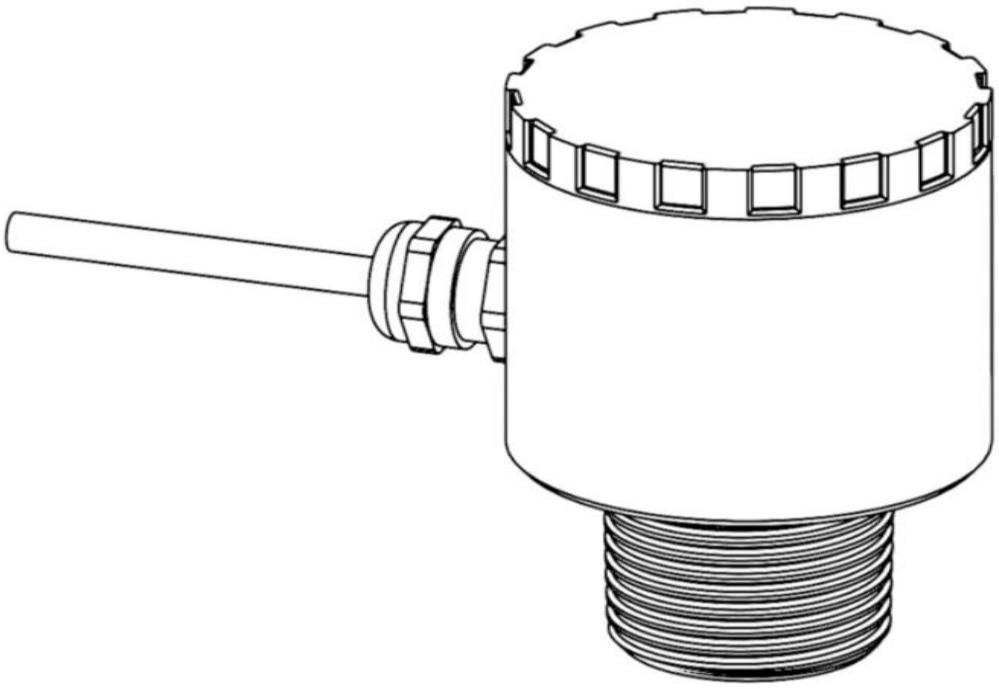
ANFIELD
SENSORS INC.



ULS

Owner's Manual

Version: 0.0
Released: 12/2021

1 General Description

The ultrasonic level sensor measures level or distance and has a 4-20 mA analog output and 4 digital outputs. It is a robust option for level sensing that offers flexibility and precision. The device is configurable either by push-button programming with a LED display or through a USB software interface.

2 Features and Benefits

- Non-contact continuous level measurement with analog output, four switches and control functions for distance of up to 82.68" (2.1 m),
- Fast programming through USB software interface or field-adjustable programming through push button interface and display,
- LED display indicates current measurement in inches or centimeters with 0.01" (1 mm) resolution,
- Precise 12-bit 4-20 mA output with invert 20-4 mA option,
- Four programmable relays each able to handle up to 200 mA peak load current,
- Selectable signal processing, fluid compensation, failsafe features that enable optimization for installation,
- Robust all-metal enclosure with 316SS port for corrosive environments,
- Automatic temperature compensation for accurate measurements.

3 Table of Contents

4 Specifications

Performance	
Sensing accuracy[1]	0.5% of maximum operating distance (perpendicular to surface)
Sensing resolution	0.027" (0.69 mm)
Minimum operating distance[3]	5.4" (138 mm)
Maximum operating distance[3]	82.68" (2.1 m)
Temperature error[2]	2%
Transducer	
Beam angle	12° ± 2°
Deadband[3]	4.33" (110 mm)
Ultrasonic frequency	112 kHz ± 4.5 kHz
Interface	
User interface	Field adjustable (push buttons and display) Software adjustable (Microsoft® Windows® with micro-B USB)
Display resolution	0.01" (1 mm)
Memory	Non-volatile
Electrical	
Supply voltage	10 – 30 V_{DC} (100 mA maximum)
Maximum power consumption	1.2 W
Analog output	12-bit 4-20 mA output
Analog conversion error	<0.5%
Signal failsafe	2 mA, 4 mA, 20 mA, 22 mA or hold last
Hysteresis	Adjustable
Contact type	(4) Normally open SPST relays (48 V_{DC} 200 mA peak load current)
Contact failsafe	Power loss: open
Environment	
Ambient temperature	14 °F to 140 °F (-10 °C to 60 °C)
Enclosure rating	IP 65
Enclosure material	Powder coated aluminum
Transducer material	Glass reinforced epoxy
Cable jacket material	PVC
Cable type	8-conductor, shielded
Process connection	1" NPT (Stainless Steel)

[1] - Accuracy specification in stable homogeneous standard environments (affected by temperature gradients, vapors, supply voltage).

[2] - Thermal error specification defined for supply voltage of 12V and 24V. Error may be larger for other voltage inputs or due to localized heating of tank or sensor.

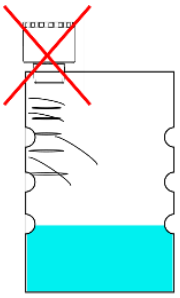
[3] - Operating distances referenced from bottom of enclosure. Deadband referenced from sensor bottom.

5 Installation

Locating the ULS and Application Considerations

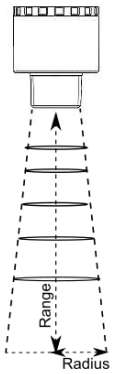
The ultrasonic level sensor (ULS) is a non-contact distance measurement device that uses a sound wave that is sent out from the bottom of the sensor to the target medium and returned back to the sensor. Due to the operating principle of the ULS, the positioning of your device in your application needs to account for how the sensor signal is transmitted to ensure proper measurement in all boundaries of operation.

Positioning of the Mount



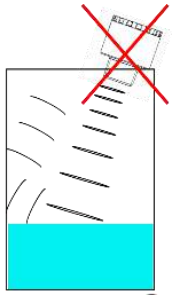
As the sound wave generated from the device travels through air, it will grow in size. This larger size creates a greater detection area at further distances. But, this detection area has a drawback; it needs to be clear of any object or interference that could reflect the sound wave.

The simplest approach is to position the mount away from walls and obstructions ensuring that the obstructions are further than the beam radius using the following guideline:



Operating Range [feet]	Operating Range [cm]	Beam Radius [inch]	Beam Radius [cm]
0.33	10	1	2.5
0.66	20	1.4	3.6
1	30	2	5.1
2	61	3.5	8.89
3	91	5	12.7
4	122	6.5	16.5
5	152	8	20.3
6	183	9.5	24.1
6.56	200	10	25.4

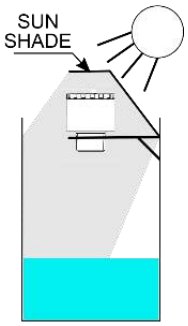
Orientation of the ULS



The device can accommodate perpendicularity errors between the thread axis and the stationary fluid surface of ± 3°. As the orientation error increases, the device at first will lose maximum range as the reflected signal strength decreases until no reflected sound is transmitted to the device and the signal is not received.

NOTE: If signal is not received, a LOSS warning will appear on the display and will default to failsafe settings. Generally, signal loss is caused by perpendicularity errors or exceeding device's maximum operating range.

Temperature



The device measures the level or distance by calculating the speed that the sound wave travelled through the air and compensates for temperature variation using an internal sensor. For accurate temperature measurement, there are two possible errors:

Error Source 1: Unit's operating temperature is biased from external inputs.

- Protect the unit from all external heat sources such as sunlight by using a thin, reflective and low emissivity radiant barrier between the unit and the heat source.

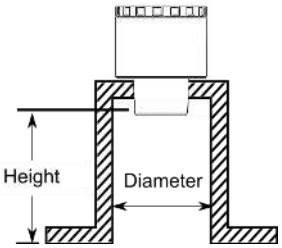
Error Source 2: Tank temperature is not the same as ambient temperature.

- Ideally keep tank and sensor at ambient temperature. A variation between temperatures will cause the sensor to measure incorrectly.

Riser

After sending a sound wave, an ultrasonic sensor needs time to settle before it can start listening for the echo. This time delay results in a distance that cannot reliably measure because it is not listening which is commonly called the deadband, or minimum operating distance. If the target medium were to enter the deadband, the device may not be able to consistently measure any target. It is mandatory that the unit is positioned away from the target medium to avoid the deadband.

If your fluid tank needs to be fully filled, then the unit will need to be placed on a riser. The following is the recommended riser guidelines.



Inner Diameter	Maximum Standpipe Height
2 “ (5 cm)	4” (10 cm)
4 ” (10 cm)	8” (20 cm)
6 ” (15 cm)	12” (30 cm)

NOTE: The inner rim of the standpipe must be smooth and free of burrs.

Foams

The surface quality of your target can impact the strength of the return signal causing sensing issues. If the target surface has a foam layer, the amount of energy reflected in the return echo will be reduced. If possible, mounting the unit in a location with minimal foam is the best practice. If the location is fixed, then using a stilling well is necessary to avoid signal issues from foam.

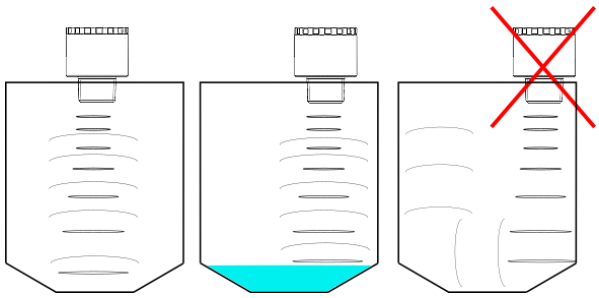
Vapors

The device is configured for measurements in air. If the tank is closed and contains liquids that create vapors, it will affect the accuracy of the measurement and may impact the maximum operating distance.

Tank Shapes

In some cases, the shape of the tank can cause inconsistent measurements by the way the signal reflects in the tank. Validate that the unit is placed using the following guidelines:

1. Tank top
   - Do not install the unit in the center of a dome top tank. The ideal mount position for cylindrical tanks is between 1/3 and 1/2 of the radius of the tank.
2. Tank bottom
   - Cone and rounded bottom tanks can have issues depending upon unit placement and fluid level. The sensor signal may be lost if the fluid level lowers such that the angled or curved tank wall that is exposed, which the sensor is directly above, reflects the sensor signal. The reflected sound wave may not return to the unit or it can provide inaccurate measurements.

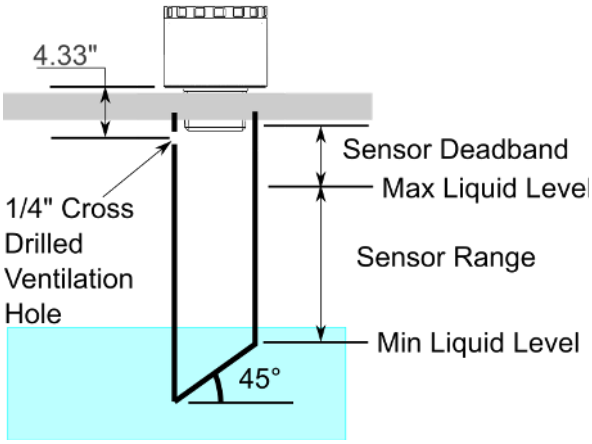


Stilling Well

A stilling well is a pipe that goes below the minimum level of the fluid. The stilling well allows for easy mounting: it can be near obstructions, reduces orientation requirements, avoids foam's negative influence on the sensor and reduces turbulence of the fluid.

A stilling well should have these features:

1. The stilling well pipe can made of any material,
2. Select a pipe that is 2" ID (51 mm) or greater,
3. Attach the ULS to the stilling well with a coupling and a reducer bushing,
   - Use a plastic fitting such as P/N TM3216
4. The stilling well should exceed the sensing range of the application,
   - The bottom of the pipe should always be submerged to avoid foam from entering the pipe
5. A 1/4" cross drilled ventilation hole within the sensor deadband,
6. A 45° angle cut on the bottom of the pipe if there is a chance the fluid will lower more than the pipe bottom,



7. The placement of the unit should be away from pumps as the level will vary during pump operation.

NOTE: The pipe bottom should never be exposed to air. If exposed to air, the reflected sound may not return to the sensor.

Mounts

For ease of installation, it is suggested that the non-metallic fittings be used. The unit should only be tightened to finger-tight (15 inlb to 20 inlb). The following are the recommended fittings for your application:

1) Installation in existing fittings or with stilling wells
   - The isolation mount, P/N TM3216, provides excellent isolation between the sensor and a metallic fitting. The isolation mount can be threaded directly into a 2" NPT adaptor, or it can be threaded into a pipe adaptor and a threaded pipe.
2) Installation on a tank with a flange
   - The flange mount, P/N FM16, can be mounted directly to a tank. It uses a 4-bolt-circle pattern at 3.125" [79.4 mm]. Flange gaskets are sold separately.

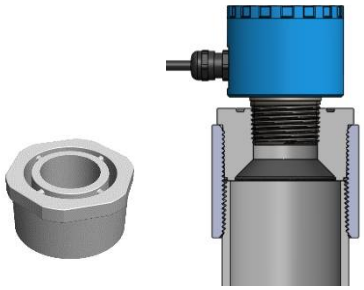


Figure 1: P/N TM3216 (left) and in a stilling well (right)

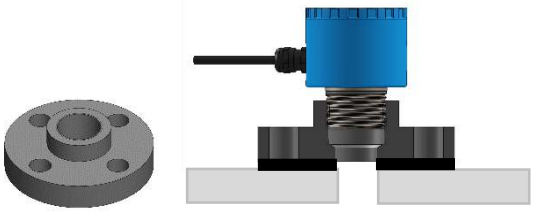
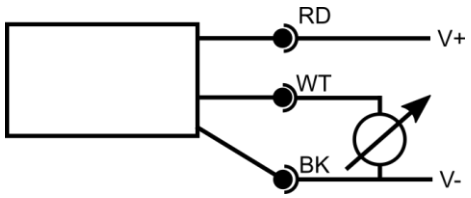


Figure 2: P/N FM16 (left) and on a tank (right)

6 Electrical Connection

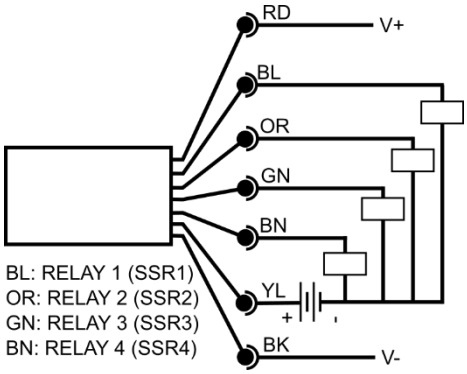
Depending upon your device configuration, some wire may not be used. Terminate unused wires.

Current Output Connection

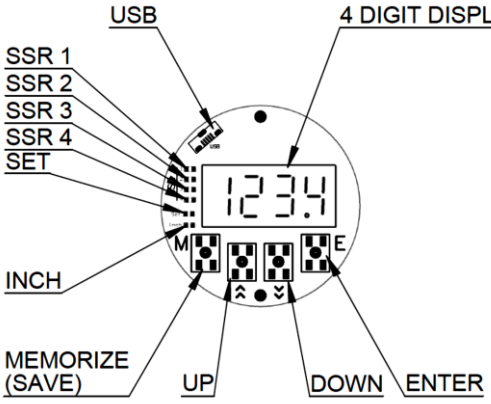


Wire Color		*Description*
RD	Red	+VDC (10-30 V_{DC} 100 mA)
BK	Black	-VDC
WT	White	4-20 mA output
YL	Yellow	Relay Common
BL	Blue	Relay 1 (SSR1)
OR	Orange	Relay 2 (SSR2)
GN	Green	Relay 3 (SSR3)
BN	Brown	Relay 4 (SSR4)

Relay Output Connection



7 Display Elements



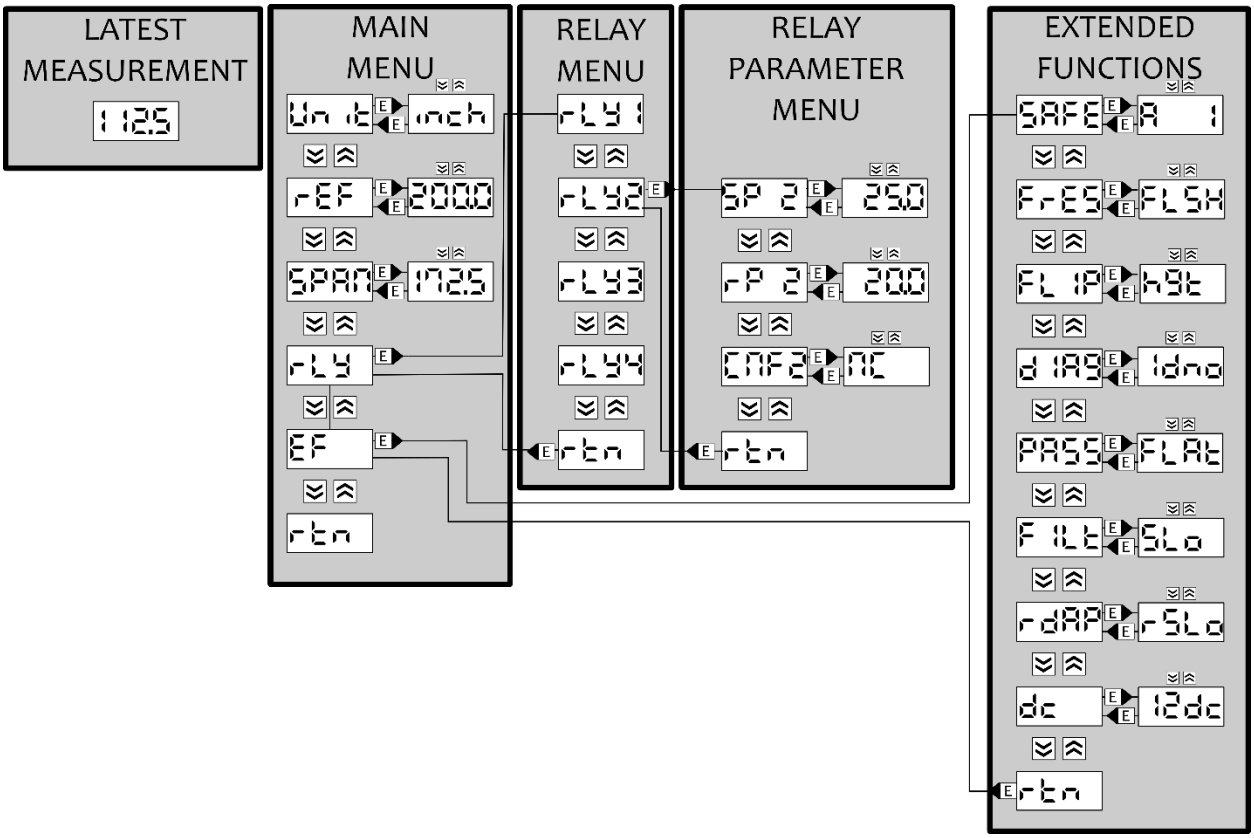
M	Memorize
⩓	Up
⩔	Down
E	Enter

1	Relay 1 (SSR1) Make Status LED
2	Relay 2 (SSR2) Make Status LED
3	Relay 3 (SSR3) Make Status LED
4	Relay 4 (SSR4) Make Status LED
Set	Settings Mode LED
Inch	Inch Mode LED
USB	USB Communication Port

The device has a 4-digit LED display with status LEDs on the side. The display shows either the current measurement (in inches or centimeter) or the menu parameter. Following is a breakdown of the pushbutton menu.

8 Menu Hierarchy

NOTE: The displayed parameters are an example. Your parameters may not be setup to the same values.



Explanation of Run Mode

(blank)	Display off / quick press any key to wake up screen.
1905	Latest measurement / displays latest filtered measurement based upon system units, reference (height/level mode) or distance from sensor datum (distance mode).
UL	Under limit warning / measurement is below minimum operating distance. If it persists, • Ensure no object (burr, weld, target) within deadband, • Ensure unit is not over-tightened.
OL	Over limit warning / measurement is above maximum operating distance. If it persists, • Check installation to maximize operating distance, • Ensure target is within maximum operating distance
LOSS	Signal loss / sensor does not receive an acceptable signal. If it persists, • Ensure target is within operating distance, • Check unit alignment to target surface.

Explanation of Menus

Explanation of main menu

Un it	System unit setting / selection between inches [inch] and centimeters [cent].
rEF	Zero reference parameter defines zero when in level measurement mode. Used for defining the 4 mA output and acts as a relay distance parameter limit. See *Setting* the Zero Reference Value for details.
SPAN	Maximum level for fluid sensing using reference parameter as zero. Used for defining the 20 mA output and acts as a relay distance parameter limit. See *Setting the Span Value* for details.
rLY	Relay menu / selection opens relay menu.
EF	Extended functions / selection opens extended functions menu.
rtn	Exit main menu and return to current measurement.

Explanation of relay menu

rLY 1	Relay 1 parameter menu / selection opens the relay 1 parameter menu.
rLY2	Relay 2 parameter menu / selection opens the relay 2 parameter menu.
rLY3	Relay 3 parameter menu / selection opens the relay 3 parameter menu.
rLY4	Relay 4 parameter menu / selection opens the relay 4 parameter menu.
rtn	Exit relay menu and return to main menu.

Explanation of relay parameter menu

NOTE: The measurement mode (level or distance) affects the relay operation. Select measurement mode prior to setting up relays. See *Selecting your Measurement Mode* for more details.

SP$_x$	Set point parameter for relay [x] / selection shows the current reset point with up and down arrows for adjustment.
rP$_x$	Reset point parameter for relay [x] / selection shows the current reset point with up and down arrows for adjustment.
CnF$_x$	Switch configuration parameter for relay [x] / selection opens the configuration of the relay with options of normally closed [NC], normally open [NO], or off [OFF].
rtn	Exit relay parameter menu and return to relay menu.

Explanation of extended functions menu

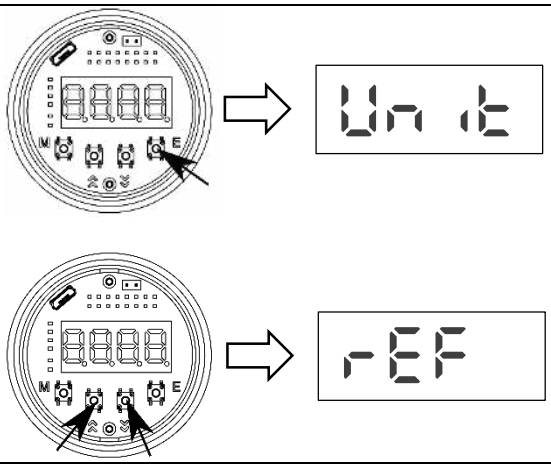
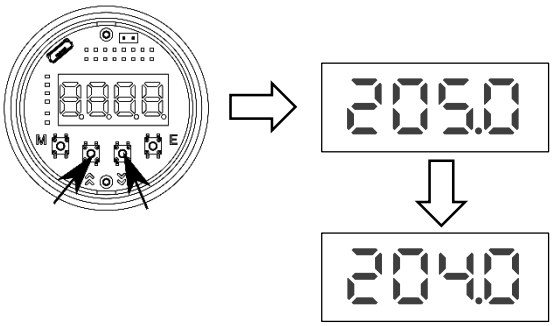
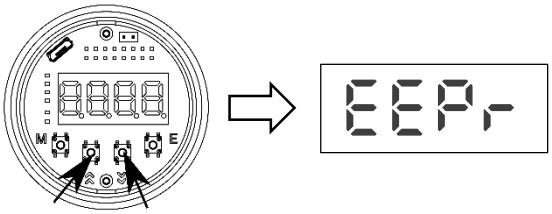
SAFE	Fail-safe analog output / selection of fail-safe 2 mA (A 1), 4 mA (A 2), 20 mA (A 3), 22 mA (A 4), or hold.
FrES	Factory reset / selection will go to additional confirmation to rewrite over the current settings in temporary memory.
FL IP	Flip the measurement mode / selection will show current setting. Changing current setting will turn off all relays.
d IAG	Diagnostic menu for device and OS information for troubleshooting.
PASS	Pass-band filter / selection for a tight pass-band (FLAt) or looser pass-band (FLUC)
F ILt	Running-mean filter / selection of a 3 samples average (FStr), 9 sample average (FAST), or 30 sample average (Slo).
rdAP	Relay damping / selection of a 5 second delay to relay switching (rSLO) or a 0.5 second delay to relay switching (rFST).
dc	Supply voltage temperature compensation / selection optimizes temperature compensation based upon the input voltage supply: 12 DC (12dc) or 24 DC (24dc).
rtn	Exit extended functions menu and return to main menu.

9 Parameter Selection

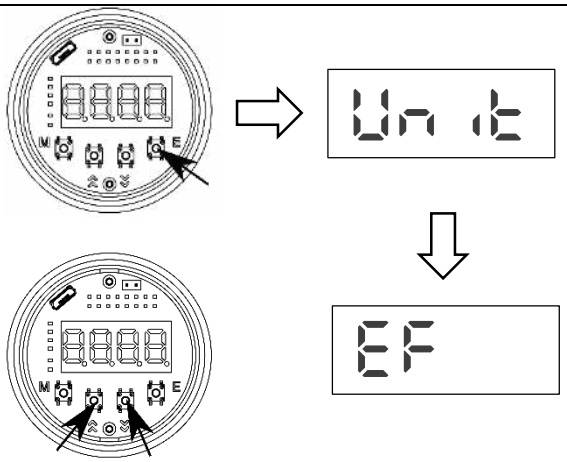
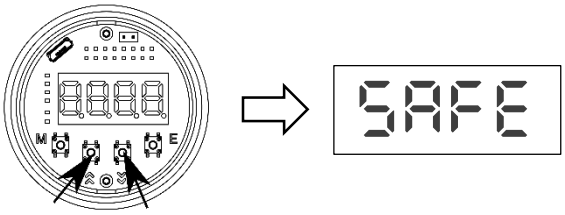
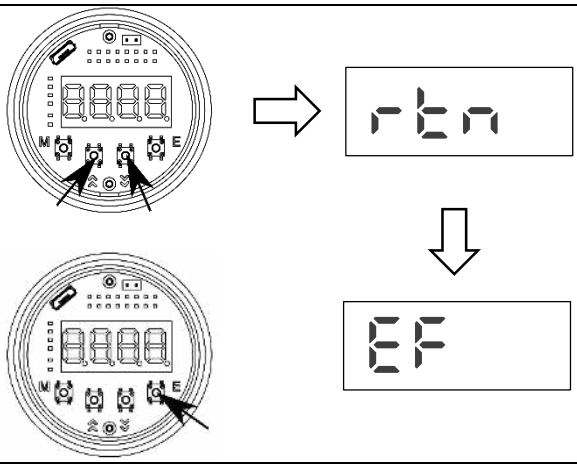
During parameter setting, the unit will continue to operate. Changes to parameters will change the temporary memory for the parameter. All settings that are not saved to memory are temporary and will be reverted after a power cycle.

General Setting Features

When setting a parameter the following steps need to occur:

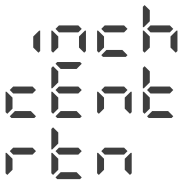
<table>
<tr>
<td>1</td>
<td>Go to parameter
➢ If display is off, press any key to turn it on.
➢ Press [E] to enter the main menu or sub menus.
➢ Scroll using [⩓] or [⩔] until the desired parameter name is displayed.</td>
<td>  </td>
</tr>
<tr>
<td>2</td>
<td>Adjust parameter value
➢ Press [E] to enter the adjustment of the parameter.
➢ Press [⩓] or [⩔] until the desired value is displayed.
NOTE: A short press has small increments and a long press has larger increments.
➢ Press [E] to store the adjustment to temporary memory.</td>
<td>  </td>
</tr>
<tr>
<td>3</td>
<td>Save parameters to memory
WARNING
All adjusted parameters are stored in temporary memory which will not be retained after power loss.
➢ To save all parameters to memory, press and hold [M] for 5 seconds.
▪ Screen will flash EEPr to indicate saving and return to Run Mode.</td>
<td>  </td>
</tr>
<tr>
<td colspan="3">Returning to Run Mode
➢ Wait 30 seconds without no input to return to run mode ,
➢ Or, press [⩓] or [⩔] until [rtn] is displayed and press [E]. Repeat until current measurements are displayed,</td>
</tr>
</table>

Navigating between Menu Levels

1	**Go into main menu** ➢ Press [E] to enter the main menu. ➢ Press [⩓] or [⩔] until the sub-menu is displayed on screen (from main menu [rLY] or [EF] are the names for higher menu levels).	
2	**Go to parameter sub menu** ➢ Press [E] to enter the parameter sub menu. **NOTE:** The first parameter of the relay menu will be displayed [rLY1]. **NOTE:** The first parameter of the extended functions menu is displayed (either [SAFE] or [FSEt] will be displayed).	
3	**Return to a lower menu level** ➢ To exit out of a menu, either - Wait 30 seconds for display to return to measurement, - Press [⩓] or [⩔] in the menu until return [rtn] is displayed. Press [E] to return to previous level.	

10 Setting up the ULS

Configuring the System Units

1	**Go to the parameter** ➢ Press [E] to enter the main menu and scroll with [⩓] or [⩔] until the unit parameter [unit] is displayed.	
2	**Adjust parameter value** ➢ Press [E] to adjust the system unit parameter value. Scroll with [⩓] or [⩔] to the option and press [E] to choose it: inch = inch units, cent = centimeter units, rtn = keep previous settings and return to previous menu.	
3	**Save parameters to memory** ➢ To save all parameters to memory, press and hold [M] for 5 seconds. ▪ Screen will flash EEPr to indicate saving and return to Run Mode.	
Return to Run Mode ➢ To exit out of a menu, either - Wait 30 seconds for display to return to measurement, - Press [⩓] or [⩔] in the menu until return [rtn] is displayed. Press [E] to return to previous level.		

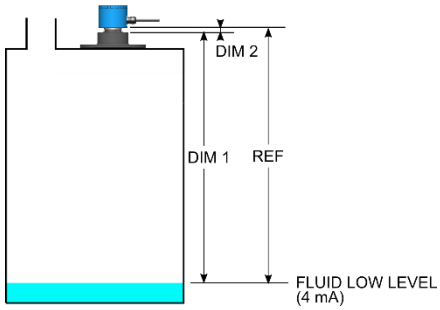
NOTE: All displayed parameter values will match the unit parameter value in program memory.

Setting the Zero Reference Value

The zero reference is a necessary parameter for device operation. It defines the point of reference for all displayed levels, it acts as the low level indication (4 mA) and is the zero reference for digital outputs. To get an accurate zero reference, you should validate two dimensions:

DIM 1: The fluid low level to the top of the mount,

DIM 2: The gap between the mount and the bottom of the blue ULS enclosure.



1	**Go to parameter** ➢ Press [E] to enter the main menu and scroll with [⩓] or [⩔] until the reference parameter [rEF] is displayed.	
2	**Adjust parameter value** ➢ Press [E] to adjust the zero reference parameter value. Press [⩓] and [⩔] to adjust parameter value. **NOTE:** The setting will show the current reference parameter value in temporary memory. ➢ Press [E] to leave the parameter setting menu.	
3	**Save parameters to memory** ➢ To save all parameters to memory, press and hold [M] for 5 seconds. ▪ Screen will flash EEPr to indicate saving and return to Run Mode.	

Setting the Span Value

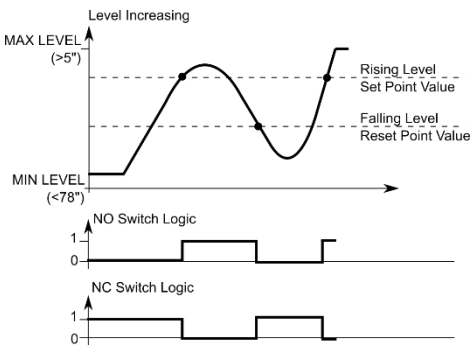
The span setting is the maximum fluid level value indicated through the analog output. It uses the fluid low level (ref) as a zero reference point. The span must be a positive number and the maximum value is limited to ensure that the span does not go into the device's minimum operating distance, or deadband.

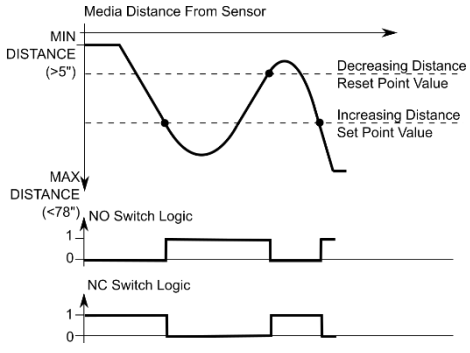
1	**Go to parameter** ➢ Press [E] to enter the main menu and scroll with [⩓] or [⩔] until the span parameter [SPAN] is displayed.	
2	**Adjust parameter value** ➢ Press [E] to adjust the span value parameter value and use [⩓] and [⩔] to adjust parameter value. **NOTE:** The setting will show the current reference parameter value in temporary memory. ➢ Press [E] to leave the parameter setting menu.	
3	**Save parameters to memory** ➢ To save all parameters to memory, press and hold [M] for 5 seconds. ▪ Screen will flash EEPr to indicate saving and return to Run Mode.	

Setting up your Relays

The relays change state from their normal state when the measurement reaches the set point (SPx) value and return to their normal state when the measurement lowers to the reset point (rPx) value. This switching function is normally called hysteresis function. The hysteresis in the switching function means that the reset point is lower than the set point. The switch can be configured (CnFx) as either normally open (NO), normally closed (NC), or off (OFF).

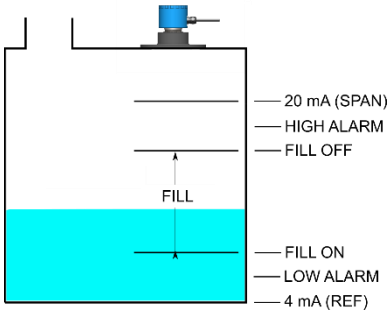
As the device can operate either in level or distance mode (see *Selecting your Measurement Mode*), it is advisable to view the diagrams below to understand what a set point and reset point are in relation to the measurement for your configuration. .



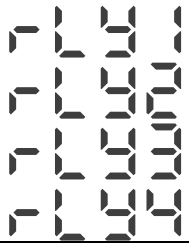
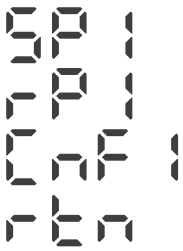


NOTE: The reset point cannot be a higher value than the set point and have a fixed minimum hysteresis of 20 mm (0.79").

The following list defines some example relay configurations for the level sensing mode:



- **High Alarm** is on when the tank is full and turns off after the level drops. For a level sensor when the level rises past the rising level set point value, the electrical connection is made and the high alarm is ON. The relay will de-energize (OFF) when levels falls below the reset value and the high alarm turns OFF. It is in a normally open (NO) configuration.
- **Low Alarm** is the opposite of the high alarm relay. It is a NC configuration and it remains connected (ON) until the level rises above a set point value, which breaks the circuit (OFF). When the level falls below the falling level set point value, the switch connects the circuit (ON) again.
- **Fill** operations are used when the tank level is approaching empty. For a level sensor, the relay is set to a normally closed (NC) configuration. The circuit remains connected (ON) until the level reaches the fill off value, which breaks the circuit (OFF). When the level falls below the falling value, the relay returns to normally closed which makes the circuit (ON). This remains ON until the level again reaches the set point value.
- **Drain** is opposite of the fill operation. The relay is in the NO configuration. It makes the circuit (ON) when the level reaches the high point and is broken when the level reaches below the low setting.

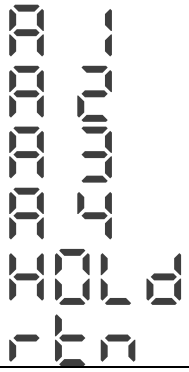
1	**Go to parameter** ➢ Press [E] to enter the main menu and scroll with [⩓] or [⩔] until the relay parameter [rLY] is displayed.	
2	**Navigate to parameter menu** ➢ Press [E] to enter the relay menu and scroll with [⩓] and [⩔] to find relay number [rLYx] that needs adjustment. ➢ Press [E] to enter the relay x's parameter menu. **NOTE:** x indicates the relay number displayed. It can range from 1 to 4.	
2	**Go to and adjust relay x's parameter value** ➢ Press [⩓] and [⩔] to scroll to one of the following relay parameters: SP x = set point x, rP x = reset point x, CnFx = relay configuration x, - Normally open (NO), normally closed (NC) or off (OFF) configurations. rtn = keep previous settings and return to previous menu. ➢ Press [E] to enter relay x's parameter menu and adjust as desired. Press [E] to return to the previous menu. **NOTE:** x indicates the relay number displayed. It can range from 1 to 4.	
3	**Save parameters to memory** ➢ To save all parameters to memory, press and hold [M] for 5 seconds. ▪ Screen will flash EEPr to indicate saving and return to Run Mode.	

Defining your Failsafe Mode

If the unit is not able to get a consistent measurement, the analog output will default to a failsafe value. The failsafe value is an output value that notifies the user or the control system that the unit is having difficulty getting a reliable measurement that passes the validation filter.

NOTE: In failsafe mode, the measurement output will indicate loss [LOSS] to indicate a lost measurement.

To adjust the failsafe value the following steps need to occur:

1	**Navigate to the extended functions menu level** ➢ Press [E] to enter the main menu and scroll with [⩓] or [⩔] until the extended functions [EF] is displayed. Press [E] to enter the extended functions menu	
2	**Navigate to parameter menu** ➢ Scroll [⩓] and [⩔] until the failsafe [SAFE] menu option is displayed and press [E] to enter the fail-safe sub menu. **NOTE:** If you are using a relay only model the fail-safe menu will not show. Relay failsafe is to hold the previous value.	
3	**Adjust parameter value** ➢ The initial displayed value is the current setting. Press [⩓] and [⩔] and [E] to set the function: [A 1] = 2.0 mA, [A 2] = 4 mA, [A 3] = 20 mA, [A 4] = 22 mA, [HOLd] = hold last value, [rtn] = keep previous setting and return to previous menu.	
4	**Save parameters to memory** ➢ To save all parameters to memory, press and hold [M] for 5 seconds. ▪ Screen will flash EEPr to indicate saving and return to Run Mode.	

Returning to Factory Defaults & Saving to Memory

The unit can be returned to the as-received defaults through the factory reset menu.

NOTE: Returning to factory defaults is temporary if you do not save parameters to memory.

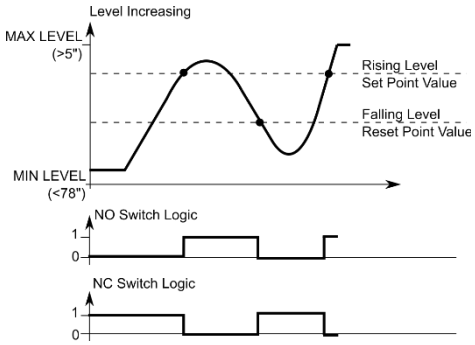
1	**Navigate to the extended functions menu level** ➢ Press [E] to enter the main menu and scroll with [⩓] or [⩔] until the extended functions [EF] is displayed. Press [E] to enter the extended functions menu.	
2	**Navigate to parameter menu** ➢ Press [⩓] and [⩔] to scroll until the factory reset [FSEt] menu option is displayed. Press [E] to enter the factory reset sub menu.	
3	**Reset all parameter values** ➢ To confirm flashing of stored parameters, press [YES]. ➢ To exit without factory reset, press [NO].	
4	**Save parameters to memory** ➢ The factory set parameters are stored on temporary memory and will be lost after a power cycle. To save them to memory, press and hold [M] for 5 seconds. ▪ Screen will flash EEPr to indicate saving and return to Run Mode.	

Selecting your Measurement Mode

The device can indicate either the measured level or distance based upon a user-configurable setting in the extended functions. As the measurement mode parameter alters the display indication, analog output and digital outputs, it is best to select this mode before configuring your relays.

Level measurement mode

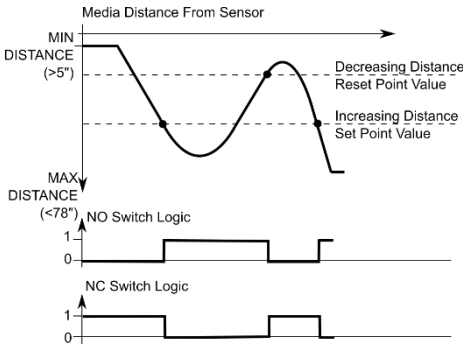
In the level measurement setting, the output is linked to a tank level. As the tank level increases, the analog output increases and as the level decreases so does the analog output.



In this configuration the reference parameter acts as the analog zero output, or 4 mA, and the span parameter acts as the analog full scale output, or 20 mA. For the switching functions, the set point is based upon rising level and the reset point is based upon falling level.

Distance measurement mode

In the distance measurement setting, the measurement is referenced from the bottom of the sensor enclosure. As the distance measurement increases the analog output increases and as the distance decreases so does the analog output.



In this configuration, the reference parameter acts as the analog full scale output, or 20 mA, and the span parameter acts as the analog zero output, or 4 mA. For the switching functions, the set point will trigger with increasing distance and the reset point will act when distance is decreasing.

The following steps will adjust the measurement mode:

NOTE: All relay values are turned off when switching between modes.

1	**Navigate to the extended functions menu level** ➢ Press [E] to enter the main menu and scroll with [⩓] or [⩔] until the extended functions [EF] is displayed. Press [E] to enter the extended functions menu	EF
2	**Navigate to parameter menu** ➢ Press [⩓] and [⩔] to scroll until the flip logic mode [FLIP] menu option is displayed. Press [E] to enter the flip logic sub menu.	FL IP
3	**Adjust parameter value** ➢ The initial displayed value is the current setting. Scroll with [⩓] and [⩔] and set [E] the function: [Hgt] = level measurement, [dISt] = distance measurement, [rtn] = return to previous menu.	Hgt d ISt rtn
4	**Save parameters to memory** ➢ To save all parameters to memory, press and hold [M] for 5 seconds. ▪ Screen will flash EEPr to indicate saving and return to Run Mode.	EEPr

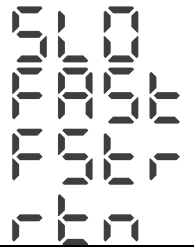
Adjusting the Filters

The device has digital filters to condition the output which is a compromise between stability and responsiveness. It is possible to adjust the filter settings to better suit your application. The two filters are a pass-band filter and a moving average filter.

The pass-band filter accepts any reading that is within a range of the previous averaged measurement. It is used to minimize large amplitude noise that is present with turbulent or sloshing fluid. The following steps allow you to adjust the pass-band filter:

1	**Navigate to the extended functions menu level** ➢ Press [E] to enter the main menu and scroll using [⩓] or [⩔] until the extended functions [EF] is displayed. Press [E] to enter the extended functions menu.	
2	**Go to parameter** ➢ Press [⩓] and [⩔] until the pass-band filter (PASS) menu option is displayed. Press [E] to enter the flip logic sub menu.	
3	**Select parameter value** ➢ The initial displayed value is the current setting. Scroll with [⩓] and [⩔] and set [E] the function: [FLAt] = narrow pass-band used to minimize noise, [FLUC] = large pass-band used to accommodate fluid sloshing/turbulence, [rtn] = return to previous menu. ➢ Press [E] to store new value in RAM or press [E] on [rtn] to keep previous value.	
4	**Save parameters to memory** ➢ To save all parameters to memory, press and hold [M] for 5 seconds. ▪ Screen will flash EEPr to indicate saving and return to Run Mode.	

The moving average filter is a filter that takes the average of certain amount of previous measurements starting with the latest. It reduces short term fluctuations at the expense of step response time. The following steps will modify the running mean filter:

1	**Navigate to the extended functions menu level** ➢ Press [E] to enter the main menu and scroll with [⩓] or [⩔] until the extended functions [EF] is displayed. Press [E] to enter the extended functions menu.	
2	**Go to parameter sub menu** ➢ Press [⩓] and [⩔] to scroll until the moving average filter [FILt] menu option is displayed and press [E] to enter the filter sub menu.	
3	**Select parameter value** ➢ The initial displayed value is the current setting. Scroll with [⩓] and [⩔] and set [E] the function: [SLO] = 10 second averaging window, [FAST] = 3 second averaging window, [FSTr] = 1 second averaging window, [rtn] = keep previous settings and return to previous menu.	
4	**Save parameters to memory** ➢ To save all parameters to memory, press and hold [M] for 5 seconds. ▪ Screen will flash EEPr to indicate saving and return to Run Mode.	

Selecting the Relay Damping Value

In some application, the fluid level may oscillate causing relay chatter, repeated toggling of the digital outputs on and off. To mitigate this problem, the device has a minimum relay delay of 0.5 seconds. If the measurement remains at a value that would cause the relay to flip, it will do so once the relay damping timer has elapsed.

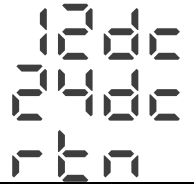
The following steps will adjust the amount of the delay, or relay damping value:

1	**Navigate to the extended functions menu level** ➢ Press [E] to enter the main menu and scroll with [⩓] or [⩔] until the extended functions [EF] is displayed. Press [E] to enter the extended functions menu.	
2	**Navigate to parameter menu** ➢ Press [⩓] and [⩔] to scroll until the relay damping [rDAP] menu option is displayed and press [E] to enter the relay damping sub menu.	
3	**Adjust parameter value** ➢ The initial displayed value is the current setting. Scroll with [⩓] and [⩔] and set [E] the function: [rSLO] = 5 second delay, [rFST] = 0.5 second delay, [rtn] = keep previous setting and return to previous menu.	
4	**Save parameters to memory** ➢ To save all parameters to memory, press and hold [M] for 5 seconds. ▪ Screen will flash EEPr to indicate saving and return to Run Mode.	

Selecting your Temperature Compensation

There is an additional input supply voltage temperature compensation parameter to improve the steady state temperature bias caused by different supply voltages. There are two input supply voltage (12 and 24 V_{dc}) that the device can compensate for temperature bias.

The following steps will adjust the temperature compensation parameter:

1	**Navigate to the extended functions menu level** ➢ Press [E] to enter the main menu and scroll with [⩓] or [⩔] until the extended functions [EF] is displayed. Press [E] to enter the extended functions menu.	
2	**Navigate to parameter menu** ➢ Press [⩓] and [⩔] to scroll the voltage temperature compensation [dc] menu option is displayed and press [E] to enter the sub menu.	
3	**Adjust parameter value** ➢ The initial displayed value is the current setting. Scroll with [⩓] and [⩔] and set [E] the function: [12dc] = 12 V_{DC} compensation, [24dc] = 24 V_{DC} compensation, [rtn] = keep previous value and return to previous menu.	
4	**Save parameters to memory** ➢ To save all parameters to memory, press and hold [M] for 5 seconds. ▪ Screen will flash EEPr to indicate saving and return to Run Mode.	

11 Troubleshooting/FAQ

The following are the most common issues and the procedures that can resolve them.

Powering the Sensor Properly

1. Check the power supply specs.
   - The device requires a 100 mA, 10 to 30 V_{DC} power supply.
2. Unplug the power supply.
3. Respectively connect the red and black wires to the positive and negative terminals.
4. Plug in the power supply.

NOTE: Check the unit is powered either by checking the display, checking the output, or measuring the current consumption through the power supply lines.

Display Warnings

Sensor display shows LOSS

The display will indicate loss (LOSS) when the unit does not receive a consistent measurement of the target. The common causes of inconsistent measurements are installation errors (orientation of sensor), poor target surface quality (foam, turbulence or fluid sloshing), or exceeding the maximum operating distance.

Sensor display shows UL

The display indicates under limit (UL) when the unit determines that the echo return is within the minimum operating distance, or deadband. The unit will continue to output but may not be reliable at these ranges.

1. The distance from bottom of enclosure to maximum target height must be greater than the minimum operating distance. If the target would enter into the minimum operating distance, then it is suggested to use a riser to ensure proper operation.
2. If the target is not in the deadband, then double check that no burrs or edges that could cause a signal reflection.

Sensor display shows OL

The display indicates over limit (OL) when the unit measures that the echo return exceeds its maximum operating range. The unit will continue to operate but may not consistently measure if the target is outside the maximum range.

1. The distance from bottom of enclosure to minimum target height must be less than the maximum operating distance. If the target exceeds the maximum operating distance, then the unit may not reliably operate.
2. If the distance from bottom to target does not exceed the maximum operating distance, then common errors can be orientation of sensor or target surface quality.

Measurement Errors

Sensor goes to LOSS/failsafe

A unit that goes to LOSS/failsafe indicates that it is generally at extremes of operation.

If fluid is close to the unit, the fluid may have entered the minimum operating range, or deadband. When it enters the deadband, the unit may not measure correctly or consistently enough for it to keep to a value.

1. Ensure in all operation cases that no fluid enters the deadband.

If the target is far away from the unit, the problem may be that the signal is not strong enough.

2. Verify installation and operation conditions.
    - Loss of range indicates the unit is not receiving the signal clearly. Common sources of errors are the installation, surface quality, propagating medium.

Analog Output Errors

Sensor indicates 0 mA

Check that the unit is properly powered (see *Powering the Sensor Properly*). If it is still 0 mA, an output of 0 mA generally indicates an open circuit.

1. Check the connection between your measuring system and the transmitter.

If your system only shows values between 4 and 20 mA, then it is possible that the sensor may be out of the measuring range.

2. Validate that the current is outputting by integrating a multimeter in series with your measurement system.

Sensor output greater than 22.5 mA

If the unit is outputting more than 22.5 mA, there is a short circuit.

1. Immediately check the connections for a short circuit. The maximum output is failsafe value of 22 mA. Anything greater indicates a faulty setup.

Output decreases with increasing fluid height

The unit's measurement mode is configured to distance mode. Follow the steps outlined in *Selecting your Measurement Mode* to adjust the parameters.

Digital Output Errors

Relay chatters on/off repeatedly

The relay chattering is likely caused by sloshing or turbulence in the target.

1. Increasing the hysteresis between switch set point and reset point should resolve the problem,
2. If increasing hysteresis is not possible, then increasing relay damping may resolve problem or minimize chatter.

12 Warranty

Anfield Sensors Inc. (the “Manufacturer") warrants this product only (the "Product") to the original purchaser only (the “Purchaser”) against defective workmanship and materials under normal use of the Product for a period of twelve (12) months from the date of shipment by the Manufacturer.

This Warranty is absolutely conditional upon the Product having been properly installed, maintained and operated under conditions of normal use in accordance with the Manufacturers recommended installation and operation instructions. Products which have become defective for any other reason, according to the Manufacturers discretion, such as improper installation, failure to follow recommended installation and operational instructions, neglect, willful damage, misuse, accidental damage, alteration or tampering, or repair by anyone other than the manufacturer, are not covered by this Warranty.

THIS WARRANTY IS EXCLUSIVE AND EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, OBLIGATIONS OR LIABILITIES, WHETHER WRITTEN, ORAL, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE. IN NO CASE SHALL THE MANUFACTURER BE LIABLE TO ANYONE FOR ANY CONSEQUENTIAL OR INCIDENTAL DAMAGES FOR BREACH OF THIS WARRANTY OR ANY OTHER WARRANTIES WHATSOEVER, AS AFORESAID. THE MANUFACTURER SHALL IN NO EVENT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, CONSEQUENTIAL OR PUNITIVE DAMAGES OR FOR LOSS, DAMAGE, OR EXPENSE, INCLUDING LOSS OF USE, PROFITS, REVENUE, OR GOODWILL, DIRECTLY OR INDIRECTLY ARISING FROM PURCHASER’S USE OR INABILITY TO USE THE PRODUCT, OR FOR LOSS OR DESTRUCTION OF OTHER PROPERTY OR FROM ANY OTHER CAUSE, EVEN IF MANUFACTURER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE. THE MANUFACTURER SHALL HAVE NO LIABILITY FOR ANY DEATH, PERSONAL AND/OR BODILY INJURY AND/OR DAMAGE TO PROPERTY OR OTHER LOSS WHETHER DIRECT, INDIRECT, INCIDENTAL, CONSEQUENTIAL OR OTHERWISE, BASED ON A CLAIM THAT THE PRODUCT FAILED TO FUNCTION.

However, if the Manufacturer is held liable, whether directly or indirectly, for any loss or damage arising under this limited warranty, the Manufacturer's maximum liability (if any) shall not in any case exceed the purchase price of the Product, which shall be fixed as liquidated damages and not as a penalty, and shall be the complete and exclusive remedy against the Manufacturer.

When accepting the delivery of the Product, the Purchaser agrees to the said conditions of sale and warranty and he recognizes having been informed of. Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages, so these limitations may not apply under certain circumstances. The Manufacturers obligations under this Warranty are limited solely to repair and/or replace at the Manufacturer’s discretion any Product or part thereof that may prove defective. Any repair and/or replacement shall not extend the original Warranty period. The Manufacturer shall not be responsible for dismantling and/or reinstallation costs. To exercise this Warranty the Product must be returned to the Manufacturer freight pre-paid and insured. All freight and insurance costs are the responsibility of the Purchaser and are not included in this Warranty. This warranty shall not be modified, varied or extended, and the Manufacturer does not authorize any person to act on its behalf in the modification, variation or extension of this warranty. This warranty shall apply to the Product only. This Warranty is exclusive to the original Purchaser and is not assignable. This Warranty is in addition to and does not affect your legal rights. Any provision in this warranty which is contrary to the Law in the state or country were the Product is supplied shall not apply.