Smart Storm

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AVOCET-9000

Instruction Manual

CERTIFIED ISO 9001:2015 COMPANY

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Contents

1. Specifications

Tank Depth Range	0.7 m to 7 m.
Level Resolution	This is a percentage of depth and is equivalent to 0.03 m (3cms) at 5 metres range.
Stability	0.1% /deg. Celsius.
Dead Zones	Normally 0 - 0.7 metres and above 7 metres.
Temperature Range	-20 to +60 for the internal temperature in the enclosure.
Enclosure Protection	IP 65 for Outstation
Power Requirements	Either 110 Volts A.C. or 250 Volts A.C. Switch selectable.
Ultrasonic Sensor	The outstation is fitted with a low voltage transceiver type operating at VHF (1.1MHz).
Outputs	A single pole changeover relay rated at 250 A.C. continuous. 4-20 mA which encodes the blanket depth as a percentage of the tank depth. 2 trip point programmable relays.
Features	The self-purging sensor reduces difficulties due to fouling. The system is essentially non-invasive.

Table 1.1 – Device Specifications

2. General Information

The information contained in this manual has been carefully checked and is believed to be accurate. However, Smart Storm assumes no responsibility for any inaccuracies that may be contained in this manual. In no event will Smart Storm be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual, even if advised of the possibility of such damages. In the interest of continued product development, Smart Storm reserves the right to make improvements in this manual and the products it describes at any time, without notice or obligation. Revised editions may be found on Smart Storm's web site www.smartstormgroup.com.

2.1. Safety Information

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger, warning and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment. Make sure that the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that specified in this manual.

⚠ DANGER

Smart Storm products are designed for outdoor use and are provided with a high level of ingress protection against liquids and dust (see specification for rating). If these products are connected to a mains electricity socket by means of a cable and plug rather than by fixed wiring, the level of ingress protection of the plug and socket connection against liquids and dust is considerably lower. It is the responsibility of the operator to protect the plug and socket connection in such a manner that the connection has an adequate level of ingress protection against liquids and dust and complies with the local safety regulations. When the instrument is used outdoors, it should be connected only to a suitable socket with at least IP44 rating (protection against water sprayed from all directions).

2.2. Use of Hazard Information

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.
WARNING
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.
NOTICE
Indicates a situation that, if not avoided, could result in damage to the instrument. It also indicates information that requires special notice.

2.3. Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not fully observed.

	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
	This symbol, when noted on a product enclosure or barrier, indicates that a risk of electrical shock and/or electrocution exists
	This symbol, if noted on the product, indicates the need for protective eye wear.
	This symbol, when noted on the product, identifies the location of the connection for Protective Earth (ground).
	This symbol, when noted on the product, identifies the location of a fuse or current limiting device.

2.4. Wiring and Handling Precaution

⚠ DANGER

Electrocution Hazard. Always disconnect mains supply before removing covers and connecting any external wiring.
Only qualified Electricians should install this product. IET BS7671:2008 wiring regulations must be adhered to when installing the product.

NOTICE

Delicate internal electronic components can be damaged by static electricity, resulting in indeterminate instrument performance or eventual failure. Smart Storm recommends taking the following steps to prevent ESD damage to your instrument:

- Before touching any instrument electronic components (such as printed circuit cards and the components on them) discharge static electricity from your body. The user can accomplish this by touching an **earth - grounded** metal surface for 3 seconds such as the chassis of an instrument, or a metal conduit or pipe.
- To reduce static build-up, avoid excessive movement. Transport static-sensitive components in anti-static containers or packaging.
- To discharge static electricity from your body and keep it discharged, wear a wrist strap connected by a wire to earth ground, especially when handling circuit boards.
- Handle all static - sensitive components in a static - safe area. If possible, use anti-static floor pads and work bench pads.

⚠ DANGER

Electrocution hazard. Always install a ground fault interrupt circuit (GFIC)/ residual current circuit breaker (RCCB) with a maximum trigger current of 30 mA. If installed outside, provide overvoltage protection through a MCB rated not greater than 5 Amps.

⚠ DANGER

With fixed wiring, a disconnecting device (local interruption) must be integrated into the power supply line. The disconnecting device must meet BS7671:2008 standards and regulations. It must be installed near the device, be able to be reached easily by the operator and labelled as a disconnecting device.
If the connection is established using a mains connection cable that is permanently connected to the power supply, the plug of the mains connection cable can serve as local interruption.

⚠ DANGER

Ensure the relays are not subjected to loads great than 5 Amps as this will cause internal damage and possible product destruction.

3. Introduction

The Avocet 9000 monitors sedimentation of solids in tanks up to 7 metres deep. When used in conjunction with its telemetry options then any number of remote tanks can be monitored simultaneously from a control room situated within 500 metres of the tanks (site dependant).

The entry level for Avocet 9000 is an outstation attached to a sensor. This enables a single tank to be monitored. The Avocet 9000 works by bouncing pulses of ultrasound off the sediment particles themselves. The Avocet 9000 outstation can operate as a standalone instrument and provides alarm relays as standard and 4-20mA and RS232 outputs.

The ultrasonic sensor probe is immersed just below the surface of the supernatant pointing directly towards the bottom of the tank. The sensor both transmits the sonar pulse and then receives the returned backscattered signal. The computer system in the Outstation processes this backscattered data to build up the distribution of particles as a function of depth into the effluent. This is displayed in a graphical form on the Outstation along with all relevant measurement data.

The graphical display allows the user to recognise the interface and the quality of the interface.

The Avocet 9000 only measures **relative** density as opposed to absolute. This is because during operation the signal strength may vary due to factors such as turbidity of the supernatant and algal growth on the sensor. The system adjusts for this over a range of magnitude by hunting for the strongest echo return.

During normal operation sludge blanket inversion and other processes can cause excessive fouling of the sensor. If this happens then the purge cleaning facility should be used. A blast of either water or compressed air is forced across the sensor face causing the obstructing matter to be removed. This auto purge increases the time between any routine maintenance requirements.

4. Installing the Avocet – 9000 Outstation

Outstations are normally fitted to static or circular sediment tanks. They may equally be fitted to rectangular tanks with the traversing type of scrapers, but care must be taken to ensure that on such a tank, the sensor (which is minimally immersed at water level) can never become fouled (typically by weirs or scum bars). If there is any doubt about the suitability of the tank, then consult the manufacturer. The usual installation is on the circular type of tanks, and this is the type of installation described.

Figure 4 Avocet-9000 Outstation Installation

The issues needing to be addressed are as follows:

1. Mounting of the Outstation on the handrail or similar structure.
2. Attachment and adjustment of the Sensor arm.
3. Connecting of the Outstation to 115 V, 230 V or other suitable power supply.
4. Programming and commissioning.

The ideal and usual mounting configuration for the Outstation is to attach the unit to a frame – this is available as an option, which also comes provided with a sensor arm which conveniently holds the sensor away from obstructions.

Care should be taken as to where the Outstation is mounted on the bridge – see diagram on the next page (Figure 4.1).

4.1. Plan View of Circular Sediment Tank

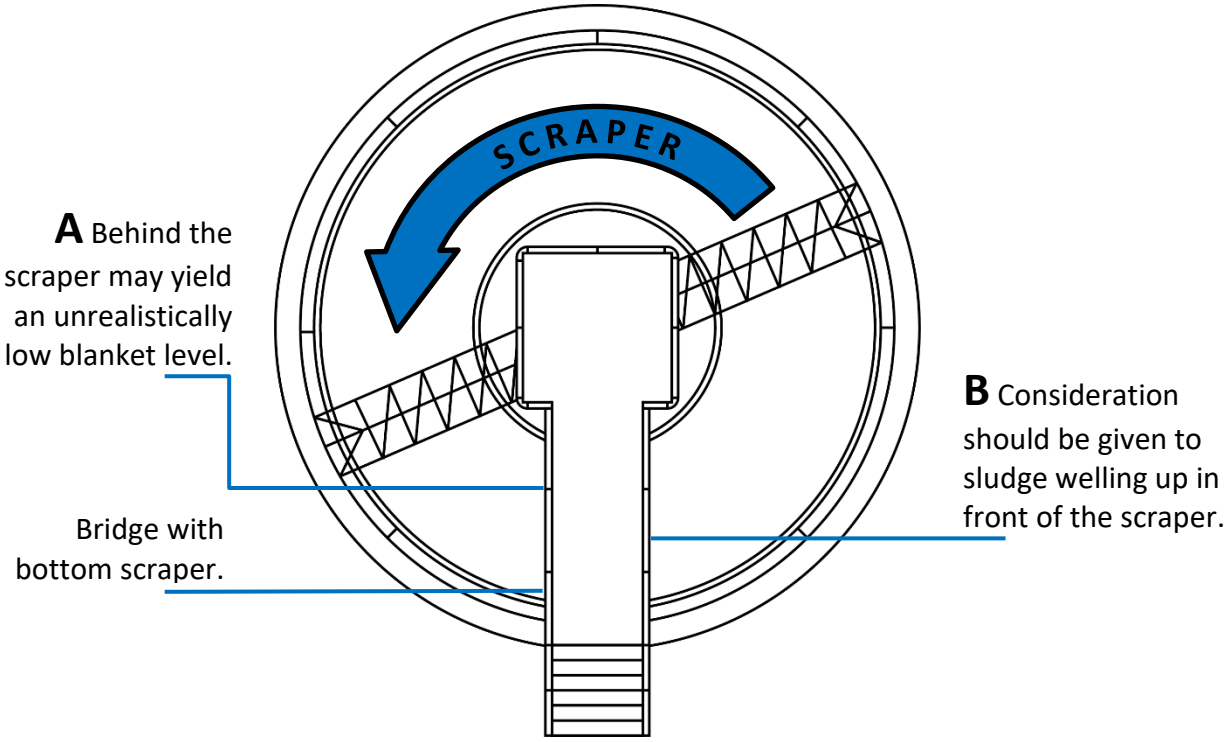


Figure 4.1 Avocet-9000 Outstation Installation

Position **B** is usually better than **A** but may depend on the dynamics of the tank.

5. Programming Steps

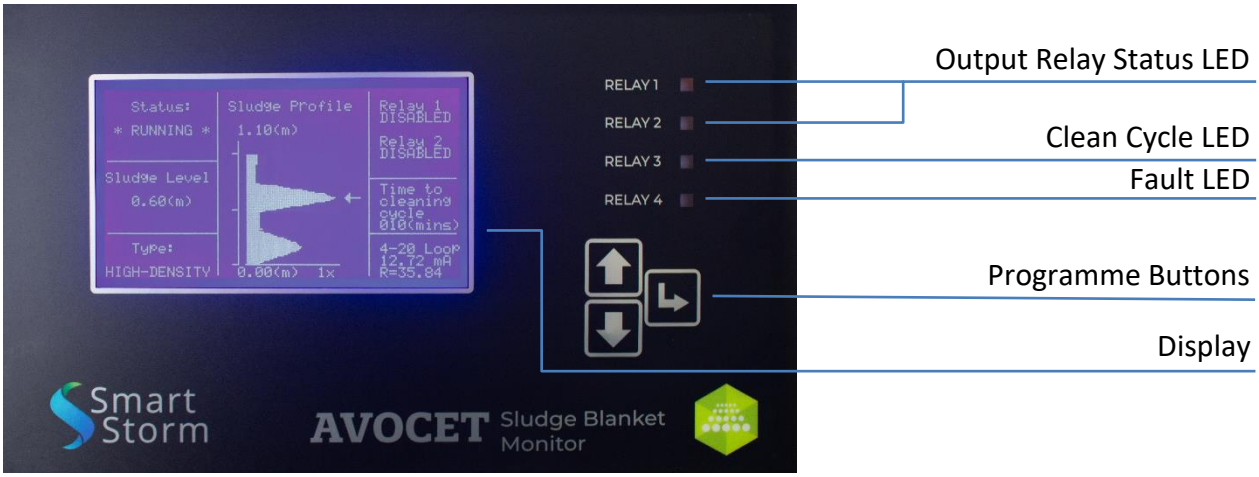


Figure 5A Avocet-9000 Front Pannel

To begin programming the device press the **SET** key and select **Quick Setup** menu from the options.

Figure 5B Avocet-9000 Main Menu

To programme the device, enter the default password to proceed. Use the **UP** and **DOWN** keys to enter the password number and then press **SET** to continue. If an incorrect password is entered the system will return automatically to the normal RUN MODE. The factory default password is 1. This can be changed latter in the menu by the user.

Figure 5C Avocet-9000 Password

Once the correct password is the main **SETUP MENU** will be presented.

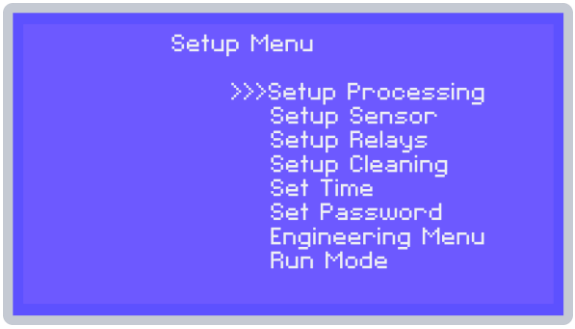


Figure 5D Avocet-9000 Setup Menu

5.1. Programming the sensor

Note: All programming values presented are examples and the user should enter the values specific to their application. To identify the correct sludge levels the user may have to go through several changes of the processing choices to get the best sludge profile.

The first step once the unit has been installed is to programme the sensor for the tank or lagoon in which it is measuring the sludge level.

Scroll to the **Setup Sensor** option of the **Setup Menu** and press the **SET** key.

First enter the distance in metres from the face of the sensor head to the bottom of the tank/Lagoon. Use the **UP** and **DOWN** keys to enter the appropriate value for the depth.

The distance set for the bottom of the tank must be about 0.2m less than the tank depth at its shallowest under the sensor's detection field. This is necessary because in a tank where the sludge density is low the largest echo will come from the bottom of the tank and mask out any sludge level so this echo must be discarded.

If the tank is new or has no sludge in it this value can be obtained using the **Test ADC** function in the **Engineering menu**. This function shows raw digital map of all echoes without processing and is a useful tool to allow you to select processing choices.

Once the desired value is displayed press the **SET** key to enter the value shown and continue.

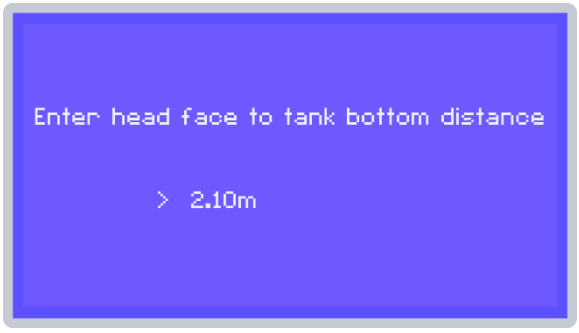


Figure 5.1A Avocet-9000 Head Face to Tank Bottom

Now enter the blanking distance in metres.

Figure 5.1B Avocet-9000 Blanking Distance

The blanking distance extends out from the face of the sensor head to the point at which measurements can be made without interference from obstructions. The instrument has a minimum blanking distance of 0.70 metres. If there is a structure or obstacle deeper than 0.70 metres this can be ignored by extending the blanking distance deeper than the obstacle.

When the desired value is shown press the **SET** key to continue.

The ultrasonic signal in a sludge blanket monitor has numerous return echoes due to the particulates in the water column causing back scatter. This causes signal noise, and it is necessary to overcome this noise level by selecting a suitable threshold level. If the level is too low, you will see a continuous block image on the display and no distinct peaks.

Enter the threshold value in millivolts (mV). The threshold value should be set to give reliable readings, without giving false readings from interference pickup. The threshold is automatically used in the **Peak Detection** or **Threshold Crossing** algorithm programmed in the **Detection Type** menu selected when in the **Set Up Processing** menu. Below this threshold any value or peak detected is considered noise.

Figure 5.1C Avocet-9000 Threshold Value

5.1.1 Save Settings

Selecting **YES** will make the changes permanent, and you will have re-programmed the device. Selecting **NO** will return you back to the **Setup Menu** without making any changes to the original settings.

Figure 5.1.1A Avocet-9000 Save Setting

If you select **Yes,** the unit will show the following screen momentarily.

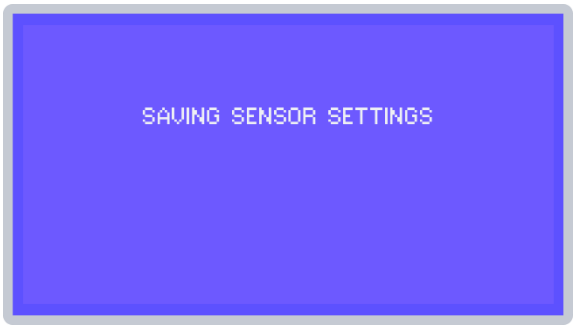


Figure 5.1.1B Avocet-9000 Settings Saved

If you select **No** the unit will show the following screen momentarily.

Figure 5.1.1C Avocet-9000 Settings Not Saved

5.2. Setup Processing

This option allows the user to programme the detection algorithm and filtering settings. Scroll to the **Setup Processing** option and press the **SET** key. Selecting this will display the **Processing Menu**.

Figure 5.2 Avocet-9000 Processing Menu

5.2.1 Tank Type

Selecting **Tank Type** allows the user to select between two fundamentally different modes of operation.

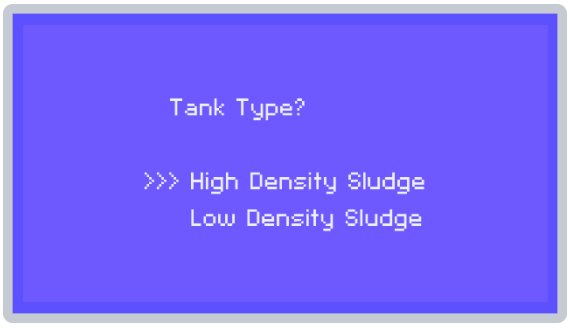


Figure 5.2.1A Avocet-9000 Tank Type

The two modes are designed for Primary clarifiers and Secondary clarifiers due to their differing Sludge characteristics.

The **High Density** tank mode is designed for tanks with rapid settling dense sludge with good signal returns as found in Primary Clarifiers or lagoons.

The **Low Density** tank mode is designed for secondary clarifiers where the sludge blanket has a low density and diffuse interface, resulting in very low signal returns. This mode has all set-up parameters factory pre-set for optimum operation, except for the minimum peak height value setting.

Selecting Low Density tank brings up the minimum peak height setting. This is used to set a minimum detection level, below which the instrument will ignore return signals. This is used to remove false blanket detection caused by artefacts in the signal return from diffuse particles, such as pin floc and algal bloom.

Initially set the minimum value to Zero (0) then put the device into run mode. In the running display a value of H= XXXX will be seen. Return to the programming menu and adjust the Min Peak Height value up to just above the H value. The H value is a measure of spurious signals.

Note: setting this value too high will result in the sludge blanket level always reading zero.

Figure 5.2.1B Avocet-9000 Minimum Peak Height

5.2.2 Detection Type

Selecting **Processing Type** from the options allows a choice of algorithms to detect the sludge layer when in **High Density** tank type mode. The instrument supports three detection algorithms, peak detection, threshold crossing and a differential filter option. **Peak detection** or **Threshold** crossing must be programmed whilst the **Differential filter** is an option for **low density** sludge only. The parameters for each of the algorithms are fully configurable by the user. The basic details of each are outlined below.

Peak detection algorithm.
The peak detection algorithm searches for the highest return signal or signal slope above a user set threshold level between the end of the blanking distance and the tank base. For this algorithm, the head face to tank bottom must be set to be less than the actual tank depth at the sensor, or the instrument will always detect the bottom echo and disregard the desired sludge interface level.

Threshold crossing algorithm.
The threshold crossing algorithm searches for the first return signal to cross the user set threshold, starting from the end of the blanking distance, moving towards the tank base. This method is insensitive to the echo from the tank bottom being included in the analysis, so the tank bottom can be included in the sensor setup.

Scroll to the **Processing Type** option of the **Processing Menu** and press the **SET** key. This selection will present you with the detection algorithm selections.

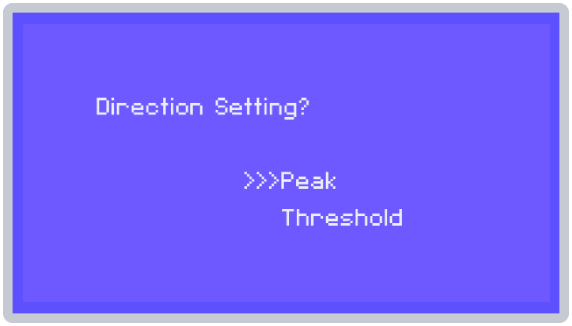


Figure 5.2.2A Avocet-9000 Direction Setting

Select the required echo detection algorithm required then press the **Set** key to display the **Threshold** type selection menu.

Note: There is no need to enter a threshold value as this has already been set when the sensor was programmed. If you wish to change this value, reprogram the sensor.

Select the required type required then press the **Set** key.

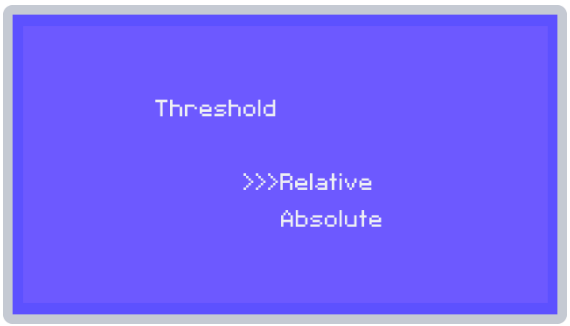


Figure 5.2.2B Avocet-9000 Threshold Type

The threshold menu allows the user to select the reference point used to calculate the baseline for the signal detection threshold level.

The **Relative** option uses a dynamic baseline relative to the noise baseline present in the return signals. As the noise varies with time the baseline will adjust to compensate for the varying noise levels.

The **Absolute** option sets the threshold relative to a zero-return signal (i.e. a noise free return signal).

5.2.3 Pre-processing

This menu allows you to adjust the actions performed on the raw echo signal prior to the application of the processing algorithms.

Scroll to the **Pre-processing** option of the **Processing Menu** and press the **SET** key.

This selection will present you with the **Pre-processing** selections.

Figure 5.2.3A Avocet-9000 Pre-processing

Note: Differential filter option only available for Low Density tank.

Selecting the **Signal History length** option presents you with the following display.

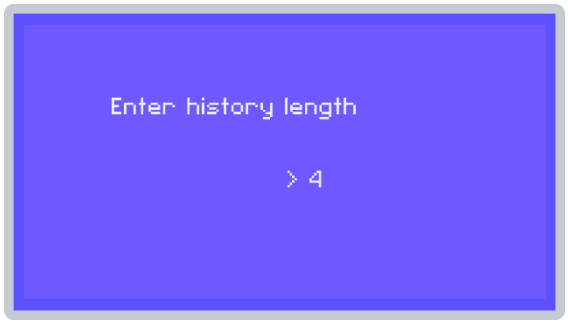


Figure 5.2.3B Avocet-9000 History Length

The History length value is the number of complete echo detection routines, which are then used to update the level and 4 to 20mA outputs. Increasing the value will damp the system response.

Enter the history length required then press the **SET** key to return you to the **Pre-processing** menu. The allowed length is from **1** to **32**.

Selecting the **Differential Filter** option (**Low Density tank only)** presents the following display.

Figure 5.2.3C Avocet-9000 Differential Filter

The slope-filtered setting multiplies the return signal with a differential filter, which outputs high peaks for steep slopes. The algorithm then searches the output for either the highest peak, or the first slope, above a user set threshold level, between the end of the blanking distance and the tank base. This is an advanced feature, but it can pull out sludge levels from complex multiple sludge layers in a sludge column, often found in **low density sludge.** The user may have to gain experience in using the device before this feature can be effectively utilised.

If the slope filter is selected the length of the filter is then required.

Figure 5.2.3D Avocet-9000 Slope Filter Length

Scroll using the **UP** and **DOWN** keys to the appropriate length and press the **SET** key to return you to the **Pre-processing** menu. The allowed values are **1** to **16**.

5.2.4 Display Scale

The **display scale** is not strictly a processing method and only affects the size the returned signal is displayed on the LCD screen for ease of viewing of small signals. This should be set up in both secondary and primary tank modes.

Figure 5.2.4 Avocet-9000 Display Scale

Enter the **display scale** required then press the **SET** key to return you to the **Processing** menu.

The allowed scale is from **1** to **10**. E.G. 2 will magnify the echo display with a factor of 2 times.

5.2.5 Damping

This filter calculates the average level from a history of stored values determined from the return signal. The length of the filter determines the amount a single reading affects the output but slows the response time of the system by an amount determined by the length.

Figure 5.2.5A Avocet-9000 Filter Length

Select the number of sample sets to be used in the selected filter type from the previous step (median or average filter type). The allowed values are **1** to **256** echo samples. Press the **SET** key to return you to the **Pre-processing** menu.

To **Exit,** selecting **YES** will make the changes permanent, and the unit will return to the **Set-up** menu.

Figure 5.2.5B Avocet-9000 Save Setting

Selecting **NO** will return you back to the **Set-up Menu** without making any changes to the original settings. In both cases the instrument will momentarily show an appropriate message.

5.2.6 Setting the Run Mode

Selecting the **Run Mode** option will exit the programming menu and start the unit running.

Figure 5.2.6 Avocet-9000 Run Mode

5.3. Return to Setup Menu

Return to the setup menu to programme the remaining parameters.

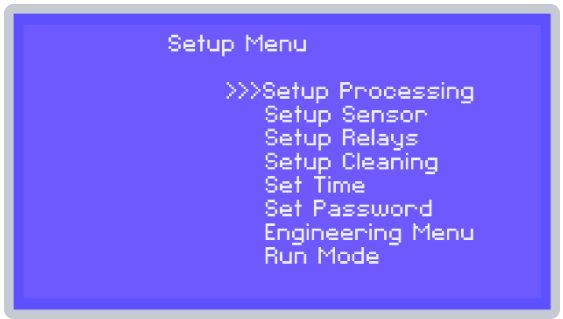


Figure 5.3 Avocet-9000 Setup Menu

5.3.1 Programming the Relays

To program the relays, scroll to the **Setup Relays** option of the **Setup Menu** and press the **SET** key. Follow the instructions on the display. You will first be presented with a sub-menu showing the available relays that can be programmed. Scroll to the relay required and press the **SET** key.

Figure 5.3.1A Avocet-9000 Relay Number

On selecting a relay, choose the type of relay you are configuring, **HIGH**- or **LOW** level then press the **SET** key to continue. The **DISABLED** option can be used to disable a previously programmed relay.

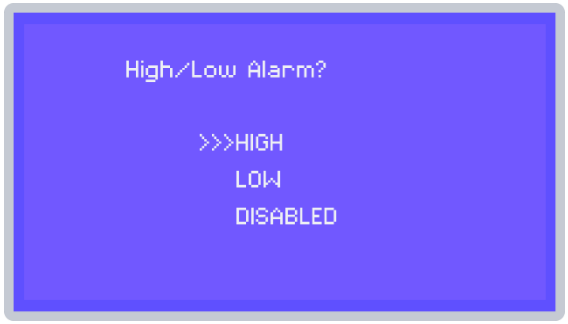


Figure 5.3.1B Avocet-9000 High/Low Alarm

Once the relay mode has been selected enter the relay **ON** level using the **UP** and **DOWN** keys to set the value.

Figure 5.3.1C Avocet-9000 RELAY On Level

Enter the relay **OFF** level using the **UP** and **DOWN** keys to set the value. Enter the value in metres. Note that for a **High-level** relay the **OFF** value is always less than or equal to the **ON** value. This allows the user to set a varying level of hysteresis for the relays enabling more complex control schemes to be implemented.

Figure 5.3.1D Avocet-9000 Relay Off Level

Save settings: Selecting **YES** will make the changes permanent and you will have re-programmed the relay. Selecting **NO** will return you back to the **Setup Menu** without making any changes to the original settings. In both cases the instrument will momentarily show an appropriate message.

Figure 5.3.1E Avocet-9000 Save Setting

5.3.2 Programming the Cleaning Cycle

To prevent the sensor from fouling with the build-up of an organic film on the surface of the sensor an air purge can be applied to the facia of the sensor through the cleaning relay. This pump can be supplied by Smart Storm, but any large Aquarium type pump will suffice.

To program the head cleaning cycle, scroll to the **Setup Cleaning** option in the **Setup Menu** and press the **SET** key. Follow the instructions on the display. You will first be asked to enter the cleaning interval time. This is the time interval in minutes between each cleaning cycle up to a maximum of 720 minutes (12 hours). To continue press the **SET** key.

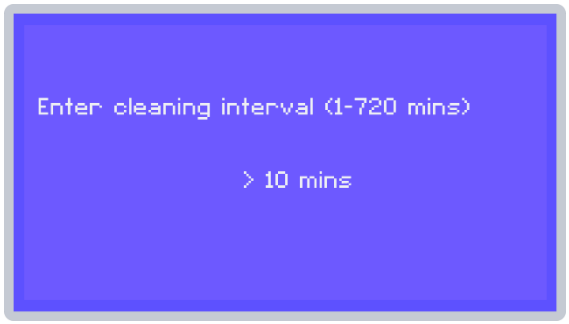


Figure 5.3.2A Avocet-9000 Cleaning Interval

This is the amount of time that the cleaning process will operate for up to a maximum of 720 seconds (12hrs). To continue press the **SET** key.

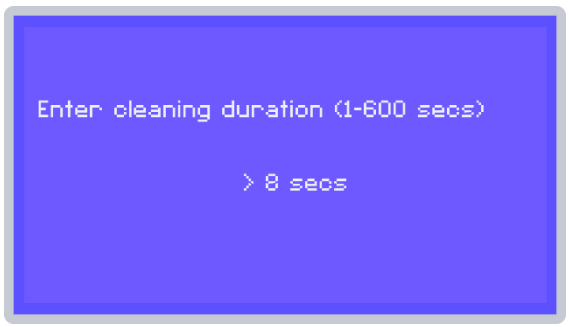


Figure 5.3.2B Avocet-9000 Cleaning Interval

Note: Normally 10 seconds on a 3hr interval is suffice.

Save Settings: Selecting **YES** will make the changes permanent. Selecting **NO** will return you back to the **Setup Menu** without making any changes to the original settings. In both cases the instrument will momentarily show an appropriate message.

Figure 5.3.2C Avocet-9000 Save Setting

5.3.3 Set Date and Time

This option allows the user to set the internal real time clock. The present version of the Avocet has a volatile clock function, i.e. when the unit is powered off the clock settings are lost. At the present time, the clock function is not used for logging data, so the user, without any detriment may omit setting the time shown by the clock, from the programming procedure.

To set the clock select the **Set Time** option.

Follow the programme selection to set year, date and time.

Figure 5.3.3 Avocet-9000 Save Setting

Save Settings: Selecting **YES** will make the changes permanent. Selecting **NO** will return you back to the **Setup Menu** without making any changes to the original settings. In both cases the instrument will momentarily show an appropriate message.

5.3.4 Setting a new password

To enter a new password, scroll to the Set Password option in the **Setup Menu** and press the **SET** key. This will take you to the set password screen. Enter the new password using the **UP** and **DOWN** keys and then press the **SET** key when the new value has been selected.

Selecting **YES** will make the changes permanent. Selecting **NO** will return you back to the **Setup Menu** without making any changes to the original settings. In both cases the instrument will momentarily show an appropriate message.

Figure 5.3.4 Avocet-9000 Save Setting

5.4. Engineering Menu

To enter the engineering menu, scroll to the **Engineering Menu** option in the **Setup Menu** and press the **SET** key.

This will bring up a new menu as shown below allowing the user to test the functionality of the unit and set up the detection algorithm to be used in the particular installation.

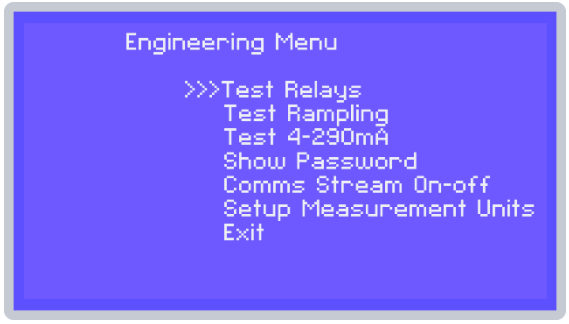


Figure 5.4 Avocet-9000 Engineering Menu

5.4.1 Test Relays

Selecting this option will turn on each of the four relays with each key press. The associated LED on the front panel will also be lit. This can be used to check the functionality of equipment controlled by the relays.

5.4.2 Test ADC

The **Test ADC** option can be used to examine the echo returns from the settlement tank. On selecting this option, the display will show **Sampling** while the instrument collects a batch of echo returns from the tank. The unit will then display a graph of the echo profile in mV versus distance in metres.

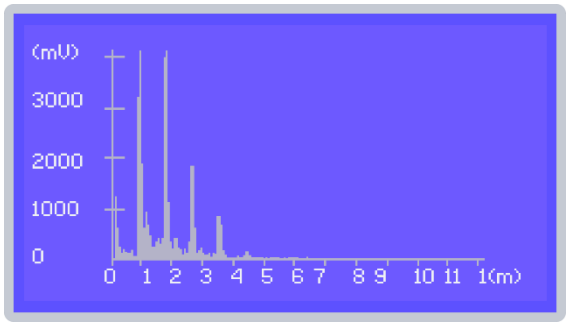


Figure 5.4.2 Avocet-9000 Test ADC

This option is useful for determining the current state of the tank and showing the distance to the tank bottom, which is indicated by a large vertical echo return on the display. In a tank containing a very dense sludge there may be no bottom echo at all due to the sludge totally absorbing the ultrasound pulse.

To exit the **Test ADC** routine, press any key, then select the **NO** option from the **Output to com?** to return to the **Engineering Menu**. If the **YES** option is selected the display shows **'SENDING DATA'**, while the unit outputs an ascii formatted string to the serial port representing the current echo return as displayed on the **ADC** trace.

5.4.3 Test 4-20mA

On selecting this option, the unit will step up through the 4-20mA output settings starting at 0mA in 1mA steps each time any key is pressed. After the 20mA step the **Engineering Menu** will be displayed.

This can be used to check the functionality of any equipment attached to the 4 to 20mA output as well as a basic instrument check.

5.4.4 Show Password

Selecting this option will show the current password set by the user. Press any key to return to the **Engineering Menu**.

5.4.5 Comms Stream – On -Off

Setting this to on will continuously stream the serial data ADC values to the RS232 output but setting it to off will just stream the distance and sludge height.

5.4.6 Setup measurement units

The device can be set up to measure in either Imperial or Metric units.

6. Quick Setup Guide

For rapid installation and evaluation, it is recommended that the following settings are used.

1. Set the tank depth set to 20cm less than the actual tank depth. (Setup **Sens**or menu)
2. Set the Blanking distance to 0.70m.
3. Set the threshold offset to 100mV.
4. Set the Tank type to **High Density Sludge**.
5. Set the minimum peak Height detection to zero.
6. Adjust the **Display Scale** to show the sludge level without filling the tank display screen

7. Outputs and External Connections

All connections are made to the bottom of the main circuit board, which can be accessed by removing the lower panel of the main unit.

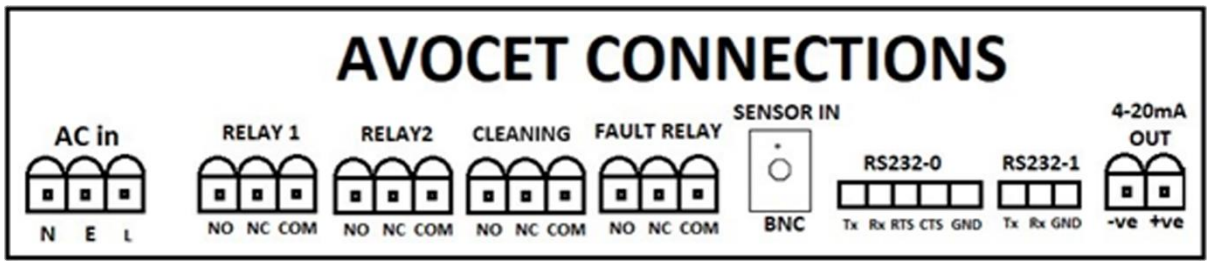


Figure 7 Avocet-9000 Connections

7.1. 4-20 mA Output

This is available from 2 terminals in the lower compartment and is encoded as follows:

The 4-20 output is proportional to the percentage depth of the sludge blanket in the tank. Thus, if the blanket pointer (BP) was at the top of the display (zero depth) - this is not possible but will suffice for reasons of explanation, then the percentage depth would be 100% and the output would be 20 mA. If there is no sludge in the tank, then the BP would be at the bottom of the display and the percentage depth would be 0% and the output would be 4 mA. If as is more usual the BP was at 2 metres in a 4-metre tank, then the percentage depth would be 50% and the output would be 12 mA.

7.2. Relay Connections

The change-over relay contacts are accessible beneath the lower cover. The connections beneath this cover are shown in the diagram below. All relay states are indicated by the LEDs on the front panel.

7.3. Telemetry Options for the Avocet 9000

The basic standalone unit described in this manual can be linked along with any number of other standalone units to a central control unit or Base station using either the RS 232 connections or an additional “bolt-on” radio module available as an option. For further details please contact Smart Storm Ltd.

8. RF Modem Connections

1. **RF Modem Transmitter module wire connection to Sludge Blanket relay Board:**

   RS232 – 0 Terminal Block (Sludge Blanket Relay Board):

   TX – Red wire (RF Tx Module wire).

   Gnd – Blue wire (RF Tx Module wire).

2. **Power supply for the RF Modem Transmitter & RF Modem Receiver modules:**

   Voltage input: 100-240Vac. Connect suitable 2 core mains cable with 2.5A fuse or similar to the Power supply module IRM-30-12ST input L-Live, N, Neutral.

3. **RS232 to USB convertor from the RF Modem Receiver Module (If provided):**

   Install the RS232 to USB convertor drivers to the PC if necessary. Insert RS232 USB connector to PC USB. To Test RF Modems, use Comport tool kit or similar.

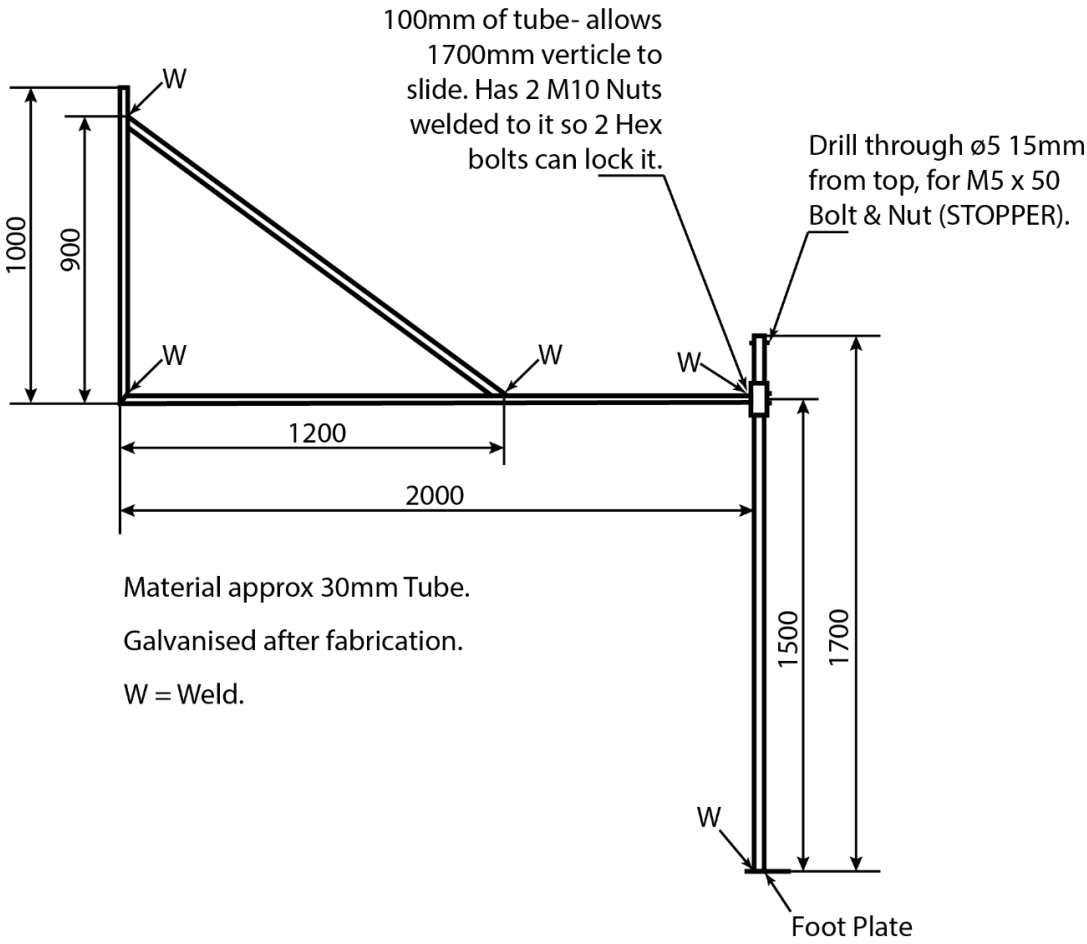
   RF Modems COM Port set to default.

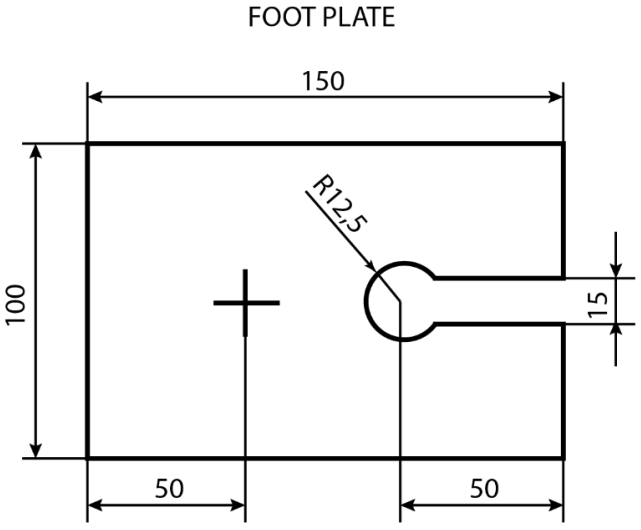
   Baud Rate: 9600 bps, Data Bit: 8 bit

   Parity Bit: No Parity Stop Bit: 1 stop bit.

   Flow Control: None

9. Mounting Bracket





Weld Plate to 1700mm Verticle tube at cross.

Circle cut out has ø25.

Material thickness 5mm.

Figure 9 Avocet-9000 Mounting Bracket

10. Knowledge Document

The following explains in depth the advanced processing methods used in the Avocet 9000.

Sludge Level is processed by analysing the echo captured by the sensor attached to the electronic relay board via an SMA connector (plug and socket). The use of the SMA connectors is very important because of the high frequency ultrasonic crystal used in the sensor. Therefore, to ensure signal integrity and minimal loss, a matched impedance for connecting the sensor to the electronic board is necessary.

After adequately filtering, mixing and amplifying the echo signal, the signal is captured by a 12-bit ADC. The digitised signal is used by the software to find sludge level.

Digital signal processing is done by the software, and it is done using a Mealy State-Machine to process the data. There are six states with which digitized signal is processed: SAMPLING, DUMP, ANALYSIS, PROCESS, OUTFILTER and CHECKECHO.

The software has the capability to process two types of sludge in sedimentation tanks common in the wastewater industry: High-Density Sludge (Primary Sedimentation tank) and Low-Density Sludge (Secondary Sedimentation tank). Therefore, to achieve the best results using the unit, it has to be configured to use the correct mode for the appropriate tank. For example, when a Primary tank is monitored for the sludge level, the unit has to be configured as High-Density Sludge monitor and when a Secondary tank, the unit has to be configured as Low-Density Sludge monitor.

In both settings, the sensor head parameters (Setup Sensor->) have to be set correctly as well. The accuracy of these parameters determines the accuracy of the readings displayed by the unit. These parameters are *Tank Height:* Distance from the face of the sensor to the bottom of the tank; *Blanking Distance:* Distance from the face of the sensor to the point at which measurements can be made without interference from obstructions and *Threshold Offset Value:* Minimum amplitude for which an echo can deemed as valid (only used in Primary tank (High-Density Sludge setting) as Detection Threshold).

Sludge Level Calculation Procedure:

1. Secondary Tank (Low-Density Sludge)

Low density sludge has the characteristics of diffused layers of settling particles and semi-solids. Depending on the density of the layers is the strength of the echo returned which the sensor captures. Therefore, the user will have to know how the density of the sludge to be monitored settles in the tank.

In this mode of operation, the result achieved is much dependent on the user's knowledge of the sludge tank monitored and accurate setting of the parameters with respect to low-density sludge.

In the unit, after the selection of Low-Density Sludge in Setup Processing->Tank Type->Low-Density sludge, a very important parameter must be set to determine which layer of sludge within the tank is to be monitored, *Min. Peak Height*. This parameter set determines whether a less dense or highly dense layer of sludge is monitored. This value is compared with the amplitude data captured by the ADC accumulated 16 times. Hence value (0 – 20000) must be carefully chosen not to be too low to pick up the noise levels and not too high to pick thick sludge level (or even bottom of the tank). A set of 5 echoes which are the first 5 echoes in the data are selected, the highest echo amongst these selected echoes is compared with Min. Peak Height, if its greater valid echo is found, else its entire data set is rejected.

Also, the user must ensure that the value is just appropriate so as to enable trigger the LOST ECHO fault if no valid echo is found after 10 consecutive sampled processing (going through all the states in the state-machine).

Please note that if during processing, there is one valid echo found, the lost echo counter is reset to zero and begins again. Hence it is possible for lost echo fault to take longer time to be triggered if there is a close margin between valid echo and invalid echo.

The amplitude value of the echo for which the level of sludge is reading is displayed at the bottom right corner of the run screen in Run mode as H = 'xxxxx'. The higher the value of 'H', greater the possibility of picking up echo at the level of highly dense sludge / tank bottom. The Min. Peak Height must be tuned appropriately until the desired level is achieved, tuning depends on the type of settlement of sludge in different tanks, thus is not a universal value.

2. Primary Tank (High-Density Sludge)

High-density sludge has the characteristics of heavy particles settlement in the tank. The tank will have well-defined layer of sludge. Here the user's knowledge of the tank is not necessary, just the physical properties of the tank are needed.

The best way to configure setting in the mode is using Test Sampling function in Engineering Mode->Test Sampling. This gives a graphical representation of the tank depth vs the amplitude of echo. Usually, the first peak after the blanking distance is the best to use for the configuration of Setup Sensor->Threshold Offset.

In High-Density sludge mode, the Detection Type (Setup Processing->Detection Type) must be chosen, either absolute or relative. Absolute implies it compare it amplitude of the echo sampled with the value set in Threshold Offset. Relative implies it compares the echo sampled with the value set in Threshold Offset plus minimum value in the entire sample echo buffer

(Threshold Offset + Noise Level). The values of these parameters are used only in the High-Density Sludge mode, *a valid echo is the first echo that has its amplitude greater than the detection threshold, the distance of the echo is processed to calculate the sludge level.*

Note: In Absolute: Detection threshold = Threshold Offset (0-4094 mV); In Relative: Detection threshold = Threshold Offset + Minimum Noise Level.

The **LOST ECHO** fault is also triggered just as described for secondary tank, just with a slight difference. In the primary tank mode, the lost echo triggers if none of the echo amplitude crosses the detection threshold after 10 consecutive sampling processing (going through all the states in the state-machine).

Set the Threshold Offset low enough to adequately detect good echoes and not avoid marginal behaviour, which might cause delay in the triggering lost echo fault.

3. Pre-Processing Setting

These are setting that configure how data captured are processed. Care should be taken in setting these values. Unless very necessary it is advised to keep them at their default values.

a. Signal History Length: Default is 8, as the value is increased; this implies that more samples have to be taken to find the true sludge. It means longer processing times; hence fault conditions might take longer to trigger even though it gives a steadier result. The range allowed is 1 to 32.

b. Differential Filter (Slope Filter): Default is 4, the slope filter is used for low-density mode only. The value helps to give a better identification between the diffused layers in the secondary tank. The range allowed is 1 to 16.

4. Damping

Damping is the length of the filter applied to the distance of the sludge detected in the tank. In the low-density sludge mode, running average is the filter used and in the high-density mode median filter is used. The length of both filters is the length input by user in Setup Processing->Damping->Filter Length. Allowed values are 1 to 256.

5. Debug

The unit has a debug option to validate the functioning of the unit and the values. Turn on the Communication Stream by enabling it in Engineering Menu->Communication Streams->Enable. Serial communication streams for the running process are now output via RS232-0, using RS-232 protocol. The output of the COM port is in ASCII (strings) and the settings for port parameters are 9600-N-1 (9600 Baud, No parity, 1 Stop bit).

Connect serial cable to RS232-0 connector (flow control not necessary) to a serial port data programmer (e.g. Comport toolkit, hyperterminal etc). Change setting to enable ASCII mode.

Output from the serial are formatted as follows:

F 'firing count' 'valid sludge distance' 'lost echo counter' 'sludge level (mm)'

S [Dist='valid sludge distance'], [F_Dist='outfiltered sludge distance'] (for secondary tank mode only).

A ['Dist of min. amplitude found','Min. amplitude found'], ['Dist of max. amplitude found','max. amplitude found'], ['Dist of max. amplitude found','max. amplitude found'], [0,0], [Dist='valid sludge distance'] (for primary tank mode only).

adc= 'values of echo amplitude1', 'values of echo amplitude2',....., 'values of echo amplituden' (values of echo accumulated up to 1620).

This will enable engineer to view and adequately configure the unit appropriately to work.

6. Facts

- Lost echo fault takes 142 seconds to trigger if pre-processing parameters are at default and Min. Peak Height or Threshold Offset is set properly not to detect valid echoes for Low-density sludge mode and High-density sludge, respectively. This value will increase if Signal History Length and/or Differential Filter Length are/is increased and vice versa.
- In low-density sludge mode, it is possible to read the distance of sludge as within the Blanking Distance, if the Min. Peak Height is set lesser than the amplitude of the echo found at the Blanking Distance. Min. Peak Height should be adjusted appropriately.

11. Declaration of Conformity

We
Smart Storm Limited
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Cibyn Industrial Estate
Caernarfon
Gwynedd
LL55 2BD
United Kingdom

Declare under our sole responsibility that the products:
USI, Hydrocell, USM, Avocet 9000, Greasebuster, Neutralizer

is in conformity with the following directives where applicable:

- The Electromagnetic Compatibility (EMC) Directive 2014/30/EU
- The Low Voltage Directive 2014/35/EU
- RoHS2 Directive 2011/65/EU
- Machinery Directive 2006/42/EC
- S.I. 2016/1091 The Electrical Compatibility Regulations 2016-UKCA
- S.I. 2016/1091 The Electrical Equipment (Safety) Regulations 2016 -UKCA

We also declare that the products:

Named above

are of UK origin and are manufactured and tested to Smart Storm internal quality standards defined in the company's formal ISO9001:2015 quality manual.

Dr John Duffy
Managing Director