

# **LOE Ultrasonic Level Sensors User Manual**

Web Enabled Controller, Series B



Doc #9004258  
Rev C, 04/16

Find Quality Products Online at:

[www.GlobalTestSupply.com](http://www.GlobalTestSupply.com)

[sales@GlobalTestSupply.com](mailto:sales@GlobalTestSupply.com)

# Table of Contents

<b>Introduction .....</b>	<b>iii</b>
<b>Warranty and Warranty Restrictions .....</b>	<b>iv</b>
<b>Chapter 1: Specifications and Options.....</b>	<b>1</b>
Dimensions .....	1
Specifications .....	2-3
Model Number Configurator.....	3
System Wiring Diagrams .....	4-6
<b>Chapter 2: Installation and Removal Procedures and Notes.....</b>	<b>7</b>
Tools Needed.....	7
Connection Notes.....	7
Electrical Installation .....	7
Installation Notes .....	8
Mounting Instructions .....	8
Software Setup .....	9-13
Removal Instructions .....	13
<b>Chapter 3: Programming with Modbus TCP/IP .....</b>	<b>14</b>
Modbus Polling via Ethernet with Modbus TCP/IP.....	14-15
LOE Generic Modbus Register List .....	15
Modbus Programming of Individual Sensors.....	16
<b>Chapter 4: LOE Embedded Web Server.....</b>	<b>16</b>
Accessing the LOE Embedded Web Server .....	16
Navigating the LOE Embedded Web Server .....	16-17
LOE Sensor Input Configuration Submenus .....	18-32
Modbus Sensor Configuration Registers.....	33-35
LOE Utility Menus .....	36-39
<b>Chapter 5: Maintenance .....</b>	<b>40</b>
General Care .....	40
Troubleshooting .....	40
Calibration .....	41
Repair and Returns.....	41

# Introduction

Thank you for purchasing an LOE Ultrasonic Level Sensor and Web Enabled Controller from APG. We appreciate your business! Please take a few minutes to familiarize yourself with your LOE and this manual.

The LOE Ultrasonic Level Sensor and Web Enabled Controller offers a wide degree of integrated, flexible, remote and local control and monitoring for your system. The LOE can control up to 10 APG Modbus sensors--any combination of level, pressure, magnetostrictive and ultrasonic--and two input or output relay terminals. All readings are available for control and monitoring via TCP/IP for local or remote network access. The LOE also had flexible power options: it can use either POE or an independent 12-28 VDC power source.

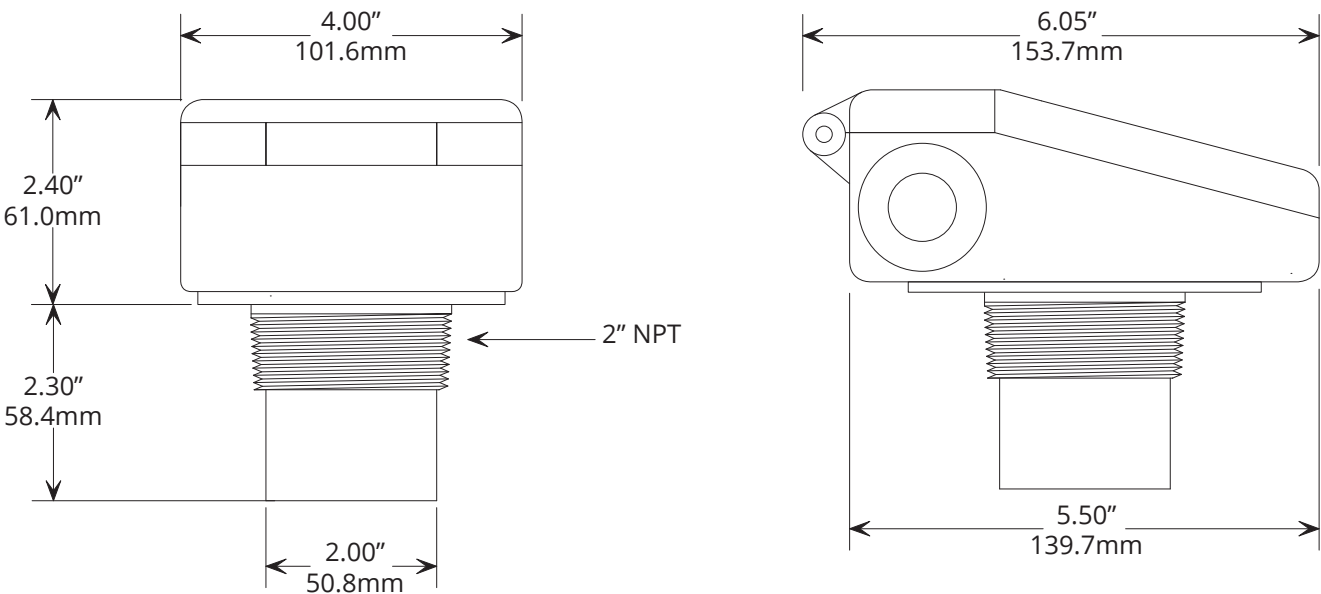
## Reading your label

Every APG controller comes with a label that includes the controller's model number, part number, and serial number. The LOE label also indicates the default IP address, subnet mask, and mac address. Please ensure that the model number on your label matches your order.

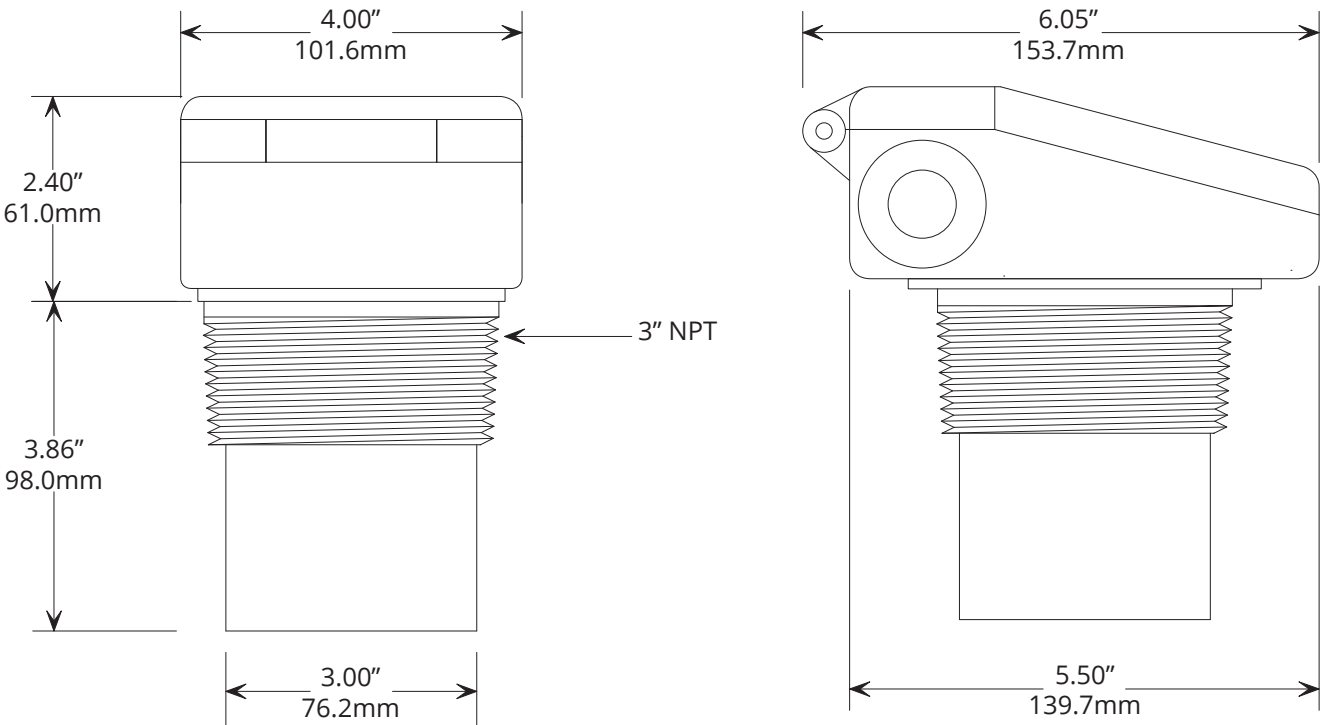
# Chapter 1: Specifications and Options

- Dimensions

LOE-2126, LOE-6126



LOE-3136



## • Specifications

### Performance

Operating Range	0.6 - 15.0 ft. / 7 in. - 180 in. / 178mm - 4572mm (6126) 1.0 - 25.0 ft. / 12 in. - 300 in. / 305mm - 7620mm (2126) 1.5 ft. - 40 ft. / 18 in. - 480 in. / 458mm - 12192mm (3136)
Beam Pattern	9° off axis
Transducer Frequency	43 kHz (3136) / 69 kHz (2126, 6126)
Response Time	Programmable, 5 Hz maximum (200 ms)

### Communications

Digital Output	Ethernet TCP/IP Modbus Ethernet TCP/IP via embedded webserver (LAN only) Ethernet TCP/IP to APG-provided website
Inputs	0-2 Isolated Solid State Relays RS-485 Modbus (up to 10 slave sensors) 0-2 Discrete Switches

### Electrical

Operational Supply Voltage (at sensor)	48 VDC via POE (requires injector or switch) 12-28 VDC
Current Draw	40 mA @ 48 VDC 80 mA @ 24 VDC
Power Rating (LOE)	2.0 W Max
Isolated SS Relays	120V, 120 mA Max

### Accuracy

Accuracy	±0.25% of detected range
Resolution	0.1 inch (2.54 mm)

### Environmental

Operating Temperature	-40 to 60°C (-40 to 140°F)
Internal Temperature Compensation	Yes
Enclosure Protection	IP65

### Materials of Construction

Transducer Housing	PVDF
Upper Housing	PC/PET
Transducer Type	Ceramic, PVDF faced

## Mounting

LOE-2126  
LOE-3136  
LOE-6126

2" Ø NPT  
3" Ø NPT  
2" Ø NPT

## Compatible APG Modbus Senors

Ultrasonic  
Magnetostrictive  
Pressure  
Controllers

MNU  
MPX-E1, MPX-R1  
PT-400-L5, PT-400-L31, PT-500-L5, PT-500-L31  
DCR-1006A, MND

## • Model Number Configurator

Model Number: LOE -        -         
                                  A      B

### A. Model

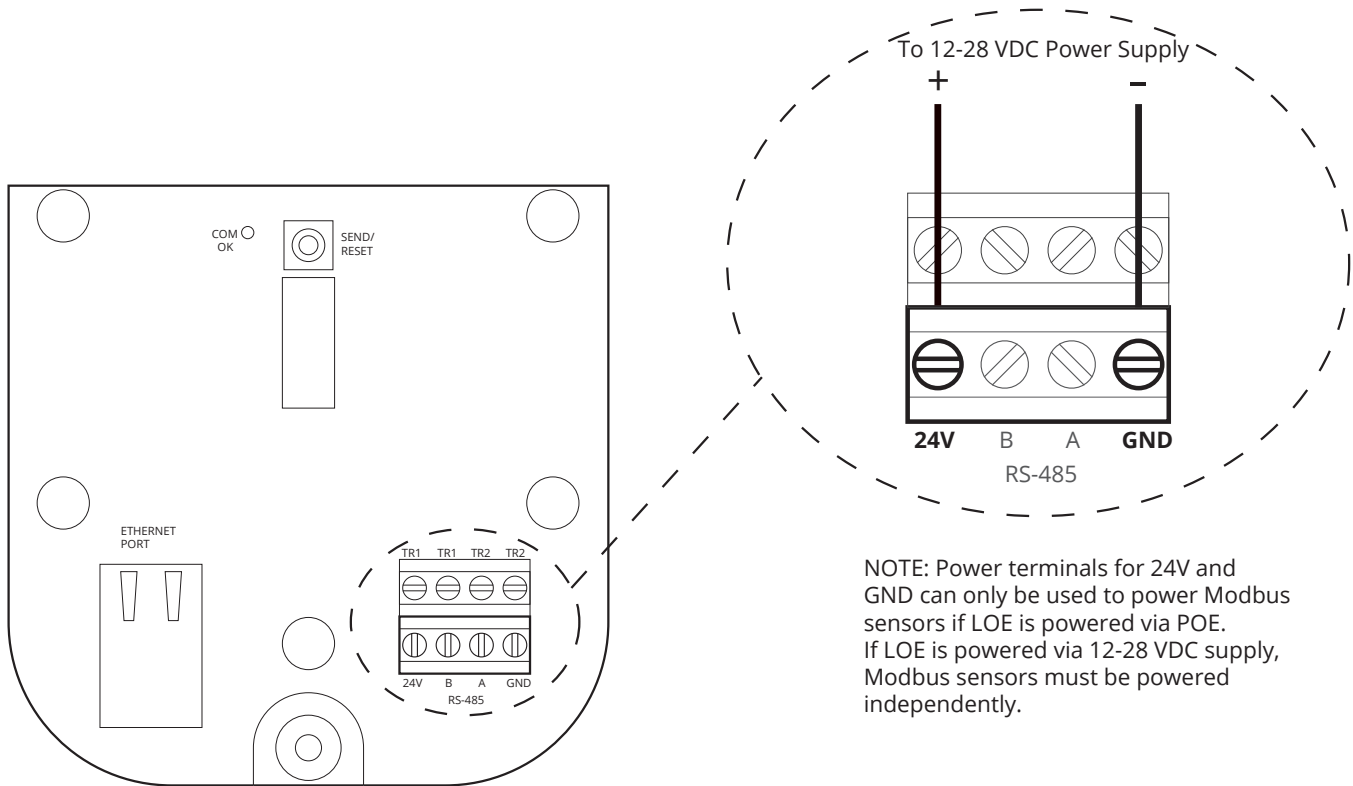
- ☐ **2126**      1 - 25 ft. (305mm - 7620mm); 69 kHz; 2" NPT threads
- ☐ **3136**      1.5 - 40 ft. (458mm - 12192mm); 43 kHz; 3" NPT threads
- ☐ **6126**      0.6 - 15 ft. (178mm - 4572mm); 69 kHz; 2" NPT threads

### B. Relay Configuration

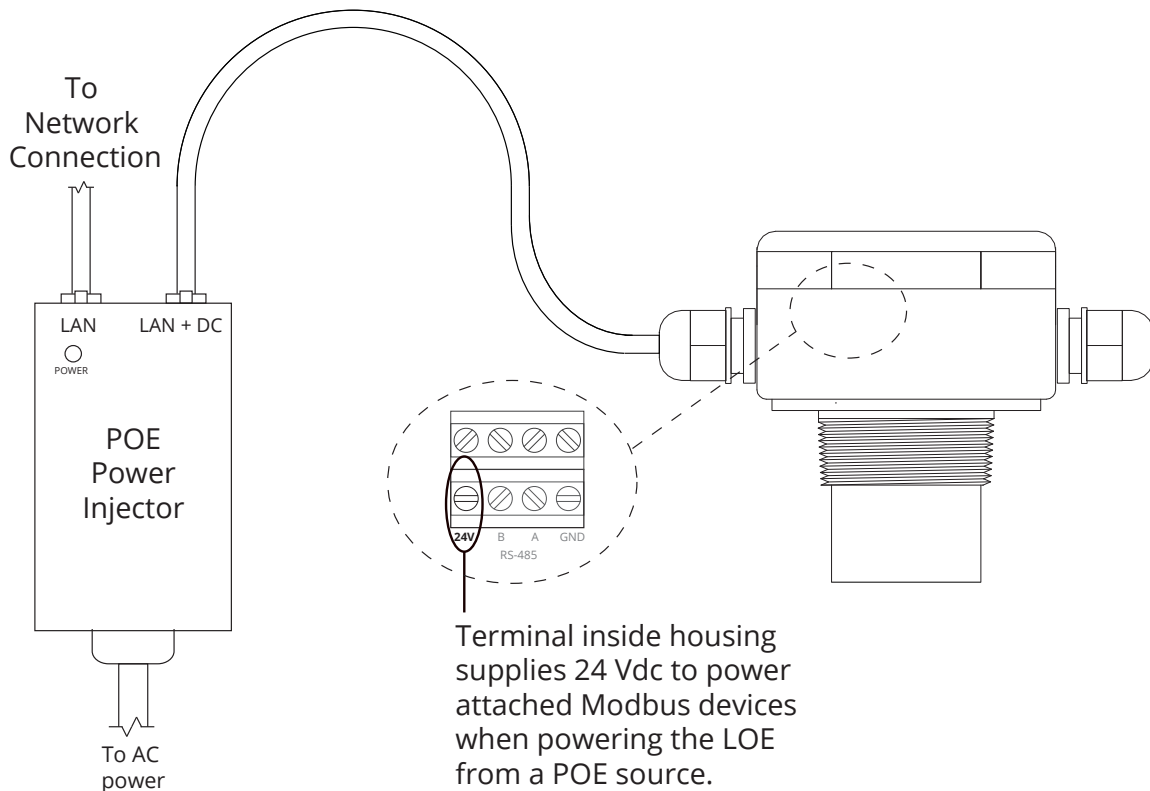
- ☐ **0000**      2 relay outputs
- ☐ **0010**      1 relay output, 1 switch input
- ☐ **0110**      2 switch inputs

- **System Wiring Diagrams**

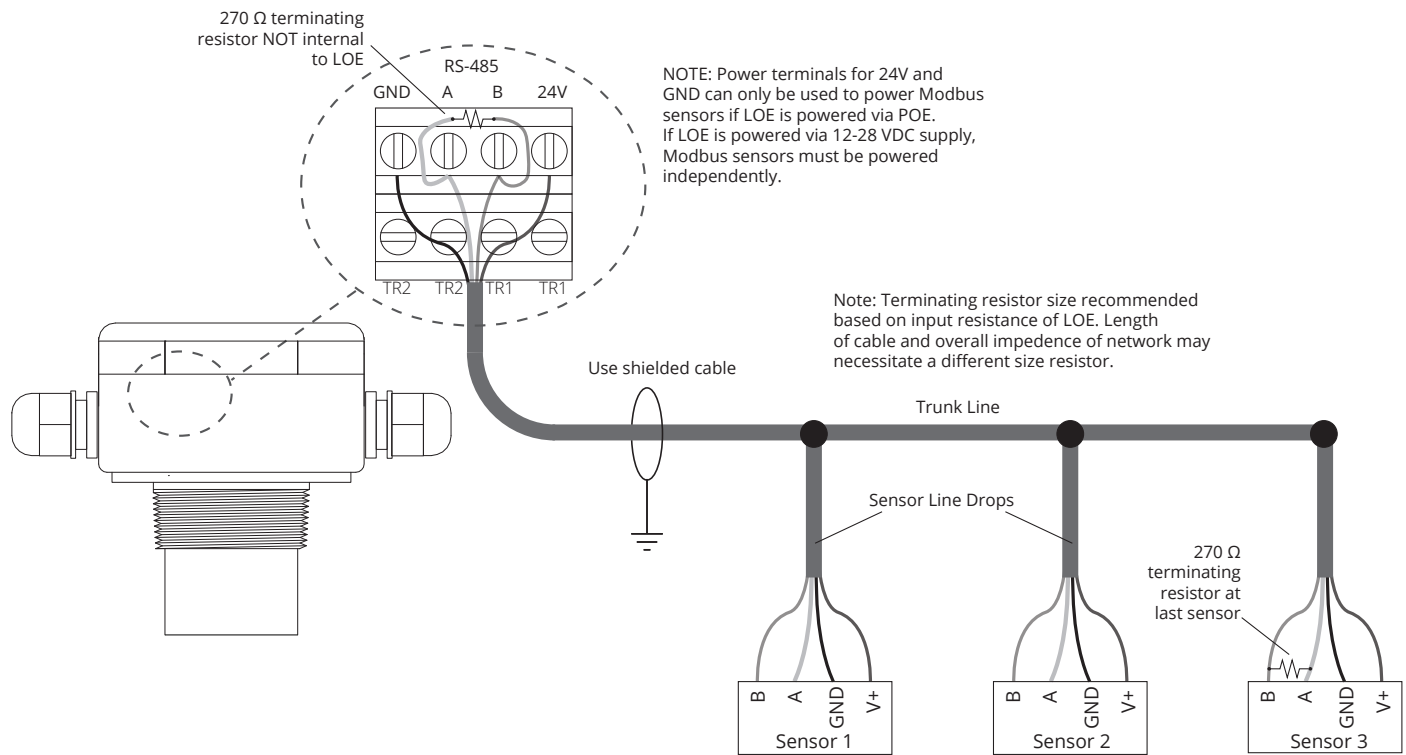
## External 12-28 VDC Source Wiring



## POE (Power over Ethernet) Wiring

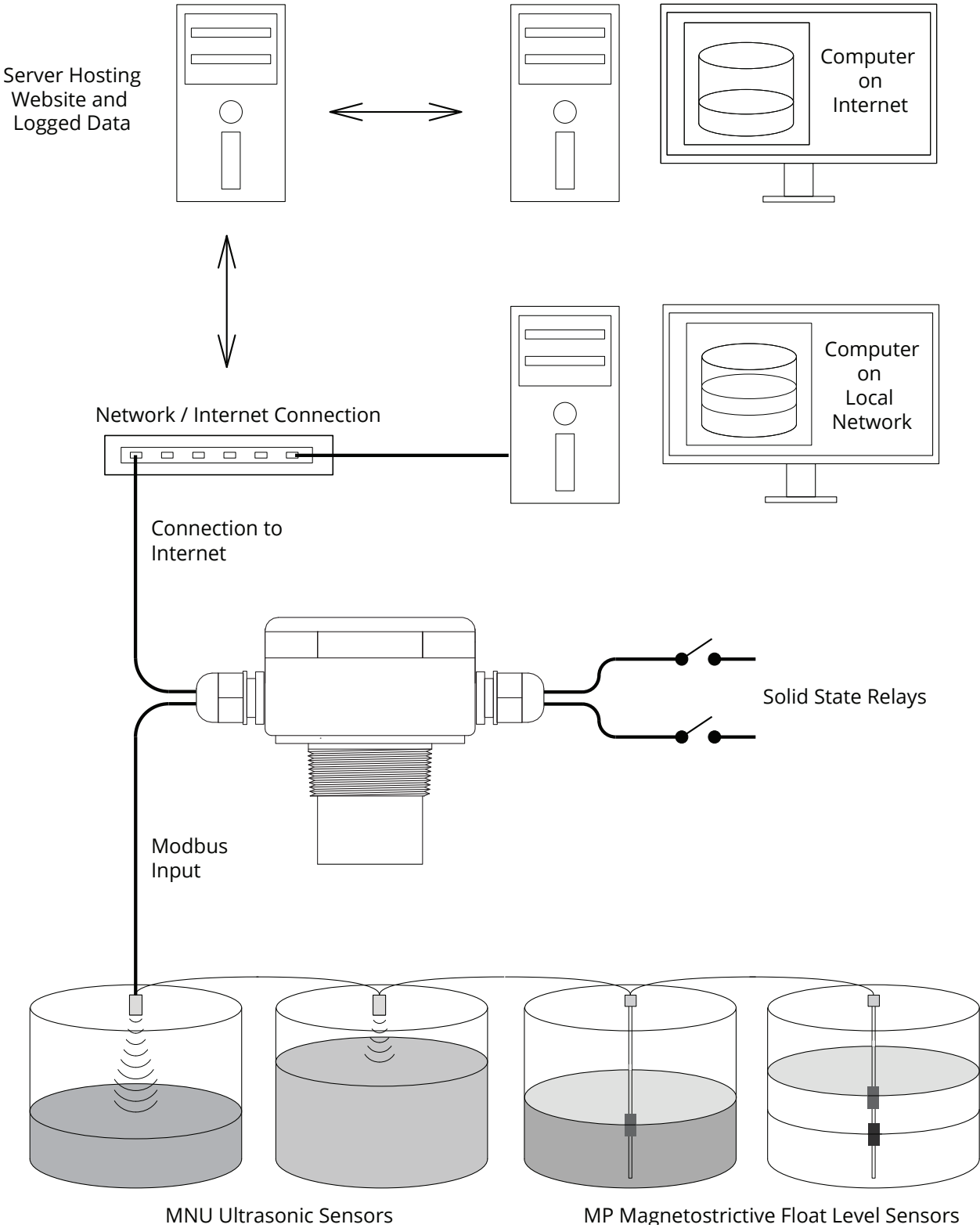


## Modbus Sensor Daisy-chain Wiring





System Overview - LOE with Modbus network, SSR's and Internet Connection



## Chapter 2: Installation and Removal Procedures and Notes

- **Tools Needed**

- Flat head screwdriver to remove knockouts for cables.
- If you are using a stand pipe to mount your LOE, you will probably need tools to install the stand pipe.
- For any attached Modbus sensors, please consult each sensor's user manual for installation notes and instructions.

- **Connection Notes**

- Up to 10 Modbus sensors can be connected to the LOE in any combination.
- Output SSR's are rated for 120V, 120mA max.

**i** IMPORTANT: Each Modbus sensor must be connected to the network individually and assigned a unique Sensor Number before the next sensor can be added.

- **Electrical Installation**

- Use flat head screwdriver to remove knockouts on either side of LOE housing.
- Insert included cable fittings in knockout holes.
- Connect any relays first.
- Connect LOE to Ethernet/network.
- Connect independent 12-28 VDC supply if not using POE.
- Connect and set up one Modbus sensor at a time.

**i** IMPORTANT: Multiple Modbus sensors added to the network simultaneously are all assigned the same Modbus address/sensor number: 1. Sensors MUST be added to the network individually.

## • Installation Notes

- Mount your LOE sensor so that it has a clear, perpendicular sound path to the surface being monitored. Your sensor should be mounted away from tank or vessel walls and inlets. (See Figure 2.1)
- The sound path should be free from obstructions and as open as possible for the 9° off axis beam

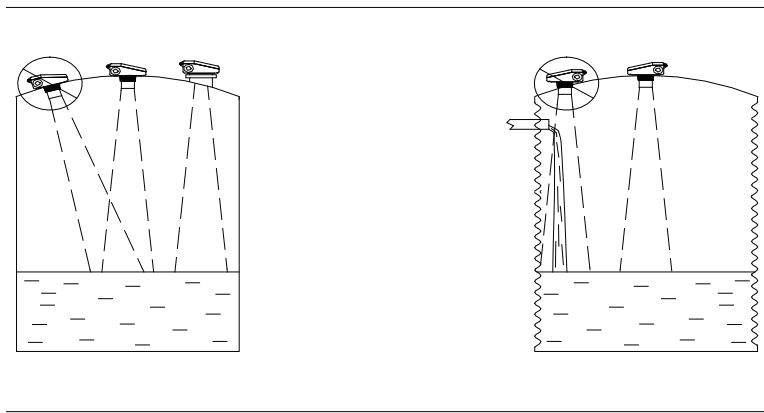


Figure 2.1

## • Mounting Instructions

Mounting your LOE is easy if you follow a few simple steps:

- Never over-tighten the sensor.
- Always screw in your sensor by hand to avoid cross-threading. Thread failure can be a problem if you damage threads by over-tightening them or by crossing threads.

**i** IMPORTANT: Do not over tighten! The sensor should be threaded in only hand tight.

**p** NOTE: Do not mount the sensor where the beam will intersect objects such as fill streams, pipes, ladder rungs, wall seams, or corrugated tank walls.

- **Software Setup**

Initial setup of the LOE and individual Modbus sensors is done via an embedded web server. The embedded server can be accessed by using either the serial number or local IP address of the LOE and a web browser (Internet Explorer, Chrome, Firefox, etc).

 **NOTE:** Port 6700 must be open on your local network for the LOE to connect.

### Accessing LOE Embedded Web Server via Serial Number

The easier way to access the embedded web server is to type `loe_xxx` into a web browser on a computer connected to the same local network as the LOE. `xxx` represents the numeric portion of the LOE's serial number. See Figures 2.2 and 2.3.

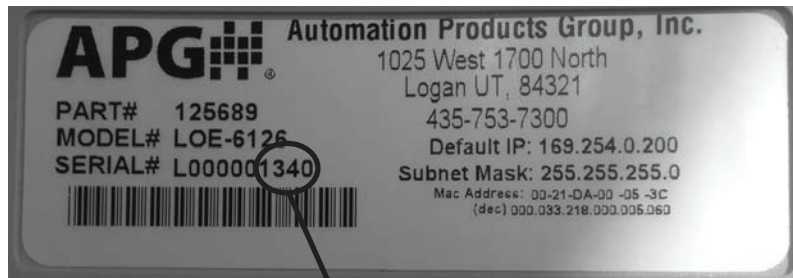


Figure 2.2

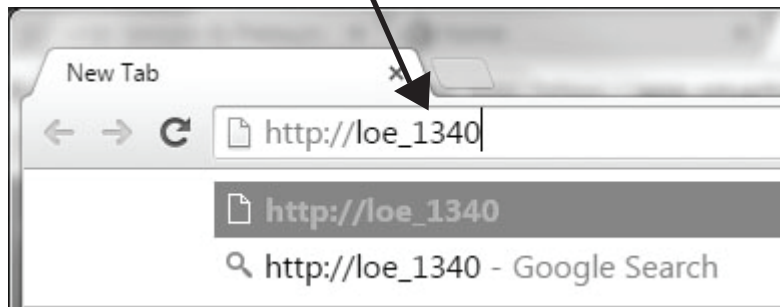



Figure 2.3

 **NOTE:** If your web browser performs a web search for “loe\_xxx” instead of accessing the server, type “http://loe\_xxx”.

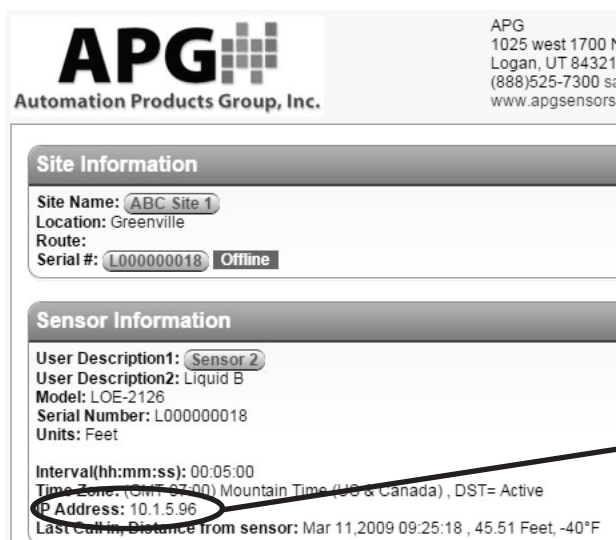


Figure 2.6

On the Sensor Information screen you will see the IP Address of the newly installed LOE. (See Figure 2.6.)

Type the LOE's IP address into your browser's address bar (See Figure 2.7).



Figure 2.7

## Logging on to the LOE Embedded Web Server

The LOE's embedded webpage should now be open, showing the Main Display page (See Figure 2.8). This page lists the LOE, any Modbus sensors attached to the LOE, and displays each sensor's current reading. The LOE is displayed as sensor #11. The configured sensor number for each Modbus sensor will show as its Sensor Number. Every new Modbus sensor defaults to sensor number 1.

Sensor #	Description	Reading	Units
11 (LOE)		69.0	Inches
Refresh		Home	

Figure 2.8

**IMPORTANT:** Multiple Modbus sensors added to the network simultaneously are all assigned the same sensor number: 1. Sensors must be added to the network individually.

Click on Home to bring up the Menu page (See Figure 2.9). The first menu link clicked during each session will prompt a User Name and Password login for the LOE (See Figure 2.10). The default User Name is **admin**, and the default Password is **password**.

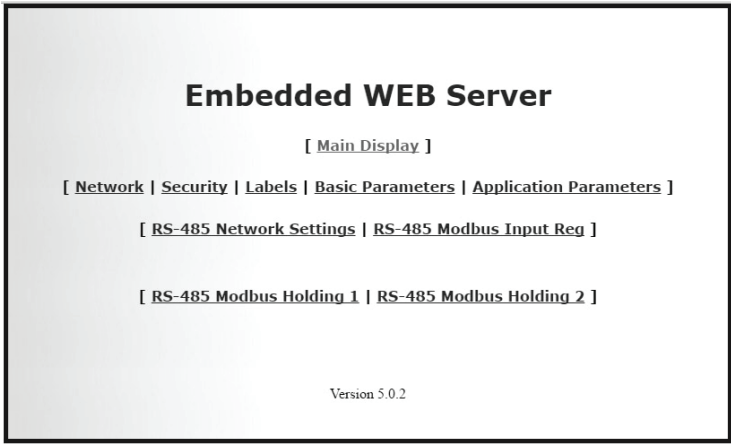


Figure 2.9



Figure 2.10

 **NOTE:** See the Security Setting Menu (Page 37) to change this user name and password.

### Assigning Modbus Sensor Numbers

Click on RS-485 Network Settings to bring up the RS485 Settings page (See Figure 2.11). See section RS-485 Network Settings for a full description of each parameter in this menu (Page 38).


RS-485 Network Settings		
Definition	Range	Value
9600 Baud	Checked	<input checked="" type="checkbox"/> 9600 Baud
Numb of Sensors On Line	0 to 10	0 <input type="text"/>
Sensor Number to View	1 to 10	1 <input type="text"/>
New Sensor Number	0=No Change or 1 to 10	0 <input type="text"/>
RS485 Sample Rate	1 to 20 Seconds	1 <input type="text"/>
<div>Change <input type="button" value="Refresh"/> Home <input type="button" value=""/></div>		

Figure 2.11

Change *Numb of Sensors On Line* to reflect the **total** number of Modbus sensors you will be connecting to your LOE. Click Change (or press Enter) to send the new value to the LOE.

With *Sensor Number to View* set to 1 (for the latest sensor added to the Modbus network), set *New Sensor Number* to the highest available number. Click Change (or press Enter) to send the new value to the LOE.

Repeat this process for each Modbus sensor as it is added to the network.

 **NOTE:** If you control the power to each Modbus sensor separately, powering up a new sensor after assigning a Modbus address to the previous sensor will allow you to assign an address to the new sensor without leaving the RS485 Settings Menu.

 **IMPORTANT:** None of parameters in the RS485 Settings menu automatically update. Each one must be manually configured.

## • Removal Instructions

- Disconnect power to the LOE first.
- Disconnect network connection.
- Disconnect any sensors, relays, and switched inputs.
- Remove the LOE and store it in a dry place, at a temperature between -40° F and 180° F.

# Chapter 3: Programming with Modbus TCP/IP

- **Modbus Polling via Ethernet with Modbus TCP/IP**

Using the LOE’s IP address, and port number 502, readings can be polled from the LOE for any attached sensors via RS-485 Modbus commands. Up to 14 16-bit Input Registers, beginning with register 299, can be polled with a single command. Below is a sample Modbus command illustrating the necessary syntax.

Example:

- 00 01 : Transaction Identifier
- 00 00: Protocol Identifier
- 00 06: Message Length (6 bytes to follow)
- 0B : The Reporting Unit Identifier [sensor number] (0B hex = 11)
- 04 : The Function Code (04 = read Input Registers)
- 01 2E: The Data Address of the first register requested. (12E hex + 1 = 303)
- 00 02: The total number of registers requested. (read 2 registers, i.e. 303 to 304)

Byte order (hex values)  
00 01 00 00 00 06 0B 04 01 2E 00 02

Notes:

- Reporting Unit indicates the sensor reading being polled from the LOE, in hex. 01 - 0A are for Modbus sensors 1 - 10 attached to the LOE. 0B (i.e. sensor 11) reads the values from the LOE sensor (See Figure 2.8). Unused registers (i.e., those not associated to an attached sensor) will return zeros when polled.

- Data Address of registers, decimal to “hex minus 1” conversion:

Decimal Address	Hex minus 1	Decimal Address	Hex minus 1
299	12A	306	131
300	12B	307	132
301	12C	308	133
302	12D	309	134
303	12E	310	135
304	12F	311	136
305	130	312	137



- Total number of registers requested, up to 14, given in hex:

# of Registers	Hex equivalent	# of Registers	Hex equivalent
01	01	08	08
02	02	09	09
03	03	10	0A
04	04	11	0B
05	05	12	0C
06	06	13	0D
07	07	14	0E

## • LOE Generic Modbus Register List

### Input Registers (0x04)

<u>Register</u>	<u>Returned Data</u>
30299	Sensor Type
30300	Distance/Level 1, Top (in mm, unsigned)
30301	Distance/Level 2, Bottom (in mm, unsigned)
30302	Sensor Temperature Reading (in °C, signed)
30303-30304	Calculated 1 (raw)
30305-30306	Calculated 2 (raw)
30307 (upper bits)	Version
30307 (lower bits)	Signal Strength
30308	Battery Voltage
30309 (upper bits)	Sensor Trip 1 Alarm
30309 (lower bits)	Sensor Trip 1 Status
30310 (upper bits)	Sensor Trip 2 Alarm
30310 (lower bits)	Sensor Trip 2 Status
30311 (upper bits)	Sensor Trip 3 Alarm
30311 (lower bits)	Sensor Trip 3 Status
30312 (upper bits)	Sensor Trip 4 Alarm
30312 (lower bits)	Sensor Trip 4 Status

This is the list of generic Input Registers for polling the LOE and any connected sensors. Actual registers used vary by sensor. Please see the user manual for each sensor for a full and accurate list of registers.

## Chapter 4: LOE Embedded Web Server

- **Accessing the LOE Embedded Web Server**

See the Software Setup section of chapter 2 (pages 9 - 11) for instructions for accessing and signing into the LOE embedded web server.

- **Navigating the LOE Embedded Web Server**

The LOE embedded web server has two primary screens--the Main Display Page (Figure 4.1) and Menu Page (Figure 4.2)--and a screen for each of 9 submenus. The submenus can be understood in three groups:

- LOE Sensor Input Configuration Submenus
  - Application Parameters
  - Basic Parameters
- Modbus Sensor Configuration Registers
  - RS-485 Modbus Input Reg
  - RS-485 Modbus Holding 1
  - RS-485 Modbus Holding 2
- LOE Utility Menus
  - Network
  - Security
  - Label
  - RS-485 Network Settings

The Menu Page also has a link back to the Main Display Page.

Sensor #	Description	Reading	Units
11 (LOE)		73	Gallons
Refresh		Home	

Figure 4.1

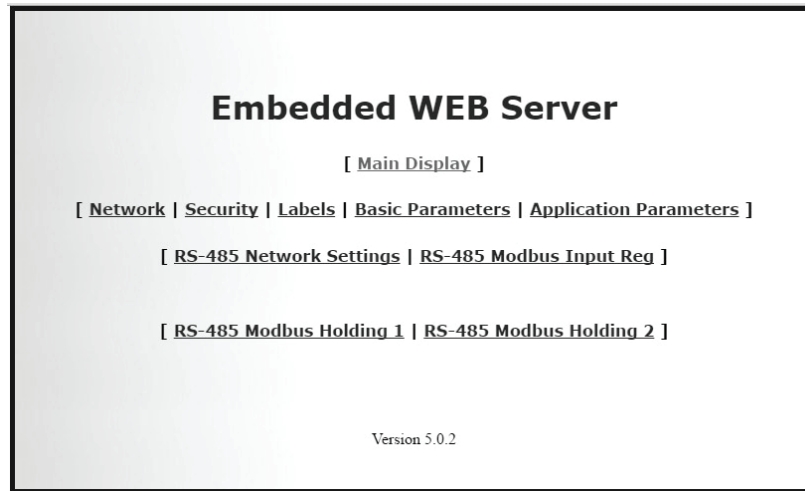


Figure 4.2

- **LOE Sensor Configuration Submenus**

## LOE Application Parameters

Application Parameters		
Parameters	Information	Values
▶ Units	1=feet,2=inches,3=meters	1
▶ Decimal Place	0-3	2
▶ Full Distance	0.00-15.00 Feet	0.50
▶ Empty Distance	0.00-15.00 Feet	6.00
▶ Application Type	HoriCylTank Sphericalends	5
▶ Volume Units	Gallons	3
▶ Tank Parameter 1	Tank Length Feet	10.00
▶ Tank Parameter 2	Tank Diameter Feet	6.00
▶ Tank Parameter 3	Radius of Hemisphere Ends Feet	3.00
▶ Tank Parameter 4	Not Used	0.00
▶ Tank Parameter 5	Not Used	0.00

Figure 4.3

The Application Parameters menu configures the application-specific parameters applied to the calculated reading from the LOE sensor.

PARAMETER	RANGE
<i>Units</i>	1 - feet 2 - inches 3 - meters

*Units* is used to select the units of measurement for distance or level applications. The units will also determine the resolution of Basic and Application Parameters. The resolution is: feet 0.01, inches 0.1, and meters 0.001.

PARAMETER	RANGE
<i>Decimal Place</i>	0 - 3

*Decimal Place* determines the number of decimal places shown on the output reading (see Figure 4.1). As the output reading is used for setting/evaluating *Trip Distance* and *Window*, the *Decimal Place* setting applies to those parameters as well.

<b>PARAMETER</b>	<b>RANGE</b>
<i>Full Distance</i>	0 - Sensor Maximum

*Full Distance* sets the distance from the LOE sensor Zero Point (See Figures 4.5 - 4.7) to the full level of the vessel being monitored. Not used when Application Type is set to 0 (Value).

<b>PARAMETER</b>	<b>RANGE</b>
<i>Empty Distance</i>	0 - Sensor Maximum

*Empty Distance* sets the distance from the LOE sensor Zero Point (See Figure 4.5 - 4.7) to the empty level of the vessel being monitored. Not used when Application Type is set to 0 (Value).

<b>PARAMETER</b>	<b>RANGE</b>
<i>Application Type</i>	0 = Value (Distance) 1 = Level 2 = Volume of Standing Cylindrical Tank with or without Hemispherical Bottom 3 = Volume of Standing Cylindrical Tank with or without Conical Bottom 4 = Volume of Standing Rectangular Tank with or without Chute Bottom 5 = Volume of Horizontal Cylindrical Tank with or without Spherical Ends 6 = Volume of Spherical Tank 7 = Pounds (Linear Scaling) 8 = User Defined Units 9 = Volume of Vertical Oval Tank 10 = Volume of Horizontal Oval Tank 11 = Polynomial (Strapping Chart)

*Application Type* is used to choose the parameter configuration to convert the distance of *Distance* into the configured reading on the Main Display Page (See Figure 4.1; also, *Calc Dist, Level, Volume* on Figure 4.4). After selecting an *Application Type* and clicking "Change" or pressing Enter, the Application Parameters menu updates to reflect the parameters of the chosen application.

See *Tank Parameters* for an explanation of each *Application Type* and its associated parameters.

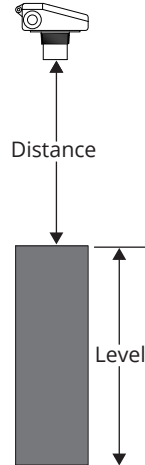
<b>PARAMETER</b>	<b>RANGE</b>
<i>Volume Units</i>	1 = Feet <sup>3</sup> 2 = Million Feet <sup>3</sup> 3 = Gallons 4 = Meters <sup>3</sup> 5 = Liters 6 = Inches <sup>3</sup> 7 = Barrels

*Volume Units* selects the units of measure for the configured reading on the Main Display Page (See Figure 4.1) when a volumetric application is selected. The settings is not used when the Application Type is set to 0, 1, 7, or 8.

## Tank Parameters

Application Type	Tank Parameter	Function
0 - Distance	Parameter 1	Not Used
	Parameter 2	Not Used
	Parameter 3	Not Used
	Parameter 4	Not Used
	Parameter 5	Not Used

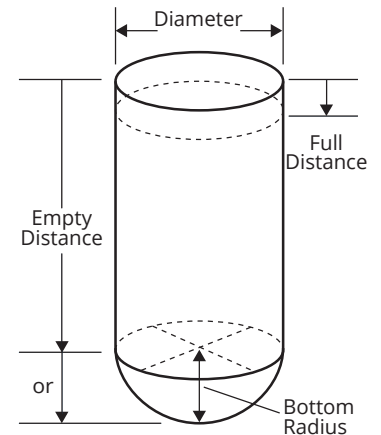
*Distance* (factory default) measures the distance from the Zero Point of the LOE sensor to the target surface.



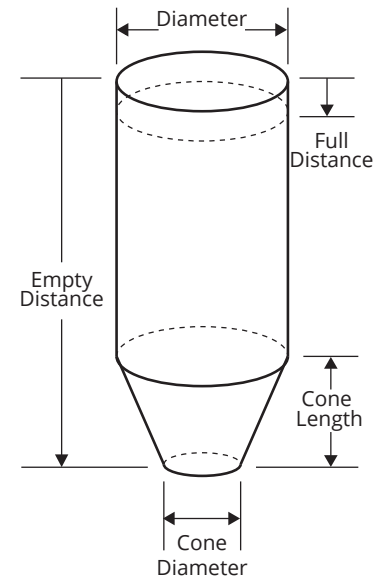
Application Type	Tank Parameter	Function
1 - Level	Parameter 1	Not Used
	Parameter 2	Not Used
	Parameter 3	Not Used
	Parameter 4	Not Used
	Parameter 5	Not Used

*Level* calculates the depth (level) of the vessel being monitored, based on the *Full Distance* and *Empty Distance*.

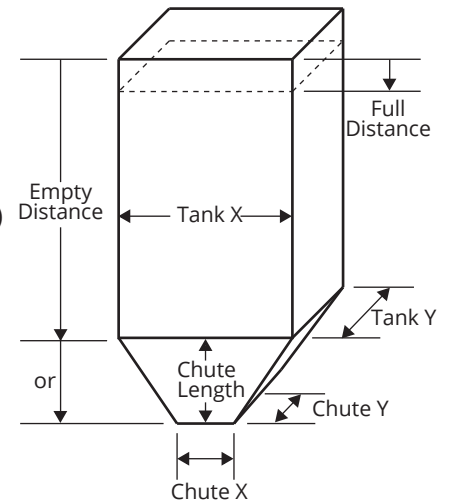
Application Type	Tank Parameter	Function
2 - Standing Cylindrical Tank with Hemispherical Bottom	Parameter 1	Tank Diameter
	Parameter 2	Bottom Radius
	Parameter 3	Not Used
	Parameter 4	Not Used
	Parameter 5	Not Used



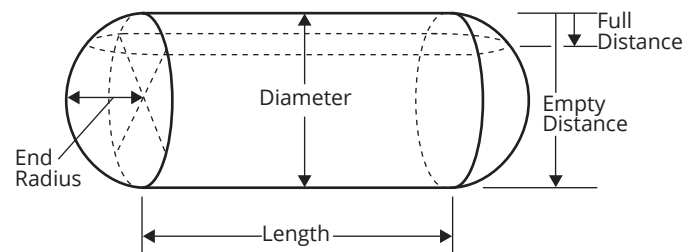
<b>Application Type</b>	<b>Tank Parameter</b>	<b>Function</b>
3 - Standing Cylindrical	Parameter 1	Tank Diameter
Tank with	Parameter 2	Bottom Radius
Conical	Parameter 3	Cone Length (Height)
Bottom	Parameter 4	Not Used
	Parameter 5	Not Used



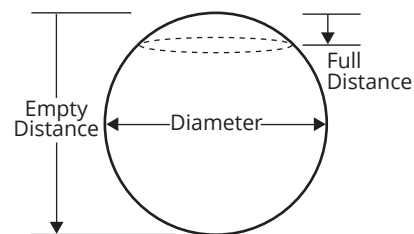
<b>Application Type</b>	<b>Tank Parameter</b>	<b>Function</b>
4 - Standing Rectangular	Parameter 1	Tank X Dimension
Tank with	Parameter 2	Tank Y Dimension
Chute	Parameter 3	Chute X Dimension
	Parameter 4	Chute Y Dimension
	Parameter 5	Chute Length (Height)



<b>Application Type</b>	<b>Tank Parameter</b>	<b>Function</b>
5 - Horizontal Cylindrical	Parameter 1	Tank Length
Tank with	Parameter 2	Tank Diameter
Spherical Ends	Parameter 3	Radius of Ends
	Parameter 4	Not Used
	Parameter 5	Not Used



<b>Application Type</b>	<b>Tank Parameter</b>	<b>Function</b>
6 - Spherical Tank	Parameter 1	Tank Diameter
	Parameter 2	Not Used
	Parameter 3	Not Used
	Parameter 4	Not Used
	Parameter 5	Not Used



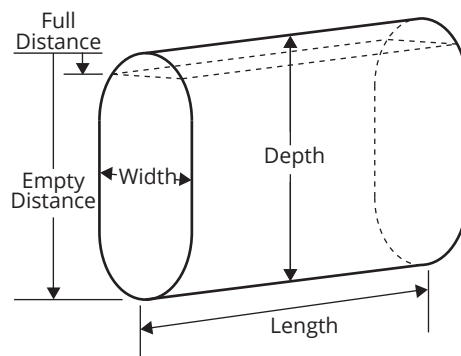
<b>Application Type</b>	<b>Tank Parameter</b>	<b>Function</b>
7 - Pounds (Linear Scaling)	Parameter 1	Multiplier
	Parameter 2	Unit Definition (label)
	Parameter 3	Not Used
	Parameter 4	Not Used
	Parameter 5	Not Used

*Pounds* allows for a multiplier (*Parameter 1*) to be applied to the calculated level measurement, creating a linear scalar as the output to configured reading on the Main Display Page. Such a multiplier could convert the distance or level measurement of a tank with simple geometry into a measurement of weight.

<b>Application Type</b>	<b>Tank Parameter</b>	<b>Function</b>
8 - User Defined Units	Parameter 1	Not Used
	Parameter 2	Not Used
	Parameter 3	Not Used
	Parameter 4	Not Used
	Parameter 5	Not Used

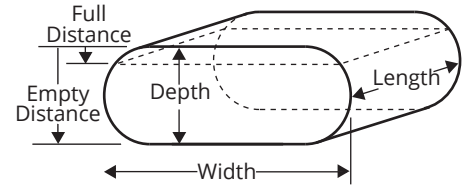
*User Defined Units* is not used by the LOE. *Application Type 8* can be selected, but after leaving the Application Parameters Menu, *Application Type* reverts to 0.

<b>Application Type</b>	<b>Tank Parameter</b>	<b>Function</b>
9 - Vertical Oval Tank	Parameter 1	Tank Length
	Parameter 2	Tank Depth
	Parameter 3	Tank Width
	Parameter 4	Not Used
	Parameter 5	Not Used





Application Type	Tank Parameter	Function
10 - Horizontal Oval Tank	Parameter 1	Tank Length
	Parameter 2	Tank Depth
	Parameter 3	Tank Width
	Parameter 4	Not Used
	Parameter 5	Not Used



Application Type	Tank Parameter	Function
11 - Polynomial (Strapping Chart)	Parameter 1	X <sup>3</sup> Coefficient
	Parameter 2	X <sup>2</sup> Coefficient
	Parameter 3	X <sup>1</sup> Coefficient
	Parameter 4	X <sup>0</sup> Coefficient
	Parameter 5	Not Used

## Basic Parameters

Basic Parameters						
Parameters	Information	Values		Parameters	Information	Values
► Sensitivity	0 to 100	85		► Offset	-120.0 to +120.0 Inches	0.0
► Blanking	0-180.0 Inches	0.0		► Max Distance	24.0-180.0 Inches	180.0
► Pulses	0 to 20	16	Change	► Trip1 Dist	0-10,000.000	0.004
► Gain Control	0=Man,1=Auto,2=Hard,3=Soft,4=AutoS,5=AutoH	1		► Trip1 Window	0-10,000.000	0.001
► Average	1 to 32	20		► Trip1 Type Input	(18,28,30) 18=Alarm on ON Trip Input	18
► Window	0.0-180.0 Inches	3.0		► Trip2 Dist	On Time Limit (30-3600 Seconds)	30
► Out of Range Samples	0 to 250	20		► Trip2 Window	Relay On Time (Seconds)	28
► Sample Rate	1 to 10 Hertz	4		► Trip2 Type Input	(18,28,30) 30=Relay On Time Check Limit	30
► Multiplier	0 to 1.999	1.012		► Retry Time	30 to 3600 Seconds	30
► Temp Comp	0=Off,1=On	0				
			Call In	► Remote Call in Time	1 to 86400 Seconds	0 ( 3 )
► Distance	0.0-180.0 Inches	50.2 Inches		► Remote Bytes	8 or 160	8
► Calc Dist,Level,Volume	Gallons	164.464	Refresh			
► Signal Strength	0-100(100=Best),Pulses,Sensit,Blank(Feet)	20, 13, 9, 0.00		► Trip1 Status	Green=ON Red=OFF	Trip1 ON
► Temperature	Readout in Celsius	26 C	Home	► Trip2 Status	Green=ON Red=OFF	Trip2 ON

Figure 4.4

<b>PARAMETER</b>	<b>RANGE</b>
<i>Sensitivity</i>	0 - 100%

*Sensitivity* sets the level of gain that is applied to the echo. When operating in AutoSense, Hard-Target, or Soft-Target (see *Gain Control*), *Sensitivity* sets an upper limit for the amplification that can be applied to the echo. If operating in Manual, this parameter sets the gain.

When using manual gain control, set *Sensitivity* to the minimum value that will allow the target to be reliably tracked through the full range of expected environmental conditions.

**i** IMPORTANT: Parameter values stored on the LOE will not update until the “Change” button is clicked or the Enter key is pressed.

<b>PARAMETER</b>	<b>RANGE</b>
<i>Blanking</i>	Determined by sensor model

*Blanking* sets the blanking distance, which is the zone from the Zero Point of the sensor to the point from which the first echo will be accepted. While blanking distance can be used to ignore unwanted targets--such as welds, seams, pipe fittings, or gaskets--between the sensor and the closest acceptable target level, such objects generally create additional reflections and echoes, which are hard to filter out. More often, blanking distance is used for a sensor installed in a stand pipe.

Because of the physical properties of an ultrasonic sensor, objects cannot be detected closer than approximately 1 foot from the face of most transducers (5 inches for LOE-7126, 7 inches for LOE-6126). However, this distance varies according to how much energy is being transmitted (*Pulses*) and the installation.

**i** IMPORTANT: *Blanking* is always measured from the Zero Point of the sensor. See Figures 4.5 - 4.7.

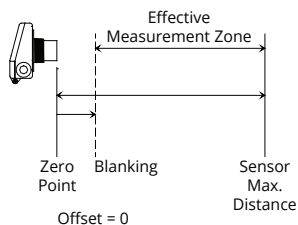


Figure 4.5

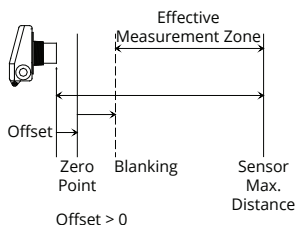


Figure 4.6

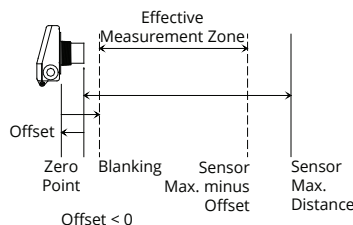


Figure 4.7

PARAMETER	RANGE
-----------	-------

<i>Pulses</i>	0-20
---------------	------

*Pulses* sets the maximum number of pulses the sensor can transmit when operating in AutoSense, Hard-Target, or Soft-Target (see *Gain Control*), or sets the number of pulses when operating in Manual. The more pulses that are sent in a burst, the stronger the returning echo.

When operating in Manual, increase the strength of the transmission by increasing *Pulses* for detecting soft targets in damping environments. In acoustically active environments or small enclosed areas, decrease *Pulses* to reduce multiple echoes.

PARAMETER	RANGE
-----------	-------

<i>Gain Control</i>	0 = Manual 1 = AutoSense 2 = Hard-Target 3 = Soft-Target 4 = Auto-Soft Target 5 = Auto-Hard Target
---------------------	---

*Gain Control* selects the control mode for the LOE sensor's gain settings (*Sensitivity* and *Pulses*). In AutoSense, the sensor automatically adjusts the sensitivity and pulses for the best quality return signal. Manual, Hard Target, and Soft Target are user controlled scenarios. In Manual, the user is in full control of *Sensitivity* and *Pulses*. For Hard and Soft Target, the user sets maximum *Sensitivity* and *Pulses*, but the overall gain is either ramped up slowly (Hard Target) or quickly (Soft Target) by the sensor.

PARAMETER	RANGE
-----------	-------

<i>Average</i>	1-32
----------------	------

*Average* sets the number of qualified samples to average for the displayed reading. Qualified samples are placed in a first-in, first-out buffer, the contents of which are averaged for *Distance*. The larger the number of qualified samples being averaged, the smoother the *Distance* reading will be, and the slower the reading will be to react to quick changes.

<b>PARAMETER</b>	<b>RANGE</b>
<i>Window</i>	0 - Sensor Maximum

*Window* determines the corresponding physical range for qualified samples, based on the current *Distance*. Samples beyond the +/- *Window* range of the current *Distance* will not qualify unless the average moves. Samples outside the extents of the *Window* are written to the *Out of Range Samples* buffer. (See Figure 4.8.)

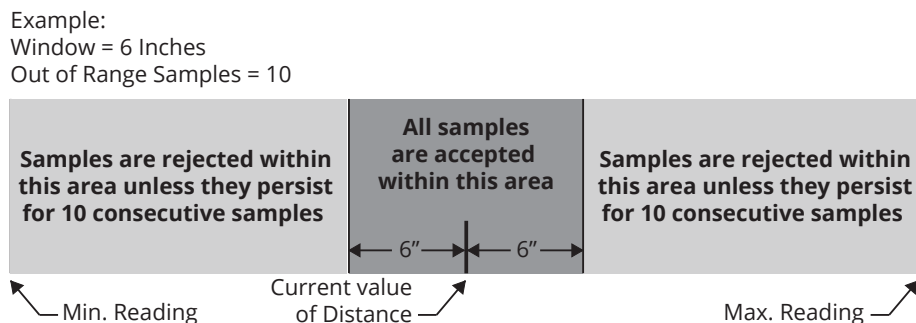


Figure 4.8

<b>PARAMETER</b>	<b>RANGE</b>
<i>Out of Range Samples</i>	0-250

*Out of Range Samples* sets the number of consecutive samples outside the *Window* necessary to automatically adjust the current *Distance* and move the *Window*.

<b>PARAMETER</b>	<b>RANGE</b>
<i>Sample Rate</i>	1 - 20 Hz

*Sample Rate* is the number of sample readings taken by the LOE every second.

<b>PARAMETER</b>	<b>RANGE</b>
<i>Multiplier</i>	0 - 1.999

*Multiplier* is used to calibrate the LOE sensor for variations in the speed of sound due to variations in atmospheres. The default of 1.000 is used for most applications.

<b>PARAMETER</b>	<b>RANGE</b>
<i>Temp Comp.</i>	0 = Off 1 = On

*Temperature Compensation* activates or deactivates the LOE's internal temperature compensation circuit. The speed of sound changes with changes in temperature, therefore changes in temperature can affect distance measurements. These effects can be minimized by activating temperature compensation.

<b>PARAMETER</b>	<b>RANGE</b>
<i>Offset</i>	-10 ft - + 10ft

*Offset* is used to change the Zero Point of the LOE sensor. The Zero Point of the sensor is the point from which the calculated distance is measured. When the Offset is set to 0, the Zero Point of the sensor is at the face of the transducer (See Figure 4.5). A positive setting will move the Zero Point forward, in front of the sensor face (See Figure 4.6). Setting the Offset to a negative number will move the Zero Point backward, behind the sensor face (See Figure 4.7).

In all cases, Blanking is measured from the end of Offset, and the effective measurement zone of the sensor begins at the forward end of Blanking. If Offset is more negative than Blanking is positive, the net difference will be a loss in sensor maximum range (See Figure 4.7).

<b>PARAMETER</b>	<b>RANGE</b>
<i>Max Distance</i>	Determined by sensor model

*Maximum Distance* sets the maximum acceptable signal range (up to the physical maximum of the sensor), measured from the Zero Point. Signals beyond the *Maximum Distance* are ignored. Under Loss of Echo conditions, the *Distance* reading will display the *Maximum Distance*.

## LOE Readings

► Distance	0.00-15.00 Feet	0.09 Feet
► Calc Dist,Level,Volume	Gallons	2860.27
► Signal Strength	0-100(100=Best),Pulses,Sensit,Blank(Feet)	13, 15, 84, 0.00
► Temperature	Readout in Celsius	26 C

Figure 4.9

<b>Reading Type</b>	<b>Range</b>
<i>Distance</i>	Determined by model

*Distance* displays the distance from the sensor to the detected target in the units selected in the *Units* parameter in the Application Parameters Menu (See Figure 4.3). This reading is always Distance, regardless of the *Application Type* selected in the Application Parameters Menu. *Distance* is used for *Average* and *Window*.

<b>Reading Type</b>	<b>Range</b>
<i>Calc. Dist,Level,Volume</i>	Determined by vessel being measured

*Calc. Dist,Level,Volume* displays the configured output of the sensor. This is also shown on the Main Display. *Calc. Dist,Level,Volume* is used for Trip measurements.

<b>Reading Type</b>	<b>Range</b>
<i>Signal Strength</i>	0 - 100

*Signal Strength* displays the strength of the signal being received by the sensor. 0 represents the lowest quality signal, and 100 represents the highest quality.

<b>Reading Type</b>	<b>Range</b>
<i>Temperature</i>	

*Temperature* displays the current temperature of the thermal device in the LOE sensor body.

## LOE Trip Outputs and Settings

▶ Trip1 Dist	0.00-15.00 Feet	2.54
▶ Trip1 Window	0.00-15.00 Feet	1.04
▶ Trip1 Type Output	(0 to 29) 3=Far	3
▶ Trip2 Dist	0.00-15.00 Feet	3.04
▶ Trip2 Window	0.00-15.00 Feet	1.04
▶ Trip2 Type Output	(0 to 30) 3=Far	3

Figure 4.10

Figure 4.11

▶ Trip1 Status	Green=ON Red=OFF	Trip1 ON
▶ Trip2 Status	Green=ON Red=OFF	Trip2 ON

The LOE can have up to 2 output relays that can be configured to turn on or off based on the *Calc. Dist, Level, Volume* reading of the sensor.

Trip Type Outputs are configured with two independent digits: the first for Alarm Type (Blank, 1, or 2), and the second for Trip Condition (0-5, 7, or 9).

<b>PARAMETER</b>	<b>RANGE</b>
<i>Trip Distance</i>	0 - Sensor Max Distance

*Trip Distance* sets the value of the primary trip position, which is closest to the Zero Point of the sensor.

<b>PARAMETER</b>	<b>RANGE</b>
<i>Trip Window</i>	0 - Sensor Max Distance

*Trip Window* sets the value from the primary trip position to the secondary trip position, which is farther from the sensor's Zero Point.

<b>Alarm Type</b>
<i>Blank_ - No Alarm</i>

## Alarm Type

### 1\_ - Active Alarm

Designates the active trip point as a web alarm condition. To initiate web alarm whenever the Trip Condition 3 is ON, *Trip Type* would be set to **13**.

## Alarm Type

### 2\_ - Inactive Alarm

Designates an inactive trip point as a web alarm condition. To initiate a web alarm whenever the Trip Condition 3 is OFF, *Trip Type* would be set to **23**.

## Trip Condition

### 0 - Near

*Near* activates the Trip whenever the *Calc. Dist,Level,Volume* is less than the *Trip Distance* setting.

## Trip Condition

### 1 - Exclusive

*Exclusive* activates the Trip whenever the *Calc. Dist,Level,Volume* is less than the *Trip Distance* setting OR greater than the *Trip Distance + Trip Window* settings.

## Trip Condition

### 2 - Hysteresis Near

*Hysteresis Near* activates the Trip whenever the *Calc. Dist,Level,Volume* becomes less than the *Trip Distance* setting. The Trip remains activated until the *Calc. Dist,Level,Volume* becomes greater than the *Trip Distance + Trip Window* settings. The Trip then remains off until the *Calc. Dist,Level,Volume* becomes less than the *Trip Distance* setting again.

## Trip Condition

### 3 - Far

*Far* activates the Trip whenever the *Calc. Dist,Level,Volume* is greater than the *Trip Distance* setting.

## Trip Condition

### 4 - Inclusive

*Inclusive* activates the Trip whenever the *Calc. Dist,Level,Volume* is greater than the *Trip Distance* setting AND less than the *Trip Distance + Trip Window* settings.

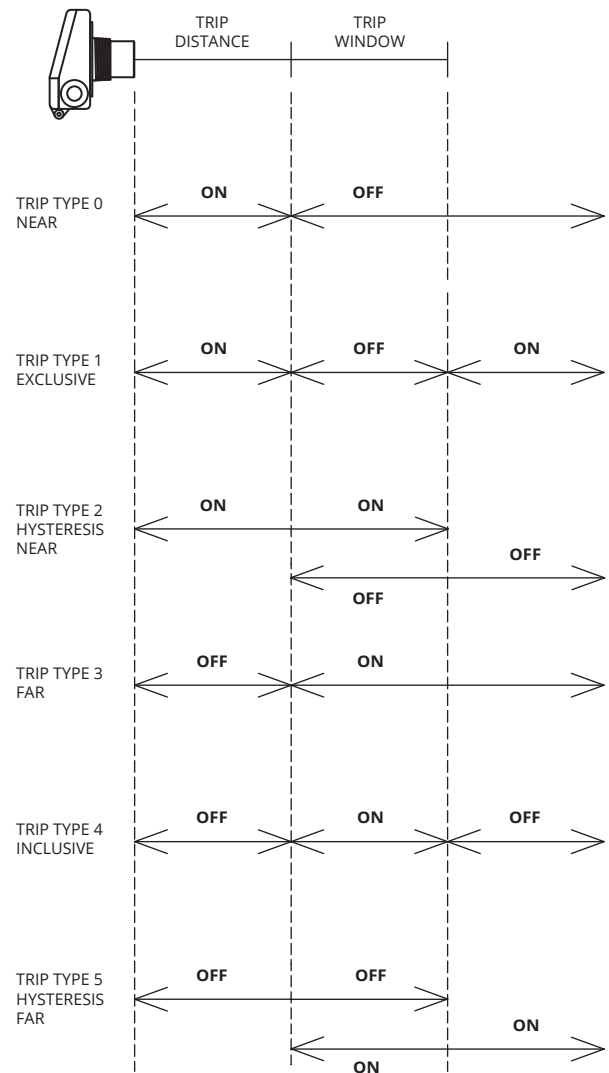


Figure 4.12

## Trip Condition

### 5 - Hysteresis Far

*Hysteresis Far* activates the Trip whenever the *Calc. Dist,Level,Volume* becomes greater than the *Trip Distance + Trip Window* settings. The Trip remains activated until the *Calc. Dist,Level,Volume* becomes less than the *Trip Value* setting. The Trip remains off until the *Calc. Dist,Level,Volume* becomes greater than the *Trip Distance + Trip Window* settings again.

## Trip Condition

### 6 - Disable Trip Relay

### 16 - Turn on Trip Relay

### 26 - N/A

*Disable* de-activates the Trip or SS Relay output.

## Trip Condition

### 7 - Loss of Echo

*Loss of Echo* activates the output when the maximum calculated reading is reached.

## Trip Condition

### 8 - Timed Interval

*Timed Interval* activates the output for a set amount of seconds every set amount of minutes (See Figure 4.13). When Trip Type is set to 8, *Trip Distance* and *Trip Window* are changed to "Interval Time (minutes)" and "On Time (seconds)".

## Trip Condition

### 9 - Abrupt Change

*Abrupt Change* activates the output whenever a user-defined maximum rate of level change (change in distance or level divided by elapsed time) is exceeded. *Trip Distance* defines the distance and *Trip Window* defines the time.

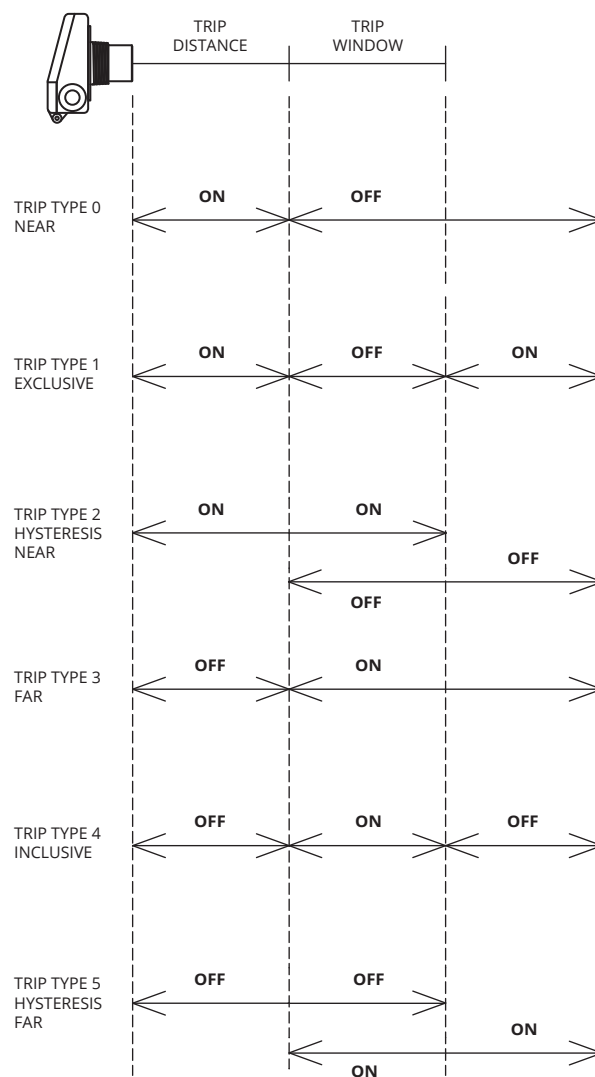


Figure 4.12

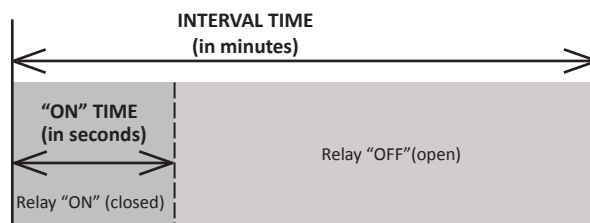


Figure 4.13



## LOE Trip Outputs and Settings

▶ Trip1 Dist	0-10,000.000	0.004
▶ Trip1 Window	0-10,000.000	0.001
▶ Trip1 Type Input	(18,28,30) 18=Alarm on ON Trip Input	18
▶ Trip2 Dist	On Time Limit (30-3600 Seconds)	30
▶ Trip2 Window	Relay On Time (Seconds)	28
▶ Trip2 Type Input	(18,28,30) 30=Relay On Time Check Limit	30

Figure 4.14

The LOE can have up to 2 input relays that can be tied to alarms on the remote APG-provided website. There are three alarm configurations for Trip Inputs: Alarm On on Input, Alarm Off on Input, and Relay On Time Check Limit.

### **Alarm Type**

*18 - Alarm on ON Trip Input*

*Alarm on ON Trip Input* activates the alarm when the input circuit is closed.

### **Alarm Type**

*28 - Alarm on OFF Trip Input*

*Alarm on OFF Trip Input* activates the alarm when the input circuit is opened.

### **Alarm Type**

*30 - Relay On Time Check Limit*

*Relay On Time Check Limit* generates an alarm when the input circuit has been closed past the time limit (in seconds) set in the Trip Dist (See Figure 4.14). Trip Window contains a running counter of the time (in seconds) the input circuit has been closed. The counter is cleared when the input circuit opens.

## External Website Communication Status

	▶ Retry Time	30 to 3600 Seconds	30
Call In	▶ Remote Call in Time	1 to 86400 Seconds	60 ( 45 )
	▶ Remote Bytes	8 or 160	8

Figure 4.15

The LOE embedded web server includes one parameter, a button, and two status reports for communication with the remote APG-provided website (i.e., [www.levelandflow.com](http://www.levelandflow.com)).

PARAMETER	RANGE
-----------	-------

<i>Retry Time</i>	30 - 180 Seconds
-------------------	------------------

*Retry Time* sets the time delay (in seconds) between attempts by the LOE to contact the external website.

BUTTON
--------

<i>Call In</i>
----------------

*Call In* forces the LOE to call in to the external website.

DISPLAY	RANGE
---------	-------

<i>Remote Call in Time</i>	1 - 86400 Seconds
----------------------------	-------------------

*Remote Call in Time* displays the duration of the last communication between the LOE and the external website.

DISPLAY	RANGE
---------	-------

<i>Remote Bytes</i>	8 or 160 Bytes
---------------------	----------------

*Remote Bytes* displays the number of bytes of data sent in the last communication between the LOE and the external website. 8 bytes indicates a normal, successful transmission. 160 bytes indicates an error occurred in the transmission.

- **Modbus Sensor Configuration Registers**

## RS-485 Modbus Input Registers

Modbus Input Registers Sensor #1 Comm Good		
Address	Value	Definition
30299	6	Sensor Type
30300	1767	Distance/level 1 (Top)
30301	0	Distance/level 2 (Bottom)
30302	21	Temperature C
30303-30304	69.566	Volume 1 Data
30305-30306	0.000	Volume 2 Data
30307	3	Version Number
30307	0	Signal Strength
30308	NA	Sensor Voltage
30309	Relay Off Alarm Off	Trip 1 Status
30310	Relay Off Alarm Off	Trip 2 Status
Refresh		Home

Figure 4.16

This display-only menu shows the contents of the Input Registers for the selected Modbus sensor (See Figure 2.8). Registers used vary by sensor type. Please see the user manual for each sensor for a full list of registers.

- Detected Sensor Type Number and Sensor Model Number List:

Sensor Type	Model Number	Sensor Type	Model Number
0	LOE-2126	9	PT-400/PT-500-L31 (Level)
1	LOE-6126	10	PT-400/PT-500-L5 (Pressure)
2	LOE-3136	11	DCR-1006A
3	LOE-7126	12	LPD
4	RST-5001	13	MND
5	MPX-E1/R1 (2 floats)	14	RST-5003/4
6	MPX-E1/R1 (1 float)	15	AUS-7123
7	PG-7	16	MTM-1000
8	PG-10		

Note: This list represents sensors that interface with various APG Modbus software packages. Not all interface with the LOE.

## RS-485 Modbus Holding 1

MODBUS Holding Registers 1 Sensor #1 Comm Good			
Address	Value	Definition	Value Restrictions
40401	2	Units	1=Feet 2=Inches 3=Meters
40402	0	Application Type = Distance	0=Distance 1=Level 2-7,9-11=Volume
40403	3	Volume Units = Gallons	1-7
40404	3	Decimal Place	0-3
40405	7620	Max Distance	0 to Max Distance mm
40406	304	Full Distance	0 to Max Distance mm
40407	2500	Empty Distance	0 to Max Distance mm
40408	100	Sensitivity	0-100
40409	20	Pulses	0-20
40410	300	Blanking	0 to Max Distance mm
40411	0	Gain Control	0-4
40412	2	Averaging / Response Time	0-20
40413	150	Filter Window	0 to Max Distance mm
40414	2	Out Of Range	0-255
40415	200	Sample Rate	10-1000
40416	1.011	Multiplier (Calibration)	0-1.999
40417	-10	Offset	-32000 to 32000 mm
40418	0	Fail Safe	0-2
40419	15	Fail Safe Delay	15-9999
40420	1	Temperature Compensation	0-1
<div> <div>Change</div> <div>Refresh</div> <div>Home</div> </div>			

Figure 4.17

This menu shows the contents of the first set of Holding Registers for the selected Modbus sensor (See Figure 2.8). The register names and value restrictions are automatically configured for the type of sensor detected (See Figure 4.16). Because register name and use varies by sensor, including a full breakdown of the registers in this manual would be counterproductive. Please see the user manual for each sensor for a full list of registers.

## RS-485 Modbus Holding 2

MODBUS Holding Registers 2 Sensor #1 Comm Good			
Address	Value	Definition	Value Restrictions
40421	0	RTD Offset	-100 C to 100 C
40422	0	Float Window	1-255
40423	0	1st Float Offset	-32000 to 32000 mm
40424	0	2nd Float Offset	-32000 to 32000 mm
40425	0	Gain Offset	0-255
40426	0	0 Volt / 4ma Set Point	0 to Max Distance mm
40427	0	5 Volt / 20ma Set Point	0 to Max Distance mm
40428	0	0 Volt / 4ma Calibration	0-4095
40429	0	5 Volt / 20ma Calibration	0-4095
40430	1000	Trip 1 Value	0 to Max Distance mm
40431	100	Trip 1 Window	0 to Max Distance mm
40432	6	Trip 1 Type	0-7
40433	2000	Trip 2 Value	0 to Max Distance mm
40434	200	Trip 2 Window	0 to Max Distance mm
40435	6	Trip 2 Type	0-7
40436-40437	0	Parameter 1 Data = Not Used	0-2147483647 mm
40438-40439	0	Parameter 2 Data = Not Used	0-2147483647 mm
40440-40441	0	Parameter 3 Data = Not Used	0-2147483647 mm
40442-40443	0	Parameter 4 Data = Not Used	0-2147483647 mm
40444-40445	0	Parameter 5 Data = Not Used	0-2147483647 mm
<div> <div>Change</div> <div>Refresh</div> <div>Home</div> </div>			

Figure 4.18

This menu shows the contents of the second set of Holding Registers for the selected Modbus sensor (See Figure 2.8). The register names and value restrictions are automatically configured for the type of sensor detected (See Figure 4.16). Because register name and use varies by sensor, including a full breakdown of the registers in this manual would be counterproductive. Please see the user manual for each sensor for a full list of registers.

- LOE Utilty Menus

## Network Settings

Network Settings		
▶ LAN IP Address	10.1.5.185	
▶ Remote IP Address	174.127.118.68	
▶ Subnet Mask	255.255.0.0	
▶ Default Gateway	10.1.1.1	
▶ Primary DNS Server	10.1.3.22	
▶ Secondary DNS Server	10.1.3.2	
▶ MAC Address	0.33.218.0.0.226	
▶ Port Number	6700	
▶ External Website Access On	<input checked="" type="checkbox"/> Checked = On	
▶ DHCP Success	<input checked="" type="checkbox"/> Checked = On	
▶ Alarm Filter On	<input checked="" type="checkbox"/> Checked = On	
▶ Domain Name	www.levelandflow.com	
▶ Domain Name IP Address	"174.127.118.68"	
▶ Serial Number	226	

Figure 4.19

Security Settings

Security Settings		
▶ User Name	<input type="text" value="admin"/>	
▶ Password	<input type="password" value="....."/>	
▶ Retype your password	<input type="password" value="....."/>	
<input type="button" value="Change"/>		<input type="button" value="Home"/>

Figure 4.20

The Security Settings allow users to set their own user name and password for logging into the embedded webpage.

Labels

Labels		
▶ Main Table Title	<input type="text"/>	
▶ LOE Description	<input type="text"/>	
▶ Modbus Sensor 1 Description	<input type="text"/>	
<input type="button" value="Change"/>		<input type="button" value="Refresh"/> <input type="button" value="Home"/>

Figure 4.21

The Labels menu allow users to create custom labels for the Main Menu, the LOE, and the sensors attached to the LOE.

Labels			
► Main Table Title		LOE System	
► LOE Description		Main LOE Tank	
Change		Refresh	Home

LOE System			
Sensor #	Description	Reading	Units
11 (LOE)	Main LOE Tank	9	Gallons
Refresh		Home	

Figure 4.22

When labels are created in the Labels menu, they will be reflected on the Main Menu page (See Figure 4.22).

## RS-485 Network Settings

RS-485 Network Settings		
Definition	Range	Value
9600 Baud	Checked	<input checked="" type="checkbox"/> 9600 Baud
Numb of Sensors On Line	0 to 10	0 <input type="text"/>
Sensor Number to View	1 to 10	1 <input type="text"/>
New Sensor Number	0=No Change or 1 to 10	0 <input type="text"/>
RS485 Sample Rate	1 to 20 Seconds	1 <input type="text"/>
Change		Refresh Home

Figure 4.23




The RS-485 (Modbus) Settings menu controls the settings for the Modbus sensors (up to 10) attached to the LOE.

<b>PARAMETER</b>	<b>RANGE</b>
<i>Baud Rate Checkbox</i>	9600 Baud

*Baud Rate Checkbox* is used to select the baud rate of the of the sensors connected to the LOE. All APG Modbus sensors communicate at 9600 Baud.

<b>PARAMETER</b>	<b>RANGE</b>
<i>Numb of Sensors On Line</i>	0 - 10

*Numb of Sensors On Line* sets the number Modbus sensors connected to the LOE. This setting is not automatically populated or updated. The user must change the setting manually. *Numb of Sensors On Line* must always be equal or greater than the number of actual sensors attached to the LOE.


 **NOTE:** For best results, set Numb of Sensors On Line to the highest number of number of sensor TO BE connected. No further adjustments will be needed as those sensors are connected to the LOE.

<b>PARAMETER</b>	<b>RANGE</b>
<i>Sensor Number to View</i>	1 - 10

*Sensor Number to View* selects number of the sensor for the LOE to poll for populating the Main Menu and for editing parameters in the Modbus Holding Register menus.

<b>PARAMETER</b>	<b>RANGE</b>
<i>New Sensor Number</i>	0 = No Change 1 - 10

*New Sensor Number* changes the sensor number assigned to the sensor selected by *Sensor Number to View*.

 **IMPORTANT:** When “Change” is pressed to assign a new sensor number, *Sensor Number to View* DOES NOT update.

<b>PARAMETER</b>	<b>RANGE</b>
<i>RS485 Sample Rate</i>	1 - 20 Seconds

*RS485 Sample Rate* determines how often the LOE polls the selected Modbus sensor.

# Chapter 5: Maintenance

## • General Care

Your LOE series controller is very low maintenance and will need little care as long as it is installed correctly. However, in general, you should:

- Avoid applications for which the sensor was not designed, such as extreme temperatures, contact with incompatible corrosive chemicals and fumes, or other damaging environments.
- Inspect the threads whenever you remove the sensor from duty or change its location.

## • Troubleshooting

Should you have problems with your LOE Ultrasonic Sensor, here are some troubleshooting steps.

- Check the received signal strength (See Figure 4.9). If the signal strength is low, alternately increase Pulses and Sensitivity (See Figure 4.4) until the signal strength improves.
- Ensure Temperature Compensation (See Figure 4.4) is On (set to 1).
- Set the Gain Control to AutoSense (See Figure 4.4).
- Ensure that Blanking (See Figure 4.4) is accurately set to account for any unwanted targets between the sensor and the closest acceptable target (See Figures 4.5 - 4.7).

Should you have problems with your LOE Modbus Network Controller, here are some troubleshooting steps.

- Check the Modbus Network connections at the LOE and at each of the attached sensors.
- Ensure that each attached sensor has been assigned a **unique** Sensor Number (Figure 4.23; Assigning Modbus Sensor Numbers, page 12).
- Check the Holding Register Settings for each attached sensor (Figures 4.17 and 4.18).

## • Calibration

This procedure uses targets at known distances to calibrate the LOE sensor's accuracy. A wall or other large, flat object is recommended for the long range target.

- Point the sensor at a target at a known distance near the maximum range of the sensor (See Figure 5.1).
- Adjust the Multiplier value until the distance reading on the sensor matches the actual measured distance to the target (See Figure 4.4).
- Point the sensor at a target near the minimum measurement range, 1' plus any Blanking distance (See Figure 5.2).
- Adjust the Offset value until the distance reading on the sensor matches the actual measured distance to the target (See Figure 4.4).
- Repeat previous two steps until no further adjustment is required.



Figure 5.1

Figure 5.2

## • Repair and Returns

Should your LOE require service, please contact the factory via phone, email, or online chat. We will issue you a Return Material Authorization (RMA) number with instructions.

Please have your LOE's part number and serial number available. See Warranty and Warranty Restrictions for more information.