USM LEVEL METER

INSTRUCTION MANUAL

Version : 2.0
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Contents

1. Specifications

Specifications	Universal Smart Meter – Level Meter
Input	DIGISENS UltraSonic Sensor
Temperature Range	-5 - 50 °C
Display	Graphic LCD 124x64 dots Negative Blue
Relays	3 SPDT, 5A
Current Output	4 – 20 mA galvanic isolated
Mains Supply	100 – 240 VAC 50/60Hz. Switched-mode power supply
Power Consumption	5VA
Weight	450 grams, Wall Mount Version
Enclosure Dimensions	160 mm x 130 mm x 60 mm
Mounting Dimensions (including cable glands, etc.)	185 mm x 155 mm x 60 mm

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 the 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 the Smart Storm's web site www.smartstorm.eu

• 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 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).

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.

• 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.

Wiring and Handling Precautions

⚠ 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. Turning On the USM

The USM measures Distance using a DIGISENS Sensor. The DIGISENS sensor is an intelligent sensor which measures time of flight of an ultrasonic echo and communicates to the USM using RS422.

The USM can then be configured as a Level measurement instrument, subtracting the distance from a known baseline or for Volume measurement by entering Tank dimensions

The USM can interface with other instruments (e.g. Data Logger) through a galvanic isolated 4-20mA output.

Three configurable relays are provided for control, alarm and monitoring.

3.1. CONNECTIONS

The connection terminals are accessible by removing the cover of the USM. All connections should be made through appropriate cable glands to maintain the IP rating of the unit.

The unit is factory built to either 100 – 240 Vac input or 9-24Vdc input.

The DIGISENS Sensor is supplied with clearly paired wires and should be connected as follows.

Green	TX+
Black (with green)	TX-

White	RX+
Black (with white)	RX-

Red	15V
Black (with red)	GND

Some DIGISENS Sensors are supplied with an additional pair of wires which should be connected as follows:

Blue	15V
Black (with blue)	GND

Relays can be connected as COM & NO (connection made when relay ON) or COM & NC (connection made when relay OFF).

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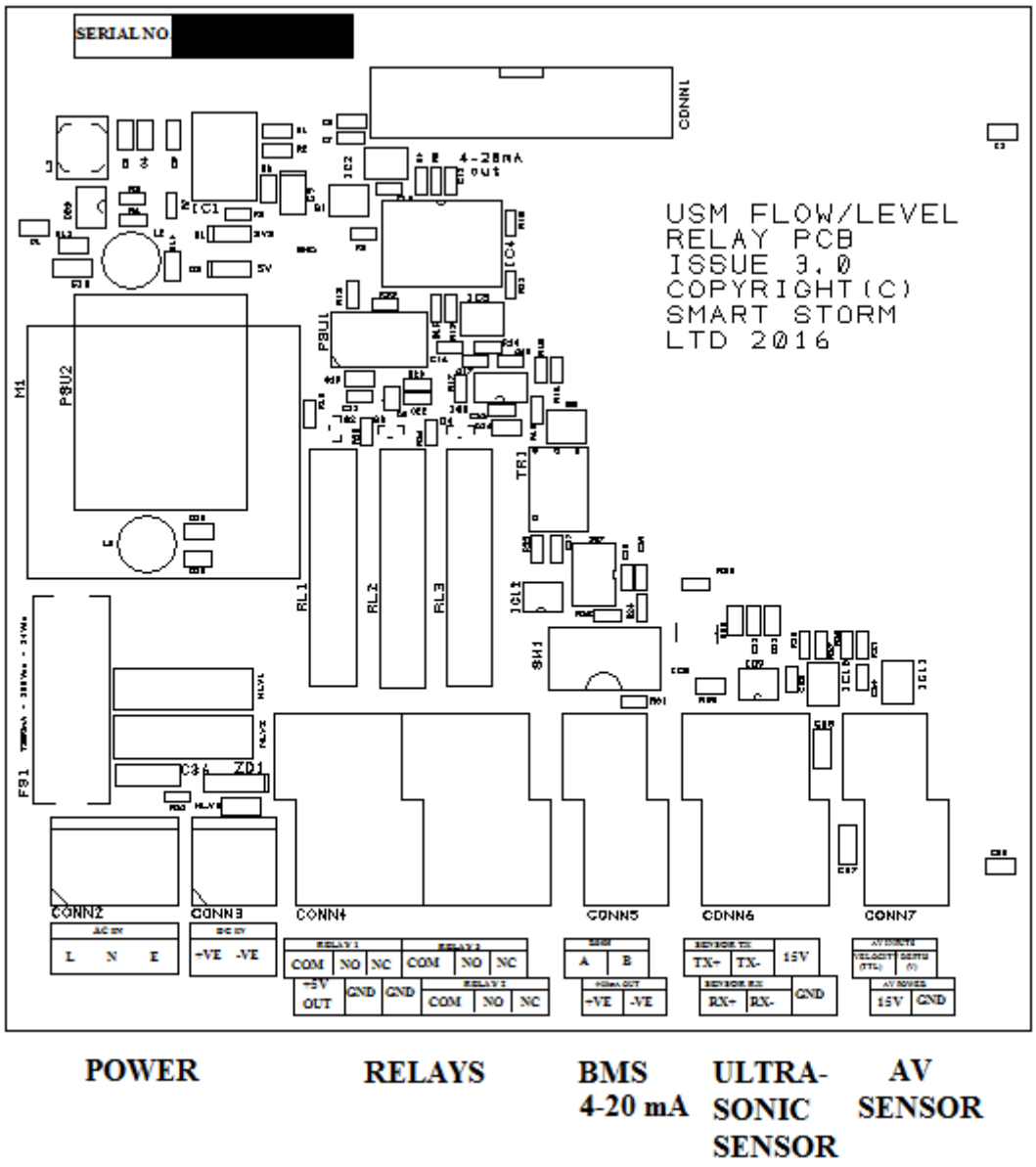


Figure 3.1 RELAY BOARD CONNECTIONS.

3.2. Turn On

When the unit is turned on a splash screen (Figure 1) will be shown detailing the contact details of Smart Storm.

Figure 3.2 Smart Storm Screen

This will be followed automatically by the Home Screen (Figure 2).

Figure 3.3 Home Screen

The Home Screen shows the selected Main Display Parameter (in the selected units) with a bar graph and percentage indicating either the Level or Volume . When the unit is first turned on the display will be inaccurate as tank parameters will not have been set. Further display options are outlined in Section 5. The red LED at the side of the display will flash at a rate of 2Hz. This indicates data is being received.

Pressing the Home Button  will return the Display to the Home Screen from all other display screens.

4. Configuring the USM.

Figure 4.1 USM

The USM is configured using the four push buttons.

Button	Action
	Scroll Right or Enter
	Scroll up, Increment Numbers
	Scroll down, Decrement Numbers
	Return to previous menu level or to Home Screen and Abort

Table 3.1 Keys' Functionalities

The unit is configured through the MENU page which is password protected. From the Home Screen, press ▶ button to access the PASSWORD page.

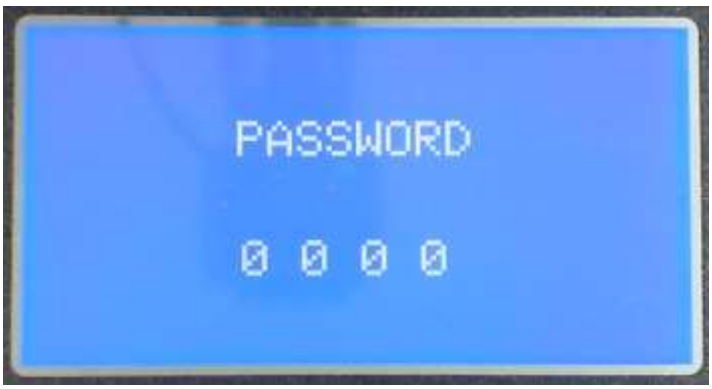


Figure 4.2 Password Screen

Use ↑ and ↓ buttons to select the desired digit at each location and press ▶ button to select the next digit. If a digit is entered incorrectly press ⌂ to return to the Home Screen.

The factory set password to access the configuration menu is '0000'. This can be changed.

If an incorrect password is entered 3 times the USM will lock the menu for 5 minutes.

If PASSWORD is correct, access to The Configuration MENU page is granted

Figure 4.3 Configuration Menu Screen

There are 16 sub menus to the Configuration menu:

1. LEVEL SET UP
2. DISPLAY SET UP
3. LOGGER SET UP
4. SENSOR SET UP
5. RELAY SET UP
6. 4–20 mA SET UP
7. COMMS SET UP
8. RELAY TEST
9. 4-20mA TEST
10. SIMUL. TEST
11. CHANGE PASSWORD
12. ECHO PROFILE
13 SLEEP TIMER
14 CHANGE FILTERS
15. ENGINEERING MENU
16 EXIT

Use  and  buttons to align the cursor with required sub menu and press  button to select. The key will return the USM to the Home Screen.

The ENGINEERING menu contains settings which should only be changed by Smart Storm and requires an additional password.

N.B. When the Configuration Menu is entered, the status of the relays and the 4-20mA output are not updated.

if No key is pressed for 2 minutes the USM will exit the Configuration Menu and return to the Home Screen.

4.1. Configuring the USM for LEVEL or FLOW.

Select **LEVEL SET UP** on the MENU page and press ▶ button. The following Sub-menu will be accessed.

Figure 4.4 – Tank Set Up Menu

Select Level or Volume using the ▲ and ▼ buttons and press ▶ to confirm your selection.

N.B. Changing the USM from Level to Volume or vice versa will delete programmed parameters (e.g. relay levels, Display options etc.) from the USM.

4.1.1. Configure Level.

After selecting Config. Level the measurement units must be selected.

Figure 4.5 Level Set Up Menu.

The measurement is changed using the ↑ and ↓ Keys and selected with the ▶ Key. The selection will be used as the main USM measurement units for inputing and displaying variables such as Relay ON and OFF levels.

The available measurements are:

millimetres **inches**

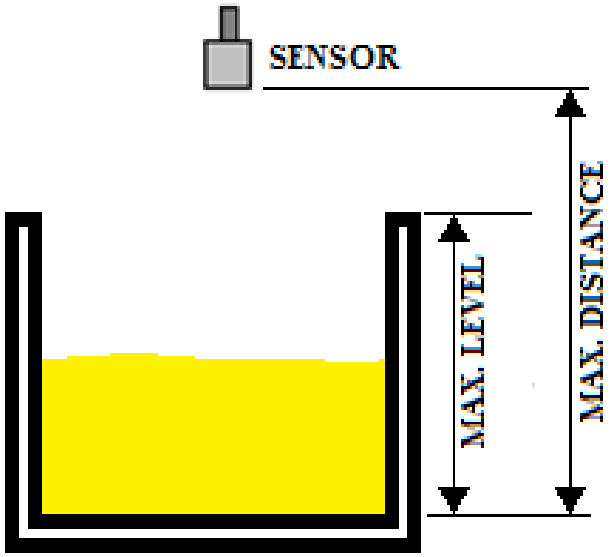
meters. **feet**

feet and inches

After selecting the measurement units, the Maximum Distance and Maximum level are entered.

Figure 4.6 Level Set Up Menu.

The distance is changed using the ↑ and ↓ Keys and selected with the ▶ Key.



The Max. Distance allows the USM to calculate a level (level = maximum distance – measured distance) and show the measured distance as a percentage. Similarly, entering a maximum level allows level to be shown as a percentage.

These values also form the limits of relays and 4-20mA parameters

The maximum distance which can be entered in limited by the head type (see section 4.X)

Figure 4.7 Level & distance.

N.B. After entering the values they must be saved or the USM will revert to the previous values.

4.1.2. Configure Volume.

After selecting Config. Volume a sub menu will appear to allow the entry of the required parameters.

Figure 4.8 Tank Set Up Menu.

4.1.2.1. Tank Set Up.

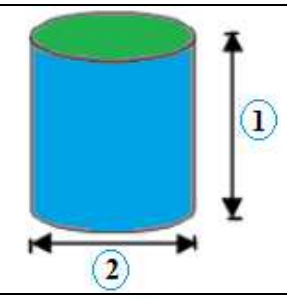
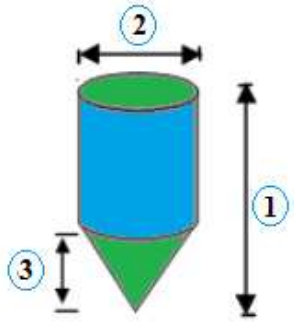
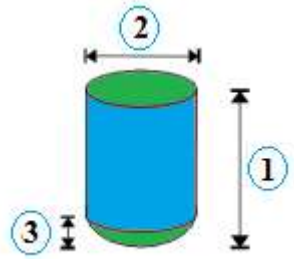
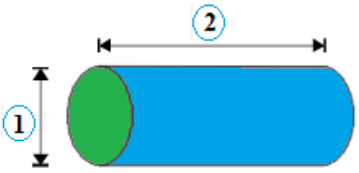
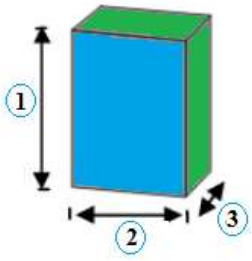
Select **Tank SET UP** on the MENU page and press ▶ button.

Figure 4.9a & b Select Tank Screens

There are 10 Default Tanks available on the USM level Meter, including the programmable Area Table which can be used for any device. Other devices are available on request from Smart Storm.

More the cursor using the ⬆ and ⬇ buttons and press ▶ to select the required tank shape.

AVAILABLE TANKS:

TANK SHAPE	TANK NAME	DIMENSIONS
	CYLINDER VERTICAL	1. Tank Height 2. Tank Diameter
	CYLINDER VERTICAL WITH CONE	1. Tank Height (including cone) 2. Tank Diameter 3. Height of Cone
	CYLINDER VERTICAL WITH ELLIPSE	1. Tank Height (including ellipse) 2. Tank Diameter 3. Height of ellipse
	CYLINDER HORIZONTAL	1. Tank Diameter 2. Tank Length
	CYLINDER HORIZONTAL WITH ELLIPSE	1. Tank Diameter 2. Tank Length 3. Length of ellipse
	RECTANGULAR	1. Tank Height 2. Tank Length 3. Tank Width

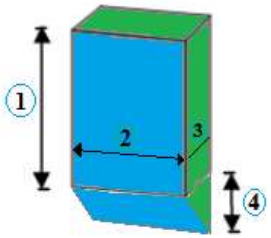
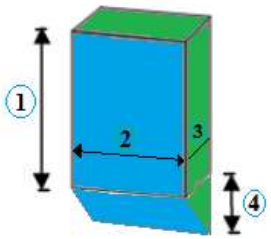
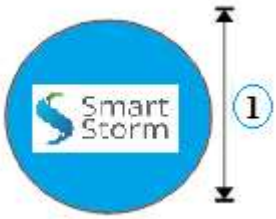
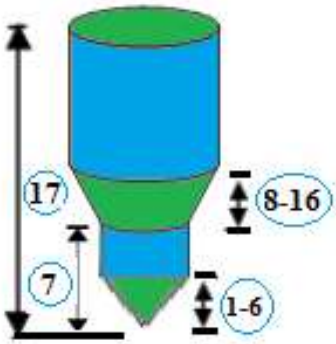
TANK SHAPE	TANK NAME	DIMENSIONS
	RECTANGULAR WITH CHUTE	1. Tank Height (including Chute) 2. Tank Length 3. Tank Width 4. Chute Height
	RECTANGULAR WITH OBLIQUE	1. Tank Height (including Oblique) 2. Tank Length 3. Tank Width 4. Oblique Height
	SPHERE	1. Tank Diameter
	TABLE	1-6. Non-Linear Section 7. Height of 1st Linear Cylinder. 8-16 Non-Linear Section 17. Height of 2nd Linear Cylinder (32 points available)

Table 4.1 Tank Shapes.

The tank Dimensions can now be entered. The Dimensions are entered in the order dictated by table 4.1. The example below shows the entry for A Vertical Cylinder with Cone.

Use the ⬆ and ⬇ buttons to change the value and press ▶ to select to enter and move to the next dimension.

Figure 4.6a,b & c Dimension Input Screens

The dimensions (and relay settings etc.) are entered in the units selected in the system unit menu (**see section 4.1.5**).

After entering all the tank dimensions any offset for the tank can be entered. Ultrasonic Sensors have a dead band in which they are unable to record distance. This is due to the resonance in the sensor and normally equates to around 300mm (6 inches). In order to read the full height of the tank it is therefore necessary to mount the sensor an equivalent distance above the tank and this is known as the offset. It equates to the distance from the bottom of the sensor to the top of the tank.

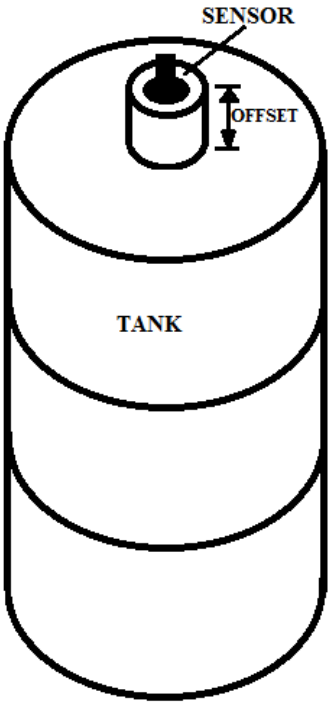


Figure 4.7 Tank Offset

Similarly, it is sometimes necessary to place the sensor inside the tank. Again, the offset is the distance from the bottom of the sensor to the top of the tank.

Care should be taken if a sensor is placed inside a tank to ensure the sensor does not become immersed if the tank is full.

The direction of the offset is selected and then the offset entered (see figure 4.8 below).

Figure 4.8 Offset Input Screens

***N.B. THE VALUES ENTERED FOR ANY TANK WILL NOT BE SAVED UNTIL THE TANK SET UP MENU IS EXITED AND SAVE SELECTED*.**

Area Table.

Non-uniform channels can be configured by Table entry into a 32-point table. The first point is automatically set to 0 Level and 0 Volume. The change of area between points is assumed to be linear.

Figure 4.9a & b Table Dimension Entry

The Level and volume are entered in the units selected in SYSTEM UNITS (section 4.1.2.3)

Points must be entered in the correct order i.e. the Level and Volume of point 4 must be greater than the Level and Volume of point 3 and greater than the Level and Volume of point 5. The Level and Volume of the previous Point are shown at the top of the Display.

Use the ⬆ and ⬇ buttons to change the value of the Level (L1 in 4.9a) and press ▶ to select to accept. The display will change to Fig 4.9b to allow the Volume to be entered.

If the value entered is less than the previous point an error message will appear and the dimension must be re-entered (see Figs 4.10a&b below)

Figure 4.10a & b Table Error Message

Table entry will continue up to 32 points. If the table is less than 32 points, entry can be terminated by entering a value of 0 into the level field.

When the table is complete an Offset can be entered as described above.

N.B. THE VALUES ENTERED FOR ANY TANK WILL NOT BE SAVED UNTIL THE TANK SET UP MENU IS EXITED AND SAVE SELECTED.

4.1.2.2. Specific Gravity.

Allows the Specific gravity of the substance in the tank to be entered to allow the accurate calculation of the weight.

Figure 4.11 Specific Gravity

4.1.2.3. System Units.

This menu selection allows the user to enter the units to be used for distance/length, flow and volume. These units are used on the display pages and as entry units when configuring the relays and 4-20mA.

Figure 4.14 System Units Entry.

The units are selected from a rotating list and the available units are:

Length/Distance:

millimetres	inches
meters	feet
	feet and inches

Volume:

cubic meters	cubic feet

Weight:

Tonne	(Metric Ton = 1000 Kg)
Short Ton	(US Ton = 2000 LBs or 907.18 Kg)
Long Ton	(Imperial Ton = 2240 LBs or 1016.05 Kg)

N.B. The USM Level calculations are performed in metric. This may lead to slight discrepancies between the entered and displayed parameters (due to rounding) when using imperial units, there is however no loss of accuracy or resolution.

4.1.2.4. Saving the Settings.

Parameters are not saved to the USM until a correct exit from the Set Up Menu is performed.

If at any time the USM is returned to the Home Screen without saving the parameters must be re-entered.

From the Tank Set Up Menu, use the ⬆ ⬇ and ▶ buttons to select Save & Exit.

Figure 4.15 Selecting Save and Exit

On the Save Settings use the ⬆ to select YES and press the ▶ button to confirm

Figure 4.16 – Save Screen

The Parameters will now have been saved to memory and a confirmation message will flash on the screen.

4.2. Configuring the Display Set Up.

The USM allows some display screens to be customised to show different measurements. These measurements are configured from the Display Set Up Menu. The Select Display for a USM configured as Level appears in fig 4.17a and for Volume in 4.17b. The Volume has additional configurable screen.

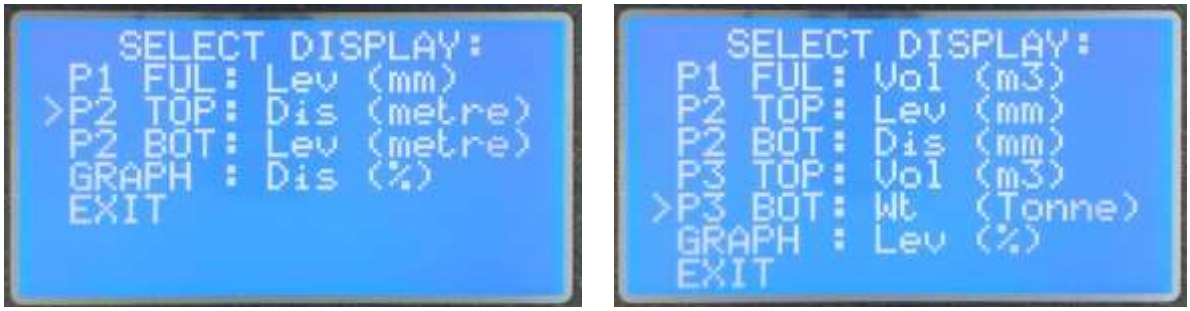


Figure 4.17a&b Display Set up Screen 1.

The displayed measurement to be changed is selected using the ⬆ ⬇ buttons. The ▶ button will then change the measurement in a rotating list. The selection in figwould result in the following screens:

Home Screen Measurement Page1 Measurement Page2 (Volume Only)

Figure 4.18 – Display Screens from Set up

The available measurements for P1 FULL are:

LEVEL and Volume		**Volume Only**	
Level mm	Distance mm	Volume m3	Weight Tonne
level metres	Distance meters	Volume cubic feet	Weight Short Ton
level inches	Distance inches	Volume %	Weight Long Ton
level feet	Distance feet		
level %			

The GRAPH can be configured as

LEVEL	**Volume**
% Level	% Level
% Distance	% Volume

In addition to the flow measurements used for P1 Full the following measurements are available for P2 and P3

Level (feet and Inch)

Distance (feet and Inch)

Figure 4.19 – Measurement Page Example.

4.3. Configuring the Logger.

Figure 4.20 – Data Logger Set Up.

The USM can be fitted with a Micro-SD card to give a Time Stamped record the main variables. These can then be displayed in text and graphical form using the Smart Storm INQUISTER 10 software.

Log Int. sets the interval at which the measurements are recorded and can be set to:

OFF	1 minute	2 minutes
5 minutes	10 minutes	30 minutes

Format is used to select the date format on the Home Screen and can be set to:

OFF	DD/MM/YY	MM/DD/YY (US format)

Date and **Time** are used to set the date and time both for the home screen display and the record Time Stamp.

Connect to USB is selected when records are to be downloaded.

Figure 4.21(a & b) – USB Connection Screens.

Select **Connect to USB** without a USB connection. The screen shown is Figure 4.21a will appear. A connection can now be made to a windows PC and the screen will change to Figure 4.21b.

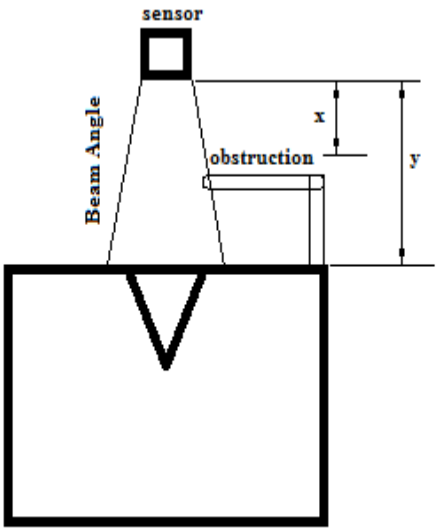
The data on the SD card can now be viewed in windows explorer. The SD card will appear as a new drive (similar to a USB memory stick). The files can be saved to the PC and opened using INQUISTER 10.

To return to the menu, unplug the USB link and press the key.

4.4. Configuring the Sensor.

The Sensor Set Up Menu allows the Threshold (level at which the device triggers) and blanking period (distance from the sensor at which readings begin to be taken) of the DIGISENS sensor to be changed.

The return echo under normal circumstances is returned at a level of 100%. This can be checked using the Echo Profile (see section 4.12). If the return echo is poor the threshold can be lowered to prolong the life of the sensor. The factory setting is 80%.



The Blanking period can be used to make the sensor 'blind' to objects between the sensor and the effluent. In figure 5.18 there is a potential obstruction which may cause a false echo when used in a flow application(similar considerations apply to any obstructions). If the Blanking Distance is set to x the sensor could report this false echo as the height of the effluent.

Setting the Blanking Distance to y will make the head ignore the return echo from the obstruction and return the 2nd echo from the effluent. In most cases the Blanking Distance can be set to the distance from the sensor to the Max Height.

Figure 4.22 – Blanking Distance.

Please contact Smart Storm for further information on changing these settings.

4.5. Configuring the Relay Set Up.

The USM has three programmable relays. These are configurable as ON/OFF FLOW, LEVEL or DISTANCE switches, as a Sample Request to a composite sampler or as LOST ECHO (no distance returned from the DIGISENS sensor).

Fig 4.22 Relay Set Up.

Use the or buttons to select the relay to be configured. and select by pushing the button.

Fig 4.23a & 4.23b Relay Set Up.

When the Status field is selected pressing the button toggles the selection between ENABLED and DISABLED. Selecting ENABLED shows the additional configurable parameters.

When the Mode field is selected pressing the button toggles the selection between the available relay types.

4.5.1. Lost Echo Relay.

When LOST ECHO is selected, no further input is required and Exit should be selected and the parameters saved. This relay will now turn on when either there are 5 consecutive readings from the DIGISENS sensor with zero distance returned or no communication from the DIGISENS sensor for 10 seconds.

Fig 4.24 Lost Echo Relay.

4.5.2. Distance, Level, Volume and Weight Relays.

When Distance, Level, Volume or Weight Switch is selected the ON and OFF parameters are visible (N.B. Volume and Weight are only available when the USM is configured for Volume). These are configurable by moving the cursor to the required field and pressing the button. An arrow will appear next to the parameter to show it as selected.

The Parameter can then be changed using the keys and the value entered using the button.

Fig 4.25 Setting Relay Parameters.

The maximum Distance is set by the Digisens maximum distance (3000mm, 60000mm, 10000mm or 20000mm).

The maximum Level is the Maximum Level or Tank Hight set when defining the device in the set up.

The maximum Volume is calculated from the dimensions of the tank.

The maximum Weight is the maximum Volume * 1.5 (to allow for high specific gravities).

N.B. THE VALUES ENTERED WILL NOT BE SAVED UNTIL THE RELAY SET UP MENU IS EXITED AND SAVE SELECTED.

4.6. Configuring the 4-20mA Set Up.

The USM has a 4-20 mA output which can be configured to represent Level, Distance, Volume or Weight (N.B. Volume and Weight are only available when the USM is configured for Volume).

The 4-20mA SETUP is accessed from the Configuration MENU.

Figure 4.26 4-20mA Setup Screen.

The 4mA and 20mA values are configurable by moving the cursor to the required field and pressing the button. An arrow will appear next to the parameter to show it as selected.

The Parameter can then be changed using the keys and the value entered using the button.

The maximum Distance is set by the Digisens maximum distance (3000mm, 60000mm, 10000mm or 20000mm).

The maximum Level is the Maximum Level or Tank Hight set when defining the device in the set up.

The maximum Volume is calculated from the dimensions of the tank.

The maximum Weight is the maximum Volume*1.5 (to allow for high specific gravities).

N.B. THE VALUES ENTERED WILL NOT BE SAVED UNTIL THE 4-20mA SET UP MENU IS EXITED AND SAVE SELECTED.

4.7. Configuring the Comms Parameters.

The USM can be configured to respond to a Building Management System using Modbus RTU (RS485).

Figure 4.27 Comms Setup Screen.

The Parameter can be selected using the keys and the value changed using the button. The following selections are available:

Baud rate : 9600, 19200

Parity : ODD, EVEN, NONE

No of Bits : 7, 8

Address : OFF, 1 – 247.

The USM uses standard Modbus Protocol with CRC 16. The registry structure is detailed in Appendix.

4.8. Relay Test.

The USM Relay Test Screen can be used for testing the relays or for driving the connected equipment (e.g. testing a sampler will respond to a sample request or testing an alarm).

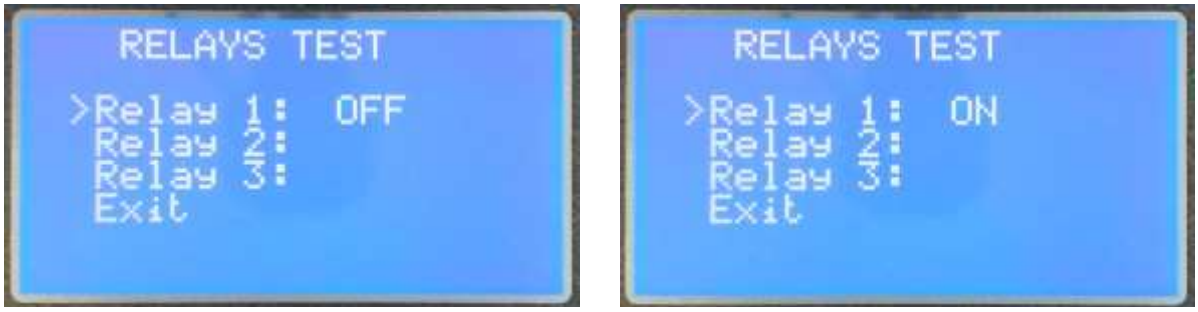


Figure 4.28a & b Relay test Screens.

Move the cursor to the required relay using or buttons. Pressing the button will toggle the relay state. The appropriate LED should light.

4.9. 4-20mA Test.

The USM 4 - 20mA Test Screen can be used for testing the current and for driving the connecting equipment.

The output value can be changed using the or buttons. Pressing or will exit to the Configuration MENU.

Figure 4.29 4 - 20mA test Screen.

The output can be checked by measuring the voltage generated across a 100 ohm resistor on the output (current = voltage/100) or by direct measurement using the current input on a suitable multi-meter.

N.B. In both cases any other connections from the 4-20mA output circuit should be removed.

The 4-20mA test can be used for calibration to other equipment.

To integrate to a data logger, configure the 4mA output to 0.0 flow and the 20 mA to the span of the Flow Device.

In the 4-20mA Test, set the output to 4mA and enter 0.0 as the 4mA value on the data logger.

Set the output to 20mA and enter the Span as the 20mA value on the data logger.

This will calibrate the USM to the data logger. Refer to the data logger instruction manual for details of calibrating the values.

4.10. Simulation Test

The USM Simulation Test Screen can be used for testing the Relays and f4 – 20mA outputs. There are two test modes: SWEEP and FIXED.

Figure 4.30 Simulation test Screen.

When SWEEP is selected the USM will return to the Home Screen and change the level recorded from 0mm to the Maximum height and back to 0mm. This will continue for two minutes allowing the functionality of the outputs to be checked. The USM will then return to monitoring the flow in the device.

In FIXED mode a value of level is entered and this value will again drive the outputs for two minutes.

Whilst in Simulation Test flow values are not recorded as Daily Maximum and Minimum.

4.11. Change Password.

The default password can be changed from 0000. On selecting this option the user will be required to enter the current password and then the new password.

Caution is advised as the new password is saved immediately after the last digit is entered. The new password will appear temporarily after it is input.

4.12. Echo Profile.

The Echo Profile provides a real time representation of the Ultrasonic Echo received by the sensor. It can be used to ensure there are no obstructions causing false echoes and that the displayed distance is coming from a strong return echo.

The scale for the X axis is selectable and dependant on the sensor type.

Figure 4.31 Scales for a Digisens 6 Sensor.

Figure 4.32 Echo Profile Showing Strong Echo at 1.80m.

Figure 4.33 shows a good return echo from a surface around 900mm below the sensor with no false (interfering) echo in front of it. It can be seen that the echo has an amplitude of 100%. A second (Harmonic) echo at 3.6m will have no effect on the reading of the USM.

Figure 4.34 shows the same echo at a zoomed in (3m) scale.

Figure 4.33 Echo Profile with 3m Scale.

4.13. Sleep Timer.

The screen of the USM can be configured to turn off after a programmed time to allow low powered operation.

Figure 4.34 Sleep Timer Screen.

The Sleep Timer can be configured as: **OFF, 1 minute, 2 minutes, 5 minutes, 10 minutes and 30 minutes**.

The USM will come out of sleep mode when any button is pressed.

4.14. Changing Filters.

The USM uses two filter parameters to stabilise the displayed readings. The measurements can be heavily slugged if, for example, a mixing blade is operating in a tank and causing ripples on the surface of the fluid.

The 1st co-efficient is the Filter Length and the 2nd is the Filter Co-efficient.

Figure 4.35a & b Filter Co-efficients.

If the Filter Co-efficient is set to zero, the filter Length sets up a moving average filter of the length entered. The screen will be updated every second with an average of the previous specified number of readings (An average of 8 values in Figure 4.35).

If the Filter Co-efficient is non-zero a turbulence filter operates. The USM waits until it has a received the number of measurements specified in Filter Length and takes an average of these values (in Figure 4.35 it would wait for 8 measurements). The difference between this average and the average 8 seconds before is calculated and a fraction of this difference is added to the previous average.

The fraction is calculated from the Filter Co-efficient according to the formula:

(21 – Filter Co-efficient)/20.

A Filter Co-efficient of 1 will add the full difference and the result will be an average of the previous 16 readings. A Filter Co-efficient of 20 will add a 20th of the difference and heavily slug the response of the USM to changes in readings.

4.15. Engineering

The Engineer Menu is password protected and not available for general use.

5. USM Display Screens.

Several Display Screens are included in the USM to enable information to be seen without accessing the configuration Menu. Relays and 4-20mA output are updated whilst on any Display screen.

5.1. Home Screen.

Figure 5.1 Home Screen

The Home Screen shows the Flow through the system. The units of flow and the graphical representation are configurable from Display Set Up (Section 4.2). An optional Date and Time can be displayed and is selectable from Logger Set Up (Section 4.3).

The Key returns the display to the Home screen from any other screen.

Other screens are accessed using the buttons with the following available:

HOME

MEASUREMENT SCREEN 1

MEASUREMENT SCREEN 2 (volume only)

4-20mA SCREEN

RELAY SCREEN 1

RELAY SCREEN 2

TANK PARAMETERS

SENSOR SET UP

CALC PARAMETERS

COMMS SET UP

ABOUT USM

SMART STORM LOGO

SUMMARY SCREEN (volume only)

HOME

If the no distance is returned for 5 consecutive Echoes (5 seconds) the screen will display LOST ECHO – this indicates that the USM is still receiving data from the sensor but the sensor is not seeing an echo.

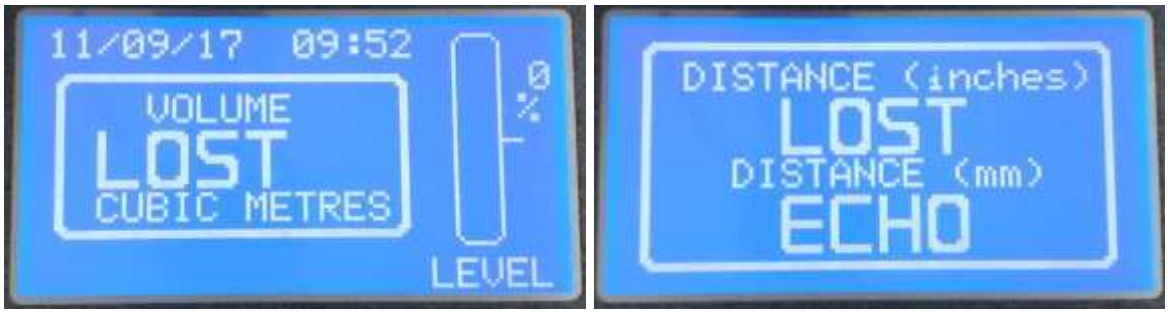


Figure 5.2a & b LOST ECHO indication.

Similarly, if the USM receives no data from the sensor for 10 seconds it will display LOST COMMS.

5.2. Measurement Screens

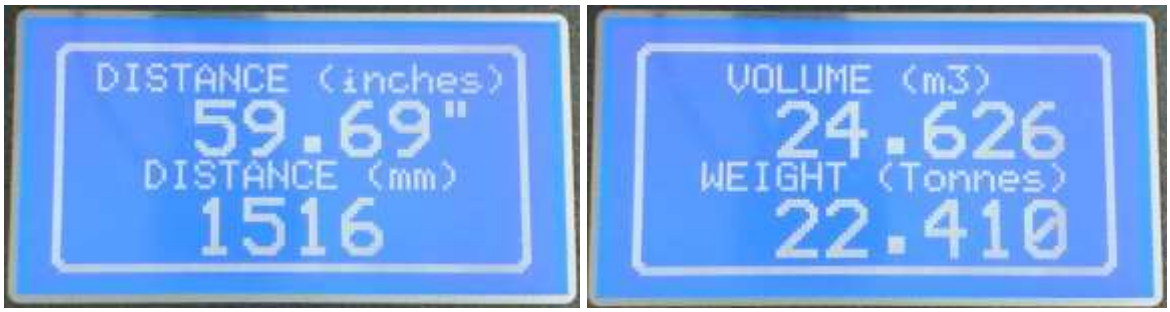


Figure 5.3a&b Measurement Page Examples.

The measurement screens allow the displaying of any two measurements on a single screen. the measurements are configurable from Display Set Up (Section 4.2).

This allows the customer to display the measurements must suitable or comply with any industry requirements.

5.3. 4-20mA Screen

Figure 5.4 4-20mA Screen.

The USM 4-20mA screen shows the current Set Up of the 4-20mA along with the current value (CUR) of the selected measurement and the mA output for the value of that measurement.

If there is a lost echo or lost comms an error measure will replace the CUR value with an error message and the output will go to 0mA.

If the 4-20mA channel is disabled the screen will be blank.

N.B. After any changes to the control Parameters, the Relay and 4-20mA Set Up screens should be checked to ensure the correct values have been saved.

5.4. Relay Screens

The USM has two relay screens which show the Set Up and state of the three relays. Relay Page 1 covers **Relay 1** and **Relay 2,** whilst Relay Page 2 repeats **Relay 2** and additional shows **Relay 3.**

Figure 5.5 Relay Screen 1.

Figure 5.5 shows **Relay 1** is set to **VOLUME**. The current recorded measurement of **VOLUME (CUR)** is **24.6m3**. As this is above the **ON** value of **Relay 1** this relay is turned **ON**. The relay will turn **OFF** when the **VOLUME** drops below 2.0m3

Relay 2 is set **LOST ECHO**. The echo is shown to be good so the relay is turned **OFF**.

Figure 5.6 Relay Screen 2.

Figure 5.6 shows **Relay 3** is set to **LEVEL**. The current recorded measurement of **LEVEL (CUR)** is **3483mm**. As this is above the **ON** value of **Relay 1** this relay is turned **ON**. The relay will turn **OFF** when the value falls below 1400mm

5.5. Tank/Level Parameters

The Tank/Level Parameter screen shows the dimensions entered in Level Set Up. The dimensions are shown in the entered SYSTEM UNITS.

Figure 5.7a & b Examples of Parameter Screens

5.6. Sensor Set Up

The Sensor Set Up Screen shows the current sensor set up. The Detection Threshold (Det Thres) and Blanking Distance are configurable from the Sensor Set Up and are discussed in Section 4.4.

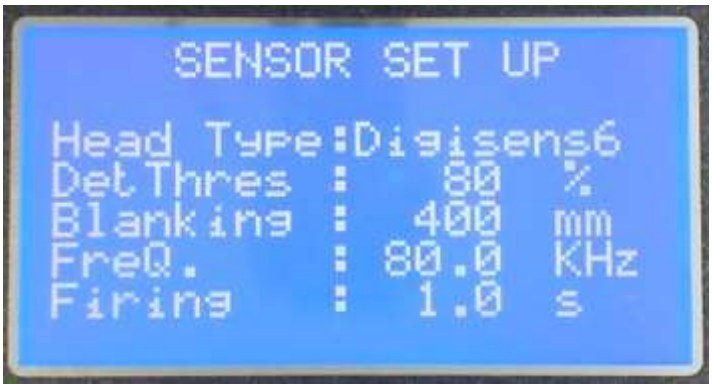


Figure 5.8 Sensor Set Up Screen.

The Head type, Frequency and Firing rate are factory set and only changeable from the engineering menu.

The available head types are:

HEAD TYPE	NOMINAL FREQUENCY	DISTANCE
Digisens 3	150 KHz	3m (9 feet)
Digisens 6	80KHz	6m (18 feet)
Digisens 10	60KHz	10m (30 feet)
Digisens 20	40KHz	20m (60 feet)

Table 5.1 Sensor Head Types

The sensors are factory tuned to give the best performance around the nominal frequency. Higher frequency crystals give improved precision but shorter distance.

5.7. Calc Parameters

The Calc Parameters show the information used by the USM to calculate the Level of the Liquid.

Figure 5.9 Calc Parameters Screen.

The USM receives a Time of Flight (ToF) from the sensor. This is the time (in µseconds) for the ultrasonic pulse to be transmitted from the sensor, hit the surface of the liquid and return to the sensor.

The sensor also sends a numerical representation of the temperature and the USM converts this to an actual temperature depending on the temperature device on the sensor (Temp Mode).

The temperature is used to calculate the speed of sound (SOS) and the distance can then be calculated from the ToF. Finally, the level can be calculated by subtracting the distance from the No Flow (see Section 4.1.2).

Distance and Level are available to be displayed on the Measurement Screens.

The Calc Parameters screen is updated every 5 seconds and if a fault occurs the ToF, Temp and SoS will be replaced with LOST ECHO/LOST COMMS.

5.8. Comms Set Up

The Comms Set Up Screen show the values entered in COMMS SET UP, and are the settings required for MODBUS RTU communication with the USM.

Figure 5.10 Comms Set Up Screen.

5.9. About USM

The About USM Screen details the **DEVICE TYPE, SOFTWARE VERSION** and **SERIAL NUMBER**

5.10. Smart Storm Logo

The splash screen with company logo displayed on turn on.

5.11. Summary Screen (Volume Only)

The summary screen provides a convenient means to view all the measurements on a single screen.

Figure 5.11 Summary Screen.

6. Fault Finding

Fault	Possible Cause	Solution
No Display	Lost Power	Check external and internal fuses
No Display	Ribbon Cable disconnected from Main PCB	Carefully remove each end of enclosure. Separate top of enclosure from the bottom. Identify cable and carefully push back onto connector. Reassemble
Lost Comms	Sensor wiring incorrect	Check Wiring of the AV sensor. Check Power to Senor is 15V
Flow reading not stable Or LOST ECHO displays continuously	AV sensor incorrectly mounted	Check and ensure the AV sensor is positioned correctly
No Current output on the 4 – 20 mA output	4 – 20 mA Setup not enabled. Setting enabled but set to zero. Incorrect wiring	Check Configuration. Ensure +ve and –ve terminals.are connected correctly.
Current mA Output read 24V	No load on 4-20mA output	Check the wiring of the 4-20mA output
Relay not triggering at set point	Relay_x is DISABLED. Set points not reached	Check the configuration of the relay

Table 6.1 – Fault Finding

7. Appendix A. Modbus RTU

Not currently implemented.

Declaration of Conformity

We
Smart Storm Limited
The Old Mill
Wainstalls
Halifax
HX2 7TJ

Declare under our sole responsibility that the products:

USI, Hydrocell, USM, Avocet 9000, Mudsens, Greasebuster FS

to which this declaration relates, is in conformity with the following directive.

The Electromagnetic Compatibility (EMC) Directive 2004/108/EC

And the following harmonised European Norms (EN standards), IRC and Environment Agency standards.

Standard	Issue
BS EN 50081-1 Emissions	1992
BS EN 50082-2 Immunity	1995
IEC 801 Immunity	1992
BS EN61010-1 Low Voltage	1993

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 ISO9001:2008 quality manual.

Dr John Duffy
Managing Director