

AUTOMATION

PRODUCTS
GROUP, INC.

Operator's Manual

PT-500

Modbus Series

Submersible Pressure Sensor

Doc 900xxxx

Rev. A 5/13



Automation Products Group, Inc.

APG...Providing tailored solutions for measurement applications

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•Warranty and Warranty Restrictions

APG warrants its products to be free from defects of material and workmanship and will, without charge, replace or repair any equipment found defective upon inspection at its factory, provided the equipment has been returned, transportation prepaid, within 24 months from date of shipment from factory.

THE FOREGOING WARRANTY IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES NOT EXPRESSLY SET FORTH HEREIN, WHETHER EXPRESSED OR IMPLIED BY OPERATION OF LAW OR OTHERWISE INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

No representation or warranty, express or implied, made by any sales representative, distributor, or other agent or representative of APG which is not specifically set forth herein shall be binding upon APG. APG shall not be liable for any incidental or consequential damages, losses or expenses directly or indirectly arising from the sale, handling, improper application or use of the goods or from any other cause relating thereto and APG's liability hereunder, in any case, is expressly limited to the repair or replacement (at APG's option) of goods.

Warranty repairs are made specifically at the factory. Any on site service will be provided at the sole expense of the Purchaser at standard field service rates.

All associated equipment must be protected by properly rated electronic/electrical protection devices. APG shall not be liable for any damage due to improper engineering or installation by the purchaser or third parties. Proper installation, operation and maintenance of the product becomes the responsibility of the user upon receipt of the product.

Returns and allowances must be authorized by APG in advance. APG will assign a Return Material Authorization (RMA) number which must appear on all related papers and the outside of the shipping carton. All returns are subject to the final review by APG. Returns are subject to restocking charges as determined by APG's "Credit Return Policy".

• Installation

The PT-500 should be installed in an area that meets the following conditions:

- The temperature at the sensor does not exceed -40°C to 85°C (-40°F to +185°F)
- Mounting location is away from strong magnetic fields, such as those produced by motors, transformers, solenoid valves, etc.
- No corrosive chemicals or gasses that will attack the sensor housing.

Caution!

Do not bend sharply or kink the sensor's cable. Crushing or otherwise obstructing the internal vent tube will result in errant readings. When suspending the PT-500 by its cable, ensure that the cable clamp does not crush the vent tube!

Do not kink or crush cable vent tube!!!

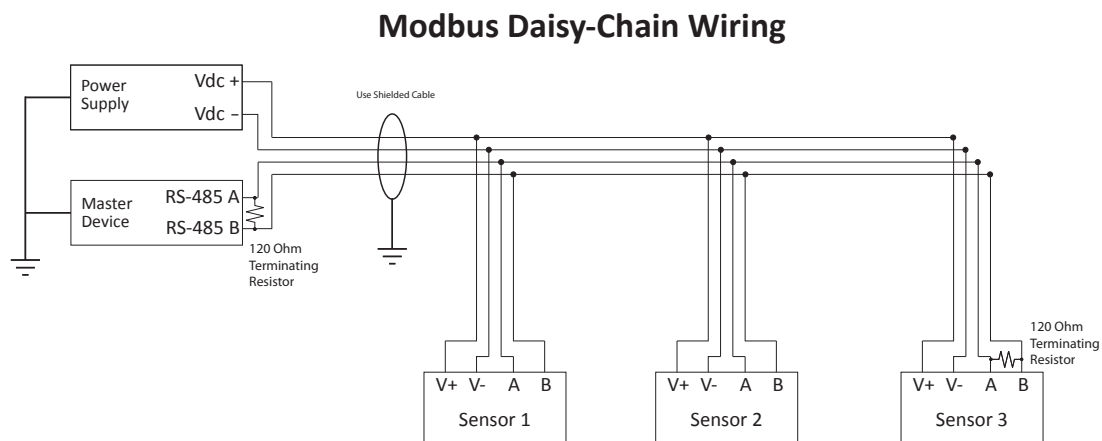


• Sensor Wiring

All PT-500 models will operate on 5-24 Vdc. Always use a high quality power source that will deliver clean, stable voltage.

Modbus RS-485 Wiring

Always use shielded cable. APG recommends using twisted-pair cable for all Modbus network wiring.



• Sensor Communications

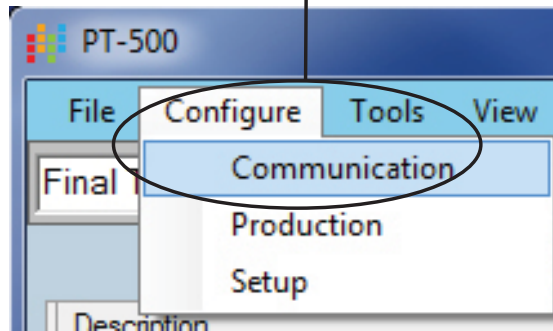
Modbus (RS-485)

The PT-500 utilizes standard Modbus RTU protocol (RS-485). The sensor can only operate as a slave device. For more information about Modbus RTU, please visit www.modbus.org.

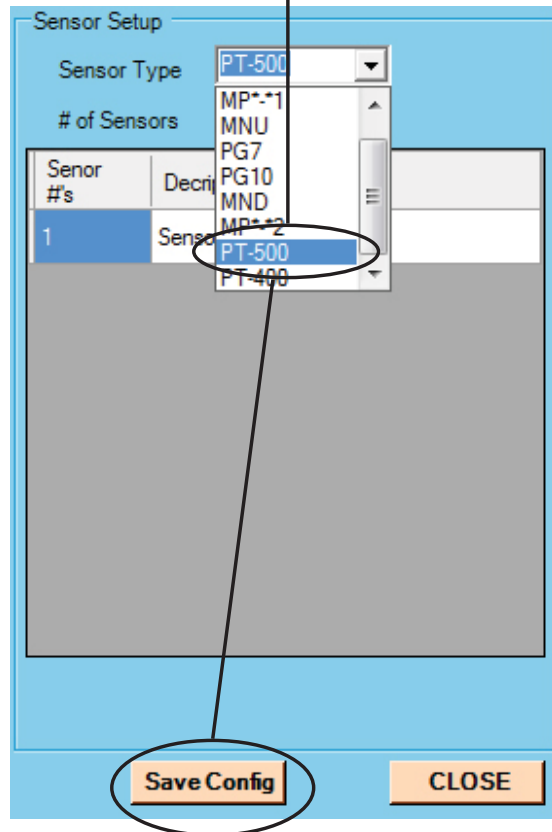
With default settings, the sensor will transmit at: **9600 baud, 8 bits, 1 Stop Bit, No parity.**

Configuring the APG Modbus Software Communications

Step 1: select "Communication" from the "Configure" menu.

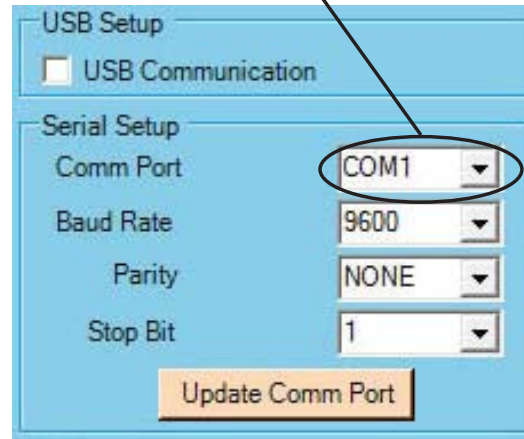


Step 2: select "PT-500" from the Sensor Type menu, then click the "Save Config" button at the bottom of the screen.



Step 3: set the mode of communication by selecting the .

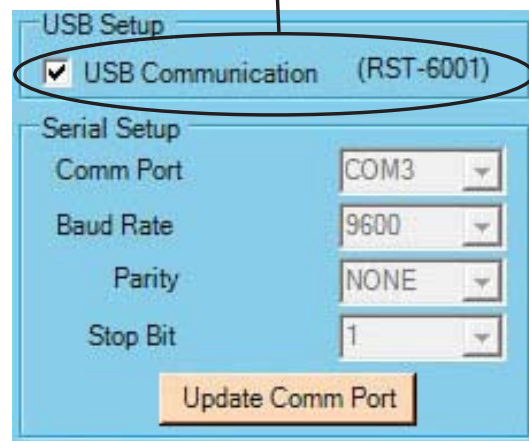
Select the appropriate Comm Port when using direct serial communications.



The screenshot shows the 'USB Setup' dialog box. Under the 'Serial Setup' section, the 'Comm Port' dropdown menu is selected and circled, showing 'COM1'. Other settings include 'Baud Rate' at 9600, 'Parity' at NONE, and 'Stop Bit' at 1. An 'Update Comm Port' button is located at the bottom.

OR

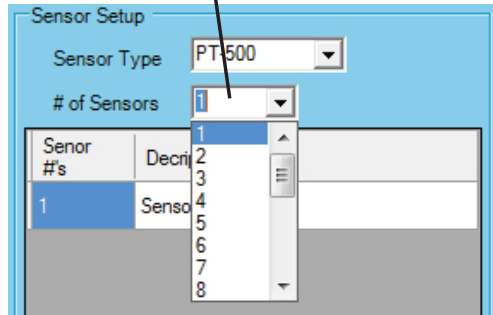
Check the “**USB Communications (RST-6001)**” box when using the RST-6001 communications module.



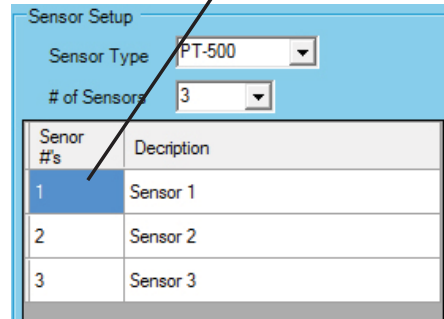
The screenshot shows the 'USB Setup' dialog box. The 'USB Communication (RST-6001)' checkbox is checked and circled. Under the 'Serial Setup' section, the 'Comm Port' dropdown menu is selected and shows 'COM3'. Other settings include 'Baud Rate' at 9600, 'Parity' at NONE, and 'Stop Bit' at 1. An 'Update Comm Port' button is located at the bottom.

Configuring Software Communications for Multiple Sensors

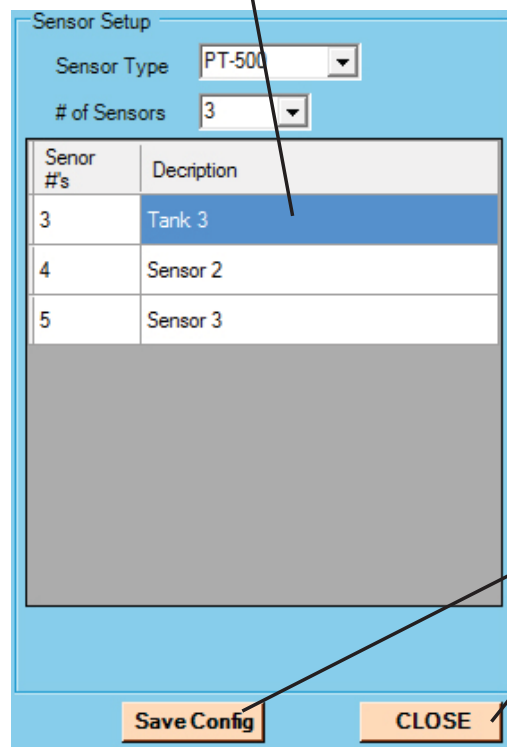
Step 1: select the total number of sensors you wish to read.



Step 2: change the "Sensor #" boxes to match the address' of the target sensors.



Step 3: Change the Description labels as desired. The Description is used to differentiate between sensors in other areas of the software.



Step 4: Click "Save Config" then "Close".

(continued)

Step 5: Click on “Start”. The sensor readings should populate as the software cycles through each sensor.

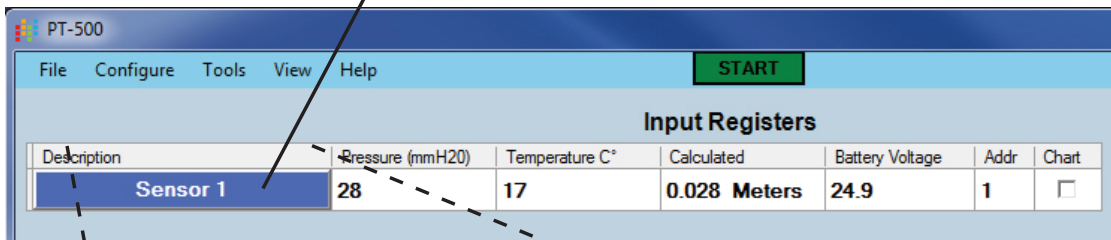
START

Description	Pressure (mmH2O)	Temperature C°	Calculated	Battery Voltage	Addr	Chart
Tank 3	491	23	61	0	1	<input type="checkbox"/>
Tank 4	1172	20	384	0	4	<input type="checkbox"/>
Tank 5	798	22	180	0	5	<input type="checkbox"/>

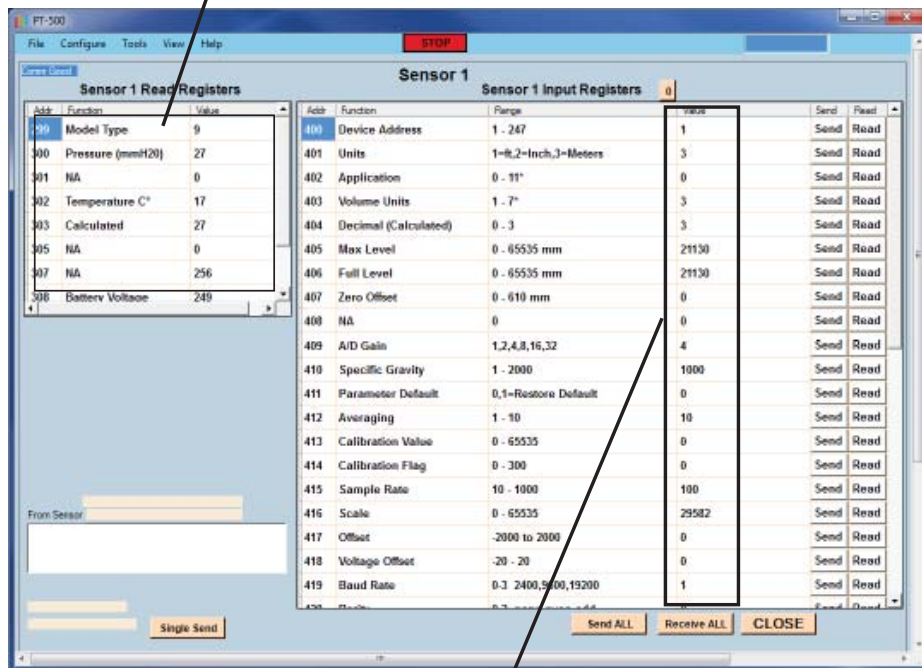
Step 6: Click on a sensor description to access that sensor’s parameters.

Using the Software Programming Window

Click on the desired sensor description to open that sensor's programming window.



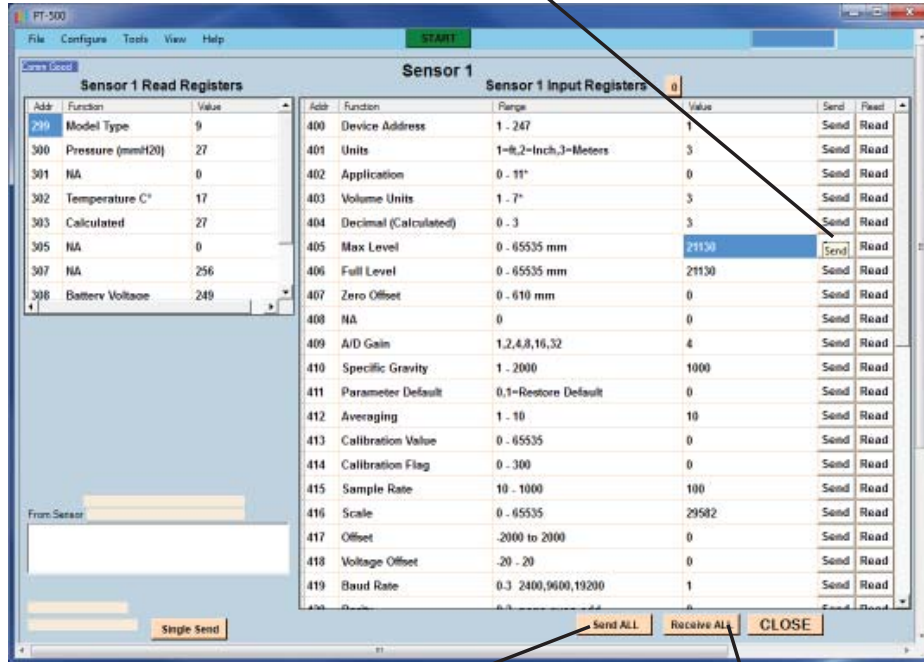
Sensor readings are displayed in the Input Registers table.



The register values should automatically populate. If not, click "Receive All" to retrieve the register values from the sensor.

(continued on next page)

To change an individual parameter, click on the value you wish to change, enter the desired value, then click the adjacent "Send" button to implement the change.



To send all the register values as currently listed, click "Send All"

To retrieve the register values saved in a sensor, click "Receive All"

A green window indicates successful communication.



A yellow window indicates a communication failure.



A red window indicates a value outside the allowable limits for the parameter.



Modbus Register Lists

Input Registers (0x04):

<u>Register</u>	<u>Returned Data</u>
30300	Raw Level Reading (in mm of H ² O)
30302	Temperature Reading (°C, signed)
30303-30304	Calculated Reading

NOTE: the Calculated Readings will be returned without a decimal place. In order to attain the true result, the Decimal Place setting must be taken into account. Refer to the Decimal Place setting on page 25 for more information.

Holding Registers (0x03):

<u>Register</u>	<u>Function</u>	<u>Value Range</u>
40400	Device Address	1 to 255
40401	Units	1 to 3
40402	Application Type	1-10
40403	Volume Units	0 to 6
40404	Decimal Place	0 to 3
40405	Max Level	0 to 10364 mm
40406	Full Level	0 to 10364 mm
40407	Zero Offset	0 to 610 mm
40408	Reserved	n/a
40409	A/D Gain	*
40410	Specific Gravity	1 to 2000
40411	Parameter Default	0 , 1
40412	Averaging	0 to 10
40413	Calibration Value	*
40414	Calibration Flag	*
40415	Sample Rate	10 to 1000 msec.

(continued)

<u>Register</u>	<u>Function</u>	<u>Value Range</u>
40416	Scale	*
40417	Offset	+/- 2000 mm
40418	Voltage Offset	-20 to 20
40419	Baud Rate	0 to 3
40420	Parity	0 to 2
40421	Stop Bit	0 to 1
40422-40423	Pressure X ³	*
40424-40425	Pressure X ²	*
40426-40427	Pressure X ¹	*
40428-40429	Pressure X ⁰	*
40430	Web Alarm 1 Level	0 to 65535
40431	Web Alarm 1 Window	0 to 65535
40432	Web Alarm 1 Type	0 to 29
40433	Web Alarm 2 Level	0 to 65535
40434	Web Alarm 2 Window	0 to 65535
40435	Web Alarm 2 Type	0 to 29
40436-40437	Parameter Data 1	0 to 100,000 mm
40438-40439	Parameter Data 2	0 to 100,000 mm
40440-40441	Parameter Data 3	0 to 100,000 mm
40442-40443	Parameter Data 4	0 to 100,000 mm
40444-40445	Parameter Data 5	0 to 100,000 mm
40446	Temperature Offset	-20 to 20
40447-40448	Temperature X ³	*
40449-40450	Temperature X ²	*
40451-40452	Temperature X ¹	*
40453-40454	Temperature X ⁰	*

*factory calibrated--do not adjust

Application Parameters

Device Address (1 to 255) (40400)

Each device within the Modbus network must be assigned a unique address. Each PT-500 sensor should be connected to the network individually and assigned an address. Each sensor is set to address 1 by default.

Units (1 = Feet, 2 = Inches, 3 = Meters) (40401)

Determines the units of measure for the calculated reading (Input registers 30303-30304 and 30305-30306) when in Application Types 0, 1, 7, or 11 (Distance, Depth of level, Pounds, Curve Fit).

Application Type (1 to 11) (40402)

Determines the type of calculated reading performed by the sensor (refer to pages 10-18). The calculated readings can be queried from Input registers 30303-30304 (top float) and 30305-30306 (bottom float).

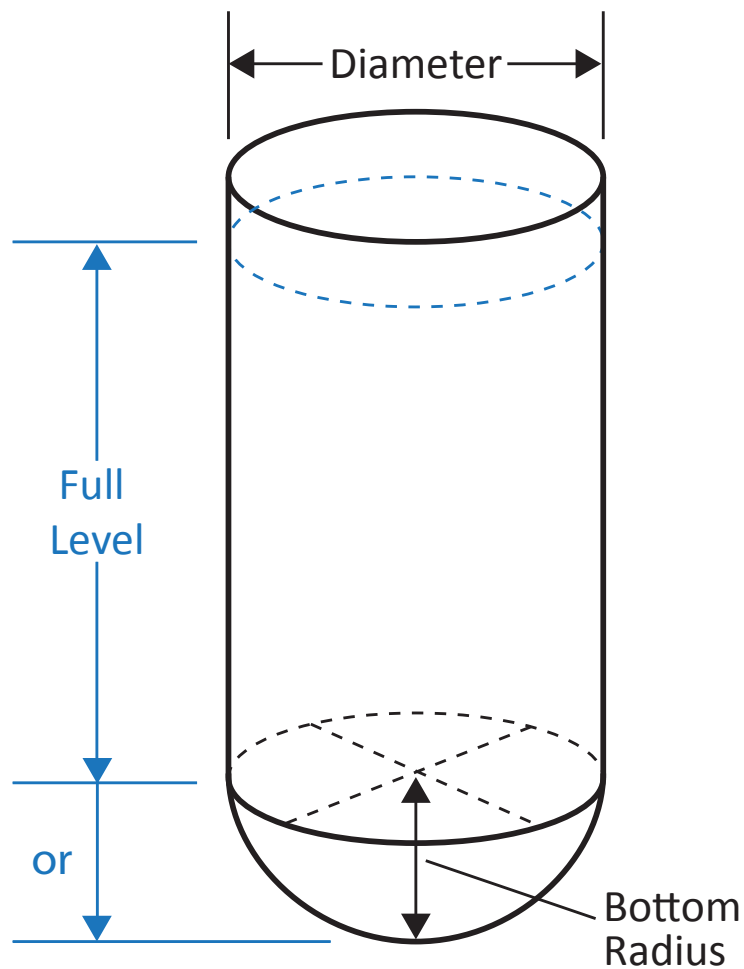
Application Type 1: Depth of level

Sets the zero reference to the bottom of the stem and measures upward to the float position.

<u>Register</u>	<u>Function</u>	<u>Value Range</u>
40401	Units	1 to 3
40402	Application Type	1
40404	Decimal Place	0 to 3
40406	Full Level	

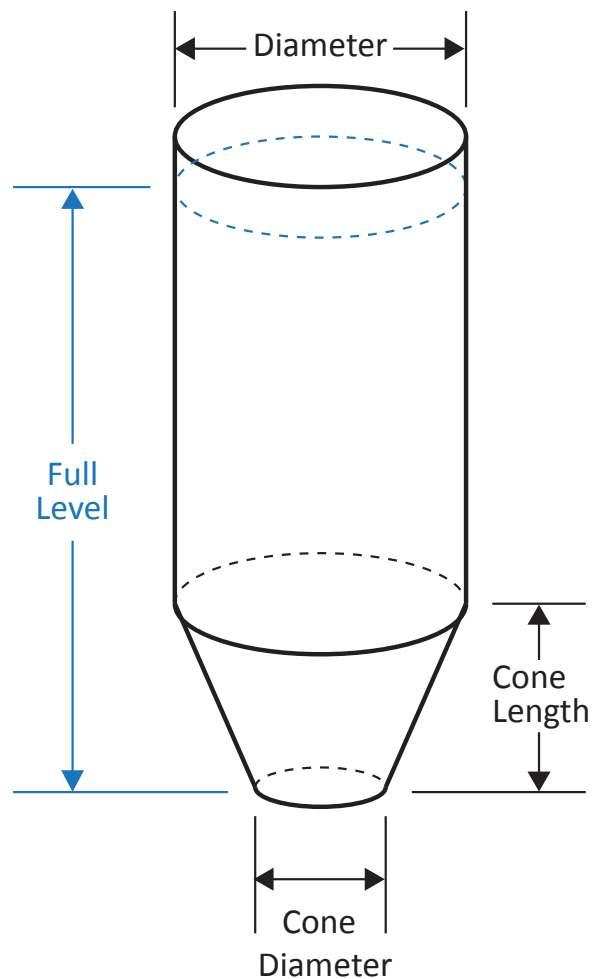
Application Type 2: Volume of cylindrical tank with/without hemispherical bottom

<u>Register</u>	<u>Function</u>	<u>Value Range</u>
40402	Application Type	2
40403	Volume Units	1 to 7
40404	Decimal Place	0 to 3
40406	Full Level	
40436-40437	Tank Diameter	0 to 100,000 mm
40438-40439	Bottom Radius	0 to 100,000 mm



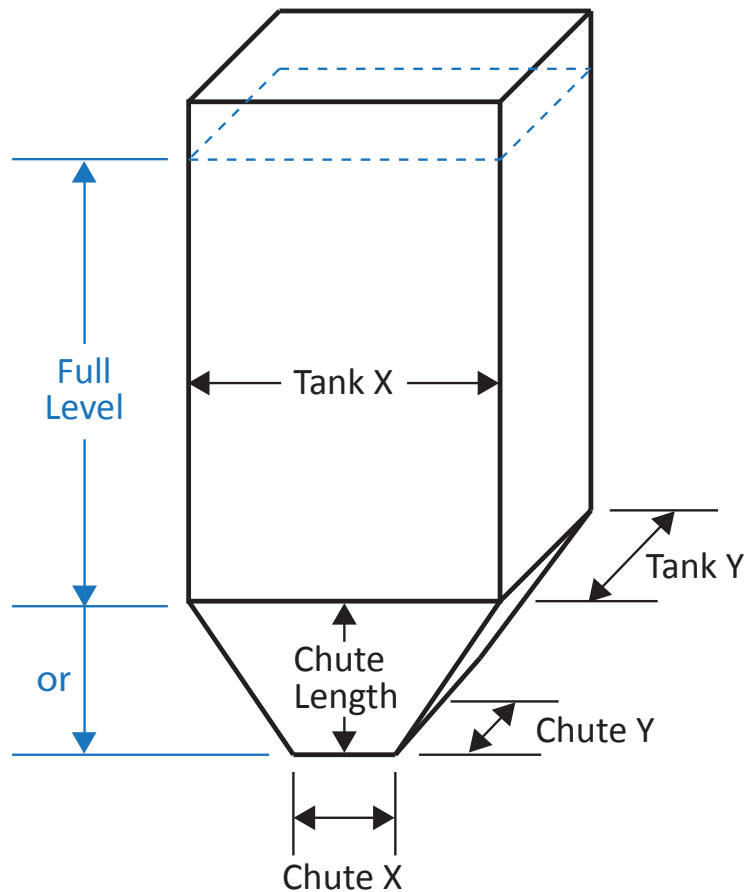
Application Type 3: Volume of cylindrical tank with conical bottom

<u>Register</u>	<u>Function</u>	<u>Value Range</u>
40402	Application Type	3
40403	Volume Units	1 to 7
40404	Decimal Place	0 to 3
40406	Full Level	0 to Max. Level
40436-40437	Tank Diameter	0 to 100,000 mm
40438-40439	Cone Diameter	0 to 100,000 mm
40440-40441	Cone Length	0 to 100,000 mm



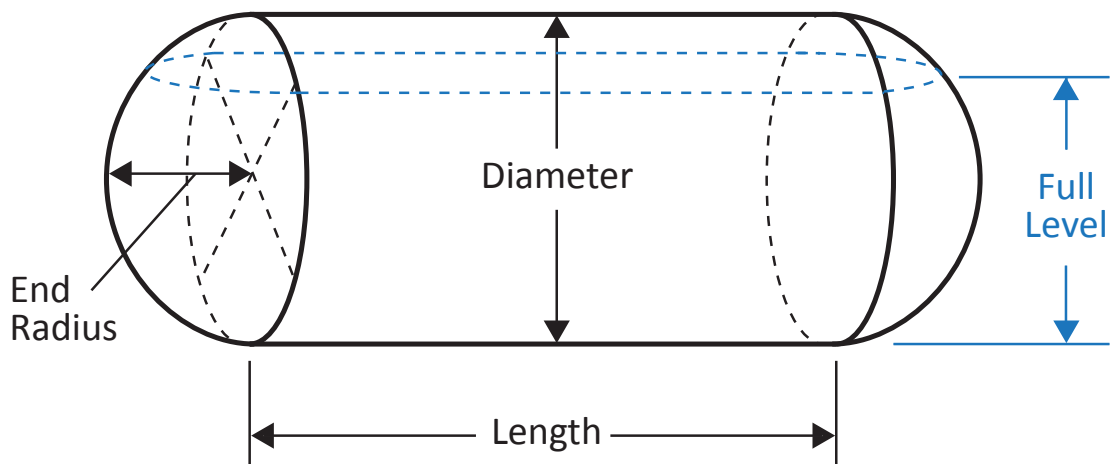
Application Type 4: Volume of rectangular tank with/without chute bottom

<u>Register</u>	<u>Function</u>	<u>Value Range</u>
40402	Application Type	4
40403	Volume Units	1 to 7
40404	Decimal Place	0 to 3
40406	Full Level	0 to Max. Level
40436-40437	Tank X	0 to 100,000 mm
40438-40439	Tank Y	0 to 100,000 mm
40440-40441	Chute X	0 to 100,000 mm
40442-40443	Chute Y	0 to 100,000 mm
40444-40445	Chute Length	0 to 100,000 mm



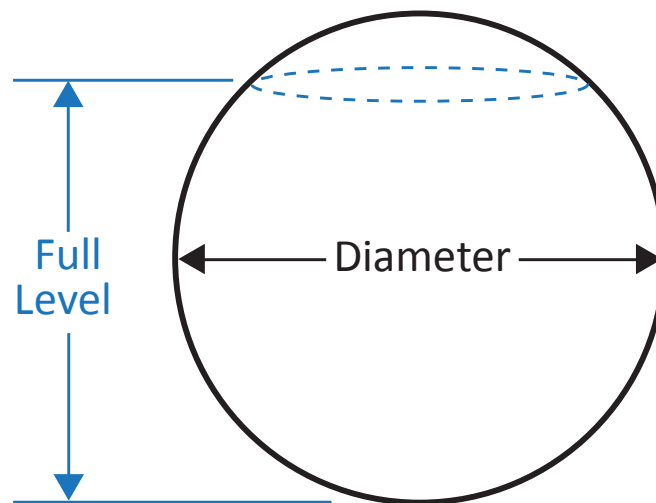
Application Type 5: Volume of horizontal cylindrical tank with or without hemispherical ends

<u>Register</u>	<u>Function</u>	<u>Value Range</u>
40402	Application Type	5
40403	Volume Units	1 to 7
40404	Decimal Place	0 to 3
40406	Full Level	0 to Max. Level
40436-40437	Tank Length	0 to 100,000 mm
40438-40439	Tank Diameter	0 to 100,000 mm
40440-40441	End Radius	0 to 100,000 mm



Application Type 6: Volume of spherical tank

<u>Register</u>	<u>Function</u>	<u>Value Range</u>
40402	Application Type	6
40403	Volume Units	1 to 7
40404	Decimal Place	0 to 3
40406	Full Level	0 to Max. Level
40436-40437	Tank Diameter	0 to 100,000 mm



Application Type 7: Pounds

Allows the user to apply a conversion multiplier to the calculated level reading.

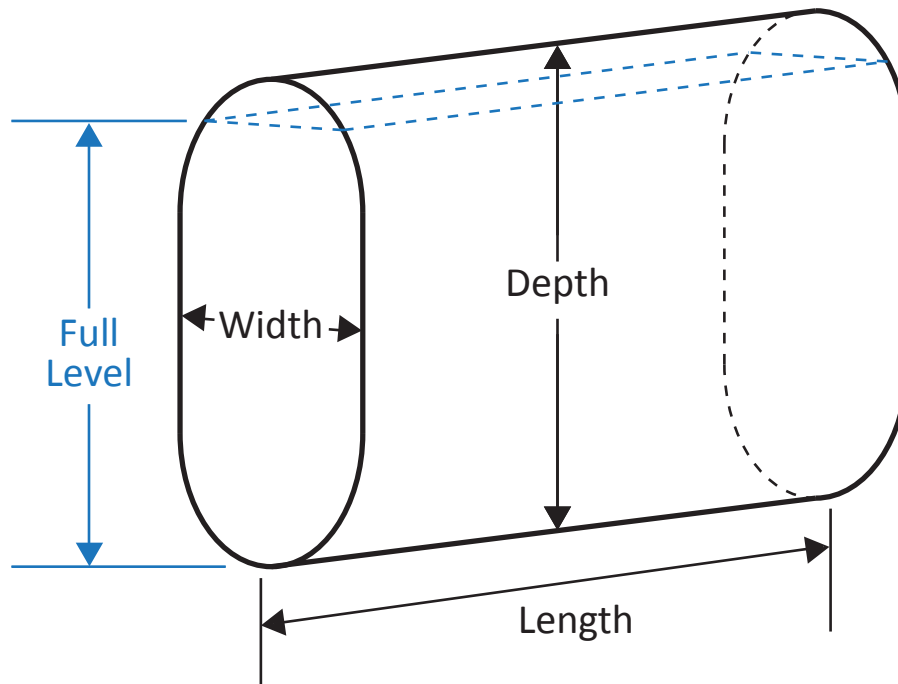
NOTE: the decimal point for the conversion multiplier (40436-40437) is always assumed to be in the thousands position, therefore a setting of 206250 = 206.250 actual multiplier.

Example: suppose the product in a tank weighs 206.25 pounds for every inch of level. With the Units set to inches (Units = 2), enter a multiplier of 206250 into Holding registers 40436-40437.

<u>Register</u>	<u>Function</u>	<u>Value Range</u>
40401	Units	1 to 3
40402	Application Type	7
40404	Decimal Place	0 to 3
40406	Full Level	0 to Max. Level
40436-40437	Multiplier	0 to 1000000 (1000 = 1.000)

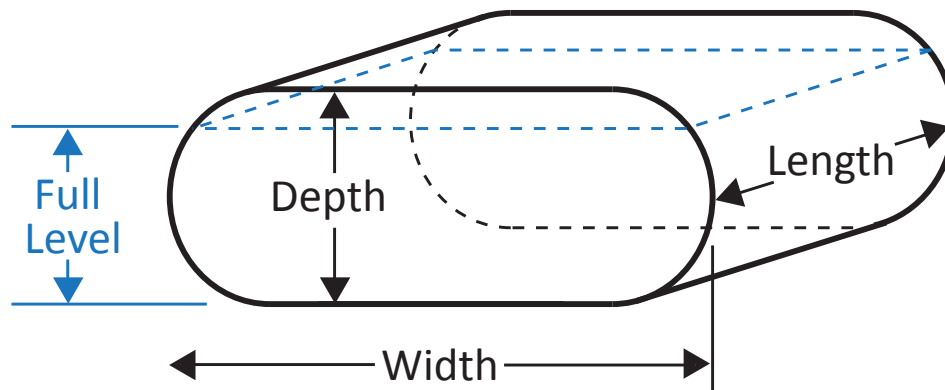
Application Type 9: Volume of vertical oval tank

<u>Register</u>	<u>Function</u>	<u>Value Range</u>
40402	Application Type	9
40403	Volume Units	1 to 7
40404	Decimal Place	0 to 3
40406	Full Level	0 to Max. Level
40436-40437	Tank Length	0 to 100,000 mm
40438-40439	Tank Depth	0 to 100,000 mm
40440-40441	Tank Width	0 to 100,000 mm



Application Type 10: Volume of horizontal oval tank

<u>Register</u>	<u>Function</u>	<u>Value Range</u>
40402	Application Type	10
40403	Volume Units	1 to 7
40404	Decimal Place	0 to 3
40406	Full Level	0 to Max. Level
40436-40437	Tank Length	0 to 100,000 mm
40438-40439	Tank Depth	0 to 100,000 mm
40440-40441	Tank Width	0 to 100,000 mm

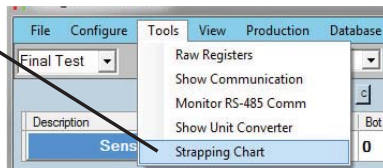


Application Type 11: Curve Fit

Allows the sensor to mimic a tank strapping chart by using a 3rd degree polynomial equation to produce a “curve fit” approximation.

<u>Register</u>	<u>Function</u>	<u>Value Range</u>
40401	Units	1 to 3
40402	Application Type	11
40404	Decimal Place	0 to 3
40406	Full Level	0 to Max. Level
40436-40437	Parameter 1	0 to 100,000 mm
40438-40439	Parameter 2	0 to 100,000 mm
40440-40441	Parameter 3	0 to 100,000 mm
40442-40443	Parameter 4	0 to 100,000 mm

Open the APG Modbus software and select “Strapping Chart” from the “Tools” menu.



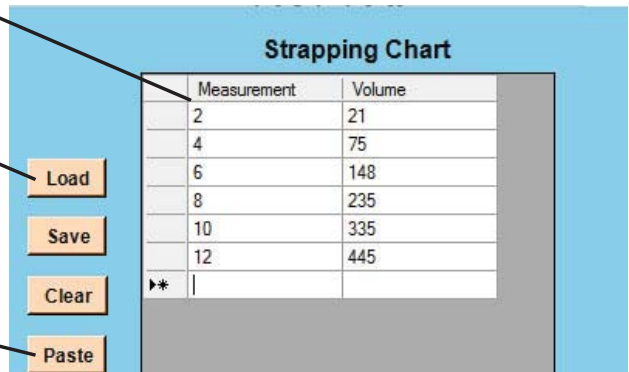
Enter the desired data points into the table.

OR

Use the “Load” button to recall a previously saved table.

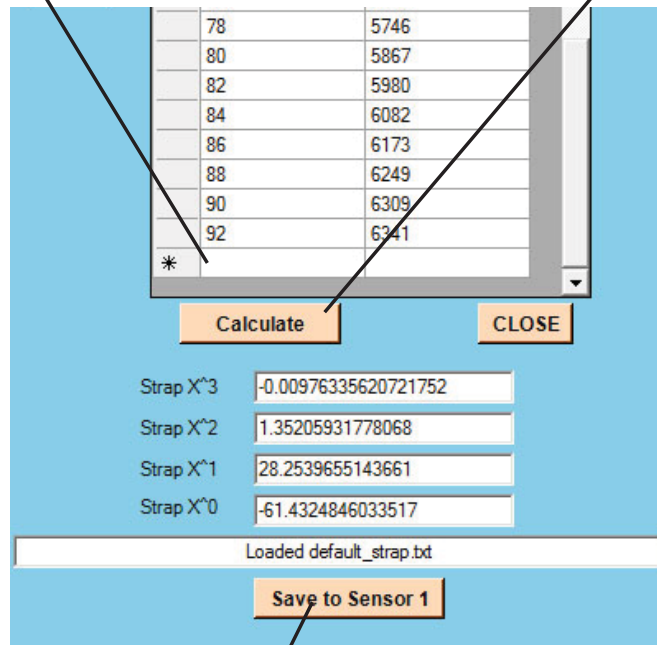
OR

Import data from an electronic document by copying the data and then using the “Paste” button to populate the table.



Once the all data points have been entered, click the “Calculate” button to determine the values required for the “curve fit” calculation.

NOTE: before clicking “Calculate” ensure that there is only one empty row following the last line of data (as shown). Use the keyboard “Delete” key to remove any addition empty rows.



Click the “Save to Sensor” button to populate the appropriate Holding Register fields (see below) and close the Strapping Chart window.

435	t2t	NA	0	Send	Read
436	Strap X ³	0 - 1000000 mm	-0.00976335620721752	Send	Read
438	Strap X ²	0 - 1000000 mm	1.35205931778068	Send	Read
440	Strap X ¹	0 - 1000000 mm	28.2539655143661	Send	Read
442	Strap X ⁰	0 - 1000000 mm	-61.4324846033517	Send	Read
444	NA	0 - 1000000 mm	0	Send	Read

At the bottom of the table are buttons for "Send ALL" and "Receive ALL".

Click the “Send All” button at the bottom of the Holding Register page to write the curve fit values to the sensor.

Volume Units (1 to 7) (40403)

Determine the units of measure for all volumetric Application Types.

1 = Cubic Feet	4 = Cubic Meter	7 = Barrels
2 = Million Cubic Feet	5 = Liters	
3 = Gallons	6 = Cubic Inches	

Decimal Place (0 to 3) (40404)

Set the number of digits after the decimal place to be included in the calculated reading (Input registers 30303-30304 and 30305-30306)

Example: a measurement of 1126.658 will be returned as follows:

Decimal Place = 0	Volume = 1127
Decimal Place = 1	Volume = 11267
Decimal Place = 2	Volume = 112666
Decimal Place = 3	Volume = 1126658

Maximum Level (0 to 65535 mm) (40405)

Factory set--do not adjust. The maximum level is determined by the maximum pressure range of the sensor.

Full Level (0 to 65535 mm) (40406)

Sets the level where the tank is considered full. This parameter is used only by the www.levelandflow.com website and does not limit or otherwise affect the sensor readings.

Zero Offset (0 to 610 mm) (40407)

Allows the user to offset the reading by up to 610 mm (2 ft).

***A/D Gain (1,2,4,8,16,32) (40409)**

Factory set--do not adjust.

Specific Gravity (1 to 2000) (40410)

Sets the specific gravity (SG) of the liquid being measured. The decimal place is assumed after the first digit, so that a SG of 1, is expressed as 1000 in the register value. For example, a specific gravity of 0.85 would be entered as 850, while a SG of 1.25 would be entered as 1250.

Parameter Default (0 or 1) (40411)

Sending a 1 to this register will reset all parameters to factory defaults. This register will automatically revert back to 0 after the reset is performed.

Averaging (1 to 10) (40412)

Defines the number of pressure readings that will be averaged together to become the Calculated Reading. A higher Averaging setting will result in smoother readings under high turbulence, but will also result in slower response to rapid level changes.

***Calibration Value (0 to 65535) (40413)**

Factory set--do not adjust.

***Calibration Flag (1 to 300) (40414)**

Factory set--do not adjust.

Sample Rate (50 to 1000 msec) (40415)

Sets the interval between pressure readings. Options allow rates from 10 to 1000 msec.

***Scale (0 or 65535) (40416)**

Factory set--do not adjust.

***Offset (-2000 to 2000) (40417)**

Factory set--do not adjust.

***Voltage Offset (-20 to 20) (40418)**

Factory set--do not adjust.

Baud Rate (0, 1, 2, 3) (40419)

- 0 = 2400
- 1 = 9600
- 2 = 19200
- 3 = 38400

Parity (0, 1, 2) (40420)

- 0 = None
- 1 = Odd
- 2 = Even

Stop Bit (0 or 1) (40421)

- 0 = None
- 1 = 1 stop bit

***Pressure X^x (40422-40429)**

Factory set--do not adjust

•Web Alarming (40430 to 40435)

When the PT-500 is interfaced with an LOE or RST-5002 web-enabled master device, it can be configured to generate website alarms via levelandflow.com. Refer to the LOE or RST-5002 user manual for more information about website alarms and using levelandflow.com.

Trip x 1 Level (40430 or 40433)

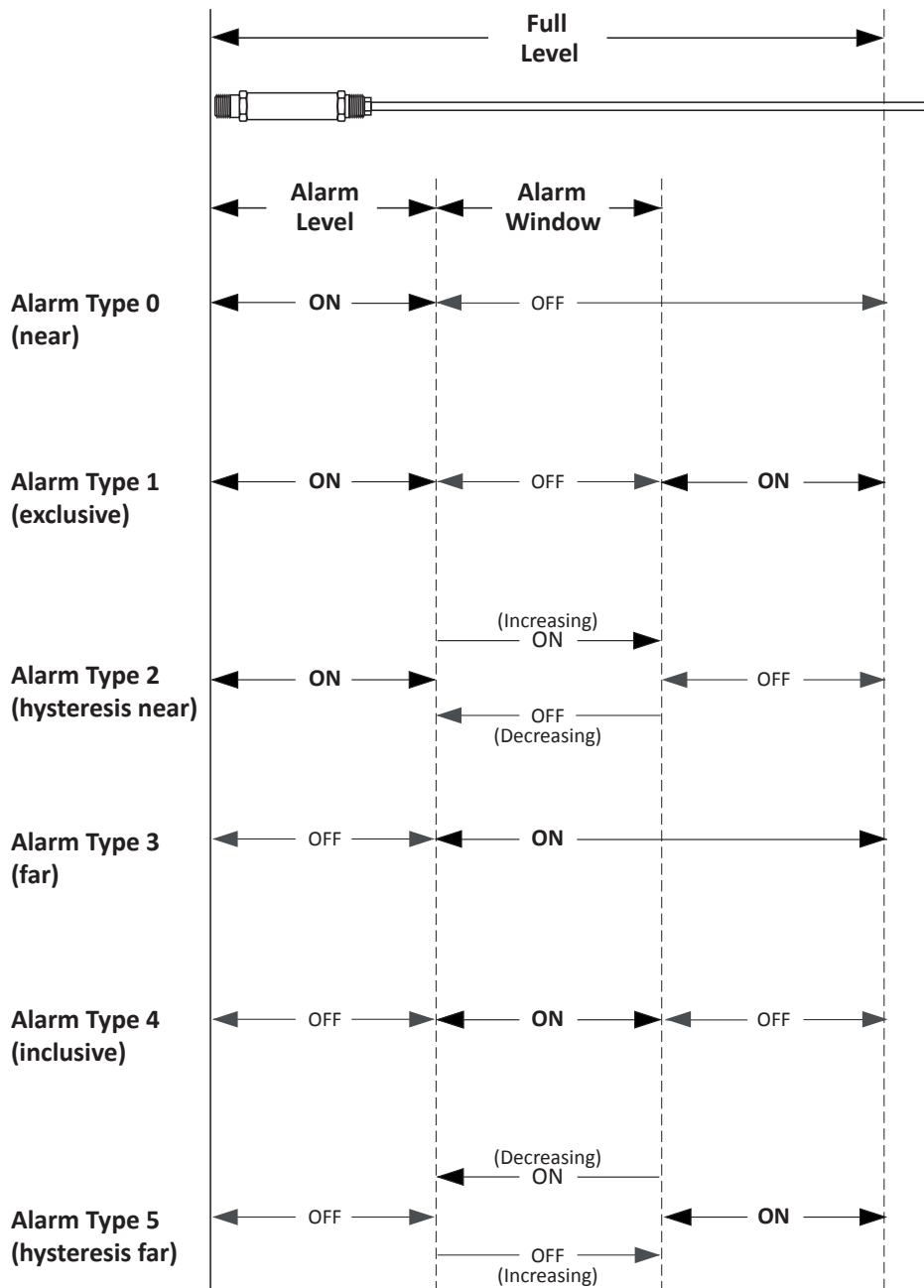
Sets the level (in mm) to the first actuation point (refer to next page for more information).

Trip x Window (40431 or 40434)

Sets the level (in mm), beginning from the Trip Distance, to the secondary actuation point (refer to next page for more information).

Trip x Type (40432 or 40435)

Determines the operational logic performed by the Alarm (refer to next page for more information).



Alarm Type 6-8: n/a

Alarm Type 9 (Rate of Change): allows the user to define a maximum rate of change (distance over time), which if exceeded will activate an alarm. The Trip Distance parameter is used to define the time value, and the Trip Window parameter is used to define the distance value.

Parameter x (40436 or 40445)

The five 32-bit parameter registers are used for entering tank dimensions or conversion multiples. Refer to the specific Application Type for information on applicable Parameter field settings.

***Temperature Offset (40446)**

Factory set--do not adjust.

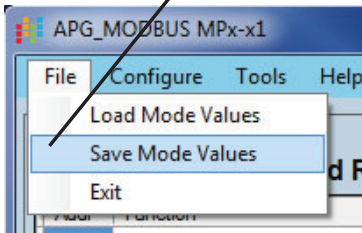
***Temperature X^x (40447 or 40453)**

Factory set--do not adjust.

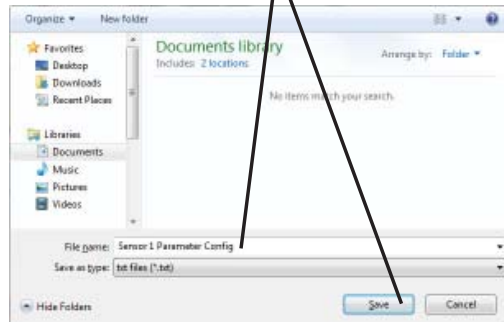
* Contact the factory for assistance before making adjustments. All factory set calibration parameters are saved in nonvolatile memory and can be reset to the factory calibrated defaults using the Parameter Default function.

Saving Sensor Parameter Configurations

Click on "File", then select "Save Mode Values".

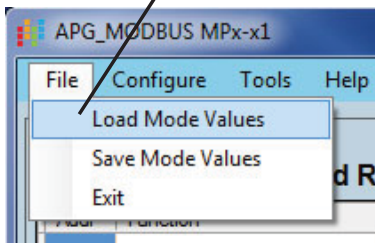


Choose a file name and the location where you wish to save the file, then click "Save"

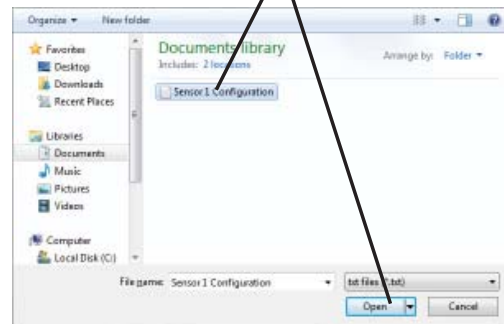


Recalling Saved Sensor Configurations

Click on "File", then select "Load Mode Values".



Choose a file you wish to upload, then click "Open". This will load the parameter values into the software.



Ensure the device address setting matches the target sensor's address, then click the "Send All" to write the parameters values to the sensor.

Addr	Function	Range	Value
400	Device Address	1 - 247	1

Send ALL

• Specifications

Supply Voltage: 5 to 28 VDC

Current Draw: 28 mA max.

Output: Modbus RTU (RS-485)

Accuracy: less than 0.25% of full span

Operating Temperature: -40 to 185 °F (-40 to 85°C)

Temperature Compensation Range: 32° to 122°F (0° to 50°C)

Temperature Effect: less than 0.025% of full scale per °F

Housing: 316L SS

Cable: 4 conductor vented Hytrel (200 lbs tensile strength)

For technical assistance, please contact APG at 435-753-7300.

AUTOMATION PRODUCTS GROUP, INC.

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