USM AV FLOW METER

INSTRUCTION MANUAL

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Contents

1. Specifications

Specifications	Universal Smart Meter – Flow 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.

Turning On the USM

2.1. General Product Information

The instrument measures Flow using a Dual-Wave Doppler AV Sensor. The sensor measures the Velocity and Depth of the fluid. The area of the fluid can then be determined from the depth and entered profile of the channel/pipe and the volume of flow calculated.

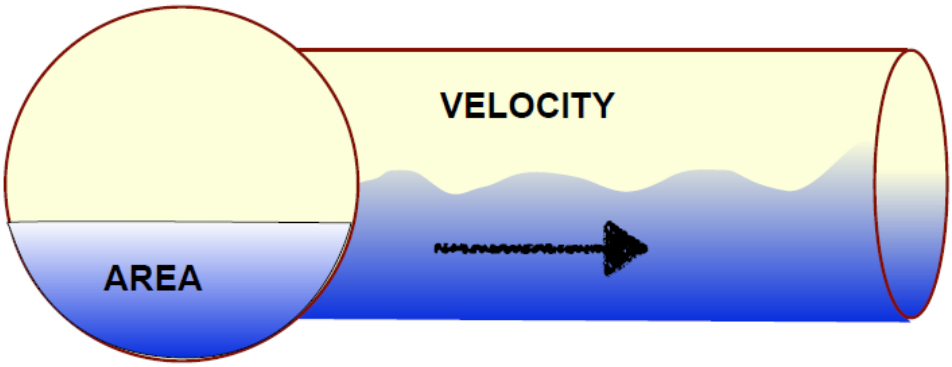


Figure 2.1 – Flow Parameters.

Using acoustic technology, the sensor measures the velocity using the Doppler effect. Ultrasonic energy is continuously transmitted under water into the flow stream. The sound waves are reflected form tiny solid matter in the flow stream and the transmitted frequency compared to particle bounce frequency. Thousands of velocity return signals are averaged to produce a representative average velocity which is a function of sample time and echo reduction parameters. The velocity is output as a TTL UART signal which is transmitted directly to the USM.

A highly sensitive and accurate pressure depth sensor is incorporated into the AV sensor. The depth is output as a Voltage in the range 0 – 5V.

All calculations are then performed by the USM to convert the inputs from the sensor into velocity, depth and flow.

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

2.2. Connections

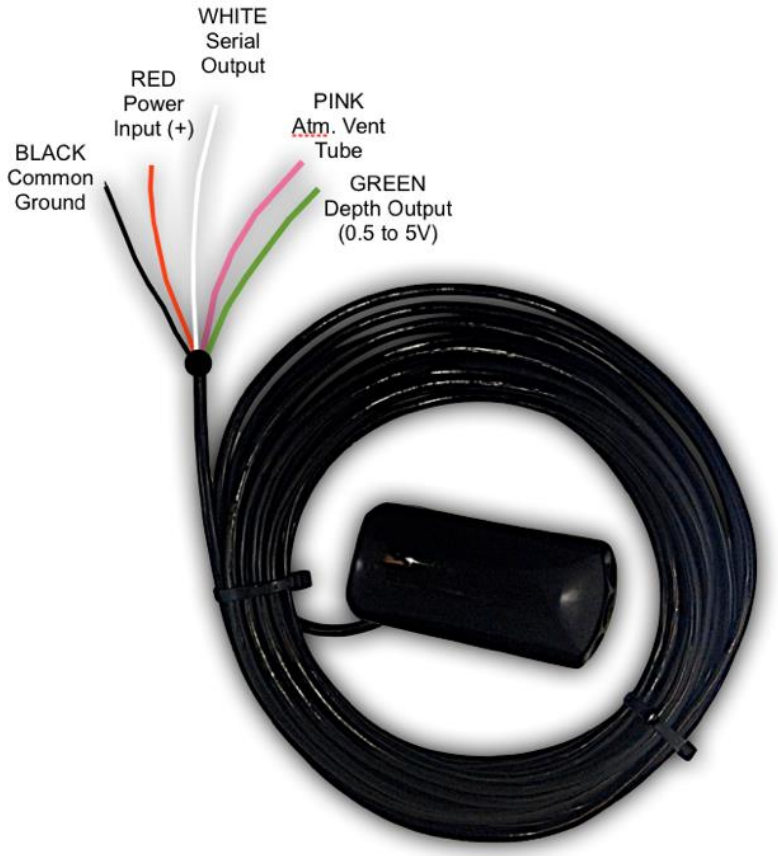
The connection terminals are accessible by removing the cover of the USM. All connections should be made through appropriate cable glands to maintain the IP rating of the unit.

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

The AV Sensor is supplied with clearly labelled wires and should be connected as follows. Connections are made to CONN7.

COLOUR	CONNECTION	VALUE	USI CONNECTION
RED	POWER IN	6-16V DC	15V
BLACK	GROUND	GROUND	GND
WHITE	VELOCITY OUT	4800 UART TTL	VELOCITY (TTL)
GREEN	DEPTH OUT	0.5 – 5V DC	DEPTH (V)

Table 2.1 – AV Sensor Connections



NOTE * * DO NOT BEND OR KINK THE PINK VENT TUBE FOUND IN THE CABLE

Figure 2.2 – The AV Sensor.

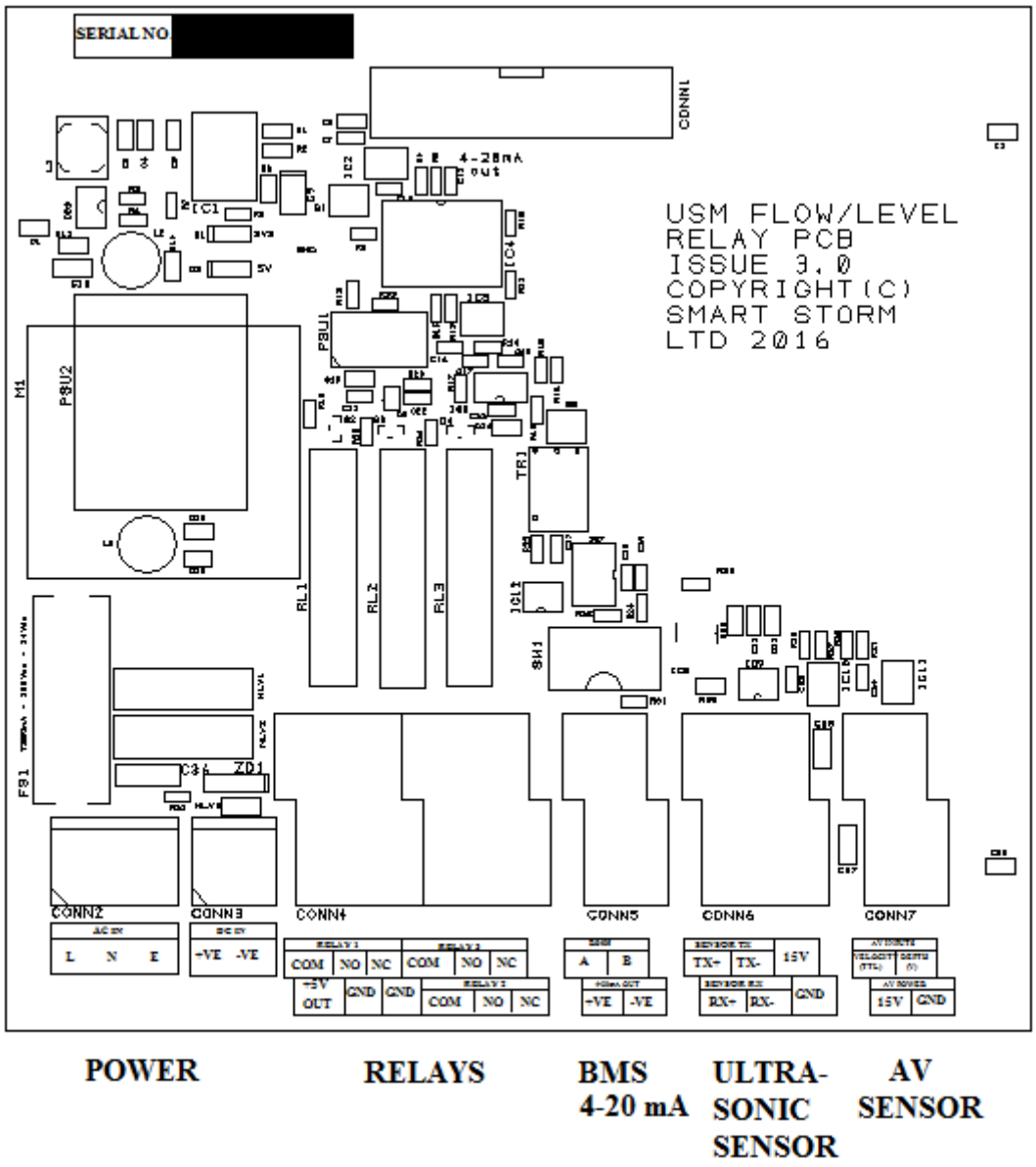


Figure 2.3 – RELAY BOARD CONNECTIONS.

2.3. Turn On

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

Figure 2.4 – Smart Storm Screen

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

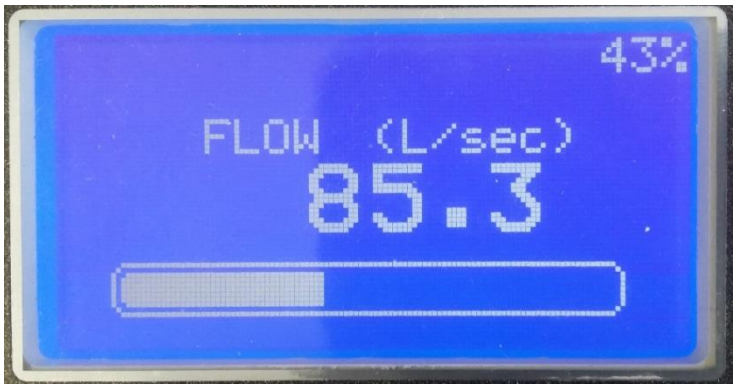


Figure 2.5 – Home Screen

The Home Screen shows the flow (in the selected units) with a bar graph and percentage indicating the 4-20mA output. When the unit is first turned on the flow will be inaccurate as flow parameters will not have been set. Further display options are outlined in Section 5. If an AV sensor is connected the red LED at the side of the display will flash at a rate of 2Hz. This indicates data is being received.

N.B. The Sensor has a warm up time and will take around 5 seconds to display an accurate reading

3. Configuring the USM.

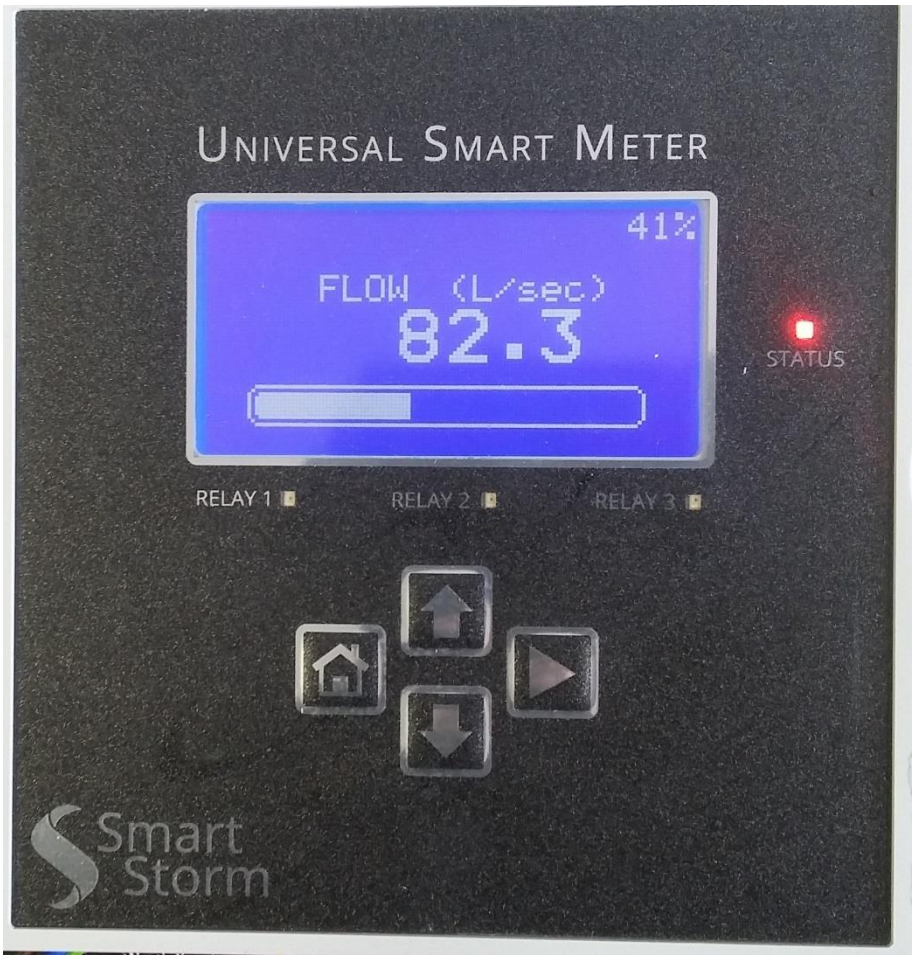


Figure 3.1 – USM

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.

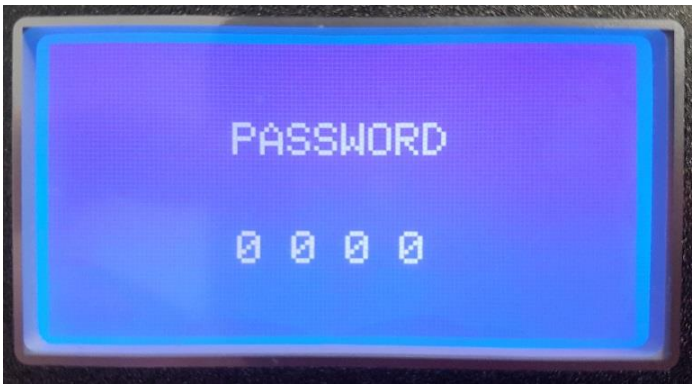


Figure 3.2 – Password Screen

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

Figure 3.3 – Configuration Menu Screen

There are 8 sub menus to the Configuration menu:

1. FLOW SETUP
2. DEPTH CALIBRATE
3. RELAY SETUP
4. 4 – 20 mA SETUP
5. RELAY TEST
6. 4-20mA TEST
7. CHANGE PASSWORD
8. ENGINEER
9 .EXIT

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

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

N.B. When the Configuration Menu is entered all relays are frozen in their current state and not updated. It is important that the USM is not left in the Configuration Menus for extended periods.

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3.1. Configuring the Flow Parameters.

Select **FLOW SETUP** on the MENU page and press ▶ button.

Figure 3.4 – Flow Set Up Screen

3.1.1. Device Set Up.

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

Figure 3.5 – Flow Device Screen

There are currently 4 Default Flow Devices available on the USM Flow Meter, including the programmable Area Table which can be used for any device. Other devices are available on request from Smart Storm.

3.1.1.1. PIPE

Move the Cursor to Pipe and press the ▶ button.

Figure 3.6 – Pipe Screen

A pipe is defined by a single parameter – Diameter.

Use the ⬆ or ⬇ to change the diameter and press the ▶ button to accept the value. The area of the Pipe will now be displayed.

Figure 3.7 – Max Area.

By definition the Max. Height for a pipe is equal to the diameter and does not need to be entered separately.

3.1.1.2. Rectangular.

Rectangular channel profiles are defined by 2 dimensions – the Width of the channel and the height of the channel. These are entered on separate, consecutive screens.

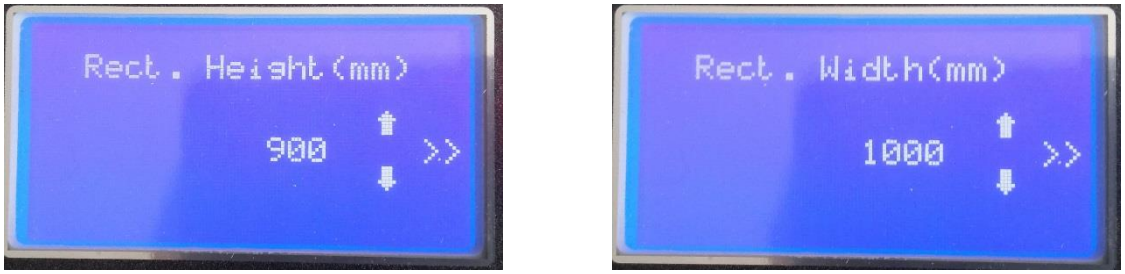


Figure 3.8 – Rectangular Channel Entry

Use the ⬆ or ⬇ to change the value to the Rectangular height and press the ▶ button. This will display the Rectangular Width screen and then the Area Screen.

The Rectangular height entered forms the maximum setting for a Relay set to trigger on Depth.

3.1.1.3. Trapezoidal Channel.

Trapezoidal Channels are defined by 4 dimensions.

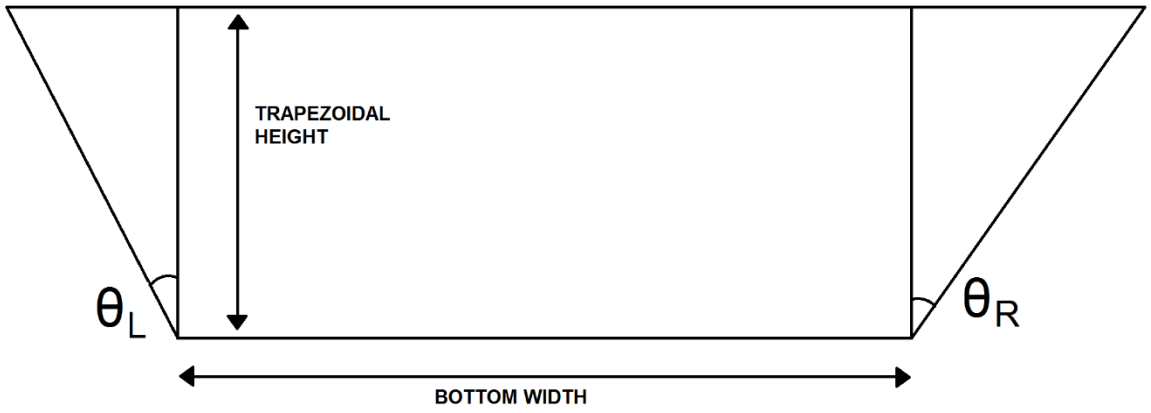


Figure 3.9 – Trapezoidal Dimensions.

Trapezoidal Height.

Bottom Width.

Slope Left (θL).

Slope Left (θR).

The Trapezoidal Height and Bottom Width are entered as for the rectangular channel with a third screen for inputing the two slopes.

Figure 3.10 – Slope entry.

The slopes are entered in degrees, with a maximum angle of 90º.

3.1.1.4. Area Table.

Non-uniform channels can be configured by Table entry into a 32-point table. The first point is automatically set to 0 depth and 0 area.

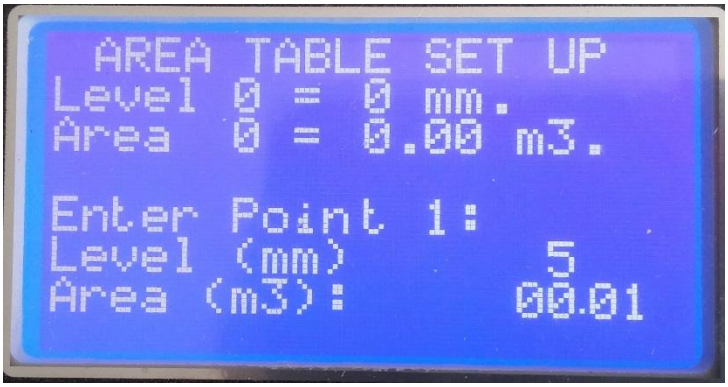


Figure 3.11 – Table Parameters

The depth is entered in mm (inches in imperial) and the area is entered in cubic meters (cubic feet in imperial). Other units must be converted before entry.

Points must be entered in the correct order i.e. the depth and area of point 2 must be greater than the depth and area of point 1.

If the table is less than 32 points, entry can be terminated by entering a value of 0 into the depth field.

The change of area between points is assumed to be linear.

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

3.1.2. Flow Units Metric.

The Flow measurement units input screen is accessed from the Flow Set Up Menu. The units are selected from a rotating list using the ⬆ or ⬇ keys. When the correct units are selected the ▶ button will accept the value and return to the **FLOW SETUP** menu.

Figure 3.12 – Flow Unit Selection.

The current list of metric flow units available on the USM are:

L/s (litres per second)	m3/min (cubic meters per minute)
L/hr (litres per hour)	m3/hr (cubic meters per hour)
m3/s (cubic meters per second)	m3/d (cubic meters per day)

3.1.3. Flow Units Imperial.

The unit also allows the use of imperial units by selecting:

gal/sec (US gallons per second)	gal/hr (US gallons per hour)
gal/mn (US gallons per minute)	gal/day (US gallons per day)

Unlike metric units when using imperial units, the meter will automatic switch between gal (gallons), Kgal (kilogallons = 1000 gallons) and Mgal (Megagallon = 1,000,000 gallons) depending on the value to be displayed.

When imperial units are used, all distances are displayed and entered in inches and temperature in Fahrenheit. The totaliser is displayed in cubic feet (ft3).

N.B. The USM FLOW 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.

3.1.4. Saving the Settings.

Parameters are not saved to the USM until a correct exit from the Flow 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 Flow Set Up Menu, use the ⬆ ⬇ and ▶ buttons to select Save & Exit.

Figure 3.13 Selecting Save and Exit

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

Figure 3.14 – Save Screen

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

3.2. Relay Setup

The USM has three programmable relays. These are configurable as ON/OFF flow switches or as LOST ECHO (no distance returned from the DIGISENS sensor).

The RELAY SETUP is accessed from the Configuration MENU

Figure 3.15 – Relays Setup Screen

Use the ⬆ or ⬇ buttons to select the relay to be configured. and select by pushing the ▶ button, the program returns to the MENU page.

3.2.1. Lost Echo Relay

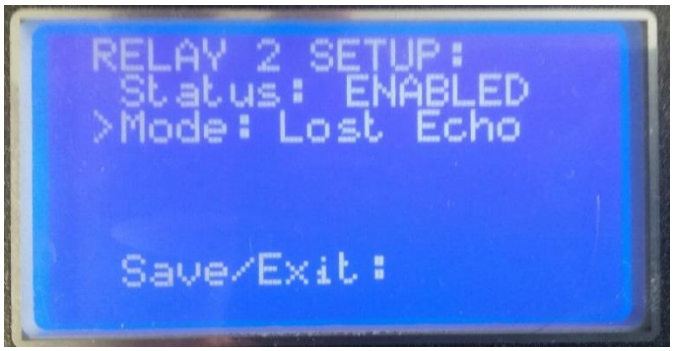


Figure 3.16 – Relay 1 Setup Screen 1

Use the ⬆ ⬇ keys to move the cursor to the setting to be changed.
When the Status field is selected pressing the ▶ button toggles the selection between ENABLED and DISABLED.

When the Mode field is selected pressing the ▶ button toggles the selection between Flow Switch, Level Switch, LOST ECHO, Sampler and Velocity.

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.

3.2.2. Flow Relay

When Flow Switch is selected the ON and OFF parameters are visible. 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.

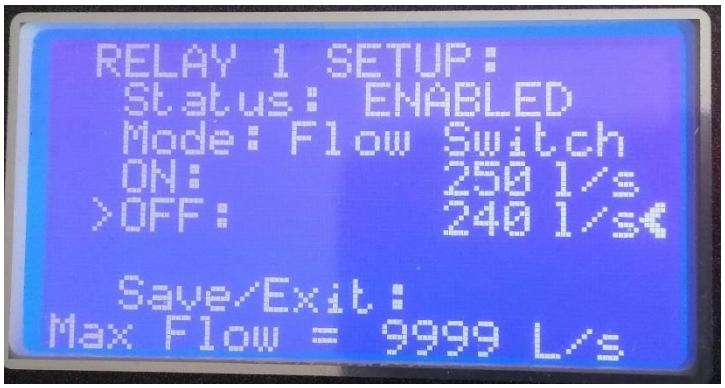


Figure 3.17 – Flow Relay Setup Screen

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

The ON/OFF values are entered in L/s (g/s in imperial) and the maximum flow which can be entered is 9999 L/s (5000 g/s in imperial). For conversions from other units see Appendix B.

In the above example the relay would turn on at 250 L/s and remain on until the flow fell to 240 L/s. This would be a high flow alarm.

3.2.3. Level Relay

Figure 3.18 – Level Relay Setup Screen

A Level Relay is set in the same way as a flow relay with the trigger points being entered in millimetres (inches if setting is imperial).

In the above example the relay would turn on when the level fell below 325mm and remain on until the level rose to 350mm. This would be the settings for a low flow alarm.

The maximum value which can be entered is the channel height/diameter set in the flow device set up.

3.2.1. Sampler Relay

Figure 3.19 – Sampler Relay Setup Screen

A volume triggered relay can be used for triggering devices such as composite samplers. These will trigger every time the entered Volume passes through the flow device.

The length of time the relay is closed is entered in the Time field i.e. with the above settings the relay will close for 150ms every time a total of 2.00m3 of effluent has flowed through the device.

3.2.2. Velocity Relay

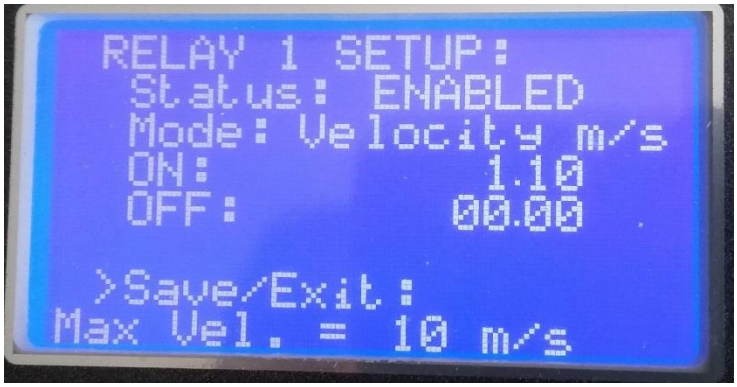


Figure 3.19 – Sampler Relay Setup Screen

Similarly the relays can be made to trigger on the velocity returned from the AV sensor. The velocity is set in m/s (in/s in imperial). The maximum value is 10 m/s (400 in/s).

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

3.3. 4-20mA Setup

The USM has a 4-20 mA output which can be configured to represent flow through the device

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

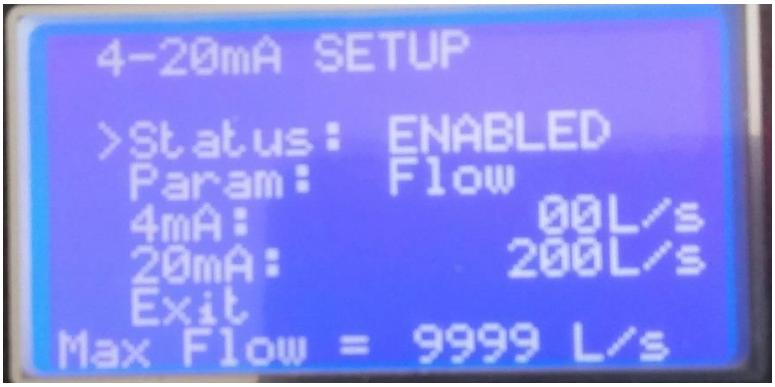


Figure 4.21 – 4-20 mA Setup Screen

When the cursor is on the Status field the ▶ button toggles the Status between ENABLED and DISABLED.

Moving the cursor to 4mA field and pressing the ▶ button allows the value to be entered at which the USM will output 4mA (use ↑ ↓ to change the value ▶ to accept).

The 20mA value is entered in the same way

The settings are saved with a correct exit from the Set Up and save selected.

If the USM detects a LOST ECHO or LOST COMMs from the DIGISENS sensor, the 4-20mA will be zero regardless of these settings.

3.4. 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.

3.5. Depth Calibration

The USM is supplied fully calibrated, however if it is felt the unit has drifted the depth can be recalibrated. The USM uses a two point depth calibration.

From the configuration menu select Depth Calibrate. Cover the AV sensor in water and measure the depth of the liquid.

Figure 4.22 – Depth Calibration 1.

Use the ⬆ ⬇ to enter the depth of the liquid and press ▶ to accept.

Figure 4.23 – Depth Calibration 2.

The USM will display the ADC value and the approximate mV reading from the sensor, this should be around 500mV with the sensor just covered. When the the values are stable, press ▶ to accept the value.

Increase the depth of the liquid (ideally to a level similar to the level in which the AV sensor will be operating) and repeat the procedure for the second calibration point.

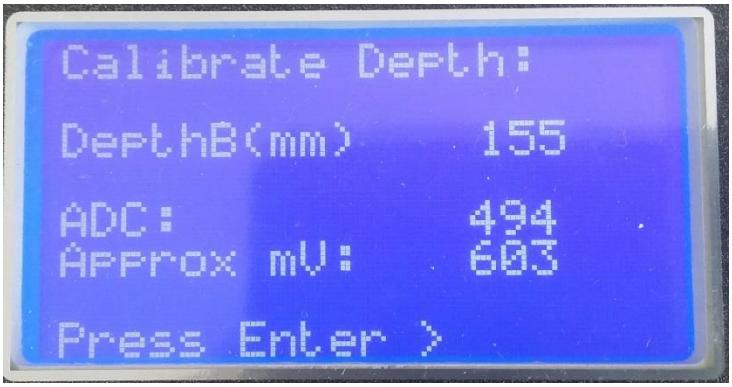


Figure 4.24 – Depth Calibration 3.

The mV reading will typically increase at around 45 mV for every 100mm of liquid. When the values are stable press ▶ to accept the value. The calibration should then be saved to memory (follow the on screen instructions).

3.6. Engineering

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

4. Test Screens

Two Test screens are provided to check the functionality of the unit. Both are selectable from the Configuration Menu.

4.1. Relays Test

Figure 4.1 – Relays Test Screen 1

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

Figure 4.2 – Relays Test Screen 2

This can be used to test the functionality of peripheral equipment connected to the USM, such as alarms and beacons.

4.2. 4-20mA Test

The 4-20mA test selects fixed value for the 4-20mA output circuit. The output value can be changed using the ↑ or ↓ buttons. Pressing ⌂ or ▶ will exit to the Configuration MENU

Figure 4.3 – 4-20 mA 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.

4.2.1. Integrating a Data Logger

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 as explained in Section 5.3.

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.

5. 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

The Home Screen shows the flow (in the selected units) with a bar graph and percentage indicating the 4-20mA output.

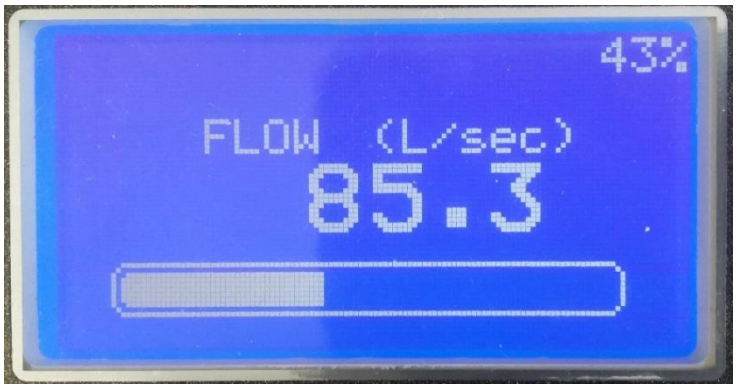


Figure 5.1 Home Screen.

If the USM does not receive any messages from the AV sensor for 10 seconds an error message will display and the 4-20mA will be zeroed.

Figure 5.2 Home Screen with LOST ECHO

5.2. Totaliser Screen

Shows the cumulative flow through the unit since the last reset. This is shown in m3 (ft3 for imperial). For alternative units contact Smart Storm.

5.3. Depth and Velocity Screen

Shows the depth measured by the AV sensor and the velocity of the liquid. If the USM does not receive any messages from the AV sensor for 10 seconds an error message will replace the reported Velocity.

Figure 5.3 Depth and Velocity screen.

5.4. Device Parameters Screen.

Displays the parameters of the channel profile and the calculated area when the channel is full.

N.B. After changes to the Device Parameters this screen should be checked to ensure the correct values have been saved.

5.5. Relay Configuration

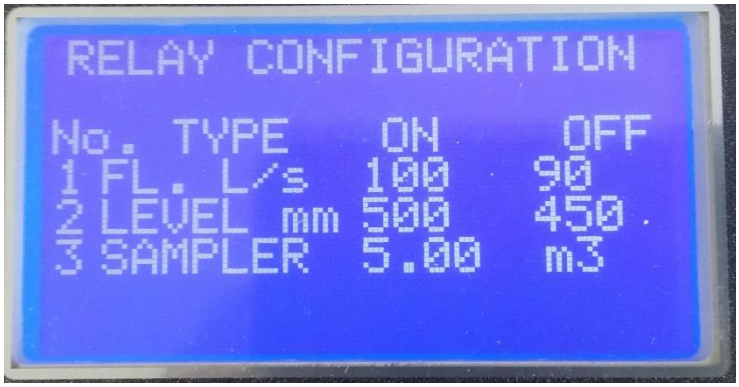


Figure 5.4 Relay Configuration

Displays the current configuration of the three relays.

5.6. 4-20mA Set Up

Displays the settings entered for the 4-20mA output parameters.

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.

5.7. About USM

Displays Information about the USM including Software Version and Serial Number.

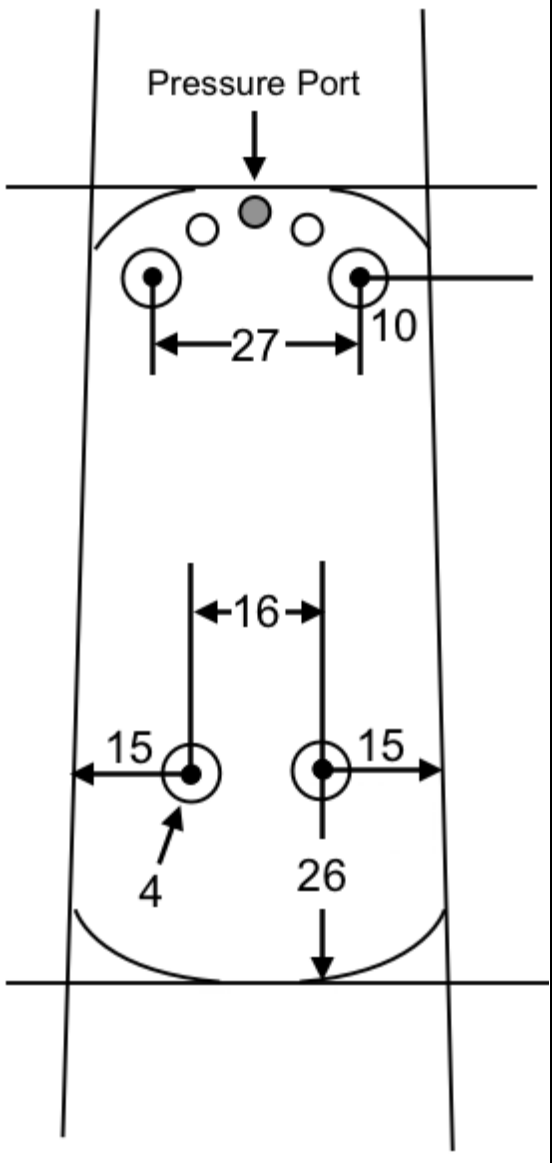
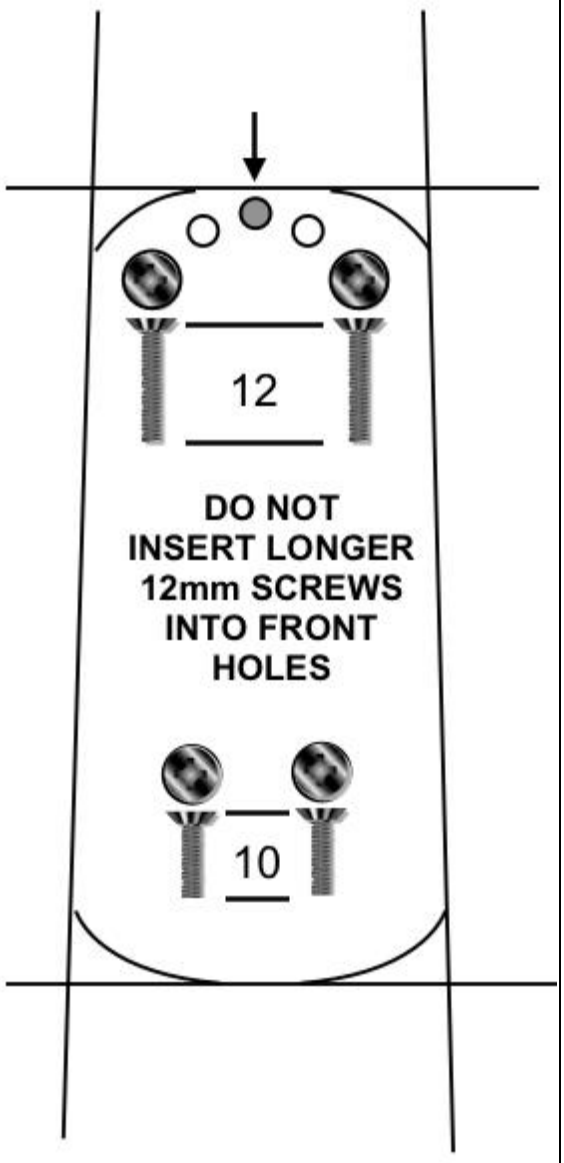
6. Fault Finding

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. Sensor Mounting

The Dual Wave Doppler AV Sensor is shipped with four 4-40 screws used to fasten the sensor to a band or steel plate to be installed in the flow stream.
The stainless steel front screws are slightly shorter than the back screws. It is very important that the front screws are not substituted with longer screws.
The following shows the mounting configuration and dimension of the AV sensor mounting.

MOUNT SPACING	SCREW DIMENSIONS
 FRONT	

8. Appendix B. Unit Conversion

The USM requires that some parameters be entered as L/s or g/s. Other units can be converted using the following tables.

Metric.

UNIT	Conversion Factor
L/mn (litres per minute)	0.0167
L/hr (litres per hour)	0.000278
m3/s (cubic meters per second)	1000
m3/mn (cubic meters per minute)	16.67
m3/hr (cubic meters per hour)	0.278
m3/day (cubic meters per day)	0.0116

I.E. To convert from a value in m3/day to L/s multiply the value by 0.0116.

Imperial.

UNIT	Conversion Factor
gal/mn(gallons per minute)	0.0167
gal/hr(gallons per hour)	0.000278
M gal/hr(Mega gallons per day)	11.574
ft3/s(cubic feet per second)	7.48052
ft3/mn(cubic feet per second)	0.24675
ft3/hr(cubic feet per second)	0.002078

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