO1Run Mode	Integral	143	PO1 run mode (1=Auto, 2=Manual)	
PO1Manual	Integral	144	PO1 Manual value	
PO2	Integral	150	PO2 final calibrated value	
PO2Span	Integral	151	PO2 span	
PO2Units	Integral	152	PO2 engineering units (0=%, 1=PPD, 2= GR/h, 3=KG/H, 4=GPH, 5=GPM, 6=GPD)	
PO2Run Mode	Integral	153	PO2 run mode (1=Auto, 2=Manual)	
PO2Manual	Integral	154	PO2 Manual value	

Table 14. Modbus RAH-280 Residual Analyzer Variable Addresses, Register Values, and Features

Name	Type	Address	Description		
**FlowDP	Hex	20	Flow decimal position	*Hexadecimal Value*	*Float Scale Factor*
				0x50	x 1
				0x31	x 10
				0x22	x 100
				0x13	x 1000
Flow	Integer	21	Flow live		
FlowSpan	Integer	22	Flow span		
FlowThreshold	Integer	23	Flow threshold for PO1Flow		
FlowMinCLC	Integer	24	Flow min to stop Resl in CLC mode		
FlowStop	Integer	25	Percent of FlowSpan below which stop	For example 10 = 10% of span	
FlowLow	Integer	26	Flow low alarm value (0=Off)		
FlowUnits	Integer	27	*Integer Value*	*Setting*	
			0	%	
			1	GPM	
			2	MGD	
			3	LPM	
			4	MLD	
			5	GPD	
			6	m^3/hour	
FlowDosage	Integer	28	Flow dosage value (% x 100)	For example 125 = 1.25%	
FlowFilterTime	Integer	29	Flow average filter time in seconds		
ReslDP	Integer	30	Resl decimal position		
Resl	Integer	31	Resl final calibrated value		
ReslLow	Integer	32	Resl low alarm value (0=off)		
ReslHigh	Integer	33	Resl high alarm value (0=off)		
ReslFlowStop	Integer	34	Resl sample water flow (0=ok, 1=stopped)		
ReslSpan	Integer	35	Resl span		
ReslUnits	Integer	36	Resl engineering units (0=PPM, 1=MG/L)		
ReslFilterTime	Integer	37	Resl filter time (seconds)		
PhInt	Integer	40	pH live calibrated value (pH x 100)	For example 725 = 7.25 pH	
PhMode	Integer	41	pH mode (0=off, 1=auto, 2=manual, 3=monitor)		
pHFilterTime	Integer	42	pH average filter time in seconds		
pHManual	Integer	43	Manual value		
Pb1Low	Integer	44	pH low alarm value (pH x 100)	For example 425 = 4.25 pH	
Pb1High	Integer	45	pH high alarm value (pH x 100)	For example 925 = 9.25 pH	
OrpEnb	Integer	50	ORP enable		
ORPVolts	Integer	51	ORP live value (mV)		

ORPFilterTime	Integer	52	ORP filter time working	seconds	
ORPLow	Integer	53	ORP Low Alarm Value		
ORPHigh	Integer	54	ORP High Alarm Value		
CondEnb	Integer	60	Conductivity enable		
COndInt	Integer	61	Conductivity live calibrated value in mS		
CondLow	Integer	63	Conductivity Low Alarm Value		
CondHigh	Integer	64	Conductivity High Alarm Value		
Temp	Integer	70	Temperature (Kelvin x 10)	For example 2555 = 255.5K, display still shows C or F	
Temp Node	Integer	71	Temp active sensor node number (where to read T)	1, 2, 3, or 4	
TempMode	Integer	72	Temp mode	*Integer Value*	*Setting*
				0	Auto
				1	Manual
TempUnits	Integer	73	Temp units	*Integer Value*	*Setting*
				0	C (Celsius)
				1	F (Fahrenheit)
PO1	Integer	90	PO1 final calibrated value		
PO1Span	Integer	91	PO1 span	Full scale value for display	
PO1Units	Integer	92	PO1 units	% etc…	
PO1RunMode	Integer	93	Run Mode	*Integer Value*	*Setting*
				0	Manual
				1	Auto
PO1Manual	Integer	94	Manual Value	User adjustable	
PIDCtrlMode	Integer	95	PID Control mode	Integer Value	Setting
				0	Off
				1	Flow
				2	Set Point
				3	Compound
PIDChannel	Integer	96	PID set point based on which channel	Select 1, 2, 3, or 4	
PIDSetPoint	Integer	97	PID Set Point	User selected value	
PIDDeadBand	Integer	98	PID Dead Band	User selected value	
PIDIntegral	Integer	99	PID Integral Value	Ex. 200 = 20.0 %	
AO1Mode	Integer	100	AO1 Mode	0=PO1, 1=Resl, 2=pH, 3=ORP, 4=Cond, 5=Temp	
AO2Mode	Integer	101	AO2 Mode		
AO3Mode	Integer	102	AO3 Mode		
AO4Mode	Integer	103	AO4 Mode		
AlarmStatus	Integer	104	Alarm Status	b0:DataLogAlm, b1:ReslLowAlm, b2:ReslHighAlm, b3:PHLowAlm, b4:PHHighAlm, b5:ORPLowAlm,b6:ORPHighAlm,	

				b7:CondLowAlm,b8:CondHighAlm, b9:FlowLowalm, b10:FlowLossAlm, b11:TempAlm, b12:FlowStopAlm, b13:ComError
AlarmMode	Integer	105	Alarm Mode	0=nonlatching, 1 = latching
Relay1Mode	Integer	110	Relay 1 mode	0=Ch1 Low, 1=Ch1 High, 2=Ch2 Low, 3=Ch2 High, 4=Ch3 Low, 5=Ch3 High, 6=Ch4 Low, 7=Ch4 High, 8=Flow Low, 9=Any Alarm
Relay2Mode	Integer	111	Relay 2 mode	
Relay3Mode	Integer	112	Relay 3 mode	
Relay4Mode	Integer	113	Relay 4 mode	
Relay1	Integer	114	Relay 1 State	0 = OFF, 1 = ON
Relay2	Integer	115	Relay 2 State	
Relay3	Integer	116	Relay 3 State	
Relay4	Integer	117	Relay 4 State	

VI. Troubleshooting

Consider the following points if having difficulty establishing communication:

1.) The master can request several addresses in one packet request, but the addresses have to be sequential.

2.) When the master requests data the slave node may not respond instantly because its running the program loop.
   a. The SCADA has a parameter that can be set which is how long to wait for a response.
   b. Another parameter is the polling interval- how often does the SCADA request data. If its too fast the slave node may not be ready.
   c. You could try to increase those times and also only request 1 address in the packet from one of the addresses which is not working to see if the address can be read properly.

3.) Another issue is that there is very specific timing required for Modbus regarding the data packet and the interval timing between packets which nodes on the network use to determine when a packet ends and when a new packet begins.
   a. Windows and Linux are not real time operating systems. So there is no way to ensure this timing in a Windows or Linux application program.
   b. The solution is the interface hardware between the computer and the RS-485 network must handle this timing.
   c. Good SCADA software accounts for this. Keep this in mind.