hydro INSTRUMENTS

Modbus Installation and Instruction Manual

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Table of Contents

I. Background 2

II. Definitions 2

III. Support Types & Address Data Format 3

IV. Programming Equipment Onto the Network 4

1. Programming Omni-Valves (OV-110 and OV-1000) 4
2. Programing Vaporizers (VPH-10000) 5
3. Programming Gas Detectors (GA-180) 5
4. Programming Automatic Changeover Controller (CS-110) 6
5. Programming Residual Analyzers (RAH-210 and RPH-250) 6
6. Programming Turbidimeter, Gas Detector, and PID Controller (TH-4000, GA-171, and HC-220) 7

V. Programming Masters 7

TABLES 3-20

Table 1. Data Formats and Baud Rates Supported by Hydro Instruments 3
Table 2. Wiring connections for Modbus RTU 3
Table 3. Description of Function Codes for Hydro Instruments Equipment 7
Table 4. Modbus OV-110 and OV-1000 Omni-valve 8-9
Table 5. Modbus VPH-10000 Vaporizer 9
Table 6. Modbus GA-180 Gas Detector 10-11
Table 7. Modbus CS-110 Automatic Changeover Controller 12
Table 8. Modbus RAH-210 and RPH-250 Residual Analyzers 12-16
Table 9. Modbus TH-4000 Turbidimeter 16-17
Table 10. Modbus GA-171 Gas Detector 17-18
Table 11. Modbus HC-220 PID Controller 18-20

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 and RPH-250 Residual Analyzers

Programming the RAH-210 and RPH-250 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 RAH-210 / RPH-250 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

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

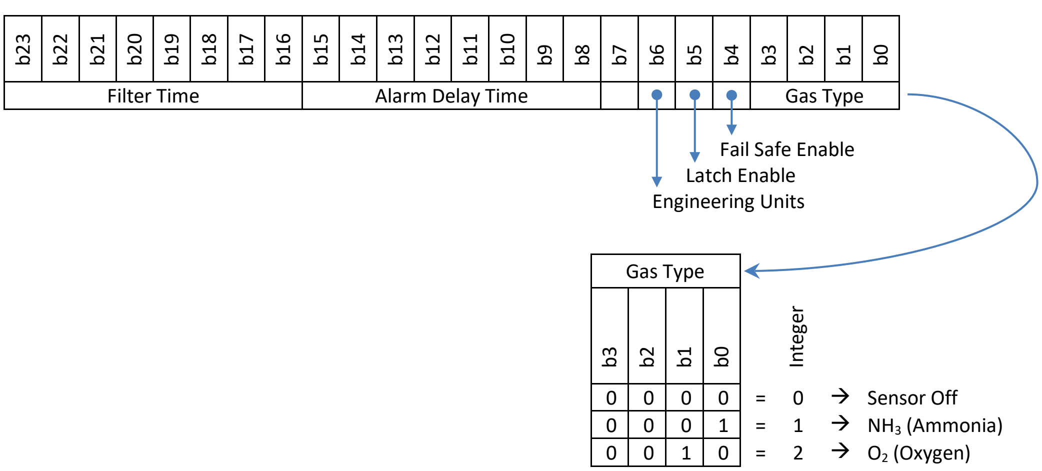
Name	Type	Address	Register Value	Feature
*Gas Temperature	Integer	1		
*Gas Pressure	Integer	2		
Gas Pressure Span	Integer	3		
High Pressure Alarm Level	Integer	4		
*Superheat Temperature	Integer	5		
Superheat Alarm Set Point	Integer	6		
*Control Water Temperature	Integer	7		
Water Temperature Set Point	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	



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)

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 Integers	81 through 96	Array holds all 16 sensor high alarm values	For example 20 = 2.0ppm	
*Temperature	Integer	97	Live temperature from thermocouple (C or F)	For example 75 = 75F	
*TempStatus	Integer	98	Temperature status	*Integer Value*	*Status*
				0	Normal
				1	High Temp
				2	Error
TempSetup	Integer Bit Field	99, 100, 101	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)		

b16	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Temp Units	Alarm Delay Time								High Alarm Temp							

RemoteAck	Integer	102	Remote acknowledge	Set to 1 to remote acknowledge alarm	
*AnyLowAlarm	Integer	103	Indicates any sensor low alarm	*Integer Value*	*Status*
				0	No Alarm
				1	Any Alarm
*AnyHighAlarm	Integer	104	Indicates any sensor high alarm	*Integer Value*	*Status*
				0	No Alarm
				1	Any Alarm
*AnyFailAlarm	Integer	105	Indicates any sensor fail alarm	*Integer Value*	*Status*
				0	No Alarm
				1	Any Alarm

*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

Name	Type	Address	Description		
*V1State	Integer	1	*Integer Value*		*State*
			0		Off
			1		On
			2		Empty
V1RunMins	Integer	2	Run time in minutes		
*V1Scale	Float	3,4	Scale reading (e.g., 868 kg)		
V1ScaleSpan	Float	5,6	Scale span value (e.g., 1,000 kg)		
*V2State	Integer	11	*Integer Value*		*State*
			0		Off
			1		On
			2		Empty
V2RunMins	Integer	12	Run time in minutes		
*V2Scale	Float	13,14	Scale reading (e.g., 868 kg)		
V2ScaleSpan	Float	15,16	Scale span value (e.g., 1,000 kg)		
ScaleUnits (Enable / Scale Units)	Integer	20	*Integer Value*		*Setting*
			0		Off
			1		Kg (kilograms)
			2		Pd (pounds)
OnDelayTime	Integer	21	Valve turn on delay time in seconds		
RemoteAck	Integer	22	Remote acknowledge		Set to 1 to remote acknowledge alarm
***RemoteCtrl	Integer	23	Remote control for valves	*Integer Value*	*Behavior*
				0	Turn OFF both valves
				1	Turn ON valve 1
				2	Turn ON valve 2

*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

Name	Type	Address	Description		
*Temp	Integer	1	Temperature live displayed (C or F)		For example 74 = 74F
TempManual	Integer	2	Temp manual (Kelvin x 10)		For example 2555 = 255.5K, display still shows C or F
TempMode	Integer	3	Temp mode	*Integer Value*	*Setting*
				0	Auto
				1	Manual
TempUnits	Integer	4	Temp units	*Integer Value*	*Setting*
				0	C (Celsius)
				1	F (Fahrenheit)

*Ph	Integer	10	pH live calibrated value (pH x 100)	For example 425 = 4.25 pH	
PhMode	Integer	11	pH mode	*Integer Value*	*Setting*
				0	Auto
				1	Manual
				2	Monitor
				3	None
PhFilterTime	Integer	12	pH average filter time in seconds		
PhManual	Integer	13	pH manual value (pH x 100)	For example 425 = 4.25 pH	
PhLow	Integer	14	pH low alarm value (pH x 100)	For example 425 = 4.25 pH	
PhHigh	Integer	15	pH high alarm value (pH x 100)	For example 425 = 4.25 pH	
**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		
**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		
**ResIDP	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 mode	*Integer Value*	*Setting*
				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 setting	*Integer Value*	*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		
				Hexadecimal Value	*Float Scale Factor*
				0x50	x 1
**Turb2DP	Hex	11	Turb2 decimal position	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		
				Flag Bit	*Alarm Condition*
				b0	High Turbidity 1
				b1	High Turbidity 2
AlarmStatus	Integer	20	Alarm status flag bits	b2	Turbid 1 Signal Loss
				b3	Turbid 2 Signal Loss
				b4	Data Log Error
				b5	I/O Node COM Error
				Integer Value	*Setting*
AlarmMode	Integer	21	Alarm mode 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		

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****** 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	
				Integer Value	*Setting*	
				0	Channel OFF	-
				1	NH_3	Ammonia
				2	O_2	Oxygen
				3	O_3	Ozone
S1GasType	Integer	3	S1 gas type	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		
PV1Span	Integer	3	PV1 span		
PV1Low	Integer	4	PV1 low alarm level		
PV1MinCLC	Integer	5	PV1 flow min in compound loop control mode		

<table>
<tr><td>PV1Threshold</td><td>Integer</td><td>6</td><td colspan="3">PV1 threshold</td></tr>
<tr><td>PV1VarLagTimeK</td><td>Integer</td><td>7</td><td colspan="3">PV1 flow used for variable lag time</td></tr>
<tr><td>PV1Stop</td><td>Integer</td><td>8</td><td colspan="2">PV1 percent of span below which stop (% x 100)</td><td>For example 3025 = 30.25%</td></tr>
<tr><td>PV1Dosage</td><td>Integer</td><td>9</td><td colspan="2">PV1 dosage (dosage x 100)</td><td>For example 125 = 1.25</td></tr>
<tr><td rowspan="5">PV1Name</td><td rowspan="5">Integer</td><td rowspan="5">10</td><td rowspan="5">PV1 name</td><td>Integer Value</td><td>Setting</td></tr>
<tr><td>0</td><td>PV1</td></tr>
<tr><td>1</td><td>H2O</td></tr>
<tr><td>2</td><td>PRO</td></tr>
<tr><td>3</td><td>FLO</td></tr>
<tr><td rowspan="8">PV1Units</td><td rowspan="8">Integer</td><td rowspan="8">11</td><td rowspan="8">PV1 units</td><td>Integer Value</td><td>Setting</td></tr>
<tr><td>0</td><td>%</td></tr>
<tr><td>1</td><td>GPM</td></tr>
<tr><td>2</td><td>MGD</td></tr>
<tr><td>3</td><td>LPM</td></tr>
<tr><td>4</td><td>MLD</td></tr>
<tr><td>5</td><td>GPD</td></tr>
<tr><td>6</td><td>m^3/hour</td></tr>
<tr><td>PV1FilterTime</td><td>Integer</td><td>12</td><td colspan="3">PV1 averaging filter time in seconds</td></tr>
<tr><td rowspan="5">**PV2DP</td><td rowspan="5">Hex</td><td rowspan="5">21</td><td rowspan="5">PV2 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>
<tr><td>PV2</td><td>Integer</td><td>22</td><td colspan="3">PV2 live</td></tr>
<tr><td>PV2DeadBand</td><td>Integer</td><td>23</td><td colspan="3">PV2 set point dead band</td></tr>
<tr><td>PV2Zero</td><td>Integer</td><td>24</td><td colspan="3">PV2 zero</td></tr>
<tr><td>PV2Span</td><td>Integer</td><td>25</td><td colspan="3">PV2 span</td></tr>
<tr><td>PV2Low</td><td>Integer</td><td>26</td><td colspan="3">PV2 low alarm level</td></tr>
<tr><td>PV2High</td><td>Integer</td><td>27</td><td colspan="3">PV2 high alarm level</td></tr>
<tr><td>PV2SetPoint</td><td>Integer</td><td>28</td><td colspan="3">PV2 set point</td></tr>
<tr><td>PV2Integral</td><td>Integer</td><td>29</td><td colspan="2">PV2 integral (% x 10)</td><td>For example 225 = 22.5%</td></tr>
<tr><td rowspan="6">PV2Name</td><td rowspan="6">Integer</td><td rowspan="6">30</td><td rowspan="6">PV2 name</td><td>Integer Value</td><td>Setting</td></tr>
<tr><td>0</td><td>PV2</td></tr>
<tr><td>1</td><td>RES</td></tr>
<tr><td>2</td><td>ORP</td></tr>
<tr><td>3</td><td>pH</td></tr>
<tr><td>4</td><td>Cl_2</td></tr>
<tr><td rowspan="6">PV2Units</td><td rowspan="6">Integer</td><td rowspan="6">31</td><td rowspan="6">PV2 units</td><td>Integer Value</td><td>Setting</td></tr>
<tr><td>0</td><td>PPM</td></tr>
<tr><td>1</td><td>MG/L</td></tr>
<tr><td>2</td><td>mV</td></tr>
<tr><td>3</td><td>pH</td></tr>
<tr><td>4</td><td>GPD</td></tr>
<tr><td>PV2FilterTime</td><td>Integer</td><td>32</td><td colspan="3">PV2 averaging filter time in seconds</td></tr>
<tr><td rowspan="3">**PO1DP</td><td rowspan="3">Hex</td><td rowspan="3">41</td><td rowspan="3">PO1DP 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>
</table>

				0x22	x 100
				0x13	x 1000
*PO1	Integer	42	PO1 live in auto mode		
PO1Manual	Integer	43	PO1 value in manual mode		
PO1Span	Integer	44	PO1 span		
PO1Units	Integer	45	PO1 units	*Integer Value*	*Setting*
				0	%
				1	PPD
				2	GR/H
				3	KG/H
				4	GPH
				5	GPM
				6	GPD
PO1GasType	Integer	46	PO1 gas type	*Integer Value*	*Setting*
				0	Cl_2
				1	SO_2
LagTimeK	Integer	51	Lag time fixed constant (secs)		
LagTimeMax	Integer	52	Lag time maximum in variable lag time mode (secs)		
VarLagTimeEnb	Integer	53	Variable lag time enable	*Integer Value*	*Setting*
				0	Off
				1	On
CtrlMode	Integer	54	control mode	*Integer Value*	*Setting*
				0	Flow
				1	Resl
				2	Compound
RunMode	Integer	55	run mode	*Integer Value*	*Setting*
				0	Auto
				1	Manual
PVxLoss	Integer	56	PV1/PV2 input loss action	*Integer Value*	*Setting*
				0	Maintain Valve
				1	Close Valve
AlarmTime	Integer	57	Alarm delay time (secs)		
AlarmStatus	Integer	58	Alarm status flag bits	*Flag Bit*	*Alarm Condition*
				b0	PV1 low alarm
				b1	PV1 loss alarm
				b2	PV2 low alarm
				b3	PV2 loss alarm
				b4	PV2 high alarm
				b5	I/O Node COM Error

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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.