

XCI

PRODUCT MANUAL



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Includes

FloCom⁺

Configuration Software

mace 
Water Monitoring Solutions

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mace 
Water Monitoring Solutions

XCi Product Manual - Interactive PDF

This user manual is setup as an interactive PDF. The user can click on any of the “**Chapters**” in the table of contents to navigate directly to the corresponding page.

To return to the table of contents click on the “**Contents**” button at the bottom of each page.



Essential Reading

Section A: The XCi Device

Section B: Doppler Ultrasonic Velocity Sensors

- *Only necessary if installing MACE Doppler ultrasonic velocity sensors*

Section C: Flocom+ Software

Section D: FloSeries3 Cards

- Chapter 14.0 Introduction to FloSeries3 cards

- Chapter 15.0 Installing FloSeries3 cards

- The chapter/s relevant to the FloSeries3 card/s in your XCi device

MACE XCi Product Manual

Product Support

Should you experience difficulty in using this product, please contact your local MACE vendor. We also welcome feedback from customers who feel that their experience may provide an improvement to the product or may be beneficial to other users.



NOTE: MACE strongly recommends that users register for Software Updates on the “Support” page of the www.macemeters.com website. Releases of product enhancements occur periodically and we recommend that these are uploaded into your XCi device.

Please go to www.macemeters.com

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WARNINGS

Water damage

MACE recommends that the XCi device be mounted above known flood peak levels. MACE will not be liable for damage caused by flooding. (The unit is weatherproof, but NOT waterproof and should NOT be submerged).

Sunlight

MACE recommends that the XCi device be mounted so that the LCD faces in a direction away from direct sunlight (ie South in the Southern Hemisphere and North in the Northern Hemisphere).

Cable damage

MACE recommends that all cables be appropriately routed through electrical conduit or other similar mechanism. MACE will not be liable for damage to cables, especially if it is caused by vehicles, digging implements, animals or debris in the pipe or channel.

Insects and moisture

After the XCi system has been installed and fully tested, MACE recommends the use of expanding “space filler” foam down the first 5 to 10cm (2 to 4”) of the conduit or mounting pole to prevent insect/moisture ingress.

Battery life

Care must be taken when a mains power supply is used to charge the internal battery instead of a solar panel. If the mains power remains disconnected for an extended period of time, the internal battery may be permanently damaged.

Electromagnetic compatibility (EMC)

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Intrinsic Safety

The XCi is NOT an intrinsically safe instrument and should not be installed in hazardous (explosive) environments. Should an intrinsically safe instrument be required, MACE can offer other instruments with this approval level.

About MACE

MACE is an family company founded in 1968 by electrical and mechanical engineer Lawrence Campbell who recognized the importance of flow measurement and flow monitoring in the global environment.

For 40 years MACE has designed and manufactured electronic monitoring instrumentation including ultrasonic flow meters, data loggers and controllers. Continued commitment to research and development over the past three decades has ensured MACE's provision of the most advanced high technology equipment for the agricultural, industrial and environmental markets.

MACE has a core team of research and development engineers who are focused on providing customer driven products that are both easy to use and withstand the test of time in often remote and harsh environmental conditions.

MACE is committed to providing its clients with personalized service, training and technical back-up to ensure successful monitoring.

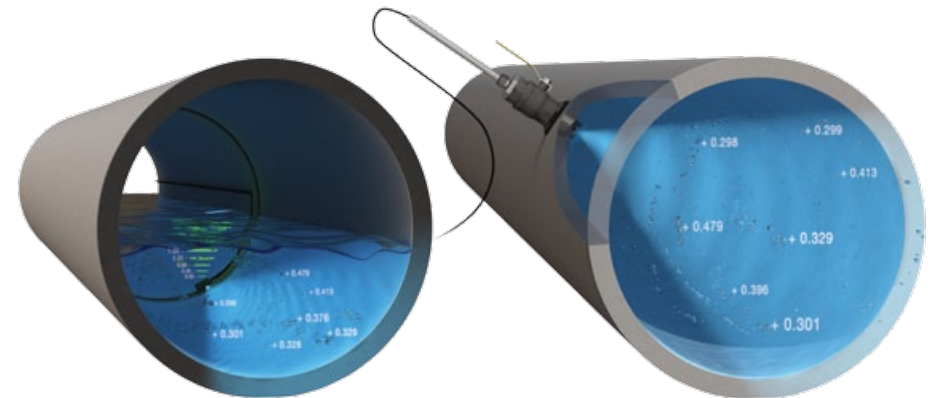
MACE continues to innovate with the introduction of the new XCi Multiple Card Interface found in all our new range of flow meters and data loggers. XCi enables the user to connect just about any environmental sensor quickly and easily. This offers the customer a highly flexible, cost effective water monitoring solution.

With the addition of a new MACE WebComm card to any XCi device, customers are able to access their data remotely for free from the MACE website.

About Doppler ultrasonics

MACE XCi devices utilise the Doppler Effect to measure velocity of stream flows. The Doppler Effect (after C. J. Doppler 1803-53) is defined as, "the apparent change in the frequency of sound or electromagnetic radiation due to relative motion between the source and the observer" (Uvarov & Isaacs (1986). Dictionary of Science).

The MACE Doppler ultrasonic velocity sensors transmit an ultrasonic (sound) wave into the flow. This sound wave is reflected by acoustically reflective particles (e.g. air bubbles, suspended solids) and the instrument detects the reflected frequencies. The difference between the transmitted frequency and the received frequencies is directly proportional to the velocity of the stream flow.



In full or partially full pipes, the velocity of the stream flow varies markedly across the cross-section of the pipe. Typically, velocity is zero along the wall of the pipe and increases to a maximum at or about the centre of the pipe. MACE Doppler ultrasonic velocity sensors receive reflected frequencies from particles moving at these different velocities. The greater the area of flow moving at a particular velocity, the greater the number of reflections with the respective frequency shift. The average velocity of the stream is therefore calculated by averaging those frequency reflections received across the whole stream profile.

In laymans terms a simple analogy for the way MACE Doppler ultrasonics operate is that it's similar to "switching on a flashlight in a fog". Any reflective particle that moves within the "beam" will be seen by the ultrasonic sensor. MACE Doppler ultrasonic velocity sensors provide a true average stream velocity.

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1.0 Overview of the XCi system

This manual describes the installation, use and maintenance of a MACE XCi device. There are three MACE XCi devices which are specifically optimised for our three main markets:



FloPro XCi Wastewater, stormwater and industrial flows

The FloPro XCi can be used to monitor just about any water quantity and quality sensor. Whether you need to measure flow as well as conductivity, pH and rainfall or utilize a downward looking ultrasonic depth sensor to measure pond levels the FloPro is fully expandable to your needs. Furthermore, FloPro is easily interfaced to SCADA/telemetry systems.



AgriFlo XCi Agricultural water and wastewater flows

The AgriFlo XCi can be used to monitor just about any agricultural sensor. Use the versatility of AgriFlo XCi to monitor inputs as diverse as: irrigation flows; farm wastewater flows; water quality; dam levels; soil moisture and engine management systems.



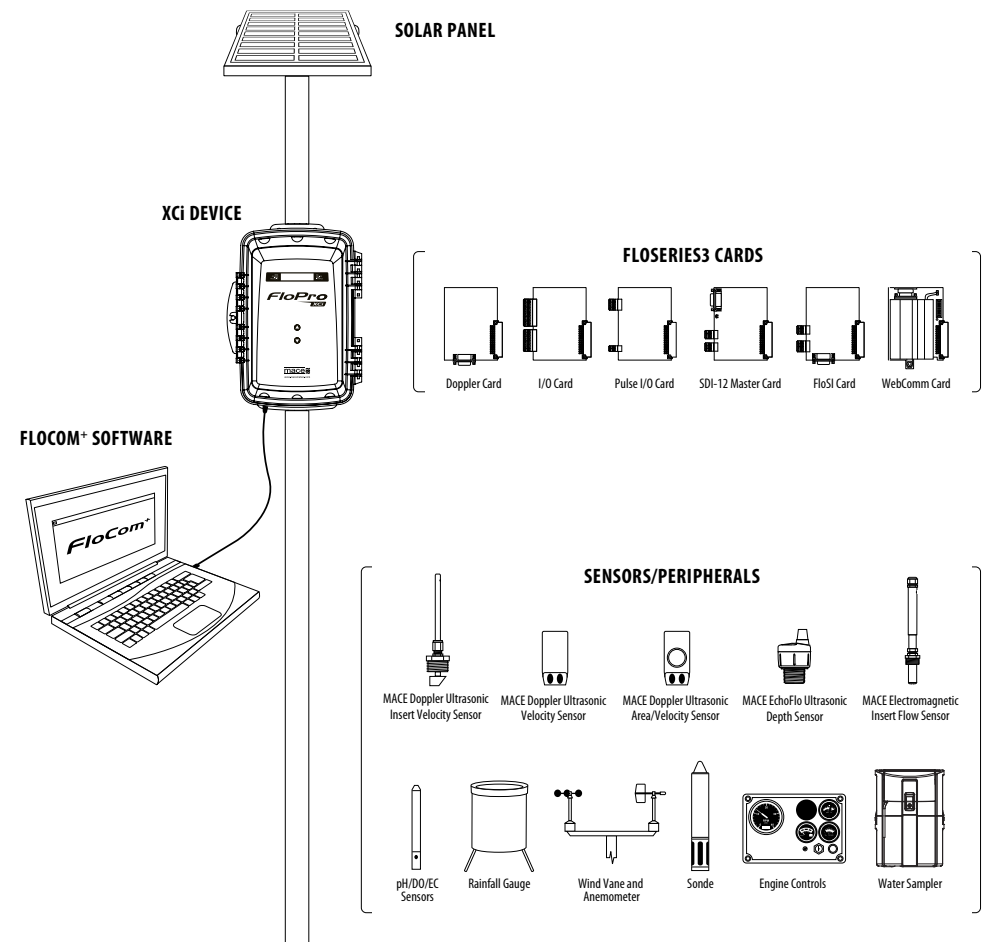
HydroMace XCi Environmental monitor and data logger

The HydroMace XCi can be used to monitor just about any environmental sensor. Use the versatility of HydroMace XCi to monitor inputs as diverse as: Flumes & weirs, water quality sensors & rainfall gauges, drinking water flows (leak detection) and weather stations.

The HydroMace XCi continues the long heritage established by MACE over 40 years ago for remote data logging and telemetry.

The XCi system typically consists of five main components:

1. The XCi device
2. The solar panel (or power supply)
3. The sensor(s) or peripherals
4. Flocom+ software enabling you to configure and download data from your XCi device
5. FloSeries3 card(s) providing inputs for connecting an array of sensors



Section A:

The XCi device

Installation, powering & maintenance

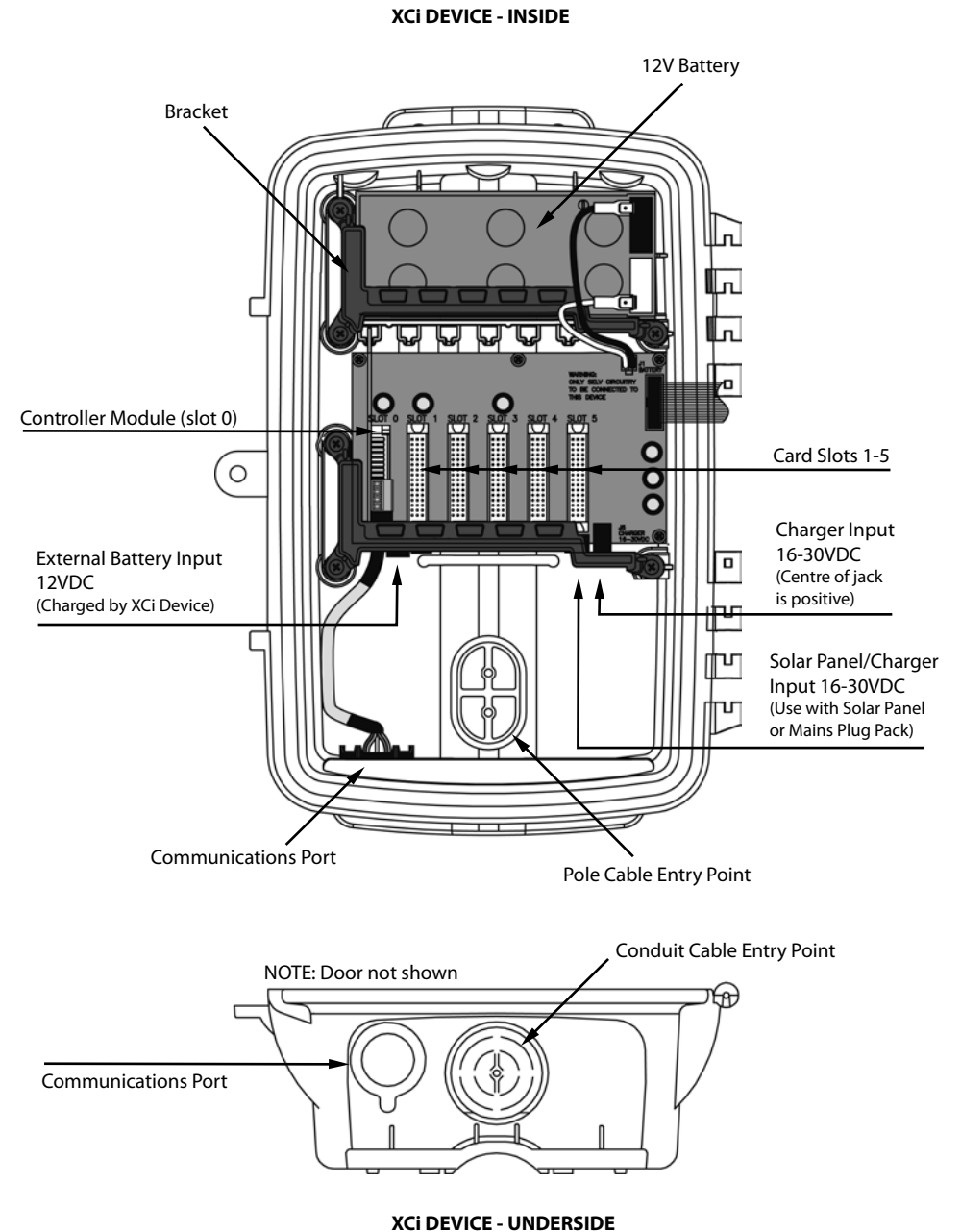
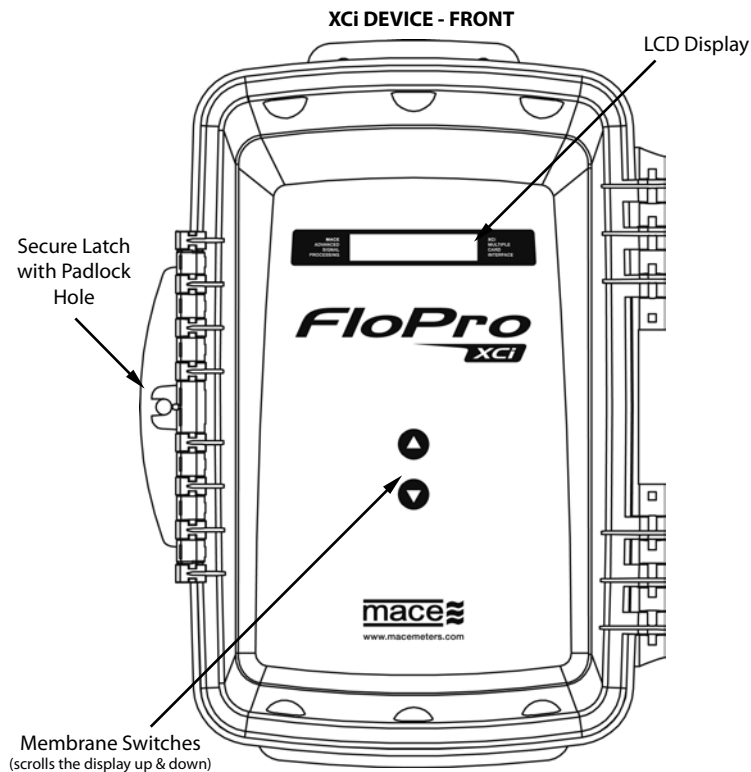
2.0 Introducing the XCi device

The XCi device is the central processing unit of the system and includes the enclosure, battery and five card slots allowing the user to install any of the six different FloSeries3 cards that control the sensors.

On the front of the XCi device, a backlit liquid crystal display (LCD) allows the user an on-site readout of parameter values and status messages. Pressing either membrane switch will turn on the LCD.

The membrane switches can be used to scroll the display between the various parameters being measured.

A communications port is located on the bottom face of the main enclosure. Using a MACE USB data cable (Part No. 850-363) between this port and a PC, users can configure, troubleshoot and download data from the device using the MACE FloCom+ software downloadable from www.macemeters.com



3.0 Installing an XCi device

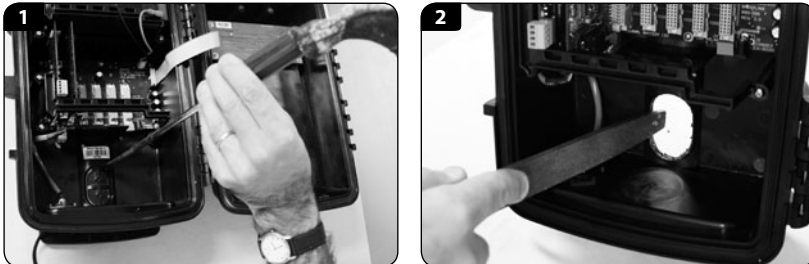
The sensor and power cables can be routed either directly through the inside of the 2" mounting pole or through electrical conduit. Installation directions for both are provided below.

! MACE recommends that the XCi device be mounted so that the LCD faces in a direction away from direct sunlight.

3.1 Installing on a 2" pole

3.1.1 Sensor and power cables routed inside the pole

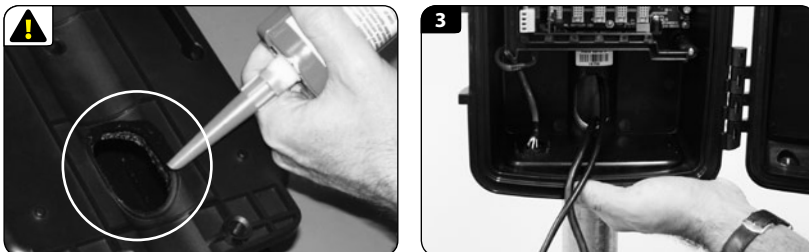
1. Place the XCi device on a work bench and using a hammer and screwdriver carefully knock out the plastic cable entry point from the rear of the enclosure. It is only thin plastic and is designed to break away at the edges so work your way around the edge of the oval shape until the cover is completely broken free of the unit.



! **IMPORTANT:** Apply **NON-ACIDIC** cure silicon sealant to the back of the XCi device in the channel around the cable entry point. This will stop water flowing down the pole and into the XCi device.

2. File away any rough edges from the plastic cable entry point

3. Hold the XCi device up against the pole so that the oval cut-away on the pole matches the cable entry point. Route the sensor and power cables through the cable entry point as shown.

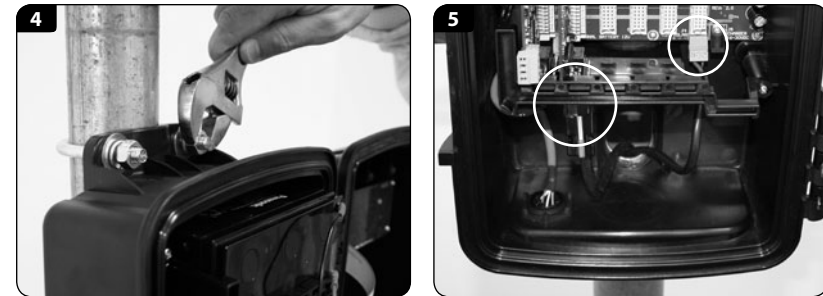


4. Use the two "U" bolts, 3/8" nuts and 3/8" washers provided to secure the XCi device to the pole.

! **Do not overtighten the pole mounting bolts as permanent damage may occur to the electronics enclosure**

5. Plug in both the sensor cable and solar panel cable into the sockets as shown in the picture below.

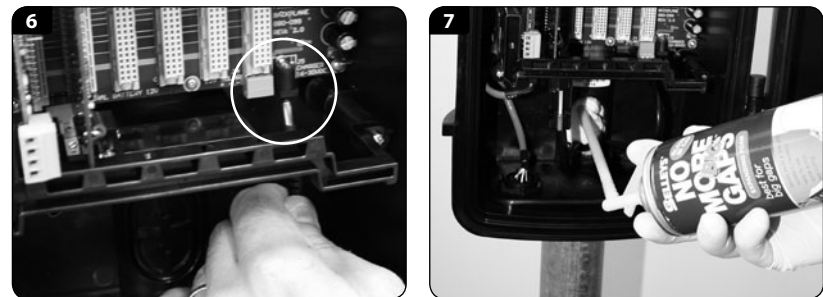
! **The Doppler sensor cable should be looped prior to connecting to act as a form of strain relief. Ensure that the sensor cable is securely attached by tightening the thumb screws.**



! **Ensure that the cable from the solar panel/charger is terminated using the three-pin connector provided in the electronics box and that the polarity is correct. The polarity is labelled on the circuit board near the connector**

6. If using a 16-30VDC mains charger then plug this into the socket shown in the picture below. Alternatively, the charger may be wired into the solar panel screw terminal block (to the left of the socket).

7. Once all the cables are connected the system should be fully tested. Assuming everything is connected and fully functional the cable entry point should be filled with expanding "space filler" foam. This is to prevent insects and/or moisture damaging the system.



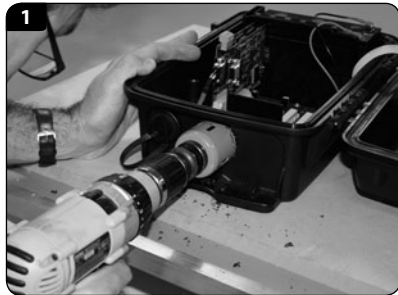
3.1.2 Sensor and power cables routed through conduit

1. Place the XCI device on a work bench. Using a power drill and 2" holesaw, carefully drill out the round plastic cable entry point at the base of the unit as shown below. It is only thin plastic and is designed to break away. Alternatively, the round cable entry point may be removed using the "hammer and screwdriver" method described in **Chapter 3.1**.

2. Use the two "U" bolts, 3/8" nuts and 3/8" washers provided to secure the XCI device to the pole.



Do not overtighten the pole mounting bolts as permanent damage may occur to the electronics enclosure



3. Carefully attach an electrical conduit adaptor (*Clipsal 50mm or Carlon 1 1/2"*) to the XCI device.

4. Plug in both the sensor cable and solar panel cable into the sockets as shown in the picture below.



The Doppler sensor cable should be looped prior to connecting to act as a form of strain relief. Ensure that the sensor cable is securely attached by tightening the thumb screws.

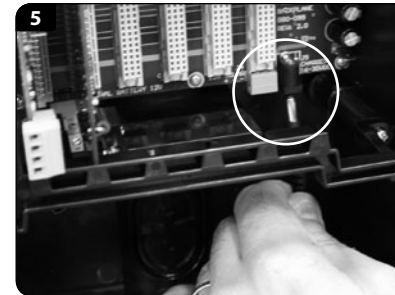


Ensure that the cable from the solar panel/charger is terminated using the three-pin connector provided in the electronics box and that the polarity is correct. The polarity is labelled on the circuit board near the connector.



5. If using a 16-30VDC mains charger then plug this into the socket shown in the picture below. Alternatively, the charger may be wired into the solar panel screw terminal block (*to the left of the socket*).

6. Once all your cables are plugged in you need to fully test the system. When you are happy that everything is connected and working properly you need to fill the cable entry point with expanding "space filler" foam. Fill down the first 5 to 10cm (2" to 4") of the conduit. This is to prevent insects and/or moisture damaging the system.



3.2 Installing on a wall

1. Follow instructions on the previous page to drill out the cable entry point for routing cables through conduit.

2. Use four M8 screws, bolts or coach screws to secure the box to the wall. (*Use flat washers between the screw head and the box*).



Do not overtighten the wall mounting bolts as permanent damage may occur to the electronics enclosure

3. Follow instructions 3-6 on the previous page for routing the cables through conduit.



4.0 Installing XCi power options

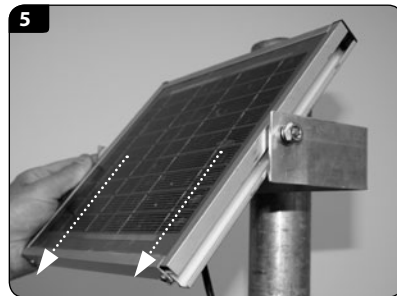
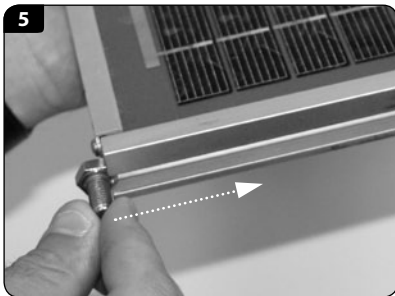
4.1 Solar panel installation on a 2" pole

The solar panel is used to charge the internal battery of the XCi device where mains power is unavailable.



Users are advised to ascertain the suitability of solar panels for their application by checking relevant solar radiation maps for their region (for example those found at http://rredc.nrel.gov/solar/old_data/nsrdb/redbook/atlas/). As a guideline, for an AgriFlo XCi/FloPro XCi with three Doppler sensors (or an HydroMace XCi with three I/O cards) and measuring every five minutes, at least three hours sunlight is required per day.

1. Place an M8 bolt with M8 flat washer through the hole in left arm of the mounting bracket. Ensure that the head of the bolt is on the INSIDE and the thread faces outward.
2. On the OUTSIDE of the bracket, place an M8 spring washer then an M8 nut. DO NOT TIGHTEN THE NUT.
3. Repeat these two steps on the right hand side of the bracket.
4. Holding the solar panel carefully, hold it above the two arms of the mounting bracket.



5. Slide the solar panel down so that the head of each of the M8 bolts fits in the channel on either side of the solar panel.



Ensure that the gutter of the solar panel is positioned between the flat washer and the head of the M8 Bolt

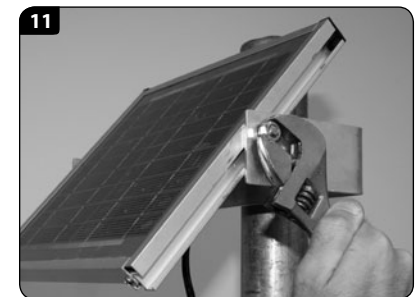
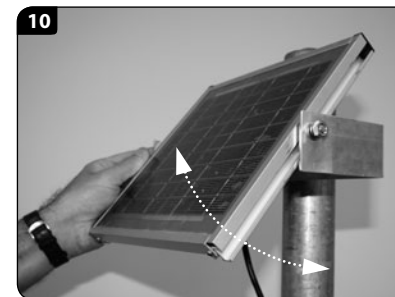
6. Place the u-bolt provided in the solar panel mounting kit around the pole.

7. Place the solar panel mounting bracket onto the u-bolt. Ensure that the arms of the bracket face out from the pole and that the mounting hole on each arm is towards the top of each arm.

8. Slide the bracket to the desired position on the pole, taking care to place it at the desired height and so that the open face of the bracket faces towards the sun.

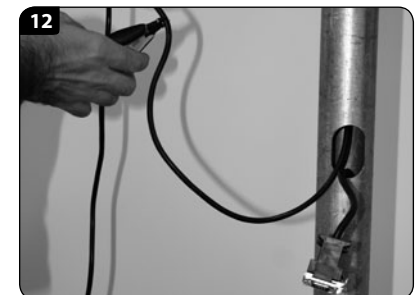
9. Place the $\frac{3}{8}$ " flat and spring washers on to the U-bolt and tighten the two nuts so that the bracket is secured on the pole.

10. Tilt the solar panel so that the active side faces towards the sun (North in Southern hemisphere, South in Northern hemisphere) at an angle specified in the data sheet provided. (your latitude + 15°).



11. Now tighten the M8 nuts on each side of the mounting bracket to secure.

12. The cables from the solar panel/charger to the electronics unit must be enclosed to minimise exposure to the elements. The cable should be either routed through conduit or through the solar panel mounting pole. You will need a hole drilled in the mounting pole at the top near the solar panel as well as a cut away where the electronics unit is to be mounted. Refer to the pictures below.

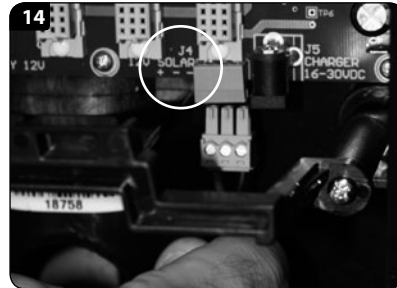
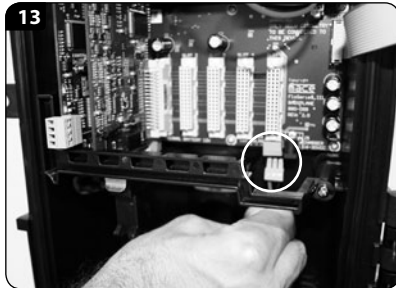


4.1 Solar panel installation on a 2" pole - Continued

13. Ensure that the cable from the solar panel is terminated using the three-pin connector provided in the XCi device and that the polarity is correct. The photo below shows the internal location of the three-pin connector.

14. The polarity is labelled on the circuit board near the connector.

NOTE: When wiring the solar panel either of the ground (-ve) terminals may be used



NOTE: The XCi device should be installed before connecting the solar panel.

MACE highly recommends the use of Tri-spikes on the top of the solar panel to reduce accumulation of bird droppings on the front face of the solar panel



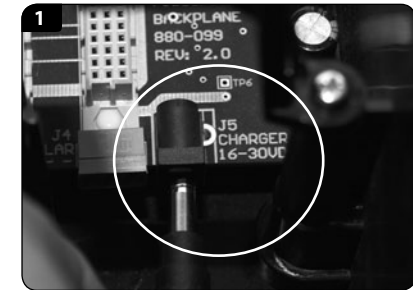
4.2 Installing a MACE mains powered trickle charger

In certain applications or where the use of a solar panel is impractical or undesirable, the XCi device can be powered from any DC source of 16-30 Volts (2Amps).

When the ambient temperature is less than -10°C (14F), the battery should be removed to avoid permanent damage to the battery. The XCi device should be powered by an external power source

1. The charger available from MACE (Part No. 850-323) comes complete with a circular barrel connector that plugs directly into the XCi device. *See photos over page.*

The barrel connector for the 16-30VDC charger input is centre positive

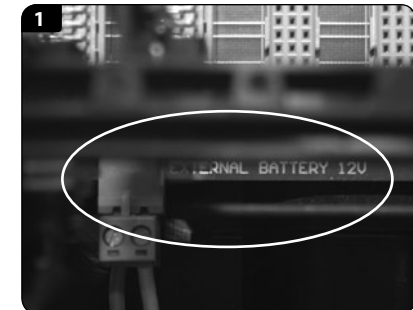
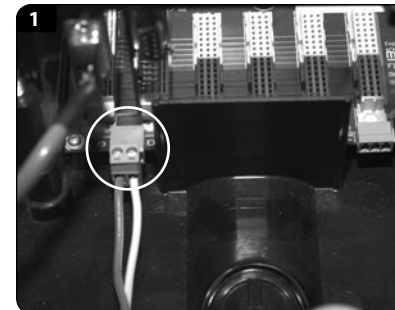


2. Alternatively, if a DC source other than a MACE charger is used, this is terminated using the same three-pin connector as for the solar panel described above.

4.3 Powering the XCi device with an external battery

In certain applications, it may be desirable to power the XCi device with an external battery.

1. The XCi device can be powered by an external 12V battery through the dedicated "External Battery 12V" terminal. *See photos below.*



2. If a solar panel is connected to the device as in Chapter 4.1, the internal charging circuit of the device will also charge the external battery. The charging circuitry of the XCi device has a 20 Watt capacity.

If the external battery is charged via its own solar panel and NOT through the XCi charging circuit, the internal device battery will discharge completely

5.0 XCi device maintenance

5.1 Battery maintenance

The XCi device's internal battery, if kept fully charged should last many years. However, if the battery remains flat for an extended time, it may be damaged and should be replaced. Contact your vendor for a replacement battery.

5.1.1 Removing the damaged/flat battery

1. Disconnect the battery cable assembly from the backplane board.
2. Carefully hold the battery in position.
3. Use a #2 Phillips head screwdriver to remove the three screws which fasten the battery bracket to the main enclosure.
4. Carefully remove the battery from the main enclosure.
5. Disconnect the battery cable from the battery terminals.

5.1.2 Installing the new battery

1. Connect the battery cable to the new battery, with the red lead to the positive terminal of the battery and the black lead to the negative terminal.
2. Place the battery in the main enclosure and hold it in place.
3. Secure the new battery in place using the battery bracket and three screws.
4. Tighten all three screws.
5. Reconnect the battery cable assembly to the backplane board.



Damage to the XCi device caused by incorrect battery replacement will void the warranty



Using a battery that is not approved MAY damage the XCi device and void the warranty

5.2 Solar panel maintenance

The solar panel should be checked regularly for build up of solids such as dust and bird droppings. These type of build-ups can affect the performance of the solar panel and result in a decrease of the charge that is received by the internal battery.

The solar panel should be cleaned with a wet brush or rag.



Do not use steel bristle brushes that may cause damage to the glass of the solar panel

Section B:

Doppler Ultrasonic Velocity Sensors

Site selection, installation & maintenance

6.0 Site selection

When selecting a suitable site to measure flow you must consider the following:

1. Does the stream flow that I wish to measure contain sufficient acoustically reflective particles such as sand, silt, dirt, leaves or air bubbles? (The stream that you wish to measure must contain at least 100 parts per million of acoustically reflective particles that are greater than 75 microns in size).

Yes – The stream flow is suitable for Doppler ultrasonic flow measurement.

No – The stream flow is unsuitable for Doppler ultrasonic flow measurement, use a MACE Electromagnetic insert flow sensor instead.

2. Does the pipe in which I am measuring, run full or partially full?

Full – An insert velocity or velocity only sensor can be used.

Partial – A combined area/velocity sensor will be required.

3. What pipe diameter is suitable for MACE Doppler ultrasonics?

MACE recommends a maximum pipe diameter of 2.5m (100"). MACE Doppler ultrasonics WILL operate in larger pipes, but a reliable gauging MUST be performed for the most accurate readings.

4. If the pipe flows full, is the internal pressure of the pipe within the range 0 - 25 m (0 - 253kPa, 0 - 37 psi)?

Yes – The stream flow is suitable for Doppler ultrasonic flow measurement.

No – The stream flow is suitable for Doppler ultrasonic flow measurement only if it contains at least 100 parts per million of suspended solids that are greater than 75 microns in size.

5. Can I get access to the outside wall of the pipe for mounting the sensor?

Yes – Consider using an insert velocity sensor if the pipe runs full.

No – Must use a ZX SnapStrap mounted sensor internally.

6. Are there any other acoustic flow meters in the vicinity?

Yes – Consider moving the monitoring point at least 25m away.

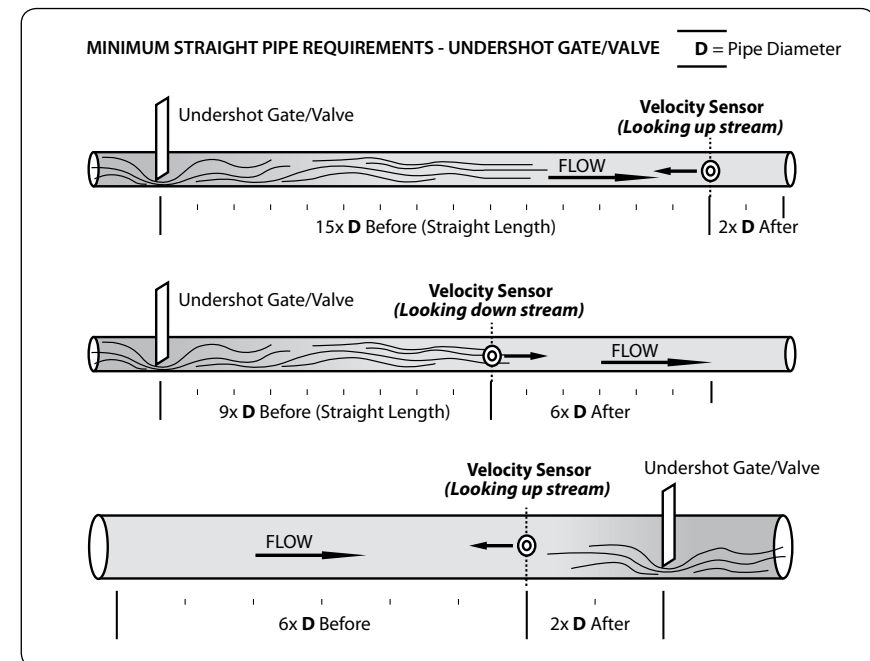
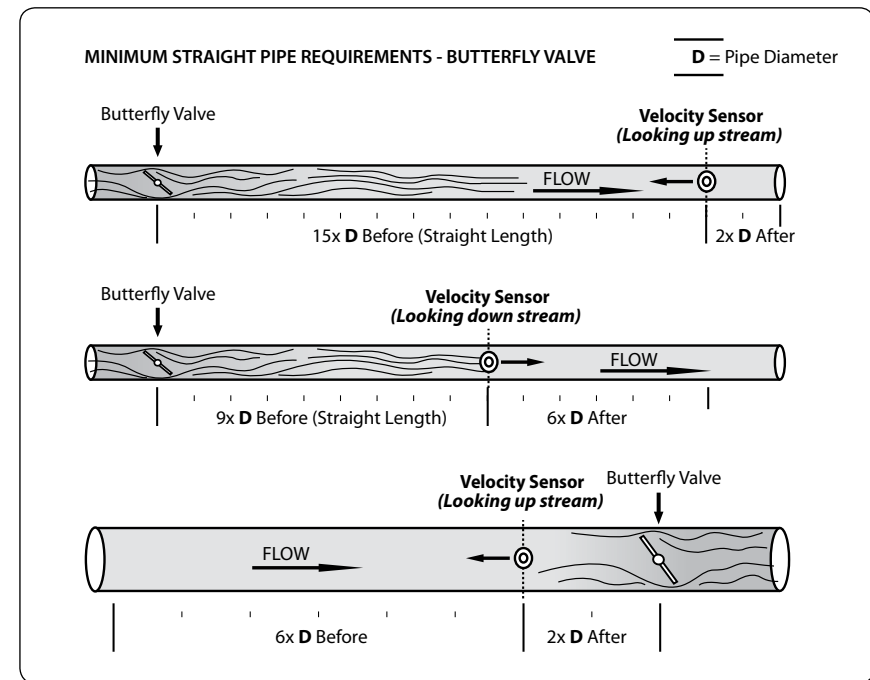
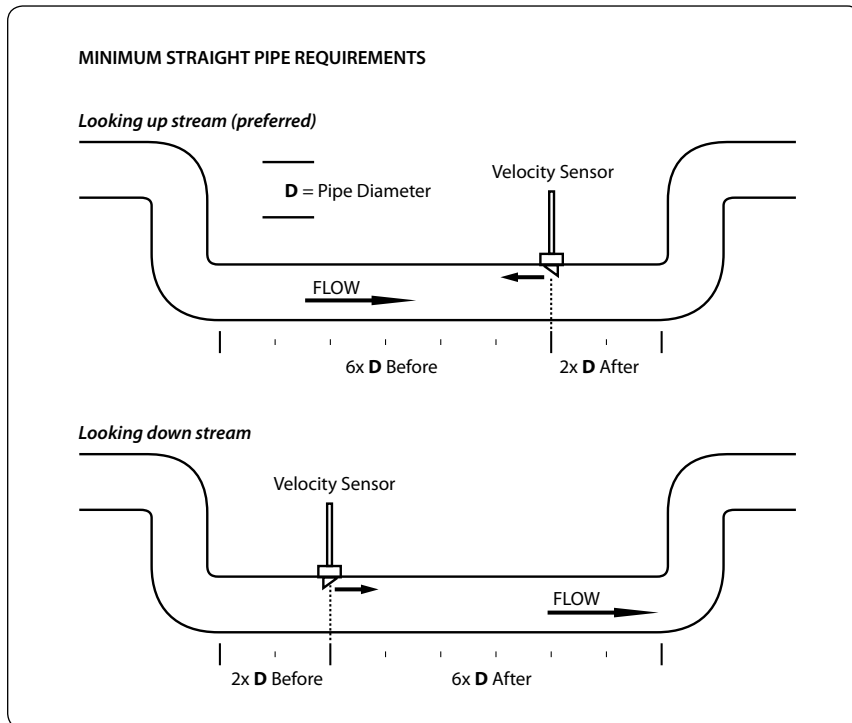
No – The stream flow is suitable for Doppler ultrasonic flow measurement.

6.0 Site selection - Continued

7. Does the proposed site have obstructions in the pipe which might cause irregularities in the flow (eg. elbows, constrictions, valves, gates etc)?

Yes – You will need to install the sensor at a point where there is at least eight pipe diameters of straight pipe with no obstructions. MACE recommends that the sensor is mounted so that there is a distance of at least six pipe diameters of straight pipe in front of it and at least two pipe diameters of straight pipe behind it.

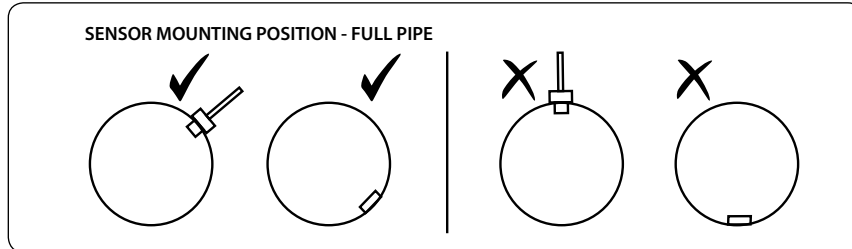
No – Even when there are no obvious obstructions, MACE recommends observing the instructions described above.



6.0 Site selection - Continued

8. Where is the best place to mount the sensor in a Full pipe?

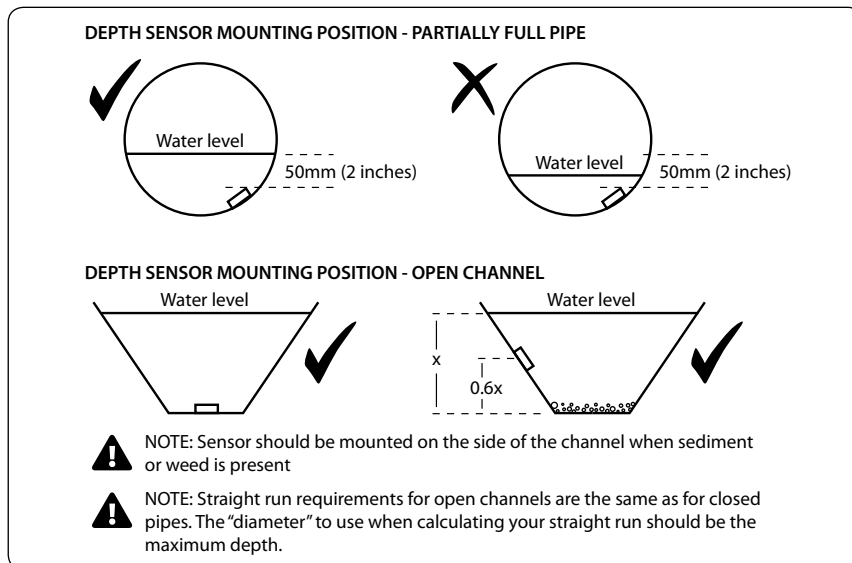
The sensor should be mounted on the side wall of the pipe, between the 2 and 5 o'clock positions. A ball valve should be used when mounting "Insert" type sensor to allow for easy maintenance.



WARNING - Don't mount the sensor at the top of the pipe as air pockets could give unreliable readings. Don't mount the sensor at the bottom of the pipe as silt build-up can cover the sensor. Only mount the sensor between 2 and 5 o'clock as shown above.

9. Where is the best place to mount the sensor in a partially full pipe or channel?

The sensor must be mounted such that the depth sensor is always covered by water to a depth of at least 50mm (2 inches).



10. What size channel is suitable for MACE Doppler ultrasonics?

Mace recommends a maximum channel width of 3m (10ft). MACE Doppler ultrasonics WILL operate in wider channels, but a reliable stream gauging MUST be performed for the most accurate readings.

11. Is there likely to be silt build-up over the sensor?

If this is the case, MACE recommends mounting the sensor on the side wall of the pipe instead of near the bottom of the pipe. Refer diagram over page.

12. How far can the sensor be mounted from the XCI device?

A maximum of 50 metres (150ft) of cable is available on any MACE sensor.

13. How do I customise the XCI device for my application?

Use the application software, FloCom+ to:

- Configure the unit for your site. For example, this includes setting the pipe diameter and logging interval.
- View the velocity profile measured by the sensors. This is useful if you think there may be irregularities in the flow at the site or you want to check the operation of the unit.
- Download data from the XCI device.

FloCom+ is available for download at www.macemeters.com

7.0 MACE velocity sensor types

7.1 MACE Doppler ultrasonic insert velocity sensor

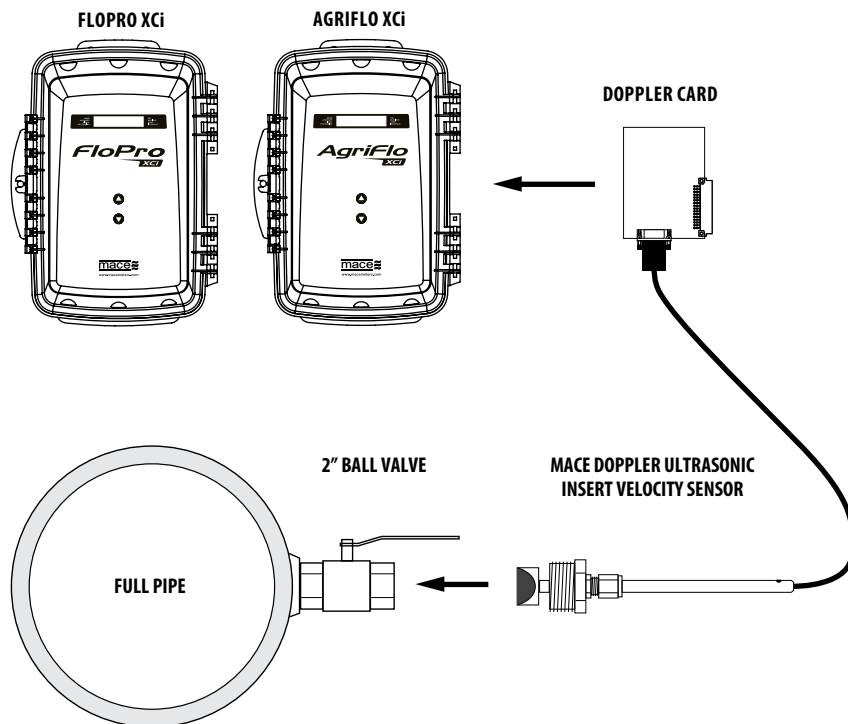
This type of sensor is used in full pipes where access into the pipe is impractical or when it may be necessary to remove the sensor in the future without stopping the flow or emptying the pipe.

Insertion sensors require access to the outside wall of the pipe in which the sensor is to be mounted. The 2" insertion sensor should be used in pipes that have a diameter of greater than 100 mm (4").



NOTE: MACE recommends that a ball or gate valve is always used when installing insertion sensors so that sensor maintenance can occur without requiring the pipe to be emptied of liquid.

The MACE Doppler ultrasonic velocity insert sensor is connected to a FloSeries3 Doppler card. These cards are installed into any of the five available card slots of a FloPro XCi/AgriFlo XCi device. A maximum of five sensors can be connected to a single FloPro XCi/AgriFlo XCi.



7.2 MACE Doppler ultrasonic strap mount velocity sensors

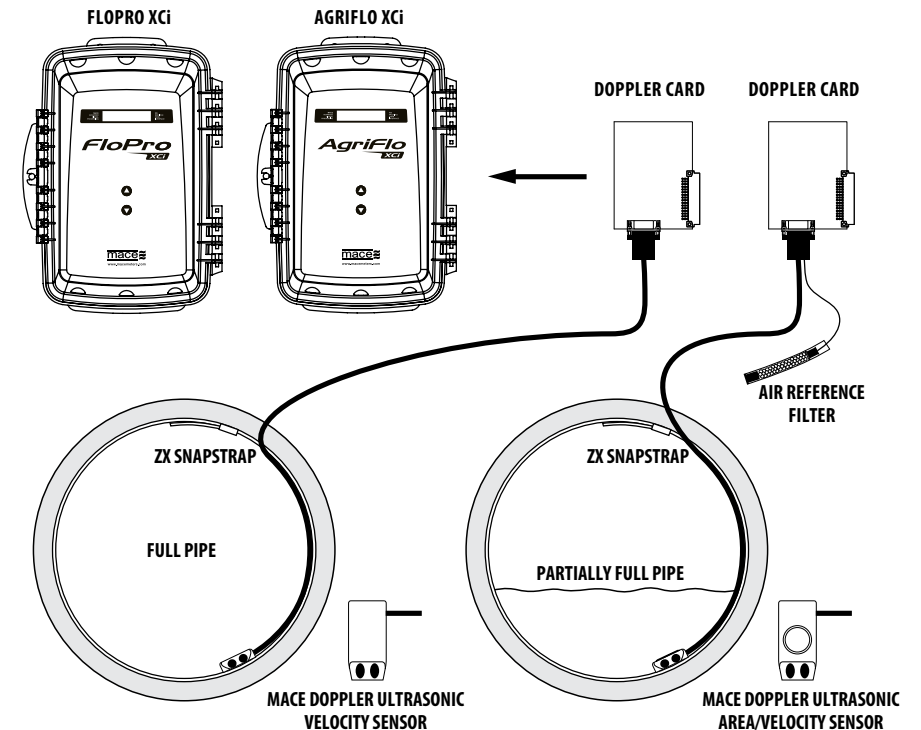
ZX SnapStrap mounted velocity only sensor

This type of configuration is used in full pipes when access to the pipe is available and the pipe can be emptied when installation or maintenance is required. Alternatively this sensor can be used in partially full pipes or open channels in conjunction with a MACE EchoFlo ultrasonic depth sensor.

ZX SnapStrap mounted area/velocity sensor

This combined velocity/depth sensor can be used in pipes that run partially full or in open channels.

The MACE Doppler ultrasonic ZX SnapStrap mounted velocity sensors are each connected to a FloSeries3 Doppler card. These cards are installed into any of the five available card slots of a FloPro XCi/AgriFlo XCi device. A maximum of five sensors can be connected to a single FloPro XCi/AgriFlo XCi.



8.0 Installing MACE velocity sensors

8.1 Installing a Doppler ultrasonic insert sensor

WARNING: DO NOT cut the sensor cable. Re-termination of the sensor is highly specialised and MUST be carried out at a MACE technical facility.

WARNING: Don't mount the sensor at the top of the pipe as air pockets could give unreliable readings. Don't mount the sensor at the bottom of the pipe as silt build-up can cover the sensor. Only mount the sensor between 2 and 5 o'clock as shown below. MACE recommends mounting the sensor facing upstream wherever possible.

1. Using a 2" coring bit (hole saw) appropriate for the pipe material (eg. in a concrete pipe MACE recommends the use of a diamond tipped bit), carefully core the pipe so that a clean cut is obtained.

The hole should ALWAYS be only just bigger than the sensor head.

2. Measure and record the pipe wall thickness.

3. Attach a male 2" BSP or NPT nipple to the pipe DIRECTLY CENTRED OVER THE HOLE in a manner suitable for the pipe material. This fitting must:

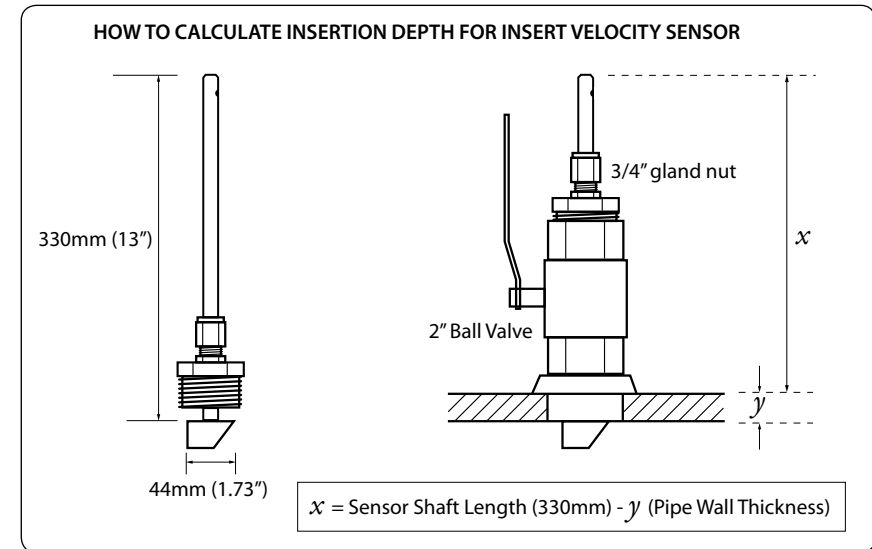
- Be at right angles to the flow
- Provide for a clean join inside the pipe (no burring etc)
- Be watertight



3. Fit a full bore 2" gate or ball valve to the male nipple, using thread sealant to ensure that it makes a water tight seal.



4. You are now ready to insert the sensor but first you must determine how far into the pipe the sensor face needs to be inserted. The sensor face must be the only thing that protrudes into the flow as shown in the diagram.



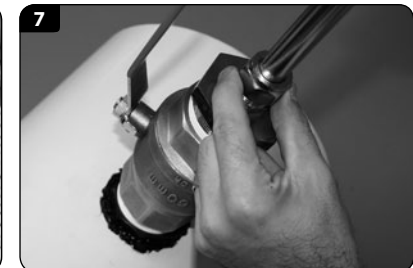
5. Calculate value x .

$$x = 330\text{mm} - y$$

Value x is the difference between the shaft length (330mm / 13") and value y (the pipe wall thickness measured and recorded in step 2)

6. Apply thread sealant onto the thread of the sensor to ensure that it makes a water tight joint with the valve. Screw the sensor assembly into the valve.

7. Make sure that the 3/4" gland nut is only finger tight. This will allow the sensor head to be moved freely while the head is aligned into the flow.



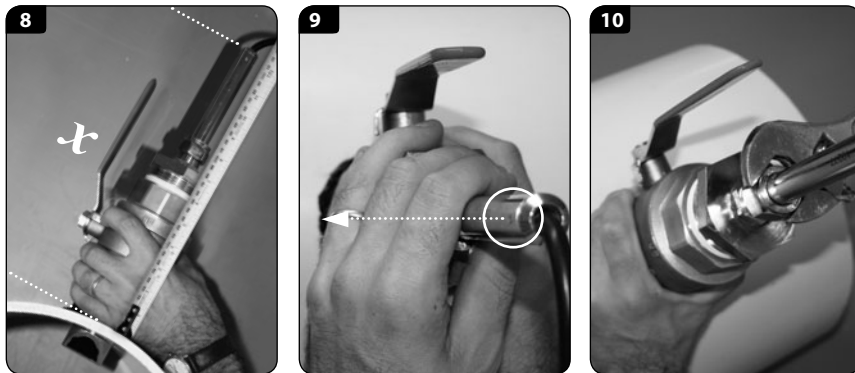
8.1 Installing a Doppler ultrasonic insert sensor - Continued

8. Open the valve fully and push the sensor head into the flow so it fully enters the stream without exposing any shaft. To get the sensor in exactly the right position you need to make the distance between the top of the sensor shaft to the top of the pipe wall the same as *value x*.

9. Now that the insertion depth is correct, rotate the sensor so that the grub screw at the top of the sensor shaft is accurately pointing in the direction of the longest straight section of pipe. Remember you must have a distance of at least six pipe diameters of straight pipe in front of the sensor and two pipe diameters of distance behind the sensor.

NOTE: The grub screw indicates the velocity sensing face.

10. Tighten the $\frac{3}{4}$ " gland nut to lock the sensor in place. **Do not use thread sealant on the $\frac{3}{4}$ " gland nut**



11. When the installation is complete, the sensor shaft should be pointing directly towards the centre of the pipe in all planes.

12. Carefully route the cable from the sensor back to where the XCi device enclosure will be mounted.

! Particular care should be taken when routing cables to ensure that moisture CANNOT enter the connector of the sensor cable as permanent damage may occur

! MACE recommends that all cables be appropriately routed through electrical conduit or other similar mechanism. MACE will not be liable for damage to cables, especially that caused by vehicles, digging implements, animals or debris in the pipe or channel.

8.2 Installing a Doppler ultrasonic strap mount sensor

8.2.1 Installation with a ZX SnapStrap

! **WARNING: DO NOT cut the sensor cable. Re-termination of the sensor is highly specialised and MUST be carried out at a MACE technical facility.**

The plastic (polypropylene) ZX SnapStraps are typically used to mount the sensor in locations where temporary monitoring will take place or when it is undesirable to drill in to the pipe wall. They allow for both very quick installation and removal of a strap mount sensor. The ZX SnapStrap comes in five lengths to suit different pipe diameters.

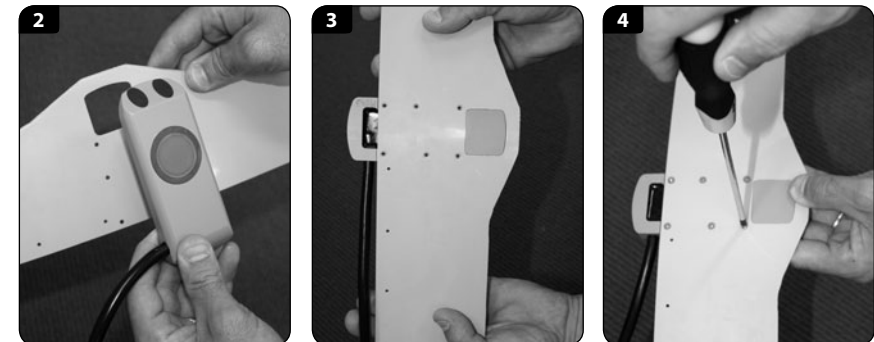
- 225-300mm (12" max)
- 300-450mm (18" max)
- 450-625mm (25" max)
- 600-725mm (29" max)
- 700-810mm (32" max)

1. Hold the sensor so that you can see the 'eyes' of the sensor in front of you, the sensor cable running to your left

2. Place the ZX SnapStrap on a flat surface so that you can see the chamfered edge of the strap in front of you. Place the 'toe' of the sensor into the front of the hole in the strap. Press the body of the sensor down onto the strap.

3. Turn the whole assembly over. Make sure the cut out in the strap sits down around the 'foot' on the sensor.

4. You should see six countersunk holes in the strap. Fit the six screws supplied (M3 x 8 mm Phillips head countersunk 304 s/s).



! **WARNING: Use only a hand screwdriver. Do not over tighten these screws as permanent damage to the thread may result**

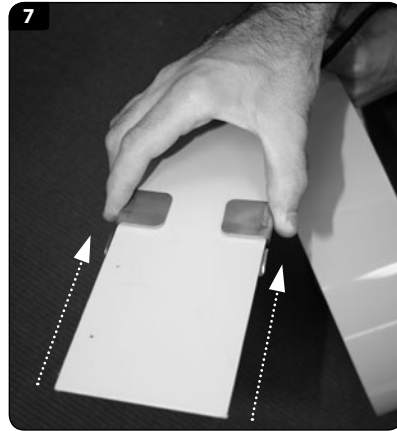
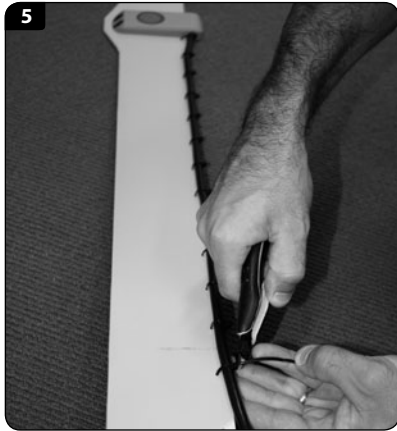
5. Tie the cable to the plastic strap using the holes and cable ties provided. Make sure that the knob of the cable tie sits to the back of the assembly, out of the flow. **DO NOT OVERTIGHTEN CABLE TIES.**

6. Place the strap so you are behind the sensor looking upstream.

8.2.1 Installation with a ZX SnapStrap - Continued



Upstream is preferred (due to better debris shedding characteristics of the bevelled leading edge) but not critical as this can be reversed in FloCom+. Ensure that minimum straight pipe requirements are still met.



7. A stainless steel buckle is provided. Slide the buckle onto the ZX SnapStrap as shown.

8. The left side of the strap will simply run through the buckle. The position of the buckle on the left side of the strap determines the diameter of the hoop. Therefore, the largest diameter occurs when you first place the buckle on the strap. The right side of the strap curves around inside the left and tucks into the buckle. Pick up the left side of the mounting strap and curve it over to form a semi circle.

9. Bring the right side of the strap up, inside the left and tuck into the ZX SnapStrap. The strap should now form a complete hoop.

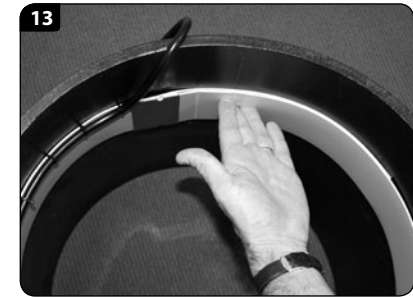
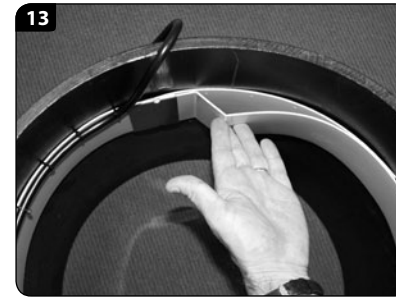
10. Position the buckle so that the whole assembly is slightly too large to comfortably fit in the pipe

11. Now, form a 'Z' at the creases in the strap as shown below.



12. Hold the 'Z' with one hand, the sensor with the other and place the assembly into the pipe reaching as far as is comfortable. Ensure that the sensor is parallel to the flow and in the bottom part of the pipe, off set to either side (if there is a build up of debris the sensor will not get covered)

13. Press out the 'Z' in the hoop with the palm of your hand. The strap will 'snap' into place. You won't be able to move the ZX SnapStrap up or down the pipe by hand if done properly.

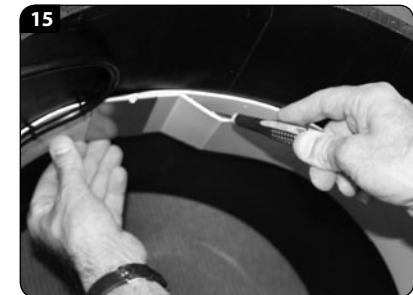


14. Carefully route the cable from the sensor back to where the XCi device enclosure will be mounted as described in installation of insertion sensors.



Particular care should be taken when routing cables to ensure that moisture CANNOT enter the connector or the air reference line of the sensor cable as permanent damage may occur

15. To remove, open the strap by wedging a screwdriver into the flattened 'Z' and bearing down on the strap.



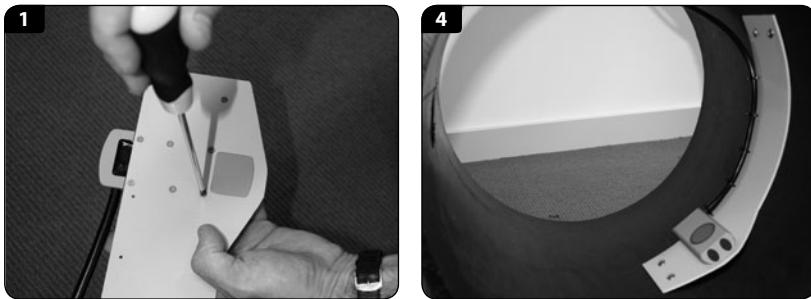
8.2.2 Installation with a mounting plate

WARNING: DO NOT cut the MACE Doppler sensor cable. Re-termination of the sensor connector is highly specialised and MUST be carried out at a MACE technical facility.

A mounting plate is normally used in large pipes where a cost-effective solution is required. The sensor is attached to the plate, which is then bolted to the inside surface of the pipe. This plate is supplied in polypropylene.

1. Attach the sensor head securely to the mounting plate by the six 3mm screws supplied (M3 x 8 mm Phillips head countersunk 304 s/s).

WARNING: Use only a hand screwdriver. Do not over tighten these screws as permanent damage to the thread may result



2. Tie the cable to the mounting plate using the holes and cable ties provided. Make sure that the knob of the cable tie sits to the back of the assembly, out of the flow. **DO NOT OVERTIGHTEN CABLE TIES.**

3. The cable from the sensor to the XCi device should then be run inside the pipe and secured to the pipe in such a manner as to prevent damage by debris in the pipe. The cable should be routed through electrical conduit.

4. Using a fixing method that is suitable for the pipe material, the sensor plate should be attached to the pipe or channel in a position such that the sensor is always facing parallel with the pipe.

WARNING: Take care to ensure no gap exists between the plate and the pipe wall. This will stop the collection of debris.

5. Carefully route the cable from the sensor back to where the electronics box will be mounted as described in installation of insertion sensors.

WARNING: Particular care should be taken when routing cables to ensure moisture CANNOT enter the connector or the air reference line of the sensor cable as permanent damage may occur

9.0 Sensor maintenance

To ensure trouble free data collection, sensors mounted in the flow should be kept free of built up debris, silt or grease. This is done by using a stiff bristle brush and carefully cleaning the sensor head and surrounding area. This process should be repeated as often as necessary in order to keep the sensors clean. Also check the sensor cable for physical damage.

WARNING: Do not use steel bristle brushes that may cause damage to either the MACE velocity or depth sensors.

9.1 Depth sensor reference filter maintenance

The ceramic depth sensor used in a MACE Doppler ultrasonic area/velocity sensor measures the hydrostatic pressure of the stream depth. This sensor is vented to atmospheric pressure via a vent tube inside the sensor cable, which passes through a filter before entering the silica gel canister. This is attached to the sensor connector and housed within the XCi device.

In order to keep the depth sensor working properly, this vent tube must always remain free from moisture.

The silica gel crystals contained within the reference filter effectively entrap atmospheric moisture. However, these crystals require changing regularly to ensure that they are still effective.

The silica gel crystals used in the reference filter are an indicator type. When fresh they are a deep blue in colour and when exhausted they are light pink. The crystals should be replaced when they first appear to be light pink. The following procedure should be followed to change the crystals:

1. Remove the large rubber stopper on the bottom of the filter housing. (*This is the stopper without the tube attached*).
2. Empty the filter chamber of exhausted crystals.
3. Add new crystals (MACE Part No. 590-009) to the filter chamber so that there is enough room for the rubber stopper to be replaced.
4. Replace the rubber stopper.

WARNING: Ensure that the reference filter tube is not crimped as a blockage will result in incorrect depth readings from the sensor

WARNING: The longevity of the silica gel crystals is dependent on the amount of moisture in the atmosphere. It is recommended that the crystals be checked at least on a monthly basis

WARNING: Do not eat the crystals. Wash hands after use

Section C:

FloCom⁺ Software

Installation & connecting to XCi devices

10.0 Introduction to FloCom⁺

This section describes MACE FloCom⁺ software enabling you to connect, configure and download data from your XCi devices.

System Requirements

Minimum system requirements for PC are:

- Windows[®] XP
- 4Mb available hard drive space
- Serial or USB port
- FloCom⁺ Version 2.0.0.0 (*minimum requirement*)



MACE Software End User License Agreement (EULA)

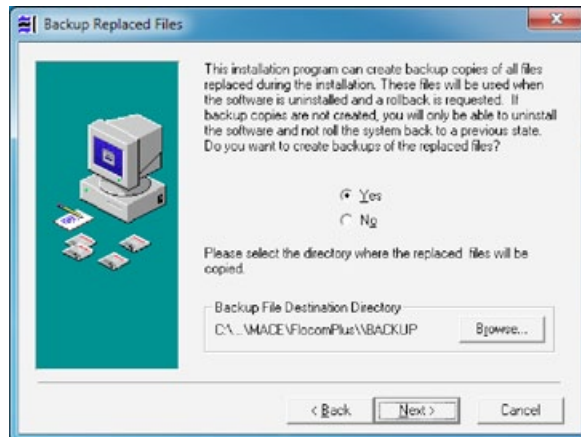
Users should read and accept the terms of the MACE EULA before installing FloCom⁺ on their PC. The EULA can be found on the downloads page of the MACE website, www.macemeters.com

IMPORTANT: The minimum version of FloCom⁺ required to communicate with an XCi device is **Version 2.0.0.0**. You can check the version number by clicking **"Help"** from the main menu and clicking **"About FlocomPlus"**. The latest version of FloCom⁺ is available for download from www.macemeters.com

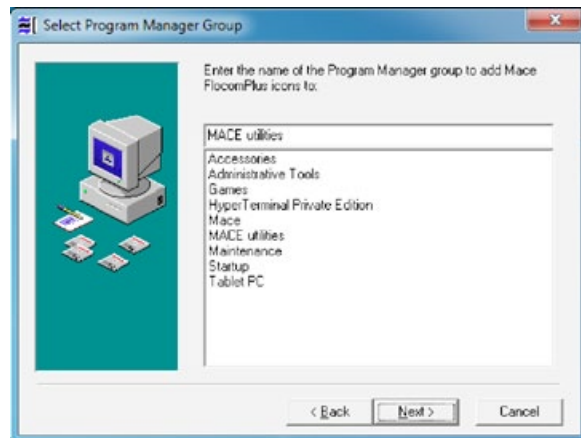
11.0 Installing FloCom+ software

Download FloCom+ from our website www.macemeters.com

1. Run the "*FlocomPlus_[version number].exe*" file to start the installation process.
2. Follow the instructions on the welcome screen then click the "*Next*" button to move to the next screen.
3. Choose a location on your computer to install FloCom+. FloCom+ will setup a folder in your program files called "*Mace\FlocomPlus*". This is the default option. Click the "*Next*" button to continue
4. Backing up replaced files. FloCom+ will ask if you wish to create backups of replaced files. We advise you to click "*Yes*" and then click the "*Next*" button.
5. Selecting a Program Manager Group. "*Mace utilities*" is the default group and we suggest leaving this as is.



6. Starting installation. Click "*Next*" to begin installing FloCom+.



7. FloCom+ will now install. Once the software installation is complete click the "*Finish*" button to exit the setup program. FloCom+ is now ready to be used.

8. Run FloCom+ using the shortcut provided on your desktop. The startup menu will appear as shown below. Click "*File>Comms settings...*" to configure FloCom+ for your computer.



Windows XP:

Download and install the drivers for *MACE FloSeries3 - USB external comms lead* from www.macemeters.com prior to plugging the cable into a USB port.

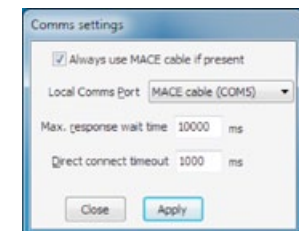
Windows Vista/ Windows 7:

After plugging the MACE comms lead into a USB port the drivers will automatically download and install on your PC.

! Check the "Always use MACE cable if present" box

10. If you are not using a MACE USB Comms lead, select the "*Local Comms Port*" of your computer which will be used to communicate with the XCI device when a local connection will be made.

! If using a USB to Serial adapter please refer to the product documentation supplied with the adapter to ensure the correct driver is installed

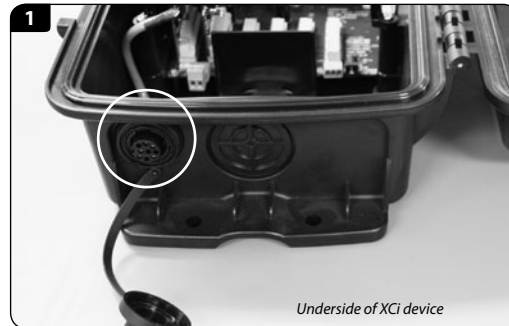


Click "*Apply*" to save the settings.

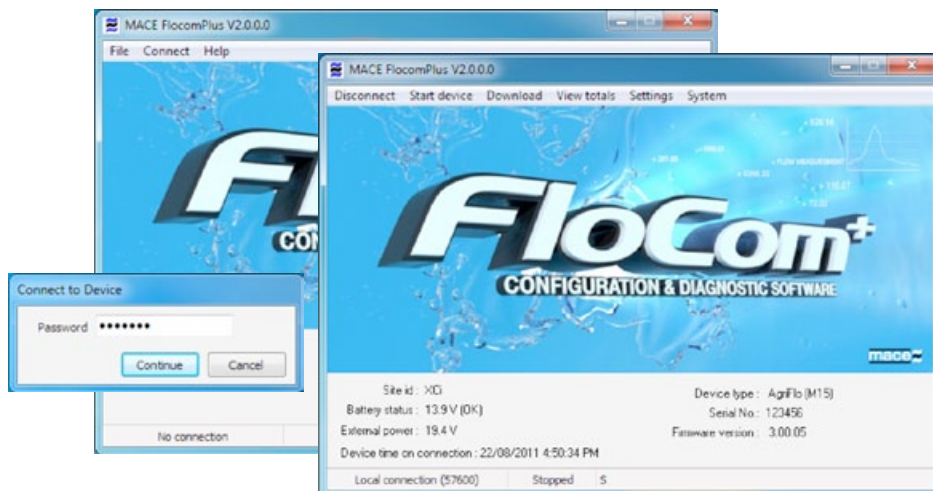
12.0 Connecting to an XCi device

12.1 Connecting to the device using the comms port

1. Unscrew the cover from the communications port.
2. Connect a MACE USB Comms cable (Part No. 850-363) between the USB port of the computer and the comms port of the XCi device located on the underside of the enclosure.



3. Click **“Connect”**. Enter the password which has been set in the unit and select continue. (The default password is **“superid”**).
4. The main menu which includes the device status summary screen is now visible as shown below.

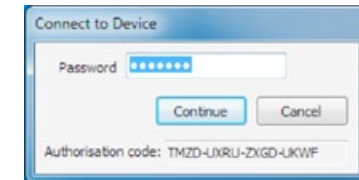


- ⚠ **The device must be configured and started before the instrument will measure and record data**
- ⚠ **Once finished, remove the MACE comms cable and screw the comms port cover back in place to maintain environmental protection**

12.2 What to do if the password is lost/forgotten

In the event that you have forgotten or lost your password, the following steps should be taken.

1. From the **“MACE FloCom Plus”** main screen, click **“Help>Show device authorisation code”**.
2. Click **“Connect”** and the **“Connect to device”** dialogue box will appear.



3. In this dialogue box the device's unique authorisation code is seen at the bottom.

- ⚠ **You MUST note this code EXACTLY to fulfil the next steps**
- 4. The unique device serial number located on an adhesive label inside the box should also be noted. This will be used to verify the history of the device.
- 5. Once you have noted the code and serial number, you must contact your local MACE dealer/distributor and inform them of these details. They will obtain a **“counter-code”** for your device.

- ⚠ **You will be required to prove that you have the authority to access the device prior to a “counter-code” being issued. For a billing device, only an official of the water distribution authority will be given the “counter-code”. No exemptions from this requirement will be given**

6. From the **“MACE FloCom Plus”** main screen, click **“Connect”** and the **“Connect to device”** dialogue box will appear.

- ⚠ **This “counter-code” has a time limit on its validity (typically three days). It must be used to access the unit within this time or it will be void and a new one will need to be produced**

Enter the 16 digit authorisation **“counter-code”** into the **“Password”** field and click **“continue”**. You will now have super user access to the device.

- ⚠ **You should immediately change the super password to one that will not be forgotten (see Chapter 13.3 for details)**

13.0 The FloCom+ main menu

13.1 The System menu

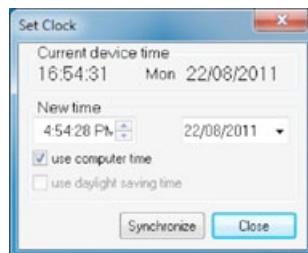
From the main menu click **"System"** and the following menu options will appear as listed below:



13.1.1 Set device date/time

The device date and time must be set correctly, so that data can be accurately matched to known time intervals.

- The date and time can be set by manual entry or by synchronizing with the computer time.
- The time is held in 24 hour time.
- Allowance can be made for daylight savings time.



13.1.2 Change download password

The download password allows low level access to the device. When this password is used for entry to the device, channel totals may be viewed and data can be downloaded.

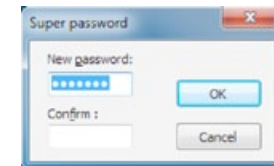
Many irrigation districts give this password to irrigators to allow them to use the data for water management operations.



13.1.3 Change super password

The super password allows high level access to the device. When this password is used for entry to the device, all editing functions (including data downloading) are allowed.

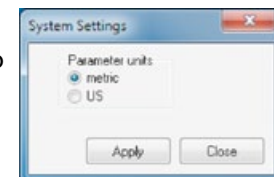
Most irrigation districts set this password to prevent non authorized access to the device.



! Both the super and download passwords are case sensitive.

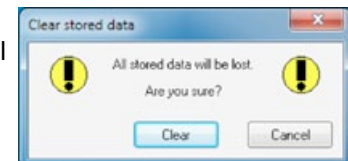
13.1.4 System settings

The system settings function allows the user to change the measurement units from metric to U.S and vice versa.



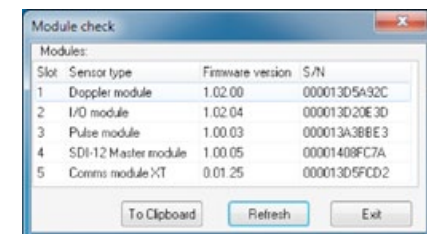
13.1.5 Clear stored data

This function should only be used by high level users. It clears all stored data from the device including all time stamped flow rate data.



13.1.6 Module check

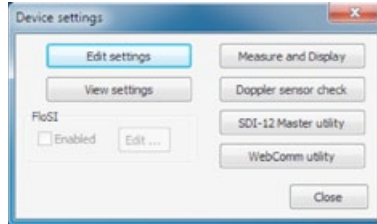
This function provides the user with a simple method of identifying the FloSeries3 modules which are currently installed in the device. It also includes the various modules firmware versions and serial numbers. This information is important as functionality may be increased with later firmware releases.



13.2 Settings

From the main menu click **“Settings”** and the interim **“Device Settings”** dialogue box will appear as shown.

Click **“Edit settings”** and the main **“Device Settings”** dialogue box will appear as shown below.



The procedure for configuring an XCI device is structured in a logical sequence so that the device is configured in the correct order. For example, in the main **“Device Settings”** dialogue box the user must **“Configure modules”** prior to being able to **“Configure channels”** and **“Configure outputs”**. FloCom+ uses this logical sequence throughout the entire configuration process to minimise user error.

The essential steps to configure your XCI device are listed below.

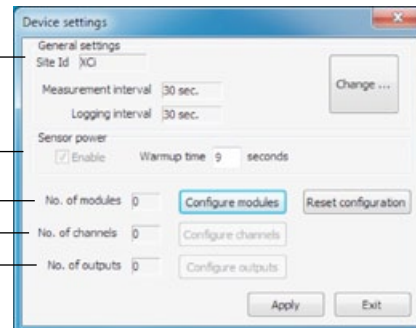
General settings

Sensor power

Configure modules

Configure channels

Configure outputs



Essential Steps to configure your XCI device

1. Edit General Settings
2. Add Modules
3. Edit Modules
4. Add Channels
5. Edit Channels
6. Add Outputs (where required)
7. Edit Outputs (where required)
8. Apply Settings



WARNING: Once Steps 1 - 7 have been completed, apply all settings by clicking “Apply” from the “Device settings” dialogue box as shown above.

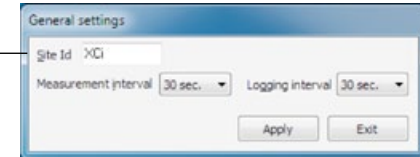
13.2.1 General settings

1. From the main **“Device Settings”** dialogue box click **“Change”** and the **“General Settings”** dialogue box will appear as shown below.

Site Id

The **“Site Id”** is a text field used to identify the location of the device. When data is retrieved from the device, it will be identified by this name.

For example, the **“Site Id”** might be the name of the treatment plant or license number.



NOTE: The instrument’s “Site Id” is required before the configuration can be applied successfully

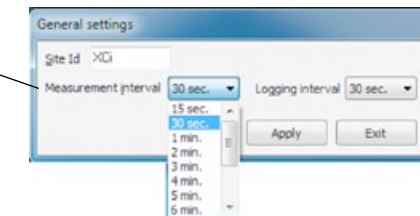
Measurement and Logging Interval

The measurement interval is the time at which the device ‘wakes up’ to measure/calculate the values on each of the configured channels.

Data is logged in the data file **ONLY** at the logging interval.

The measurement interval will always be shorter than or equal to the logging interval.

In the case of the measurement interval being shorter than the logging interval, then the data logged will be the average of those values calculated per measurement interval.



2. Click **“Apply”** and the main **“Device Settings”** dialogue box will re-appear.

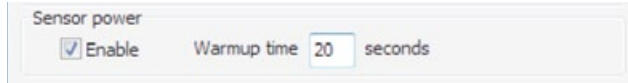


NOTE: The logging interval can only be a multiple of the measuring interval.

13.2.2 Sensor power

When enabled (via the check box), this function instructs the device to switch the 12VDC power line ON for sensors wired to I/O card/s.

A warmup time must be set by the user, suitable for the sensor/s application. For example, a 4-20mA output downward looking ultrasonic depth sensor may require a 20 second warm up prior to recording a stable depth reading.

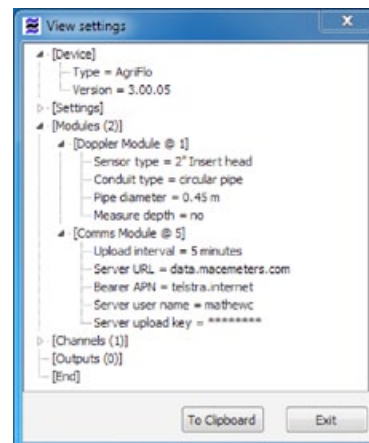
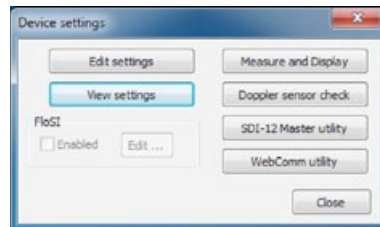


WARNING: The maximum system current available for powering sensors attached to ALL I/O cards is 1.25 Amps at 12VDC

13.2.3 View configuration

By clicking “*View settings*” from the interim “*Device settings*” dialogue box the user is able to see a tree view of all configured modules and their respective measured channels.

By clicking “*To Clipboard*” the user can then paste the tree view into any text document.



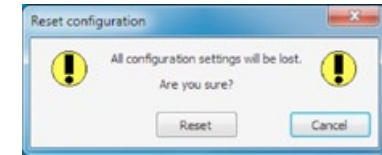
NOTE: There is no tree view available until at least one channel is configured.

NOTE: Derived channels, those that are calculated based on the values of two or more measured channels are not displayed.

13.2.4 Reset configuration

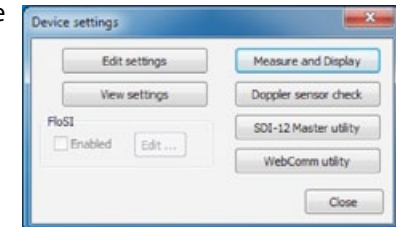
WARNING: Use “*Reset configuration*” with care.

Clicking “*Reset configuration*” causes all configured modules, channels and outputs to be removed.

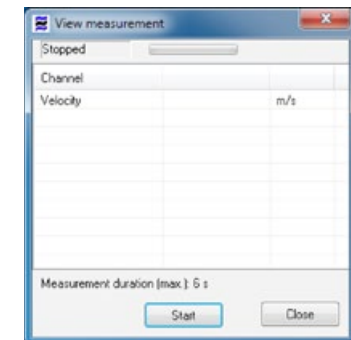


13.2.5 Measure and display

On the interim “*Device settings*” dialogue box the real time diagnostic function “*Measure and Display*” is available.



1. Click “*Measure and display*” then “*Start*” to observe the current channel values.
2. Click “*Stop*” then “*Close*” to return to the main menu.



13.3 Start/Stop device

Once the XCI device has been configured and tested it is ready to be started so that measuring and logging is initiated.



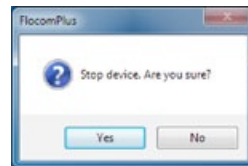
WARNING: If the device is NOT started measurements will NOT occur

From the main menu click **“Start device”** and you will be asked **“Are you sure?”**. Click **“Yes”** and the device will start and you will be returned to the main menu. You will notice that the **“Start Device”** has changed to **“Stop device”** in the main menu.



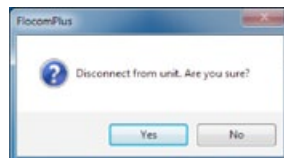
To enable changing of settings, access of real-time data and resetting totals, the XCI device must first be stopped.

From the main menu click **“Stop device”** and you will be asked **“Are you sure?”**. Click **“Yes”** and the XCI device will stop and you will be returned to the main menu. You will notice that the **“Stop Device”** has changed to **“Start device”** in the main menu.



13.4 Disconnect

From the main menu click **“Disconnect”** and you will be asked **“Are you sure?”**. Click **“Yes”** and the XCI device will be disconnected and you will be returned the start up menu. Click on **“File>Exit”** to shut down FloCom⁺.

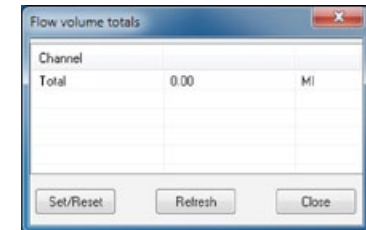


WARNING: If FloCom⁺ is not disconnected from the XCI device excess current will be drawn from the main battery

13.5 View totals

From the main menu click **“View totals”** and the **“Flow volume totals”** dialogue box will appear.

This dialogue box lists all the accumulated flow channels and their respective totals and units.



If the XCI device has not been started, the **“Set/Reset”** button will be active and the totalised reading can be changed.

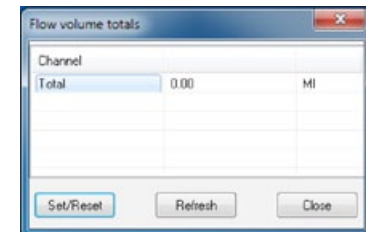


NOTE: Only total channels that have been configured as Resettable can have their value reset

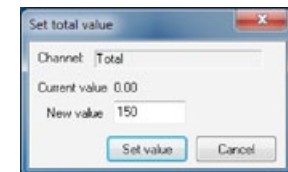


WARNING: It is strongly advised to download the logged data PRIOR to resetting the total value

1. Highlight the channel you wish to reset by clicking on it's name.
2. Click **“Set/Reset”** and the **“Set total value”** dialogue box will appear.



3. Enter the **“New value”** into the field and click **“Set value”**. The new value will then be displayed in the **“Flow volume totals”** dialogue box.



Double check that this value is CORRECT

4. If the XCI device has not been stopped, the **“Set/Reset”** button will be greyed out and the total/s will not be re-settable.
5. To update the reading whilst flow is accumulating, click **“Refresh”**.

13.6 Download

From the Start up screen click **“Connect”** to display the main menu.

Select **“Download”** to initiate the stored data download procedure.

A save file dialogue box will appear. The default file name is the unit ID. The default target directory is the directory into which the previous download file was stored.

Click **“Save”** once you are ready to download the device. The **“Download”** dialogue box will appear which shows the amount of stored data in the device and the date of the earliest available record. If the download end time is left unchanged or set to a time earlier than the earliest record, all stored records will be downloaded. Otherwise, only those data stored after the chosen **“Download from”** date will be downloaded.

Click **“Start download”** to complete the download procedure.



WARNING: Adding a new channel creates a new data session. It is essential to download the data from the XCi device PRIOR to adding new channels to an XCi device that has already been configured and has had data recorded.

13.7 View downloaded data file

This function is accessed via the **“File”** menu and then selecting the **“View download file”** option. The **“File”** menu is only available when not connected to the XCi device.

Opening a file

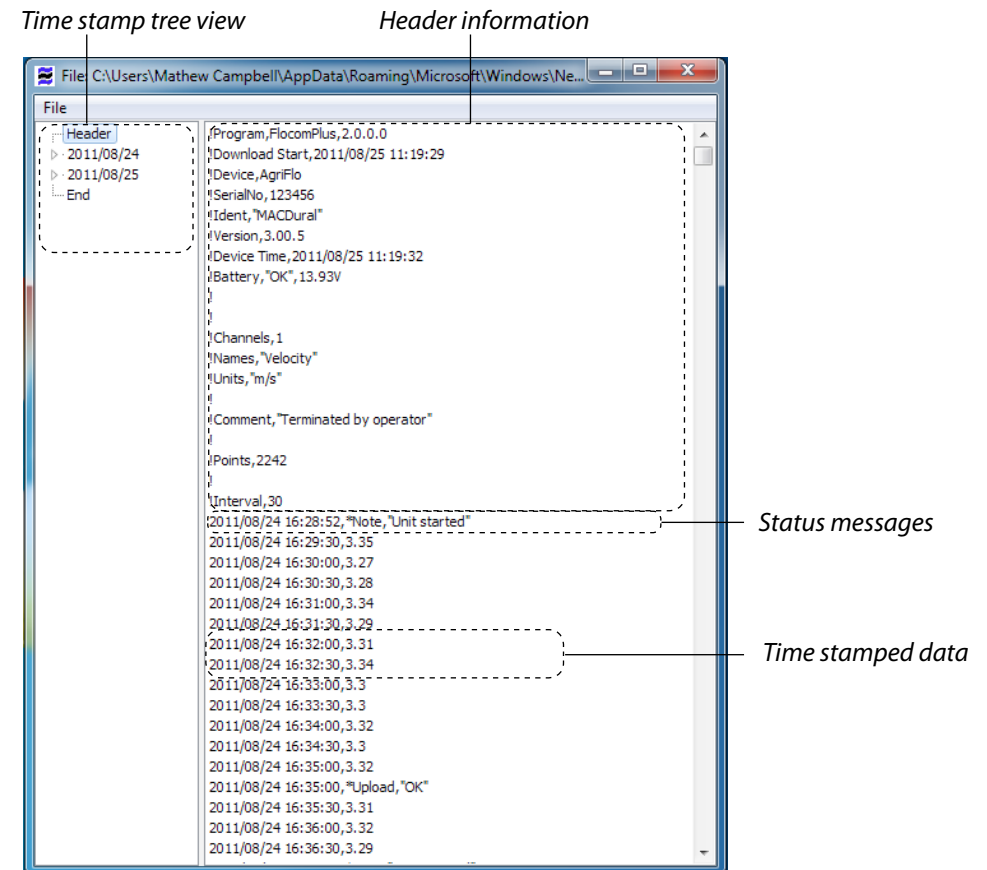
On entry, an open file prompt window is displayed. If downloaded data was saved during the current session, the last downloaded data file appears as

the default selection. On selecting **“Open”** the selected file is loaded and if successful the data is displayed as a text file. A different downloaded data file may be selected at any time by selecting the local **“File”** function and repeating the file selection procedure.

Viewing a file

Time stamp tree view

This pane enables the user to quickly navigate the data file by date and time. Expand the tree on the date of interest to reveal the various time stamps. Click the time stamp you wish to view and the data file will automatically scroll to it.



13.7 View downloaded data file - *continued*

Header information

At the top of each data file the following information is displayed:

- Version of FloCom+ used to download the file;
- Time and date the data was downloaded to the PC;
- Device type; ie AgriFlo, FloPro or HydroMace;
- Serial number of the XCI device;
- Version of firmware installed in the XCI device;
- Time and date of the clock in the XCI device;
- Battery status and charge (voltage) of the XCI device;
- Number of channels being recorded;
- The names of each channel being recorded;
- The units of measure used for each channel being recorded;
- 'Points' refers to the number of data lines in the downloaded file;
- 'Interval' refers to the time in seconds between each time stamp (logging interval).

Status messages

Status messages are defined by the use of an asterisk (*) immediately following a time stamp. For example, in the download on the previous page the following message appears which tells the user the date and time the unit was started.

```
11/08/24 16:28:52,*Note,"Unit started"
```



NOTE: Refer to the table over page for a full listing of status messages

Time stamped data

At each time stamp the date, time and recorded channel values are shown. In the example below the date and time are followed by the recorded values for each of the five configured channels which are Depth, Flow Rate, Flow Total, Pulse Total and Pump Status..

```
2008/11/04 13:45:00,1,115.78,0.16,0,1
```

End of file

The end of the data file is always delineated by a 'Download End' followed by the date and time.

Status message table

Status message	Description
Unit started	Device was started
Unit stopped	Device was stopped
No external power	No external power is detected. If a solar panel is used this will occur at sunset.
External power restored	External power is detected. If a solar panel is used this will occur at sunrise.
Low Battery	Time at which battery voltage fell below 11.5V
Battery normal	Time at which battery voltage exceeded 11.5V
Flat battery condition	Battery voltage at download time is less than 10V
Battery was flat	Battery was less than 10V
Sensor not detected	MACE Doppler sensor not detected
Sensor error	Any configured module not detected
Device reset #0	Power up reset occurred
TOD clock error	Error reading Time-of-day clock
Pulse event	A pulse from a pulse event channel has occurred
Status change	The value on a status event channel has changed
Upload OK	A successful upload was made to the MACE data server
Upload Timeout	A unsuccessful upload attempt was made
Upload Bearer Error	The WebComm card was unable to establish a bearer connection and an unsuccessful upload attempt was made
Terminated by operator	The download was aborted by the user
Incompatible session/s skipped	The download includes only data since the last channel re-structure

14.0 Introduction to FloSeries3 cards

Multiple cards for multiple sensor applications.

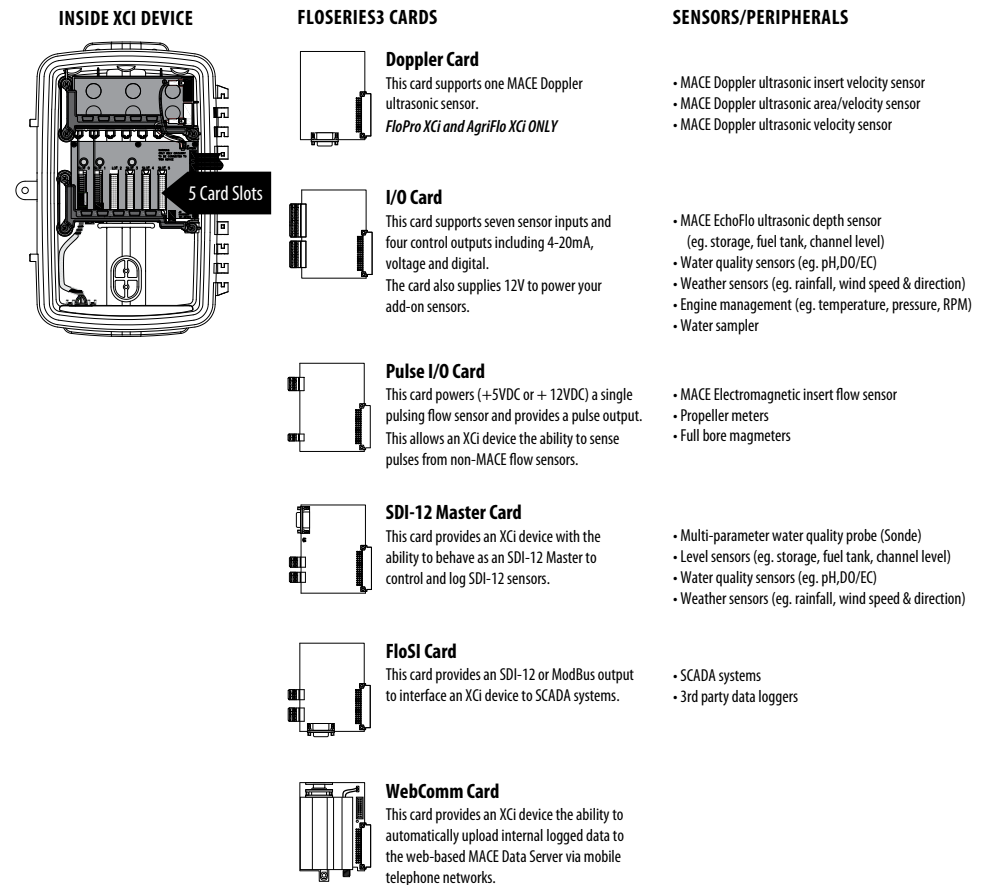
The XCi system (multiple card interface) allows the user to monitor just about any sensor. Users can install any combination of the six MACE FloSeries3 cards shown, into the five available card slots within an XCi device. Choose the right card/s for your application to tailor the XCi device to your exact monitoring requirements.

With a MACE WebComm card installed, your data can be accessed free, 24/7 from the MACE website via PC or smartphone.

Section D:

FloSeries3 Cards

Installation & configuration



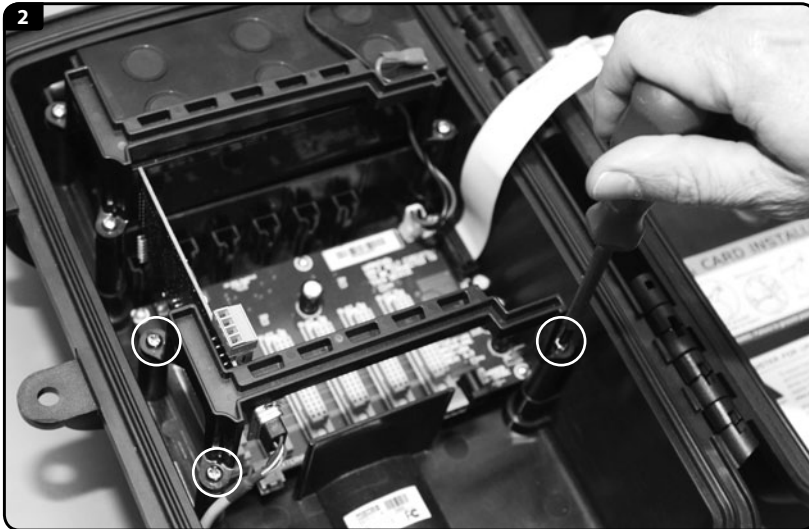
15.0 Installing FloSeries3 cards

1. Open the XCi device enclosure and ground yourself by touching the screw labelled “Ground yourself here” on the LCD circuit board.

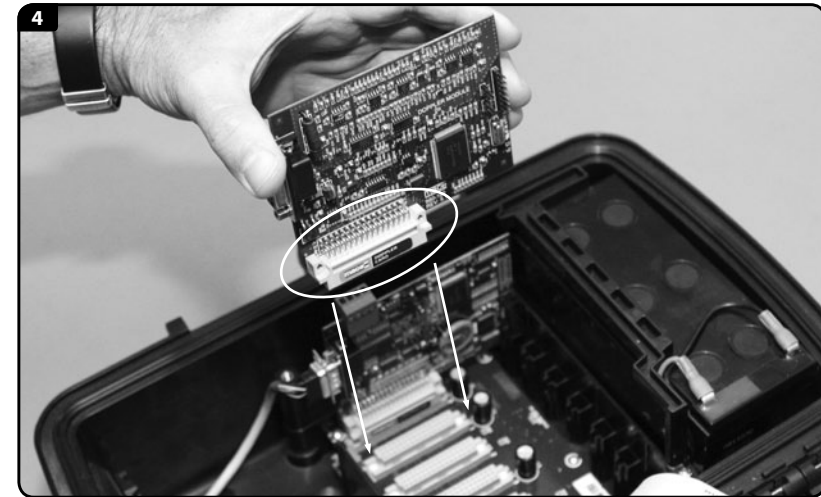


2. Remove the three screws (using a #2 Phillips screwdriver) fastening the PCB clamping bracket. Take care not to drop screws in the box as damage may occur to the circuitry.

3. Ground yourself again as per instructions in step 1.



4. Remove the FloSeries3 card from its packaging. Position the new card in your hand such that the large cream 48-pin connector is facing down and aligned with the mating connector on the backplane PCB.



5. **Ground yourself again.** Your finger must remain grounded on the screw whilst carefully inserting the card into any spare slot.

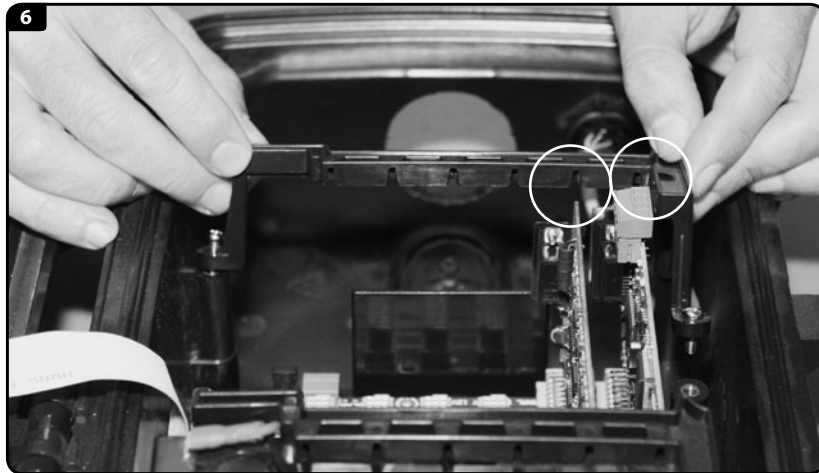
NOTE: If installing a WebComm card then you MUST use card slot 5.

Take care to align the pins of the two connectors together. There is a slot at the top of the card area that helps the alignment process. Ensure that the card is contained within this slot and press down firmly to ensure that it is fully seated.



15.0 Installing FloSeries3 cards - *continued*

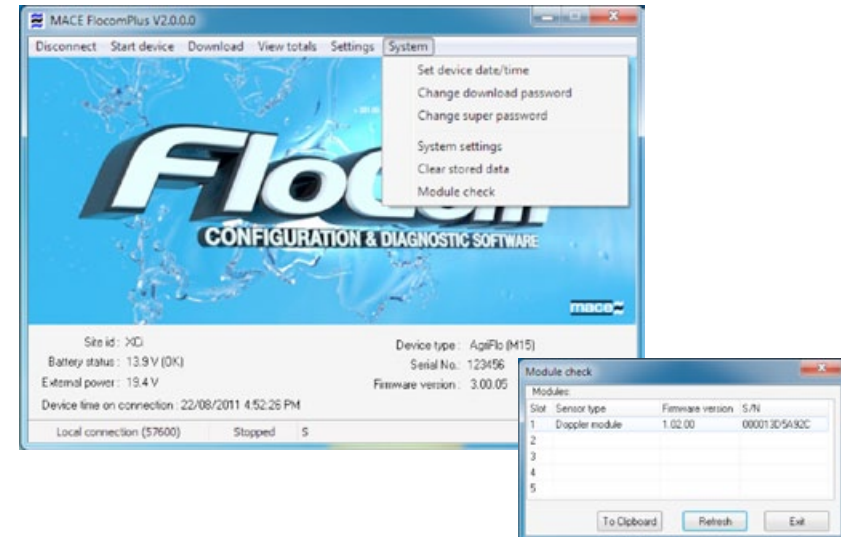
6. Replace the PCB clamping bracket ensuring that the slots in the underside of the bracket are aligned with the tops of all the cards. Fix the bracket into place with the three screws. **DO NOT over tighten the screws.**



7. **“Connect”** to the XCi device with a PC using FloCom+ as detailed in Chapter 12.



8. From the main menu of FloCom+, click **“System”** then **“Module check”** and ensure that your newly installed card/s are listed **and in the correct card slots.**



9. If they are not listed and/or not in the correct slot, **“Disconnect”** from the device in FloCom+.

10. **REMOVE** the offending card/s and **WAIT** for at least one minute. This allows the microprocessor on the card to reset. Follow steps 1-9 for re-installation.

⚠ WARNING: Before removing the card/s you **MUST** re-ground yourself by following the procedure outlined in step 3.

16.0 The Doppler card

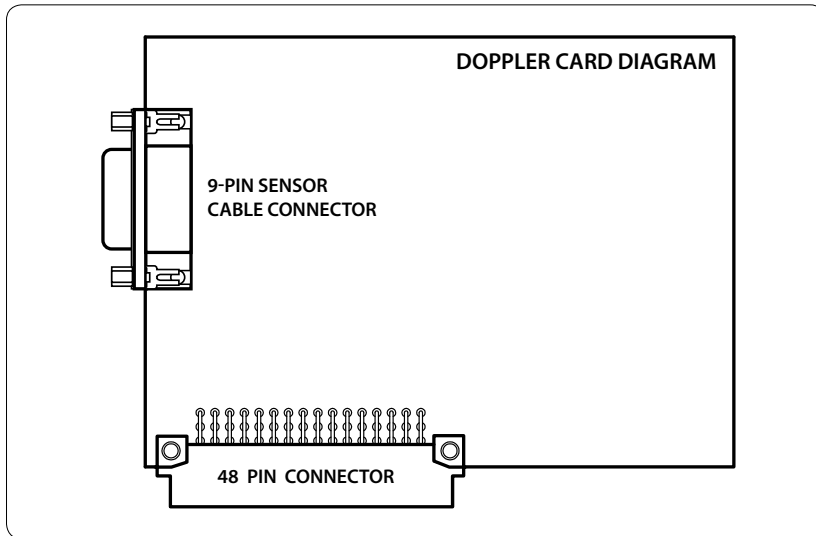
16.1 About the Doppler card

The Doppler card provides the input for connecting MACE Doppler velocity sensors to a FloPro XCI or AgriFlo XCI device.

Each MACE Doppler sensor is terminated with a 9-pin d-connector that plugs in to the Doppler card. The sensor cable is securely attached to the card by tightening the thumb screws.

NOTE: Refer to Chapter 3 for instruction on sensor cable connection

Once a sensor has been connected to the Doppler card it must be configured using FloCom+ software so that the XCI device can control and record data from the sensor.



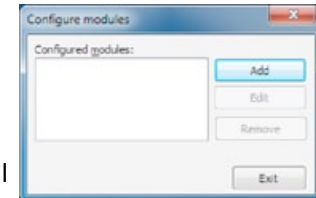
Essential Steps to configure a Doppler card using FloCom+ software:

1. Add Modules
2. Edit Modules
3. Add Channels
4. Edit Channels
5. Apply Settings
6. Run Doppler sensor check

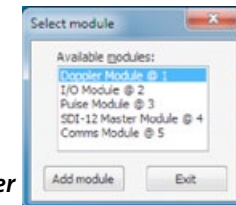
16.2 Add and configure a Doppler module in FloCom+

NOTE: Once a FloSeries3 card is installed in an XCI device, FloCom+ defines this as a module.

1. From the main "Device settings" dialogue box click "Configure modules" and a dialogue box will appear as shown.



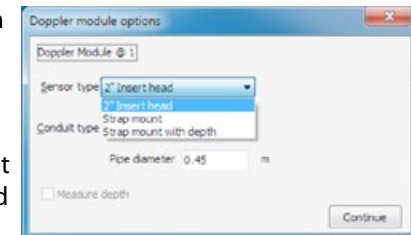
2. Click "Add" and the available modules will be listed in the "Select module" dialogue box.



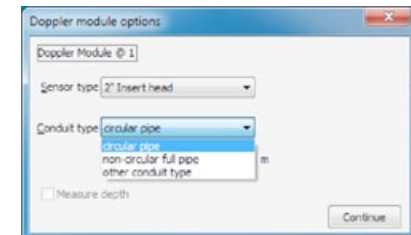
3. Each MACE module available is referenced in the list by its type and slot number. (eg. Doppler module in card slot 1). Highlight the module you wish to add and click "Add module". The "Doppler module options" dialogue box will appear.

NOTE: Once a module has been added it will no longer appear on the available modules list

4. From the "Sensor type" drop down list box, select the type of sensor connected to the Doppler module.



5. From the "Conduit type" drop down list box, select the type of conduit in which the sensor is installed.



Conduit type	Description
Circular pipe	Full or partially full
Non circular full pipe	A full pipe with a known cross-sectional area such as: <ul style="list-style-type: none"> • Box culvert • Oval pipe
Other conduit type	Non-circular open channel such as: <ul style="list-style-type: none"> • Trapezoidal • Irregular earthen channel

16.2 Add and configure a Doppler module in FloCom+ - continued

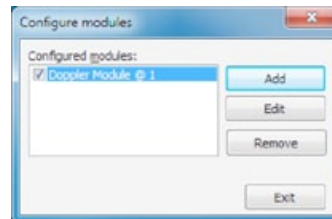
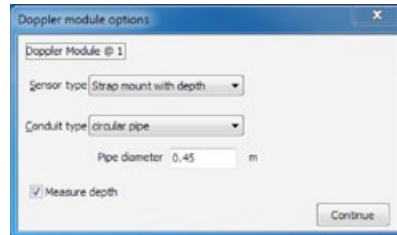
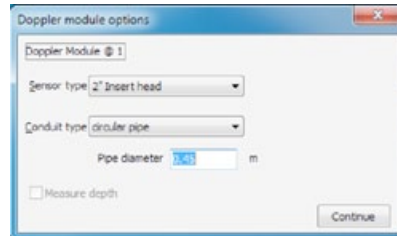
6. Enter the **“Pipe diameter”** or **“Cross-sectional area”** if applicable.



WARNING: Ensure the diameter or cross-sectional area of the pipe is entered in the appropriate units of measure.

7. If a **“Strap mount with depth”** sensor was selected and you wish to measure depth with this sensor, check the **“Measure depth”** check box.

8. Click **“Continue”** and the **“Configure modules”** dialogue box will appear with a listing of the configured modules.



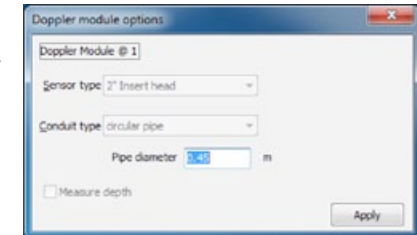
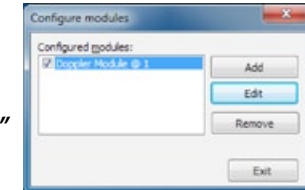
16.3 Edit/Remove a Doppler module in FloCom+ ---

16.3.1 Edit a Doppler module

If you wish to edit a Doppler module after it has been added and configured, click **“Edit”** from the **“Configure modules”** dialogue box. Only the **“Pipe diameter”** or **“Cross-sectional area”** may be edited.

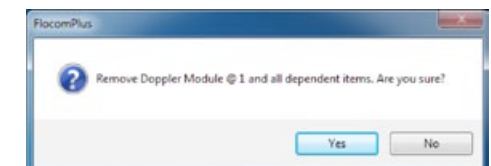
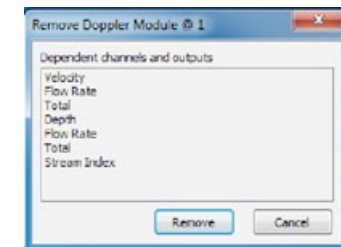
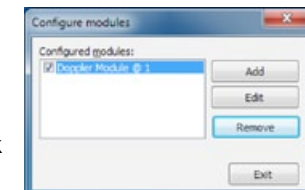


NOTE: If you wish to edit the “Sensor type” or “Conduit type” the entire module must be removed and a NEW module must be added



16.3.2 Remove a Doppler module

1. From the **“Configure modules”** dialogue box highlight the module that you wish to remove. Click **“Remove”** and a dialogue box will appear listing the **“Dependent channels and outputs”**. Click **“Remove”** and you will be prompted to confirm your action. Click **“Yes”** and the module and dependent channels will be removed.

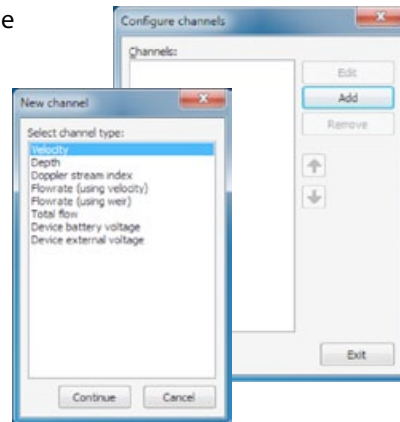


16.4 Add Doppler module channel types

From the main “*Device Settings*” dialogue box click “*Configure channels*” and the “*Configure channels*” dialogue box will appear.

1. Click “*Add*” and the “*New channel*” dialogue box will appear as shown.

The “*Channel types*” visible in the “*New channel*” dialogue box are dependent upon the modules that have been configured.



WARNING: Adding a new channel creates a new data session. It is essential to download the data from the XCi device PRIOR to adding new channels to an XCi device that has already been configured and has had data recorded.

Doppler module channel types

Channel types	Description
Velocity:	MUST be used whenever a MACE Doppler velocity sensor is configured.
Depth:	MUST be used whenever a MACE area/velocity sensor is configured.
Doppler stream index	Provides a measure of the signal strength received by a MACE Doppler velocity sensor in calculating the average stream velocity.
Flowrate: (using velocity)	Used to calculate a flow rate based upon the results obtained from configured velocity and depth channels.
Total Flow:	Used to calculate an accumulated positive or negative total based on the results obtained from a configured flow rate channel.
Device battery voltage	Used to monitor the XCi internal battery voltage.
Device external voltage	Used to monitor the XCi external voltage from a solar panel or mains charger.

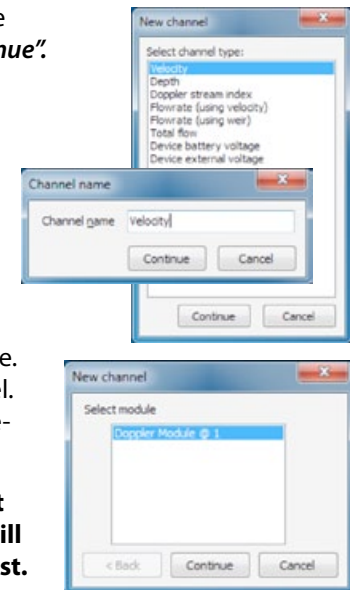
16.4.1 Add a “Velocity” channel type

1. Select the “*Velocity*” channel type from the “*New channel*” dialogue box and click “*Continue*”.

2. The “*Channel name*” dialogue box will appear. Enter a channel “*Name*” in to the text field (16 character maximum). This “*name*” will also be displayed on the XCi device main LCD if enabled. Click “*Continue*”.

3. In the “*New channel*” dialogue box highlight the “*Doppler Module*” option from which the named channel will receive its value. Click “*Continue*” to complete the new channel. The “*Configure channels*” dialogue box will re-appear with the new channel listed.

NOTE: As a particular module’s input becomes fully utilised the module will not appear on the “*Select module*” list.



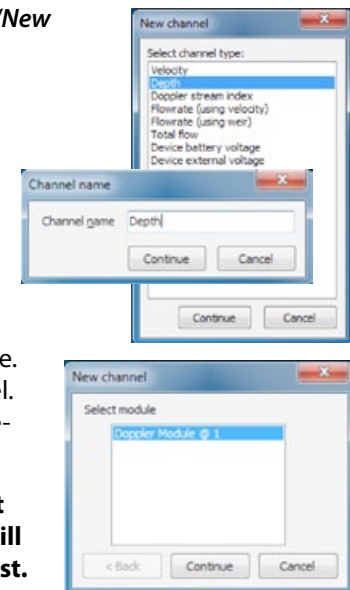
16.4.2 Add a “Depth” channel type

1. Select the “*Depth*” channel type from the “*New channel*” dialogue box and click “*Continue*”.

2. The “*Channel name*” dialogue box will appear. Enter a channel “*Name*” in to the text field (16 character maximum). This “*name*” will also be displayed on the XCi device main LCD if enabled. Click “*Continue*”.

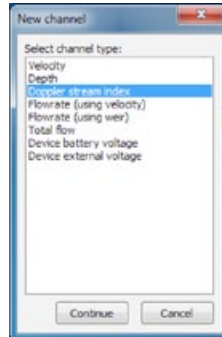
3. In the “*New channel*” dialogue box highlight the “*Doppler Module*” option from which the named channel will receive its value. Click “*Continue*” to complete the new channel. The “*Configure channels*” dialogue box will re-appear with the new channel listed.

NOTE: As a particular module’s input becomes fully utilised the module will not appear on the “*Select module*” list.

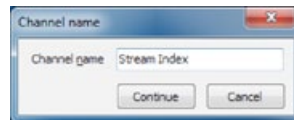


16.4.3 Add a “Doppler stream index” channel type

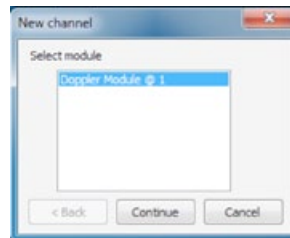
1. Select the “*Doppler stream index*” channel type from the “*New channel*” dialogue box and click “*Continue*”.



2. The “*Channel name*” dialogue box will appear. Enter a channel “*Name*” in to the text field (16 character maximum). This “*name*” will also be displayed on the XCi device main LCD if enabled. Click “*Continue*”.



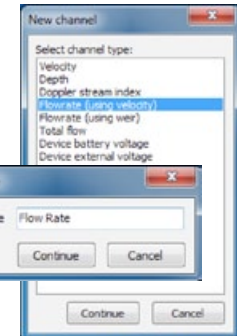
3. In the “*New channel*” dialogue box highlight the “*Doppler Module*” option from which the named channel will receive its value. Click “*Continue*” to complete the new channel. The “*Configure channels*” dialogue box will re-appear with the new channel listed.



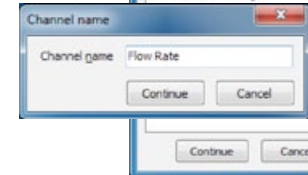
NOTE: As a particular module’s input becomes fully utilised the module will not appear on the “*Select module*” list.

16.4.4 Add a “Flowrate (Velocity)” channel type

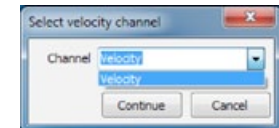
1. Select the “*Flowrate (using velocity)*” channel type from the “*New channel*” dialogue box and click “*Continue*”.



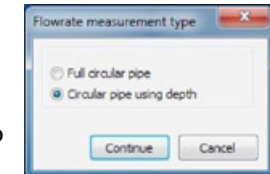
2. The “*Channel name*” dialogue box will appear. Enter a channel “*Name*” in to the text field (16 character maximum). This “*name*” will also be displayed on the XCi device main LCD if enabled. Click “*Continue*”.



3. In the “*Select velocity channel*” dialogue box use the drop down list to highlight the Doppler velocity channel named “*Velocity*” from which the channel named “*Flow rate*” will receive its value. Click “*Continue*” and the “*Flowrate measurement type*” dialogue box will appear.

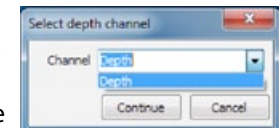


4. Select either “*Full circular pipe*” or “*Circular pipe using depth*” depending upon your application.



5. If you select “*Full circular pipe*”, click “*Continue*” to complete the new channel.

If you select “*Circular pipe using depth*”, click “*Continue*” and the “*Select depth channel*” dialogue box will appear. In the “*Select depth channel*” dialogue box use the drop down list to highlight the channel named “*Depth...*” from which the channel named “*Flow rate*” will receive its value. Click “*Continue*” to complete the new channel.



NOTE: If “*Other conduit type*” was selected when configuring a Doppler module, then the “*Flowrate measurement type*” dialogue box will not appear and FloCom+ will automatically prompt for selection of both velocity and depth channels.

6. The “*Configure channels*” dialogue box will re-appear with the new channel listed.

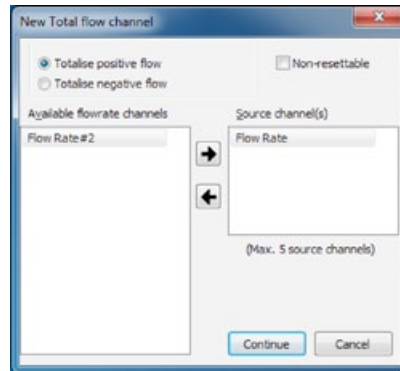
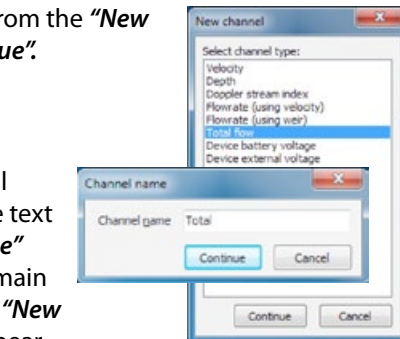
16.4.5 Add a "Total flow" channel type

1. Select the "Total flow" channel type from the "New channel" dialogue box and click "Continue".

2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue" and the "New total flow channel" dialogue box will appear.

3. From the "Available flowrate channels" list, highlight the Flowrate channel from which the channel named "Total" will receive its value. Click the "Right arrow" and the channel will appear in the "Source channel(s)" list. A maximum of five flowrate channels can be totalised together.

4. Select either "Totalise positive flow" or "Totalise negative flow" depending upon your application.



WARNING: The "Totalise positive flow" type will only increment the totaliser. If negative flows are recorded the totaliser will NOT decrement. The positive totaliser rolls over to zero.

WARNING: The "Totalise negative flow" type will only decrement the totaliser. If positive flows are recorded the totaliser will NOT increment. The negative totaliser rolls over to zero.

NOTE: Both positive and negative flow rates will be recorded in the data file.

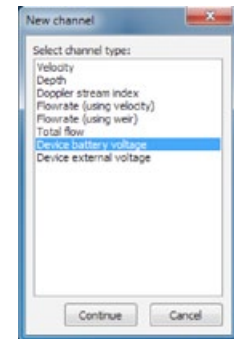
5. If the "Non-resettable" checkbox is ticked, this total flow channel will not be re-settable using the "Set/reset" procedure from the "View totals" main menu item.

6. Click "Continue" to complete the new channel and the "Configure channels" dialogue box will re-appear with the new channel listed.

16.4.6 Add a "Device battery voltage" channel type

1. Select the "Device battery voltage" channel type from the "New channel" dialogue box and click "Continue".

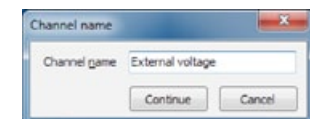
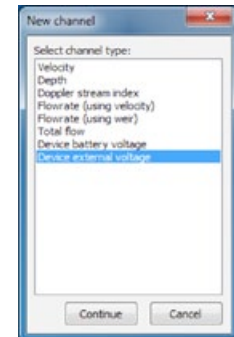
2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".



16.4.7 Add a "Device external voltage" channel type

1. Select the "Device external voltage" channel type from the "New channel" dialogue box and click "Continue".

2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".



16.5 The order and removal of channels

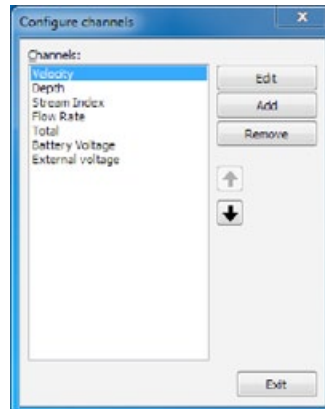
16.5.1 Ordering configured channels

The channel list after “Channels” have been added reflects the order in which they were configured and in which the XCi device takes physical measurements. This also orders the channels in both the logged data and the LCD. For example, when scrolling through the displayed channels on the LCD, the output order will be the same as the “Configure channels” dialogue box.

This order can be changed to suit the users needs.

1. Highlight the “Channel” in the list you wish to move and click either the “up” or “down” arrows (where available).

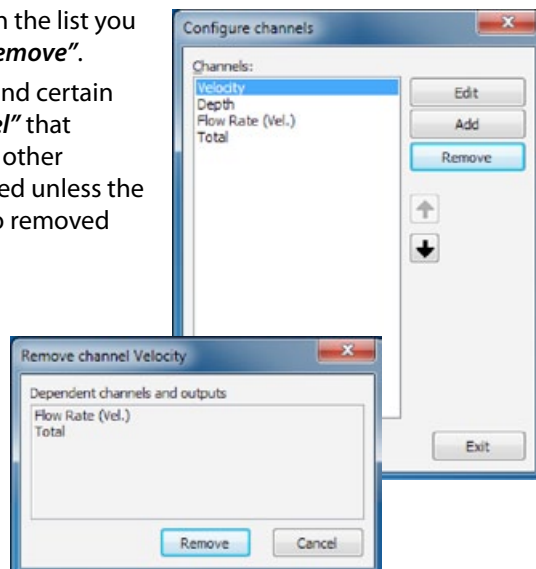
The order is hierarchical and certain limitations apply. A “Channel” that is dependent on the value of one or more channels cannot be moved higher in the list than the lowest “Channel” in which it depends upon.



16.5.2 Removing configured channels

1. Highlight the “Channel” in the list you wish to remove and click “Remove”.

The removal is hierarchical and certain limitations apply. A “Channel” that is referenced by at least one other “Channel” cannot be removed unless the dependent “Channel” is also removed first.



16.6 Edit Doppler module channel types

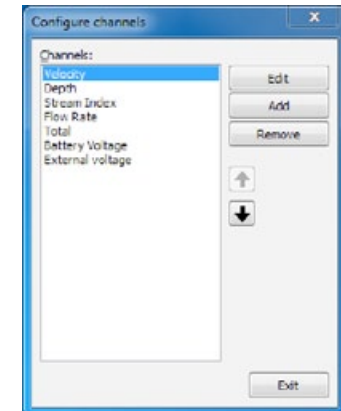


WARNING: All configured channels MUST be edited prior to starting the XCi device. Editing the channel/s enables the correct configuration information to be sent to the controller module.

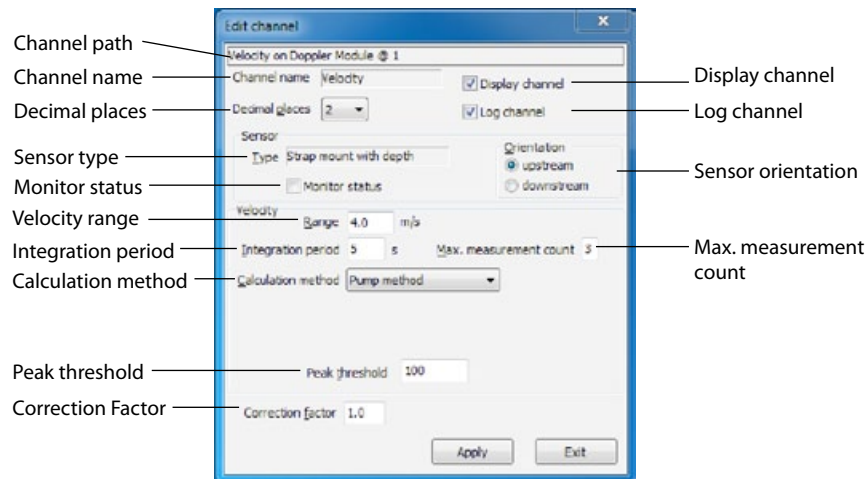
From the main “Device Settings” dialogue box click “Configure channel” and the “Configure channels” dialogue box will appear.

1. Highlight the channel you wish to edit and click “Edit”. An input specific “Edit channel” dialogue box will appear.

2. Edit the settings in the “Edit channel” dialogue box to suit your application as per the recommendations on the following pages. Click “Apply” to save the settings and return to the “Configure channels” dialogue box.



16.6.1 Edit “Velocity” channel type



Channel path

This describes the channel type and the module input source.

Channel name

This is the name given to the channel by the user when setup.



NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked.

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Sensor type

This is the Doppler velocity sensor type selected during the Doppler module configuration procedure.

Monitor status

If this check box is ticked the XCi device will monitor whether or not the sensor is correctly connected to the Doppler module.

Sensor orientation

Under usual field conditions the velocity sensor should be positioned so that the transmitted beam is faced upstream. For example, MACE recommends that the velocity sensor is positioned so that there are 6 pipe diameters of straight flow before the sensor and 2 pipe diameters of straight flow behind the sensor (*refer to Chapter 6.0 Site Selection*). In practice this may not always be possible. However, these conditions may also be met by positioning the sensor to face downstream for 6 pipe diameters. At poor signal sites, turning the sensor around may help to increase signal strengths.

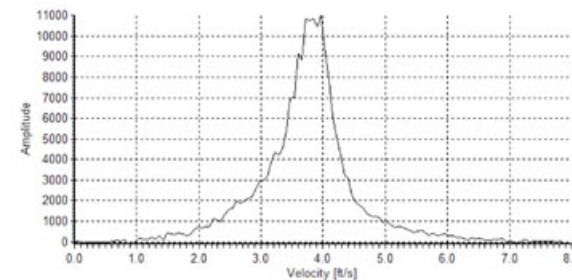
The “*Orientation*” feature allows the user to tell the processing electronics that although the velocities received are negative (when the sensor is facing downstream), you wish to totalise this flow as positive flow.



When receiving data from a sensor facing downstream, the real-time velocity graph will show a spectrum that appears upside down

Velocity range

This parameter sets the range of expected velocities that are to be analysed. MACE Doppler ultrasonic sensors “pigeon-hole” velocity readings into 128 positions over the velocity range set by the user. For example, each “hole” in a range of 0 - 4 m/s is .03125 m/s wide, whereas in a 0 - 1 m/s range each hole is .0078 m/s wide. For example, in a stream in which the user knows that the peak velocity will never exceed say, 0.6 m/s a velocity range of 1 m/s may be set. **In this way, the resolution of the final average velocity is increased.** In slow moving streams or ones that contain few acoustically reflective particles, a smaller velocity range will often result in far more repeatable data because the instrument does not waste processing power gathering data outside of expected ranges. To be safe, the velocity range should be set larger than expected and the site monitored for several weeks under different flow conditions to determine the peak expected velocity. After this period, the user may find it prudent to increase the resolution by changing the velocity range.



MACE Doppler velocity sensors calculate an average velocity by measuring the speed of particles moving through the whole stream cross-section.

16.6.1 Edit "Velocity" channel type - continued

In the real-time graph above the peak velocity (6ft/s) is typically the centre of the pipe whilst the minimum velocity (0-1ft/s) is typically found along the edges.

 **The velocity range must be set so that ALL components of the stream velocity are captured when viewed on the "real-time" graph. Failure to do so will compromise the validity of the velocity calculation.**


 **As a general rule, the velocity range should be set to double the average velocity of the stream.**

Integration period

The integration time is the period in which samples of the velocity spectrum are taken before an average velocity reading is calculated. The minimum integration time is 4 sec and the maximum integration time is 180 seconds and may be reduced automatically by the measurement interval and the maximum measurement count depending upon the instrument configuration.

The integration time may be varied for several reasons:

- Under field conditions where the flow is fluctuating dramatically, increasing the integration time will help to get a more accurate average velocity reading, because more samples are available to calculate the average .
- Under field conditions where the flow has a low number of acoustically reflective particles, increasing the integration time will help to get a more accurate average velocity reading, because more reflective targets will be sampled to calculate the average.

 **The power consumption of the system is affected by the integration time. The longer the unit is on and physically sampling, the shorter the battery life without charging.**

The XCi device internal battery has a 7.2 Ah capacity.

During an integration period each Doppler sensor will draw approximately 120 mA.

Maximum measurement count

Under certain flow or no flow conditions signal noise may disrupt the calculation of a true average velocity reading. As described the peak threshold feature is designed to overcome this problem. However, unwanted velocity readings may be derived from other sources such as aquatic life, which may give strong signal strengths.

Within all MACE Doppler ultrasonic instruments one of two flow states can occur. The stream can either be moving or stationary. For example, a sensor submerged in a river diversion pipe that is used to pump irrigation water may be full at times when no water is being pumped. Under these conditions, it is common for fish and aquatic invertebrates to inhabit the pipeline. Unfortunately, to a Doppler ultrasonic velocity sensor, a fish swimming at 500 mm/s is computed as a full pipe of water moving at 500 mm/s. This type of erroneous flow reading will result in an increase in the totalised flow. Conversely, in a slow moving stream or one that contains few acoustically reflective particles, a velocity reading may be missed if there is insufficient data to analyse. Under this circumstance, the totaliser will not be incremented.

To overcome this problem, MACE XCi devices include the maximum measurement count feature whereby if the instrument detects a state change (i.e flow has started or flow has stopped) it stays on and takes X number of readings to confirm this situation. If all X number of readings meet the criteria for a valid reading as set by, peak threshold, flow threshold, minimum stream activity and stream activity percentage, then the reading is accepted and the change of state confirmed. If the readings do not all agree that there has been a change of state, then the reading is "discarded" and the current flow state remains. That is, the unit continues to calculate zero flow or accepts the flow rate as calculated.

Furthermore, the instrument also checks that the direction of flow has not changed within the X readings. For example, if there is zero flow and the unit detects a reading of positive flow and another of negative flow then the overall reading is discarded and the unit continues to register a zero flow.

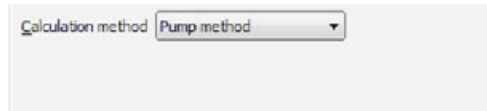
The number of readings used for the maximum measurement count is configurable by the user.

16.6.1 Edit "Velocity" channel type - continued

Calculation method

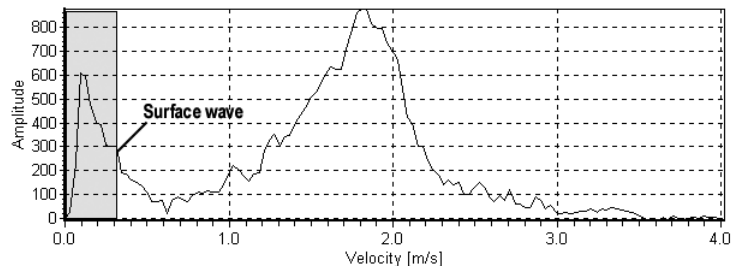
"Pump method"

Under normal conditions, water flow that is provided by a pump is turbulent and contains a vast number of acoustically reflective particles, particularly miniature air bubbles that are a result of cavitation events. In monitoring sites that are pumped, or where low signal strengths are uncommon, the pump method should be used.



"Surface wave rejection"

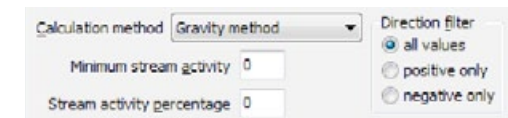
In severely turbulent, open conduit flows such as encountered in a sewerage system, it is common for standing waves to develop in the flow stream. If situated closely, these standing waves (surface waves) may confound a Doppler ultrasonic sensor because they typically result in reflections of a significantly slower velocity. In the diagram, a surface wave can be seen as a sharp peak on the real-time graph at about the 0.2 m/s mark.



In this case, if the user selects the surface wave rejection calculation method a menu item called "low-end cutoff" will be displayed. This feature enables the user to force the instrument to ignore Doppler shifts that lie between zero and the low-end cutoff. The low-end cutoff is a percentage of the range (x-axis) of the real-time graph. In the diagram the low-end cutoff would be configured to about 10% of the graph. That is, any data that are received between 0 and 0.4m/s will be ignored when computing an average stream velocity (greyed area, not represented in actual real-time graph).

"Gravity method"

This method should be used wherever a stream is slow moving and/or contains few acoustically reflective particles. Because this calculation method is designed to enhance the velocity processing of slow moving/clean streams, it may also result in erroneous velocity readings unless enabled correctly. When enabled, this method will display two new menu items.



"Minimum stream activity" - Under conditions of zero flow within a conduit (see maximum measurement count) a single aquatic life form can produce large Doppler shifts. The minimum stream activity parameter must be set to negate the effects of these aquatic life forms. This parameter should be set to low values (2-10) in sites where extremely slow average velocities are expected (< 0.2 m/s). Values greater than 10 can be set where average velocities of >0.2 m/s are expected.

"Stream activity percentage" - To be used in conjunction with the minimum stream activity parameter, this parameter forces the instrument to utilise only those velocity spectrums that have a minimum stream activity value greater than set by the user. Under good acoustic conditions typically 90 –100% of the data received by the velocity sensor will be used to calculate an average velocity. Under conditions where the data received by the velocity sensor has been caused by aquatic life, typically <10% of the data will be used. Therefore, this parameter should be set to low values (2-10) in sites where extremely slow average velocities are expected (< 0.2 m/s). Values greater than 10 can be set where average velocities of >0.2 m/s are expected.



WARNING: The user MUST check that the value entered for both "Minimum stream activity" and "Stream activity percentage" do not cause real velocity data to be ignored

16.6.1 Edit "Velocity" channel type - continued

"Direction filter" - Under certain field conditions, a stream may move in a positive direction but the prevailing winds may come from the opposite (negative) direction. The effect of this on Doppler ultrasonic processing is that a **strong negative** Doppler shift may be "seen" as well as the actual **positive** shift of the stream itself. In some cases the shift caused by the winds may overwhelm the shift from the slower moving water flow and cause erroneous flow rate readings. The **"Direction filter"** is built in to allow the user to overcome such sources of error.

"All values" - When checked, all filtering is off.

"Positive only" - When checked, all negative velocity components are filtered out.

"Negative only" - When checked, all positive velocity components are filtered out.



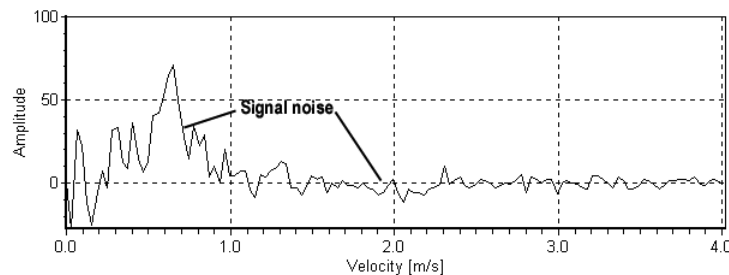
⚠ WARNING: The user MUST check that the "Direction filter" does not cause real velocity data to be ignored

Velocity peak threshold

Doppler shifts that are unrelated to the measurement of velocities in a stream are often called "signal noise". This "noise" can be a result of several different factors including:

- Electromagnetic interference;
- Reflections of signals from other echoes.

In some situations background noise may interfere with the calculation of correct average velocity readings. MACE XCi instruments feature a "noise filter" called a "peak threshold".



In the figure above signal noise can be seen on the velocity spectrum graph as low signal strength echoes. In the graph above you can see that the signal noise has an approximate amplitude value of 75. Therefore, by setting a threshold of say 100, this noise will be ignored in the computation of average velocity. The user should be careful however, at sites where signal strength is inherently lower, a peak threshold that is set too high could mean that true velocity readings are discarded.

This feature is particularly useful at sites where the sensor may be submerged for periods where no flow is occurring. For example, signal noise encountered in a submerged 1 m diameter pipeline that gives a false "average velocity" of 1 m/s will still increase a totalising counter by 785 litres per second, even though no true flow existed. By watching several real-time graphs of no flow conditions and monitoring the extent of signal noise apparent, a peak threshold may be set so that signal noise is not computed as real flow.

Correction Factor

Unfortunately, ideal hydraulic conditions cannot be achieved at every site that requires monitoring. In locations where hydraulic conditions are such that velocity calibrations at various flow regimes are required, then the **"Correction factor"** may help. Under abnormal hydraulic conditions, the average velocity of the stream must be calculated using traditional means that comply with Australian (refer to AS3778 series) or International Standards.

⚠ The velocity correction factor can be set to scale the calculated velocity result and should only be used with extreme care

It allows a single multiplication factor to be applied to the calculated velocity readings.

For example, should a **trusted** primary source of flow measurement show that the XCi device is under-reading by 5%, then the correction factor should be set to 1.05. If it is proven to be over-reading by 5% then the correction factor should be set to 0.95.

16.6.1 Edit “Velocity” channel type - continued

Recommended “Velocity” channel type settings for typical Doppler ultrasonic sensor applications

The following table is a recommended starting point for configuration of the Doppler module for typical applications. The user should ALWAYS ensure that the configuration is correct for their specific application.

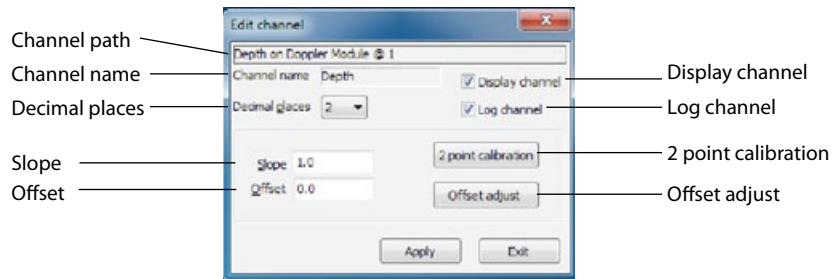
“Velocity” Channel Type Parameter	Doppler Ultrasonic Sensor Applications					
	Pumped irrigation ¹ (Full pipe)	Pumped Wastewater (Full pipe)	Gravity-fed irrigation (Full pipe)	Gravity-fed Irrigation (Partially full pipe)	Gravity-fed Wastewater (Partially full pipe)	Gravity-fed Irrigation (open channel)
Orientation	Upstream	Upstream	Upstream	Upstream	Upstream	Upstream
Velocity Range ¹	Double the Average Velocity	Double the Average Velocity	Double the Average Velocity	Double the Average Velocity	Double the Average Velocity	Double the Average Velocity
Integration Period	10 seconds	5 seconds	20 seconds	20 seconds	10 seconds	30 seconds
Calculation Method ²	Pump Method	Pump Method	Gravity Method	Gravity Method	Gravity Method	Gravity Method
Max. Measurement Count	1	1	3	3	1	3
Minimum Stream Activity ³	n/a	n/a	4	4	0	4
Stream Activity Percentage ³	n/a	n/a	5	5	0	5

1. The velocity range must be set so that ALL components of the stream velocity are captured when viewed on the “real-time” graph. Failure to do so will compromise the validity of the velocity calculation. As a general rule, the velocity range should be set to double the average velocity of the stream. To determine the average velocity the user MUST perform a “**Doppler Sensor Check**”.

2. “**Pump method**” should be used whenever a MACE Doppler ultrasonic velocity sensor is installed in either the suction or discharge pipe of a pump. Once the fluid is free flowing then the “**Gravity method**” should be used. For example, If a pump discharges into an open channel the “**Pump method**” should be used in the discharge line of the pump, whilst the “**Gravity method**” should be used in the open channel.

3. The user MUST check that the value entered for both “**Minimum stream activity**” and “**Stream activity percentage**” do not cause real velocity data to be ignored.

16.6.2 Edit “Depth” channel type



Channel path

This describes the channel type and the module input source.

Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked.

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Slope and Offset

The MACE ceramic depth sensor that is incorporated into the MACE Area/ Velocity sensor is supplied with a factory calibration tag indicating the sensor’s slope and offset values.

NOTE: The factory calibration tag includes slope/offset values for both metres (m) and inches (in). Be sure to enter the correct values for the selected depth units

Alternatively, the user should perform a 2-point calibration or calculate the slope and offset values of the sensor as described on the following pages.

2-point calibration

To correctly calibrate an environmental sensor it is important to calibrate it over its useful range. For example, if a depth sensor has a range of 0 - 2 metres but you only wish to use it to measure the range 0.0 metres to 1.25 metres, you should re-calibrate it across the reduced range.

1. Click “2-point calibration” from the “Edit channel” dialogue box and the “2 point calibration” dialogue box appears.

The “Current value” from the sensor (in this case a depth sensor with frequency output) is displayed at the top of the window and is updated approximately once per second.

2. To carry out a two point calibration, prepare the measurement set up for the first calibration point (either the sensors upper or lower range limit).

3. When the “Current value” has stabilised, click on the “Set” button in the “1st point” box. The “Current value” is copied to the “Measured value” field of the “1st point” box and the “Actual value” field is enabled.

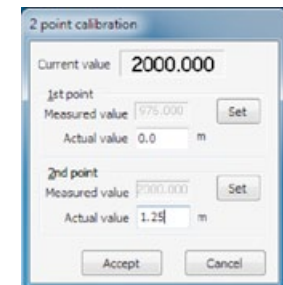
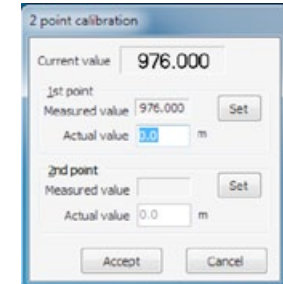
4. Enter the sensors actual value (in this case depth) in the “Actual value” field.

5. Prepare the measurement set up for the second calibration point (the opposite sensor range limit from that used in point 2 above). For example, if you used the upper range limit in point 2, now use the lower range limit.

6. When the “Current value” has stabilised, click on the “Set” button in the “2nd point” box. The “Current value” is copied to the “Measured value” field of the “2nd point” box and the “Actual value” field is enabled.

7. Enter the sensors actual value (in this case depth) in the “Actual value” field.

8. Click on the “Apply” button to calculate the new slope and offset parameter values for the associated channel. Clicking on the “Cancel” button terminates the procedure without altering the parameter values.



16.6.2 Edit "Depth" channel type - *continued*

Offset adjust

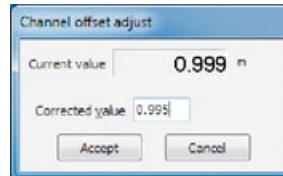
This function is used to "fine tune" the depth reading whenever the sensor is deployed or reading inaccurately. For example, the depth sensor may be sitting slightly off the bottom of the stream, or the user has deployed it above a silt line on the side of a pipe.

1. Click "**Offset adjust**" from the "**Edit channel**" dialogue box and the "**Channel offset adjust**" dialogue box appears.

The "**Current value**" from the sensor (in this case a depth sensor with frequency output) is displayed at the top of the window and is updated approximately once per second.

2. To adjust the "**Current value**", enter your current measured value in the "**Corrected value**" field.

3. Click on the "**Apply**" button to calculate the new "**Offset**" parameter value for the associated channel. Clicking on the "**Cancel**" button terminates the procedure without altering the offset value.



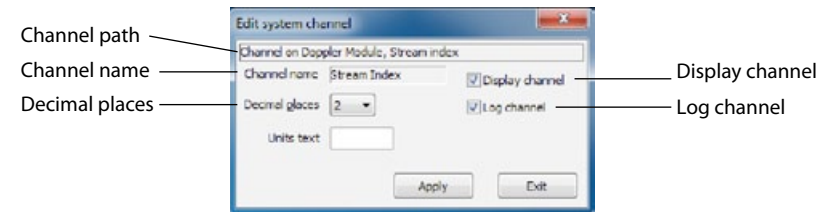
WARNING: When calibrating a depth channel, measurements should ALWAYS be carried out from the BOTTOM of the channel/pipe to the top of the water level

16.6.3 Edit "Doppler stream index" channel type

The Doppler stream index provides a simple measure of the number of acoustically reflective particles and their relative signal strengths. This index is generated for each velocity calculation. As a general rule of thumb an index value of 10 or greater is a requisite for repeatable velocity readings.



NOTE: If an index value of less than 10 is consistently observed the site may not be suitable for Doppler ultrasonic velocity measurement



Channel path

This describes the channel type and the module input source.

Channel name

This is the name given to the channel by the user when setup.



NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

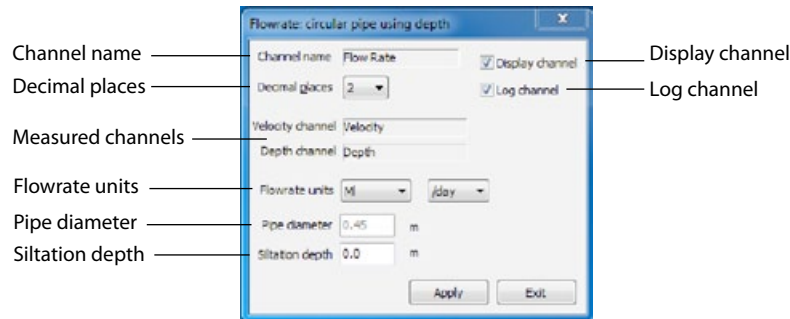
If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

16.6.4 Edit “Flowrate (Velocity)” channel type

16.6.4.1 Flowrate: circular pipe using depth or full circular pipe



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Measured channels

“Flowrate” is a derived channel type. These fields define from which measured channels flowrate is being calculated.

NOTE: In a “Flowrate: full circular pipe” dialog box only a velocity channel will be displayed

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

Pipe diameter

The “Velocity channel” source is from a MACE Doppler card. The “Pipe diameter” when configuring a “Flowrate” channel is preset when the Doppler card is added to the configuration.

If the “Flowrate” channel is configured for “Conduit using depth” then the “Pipe diameter” field will not appear.

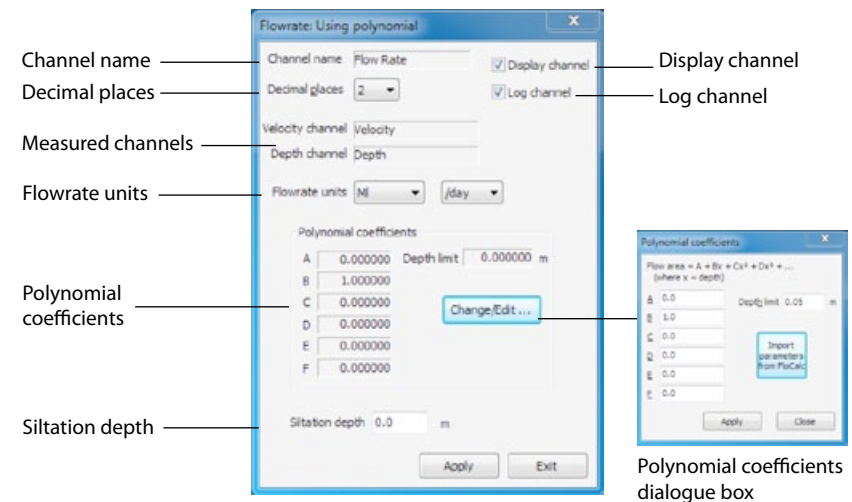
Siltation depth

This parameter can be used to correct the calculated flow rate if a known amount of silt is inside the pipe.

The depth of silt will be subtracted from the area calculation in order to calculate the corrected flow rate.

16.6.4.2 Flowrate: Using Polynomial

When the stream flow is in an open channel (non-circular), the user must determine the cross-sectional area and relate it to depth via a polynomial equation. MACE XCi devices use 5th order polynomial equations.



16.6.4 Edit “Flowrate (Velocity)” channel type - *continued*

Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Measured channels

“Flowrate” is a derived channel type. These fields define from which measured channels flowrate is being calculated.

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

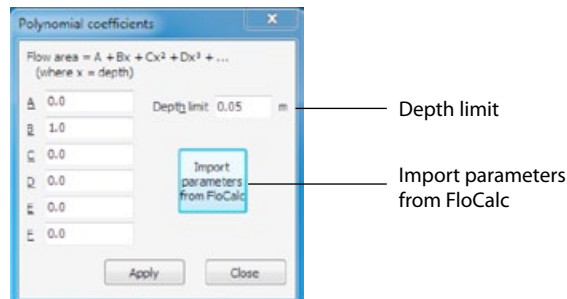
Polynomial coefficients

The polynomial coefficients listed in FloCom+ are related to the following equation:

$$\text{Cross-Sectional Area} = A + B*X + C*X^2 + D*X^3 + E*X^4 + F*X^5$$

Where X = depth of stream

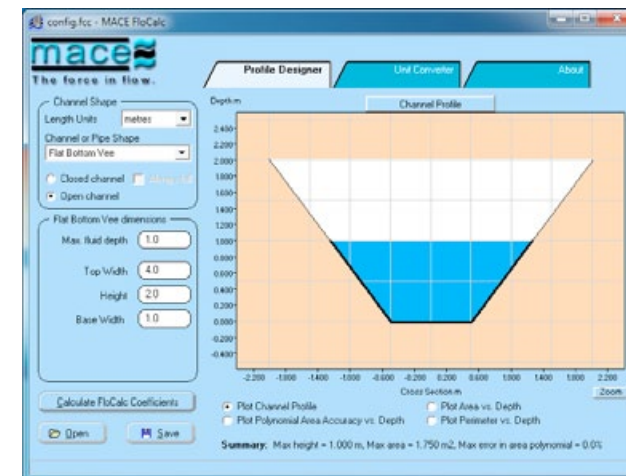
The coefficients are listed in order A, B, C, D, E, F.



Import parameters from FloCalc

The Mace utility program FloCalc (download separately from www.macemeters.com) can be used to draw regular and irregular channel shapes. These shapes are then converted into a 5th order polynomial. Their coefficients can be imported directly into the appropriate fields in FloCom+.

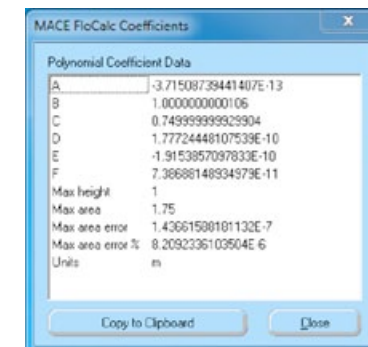
1. Click “Import parameters from FloCalc” and MACE FloCalc will open on the “Profile Designer” tab sheet.



2. Describe/draw your channel or pipe shape in FloCalc (see FloCalc Product Manual).

3. Click “Calculate FloCalc Coefficients” and the “MACE FloCalc Coefficients” dialog box will appear.

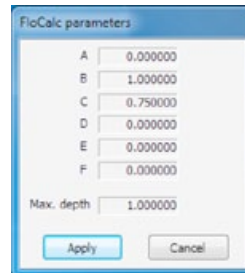
4. Click “Copy to Clipboard” then click “Close” and exit from FloCalc.



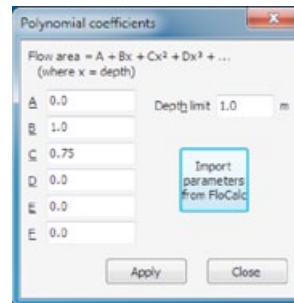
16.6.4 Edit “Flowrate (Velocity)” channel type - *continued*

5. The “*FloCalc parameters*” dialogue box will appear containing the calculated polynomial coefficients.

6. Review the coefficients and click “*Apply*” to update the “*Polynomial coefficients*” dialogue box.

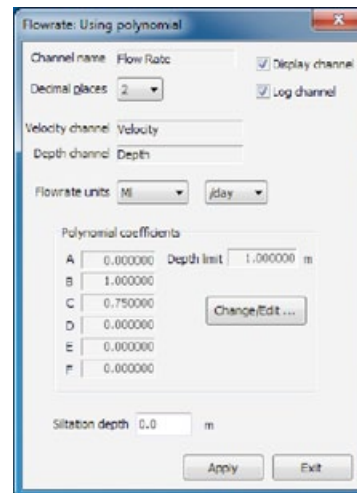


7. Click “*Apply*” and the coefficients in the “*Flowrate: Using polynomial*” dialogue box will be set.

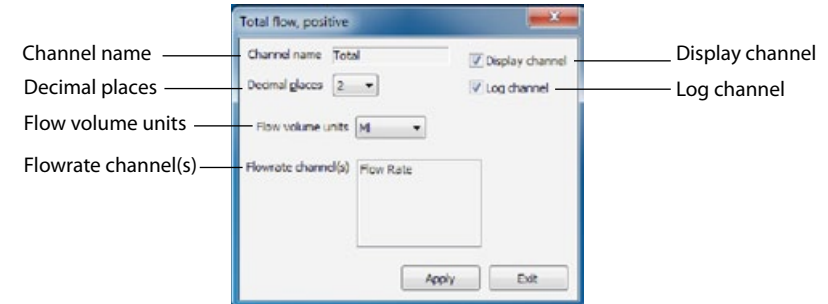


Depth limit

When the cross-sectional area of a stream is calculated using the polynomial coefficient method, the user must set the “*Depth limit*” at which the polynomial reaches a maximum. For example, if a channel has a maximum depth of 1.0m the “*Depth limit*” should be set at 1.0m as well. Alternatively the “*Depth limit*” can be set within FloCalc and the procedure described for importing polynomial coefficients.



16.6.5 Edit a “Total flow” channel type



Channel name

This is the name given to the channel by the user when setup.

⚠ NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Flow volume units

Select the units from the drop down list box. This sets the units on the logged value.

Flowrate channel

“*Total*” is a derived channel type. This field defines from which named “*Flowrate*” channel the “*Total*” is being calculated.

16.6.6 Edit a “Device battery voltage” channel type



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

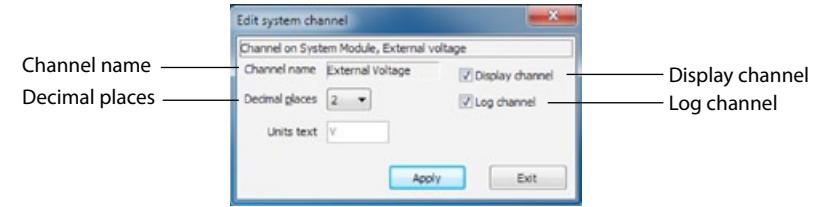
Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

16.6.7 Edit a “Device external voltage” channel type



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

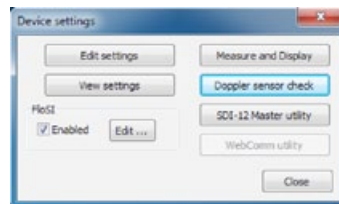
Log channel

If this check box is ticked then this channel will be logged in the data file.

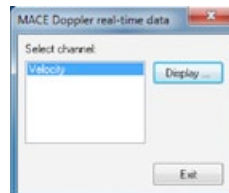
16.8 Doppler sensor check & real time data

16.8.1 Doppler sensor check

1. Click “Doppler sensor check” and the “MACE Doppler real time data” dialogue box will open.

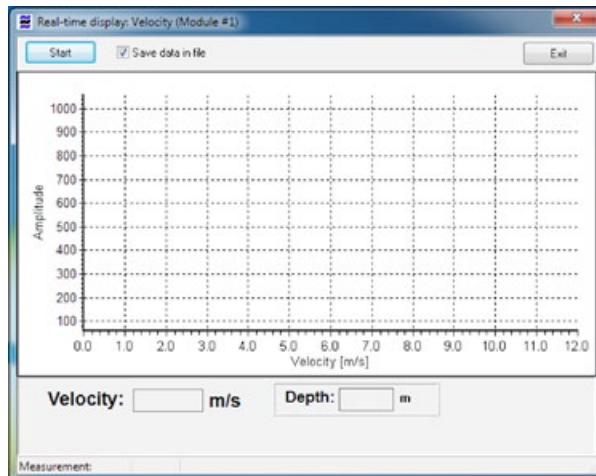


2. Highlight the channel that you wish to observe, click “Display” and the “Real time display” will open.



3. Should you wish to save Real Time graphs in a file check the “Save data to file” check box.

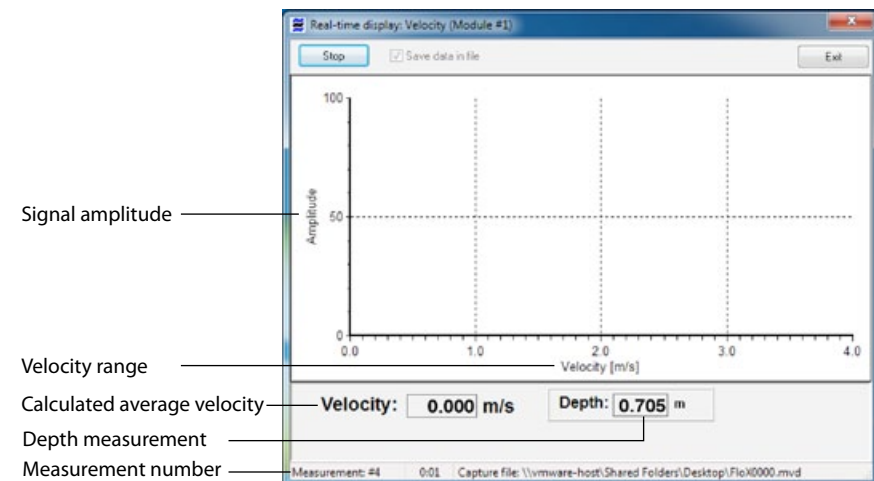
4. Click “Start” to begin measurements. If you checked “Save data to file” a Windows® “Save As” dialogue box will appear. Save the file to a location of your choice and Doppler measurements will start.



! MACE recommends that the user views/saves at least 10 real time graph measurements.

! Wherever possible, real time graphs of both non-flowing and flowing conditions should be observed. This will enable the user to adjust the various filter settings accordingly.

5. When you have viewed/saved sufficient graphs, click “Stop” to end measurements then “Exit” to return to the main menu.



Signal amplitude

Relative strength of the signal received by the Doppler card from each velocity sensed in the spectrum.

Velocity range

The range set by the user over which velocities will be sensed in the spectrum.

Calculated average velocity

The average stream velocity calculated for the current measurement.

Depth measurement

The average stream depth (if measured) calculated for the current measurement.

Measurement number

The number of real time graph measurements taken since “Start”.

! The above screen shot is an example of a real-time graph captured when the stream is NOT flowing.

16.8.2 Interpreting real-time data

MACE XCi devices measure average stream velocity using Doppler ultrasonic technology. Anything moving in the stream, which is acoustically reflective, may produce an echo and therefore a Doppler shift. Acoustically reflective particles include:

- Suspended solids;
- Bubbles, eddies and waves;
- Larger particles such as, sand, leaves and pebbles.

When selected in FloCom+, the user can display a real-time graph of the velocity spectrum received by the velocity sensor. The histogram you see in real-time data is a composite spectrum of the velocities of the stream flow as well as various other factors explained below.

- The graph is two dimensional (X-Y).
- The X-axis is the velocity (range set by user).
- The Y-axis (vertical) is the strength of the signal received by the processing electronics from each velocity sensed in the spectrum.
- Several thousand data points are plotted to give the composite graph.

MACE XCi devices measure several thousand data points and compute an average velocity. The flow is then calculated using the formula:

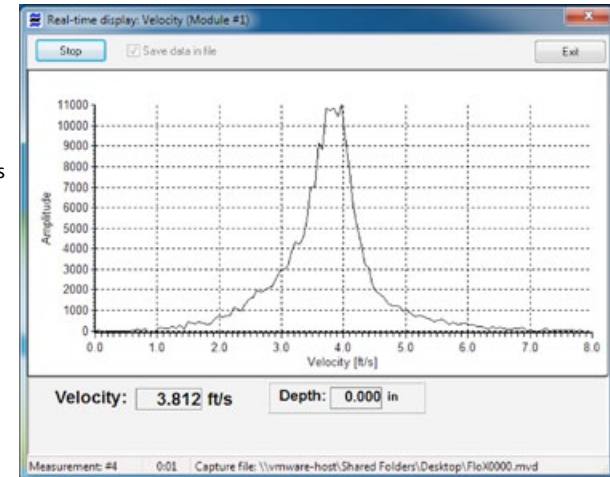
$$Q=V \times A$$

where: *Q*= Quantity, *V*= Stream velocity and *A*= Cross-sectional area.

Users of MACE XCi devices can use the real time graph to determine the correct positioning of the velocity sensor by assessing the shape of the curve and the signal strength. The following graph is an example of a spectrum that was received from a full pipe irrigation flow. Under field conditions, several factors can affect the spectrum without affecting the performance or accuracy of the velocity sensor.

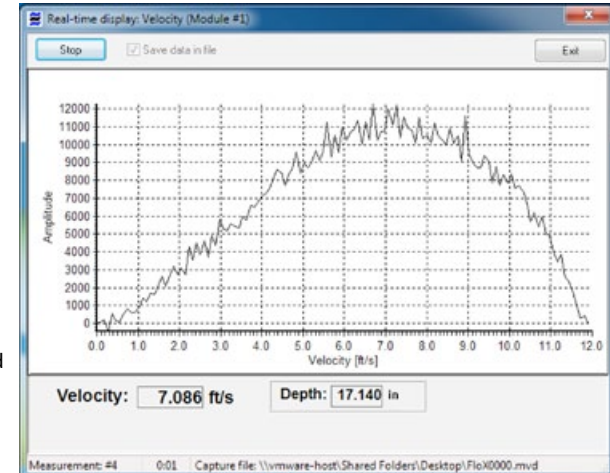
Armed with an understanding of these factors and some field experience, the operator can vary the position of the sensor and the system settings to correct site induced errors in the velocity readings.

This real-time graph displays an ideal “bell shape” centred across the velocity range. The range has been set to double the average velocity. This enables all velocities across the range to be captured.



! WARNING:

This real-time graph displays a situation where the velocity range has not been set correctly for the site conditions. Velocities exceeding the set range are not being captured. Furthermore, the velocity readings that are missed WILL cause the processing electronics to alias and the overall average velocity calculated will be unreliable. The range MUST be set to at least double the average velocity. This enables all velocities across the range to be captured.

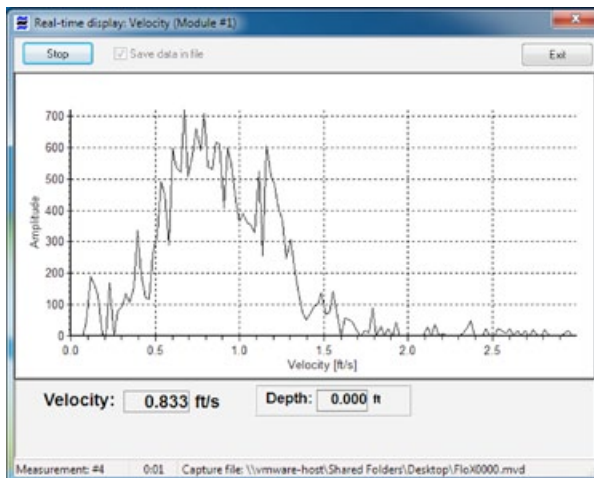


16.8.2 Interpreting real-time data - *continued*

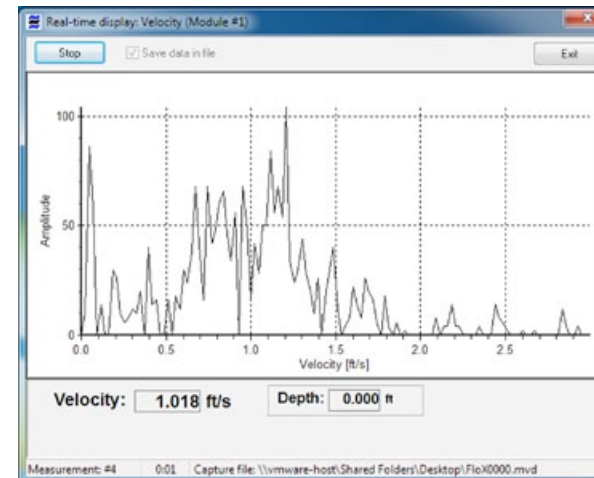
Factors affecting the velocity sensor

This chapter is designed to give the operator a brief understanding of some of the factors affecting the performance of the MACE Doppler ultrasonic velocity sensor/s.

In flowing streams, there are always a range of different velocities present, particularly in turbulent water where the effects of eddies and boundary layers can cause the velocity histogram to appear distorted in the diagram below. Although distorted, MACE XCi devices have powerful signal processing algorithms, which determine the average stream velocity from these signals.



If the operator is receiving data such as displayed in the diagram above, the sensor may be moved slightly to try to overcome the distortion. Furthermore, the operator should inspect the positioning of the sensor to ensure that there is not a build-up of debris or other matter, close to the sensor head. If no obstruction is observed and re-positioning the sensor does not improve the data, you can be assured that the sensor is operating effectively and that the displayed data is a site induced phenomenon.



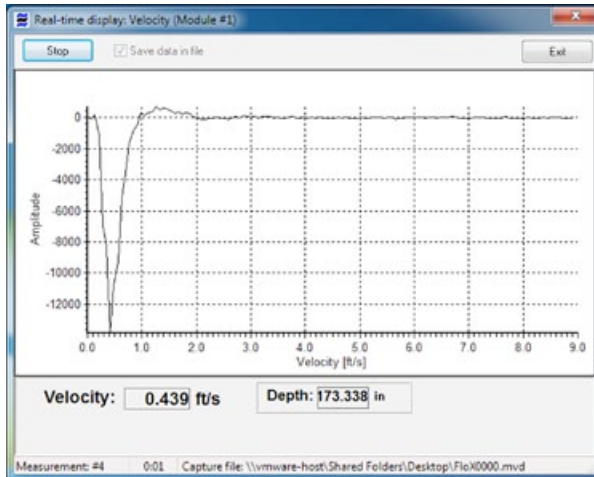
If data such as that seen above is received, the operator should ensure that the sensor is positioned correctly and monitor the site for any obstructions close to the sensor. If no obstructions are located close to the sensor, the site may be unsuitable for flow measurement with Doppler ultrasonic flow sensors.

The signal strength of received echoes on the real-time histograms, is a measure of the number of reflective particles moving in the stream. Therefore, low signal strengths do not necessarily equate to poor velocity readings. Relatively few particles may provide enough echoes for an accurate average velocity reading. Furthermore, a histogram with a broad base will generally tend to have a peak with a lower signal strength. In sites where it is suspected that there are relatively few reflective particles in the flow, the period in which the XCi devices takes readings may require extending (see, Integration Period).

16.8.2 Interpreting real-time data - *continued*

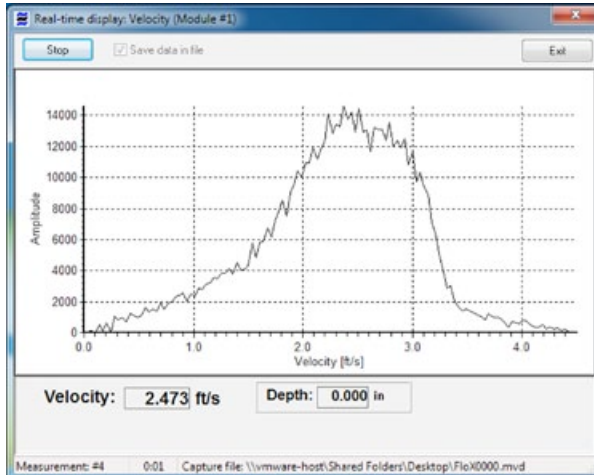
This real-time graph displays velocities captured by a sensor facing downstream.

Although the amplitude of the graph is negative the calculated average velocity is positive because the "Sensor orientation" has been set to "Downstream" in the Doppler module configuration.



This real-time graph displays velocities captured by a sensor at a wastewater pump site.

Pumped flows typically exhibit graphs with a broader base than gravity flows.



A general rule of thumb, if a spectrum has low signal strength but gives a consistent velocity reading, then the measurements should be accurate. However, if the spectrum has low signal strength and gives inconsistent velocity readings or none at all, the site may be unsuitable for flow measurement with Doppler ultrasonic flow sensors.

Very distorted signals such as that described in the diagram on the previous page may result from interference to the velocity sensor by the build-up of debris or siltation.

In sites where there is an expectation of sedimentation, the velocity sensor should be mounted in a raised position. In a full-pipe application, it is recommended that the sensor be mounted (or inserted) on the side of the pipe to avoid sedimentation.

Similarly, in partially full pipes, the sensor may be offset from the invert of the pipe. In these instances, the depth reading will need to be offset accordingly.

Covering the sensors with algae and other materials that are saturated generally does not affect the accuracy of velocity readings. This is because saturated materials exhibit the same speed of sound as water.

MACE XCi devices include several signal processing features specifically designed to overcome anomalous data produced by such phenomena as: aquatic life (fish, weeds, small invertebrates); surface waves (produced by turbulence and wind); and background noise.






It should always be remembered when examining real-time graphical data, that settings within the unit itself can have a marked effect on the data displayed. The configuration of the instrument should always be checked thoroughly before viewing real-time data.

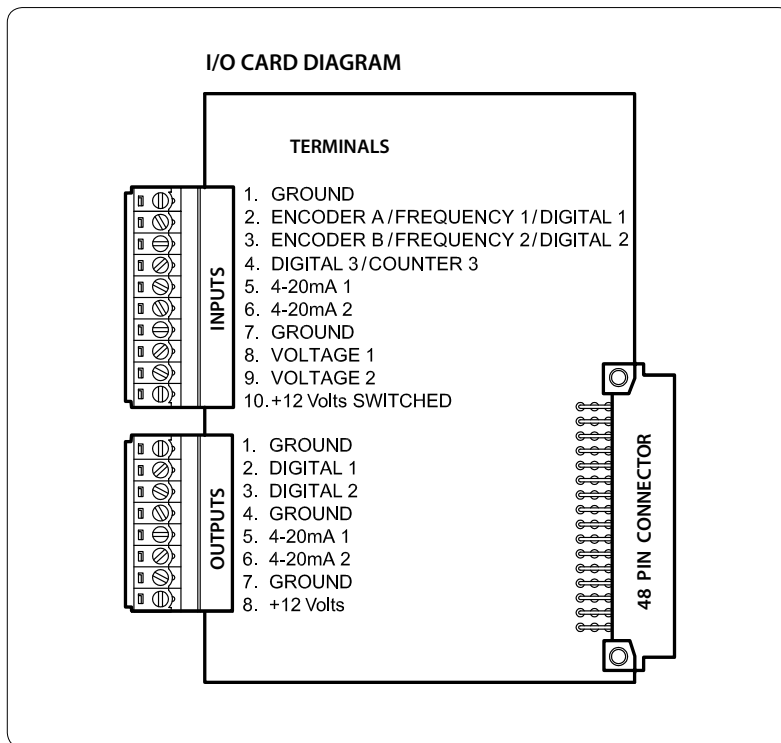
17.0 The I/O card

17.1 About the I/O card

The I/O card provides the inputs for connecting environmental monitoring sensors and outputs for connection to ancillary devices.

The input and output terminals available on each I/O card are shown in the diagram below.

-  **MACE recommends the user studies the relevant documentation supplied with each third party sensor prior to connection**
-  **WARNING: The maximum system current available for powering sensors attached to ALL I/O cards is 1.25 Amps at 12VDC**
-  **WARNING: The maximum input voltage on any terminal is 30VDC**



-  **Should insufficient I/O be available on a single I/O card another card (Part No. 850-329) should be purchased.**

Once a sensor has been wired to the I/O card it must be configured using FloCom+ software so that the XCi device can control and record data from the sensor.

Essential Steps to configure your I/O card using FloCom+ software:

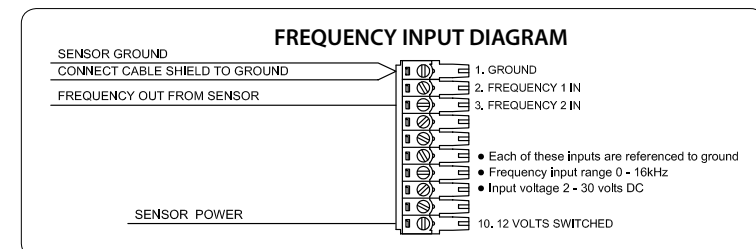
1. Add Modules
2. Edit Modules
3. Add Channels
4. Edit Channels
5. Add Outputs (where required)
6. Edit Outputs (where required)
7. Apply Settings
8. Run "Measure and Display" function

17.2 Wiring digital inputs

17.2.1 Frequency Input

Each I/O card provides up to two frequency inputs for connecting devices such as ultrasonic depth sensors and/or flow meters. The frequency input terminals available on each I/O card are shown in the diagram below.

-  **NOTE: If a frequency input is wired a shaft encoder input is not available**

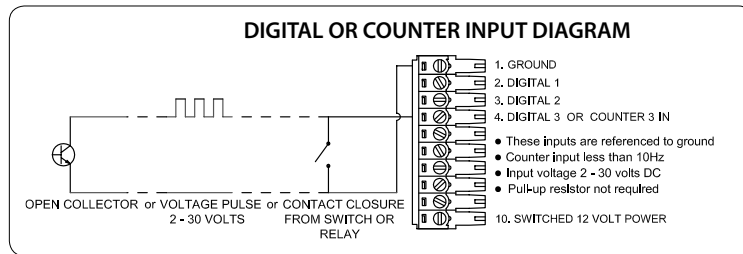


17.2 Wiring digital inputs - Continued

17.2.2 Digital or Counter Input

Each I/O card provides up to three digital inputs or one counter input for connecting devices such as rainfall gauges, hours run meters and/or counting pulses. The digital/counter input terminals available on each I/O card are shown in the diagram below.

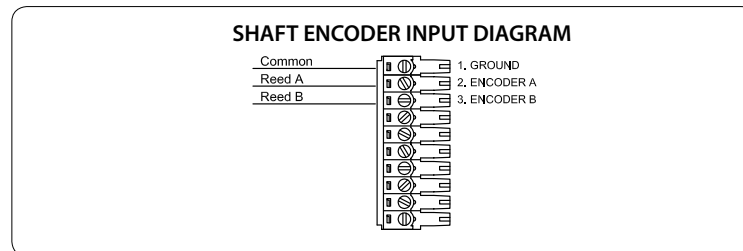
NOTE: If a shaft encoder input is wired only a single digital/counter input is available



17.2.3 Shaft Encoder Input

Each I/O card provides one input for connecting a shaft encoder. The shaft encoder input terminals available on each I/O card are shown in the diagram.

NOTE: If a shaft encoder input is wired only a single digital/counter input is available. NO frequency input is available



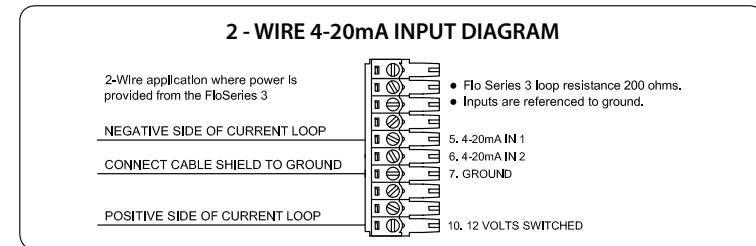
Should the field application require a shaft encoder and a frequency input another I/O card (Part No. 850-329) should be purchased

17.3 Wiring analogue inputs

NOTE: 12 VDC sensor power is available on terminal 10 of the input terminal strip. This is a switched power supply and the warm up time for sensors that require power is configurable using FloCom+ software. FloCom+ is available for download from www.macemeters.com

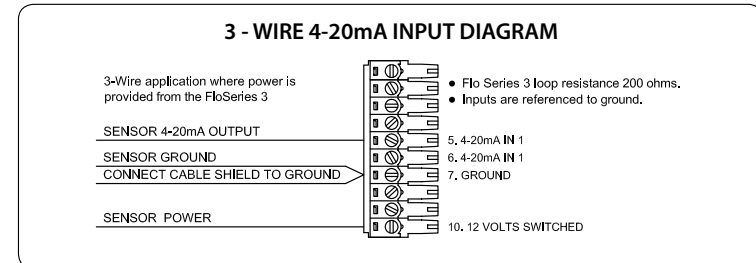
17.3.1 Two - Wire 4-20mA Input

Each I/O card provides up to two 4-20mA inputs for connecting devices such as ultrasonic depth sensors and/or flow meters. The 4-20mA input terminals available on each I/O card are shown in the diagram below.



17.3.2 Three - Wire 4-20mA Input

Each I/O card provides up to two 4-20mA inputs for connecting devices such as ultrasonic depth sensors and/or flow meters. The 4-20mA input terminals available on each I/O card are shown in the diagram below.



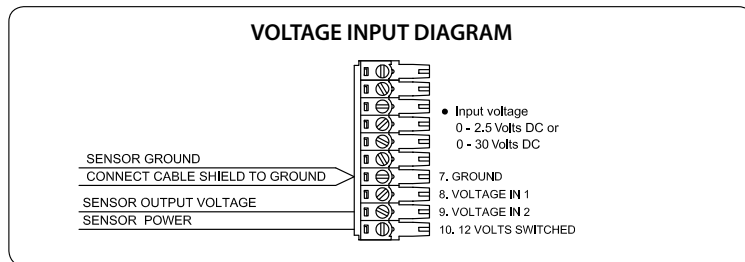
17.3 Wiring analogue inputs - *Continued*

17.3.3 Voltage Input

Each I/O card provides up to two voltage inputs for connecting devices such as ultrasonic depth sensors, conductivity probes and/or temperature sensors. The voltage input terminals available on each I/O card are shown in the diagram below.



NOTE: The input voltage range can be either 0 - 2.5 VDC or 0 - 30 VDC



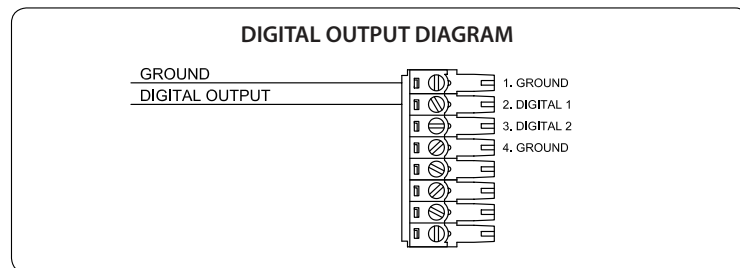
17.4 Wiring digital outputs

Digital Output

Each I/O card provides up to two digital outputs for sending pulses to devices such as water samplers and/or data loggers. The digital output terminals available on each I/O card are shown in the diagram below.



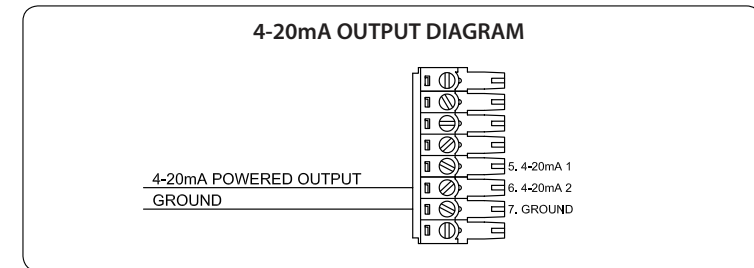
NOTE: The pulse output consists of a 50 millisecond pulse with a 50 millisecond space between pulses



17.5 Wiring analogue outputs

4-20mA Output:

Each I/O card provides up to two 4-20mA outputs for sending signals to devices such as SCADA systems and/or PLC's. The 4-20mA output terminals available on each I/O card are shown in the diagram below.

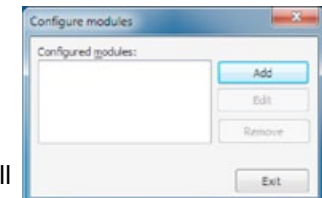


17.6 Add and configure an I/O module in FloCom⁺

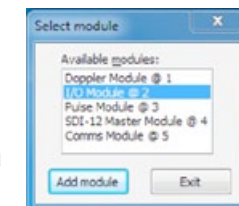


NOTE: Once a FloSeries3 card is installed in an XCi device, FloCom⁺ defines this as a module.

1. From the main "Device settings" dialogue box click "Configure modules" and a dialogue box will appear as shown.



2. Click "Add" and the available modules will be listed in the "Select module" dialogue box.

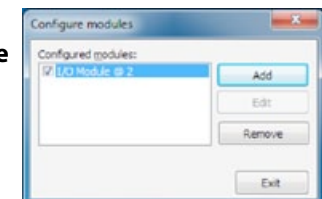


3. Each MACE module available is referenced in the list by its type and slot number. (eg. I/O module in card slot 2). Highlight the module you wish to add and click "Add module".



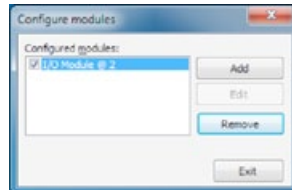
NOTE: Once a module has been added it will no longer appear on the available modules list

The "Configure modules" dialogue box will appear with a listing of the configured modules.

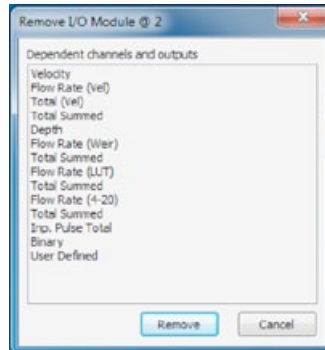


17.7 Remove an I/O module in FloCom+

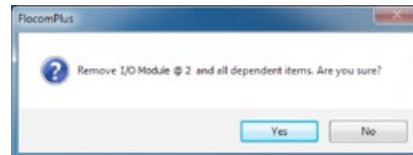
1. From the “*Configure modules*” dialogue box highlight the module that you wish to remove. Click “*Remove*” and a dialogue box will appear listing the “*Dependent channels and outputs*”.



2. Click “*Remove*” and you will be prompted to confirm your action.



3. Click “*Yes*” and the module and dependent channels will be removed.

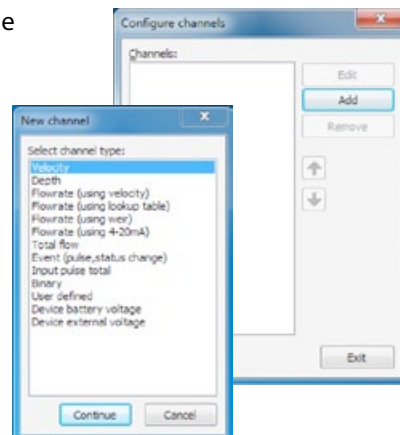


17.8 Add I/O module channel types

From the main “*Device Settings*” dialogue box click “*Configure channels*” and the “*Configure channels*” dialogue box will appear.

1. Click “*Add*” and the “*New channel*” dialogue box will appear as shown.

The “*Channel types*” visible in the “*New channel*” dialogue box are dependent upon the modules that have been configured.



WARNING: Adding a new channel creates a new data session. It is essential to download the data from the XCi device PRIOR to adding new channels to an XCi device that has already been configured and has had data recorded.

I/O module channel types

Channel types	Description
Velocity:	This channel type MUST be used whenever the resultant velocity measurement will be used in a flow rate calculation.
Depth:	This channel type MUST also be used whenever the resultant depth measurement will be used in a flow rate calculation.
Flowrate: (using velocity)	Used to calculate a flow rate based upon the results obtained from configured velocity and depth channels.
Flowrate: (using lookup table)	Used to calculate a flow rate based upon user configured lookup table of a rated structure.
Flowrate: (using weir)	Used to calculate a flow rate based upon a depth channel and a selected weir type.
Flowrate: (using 4-20mA)	Used to calculate a flow rate based upon a 4-20mA proportional current.
Total Flow:	Used to calculate an accumulated positive or negative total based on the results obtained from a configured flow rate channel.
Event: (pulse, status change)	Used to record time stamp data based on pulse or status change events.
Input pulse total:	Used to totalise pulses such as totalising flow meters and rain gauges.
Binary:	Used to monitor switch closure events such as pump on/off status and/or rainfall gauges.
User Defined:	Can be used when a 3rd party sensor with digital/analogue output is to be configured. It should NOT be used for velocity or depth sensors where the results are required for a flow rate calculation.
Device battery voltage	Used to monitor the XCi device internal battery voltage.
Device external voltage	Used to monitor the XCi device external voltage from a solar panel or mains charger.

17.8.1 Add a "Velocity" channel type

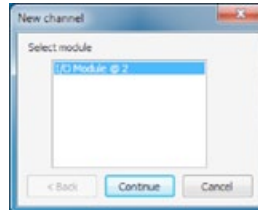
1. Select the "Velocity" channel type from the "New channel" dialogue box and click "Continue".



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".



3. In the "New channel" dialogue box highlight the "I/O Module" option from which the named channel will receive its value. Click "Continue" and a new dialogue box will appear with the available input types listed.

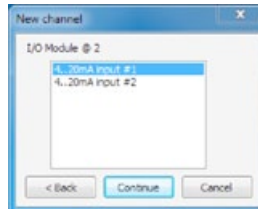


NOTE: As a particular module's input becomes fully utilised the module will not appear on the "Select module" list.

4. Select the sensor's physical wired input type from the "I/O Module @ 2" list. Click "Continue" and then select the appropriate input from which the named channel will receive its value.



5. In this example the channel named "Velocity" will be calculated using a sensor wired to "I/O Module @ 2" on "4..20mA input #1". Click "Continue" to complete the new channel. The "Configure channels" dialogue box will re-appear with the new channel listed.

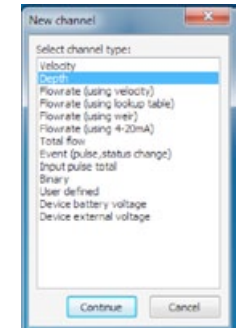


NOTE: As a particular module's inputs are utilised the input will not appear on the "I/O module" list. In the example above, the "4..20mA input #1" will no longer be available.

17.8.2 Add a "Depth" channel type (Incl. MACE EchoFlo)

NOTE: For further instruction on configuration of EchoFlo sensors refer to the EchoFlo Quick Start Guide

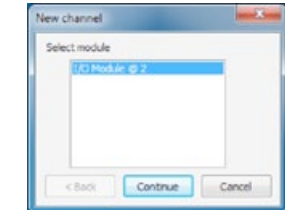
1. Select the "Depth" channel type from the "New channel" dialogue box and click "Continue".



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".



3. In the "New channel" dialogue box highlight the "I/O Module" option from which the named channel will receive its value. Click "Continue" and a new dialogue box will appear with the available input types listed.

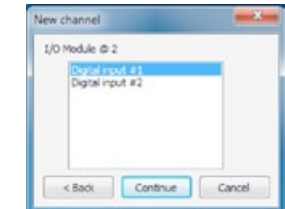


NOTE: As a particular module's input becomes fully utilised the module will not appear on the "Select module" list.

4. Select the sensor's physical wired input type from the "I/O Module @ 2" list. Click "Continue" and then select the appropriate input from which the named channel will receive its value.



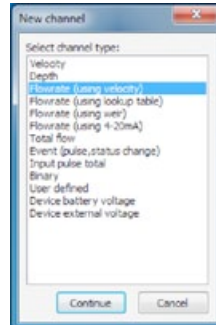
5. In this example the channel named "Depth" will be calculated using a sensor wired to "I/O Module @ 2" on "Digital input #1". Click "Continue" to complete the new channel. The "Configure channels" dialogue box will re-appear with the new channel listed.



NOTE: As a particular module's inputs are utilised the input will not appear on the "I/O module" list. In the example above, the "Digital input #1" will no longer be available.

17.8.3 Add a “Flowrate (using velocity)” channel type

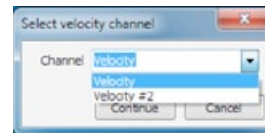
1. Select the “*Flowrate (using velocity)*” channel type from the “*New channel*” dialogue box and click “*Continue*”.



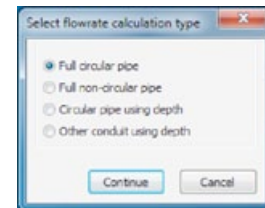
2. The “*Channel name*” dialogue box will appear. Enter a channel “*Name*” in to the text field (16 character maximum). This “*name*” will also be displayed on the XCi device main LCD if enabled. Click “*Continue*”.



3. In the “*Select velocity channel*” dialogue box use the drop down list to highlight the velocity channel on the I/O card from which the named “*Flow Rate I/O*” channel will receive its value. Click “*Continue*” and the “*Select flowrate calculation type*” dialogue box will appear.



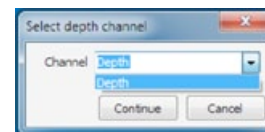
4. Select either “*Full circular pipe*”, “*Full non-circular pipe*”, “*Circular pipe using depth*” or “*Other conduit using depth*” depending upon your application.



5. If you select a “*Full...*” pipe type, click “*Continue*” to complete the new channel.

If you select a “*Circular pipe using depth*” or “*Other conduit using depth*”, click “*Continue*” and the “*Select depth channel*” dialogue box will appear.

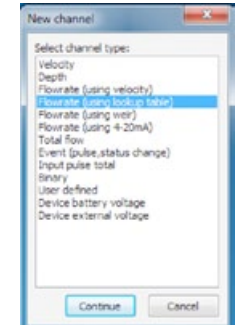
6. In the “*Select depth channel*” dialogue box use the drop down list to highlight the named “*Depth...*” channel from which the named “*Flow Rate (Vel)*” channel will receive its value. Click “*Continue*” to complete the new channel.



7. The “*Configure channels*” dialogue box will re-appear with the new channel listed.

17.8.4 Add a “Flowrate (using lookup table)” channel type

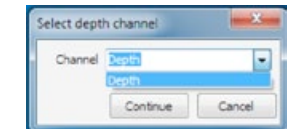
1. Select the “*Flowrate (using lookup table)*” channel type from the “*New channel*” dialogue box and click “*Continue*”.



2. The “*Channel name*” dialogue box will appear. Enter a channel “*Name*” in to the text field (16 character maximum). This “*name*” will also be displayed on the XCi device main LCD if enabled. Click “*Continue*”.



3. In the “*Select depth channel*” dialogue box use the drop down list to highlight the depth channel on the I/O card from which the named “*Flow Rate (LUT)*” channel will receive its value.



4. Click “*Continue*” and the “*Configure channels*” dialogue box will re-appear with the new channel listed.

17.8.5 Add a “Flowrate (using weir)” channel type

The XCi device’s contain in-built equations for allowing users to measure flow rate through rated structures such as flumes and weirs. The table below lists the structures supported and the equations used to calculate flow rate.

All of the weir equations assume that the flow is fully contracted, meaning that the approach channel is wide enough and deep enough that the proximity of the floor and sidewalls to the weir opening does not affect the flow (Tony L. Wahl, Bureau of Reclamation Hydraulics Laboratory in Denver, Colorado, USA).

The equations used by the XCi device’s and reproduced here are used with permission of U.S. Dept. of the Interior, Bureau of Reclamation - Hydraulic Investigations and Laboratory Services Group. For further information users are encouraged to visit the following websites:

www.usbr.gov/pmts/hydraulics_lab/pubs/wmm/index.htm
www2.alterra.wur.nl/Internet/webdocs/ilri-publicaties/publicaties/Pub20/pub20.pdf

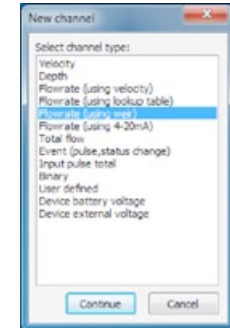
Flume and Weir Equation Summary

	Equation, cfs (head measured in feet)	Equation, kL/sec (m ³ /sec) ~ head measured in meters
Contracted rectangular weir	$Q=3.33(L-0.2h_1)h_1^{1.5}$	$Q=1.84(L-0.2h_1)h_1^{1.5}$
Suppressed rectangular weir	$Q=3.33(L)h_1^{1.5}$	$Q=1.84(L)h_1^{1.5}$
V-notch weir, 90°	$Q=2.49h_1^{2.48}$	$Q=1.34h_1^{2.48}$
V-notch weir, 30°	$Q=(8/15)(2g)^{0.5}C_e \tan(\theta/2)(h_1+k_n)2.5$	$Q=(8/15)(2g)^{0.5}C_e \tan(\theta/2)(h_1+k_n)2.5$
V-notch weir, 45°	$Q=(8/15)(2g)^{0.5}C_e \tan(\theta/2)(h_1+k_n)2.5$	$Q=(8/15)(2g)^{0.5}C_e \tan(\theta/2)(h_1+k_n)2.5$
V-notch weir, 60°	$Q=(8/15)(2g)^{0.5}C_e \tan(\theta/2)(h_1+k_n)2.5$	$Q=(8/15)(2g)^{0.5}C_e \tan(\theta/2)(h_1+k_n)2.5$
Cipoletti weir	$Q=3.367(L)h_1^{1.5}$	$Q=1.86(L)h_1^{1.5}$
Parshall flumes	$Q=Ch_1^n$	$Q=Ch_1^n$
Replogle flumes (long-throated flumes or “ramp” flumes)	$Q = K_1(h_1+K_2)^U$	$Q = K_1(h_1+K_2)^U$
Palmer-Bowlus flumes	$Q = K_1(h_1+K_2)^U$	$Q = K_1(h_1+K_2)^U$

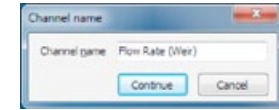
<p>Definitions, cfs Q = discharge, cfs L = weir width, ft h₁ = upstream head, ft C_e = V-notch weir coefficient k_n = V-notch weir head adjustment factor, ft θ = V-notch weir angle, degrees h_s = Parshall flume upstream head, ft C = Parshall flume coefficient n = Parshall flume exponent g = acceleration due to gravity, 32.2 ft/s²</p>	<p>Definitions, kL/sec Q = discharge, kL/sec L = weir width, m h₁ = upstream head, m C_e = V-notch weir coefficient k_n = V-notch weir head adjustment factor, m θ = V-notch weir angle, degrees h_s = Parshall flume upstream head, m C = Parshall flume coefficient n = Parshall flume exponent g = acceleration due to gravity, 9.806 m/s²</p>
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The V-notch weir and Parshall flume coefficients used by an XCi device can be found in Appendix A

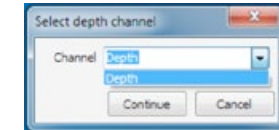
1. Select the “Flowrate (using weir)” channel type from the “New channel” dialogue box and click “Continue”.



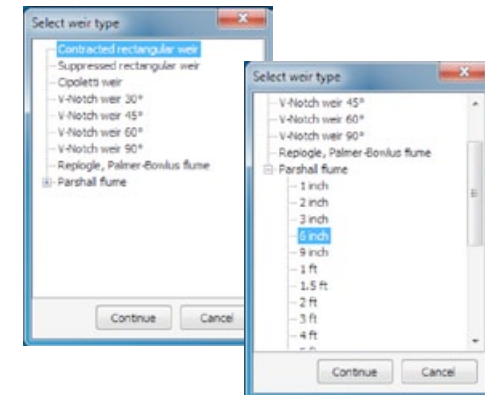
2. The “Channel name” dialogue box will appear. Enter a channel “Name” in to the text field (16 character maximum). This “name” will also be displayed on the XCi device main LCD if enabled. Click “Continue”.



3. In the “Select depth channel” dialogue box use the drop down list to highlight the depth channel from which the channel (named “Flow Rate (Weir)” in this example) will receive its value. Click “Continue” and the “Select weir type” dialogue box will appear.



4. Select the weir type that you wish to configure. If you are setting up a flow rate through a Parshall flume, expand the “Parshall flume” weir type and select the appropriate flume width from the expanded list.

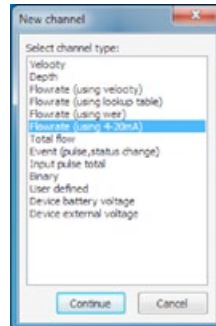


5. Click “Continue” to complete the new channel.

6. The “Configure channels” dialogue box will re-appear with the new channel listed.

17.8.6 Add a “Flowrate (using 4-20mA)” channel type

1. Select the “*Flowrate (using 4-20mA)*” channel type from the “*New channel*” dialogue box and click “*Continue*”.



2. The “*Channel name*” dialogue box will appear. Enter a channel “*Name*” in to the text field (16 character maximum). This “*name*” will also be displayed on the XCi device main LCD if enabled. Click “*Continue*”.

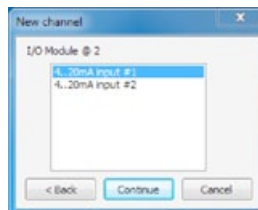


3. In the “*New channel*” dialogue box highlight the “*I/O Module*” option from which the named channel will receive its value. Click “*Continue*” and then select the appropriate input from which the named channel will receive its value.



NOTE: As a particular module’s input becomes fully utilised the module will not appear on the “*Select module*” list.

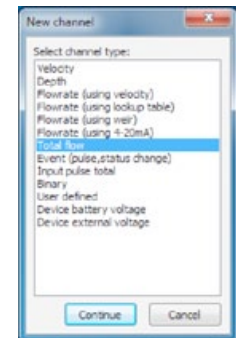
4. In this example the channel named “*Flow Rate (4-20)*” will be calculated using a sensor wired to “*I/O Module @ 2*” on “*4..20mA input #1*”. Click “*Continue*” to complete the new channel. The “*Configure channels*” dialogue box will re-appear with the new channel listed.



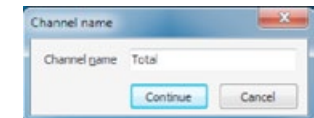
NOTE: As a particular module’s inputs are utilised the input will not appear on the “*I/O module*” list. In the example above, the “*4..20mA input #1*” will no longer be available.

17.8.7 Add a “Total flow” channel type

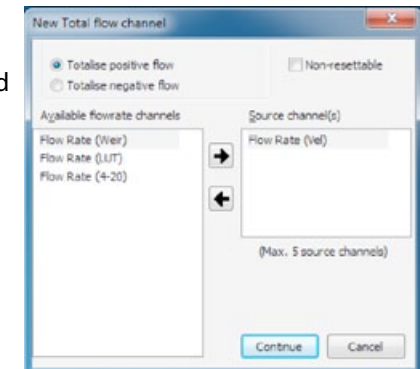
1. Select the “*Total flow*” channel type from the “*New channel*” dialogue box and click “*Continue*”.



2. The “*Channel name*” dialogue box will appear. Enter a channel “*Name*” in to the text field (16 character maximum). This “*name*” will also be displayed on the XCi device main LCD if enabled. Click “*Continue*” and the “*New total flow channel*” dialogue box will appear.



3. From the “*Available flowrate channels*” list, highlight the Flowrate channel from which the channel named “*Total*” will receive its value. Click the “*Right arrow*” and the channel will appear in the “*Source channel(s)*” list. A maximum of five flowrate channels can be totalised together.



4. Select either “*Totalise positive flow*” or “*Totalise negative flow*” depending upon your application.

WARNING: The “*Totalise positive flow*” type will only increment the totaliser. If negative flows are recorded the totaliser will NOT decrement. The positive totaliser rolls over to zero.

WARNING: The “*Totalise negative flow*” type will only decrement the totaliser. If positive flows are recorded the totaliser will NOT increment. The negative totaliser rolls over to zero.

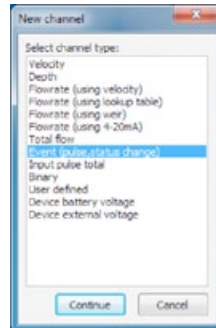
WARNING: Both positive and negative flow rates will be recorded in the data file.

5. If the “*Non-resettable*” checkbox is ticked, this total flow channel will not be re-settable using the “*Set/reset*” procedure from the “*View totals*” main menu item.

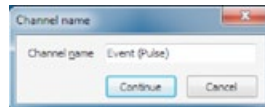
6. Click “*Continue*” to complete the new channel and the “*Configure channels*” dialogue box will re-appear with the new channel listed.

17.8.8 Add a “Event (pulse)” channel type

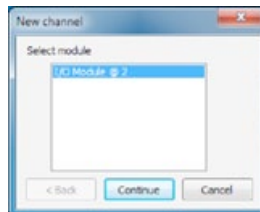
1. Select the “Event” channel type from the “New channel” dialogue box and click “Continue”.



2. The “Channel name” dialogue box will appear. Enter a channel “Name” in to the text field (16 character maximum). This “name” will also be displayed on the XCi device main LCD if enabled. Click “Continue”.

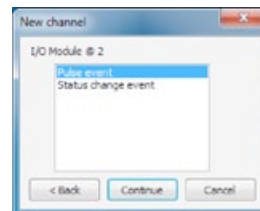


3. In the “New channel” dialogue box highlight the “I/O Module” option from which the named channel will receive its value. Click “Continue” and a new dialogue box will appear with the available input types listed.

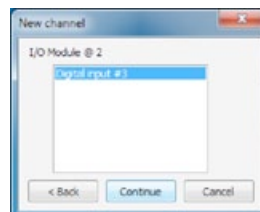


NOTE: As a particular module’s input becomes fully utilised the module will not appear on the “Select module” list.

4. Select the “Pulse event” type from the “I/O Module @ 2” list.



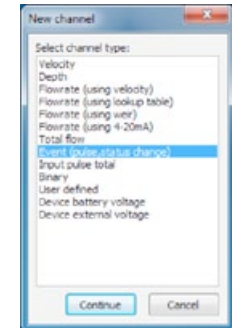
5. In this example the channel named “Event (Pulse)” will be calculated using “I/O Module @ 2” on “Digital input #3”. Click “Continue” to complete the new channel. The “Configure channels” dialogue box will re-appear with the new channel listed.



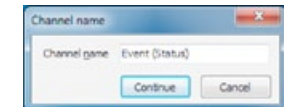
NOTE: As a particular module’s inputs are utilised the input will not appear on the “I/O module” list. In the example above, the “Digital input #3” will no longer be available.

17.8.9 Add a “Event (status change)” channel type

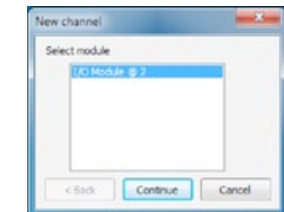
1. Select the “Event” channel type from the “New channel” dialogue box and click “Continue”.



2. The “Channel name” dialogue box will appear. Enter a channel “Name” in to the text field (16 character maximum). This “name” will also be displayed on the XCi device main LCD if enabled. Click “Continue”.

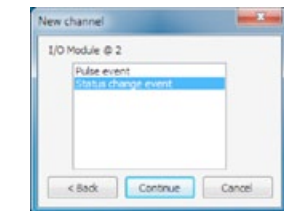


3. In the “New channel” dialogue box highlight the “I/O Module” option from which the named channel will receive its value. Click “Continue” and a new dialogue box will appear with the available input types listed.

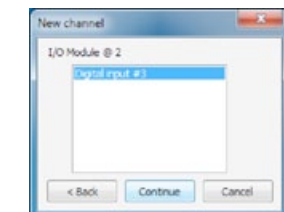


NOTE: As a particular module’s input becomes fully utilised the module will not appear on the “Select module” list.

4. Select the “Pulse event” type from the “I/O Module @ 2” list.



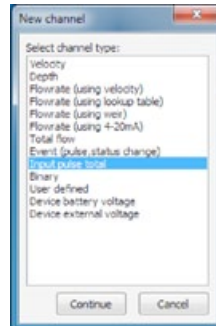
5. In this example the channel named “Event (Status)” will be calculated using “I/O Module @ 2” on “Digital input #3”. Click “Continue” to complete the new channel. The “Configure channels” dialogue box will re-appear with the new channel listed.



NOTE: As a particular module’s inputs are utilised the input will not appear on the “I/O module” list. In the example above, the “Digital input #3” will no longer be available.

17.8.10 Add an "Input pulse total" channel type

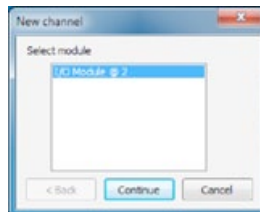
1. Select the "Input pulse total" channel type from the "New channel" dialogue box and click "Continue".



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".

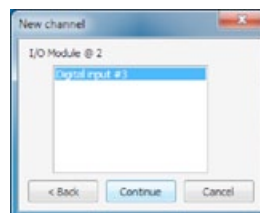


3. In the "New channel" dialogue box highlight the "I/O Module" option from which the named channel will receive its value. Click "Continue" and a new dialogue box will appear with the available input types listed.



NOTE: As a particular module's input becomes fully utilised the module will not appear on the "Select module" list.

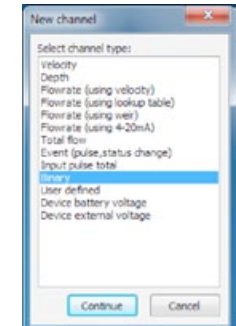
4. In this example the channel named "Inp. Pulse Total" will be calculated using "I/O Module @ 2" on "Digital input #3". Click "Continue" to complete the new channel. The "Configure channels" dialogue box will re-appear with the new channel listed.



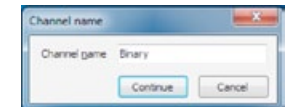
NOTE: As a particular module's inputs are utilised the input will not appear on the "I/O module" list. In the example above, the "Digital input #3" will no longer be available.

17.8.11 Add a "Binary" channel type

1. Select the "Binary" channel type from the "New channel" dialogue box and click "Continue".



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".

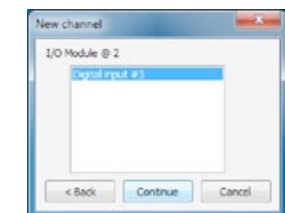


3. In the "New channel" dialogue box highlight the "I/O Module" option from which the named channel will receive its value. Click "Continue" and a new dialogue box will appear with the available input types listed.



NOTE: As a particular module's input becomes fully utilised the module will not appear on the "Select module" list.

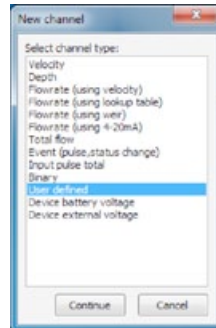
4. In this example the channel named "Binary" will be calculated using a switch attached to "I/O Module @ 2" on "Digital input #3". Click "Continue" to complete the new channel. The "Configure channels" dialogue box will re-appear with the new channel listed.



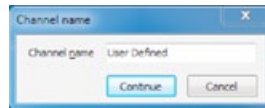
NOTE: As a particular module's inputs are utilised the input will not appear on the "I/O module" list. In the example above, the "Digital input #3" will no longer be available.

17.8.12 Add a "User defined" channel type

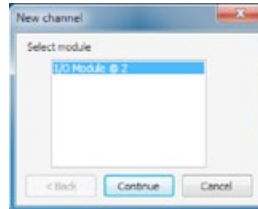
1. Select the "User defined" channel type from the "New channel" dialogue box and click "Continue":



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".

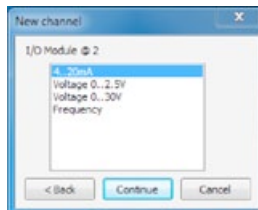


3. In the "New channel" dialogue box highlight the "I/O Module" option from which the named channel will receive its value. Click "Continue" and a new dialogue box will appear with the available input types listed.

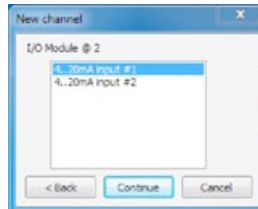


NOTE: As a particular module's input becomes fully utilised the module will not appear on the "Select module" list.

4. Select the sensor's physical wired input type from the "I/O Module @ 2" list. Click "Continue" and then select the appropriate input from which the named channel will receive its value.



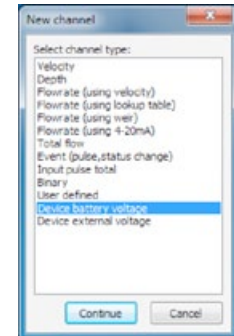
5. In this example the channel named "User defined" will be calculated using a sensor wired to "I/O Module @ 2" on "4..20mA input #1". Click "Continue" to complete the new channel. The "Configure channels" dialogue box will re-appear with the new channel listed.



NOTE: As a particular module's inputs are utilised the input will not appear on the "I/O module" list. In the example above, the "4..20mA input #1" will no longer be available.

17.8.13 Add a "Device battery voltage" channel type

1. Select the "Device battery voltage" channel type from the "New channel" dialogue box and click "Continue".

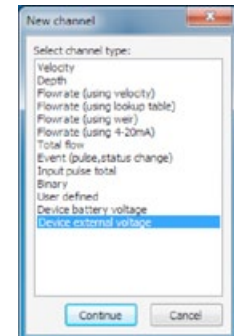


2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".

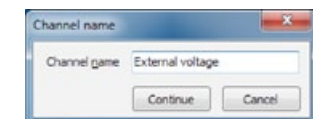


17.8.14 Add a "Device external voltage" channel type

1. Select the "Device external voltage" channel type from the "New channel" dialogue box and click "Continue".



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".



17.9 The order and removal of channels

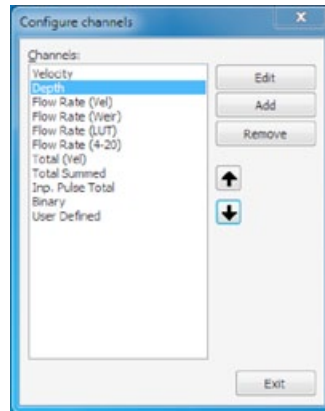
17.9.1 Ordering configured channels

The channel list after “Channels” have been added reflects the order in which they were configured and in which the XCI device takes physical measurements. This also orders the channels in both the logged data and the LCD. For example, when scrolling through the displayed channels on the LCD, the output order will be the same as the “Configure channels” dialogue box.

This order can be changed to suit the users needs.

1. Highlight the “Channel” in the list you wish to move and click either the “up” or “down” arrows (where available).

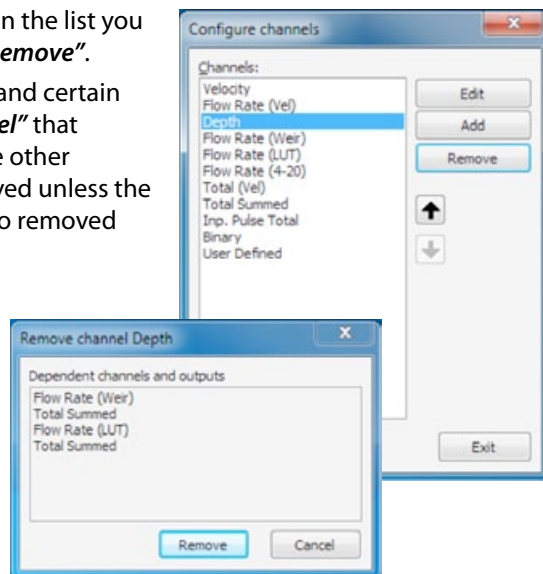
The order is hierarchical and certain limitations apply. A “Channel” that is dependent on the value of one or more channels cannot be moved higher in the list than the lowest “Channel” in which it depends upon.



17.9.2 Removing configured channels

1. Highlight the “Channel” in the list you wish to remove and click “Remove”.

The removal is hierarchical and certain limitations apply. A “Channel” that is referenced by at least one other “Channel” cannot be removed unless the dependent “Channel” is also removed first.



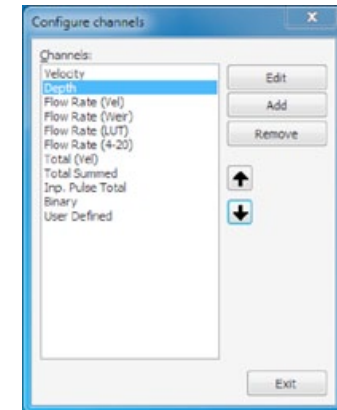
17.10 Edit I/O module channel & input types



WARNING: All configured channels MUST be edited prior to starting the XCI device. Editing the channel/s enables the correct configuration information to be sent to the controller module.

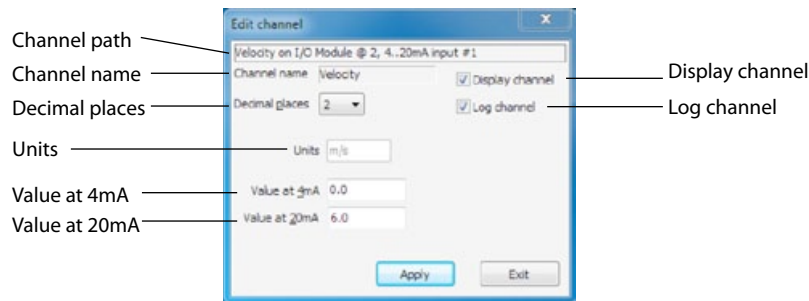
From the main “Device Settings” dialogue box click “Configure channel” and the “Configure channels” dialogue box will appear.

1. Highlight the channel you wish to edit and click “Edit”. An input specific “Edit channel” dialogue box will appear.
2. Edit the settings in the “Edit channel” dialogue box to suit your application as per the recommendations on the following pages. Click “Apply” to save the settings and return to the “Configure channels” dialogue box.



17.10.1 Edit a “Velocity”, “Depth” or “User Defined” channel types

17.10.1.1 “4-20mA” input



Channel path

This describes the channel type and the module input source.

Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Units

This sets the units on the logged value. This is a text field and is user defined.

NOTE: If a “Velocity” or “Depth” channel type is configured on a “4-20mA” input the units are defined according to the “System settings”

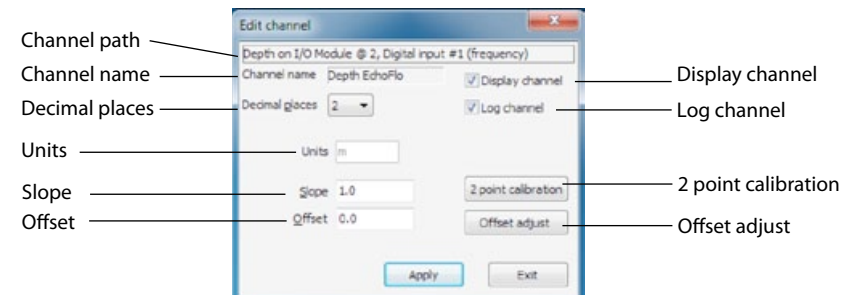
Value at 4mA

Enter the value here that corresponds to an input of 4mA.

Value at 20mA

Enter the value here that corresponds to an input of 20mA.

17.10.1.2 “Frequency”, “Voltage” & “Shaft Encoder” inputs



Channel path

This describes the channel type and the module input source.

Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Units

This sets the units on the logged value. This is a text field and is user defined.

NOTE: If a “Velocity or Depth” channel type is configured on a “Frequency, Voltage or Shaft encoder” input the Units are defined according to the “System settings”

Slope, Offset, 2 point calibration and Offset adjust

Over page

17.10.1 Edit a "Velocity", "Depth" or "User Defined" channel types

- continued

2-point calibration

To correctly calibrate an environmental sensor it is important to calibrate it over its useful range. For example, if a depth sensor has a range of 0 - 2 metres but you only wish to use it to measure the range 0.0 metres to 1.25 metres, you should re-calibrate it across the reduced range.

1. Click "2-point calibration" from the "Edit channel" dialogue box and the "2 point calibration" dialogue box appears.

The "Current value" from the sensor (in this case a depth sensor with frequency output) is displayed at the top of the window and is updated approximately once per second.

2. To carry out a two point calibration, prepare the measurement set up for the first calibration point (either the sensors upper or lower range limit).

3. When the "Current value" has stabilised, click on the "Set" button in the "1st point" box. The "Current value" is copied to the "Measured value" field of the "1st point" box and the "Actual value" field is enabled.

4. Enter the sensors actual value (in this case depth) in the "Actual value" field.

5. Prepare the measurement set up for the second calibration point (the opposite sensor range limit from that used in point 2 above). For example, if you used the upper range limit in point 2, now use the lower range limit.

6. When the "Current value" has stabilised, click on the "Set" button in the "2nd point" box. The "Current value" is copied to the "Measured value" field of the "2nd point" box and the "Actual value" field is enabled.

7. Enter the sensors actual value (in this case depth) in the "Actual value" field.

8. Click on the "Apply" button to calculate the new slope and offset parameter values for the associated channel. Clicking on the "Cancel" button terminates the procedure without altering the parameter values.

Offset adjust

This function is used to "fine tune" the depth reading whenever the sensor is deployed or reading inaccurately. For example, the depth sensor may be sitting slightly off the bottom of the stream, or the user has deployed it above a silt line on the side of a pipe.

1. Click "Offset adjust" from the "Edit channel" dialogue box and the "Channel offset adjust" dialogue box appears.

The "Current value" from the sensor (in this case a depth sensor with frequency output) is displayed at the top of the window and is updated approximately once per second.

2. To adjust the "Current value", enter your current measured value in the "Corrected value" field.

3. Click on the "Apply" button to calculate the new "Offset" parameter value for the associated channel. Clicking on the "Cancel" button terminates the procedure without altering the offset value.

WARNING: When calibrating a depth channel, measurements should ALWAYS be carried out from the BOTTOM of the channel/ pipe to the top of the water level

Manually calculating slope and offset values

$$\text{Slope} = \text{Sensor range} \div \text{Span}$$

$$\text{Offset} = - (\text{Slope} \times \text{Sensor output at zero})$$

Sensor Range: The measuring range of the sensor. For example a depth sensor may be ranged from 0 to 2m.

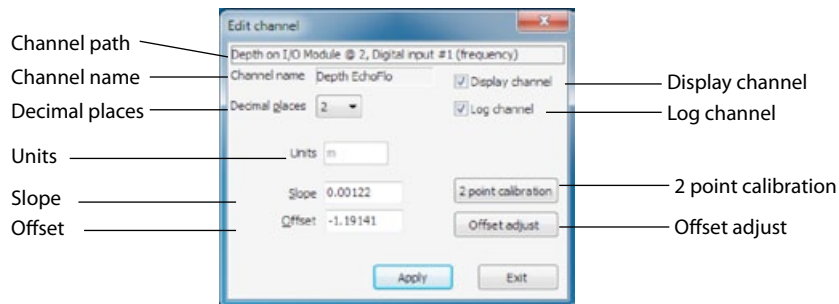
Span: Is the difference between the sensor output (Frequency or Voltage) at the top of the measured range (say 2m) and the sensor output at zero.

For example, you wish to calculate the slope and offset for an ultrasonic depth sensor that has a range of 0 to 1250mm. At 0mm the sensor outputs a frequency of 100Hz and at 1250mm the sensor outputs 2500Hz.

The following calculations will provide the sensor's slope and offset:

$$\begin{aligned} \text{Slope} &= 1250 \div (2500-100) & \text{Offset} &= - (0.5208 \times 100) \\ &= 1250 \div (2400) & &= - 52.08 \\ &= 0.5208 & & \end{aligned}$$

17.10.2 Edit a “Depth” (for EchoFlo) channel type



Channel path

This describes the channel type and the module input source.

Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Units

This sets the units on the logged value. This field is pre-defined in a metric system. If the system is using US units then the appropriate radar button should be selected.

2 point calibration

This function is not required when editing an EchoFlo sensor channel as the sensor should already be pre-configured using EchoCal as described in the EchoFlo Quick Start Guide.

17.10.2.1 Calculating the EchoFlo Slope & Offset

The Slope and Offset values of the installed EchoFlo are dependent on the “Fill Height” as entered during the EchoCal configuration procedure.

NOTE: The following calculations are based on the EchoFlo being configured with a frequency output.

Manually calculating Slope

$$\text{Slope} = \text{Fill Height} \div \text{Sensor Span}$$

Fill Height: The maximum depth measured by the EchoFlo. Refer to the EchoFlo Quick Start Guide for further details.

Sensor Span: Is the difference between the sensor output at the top of the “Fill Height” (2000Hz) and the sensor output at the bottom (976Hz). The frequency output of an EchoFlo has a span of 1024Hz .

Manually calculating Offset

$$\text{Offset} = - (\text{Slope} \times \text{Sensor output at zero})$$

Metric example - you wish to calculate the slope and offset for an EchoFlo that has been configured with a “Fill Height” of 0.75m (75cm). The following calculations will provide the sensor’s slope and offset:

$$\begin{aligned} \text{Slope} &= 0.75 \div (2000-976) \\ &= 0.75 \div 1024 \\ &= 0.00073 \end{aligned}$$

$$\begin{aligned} \text{Offset} &= - (0.00073 \times 976) \\ &= - 0.71484 \end{aligned}$$

US example - you wish to calculate the slope and offset for an EchoFlo that has been configured with a “Fill Height” of 30”.

The following calculations will provide the sensor’s slope and offset:

$$\begin{aligned} \text{Slope} &= 30 \div (2000-976) \\ &= 30 \div 1024 \\ &= 0.02929 \end{aligned}$$

$$\begin{aligned} \text{Offset} &= - (0.02929 \times 976) \\ &= - 28.59375 \end{aligned}$$

NOTE: Be sure to record the relevant “Slope” and “Offset” values.

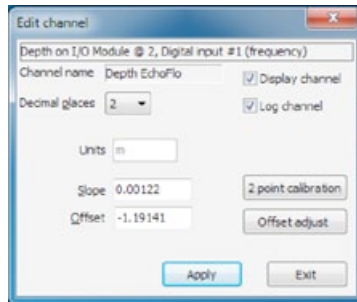
17.10.2 Edit a "Depth" (for EchoFlo) channel type - continued

17.10.2.2 Entering Slope and Offset

1. Enter the relevant "Slope" and "Offset" values as determined using the previous calculations.



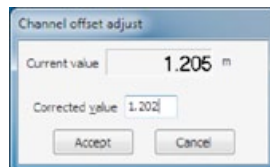
WARNING: Be sure to enter the correct values for the selected depth units



17.10.2.3 Fine tuning the EchoFlo depth reading

The "Offset adjust" function is used to fine tune the depth reading whenever the sensor is deployed.

1. Click "Offset adjust" from the "Edit channel" dialogue box and the "Channel offset adjust" dialogue box appears. The "Current value" from the sensor is displayed at the top of the window and is updated approximately once per second.



2. To adjust the "Current value", enter your current measured value in the "Corrected value" field.

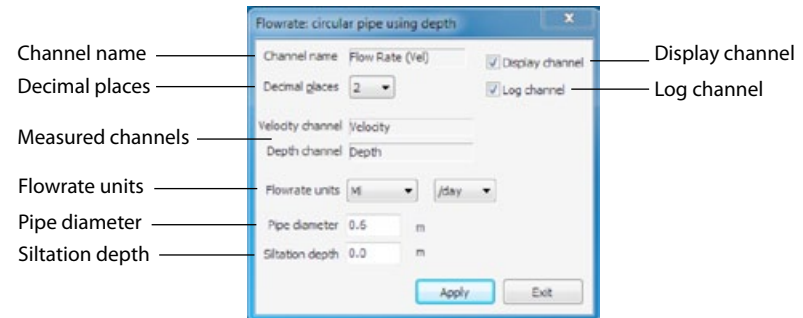
3. Click on the "Apply" button to calculate the new "Offset" parameter value for the associated channel. Clicking on the "Cancel" button terminates the procedure without altering the offset value.



WARNING: When calibrating a depth channel, measurements should ALWAYS be carried out from the BOTTOM of the channel/pipe to the top of the water level

17.10.3 Edit a "Flowrate (using velocity)" channel type

17.10.3.1 Flowrate: Full circular pipe, Full non-circular pipe, Circular pipe using depth



Channel name

This is the name given to the channel by the user when setup.



NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Measured channels

"Flowrate" is a derived channel type. These fields define from which measured channels flowrate is being calculated.



NOTE: In a "Flowrate: full circular pipe" dialogue box only a velocity channel will be displayed

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

17.10.3 Edit a “Flowrate (using velocity)” channel type - *continued*

Pipe diameter

The “*Pipe diameter*” (cross-sectional area if a non-circular pipe) is entered here.

If the “*Flowrate*” channel is configured for “*Conduit using depth*” then the “*Pipe diameter*” field will not appear.

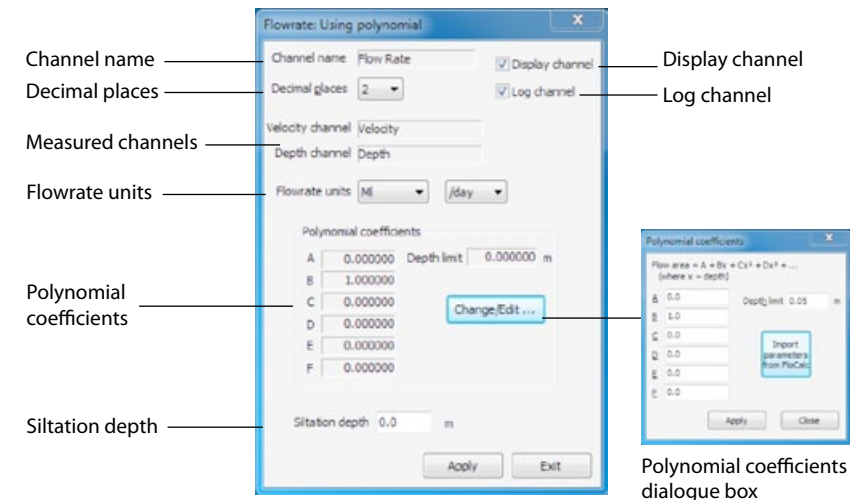
Siltation depth

This parameter can be used to correct the calculated flow rate if a known amount of silt is inside the pipe.

The depth of silt will be subtracted from the area calculation in order to calculate the corrected flow rate.

17.10.3.2 Flowrate: Other conduit using depth

When the stream flow is in an open channel (non-circular), the user must determine the cross-sectional area and relate it to depth via a polynomial equation. MACE XCi devices use 5th order polynomial equations.



Channel name

This is the name given to the channel by the user when setup.



NOTE: This name will also show on the XCi device LCD screen if the **Display channel** check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Measured channels

“*Flowrate*” is a derived channel type. These fields define from which measured channels flowrate is being calculated.

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

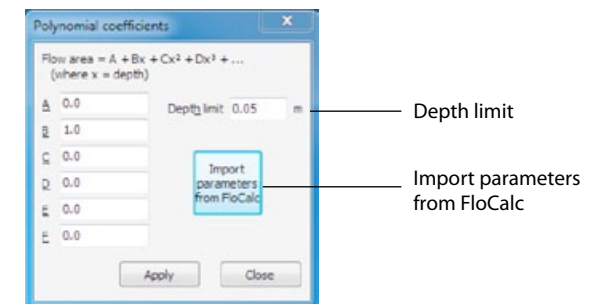
Polynomial coefficients

The polynomial coefficients listed in FloCom+ are related to the following equation:

$$\text{Cross-Sectional Area} = A + B*X + C*X^2 + D*X^3 + E*X^4 + F*X^5$$

Where X = depth of stream

The coefficients are listed in order A, B, C, D, E, F.

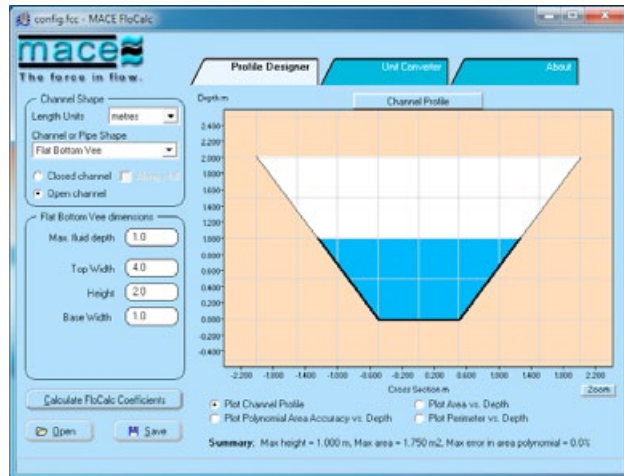


17.10.3 Edit a “Flowrate (using velocity)” channel type - continued

Import parameters from FloCalc

The Mace utility program FloCalc (download separately from www.macemeters.com) can be used to draw regular and irregular channel shapes. These shapes are then converted into a 5th order polynomial. Their coefficients can be imported directly into the appropriate fields in FloCom⁺.

1. Click “Import parameters from FloCalc” and MACE FloCalc will open on the “Profile Designer” tab sheet.



2. Describe/draw your channel or pipe shape in FloCalc (see FloCalc Product Manual).

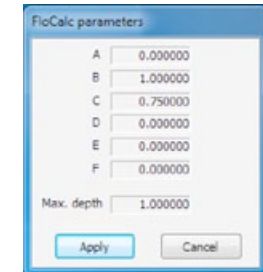
3. Click “Calculate FloCalc Coefficients” and the “MACE FloCalc Coefficients” dialogue box will appear.

4. Click “Copy to Clipboard” then click “Close” and exit from FloCalc.

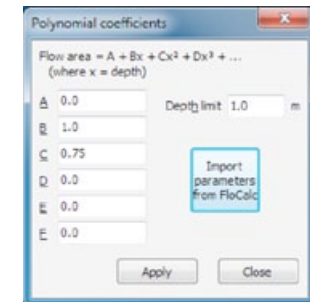


5. The “FloCalc parameters” dialogue box will appear containing the calculated polynomial coefficients.

6. Review the coefficients and click “Apply” to update the “Polynomial coefficients” dialogue box.

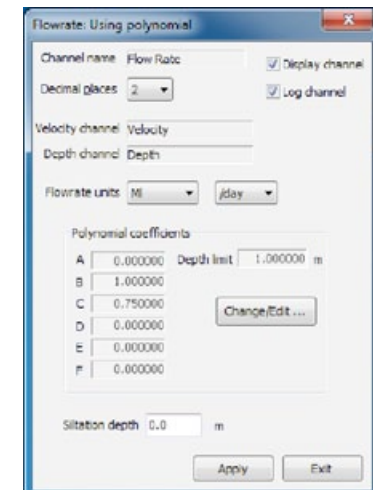


7. Click “Apply” and the coefficients in the “Flowrate: Using polynomial” dialogue box will be set.

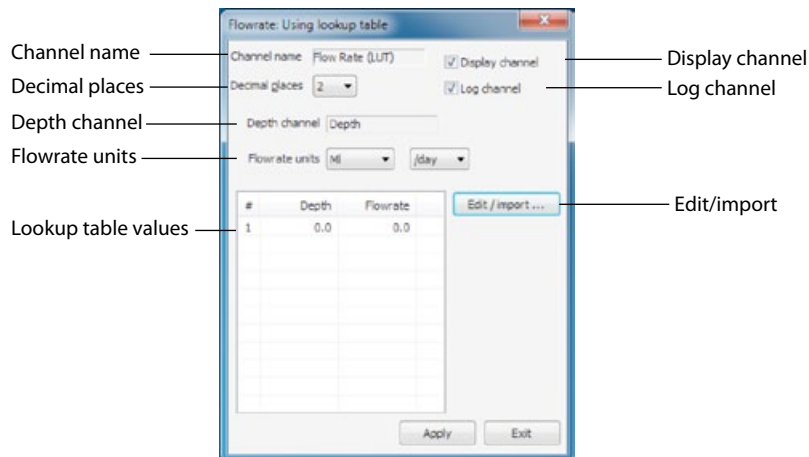


Depth limit

When the cross-sectional area of a stream is calculated using the polynomial coefficient method, the user must set the “Depth limit” at which the polynomial reaches a maximum. For example, if a channel has a maximum depth of 1.0m the “Depth limit” should be set at 1.0m as well. Alternatively the “Depth limit” can be set within FloCalc and the procedure described for importing polynomial coefficients.



17.10.4 Edit a “Flowrate (using lookup table)” channel type



Channel name

This is the name given to the channel by the user when setup.



NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Depth channel

The source channel for depth values used by the lookup table

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

Lookup table values

Lists the flowrates that will be calculated at the corresponding measured depths.



NOTE: The lookup table has a maximum of 35 lines available for use. This maximum is memory dynamic and may be reduced depending upon other channel configurations.

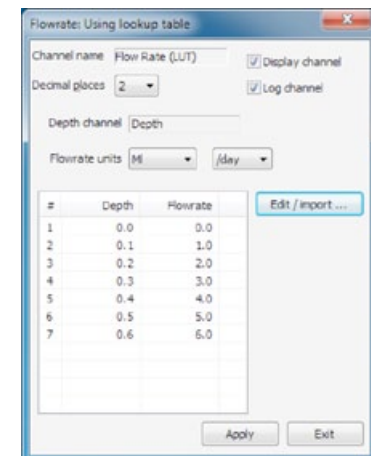
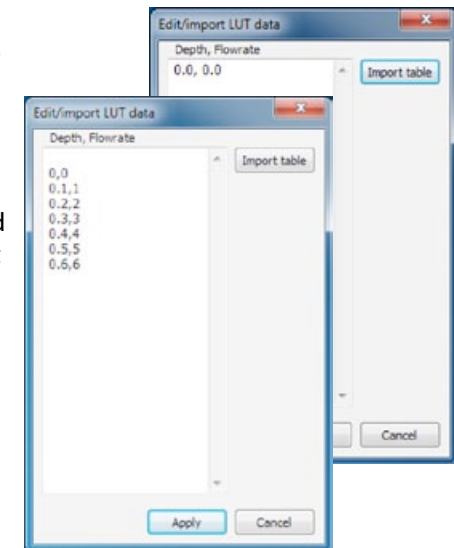
Edit/import

1. From the “Flowrate: Using lookup table” dialogue box click “Edit/import” and the “Edit/import LUT data” dialogue box will appear.

2. Lookup table values can be entered here directly. The depth and corresponding flowrate values must be separated by a comma (,).

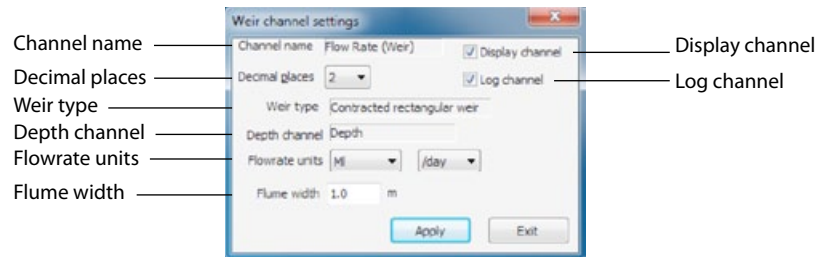
3. Alternatively, values may be imported from a *.CSV file. Click “Import table” and a Windows® “Open” dialogue box will appear prompting the selection of a *.CSV file. Click “Open” and the values will be imported.

4. Click “Apply” and the “Flowrate: Using lookup table” dialogue box will appear containing the updated values.



17.10.5 Edit a “Flowrate (using weir)” channel type

17.10.5.1 Flowrate (Weir): Rectangular and Cipoletti weirs



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Weir type

The weir type selected when the channel was added.

Depth channel

The depth channel selected for the weir calculation when the channel was added.

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

Flume width

Enter the width of the weir in the units shown. The units are defined according to the “System settings”.

17.10.5.2 Flowrate (Weir): V-Notch weirs (30°, 45°, 60°, 90°)



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Weir type

The weir type selected when the channel was added.

Depth channel

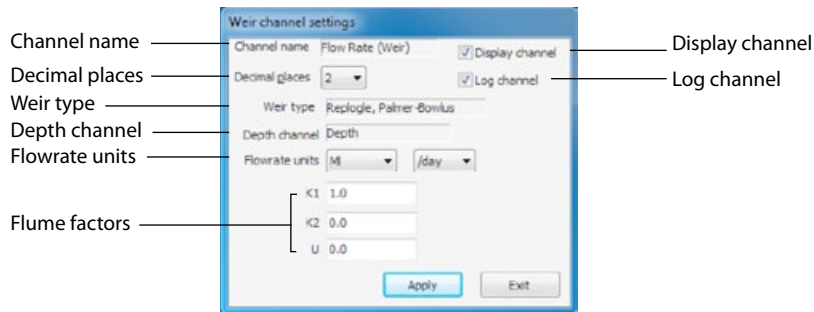
The depth channel selected for the weir calculation when the channel was added.

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

17.10.5 Edit a “Flowrate (using weir)” channel type - continued

17.10.5.3 Flowrate (Weir): Replogle, Palmer-Bowlus flumes



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Weir type

The weir type selected when the channel was added.

Depth channel

The depth channel selected for the weir calculation when the channel was added.

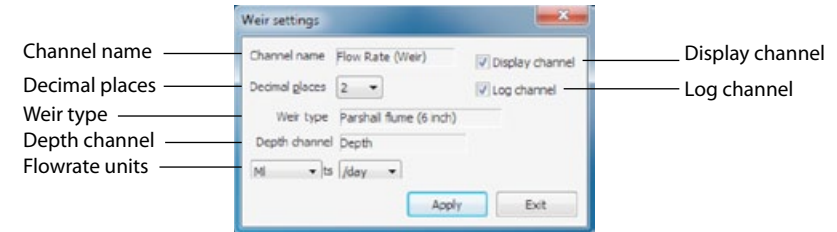
Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

Flume factors

Long-throated flumes are custom-designed. The values of K1, K2, and U are determined by the designer, using software such as **WinFlume** available from: http://www.usbr.gov/pmts/hydraulics_lab/winflume/index.html

17.10.5.4 Flowrate (Weir): Parshall flume



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Weir type

The weir type selected when the channel was added.

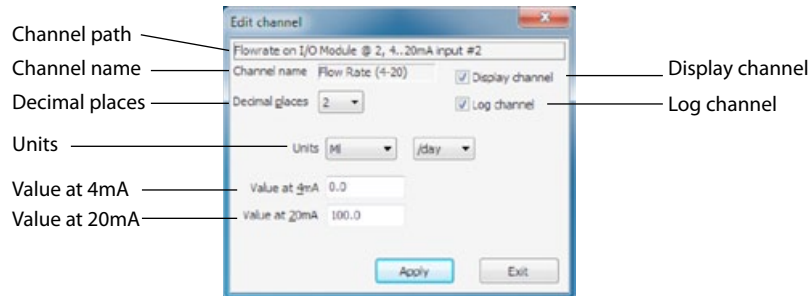
Depth channel

The depth channel selected for the weir calculation when the channel was added.

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

17.10.6 Edit a “Flowrate (using 4-20mA)” channel type



Channel path

This describes the channel type and the module input source.

Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Units

This sets the units on the logged value. This is a text field and is user defined.

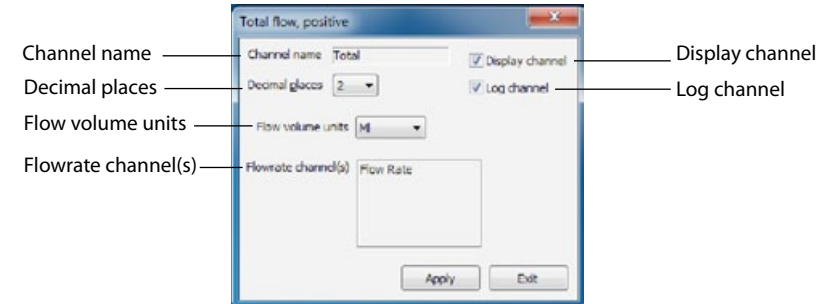
Value at 4mA

Enter the value here that corresponds to an input of 4mA.

Value at 20mA

Enter the value here that corresponds to an input of 20mA.

17.10.7 Edit a “Total flow” channel type



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Flow volume units

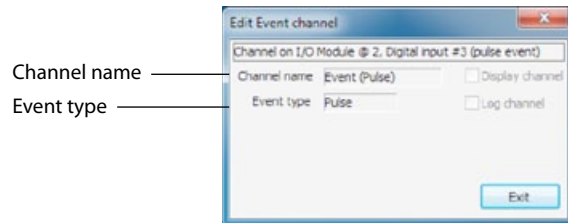
Select the units from the drop down list box. This sets the units on the logged value.

Flowrate channel

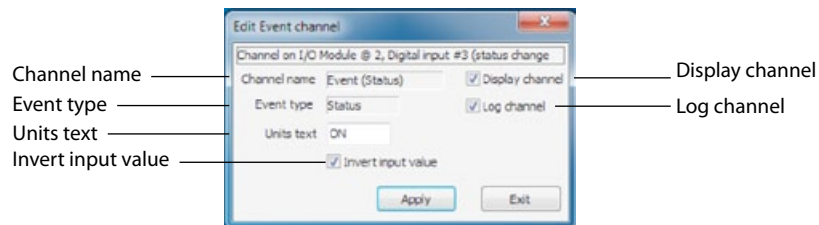
“Total” is a derived channel type. This field defines from which named “Flowrate” channel the “Total” is being calculated.

17.10.8 Edit a “Event (pulse)” channel type

NOTE: None of these paramaters can be edited



17.10.9 Edit a “Event (status change)” channel type



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Event type

This displays the type of event, either “Pulse” or “Status”.

Display channel

If this check box is ticked then this channel will be displayed on the XCi LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

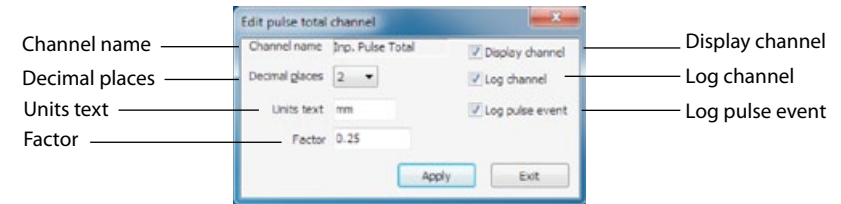
Units text

This sets the units on the logged value. This is a text field and is user defined.

Invert input value

If this check box is ticked then the value will be inverted before it is logged.

17.10.10 Edit a “Input pulse total” channel type



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Log pulse event

If this check box is ticked a “Status” message is logged in the data file when the event occurs.

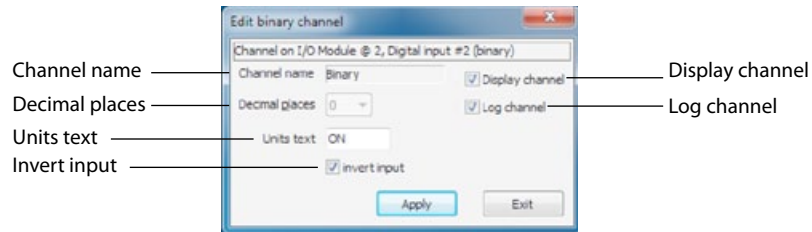
Units text

This sets the units on the logged value. This is a text field and is user defined.

Factor

This field scales the pulse to match the units being used. For example, if 1 kilolitre pulses and megalitre units are used, the factor would be 0.001 where as if 1 kilolitre pulses and kilolitre units are used, the factor would be 1.0 Alternatively when the input is from a rain gauge, if the bucket size is 0.25mm then each pulse will cause the totalizer to increment by that amount (Eg. 0.25mm, 0.50mm, 0.75mm.....)

17.10.11 Edit a “Binary” channel type



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

This field is greyed out as the “Binary” channel cannot have decimal places configured.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Units text

This sets the units on the logged value. This is a text field and is user defined. In this example the “Binary” channel is being used to monitor the on/off condition of a pump. In the data the word “Pump” will be logged whenever the pump is on.

Invert input

If this check box is ticked then the value will be inverted before it is logged.

17.10.12 Edit a “Device battery/external voltage” channel type



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

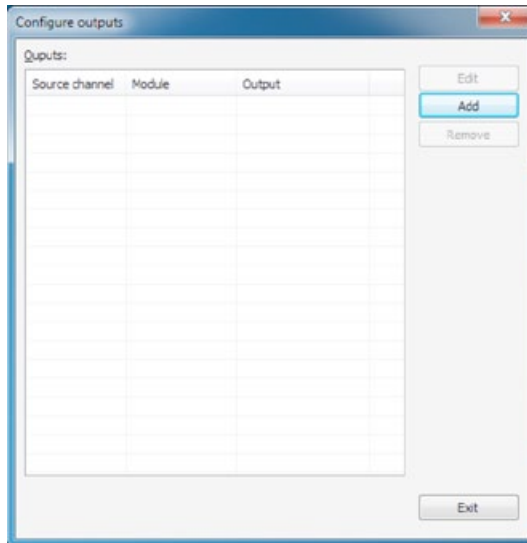
If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

17.11 Add an I/O module output

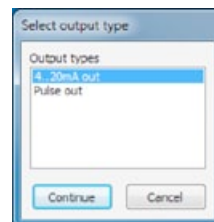
1. From the main “*Device settings*” dialogue box, click “*Configure outputs*” and the “*Configure outputs*” dialogue box will appear.



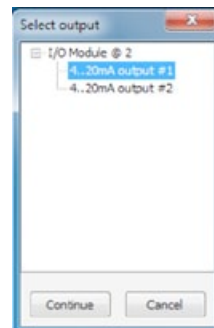
2. From the “*Configure outputs*” dialogue box click “*Add*” and the “*Select output type*” dialogue box will appear.

17.11.1 Adding a 4-20mA output

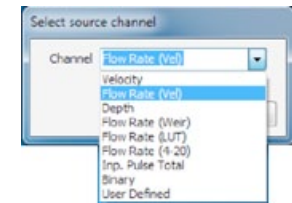
1. From the “*Select output type*” dialogue box highlight “*4..20mA out*” and click “*Continue*”. The “*Select output*” dialogue box will appear.



2. Select the “*4..20mA output #X*” that you wish to use and click “*Continue*”. The “*Select source channel*” dialogue box will appear.



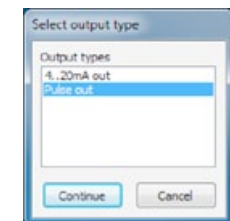
3. Select the “*Channel*” from the drop down list that you wish to output. In this example the channel named “*Flow Rate (Vel)*” will be output from “*I/O Module @ 2*” on “*4..20mA output #1*”. Click “*Continue*” to complete the new output. The “*Configure outputs*” dialogue box will re-appear with the new output listed.



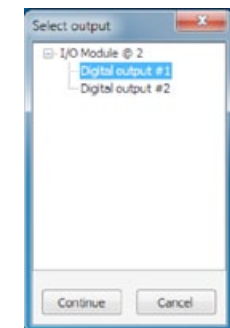
NOTE: Only channels that are suitable for outputting as a 4-20mA proportional current will be available for selection

17.11.2 Adding a pulse output

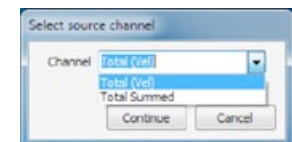
1. From the “*Select output type*” dialogue box highlight “*Pulse out*” and click “*Continue*”. The “*Select output*” dialogue box will appear.



2. Select the “*Digital output #X*” that you wish to use and click “*Continue*”. The “*Select source channel*” dialogue box will appear.



3. Select the “*Channel*” from the drop down list that you wish to output. In this example the channel named “*Total (Vel)*” will be output from “*I/O Module @ 2*” on “*Digital output #1*”. Click “*Continue*” to add the new output. The “*Configure outputs*” dialogue box will re-appear with the new output listed.

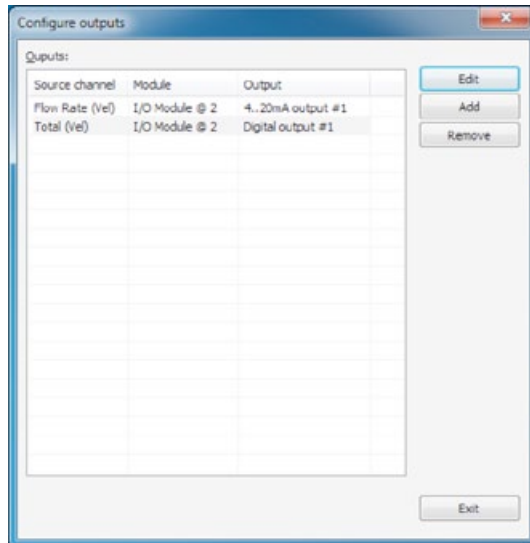


NOTE: Only channels that are suitable for “*Pulse*” outputting will be available for selection

17.12 Edit an I/O module outputs

WARNING: All configured output channels **MUST** be edited prior to starting the XCi device. Editing the channel/s enables the correct configuration information to be sent to the controller module.

From the main “*Device Settings*” dialogue box click “*Configure outputs*” and the “*Configure outputs*” dialogue box will appear.

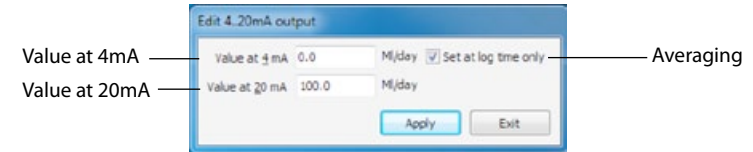


1. Highlight the channel you wish to edit and click “*Edit*”. An output specific “*Edit output*” dialogue box will appear.
2. Edit the settings in the “*Edit output*” dialogue box to suit your application as per the recommendations on the following page. Click “*Apply*” to save the settings and return to the “*Configure outputs*” dialogue box.

Removal of outputs

From the “*Configure outputs*” dialogue box highlight the “*Output*” you wish to remove and click “*Remove*”. You will be prompted to confirm the removal.

17.12.1 Editing a 4-20mA output



Value at 4mA

The value of the “*Source*” channel at which the “*4-20mA output*” will be set to 4mA.

Value at 20mA

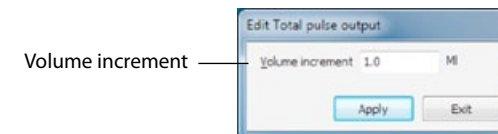
The value of the “*Source*” channel at which the “*4-20mA output*” will be set to 20mA.

Averaging

The user can elect to output an **averaged** value on the “*4-20mA output*” by checking the box. When checked, the “*4-20mA output*” will only be updated at the logging interval otherwise it is updated at each measurement interval. In the case of the measurement interval being shorter than the logging interval, then the “*4-20mA output*” will be the average of those values calculated per measurement interval.

WARNING: Click “*Apply*” to save the settings then click “*Exit*” to return to the “*Configure outputs*” dialogue box.

17.12.2 Editing a pulse output



Volume increment

The incremental value at which a pulse will be sent. In the example above, a pulse will be sent whenever an increment of 1 Megalitre is totalised.

NOTE: A maximum of 10 pulses per second may be sent per measurement interval. For example, during a measurement interval of three minutes (180 seconds) a maximum of 1,800 pulses can be sent. If the XCi device has not sent all pulses by the time of the next measurement, pulses **WILL** be lost.

WARNING: Click “*Apply*” to save the settings then click “*Exit*” to return to the “*Configure outputs*” dialogue box.

18.0 The Pulse I/O card

18.1 About the Pulse I/O card

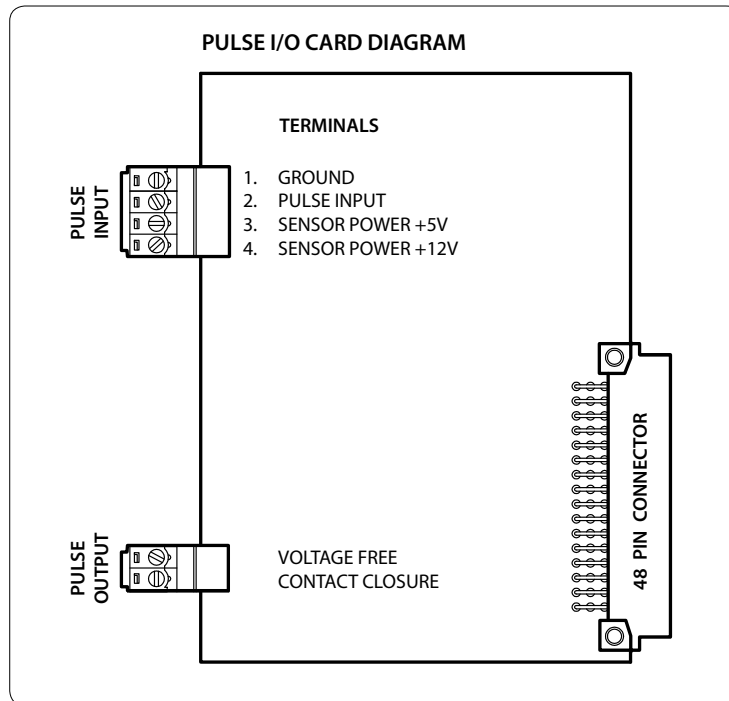
The Pulse I/O card provides the input for connecting pulsing flow meter sensors and an output for connection to ancillary devices.

The input and output terminals available on each Pulse I/O card are shown in the diagram below.

! **MACE recommends the user studies the relevant documentation supplied with each third party sensor prior to connection**

! **WARNING: The maximum system current available for powering sensors attached to ALL I/O & Pulse I/O cards is 1.25 Amps at 12VDC**

! **WARNING: The maximum input voltage on any terminal is 30VDC**



! **Should insufficient I/O be available on a single Pulse I/O card another card (Part No. 850-353) should be purchased.**

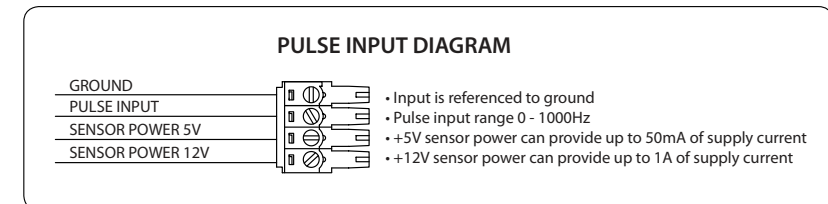
Once a sensor has been wired to the Pulse I/O card it must be configured using FloCom+ software so that the XCi device can control and record data from the sensor.

Essential Steps to configure a Pulse I/O card using FloCom+ software:

1. Add Modules
2. Edit Modules
3. Add Channels
4. Edit Channels
5. Add Outputs (where required)
6. Edit Outputs (where required)
7. Apply Settings
8. Run "Measure and Display" function

18.2 Wiring the pulse input

Each Pulse I/O card provides one pulse input for connecting devices such as rate pulsing flow meters. The pulse input terminals available on each Pulse I/O card are shown in the diagram below.



18.2.1 Cable length guidelines

- Wherever possible sensors should only be grounded at the XCi device end.
- Long pulse cable input runs require proper grounding and minimisation of ground loops.
- For sensors powered by +5V, cable lengths <10m are recommended.
- For sensors powered by +12V, cable lengths <100m are recommended.

18.2.2 Power guidelines

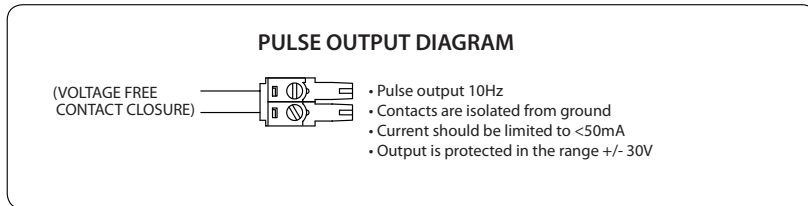
Because pulse rate sensors are often left running continuously, their power consumption is an important consideration.

- A continuously running sensor should have a current consumption <10mA.
- Sensors using >10mA require a larger solar panel (eg. 10 Watts).
- Sensors using >50mA should also have an external battery or mains power.

! **NOTE: Sensors connected to the Pulse I/O card can be configured to switch ON/OFF to save power rather than run continuously**

18.3 Wiring the pulse output

Each Pulse I/O card provides one pulse output for connection to ancillary devices such as water samplers and or data loggers. The pulse output terminals available on each Pulse I/O card are shown in the diagram below.



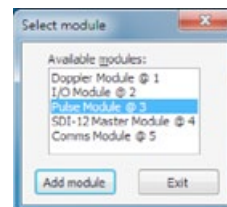
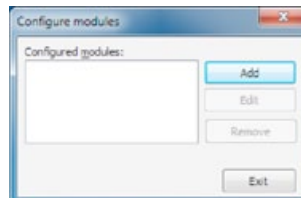
18.4 Add and configure a Pulse module in FloCom⁺

NOTE: Once a FloSeries3 card is installed in an XCi device, FloCom⁺ defines this as a module.

1. From the main “*Device settings*” dialogue box click “*Configure modules*” and a dialogue box will appear as shown.

2. Click “*Add*” and the available modules will be listed in the “*Select module*” dialogue box.

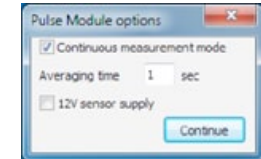
3. Each MACE module available is referenced in the list by its type and slot number. (eg. Pulse module in card slot 3). Highlight the module you wish to add and click “*Add module*”. The “*Pulse module options*” dialogue box will appear.



NOTE: Once a module has been added it will no longer appear on the available modules list

Continuous measurement mode

If selected, the Pulse module will operate in Continuous measurement mode. In this mode all input pulses will be counted and the pulsing sensor will be continuously powered.

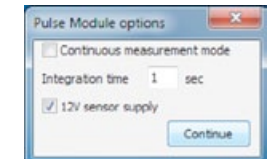


NOTE: Refer to Chapter 18.2.2 for further details on running current limitations.

The “*Averaging time*” allows the user to set a period of time over which the pulses will be counted and averaged. This average is then used to calculate a rolling average which may help in applications with unstable flow rate pulsing.

Non-Continuous measurement mode

If un-selected, the Pulse module will operate in Non-Continuous measurement mode. The pulsing sensor will only be powered for the “*Integration time*” specified. In this mode input pulses will only be counted for the configured “*Integration time*” at each scheduled “*Measurement interval*”.



12V sensor supply

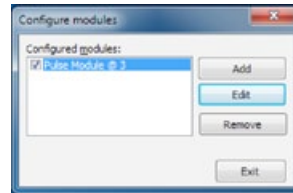
When checked, the sensor will be supplied with 12VDC otherwise it will be powered by 5VDC.

WARNING: “*Sensor power*” must be enabled in the main “*Device settings*” dialogue box or the switching of the power supply will not occur.

18.5 Edit and remove a Pulse module in FloCom+

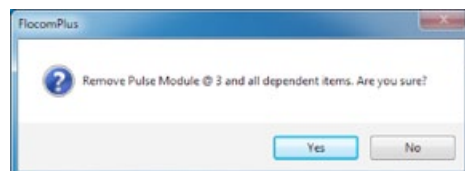
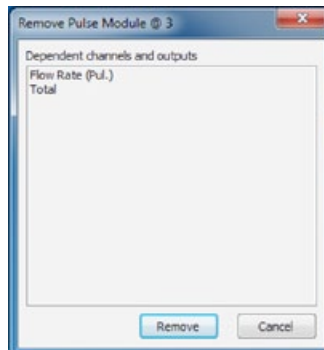
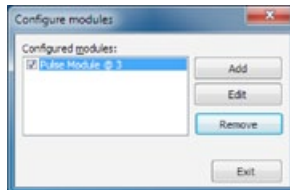
18.5.1 Edit a Pulse module

If you wish to edit a Pulse module after it has been added and configured, click **“Edit”** from the **“Configure modules”** dialogue box.



18.5.2 Remove a Pulse module

1. From the **“Configure modules”** dialogue box highlight the module that you wish to remove. Click **“Remove”** and a dialogue box will appear listing the **“Dependent channels and outputs”**. Click **“Remove”** and you will be prompted to confirm your action. Click **“Yes”** and the module and dependent channels will be removed.

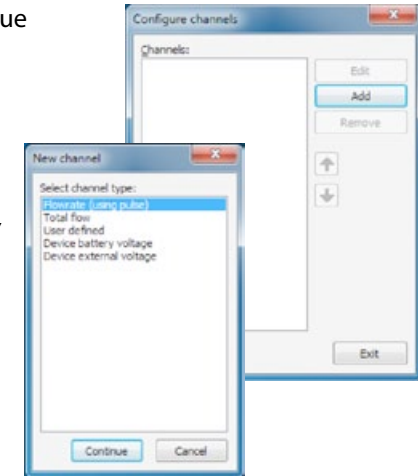


18.6 Add Pulse module channel types

From the main **“Device Settings”** dialogue box click **“Configure channels”** and the **“Configure channels”** dialogue box will appear.

1. Click **“Add”** and the **“New channel”** dialogue box will appear as shown.

The **“Channel types”** visible in the **“New channel”** dialogue box are dependent upon the modules that have been configured.



WARNING: Adding a new channel creates a new data session. It is essential to download the data from the XCi device PRIOR to adding new channels to an XCi device that has already been configured and has had data recorded.

Pulse module channel types

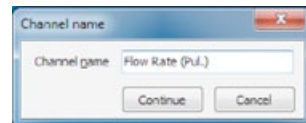
Channel types	Description
Flowrate: (using pulse)	Used to calculate a flow rate based upon the number of pulses received by a Pulse I/O module during a measurement interval.
Total Flow:	Used to calculate an accumulated positive or negative total based on the results obtained from a configured flow rate channel.
User Defined:	Can be used when a 3rd party sensor with digital/analogue output is to be configured. It should NOT be used for velocity or depth sensors where the results are required for a flow rate calculation.
Device battery voltage	Used to monitor the XCi device internal battery voltage.
Device external voltage	Used to monitor the XCi device external voltage from a solar panel or mains charger.

18.6.1 Add a "Flowrate (using pulse)" channel type

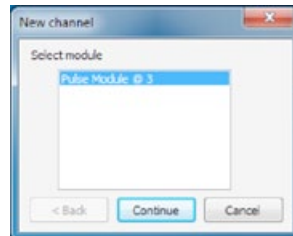
1. Select the "Flowrate (using pulse)" channel type from the "New channel" dialogue box and click "Continue".



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".



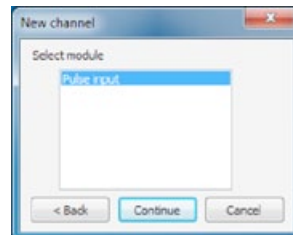
3. In the "New channel" dialogue box highlight the "Pulse Module" option from which the named channel will receive its value. Click "Continue" and a new dialogue box will appear with the available input types listed.



NOTE: As a particular module's input becomes fully utilised the module will not appear on the "Select module" list.

4. Select the "Pulse input" type and click "Continue".

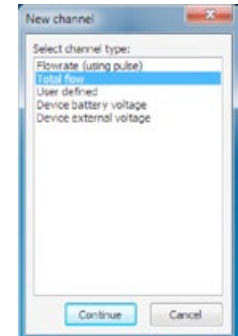
5. In this example the channel named "Flow Rate (Pul.)" will be calculated using a sensor attached to "Pulse Module @ 3" on "Pulse input". Click "Continue" to complete the new channel. The "Configure channels" dialogue box will re-appear with the new channel listed.



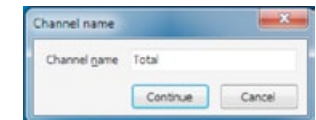
NOTE: These is only a single "Pulse input" available per "Pulse module". In the example above, the "Pulse Module @ 3" will no longer be available.

18.6.2 Add a "Total flow" channel type

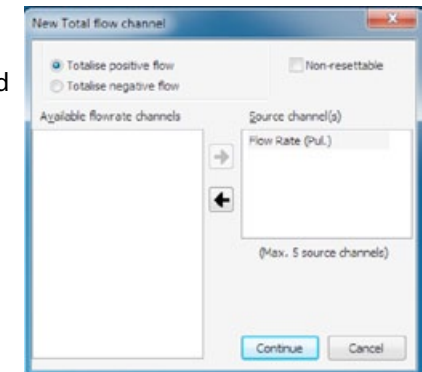
1. Select the "Total flow" channel type from the "New channel" dialogue box and click "Continue".



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue" and the "New total flow channel" dialogue box will appear.



3. From the "Available flowrate channels" list, highlight the Flowrate channel from which the channel named "Total" will receive its value. Click the "Right arrow" and the channel will appear in the "Source channel(s)" list. A maximum of five flowrate channels can be totalised together.



4. Select either "Totalise positive flow" or "Totalise negative flow" depending upon your application.

WARNING: The "Totalise positive flow" type will only increment the totaliser. If negative flows are recorded the totaliser will NOT decrement. The positive totaliser rolls over to zero.

WARNING: The "Totalise negative flow" type will only decrement the totaliser. If positive flows are recorded the totaliser will NOT increment. The negative totaliser rolls over to zero.

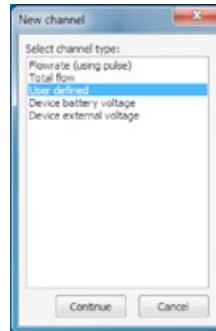
WARNING: Both positive and negative flow rates will be recorded in the data file.

5. If the "Non-resettable" checkbox is ticked, this total flow channel will not be re-settable using the "Set/reset" procedure from the "View totals" main menu item.

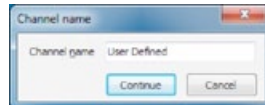
6. Click "Continue" to complete the new channel and the "Configure channels" dialogue box will re-appear with the new channel listed.

18.6.3 Add a "User defined" channel type

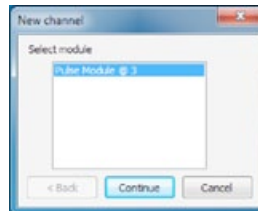
1. Select the "User defined" channel type from the "New channel" dialogue box and click "Continue".



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".

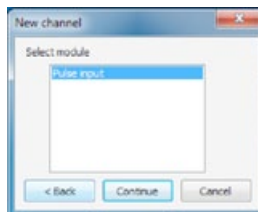


3. In the "New channel" dialogue box highlight the "Pulse Module" option from which the named channel will receive its value. Click "Continue" and a new dialogue box will appear with the available input types listed.



NOTE: As a particular module's input becomes fully utilised the module will not appear on the "Select module" list.

4. Select the "Pulse input" type and click "Continue".

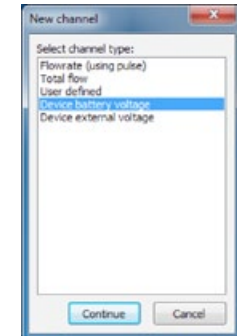


5. In this example the channel named "User defined" will be calculated using a sensor attached to "Pulse Module @ 3" on "Pulse input". Click "Continue" to complete the new channel. The "Configure channels" dialogue box will re-appear with the new channel listed.

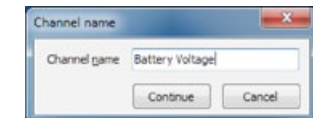
NOTE: These is only a single "Pulse input" available per "Pulse module". In the example above, the "Pulse Module @ 3" will no longer be available.

18.6.4 Add a "Device battery voltage" channel type

1. Select the "Device battery voltage" channel type from the "New channel" dialogue box and click "Continue".

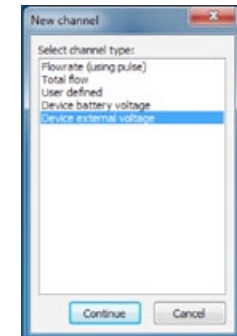


2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".

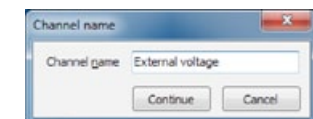


18.6.5 Add a "Device external voltage" channel type

1. Select the "Device external voltage" channel type from the "New channel" dialogue box and click "Continue".



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".



18.7 The order and removal of Pulse module channels

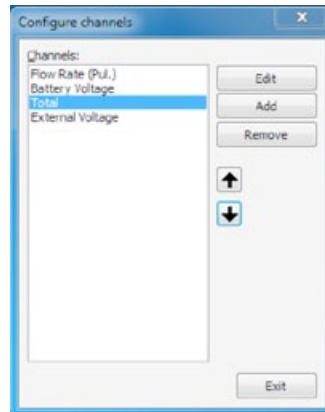
18.7.1 Ordering configured channels

The channel list after “Channels” have been added reflects the order in which they were configured and in which the XCI device takes physical measurements. This also orders the channels in both the logged data and the LCD. For example, when scrolling through the displayed channels on the LCD, the output order will be the same as the “Configure channels” dialogue box.

This order can be changed to suit the users needs.

1. Highlight the “Channel” in the list you wish to move and click either the “up” or “down” arrows (where available).

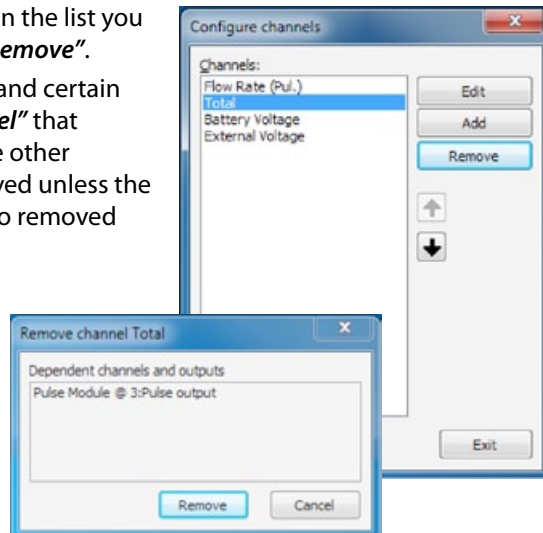
The order is hierarchical and certain limitations apply. A “Channel” that is dependent on the value of one or more channels cannot be moved higher in the list than the lowest “Channel” in which it depends upon.



18.7.2 Removing configured channels

1. Highlight the “Channel” in the list you wish to remove and click “Remove”.

The removal is hierarchical and certain limitations apply. A “Channel” that is referenced by at least one other “Channel” cannot be removed unless the dependent “Channel” is also removed first.



18.8 Edit Pulse module channel types

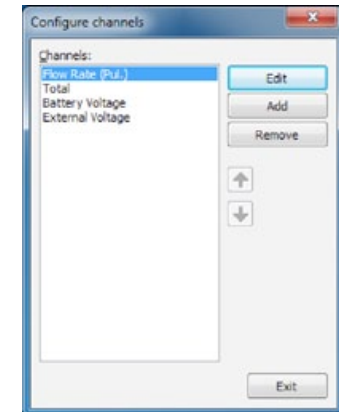


WARNING: All configured channels MUST be edited prior to starting the XCI device. Editing the channel/s enables the correct configuration information to be sent to the controller module.

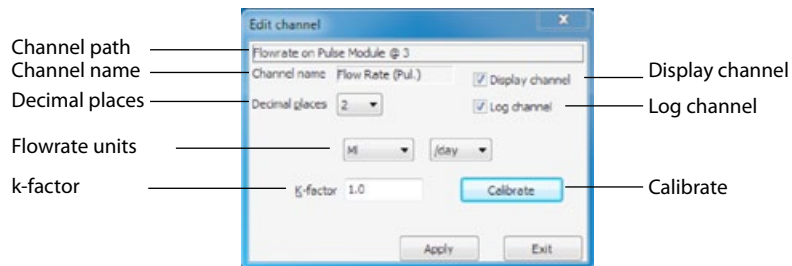
From the main “Device Settings” dialogue box click “Configure channel” and the “Configure channels” dialogue box will appear.

1. Highlight the channel you wish to edit and click “Edit”. An input specific “Edit channel” dialogue box will appear.

2. Edit the settings in the “Edit channel” dialogue box to suit your application as per the recommendations on the following pages. Click “Apply” to save the settings and return to the “Configure channels” dialogue box.



18.8.1 Edit a “Flowrate (using pulse)” channel type



Channel path

This describes the channel type and the module input source.

Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the **Display channel** check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

k-factor

The k-factor scales the input pulses to the selected flow rate units. The k-factor maybe entered directly for sensors with a known pulse rate or the “*Calibrate*” function may be used where it is unknown.

NOTE: Refer over page for instructions on the “*Calibrate*” function.

Display channel

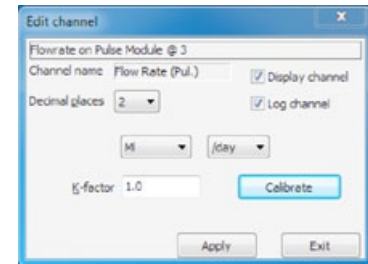
If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Calibrate function

1. Click “*Calibrate*” from the “*Edit channel*” dialogue box and the “*Calibrate channel*” dialogue box will appear.



2. With the sensor connected to the Pulse module, a steady stream flow in the pipe should be obtained. Over a number of minutes, the “*Current pulse rate*” should stabilize.

Current pulse rate

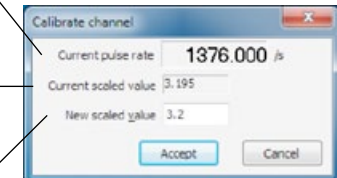
The number of pulses per second currently being received by the “*Pulse input*”.

Current scale value

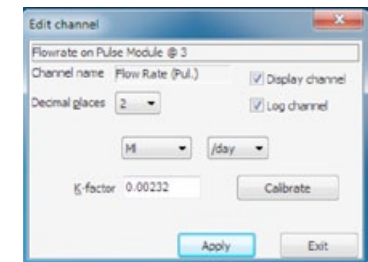
The current pulse rate multiplied by the current “*K-factor*”.

New scaled value

The current flow rate value in the configured “*Flowrate units*” is entered here.

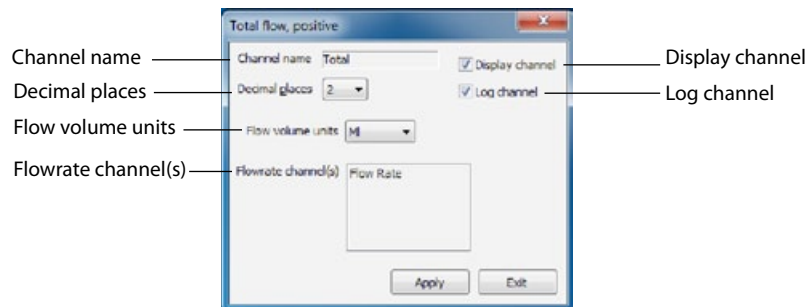


3. Once the “*Current pulse rate*” has stabilised, enter the actual flow rate value in the “*Flowrate units*” configured into the “*New scaled value*” field. Click “*Accept*” and the XCi device will calculate the new “*K-factor*” to apply to incoming pulses.



WARNING: Always use a high quality, accurate and preferably calibrated flow meter as your primary source of “*known*” flow rate.

18.8.2 Edit a “Total flow” channel type



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

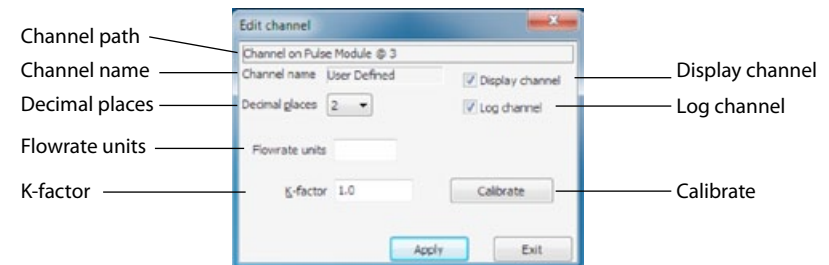
Flow volume units

Select the units from the drop down list box. This sets the units on the logged value.

Flowrate channel

“Total” is a derived channel type. This field defines from which named “Flowrate” channel the “Total” is being calculated.

18.8.3 Edit a “User defined” channel type



Channel path

This describes the channel type and the module input source.

Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Flowrate units

This sets the units on the logged value. This is a text field and is user defined.

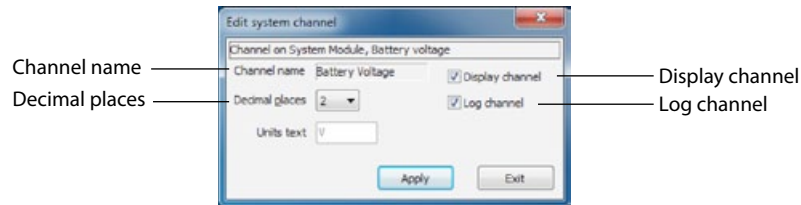
k-factor

The k-factor scales the input pulses to the selected flow rate units. The k-factor maybe entered directly for sensors with a known pulse rate or the “Calibrate” function may be used where it is unknown.

Calibrate

Refer to Chapter 18.8.1 for instructions on the “Calibrate” function.

18.8.4 Edit a “Device battery/external voltage” channel type



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

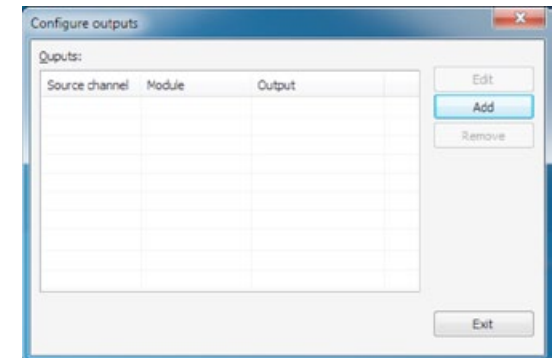
If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

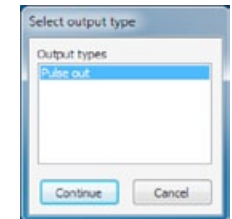
18.9 Add a Pulse module output

1. From the main “*Device settings*” dialogue box, click “*Configure outputs*” and the “*Configure outputs*” dialogue box will appear.

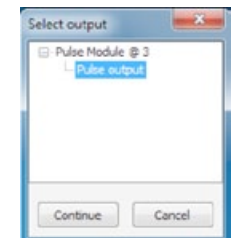


2. From the “*Configure outputs*” dialogue box click “*Add*” and the “*Select output type*” dialogue box will appear.

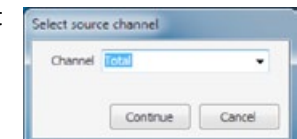
1. From the “*Select output type*” dialogue box highlight “*Pulse out*” and click “*Continue*”. The “*Select output*” dialogue box will appear.



2. Select “*Pulse output*” and click “*Continue*”. The “*Select source channel*” dialogue box will appear.



3. Select the “*Channel*” from the drop down list that you wish to output. In this example the channel named “*Total*” will be output from “*Pulse Module @ 3*” on “*Pulse output*”. Click “*Continue*” to add the new output. The “*Configure outputs*” dialogue box will re-appear with the new output listed.

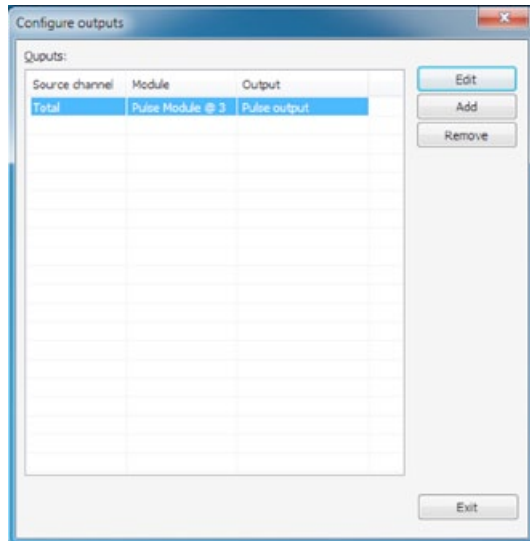


NOTE: Only channels that are suitable for “*Pulse*” outputting will be available for selection

18.10 Edit a Pulse module output

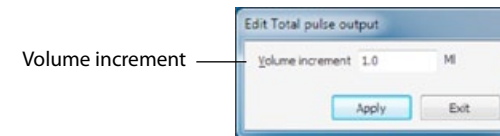
⚠ WARNING: All configured output channels MUST be edited prior to starting the XCi device. Editing the channel/s enables the correct configuration information to be sent to the controller module.

From the main “*Device Settings*” dialogue box click “*Configure outputs*” and the “*Configure outputs*” dialogue box will appear.



1. Highlight the channel you wish to edit and click “*Edit*”. An output specific “*Edit output*” dialogue box will appear.
2. Edit the settings in the “*Edit output*” dialogue box to suit your application as per the recommendations on the following page. Click “*Apply*” to save the settings and return to the “*Configure outputs*” dialogue box.

Editing a pulse output



Volume increment

The incremental value at which a pulse will be sent. In the example above, a pulse will be sent whenever an increment of 1 Megalitre is totalised.

⚠ NOTE: A maximum of 10 pulses per second may be sent per measurement interval. For example, during a measurement interval of three minutes (180 seconds) a maximum of 1,800 pulses can be sent. If the XCi device has not sent all pulses by the time of the next measurement, pulses WILL be lost.

⚠ Click “Apply” to save the settings then click “Exit” to return to the “Configure outputs” dialogue box.

Removal of outputs

From the “*Configure outputs*” dialogue box highlight the “*Output*” you wish to remove and click “*Remove*”. You will be prompted to confirm the removal.

19.0 The SDI-12 Master card

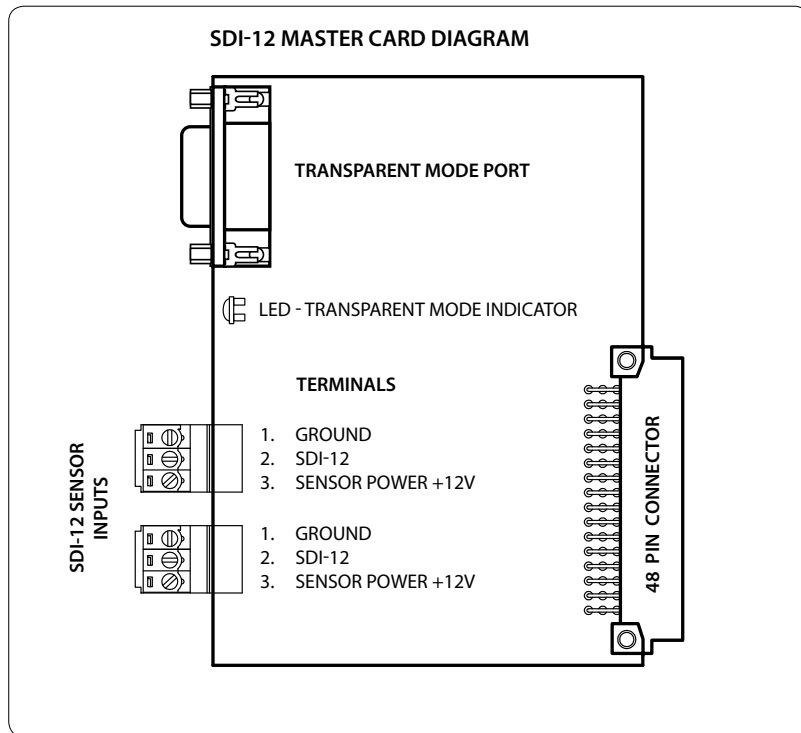
19.1 About the SDI-12 Master card

The SDI-12 Master card enables an array of SDI-12 environmental monitoring sensors to be controlled and logged by the XCi device.

The input terminals available on each SDI-12 Master card are shown in the diagram below.

! MACE recommends the user studies the relevant documentation supplied with each third party sensor prior to connection

! MACE recommends the user downloads and studies the SDI-12 protocol documentation available from <http://www.sdi-12.org>



! As per the SDI-12 protocol, each card can support up to 10 sensors. Should more inputs be required another card (Part No. 850-368) should be purchased.

19.2 Wiring a SDI-12 Master card

After installing the card, connect it to the SDI-12 sensor using either of the two 3-way terminal blocks. Two terminal blocks are provided for user convenience when wiring multiple sensors.

The "Transparent Mode" port allows you to send extended SDI-12 commands to sensors using a terminal program such as Microsoft® HyperTerminal®.

Connect the PC running the terminal program using a serial cable (or USB-to-serial adapter).

The port settings in the terminal program should be set to the following:

9600 baud
8 data bits
No parity
1 stop bit
No flow control

! **NOTE: When a transparent mode session is in progress the LED Transparent Mode Indicator will light.**

HyperTerminal is a registered trademark of Microsoft Corporation in the United States and other countries.

Once a sensor has been wired to the SDI-12 Master card it must be configured using FloCom+ software so that the XCi device can control and record data from the sensor.

Essential Steps to configure an SDI-12 Master card using FloCom+ software:

1. Run "SDI-12 Master" utility
2. Add Modules
3. Add Channels
4. Edit Channels
5. Apply Settings
6. Run "Measure and Display" function

19.3 The “SDI-12 Master utility”

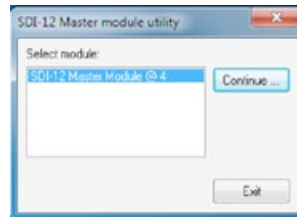
NOTE: In order to correctly add and configure SDI-12 sensor value channel types it is highly recommended to run the “SDI-12 Master utility” as described in the procedure below.

This utility provides the user with a simple SDI-12 interface to communicate with connected smart sensors. The user can send all defined SDI-12 commands as implemented in Version 1.3 of the SDI-12 Protocol specification. Download from <http://www.sdi-12.org>

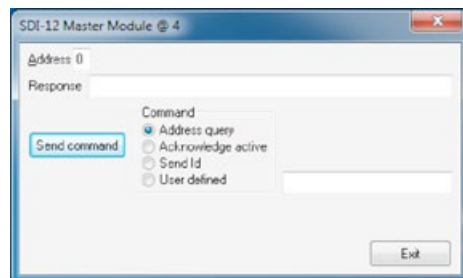
1. From the “Device settings” dialogue box click “SDI-12 Master utility”.



2. Highlight the “SDI-12 Master Module” that the sensor/s are connected too, click “Continue” and the SDI-12 Master module utility will be activated in the new dialogue box shown below.



3. Select the radio button for the command you wish to send.

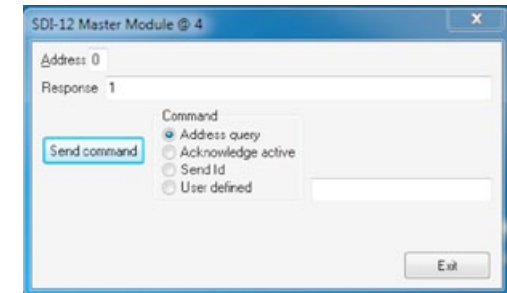


WARNING: If an incorrect SDI-12 command is sent or a command is sent to the wrong sensor address the SDI-12 Master Utility “Response” will be <error>

19.3.1 Address query:

Click “Send command” and the sensor will respond with the sensor address in the “Response” field.

In the example, the sensor has responded to an Address query with Address “1”.



WARNING: If more than one sensor is connected to the bus, all sensors will respond causing a bus contention.

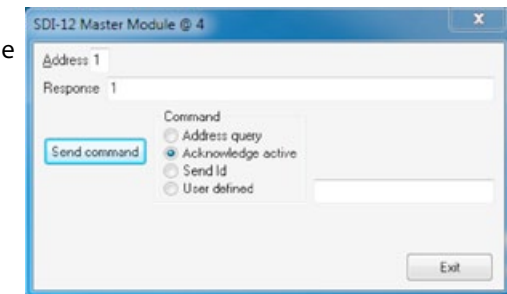
If multiple sensors are connected to the bus the user must ensure that they have an alternative means of identifying the sensor addresses. For example, each sensor may be connected to the bus individually and the “Address query” sent for each. Alternatively, sensor addresses may be added to the “Address field” and a “Send ID” command performed on each individual address. The user should then note the addresses of each sensor identified.

WARNING: For the following radar button commands it is imperative that the correct sensor address be entered into the “Address” field prior to sending commands.

19.3.2 Acknowledge active:

Enter the known address of the sensor you wish to acknowledge in the “Address” field. Click “Send command” and the sensor will respond (if active) with the sensor address in the “Response” field.

In the example, the sensor on Address “1” has responded to an Acknowledge active.

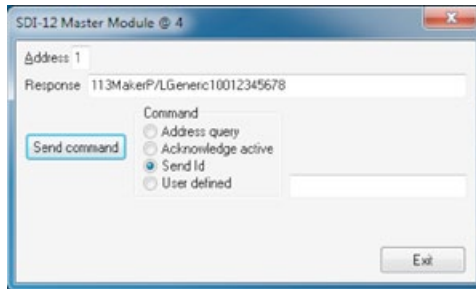


19.3 The “SDI-12 Master utility” - continued

19.3.3 Send Id:

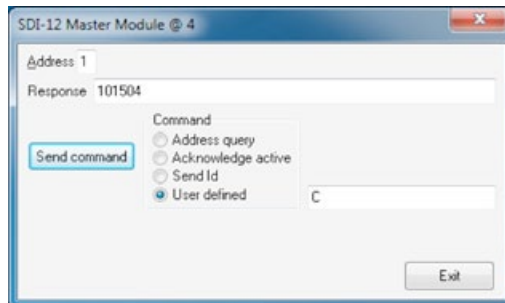
Enter the known address of the sensor you wish to identify in the “Address” field. Click “Send command” and the sensor will respond (if active) with the sensor’s identification string in the “Response” field.

In the example, the sensor on Address “1” has responded with the sensor’s identification string.



19.3.4 User defined:

Enter the known address of the sensor you wish to command in the “Address” field. Enter a valid SDI-12 command into the text field and click “Send command”. The sensor will respond (if active) in the “Response” field.

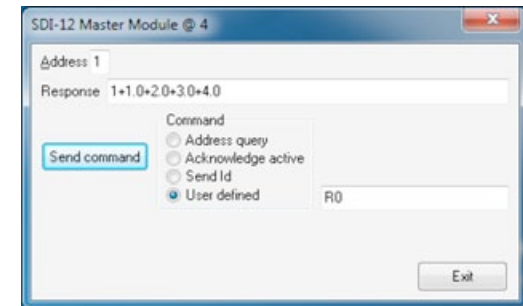


In the example above, the sensor on Address “1” of the SDI-12 bus has responded to a “C” command with the Response “101504”.

The 1st digit is the Address identifier (1). The 2nd, 3rd and 4th digits are the time the sensor requires to take a measurement (015 seconds). The 5th and 6th digits are the number of measurement values that will be sent (04).



WARNING: The user MUST ensure that the time required for the sensor to take a measurement is noted BEFORE adding “SDI-12 sensor value” channel types.



In the 2nd example, the sensor on Address “1” of the SDI-12 bus has responded to a “R0” command with the Response “1+1.0+2.0+3.0+4.0”.

The 1st digit is the Address identifier (1). The four measurement values with a polarity sign (+/-) follow.



WARNING: The user MUST ensure the position of the measurement values in the string are noted BEFORE adding “SDI-12 sensor” channel types. In the string the measurement after the address identifier is called “Value number 1”.

19.4 Add and remove an SDI-12 Master module in FloCom+

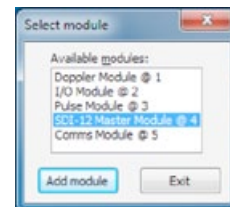
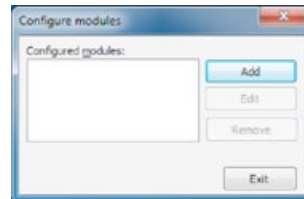
19.4.1 Add an SDI-12 Master module

NOTE: Once a FloSeries3 card is installed in an XCi device, FloCom+ defines this as a module.

1. From the main “Device settings” dialogue box click “Configure modules” and a dialogue box will appear as shown.

2. Click “Add” and the available modules will be listed in the “Select module” dialogue box.

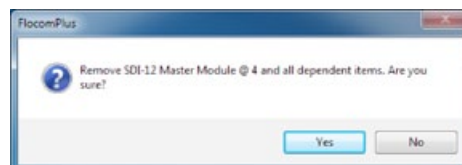
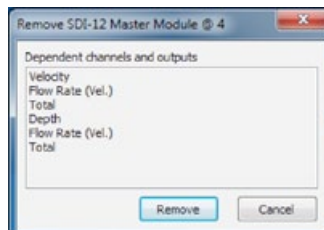
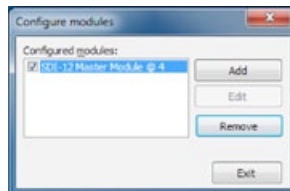
3. Each MACE module available is referenced in the list by its type and slot number. (eg. SDI-12 Master module in card slot 4). Highlight the module you wish to add and click “Add module”.



NOTE: Once a module has been added it will no longer appear on the available modules list

19.4.2 Remove an SDI-12 Master module

1. From the “Configure modules” dialogue box highlight the module that you wish to remove. Click “Remove” and a dialogue box will appear listing the “Dependent channels and outputs”. Click “Remove” and you will be prompted to confirm your action. Click “Yes” and the module and dependent channels will be removed.

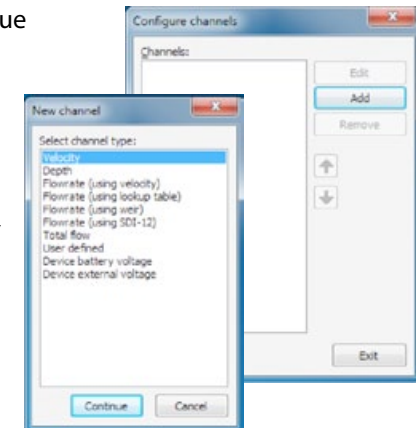


19.5 Add SDI-12 Master channel types

From the main “Device Settings” dialogue box click “Configure channels” and the “Configure channels” dialogue box will appear.

1. Click “Add” and the “New channel” dialogue box will appear as shown.

The “Channel types” visible in the “New channel” dialogue box are dependent upon the modules that have been configured.



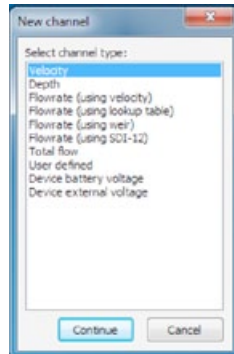
WARNING: Adding a new channel creates a new data session. It is essential to download the data from the XCi device PRIOR to adding new channels to an XCi device that has already been configured and has had data recorded.

SDI-12 Master module channel types

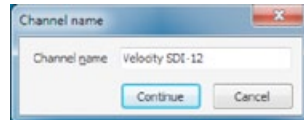
Channel types	Description
Velocity:	This channel type MUST be used whenever the resultant velocity measurement will be used in a flow rate calculation.
Depth:	This channel type MUST also be used whenever the resultant depth measurement will be used in a flow rate calculation.
Flowrate: (using velocity)	Used to calculate a flow rate based upon the results obtained from configured velocity and depth channels.
Flowrate: (using lookup table)	Used to calculate a flow rate based upon user configured lookup table of a rated structure.
Flowrate: (using weir)	Used to calculate a flow rate based upon a depth channel and a selected weir type.
Flowrate: (using SDI-12)	Used to calculate a flow rate based an SDI-12 sensor flowrate value
Total Flow:	Used to calculate an accumulated positive or negative total based on the results obtained from a configured flow rate channel.
User Defined:	Can be used when a SDI-12 sensor is to be configured for parameters other than those listed above. It should NOT be used for velocity or depth sensors where the results are required for a flow rate calculation.
Device battery voltage	Used to monitor the XCi device internal battery voltage.
Device external voltage	Used to monitor the XCi device external voltage from a solar panel or mains charger.

19.5.1 Add a “Velocity”, “Depth” or “User defined” channel type

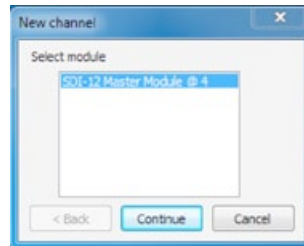
1. Select the “SDI-12 sensor value” channel type from the “New channel” dialogue box and click “Continue”.



2. The “Channel name” dialogue box will appear. Enter a channel “Name” in to the text field (16 character maximum). This “name” will also be displayed on the XCi device main LCD if enabled. Click “Continue”.



3. In the “Select module” dialogue box highlight the “SDI-12 Master Module” from which the named channel will receive its value. Click “Continue” and a new dialogue box will appear with the “Sensor address” and “Value number”.



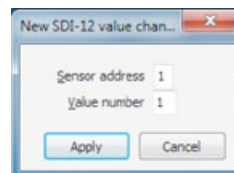
4. Input the Sensor address and the Value number into the respective text fields.

NOTE: These values should have been acquired by running the SDI-12 Master utility.

In this example the channel named “Velocity SDI-12” will receive it’s measurement from a sensor connected to “SDI-12 Master Module @ 4” on “Sensor address 1”. The “Value number 1” denotes that the measurement value comes from the first value of the SDI-12 string.

Click “Apply” to complete the new channel.

The “Configure channels” dialogue box will re-appear with the new channel listed.



19.5.2 Add a “Flowrate (using velocity)” channel type

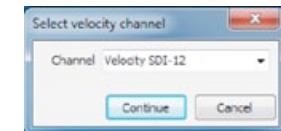
1. Select the “Flowrate (using velocity)” channel type from the “New channel” dialogue box and click “Continue”.



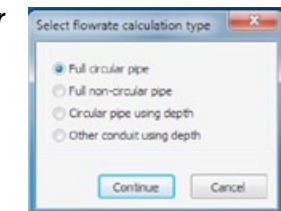
2. The “Channel name” dialogue box will appear. Enter a channel “Name” in to the text field (16 character maximum). This “name” will also be displayed on the XCi device main LCD if enabled. Click “Continue”.



3. In the “Select velocity channel” dialogue box use the drop down list to highlight the velocity channel on the SDI-12 Master card from which the named “FR (Vel) SDI-12” channel will receive its value. Click “Continue” and the “Select flowrate calculation type” dialogue box will appear.



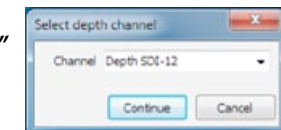
4. Select either “Full circular pipe”, “Full non-circular pipe”, “Circular pipe using depth” or “Other conduit using depth” depending upon your application.



5. If you select a “Full...” pipe type, click “Continue” to complete the new channel.

If you select a “Circular pipe using depth” or “Other conduit using depth”, click “Continue” and the “Select depth channel” dialogue box will appear.

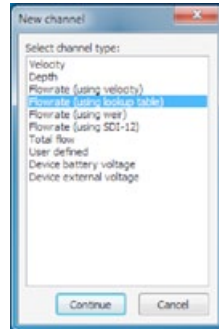
6. In the “Select depth channel” dialogue box use the drop down list to highlight the named “Depth...” channel from which the named “FR (Vel) SDI-12” channel will receive its value. Click “Continue” to complete the new channel.



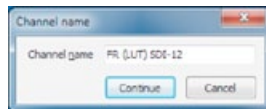
7. The “Configure channels” dialogue box will re-appear with the new channel listed.

19.5.3 Add a “Flowrate (using lookup table)” channel type

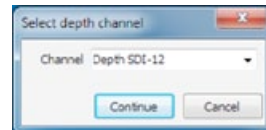
1. Select the “Flowrate (using lookup table)” channel type from the “New channel” dialogue box and click “Continue”.



2. The “Channel name” dialogue box will appear. Enter a channel “Name” in to the text field (16 character maximum). This “name” will also be displayed on the XCi device main LCD if enabled. Click “Continue”.



3. In the “Select depth channel” dialogue box use the drop down list to highlight the depth channel on the I/O card from which the named “FR (LUT) SDI-12” channel will receive its value.



4. Click “Continue” and the “Configure channels” dialogue box will re-appear with the new channel listed.

19.5.4 Add a “Flowrate (using weir)” channel type

The XCi device’s contain in-built equations for allowing users to measure flow rate through rated structures such as flumes and weirs. The table below lists the structures supported and the equations used to calculate flow rate.

All of the weir equations assume that the flow is fully contracted, meaning that the approach channel is wide enough and deep enough that the proximity of the floor and sidewalls to the weir opening does not affect the flow (Tony L. Wahl, Bureau of Reclamation Hydraulics Laboratory in Denver, Colorado, USA).

The equations used by the XCi device’s and reproduced here are used with permission of U.S. Dept. of the Interior, Bureau of Reclamation - Hydraulic Investigations and Laboratory Services Group. For further information users are encouraged to visit the following websites:

www.usbr.gov/pmts/hydraulics_lab/pubs/wmm/index.htm

www2.alterra.wur.nl/Internet/webdocs/ilri-publicaties/publicaties/Pub20/pub20.pdf

Flume and Weir Equation Summary

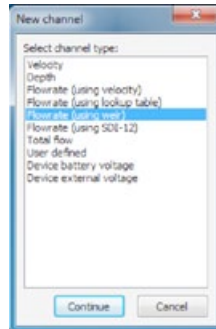
	Equation, cfs (head measured in feet)	Equation, kL/sec (m ³ /sec) ~ head measured in meters
Contracted rectangular weir	$Q=3.33(L-0.2h_1)h_1^{1.5}$	$Q=1.84(L-0.2h_1)h_1^{1.5}$
Suppressed rectangular weir	$Q=3.33(L)h_1^{1.5}$	$Q=1.84(L)h_1^{1.5}$
V-notch weir, 90°	$Q=2.49h_1^{2.48}$	$Q=1.34h_1^{2.48}$
V-notch weir, 30°	$Q=(8/15)(2g)^{0.5}C_e \tan(\theta/2)(h_1+k_n)2.5$	$Q=(8/15)(2g)^{0.5}C_e \tan(\theta/2)(h_1+k_n)2.5$
V-notch weir, 45°	$Q=(8/15)(2g)^{0.5}C_e \tan(\theta/2)(h_1+k_n)2.5$	$Q=(8/15)(2g)^{0.5}C_e \tan(\theta/2)(h_1+k_n)2.5$
V-notch weir, 60°	$Q=(8/15)(2g)^{0.5}C_e \tan(\theta/2)(h_1+k_n)2.5$	$Q=(8/15)(2g)^{0.5}C_e \tan(\theta/2)(h_1+k_n)2.5$
Cipoletti weir	$Q=3.367(L)h_1^{1.5}$	$Q=1.86(L)h_1^{1.5}$
Parshall flumes	$Q=Ch_a^n$	$Q=Ch_a^n$
Replogle flumes (long-throated flumes or “ramp” flumes)	$Q = K_1(h_1+K_2)^U$	$Q = K_1(h_1+K_2)^U$
Palmer-Bowlus flumes	$Q = K_1(h_1+K_2)^U$	$Q = K_1(h_1+K_2)^U$

<p>Definitions, cfs Q = discharge, cfs L = weir width, ft h₁ = upstream head, ft C_e = V-notch weir coefficient k_n = V-notch weir head adjustment factor, ft θ = V-notch weir angle, degrees h_a = Parshall flume upstream head, ft C = Parshall flume coefficient n = Parshall flume exponent g = acceleration due to gravity, 32.2 ft/s²</p>	<p>Definitions, kL/sec Q = discharge, kL/sec L = weir width, m h₁ = upstream head, m C_e = V-notch weir coefficient k_n = V-notch weir head adjustment factor, m θ = V-notch weir angle, degrees h_a = Parshall flume upstream head, m C = Parshall flume coefficient n = Parshall flume exponent g = acceleration due to gravity, 9.806 m/s²</p>
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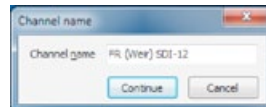
The V-notch weir and Parshall flume coefficients used by an XCi device can be found in Appendix A

19.5.4 Add a "Flowrate (using weir)" channel type - continued

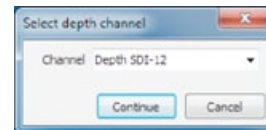
1. Select the "Flowrate (using weir)" channel type from the "New channel" dialogue box and click "Continue".



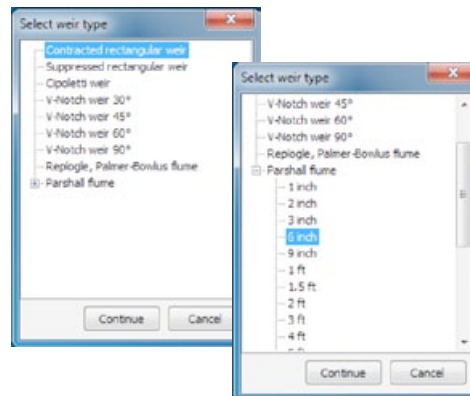
2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".



3. In the "Select depth channel" dialogue box use the drop down list to highlight the depth channel from which the channel (named "FR (Weir) SDI-12" in this example) will receive its value. Click "Continue" and the "Select weir type" dialogue box will appear.



4. Select the weir type that you wish to configure. If you are setting up a flow rate through a Parshall flume, expand the "Parshall flume" weir type and select the appropriate flume width from the expanded list.

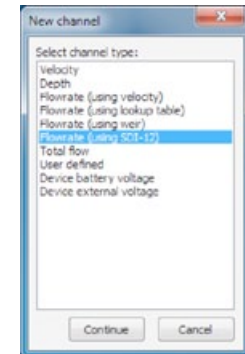


5. Click "Continue" to complete the new channel.

6. The "Configure channels" dialogue box will re-appear with the channel listed.

19.5.5 Add a "Flowrate (using SDI-12)" channel type

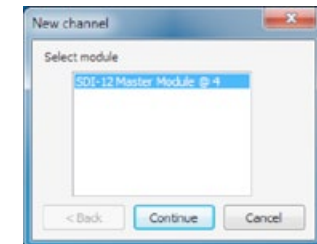
1. Select the "SDI-12 sensor value" channel type from the "New channel" dialogue box and click "Continue".



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".



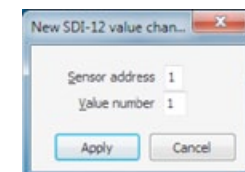
3. In the "Select module" dialogue box highlight the "SDI-12 Master Module" from which the named channel will receive its value. Click "Continue" and a new dialogue box will appear with the "Sensor address" and "Value number".



4. Input the Sensor address and the Value number into the respective text fields.

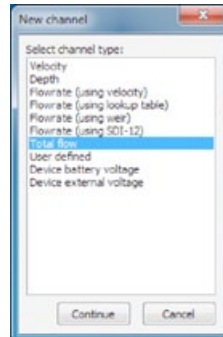
NOTE: These values should have been acquired by running the SDI-12 Master utility.

In this example the channel named "FR (SDI-12)" will receive it's measurement from a sensor connected to "SDI-12 Master Module @ 4" on "Sensor address 1". The "Value number 1" denotes that the measurement value comes from the first value of the SDI-12 string. Click "Apply" to complete the new channel. The "Configure channels" dialogue box will re-appear with the new channel listed.

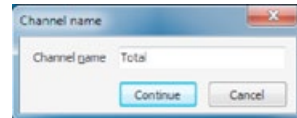


19.5.6 Add a "Total flow" channel type

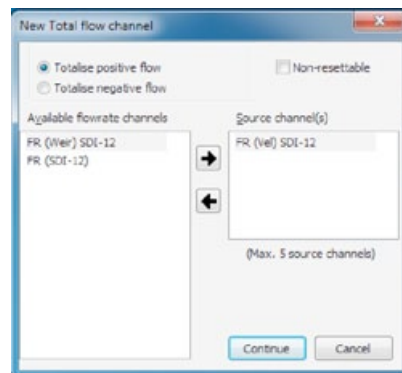
1. Select the "Total flow" channel type from the "New channel" dialogue box and click "Continue".



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue" and the "New total flow channel" dialogue box will appear.



3. From the "Available flowrate channels" list, highlight the Flowrate channel from which the channel named "Total" will receive its value. Click the "Right arrow" and the channel will appear in the "Source channel(s)" list. A maximum of five flowrate channels can be totalised together.



4. Select either "Totalise positive flow" or "Totalise negative flow" depending upon your application.

! WARNING: The "Totalise positive flow" type will only increment the totaliser. If negative flows are recorded the totaliser will NOT decrement. The positive totaliser rolls over to zero.

! WARNING: The "Totalise negative flow" type will only decrement the totaliser. If positive flows are recorded the totaliser will NOT increment. The negative totaliser rolls over to zero.

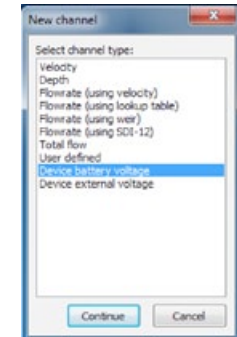
! Both positive and negative flow rates will be recorded in the data file.

5. If the "Non-resettable" checkbox is ticked, this total flow channel will not be re-settable using the "Set/reset" procedure from the "View totals" main menu item.

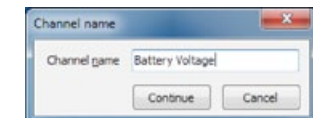
6. Click "Continue" to complete the new channel and the "Configure channels" dialogue box will re-appear with the new channel listed.

19.5.7 Add a "Device battery voltage" channel type

1. Select the "Device battery voltage" channel type from the "New channel" dialogue box and click "Continue".

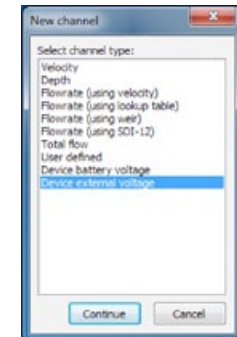


2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".

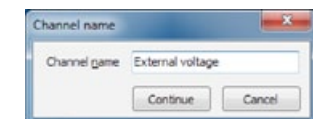


19.5.8 Add a "Device external voltage" channel type

1. Select the "Device external voltage" channel type from the "New channel" dialogue box and click "Continue".



2. The "Channel name" dialogue box will appear. Enter a channel "Name" in to the text field (16 character maximum). This "name" will also be displayed on the XCi device main LCD if enabled. Click "Continue".



19.6 The order and removal of SDI-12 Master channels

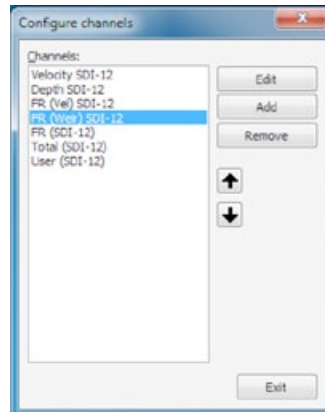
19.6.1 Ordering configured channels

The channel list after “Channels” have been added reflects the order in which they were configured and in which the XCI device takes physical measurements. This also orders the channels in both the logged data and the LCD. For example, when scrolling through the displayed channels on the LCD, the output order will be the same as the “Configure channels” dialogue box.

This order can be changed to suit the users needs.

1. Highlight the “Channel” in the list you wish to move and click either the “up” or “down” arrows (where available).

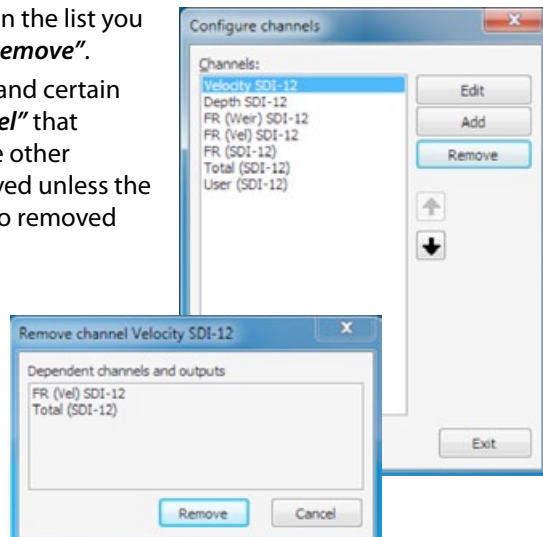
The order is hierarchical and certain limitations apply. A “Channel” that is dependent on the value of one or more channels cannot be moved higher in the list than the lowest “Channel” in which it depends upon.



19.6.2 Removing configured channels

1. Highlight the “Channel” in the list you wish to remove and click “Remove”.

The removal is hierarchical and certain limitations apply. A “Channel” that is referenced by at least one other “Channel” cannot be removed unless the dependent “Channel” is also removed first.



19.7 Edit SDI-12 Master channel types

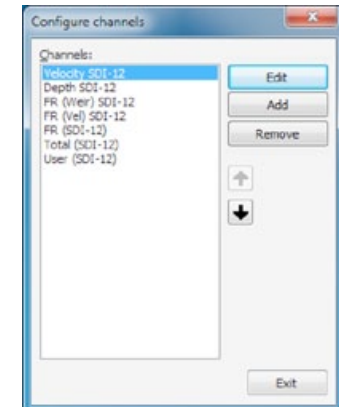


WARNING: All configured channels MUST be edited prior to starting the XCI device. Editing the channel/s enables the correct configuration information to be sent to the controller module.

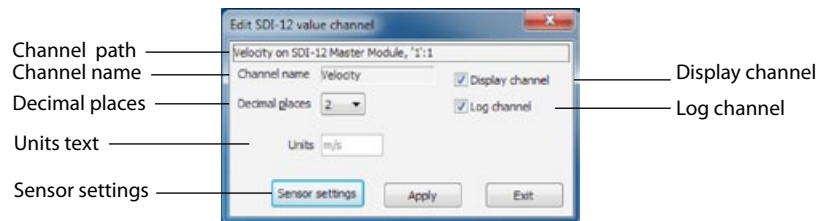
From the main “Device Settings” dialogue box click “Configure channel” and the “Configure channels” dialogue box will appear.

1. Highlight the channel you wish to edit and click “Edit”. An input specific “Edit channel” dialogue box will appear.

2. Edit the settings in the “Edit channel” dialogue box to suit your application as per the recommendations on the following pages. Click “Apply” to save the settings and return to the “Configure channels” dialogue box.



19.7.1 Edit a “Velocity”, “Depth” or “User defined” channel type



Channel path

This describes the channel type and the module input source.

Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the **Display channel check box is ticked**

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Units text

This sets the units on the logged value. This is a text field and is user defined.

NOTE: If a “Velocity” or “Depth” channel type is configured on a “SDI-12 Master” input the units are defined according to the “System settings”

Display channel

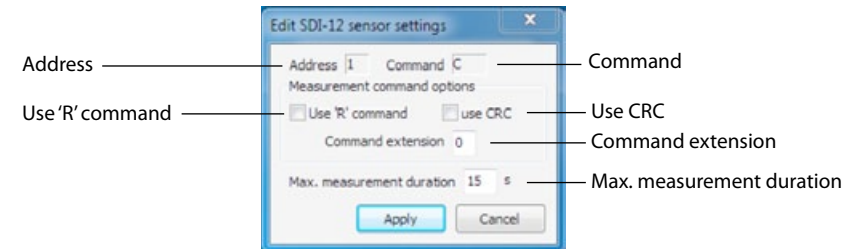
If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Sensor settings

Click “Sensor settings” and the “Edit SD-12 Sensor settings” dialogue box will appear. Use this to configure the SDI-12 Sensor measurement commands.



Address

This shows the sensor address on the SDI-12 bus.

Command

This shows the current SDI-12 command that will be sent to the sensor when starting a measuring sequence. By default this will be a “C” command.

Use ‘R’ command

If a concurrent measurement (C) is not to be initiated, check this box.

Use CRC

To enhance error detection, check this box and the data will be returned with a 16-bit cyclic redundancy check (CRC).

Command extension

Command extensions provide a means to request different types of measurements or sensor instructions.

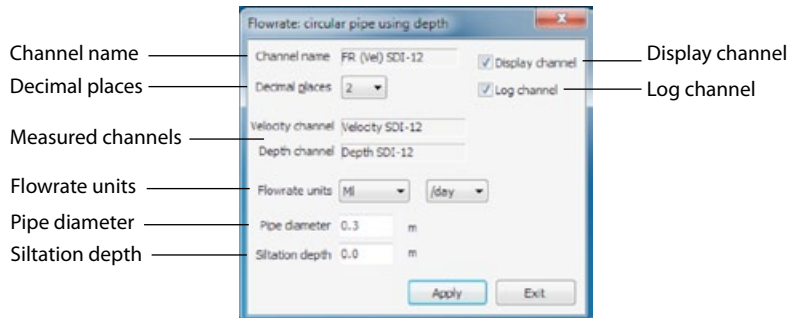
Maximum measurement duration

As identified using the “SDI-12 master utility”, a sensor will require a specified time (in seconds) until the sensor will have the measurement ready.

WARNING: The user **MUST** add an extra second to the specified time in this text field or the bus may behave erratically.

19.7.2 Edit a “Flowrate (using velocity)” channel type

19.7.2.1 Flowrate: Full circular pipe, Full non-circular pipe, Circular pipe using depth



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Measured channels

“Flowrate” is a derived channel type. These fields define from which measured channels flowrate is being calculated.

NOTE: In a “Flowrate: full circular pipe” dialog box only a velocity channel will be displayed

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

Pipe diameter

The “Pipe diameter” (cross-sectional area if a non-circular pipe) is entered here.

If the “Flowrate” channel is configured for “Conduit using depth” then the “Pipe diameter” field will not appear.

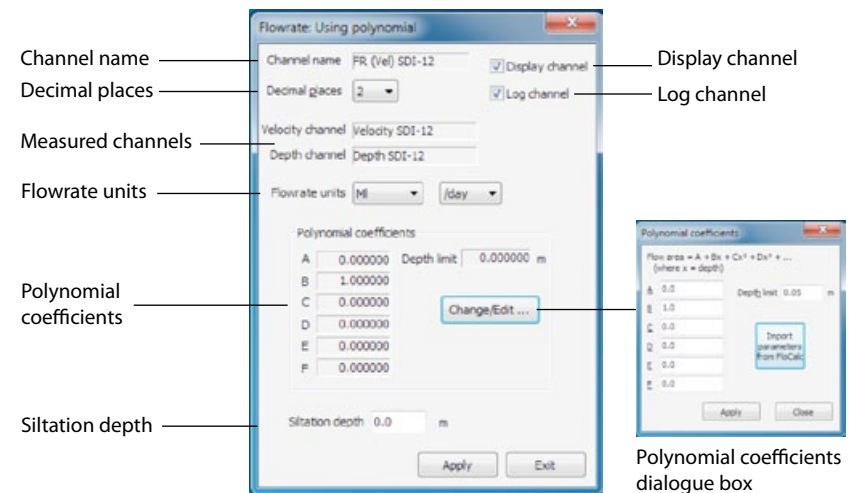
Siltation depth

This parameter can be used to correct the calculated flow rate if a known amount of silt is inside the pipe.

The depth of silt will be subtracted from the area calculation in order to calculate the corrected flow rate.

19.7.2.2 Flowrate: Other conduit using depth

When the stream flow is in an open channel (non-circular), the user must determine the cross-sectional area and relate it to depth via a polynomial equation. MACE XCi devices use 5th order polynomial equations.



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

19.7.2 Edit a “Flowrate (using velocity)” channel type - continued

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Measured channels

“Flowrate” is a derived channel type. These fields define from which measured channels flowrate is being calculated.

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

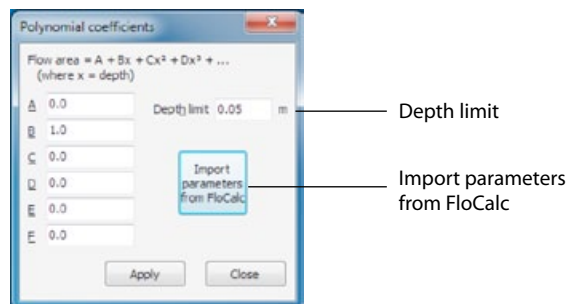
Polynomial coefficients

The polynomial coefficients listed in FloCom+ are related to the following equation:

$$\text{Cross-Sectional Area} = A + B \cdot X + C \cdot X^2 + D \cdot X^3 + E \cdot X^4 + F \cdot X^5$$

Where X = depth of stream

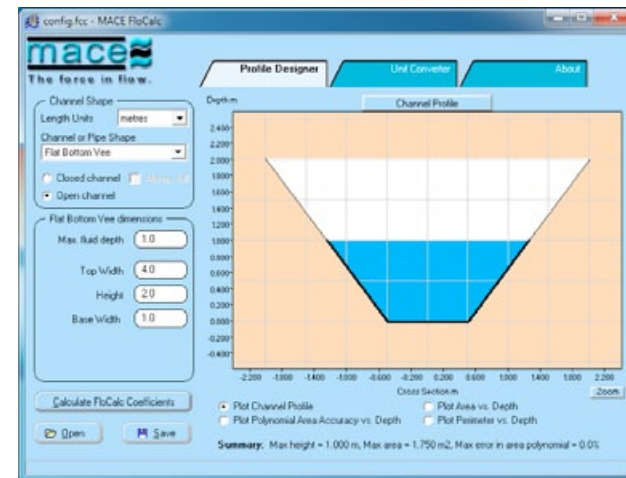
The coefficients are listed in order A, B, C, D, E, F.



Import parameters from FloCalc

The Mace utility program FloCalc (download separately from www.macemeters.com) can be used to draw regular and irregular channel shapes. These shapes are then converted into a 5th order polynomial. Their coefficients can be imported directly into the appropriate fields in FloCom+.

1. Click “Import parameters from FloCalc” and MACE FloCalc will open on the “Profile Designer” tab sheet.



2. Describe/draw your channel or pipe shape in FloCalc (see FloCalc Product Manual).
3. Click “Calculate FloCalc Coefficients” and the “MACE FloCalc Coefficients” dialogue box will appear.
4. Click “Copy to Clipboard” then click “Close” and exit from FloCalc.

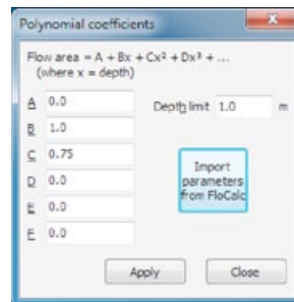
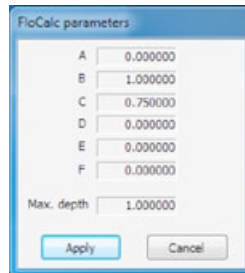


19.7.2 Edit a "Flowrate (using velocity)" channel type - continued

5. The "FloCalc parameters" dialogue box will appear containing the calculated polynomial coefficients.

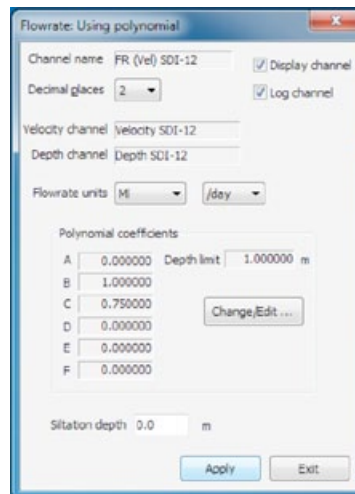
6. Review the coefficients and click "Apply" to update the "Polynomial coefficients" dialogue box.

7. Click "Apply" and the coefficients in the "Flowrate: Using polynomial" dialogue box will be set.

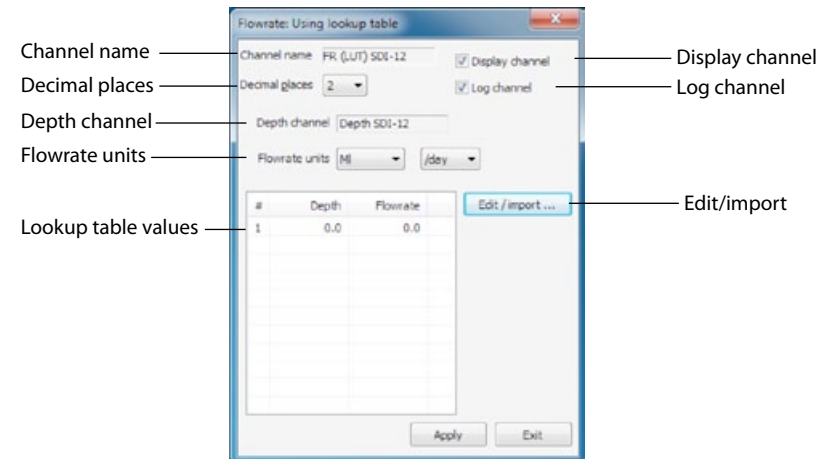


Depth limit

When the cross-sectional area of a stream is calculated using the polynomial coefficient method, the user must set the "Depth limit" at which the polynomial reaches a maximum. For example, if a channel has a maximum depth of 1.0m the "Depth limit" should be set at 1.0m as well. Alternatively the "Depth limit" can be set within FloCalc and the procedure described for importing polynomial coefficients.



19.7.3 Edit a "Flowrate (using lookup table)" channel type



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCI device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Depth channel

The source channel for depth values used by the lookup table

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

19.7.3 Edit a “Flowrate (using lookup table)” channel type - *continued*

Lookup table values

Lists the flowrates that will be calculated at the corresponding measured depths.

NOTE: The lookup table has a maximum of 35 lines available for use. This maximum is memory dynamic and may be reduced depending upon other channel configurations.

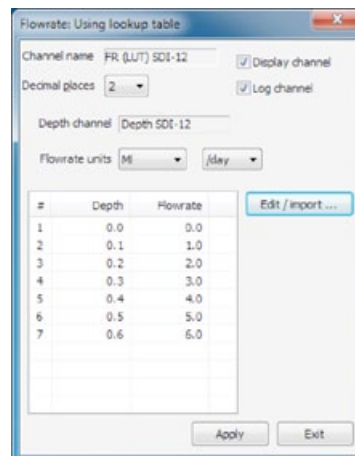
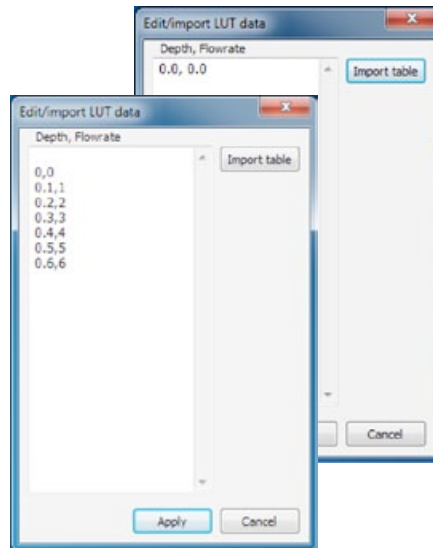
Edit/import

1. From the “Flowrate: Using lookup table” dialogue box click “Edit/import” and the “Edit/import LUT data” dialogue box will appear.

2. Lookup table values can be entered here directly. The depth and corresponding flowrate values must be separated by a comma (,).

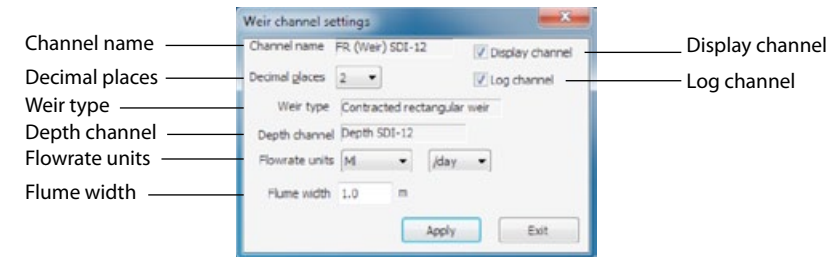
3. Alternatively, values may be imported from a *.CSV file. Click “Import table” and a Windows® “Open” dialogue box will appear prompting the selection of a *.CSV file. Click “Open” and the values will be imported.

4. Click “Apply” and the “Flowrate: Using lookup table” dialogue box will appear containing the updated values.



19.7.4 Edit a “Flowrate (using weir)” channel type

19.7.4.1 Flowrate (Weir): Rectangular and Cipoletti weirs



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Weir type

The weir type selected when the channel was added.

Depth channel

The depth channel selected for the weir calculation when the channel was added.

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

Flume width

Enter the width of the weir in the units shown. The units are defined according to the “System settings”.

19.7.4 Edit a “Flowrate (using weir)” channel type - continued

19.7.4.2 Flowrate (Weir): V-Notch weirs (30°, 45°, 60°, 90°)



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Weir type

The weir type selected when the channel was added.

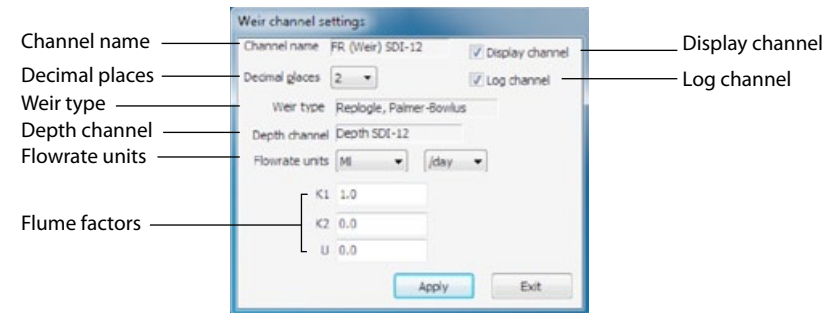
Depth channel

The depth channel selected for the weir calculation when the channel was added.

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

19.7.4.3 Flowrate (Weir): Replogle, Palmer-Bowlus flumes



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Weir type

The weir type selected when the channel was added.

Depth channel

The depth channel selected for the weir calculation when the channel was added.

Flowrate units

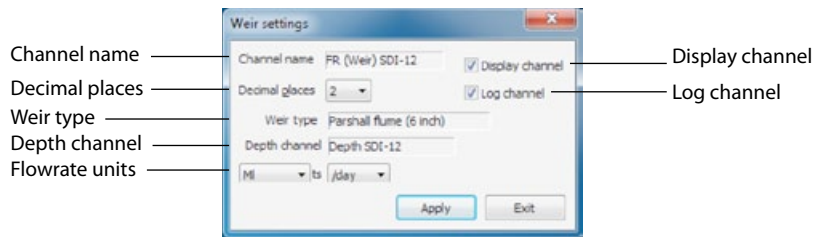
Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

Flume factors

Long-throated flumes are custom-designed. The values of K1, K2, and U are determined by the designer, using software such as **WinFlume** available from: http://www.usbr.gov/pmts/hydraulics_lab/winflume/index.html

19.7.4 Edit a “Flowrate (using weir)” channel type - *continued*

19.7.4.4 Flowrate (Weir): Parshall flume



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Weir type

The weir type selected when the channel was added.

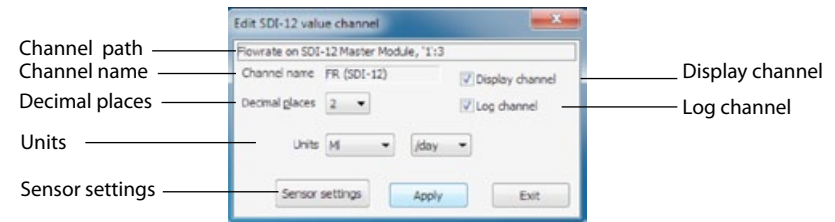
Depth channel

The depth channel selected for the weir calculation when the channel was added.

Flowrate units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

19.7.5 Edit a “Flowrate (using SDI-12)” channel type



Channel path

This describes the channel type and the module input source.

Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Units

Select the units and the timebase from the drop down list boxes. This sets the units on the logged value.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

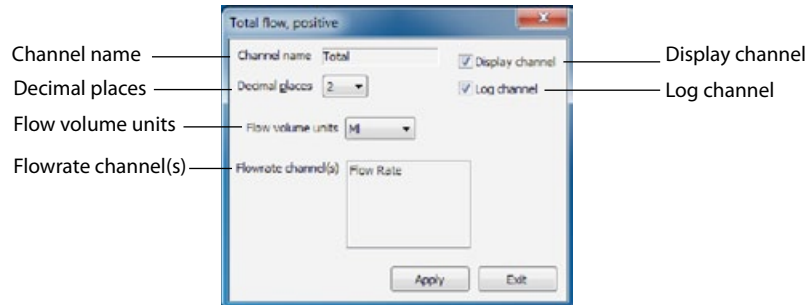
Log channel

If this check box is ticked then this channel will be logged in the data file.

Sensor settings

Refer to Chapter 19.7.1

19.7.6 Edit a "Total flow" channel type



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

If this check box is ticked then this channel will be logged in the data file.

Flow volume units

Select the units from the drop down list box. This sets the units on the logged value.

Flowrate channel

"Total" is a derived channel type. This field defines from which named "Flowrate" channel the "Total" is being calculated.

19.7.7 Edit a "Device battery/external voltage" channel type



Channel name

This is the name given to the channel by the user when setup.

NOTE: This name will also show on the XCi device LCD screen if the Display channel check box is ticked

Decimal places

The user can set the number of decimal places (0, 1, 2, 3) using the drop down list box. These decimal places will be shown in both the data file and the LCD.

Display channel

If this check box is ticked then this channel will be displayed on the LCD.

Log channel

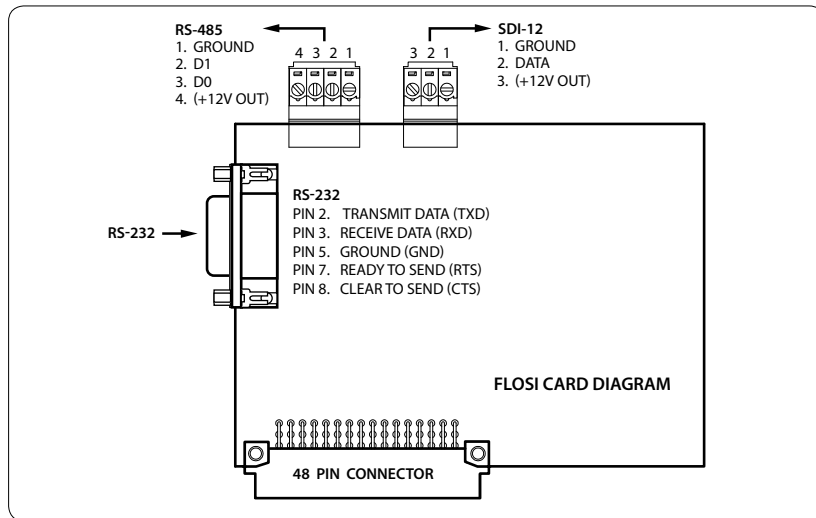
If this check box is ticked then this channel will be logged in the data file.

20.0 The FloSI card

20.1 About the FloSI card

The FloSI (Serial Interface) card provides an SDI-12 or ModBus output to interface an XCi device to SCADA systems.

This card provides unconditional polling access to the most recent user configured measurement results of XCi devices.



NOTE: Only one FloSI per XCi device is supported

RS-232, RS-485 and SDI-12, interfaces are available from the XCi device with the use of a FloSI. The FloSI enables users to request the last measurement from The XCi device without the complexity of communicating via the host communications port.

The FloSI cannot be used to download or configure a XCi device, and only one serial protocol may be used at one time.

20.2 Wiring a FloSI card

After installing the FloSI card, connect it to the remote device using either:

1. The 9-pin d-connector (RS232, ASCII or RS232 ModBUS) for RS232;



WARNING: Depending upon the type of remote device, a null modem cable may be required for RS232 communication.

2. The 4-way terminal block for RS485 ModBUS mode;
3. The 3-way terminal block for SDI-12 mode.

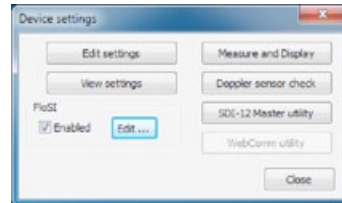
Pin out details for the various connectors are printed on the back of the FloSI card and shown in the diagram opposite.

Once a remote device has been wired to the FloSI card it must be configured using FloCom+ software so that the XCi device can provide access to it's measurement results.

20.3 Configuring a FloSI card

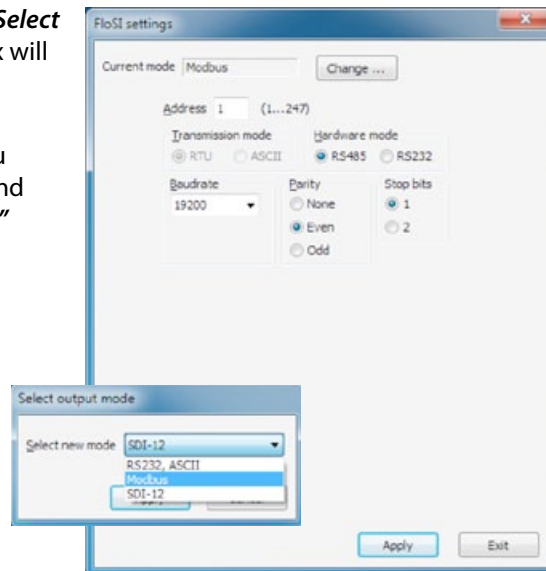
1. Ensure at least one module and one channel is configured.
2. From the "Device settings" dialogue box. Check the *FloSI enabled* check box.

3. Click "Edit..." and the "FloSI settings" dialogue box will appear.



4. Click "Change" and the "Select output mode" dialogue box will appear.

5. From the drop down list select the output mode you wish to use. Click "Apply" and the updated "FloSI settings" dialogue box will appear.



20.4 Serial interface settings

The FloSI can only be configured to use one serial protocol from the three available. The parameter values are provided in the user configured units.

20.4.1 RS-232, ASCII Mode

The line transmission characteristics are as follows:

Baud rate:	9600
Data bits:	8
Parity:	None
Stop bits:	1

In this mode, the FloSI is dormant while RTS is inactive. On RTS going active, the FloSI transmits the most current result string from the XCI device. If RTS is active when a scheduled sample is made, then the string is transmitted immediately on completion of the measurement.

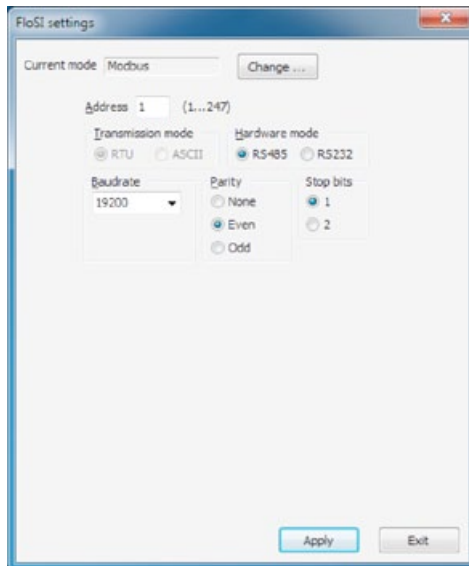
The transmitted ASCII text string starts with the character '*' (asterisk), ends with a carriage return and contains the configured number of channel values. The number and order of channel values in the output string can be configured using Flocm+. Each channel value in the string always begins with either a '+' (plus sign) or '-' (minus sign) - there are no spaces between values.

20.4 Serial interface settings - Continued

20.4.2 MODBUS Mode

The MODBUS implementation complies with the MODBUS over Serial Line Specification V1.0 and MODBUS Application Protocol Specification V1.1.

The external port is either a standard "RS232" port or a two-wire "RS485" port, depending on the selected MODBUS mode. The MODBUS parameters are configurable by entering the appropriate "Address", selecting the correct "Baudrate" from the drop down list and checking the required radar buttons.



WARNING: The user must ensure that there are no two devices with the same address on the same bus. In such a case, the behaviour of the bus is unpredictable

SUPPORTED FUNCTION CODES:

Command	Code (hex)	Sub-code (dec)
Read Input Registers	04	
Diagnostics	08	00-04,10-18

REGISTER MAP:

Parameter	Device Output ⁵	Type	Size (bits)	# Registers	Register(s)
Channel 1	Velocity	float inv.	32	2	30001 - 30002
Channel 2	Depth	float inv.	32	2	30003 - 30004
Channel 3	Flow Rate	float inv.	32	2	30005 - 30006
Channel 4	Total	float inv.	32	2	30007 - 30008
Channel 5	Velocity I/O	float inv.	32	2	30009 - 30010
Channel 6	Depth 4-20mA	float inv.	32	2	30011 - 30012
Channel 7	Binary On/Off	float inv.	32	2	30013 - 30014
Channel 8	Conductivity	float inv.	32	2	30015 - 30016
Channel 9	-	float inv.	32	2	30017 - 30018
Channel 10	-	float inv.	32	2	30019 - 30020
Channel 11	-	float inv.	32	2	30021 - 30022
Channel 12	-	float inv.	32	2	30023 - 30024
Channel 13	-	float inv.	32	2	30025 - 30026
Channel 14	-	float inv.	32	2	30027 - 30028
Channel 15	-	float inv.	32	2	30029 - 30030
Channel 16	-	float inv.	32	2	30031 - 30032
Channel 17	-	float inv.	32	2	30033 - 30034
Channel 18	-	float inv.	32	2	30035 - 30036
Channel 19	-	float inv.	32	2	30037 - 30038
Channel 20	-	float inv.	32	2	30039 - 30040

Notes:

1. Register byte order is big-endian
2. Float values are formatted according to IEEE 754 32-bit representation
3. Flow total has a range from 0 to 999999.9
4. Registers corresponding to parameters, which are not configured to be measured or calculated, contain random values.
5. XCi channel outputs are in order of channel configuration as per device settings.

WARNING: The outputs listed in this table are for illustrative purposes only.

20.4 Serial interface settings - Continued

20.4.3 SDI-12 Mode

The SDI-12 implementation complies with V1.3 of the SDI-12 specification.

Configurable parameters are:

- Address ('0'-'9', 'A'-'Z', 'a'-'z')
- Which measurement results to provide

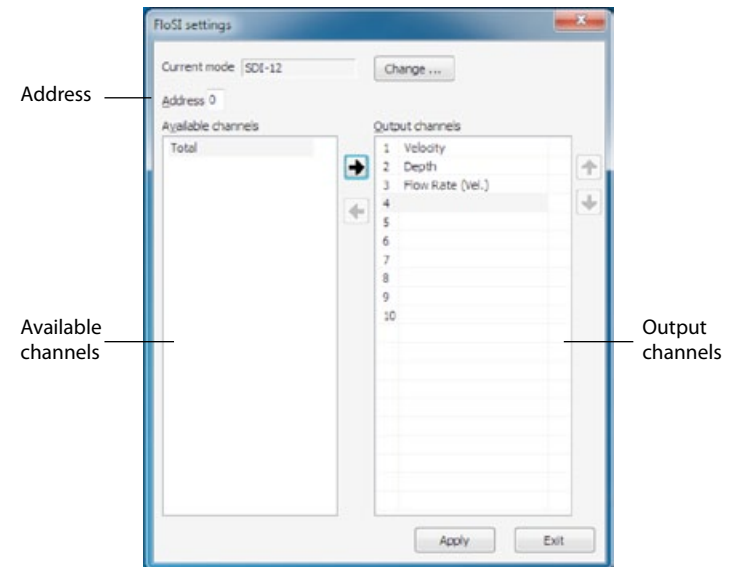
On receiving an SDI-12 Measurement command, the FloSI replies with notification that the measurement results are immediately available. Upon receiving a Send Data command, the FloSI returns the currently available result data which it has been configured to provide.

THE FOLLOWING SDI-12 COMMANDS ARE SUPPORTED:

Name	Command	Response
Acknowledge active	a!	a<CR><LF>
Send Identification	al!	a13MACE P/FloSI3100#nnnnn<CR><LF>
Address Query	?!	a<CR><LF>
Start Measurement	aM!	a000n<CR><LF>
Start Measurement and Request CRC	aMC!	a000n<CR><LF>
Send data	aD0! to aD9!	a<values><CR><LF> or a<values><CRC><CR><LF>
Additional Measurements	aM1! to aM9!	a0000<CR><LF>
Additional Measurements and Request CRC	aMC1! to aMC9!	a0000<CR><LF>
Start Verification	aV!	a0000<CR><LF>
Start Concurrent Measurement	aC!	a000n<CR><LF>
Start Concurrent Measurement and Request CRC	aCC!	a000n<CR><LF>
Additional Concurrent Measurements	aCC1! to aCC9!	a0000<CR><LF>
Continuous Measurement #0	aR0!	a<values><CR><LF>
Continuous Measurements #1 to 9	aR1! to aR9!	a<CR><LF>
Continuous Measurement #0 and Request CRC	aRC0!	a<values>< CRC><CR><LF>
Continuous Measurements #1 to 9 and Request CRC	aRC1! to aRC9!	a< CRC><CR><LF>

20.5 Ordering the SDI-12 or ASCII output string

The number and order of channel values in the output string for SDI-12 or RS232, ASCII output can be configured using Flocom⁺.



1. From the “*FloSI settings*” dialogue box, move the required channels from the “*Available channels*” table to the “*Output channels*” table by highlighting the desired channel in the “*Available channels*” table and clicking the “*Right arrow*”. If a channel in the “*Output channels*” table is no longer required, highlighting it and clicking the “*Left arrow*” will remove it from the “*Output channels*” table. The position of a channel in the “*Output channels*” table can be changed by highlighting the channel and clicking the **up** or **down** arrow.

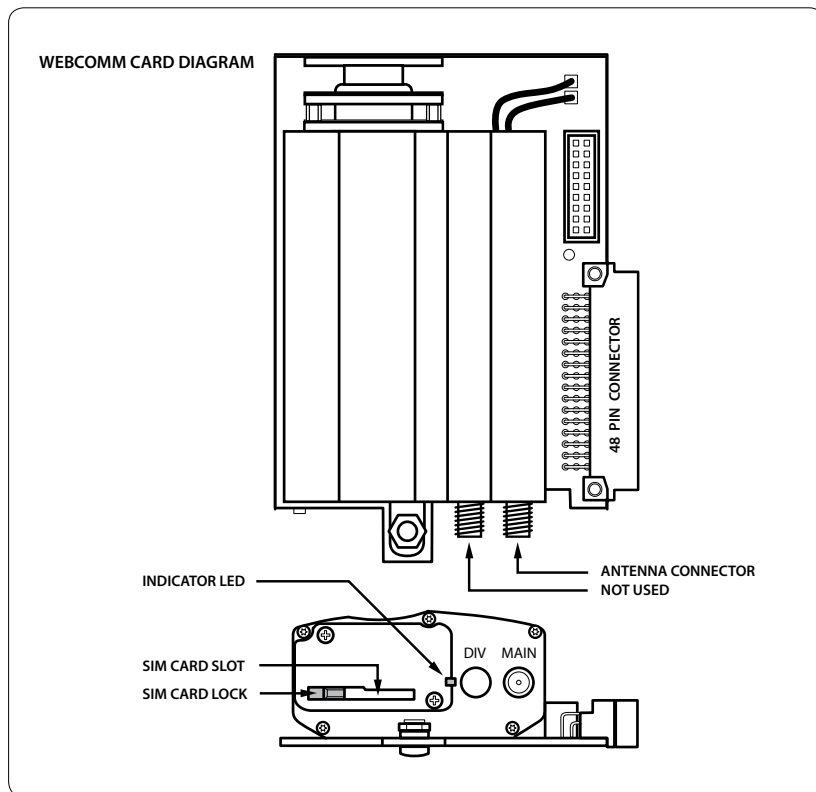
⚠ The user must ensure that there are no two devices with the same address on the same bus. In such a case, the behaviour of the bus is unpredictable

21.0 The WebComm card

21.1 About the WebComm card

The MACE WebComm card provides all MACE XCi devices (FloPro XCi, AgriFlo XCi and HydroMace XCi) the ability to automatically upload internal logged data to the web-based MACE Data Server via mobile telephone networks.

The MACE Data Server is integrated with the www.macemeters.com and www.maceusa.com websites, and allows easy access for retrieval of field data. Unlike “conventional” data services, MACE provides this data server free of charge to its’ customers (subject to MACE SLA).



NOTE: Only one WebComm card per XCi device is supported

NOTE: The WebComm card should be installed in card slot #5 of the XCi device

Essential Steps to setup a remote monitoring site with a MACE WebComm card:

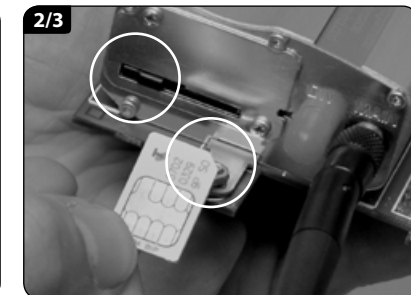
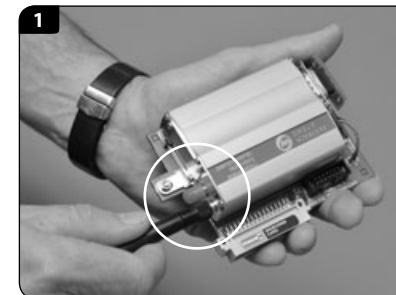
1. Contact your cell provider for a SIM card/data plan
2. Install antenna and SIM card into WebComm card
3. Install WebComm card into XCi device
4. From the WebComm page of the MACE website “Add New Site”
5. Add and Configure the WebComm card with FloCom+
6. View/download site data from the MACE website

21.2 Preparing and installing a WebComm card

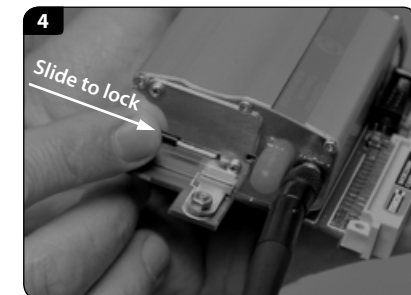


NOTE: Contact your cell provider for a SIM card/data plan.

1. Screw the supplied antenna onto the SMA antenna connector.
2. Slide the SIM card lock fully to the left (unlocked position).
3. Position the SIM card with the cutout/notched corner on the right with the electronic chip facing up as shown.



4. Slide the SIM card into the slot until a click is heard, slide the lock across to the right (locked position).
The WebComm card is now ready to be installed into the XCi device.



21.2 Preparing and installing a WebComm card - *continued*

5. Follow the instructions in Chapter 15.0 to install the WebComm card into the XCI device.



NOTE: The WebComm card should be installed in card slot #5 of the XCI device as shown



21.3 Add and configure a new site on the web



If you haven't already done so, you need to register for a "User Login" on the www.macemeters.com website.

1. "Login" to www.macemeters.com with your "User Login" and "Password". Navigate to the "WebComm" page.
2. Click on "Add new site".



If this is the first time you have added a WebComm site you will be prompted to create a new Username. This Username must be at least 4 characters long and only contain letters and numbers. Click "Save username" then click "Add new site".

Create username

A username is required before you can add a new site.

Enter new username:

UserTom

Required: Your username must be at least 4 characters long.

Save username

Cancel

3. Select a "Site ID". This should be the same "Site ID" that the XCI device in the field will have. Select the appropriate "Site Timezone" from the drop-down list and provide a "Site Description" if desired.



MACE recommends that the user does not use daylight savings time. Users should set to standard time zone at all times.

4. Check the appropriate boxes for "Site Access".

Add new site

Fields marked with * are required.

Site ID:	WCTest *
Site Timezone:	(UTC+10:00) Australia Eastern Time *
Site Description:	WebComm Card Test Site for XCI manual
Site Access:	<input checked="" type="checkbox"/> Allow MACE support staff to access this site <input checked="" type="checkbox"/> Allow third-party applications to download site data directly from the MACE Data Server.
	Save site details

21.3 Add and configure a new site on the web - *continued*

5. Click on **“Save site details”** and the **“My Sites”** page will appear.

Sites details

Site details for WCTest saved.

My Sites

All times shown on this page are site local time.

Site ID	Site Description	Latest Record
WCTest	WebComm Card Test Site for XCI manual	

6. Click on the **“Site ID”** of the site you have just added and the **“Site Details”** page will appear.

Site details

All times shown on this page are site local time.

Download site data

Site ID:	WCTest		
Site description:	WebComm Card Test Site for XCI manual		
Last record downloaded:	You have not downloaded any of the data available.		Show latest day Show latest record
Enter start date:	<input type="text"/>	Enter end date:	<input type="text"/>
	YYYY-MM-DD or YYYY-MM-DD HH:MM:SS Leave blank for all data		YYYY-MM-DD or YYYY-MM-DD HH:MM:SS Leave blank for all data
View site data		Download site data	

Site details

Last updated: 2011-09-20 16:39:29

Site ID:	WCTest
Site Timezone:	(UTC+10:00) Australia Eastern Time
Site Description:	WebComm Card Test Site for XCI manual
Site Access:	MACE support staff have access to this site. Data from this site can be downloaded directly from the MACE data server.
Oldest data record:	There is no data stored for this site.
Last record uploaded:	There is no data stored for this site.
Server storage used:	There is no data stored for this site.
Device type:	
Serial number:	
Firmware:	
Signal strength:	0

Device upload configuration

These parameters must be entered into the device configuration before data can be uploaded.

Username:	UserTom	Edit username
Site upload key:	MBY3-TRXD-8WGT	Change upload key

[Save upload details to a text file](#)

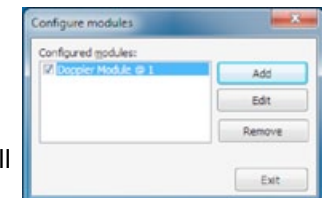
7. The details that you will require to configure your MACE WebComm card in the field are located in the **“Device upload configuration”** field. Click on the **“Save upload details to a text file”** hyperlink and the details will be saved to a text file called **“Site upload configuration (Site ID).txt”**. This text file will be needed when you are configuring the WebComm card in the field.

The WebComm card is now ready to be configured using FloCom+ software.

21.4 Add a WebComm module in FloCom+

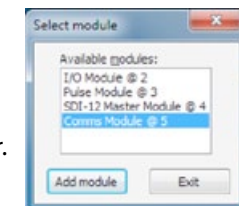
NOTE: Once a FloSeries3 card is installed in an XCI device, FloCom+ defines this as a module.

1. From the main **“Device settings”** dialogue box click **“Configure modules”** and a dialogue box will appear as shown.



2. Click **“Add”** and the available modules will be listed in the **“Select module”** dialogue box.

3. Each MACE module available is referenced in the list by its type and slot number. (eg. Comms module in card slot 5). Highlight the module you wish to add and click **“Add module”**. The **“Configure modules”** dialogue box will re-appear.

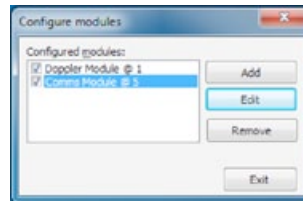


NOTE: Once a module has been added it will no longer appear on the available modules list

21.5 Edit a WebComm module in FloCom+

21.5.1 Edit a WebComm module

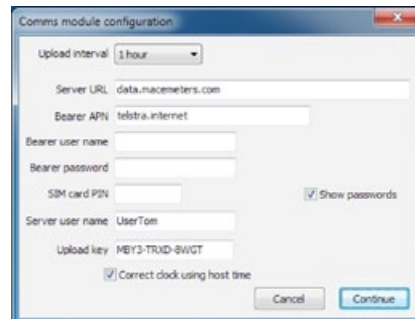
1. From the “*Configure modules*” dialogue box, highlight the “*Comms*” module and click “*Edit*” and the “*Comms module configuration*” dialogue box will appear.



2. Select the appropriate “*Upload interval*” for your application.
3. The “*Server URL*” should remain as “*data.macemeters.com*” unless you are uploading to another server.
4. Enter the appropriate “*Bearer information*” (this should be ascertained from your cell provider).

Telstra networks in Australia:

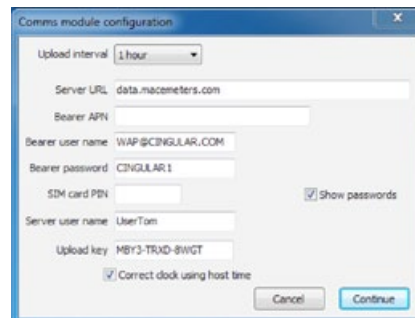
- “*Bearer APN*” - telstra.internet
- “*Bearer user name*” - LEAVE BLANK
- “*Bearer password*” - LEAVE BLANK.



AT&T networks in USA:

- “*Bearer APN*” - LEAVE BLANK
- “*Bearer user name*” - WAP@CINGULAR.COM
- “*Bearer password*” - CINGULAR1

NOTE: *User names and passwords are case-sensitive*



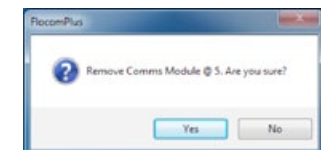
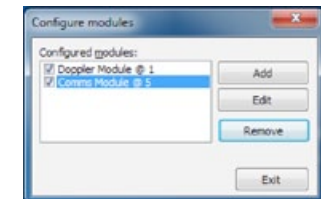
5. From the information contained in the file called “*Site upload configuration (Site ID).txt*” that was saved during the procedure outlined in **Chapter 21.3**, copy/paste the relevant “*Server user name*” and “*Upload key*”.

6. Checking the “*Correct clock using host time*” check box, will ensure that your XCi device time will always be correct. The WebComm card will “*talk*” to the MACE data server and correct the device time as necessary. This ensures you always have the correct time in your dataset.

7. Click “*Continue*” and the “*Configure modules*” dialogue box will appear.

21.5.2 Remove a WebComm module

1. From the “*Configure modules*” dialogue box highlight the module that you wish to remove. Click “*Remove*” and you will be prompted to confirm your action. Click “*Yes*” and the module will be removed.



HINT: Click on “*Show passwords*” to enable easy viewing of the “*Upload key*”.

21.6 The “WebComm utility”

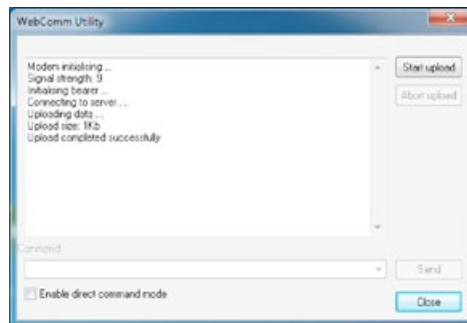
21.6.1 Using the “WebComm utility”

This utility provides the user with a simple diagnostic interface to communicate with the WebComm card in order to test the settings and initiate a data upload on the MACE data server. The user can also send AT-commands in order to change frequency bands.

1. From the “*Device settings*” dialogue box click “*WebComm utility*” and the “*WebComm utility*” dialogue box will appear.



2. Click “*Start upload*” and the utility will “force” the WebComm card to talk to the data server and upload any data stored in the log. A successful upload will be completed if all the “*Settings*” in the WebComm card have been entered correctly and there is a cell network in range with sufficient signal strength.



! The “Signal strength” is a measure between 0 and 30. For reliable uploads a “Signal strength” of at least 10 should be attained. If a “Signal strength” of 10 is not attained, then a higher gain antenna should be used.

If “*Upload completed successfully*” then click “*Close*” to exit from the WebComm utility. “*Start*” the device as described in Chapter 13.3 after the device has been fully configured.

Your data will now be uploaded regularly to the data server for storage and available for retrieval at www.macemeters.com

If the upload was not successful then refer to the “*Error messages table*” over page to troubleshoot the WebComm card.

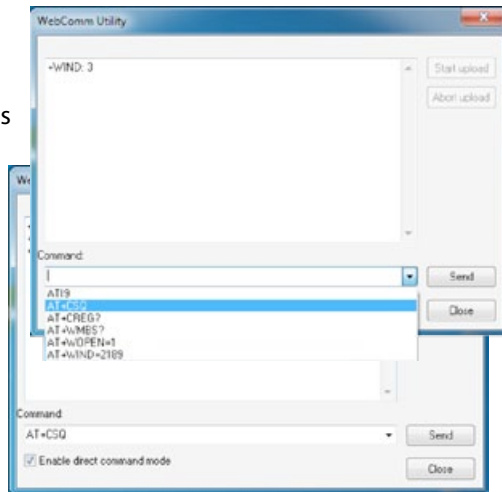
21.6.2 Error messages table

Error message	Possible cause	Remedy
Didn't register in network	<ul style="list-style-type: none"> No cell network available Wrong cell network Low cell signal strength Antenna not connected Incorrect modem band 	<ul style="list-style-type: none"> Check with cell provider that you are in a coverage zone Check with cell provider that you are in a coverage zone Check the antenna connection. Run signal strength command in WebComm utility (AT+CSQ). A high gain antenna may need to be installed in low signal strength areas. Ensure antenna connected properly Run band check command in WebComm utility (AT+WMBS?). Ensure the correct band for your location is set.
Bearer error	<ul style="list-style-type: none"> Network busy Low cell signal strength Incorrect settings in the WebComm card 	<ul style="list-style-type: none"> Wait, try again Check the antenna connection. Run signal strength command in WebComm utility (AT+CSQ). A high gain antenna may need to be installed in low signal strength areas. Check bearer settings with cell provider
HTTP authentication error	<ul style="list-style-type: none"> Incorrect username or upload key 	<ul style="list-style-type: none"> Check username and upload key and correct if necessary

21.6 The “WebComm utility” - continued

21.6.3 Using AT+Commands to troubleshoot

This WebComm utility has a “Command” field where AT+Commands can be input to troubleshoot various parameters of the WebComm card. These AT+Commands are accessed via the drop down menu of the “Command” field or by direct input.



Check “Enable direct command mode”. This enables the modem for direct communication via AT+Commands

The AT+Commands are listed in the table below:

AT+Command	Description										
AT+CSQ	Used to verify the Received Signal Strength Enter the AT+command AT+CSQ and click “Send” The response returned has the following format: +CSQ: <rssi>,<ber> with: • <rssi> = received signal strength indication, • <ber> = channel bit error rate. Verify the <rssi> value returned using the Table below:										
	<table border="1"> <thead> <tr> <th>Value of received signal strength indication (<rssi>)</th> <th>Interpretation of the received signal strength</th> </tr> </thead> <tbody> <tr> <td>0 - 10</td> <td>Insufficient(*)</td> </tr> <tr> <td>11-31</td> <td>Sufficient(*)</td> </tr> <tr> <td>32-98</td> <td>Not defined</td> </tr> <tr> <td>99</td> <td>No measure available</td> </tr> </tbody> </table>	Value of received signal strength indication (<rssi>)	Interpretation of the received signal strength	0 - 10	Insufficient(*)	11-31	Sufficient(*)	32-98	Not defined	99	No measure available
Value of received signal strength indication (<rssi>)	Interpretation of the received signal strength										
0 - 10	Insufficient(*)										
11-31	Sufficient(*)										
32-98	Not defined										
99	No measure available										
	(*) Based on general observations.										

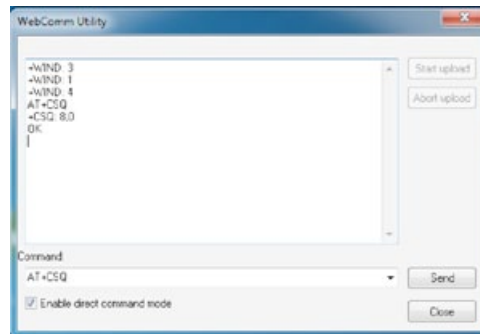
The AT+Commands table - continued:

AT+Command	Description																		
AT+CREG?	Used to verify the registration on the network Enter the AT+command AT+CREG? and click “Send” The format of the returned response is as follows: +CREG: <mode>,<stat> with: • <mode> = unsolicited registration message configuration, • <stat> = registration state. Verify the state of registration according the returned value using the table below:																		
	<table border="1"> <thead> <tr> <th>Returned Value <mode>,<stat></th> <th>Network registration</th> </tr> </thead> <tbody> <tr> <td>+CREG: 0,0</td> <td>No (no registration attempted)</td> </tr> <tr> <td>+CREG: 0,2</td> <td>No (registration attempted)</td> </tr> <tr> <td>+CREG: 0,1</td> <td>Yes (registered, home network)</td> </tr> <tr> <td>+CREG: 0,5</td> <td>Yes (registered, roaming)</td> </tr> </tbody> </table>	Returned Value <mode>,<stat>	Network registration	+CREG: 0,0	No (no registration attempted)	+CREG: 0,2	No (registration attempted)	+CREG: 0,1	Yes (registered, home network)	+CREG: 0,5	Yes (registered, roaming)								
Returned Value <mode>,<stat>	Network registration																		
+CREG: 0,0	No (no registration attempted)																		
+CREG: 0,2	No (registration attempted)																		
+CREG: 0,1	Yes (registered, home network)																		
+CREG: 0,5	Yes (registered, roaming)																		
AT+WMBS?	Used to Check the Band(s) Selection Enter the AT+command AT+WMBS? and click “Send” The table below gives the main responses returned:																		
	<table border="1"> <thead> <tr> <th>AT+WMBS response</th> <th>Band/s selected</th> </tr> </thead> <tbody> <tr> <td>+WMBS: 0,x</td> <td>Mono band mode 850MHz</td> </tr> <tr> <td>+WMBS: 1,x</td> <td>Mono band mode extended 900MHz</td> </tr> <tr> <td>+WMBS: 2,x</td> <td>Mono band mode 1800MHz</td> </tr> <tr> <td>+WMBS: 3,x</td> <td>Mono band mode 1900MHz</td> </tr> <tr> <td>+WMBS: 4,x</td> <td>Dual band mode 850/1900MHz</td> </tr> <tr> <td>+WMBS: 5,x</td> <td>Dual band mode extended 900MHz/1800MHz</td> </tr> <tr> <td>+WMBS: 6,x</td> <td>Dual band mode extended 900MHz/1900MHz</td> </tr> <tr> <td>+WMBS: 7,x</td> <td>Quad-band mode 850/900E/1800/1900 MHz</td> </tr> </tbody> </table>	AT+WMBS response	Band/s selected	+WMBS: 0,x	Mono band mode 850MHz	+WMBS: 1,x	Mono band mode extended 900MHz	+WMBS: 2,x	Mono band mode 1800MHz	+WMBS: 3,x	Mono band mode 1900MHz	+WMBS: 4,x	Dual band mode 850/1900MHz	+WMBS: 5,x	Dual band mode extended 900MHz/1800MHz	+WMBS: 6,x	Dual band mode extended 900MHz/1900MHz	+WMBS: 7,x	Quad-band mode 850/900E/1800/1900 MHz
AT+WMBS response	Band/s selected																		
+WMBS: 0,x	Mono band mode 850MHz																		
+WMBS: 1,x	Mono band mode extended 900MHz																		
+WMBS: 2,x	Mono band mode 1800MHz																		
+WMBS: 3,x	Mono band mode 1900MHz																		
+WMBS: 4,x	Dual band mode 850/1900MHz																		
+WMBS: 5,x	Dual band mode extended 900MHz/1800MHz																		
+WMBS: 6,x	Dual band mode extended 900MHz/1900MHz																		
+WMBS: 7,x	Quad-band mode 850/900E/1800/1900 MHz																		
AT+WOPEN=1	MACE internal diagnostic use																		
AT+WIND=2189	MACE internal diagnostic use																		

21.6 The “WebComm utility” - continued

The AT+CSQ command

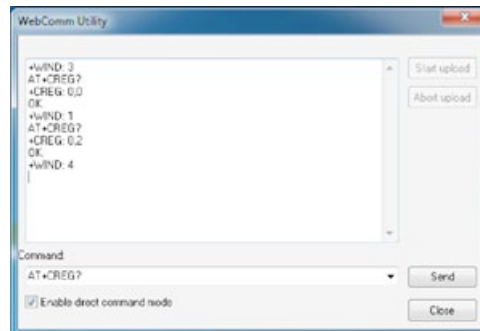
1. Wait until “+WIND: 1” is displayed in the main window.
2. From the “Command” drop down list, select “AT+CSQ”. Click “Send” and the modem will respond with the received signal strength. In this example a signal strength of “8” is returned.



The AT+CREG? command

1. Wait until “+WIND: 1” is displayed in the main window.
2. From the “Command” drop down list, select “AT+CREG?”. Click “Send” and the modem will respond with the network registration state.

In this example, although the modem has attempted a network registration the attempt has failed as evidenced by the reply “+CREG: 0,2”.

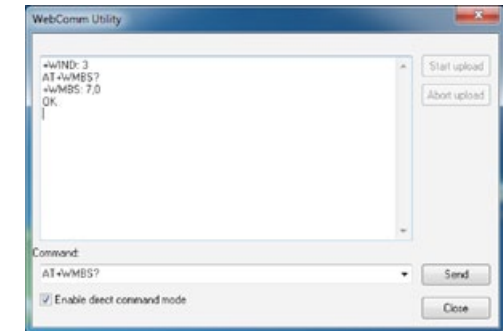


The AT+WMBS? command

! Only change the frequency band of the WebComm card after confirming the band from your cell network provider

1. Wait until “+WIND: 1” is displayed in the main window.
2. From the “Command” drop down list, select “AT+WMBS?”. Click “Send” and the modem will respond with the current frequency band setting.

In this example, the modem is currently set to “Quad-band mode...MHz” as evidenced by the reply “+WMBS: 7,0”.



3. Should the band need to be changed type into the command field “AT+WMBS=X”, where X=the number that corresponds to your required band from the AT+Commands table.

4. Click “Send” and the modem will respond with “OK”.



5. From the “Command” drop down list, select “AT+WMBS?”. Click “Send” and the modem will respond with the current frequency band setting.

In this example, the modem has been changed to “Dual-band mode.../1800 MHz” as evidenced by the reply “+WMBS: 5,1”.



! This band change will take effect next time the modem is powered up. The modem can be de-powered by unchecking the “Enable direct command mode” box.

21.7 Downloading your site data from the web

1. “Login” to www.macemeters.com with your “User Login” and “Password”. Navigate to the “WebComm” page.
2. Click on “My Sites” and then Click the “Site ID” of the site you wish view.

Site details

All times shown on this page are site local time.

Download site data

Site ID:	MACDural		
Site description:	WebComm Card Test Site for XCI manual		
Last record downloaded:	You have not downloaded any of the data available. Show latest day Show latest record		
Enter start date:	2011-09-01	Enter end date:	2011-09-20
	YYYY-MM-DD or YYYY-MM-DD HH:MM:SS Leave blank for all data		YYYY-MM-DD or YYYY-MM-DD HH:MM:SS Leave blank for all data
View site data		Download site data	



The MACE data server will store up to 500Mb of data per Site ID. When this quota is reached uploads are no longer accepted. Ensure data that you wish to keep is downloaded.

21.7.1 View/Download site data

View site data

Enter the “Start date” in the format shown, enter the “End date” in the format shown, click “View site data”.

or

If you wish to only view the latest days records, click on “Show latest day”.

or

If you wish to only view the latest record, click on “Show latest record”.

Download site data

Enter the “Start date” in the format shown, enter the “End date” in the format shown, click “Download site data”. Data will be downloaded in a *.CSV file format.

or

Clicking “Download site data” without any dates entered will download all the data for this site.

21.7.2 Editing your site details

1. Click on “Edit Site” from the “My sites” menu.

Edit site details

Fields marked with * are required.

Site ID:	MACDural *
Site Timezone:	(UTC+10:00) Australia Eastern Time *
Site Description:	WebComm Card Test Site for XCI manual
Site Access:	<input checked="" type="checkbox"/> Allow MACE support staff to access this site <input checked="" type="checkbox"/> Allow third-party applications to download site data directly from the MACE Data Server.
Email notifications:	If this site is over 90% of it's storage quota email me Never ▾ If data for this site has NOT been downloaded and is scheduled for deletion by the data server email me Never ▾ If the device at this site stops uploading to the website for longer than 4 weeks ▾ email me
	<input checked="" type="checkbox"/> Never Every hour Every 6 hours Every 12 hours Everyday Once per week Once every 2 weeks Once every 4 weeks
	Save site details

Other users with access to this site

No other users have access to this site.

Email notifications

The MACE data server will store up to 500Mb of data per Site ID. When this quota is reached data is deleted. The email service provided by the data server will notify the user under certain circumstances.

Use the dropdown list to select the frequency at which you will be notified.

21.7 Downloading your site data from the web - *continued*

21.7.3 Adding a site user

Under certain circumstances, you may wish to “share” your data with other users. For example, a farm manager may wish his irrigation superintendent to also access site data.



ONLY “Site Owners” can “Edit site details”, or “Delete site data”.

ONLY “Site Owners” can add site users.

1. Click on “*Add site user*” from the “*My sites*” menu.
2. Enter the email address of the user that you wish to add and click “*Add site user*”.
3. An email will be sent to the Site User’s address notifying them of their addition as a “*Site user*”

Add site user

Adding a user to this site (MACDural) will allow them to download the site’s data.

Enter the email address of the user you wish to add:

Note: The user you are adding must be a registered user of this website.

Appendix A - Limited warranty

1. MACE warrants that any software supplied will perform substantially in accordance with the description and/or accompanying materials for a period of 90 days from date of receipt. MACE warrants that any such software is, as far as it is possible to determine, free from errors, and that should Buyer report any software errors, MACE reserves the right to incorporate the fixes in the next scheduled release of that software product. MACE reserves the right to charge a fee for providing a software updating service.
2. MACE warrants that AgriFlo, FloPro and HydroMace electronics modules supplied shall be rendered free from all defects in materials and workmanship under normal use and service for a period of two years from date of shipment to the end user or three years from the date of manufacture, whichever comes first.
3. MACE warrants that Doppler ultrasonic sensors supplied shall be rendered free from all defects in materials and workmanship under normal use and service for a period of one year from date of shipment to the end user or two years from the date of manufacture, whichever comes first.
4. MACE warrants that all other MACE products supplied shall be rendered free from all defects in materials and workmanship under normal use and service for a period of one year from date of shipment to the end user or two years from the date of manufacture, whichever comes first.
5. Goods that are returned to Buyer following service by an authorised, quality certified, MACE service centre carry a 3-month warranty.
6. Goods that have been tampered with, adjusted, dismantled, or otherwise interfered with will be denied warranty.
7. In no event shall MACE, or its distributor, be liable for any damages whatsoever (including, without limitation, damages for loss of business profits, business interruption, loss of business information, or other pecuniary loss) arising out of the use of, or inability to use any MACE product, even if MACE has been advised of the possibility of damages.
8. Should any Product become defective during the warranty period, and provided that the customer returns the defective Product to MACE for inspection and testing, MACE will, in its sole discretion and at no cost to the customer, repair or replace the defective Product in question.
9. No warranty is included against any expense for removal, re-installation or other consequential damages of any nature arising from any defect.
10. The warranties set out above are the only warranties made by MACE and are expressly in lieu of all other warranties, expressed or implied including the warranties of merchant ability and fitness for a particular purpose.
11. During the warranty period, MACE will pay surface transportation charges both ways (between MACE and the customer) within Australia if the product proves to be defective within 30 days from the date of original shipment to the end user. Throughout the remainder of the warranty period, the customer will pay transportation charges to return the defective product to MACE, and MACE will pay for the surface transportation charges to return the repaired product to the customer. MACE will not pay air freight or packing and crating charges at any time during the warranty period.
12. This warranty does not apply if the Product has been used in a manner contrary to the Products manual or other instructions or has been used in detrimental environmental or other conditions or has been used in a manner likely to cause excessive wear and tear or has otherwise been improperly used or altered in any way.
13. Expendable items such as pump tubing or silica gel satchels are not covered by this warranty.
14. Third party items such as solar panels or trickle chargers are not covered by this warranty but are covered by their manufacturers warranty.
15. All requests for warranty service must be received within the warranty period.
16. This warranty is to the benefit of the original purchaser only and is not transferable on the re-sale of the Product without the expressed written approval of MACE.
17. Subject to any non-excludable contrary provisions of the Australian Trade Practices Act 1974 and corresponding New South Wales State legislation, MACE excludes all terms, conditions, warranties, undertakings, inducements or representations whether express, implied, statutory or otherwise relating in any way to the Product or its use.
18. Subject to any non-excludable contrary provisions of the Australian Trade Practices Act 1974 and corresponding New South Wales State legislation, MACE has no liability to the customer or third party in respect of any loss, consequential or otherwise, damage, injury, claim, demand, cost or expense however caused which may be suffered or which may arise in respect of the supply or use of the Product or in respect of any negligent act or omission of MACE of its servants or agents, or otherwise in connection with the supply or use of the Product or its fitness for a particular purpose. In no event shall the total liability of MACE (howsoever arising) exceed the amount paid by the customer for the Product covered by this warranty.
19. This statement represents the total warranty for MACE products and no person has the authority to alter it.

Appendix B - Flume/weir coefficients

V-notch weir factors

θ , degrees	C_e (same for all systems of units)	k_h , ft	k_h , m
30	0.586	0.007	0.0021
45	0.58	0.005	0.0015
60	0.577	0.0038	0.0012

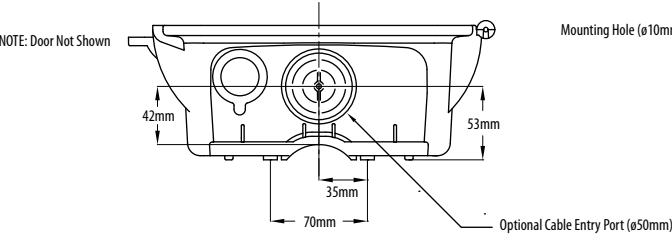
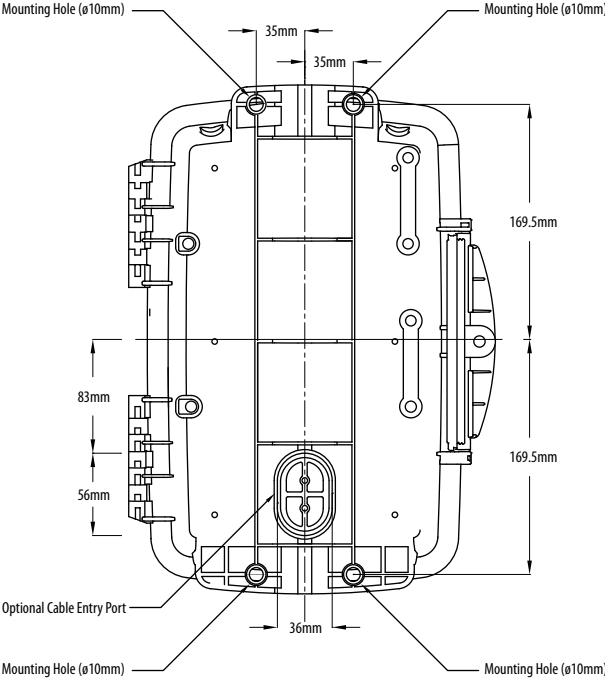
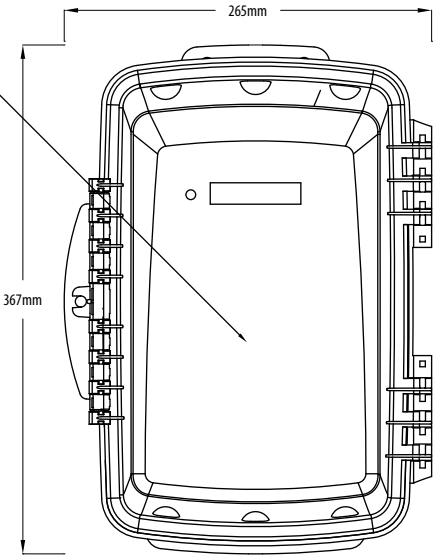
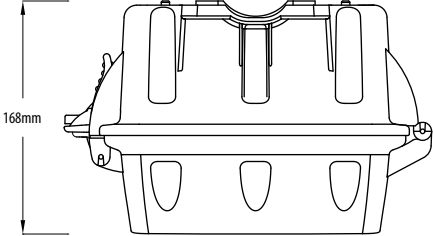
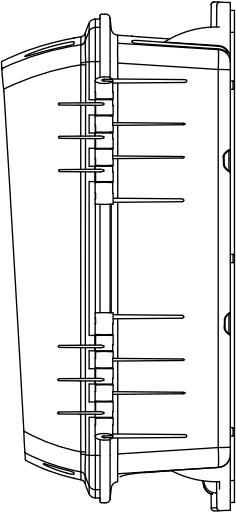
Parshall flume factors

Width of flume	C (for use with h_a in feet)	C (for use with h_a in meters)	n (same for cfs or kL/sec)
1-inch	0.338	0.0604	1.55
2-inch	0.676	0.1207	1.55
3-inch	0.992	0.1771	1.55
6-inch	2.06	0.381	1.58
9-inch	3.07	0.535	1.53
1-ft	3.95	0.705	1.55
1.5-ft	5.975	1.067	1.55
2-ft	8	1.429	1.55
3-ft	12	2.19	1.57
4-ft	16	2.96	1.58
5-ft	20	3.75	1.59
6-ft	24	4.49	1.59
7-ft	28	5.31	1.6
8-ft	32	6.14	1.61
10-ft	39.38	7.46	1.6
12-ft	46.75	8.86	1.6
15-ft	57.81	10.96	1.6
20-ft	76.25	14.45	1.6
25-ft	94.69	17.94	1.6
30-ft	113.13	21.4	1.6
40-ft	150	28.4	1.6
50-ft	186.88	35.4	1.6

Appendix C - Engineering submittal drawings

i) MACE FloPro XCi device

UV Stabilised Decal With Membrane Switches

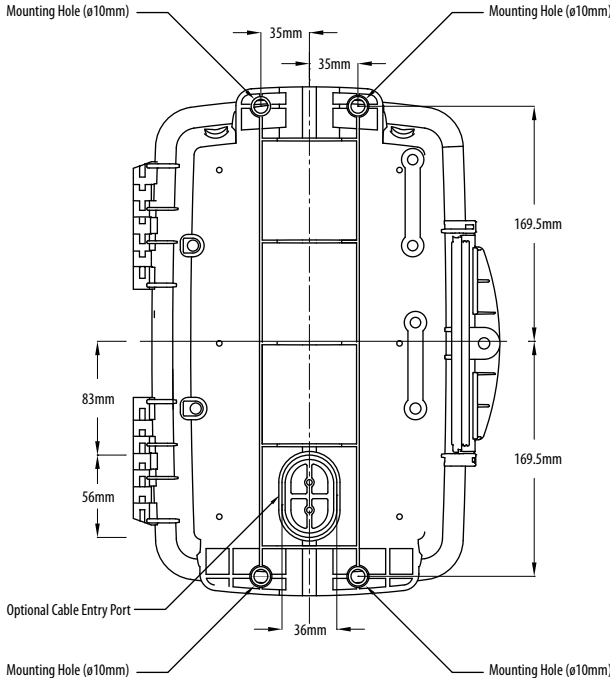
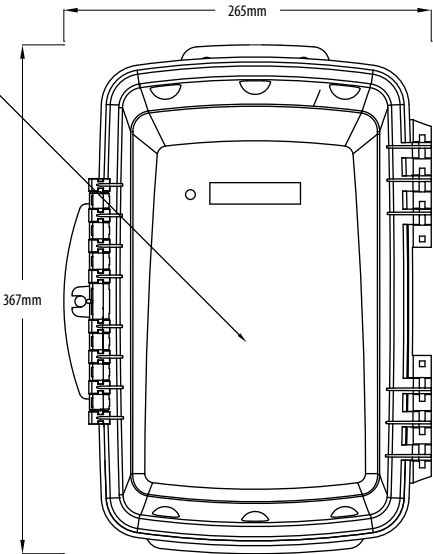
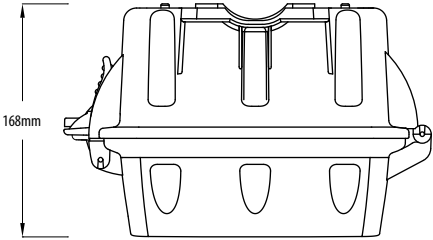
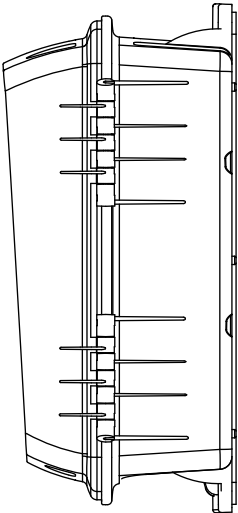


Part No.	Description
850-366	MACE FloSeries3 - FloPro XCi

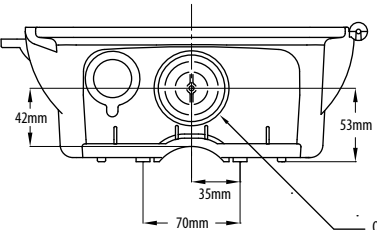
Appendix C - Engineering submittal drawings - continued

ii) MACE AgriFlo XCi device

UV Stabilised Decal With Membrane Switches



NOTE: Door Not Shown



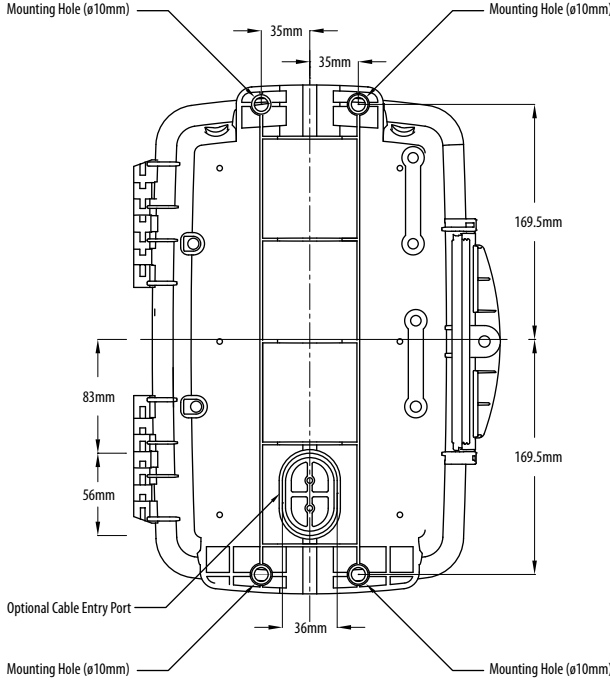
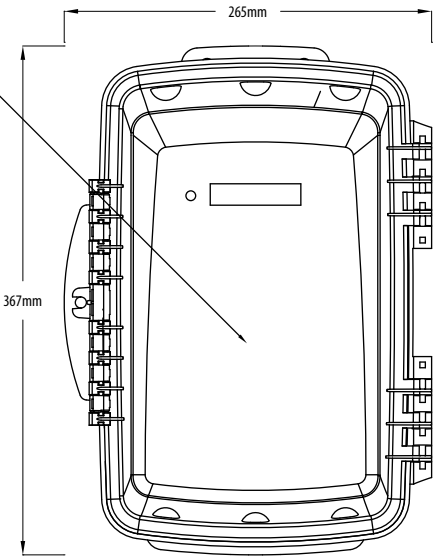
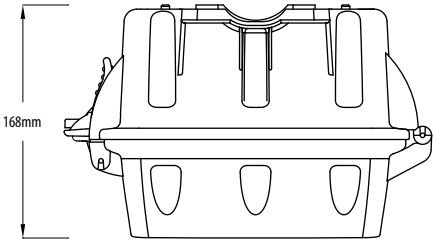
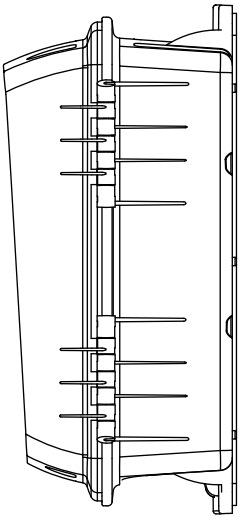
Optional Cable Entry Port (ø50mm)

Part No.	Description
850-365	MACE FloSeries3 - AgriFlo XCi

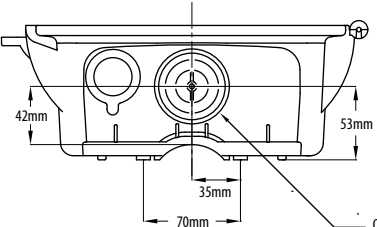
Appendix C - Engineering submittal drawings - continued

iii) MACE HydroMace XCi device

UV Stabilised Decal With Membrane Switches



NOTE: Door Not Shown

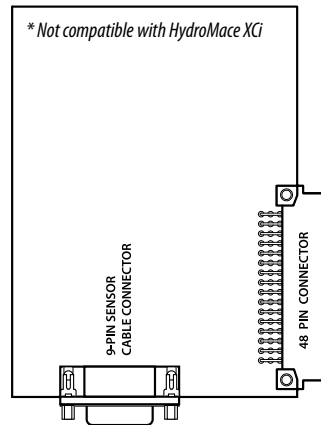


Part No.	Description
850-367	MACE FloSeries3 - HydroMace XCi

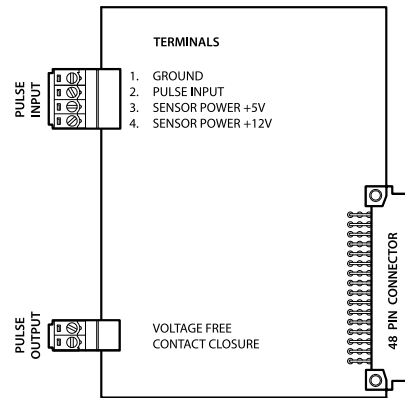
Appendix C - Engineering submittal drawings - continued

iv) MACE FloSeries3 cards

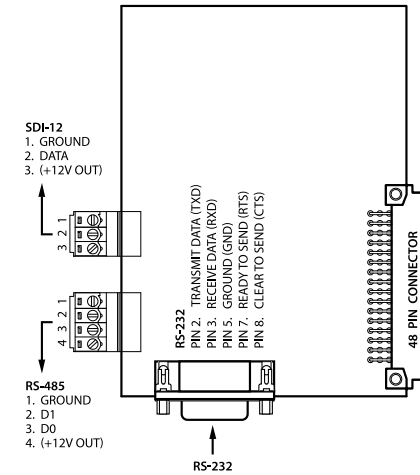
DOPPLER CARD Part No. 850-328



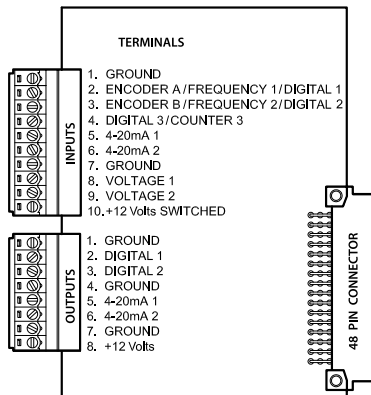
PULSE I/O CARD Part No. 850-353



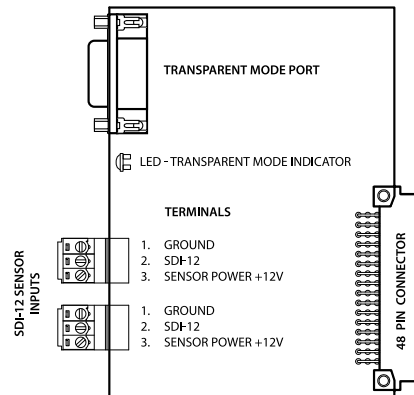
FLOSI CARD Part No. 850-330



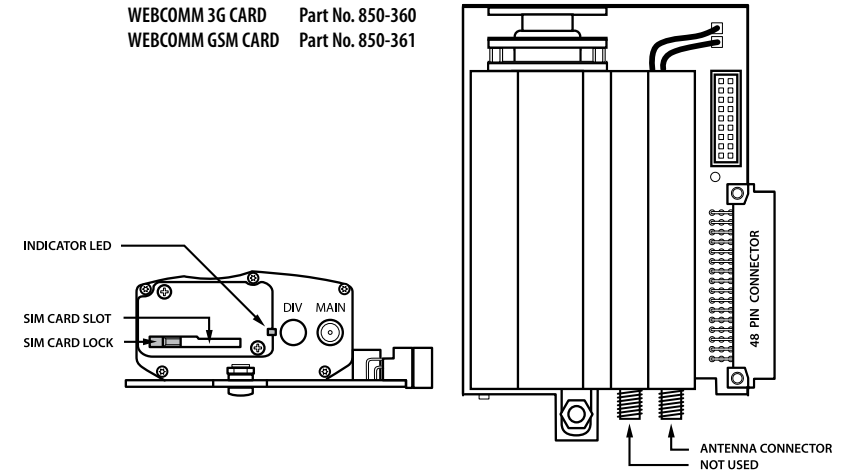
I/O CARD Part No. 850-329



SDI-12 MASTER CARD Part No. 850-368



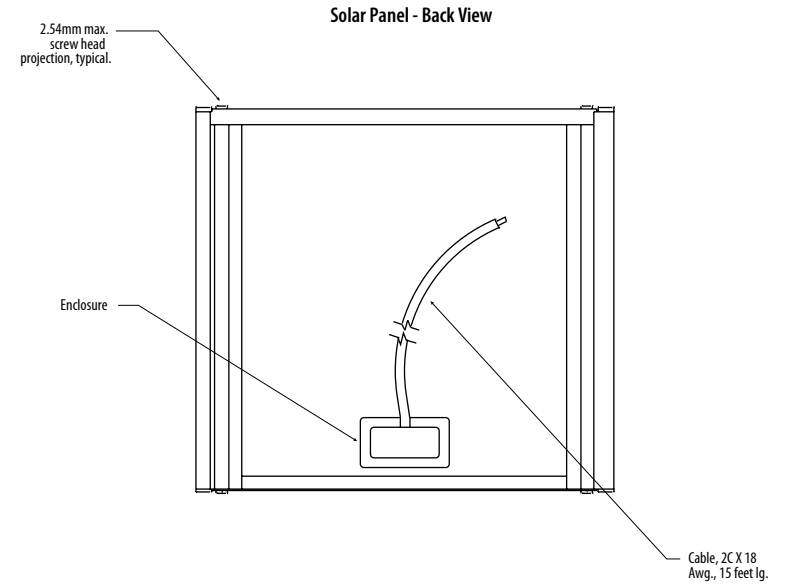
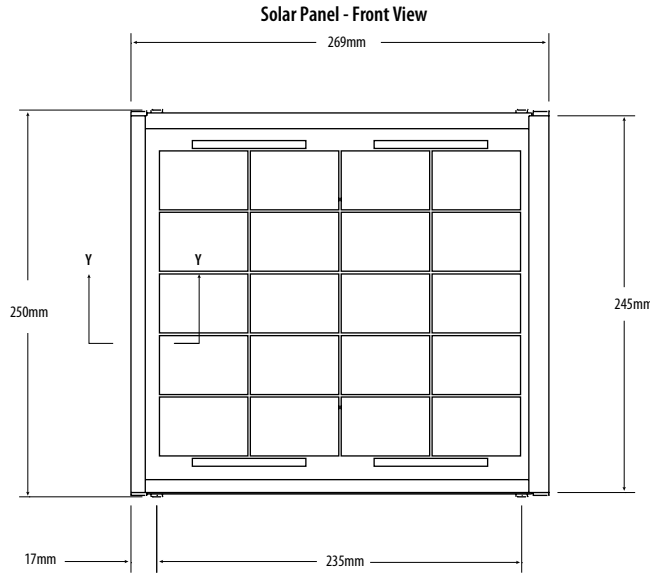
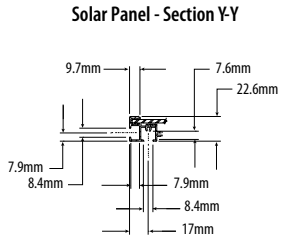
WEBCOMM 3G CARD Part No. 850-360
WEBCOMM GSM CARD Part No. 850-361



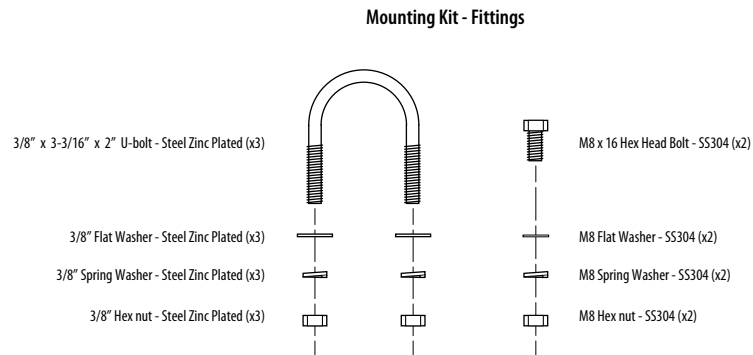
Appendix C - Engineering submittal drawings - continued

v) Solar panel and mounting kit

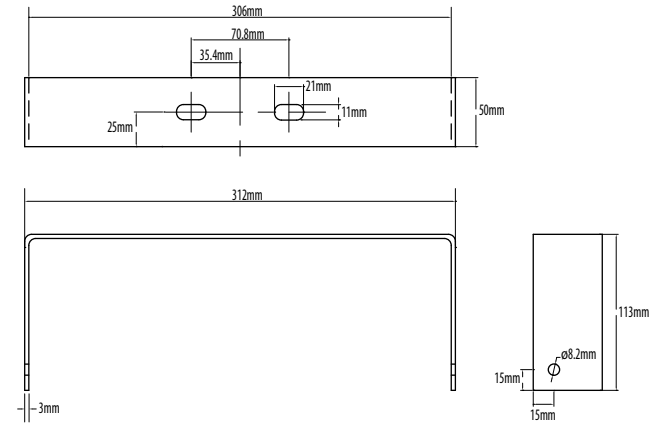
Part No.	Description
814-017	MACE FloSeries3 - Solar Panel (12V/5W)



Part No.	Description
850-302	MACE FloSeries3 - Mounting Kit - Device & Solar Panel (5W)



Mounting Kit - Solar Panel Bracket (Aluminium)

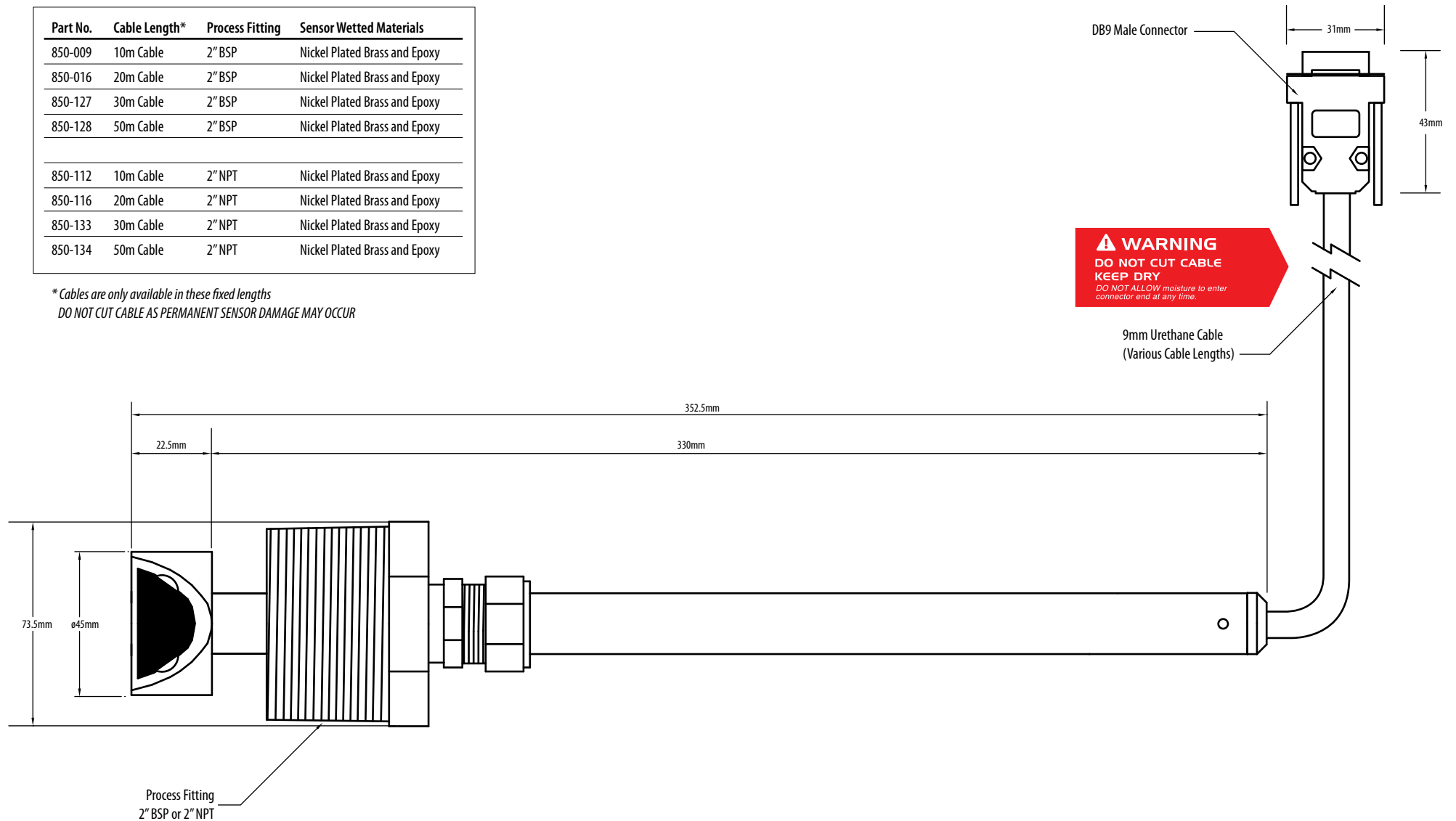


Appendix C - Engineering submittal drawings - continued

vi) MACE Doppler insert velocity sensor

Part No.	Cable Length*	Process Fitting	Sensor Wetted Materials
850-009	10m Cable	2" BSP	Nickel Plated Brass and Epoxy
850-016	20m Cable	2" BSP	Nickel Plated Brass and Epoxy
850-127	30m Cable	2" BSP	Nickel Plated Brass and Epoxy
850-128	50m Cable	2" BSP	Nickel Plated Brass and Epoxy
850-112	10m Cable	2" NPT	Nickel Plated Brass and Epoxy
850-116	20m Cable	2" NPT	Nickel Plated Brass and Epoxy
850-133	30m Cable	2" NPT	Nickel Plated Brass and Epoxy
850-134	50m Cable	2" NPT	Nickel Plated Brass and Epoxy

*Cables are only available in these fixed lengths
DO NOT CUT CABLE AS PERMANENT SENSOR DAMAGE MAY OCCUR



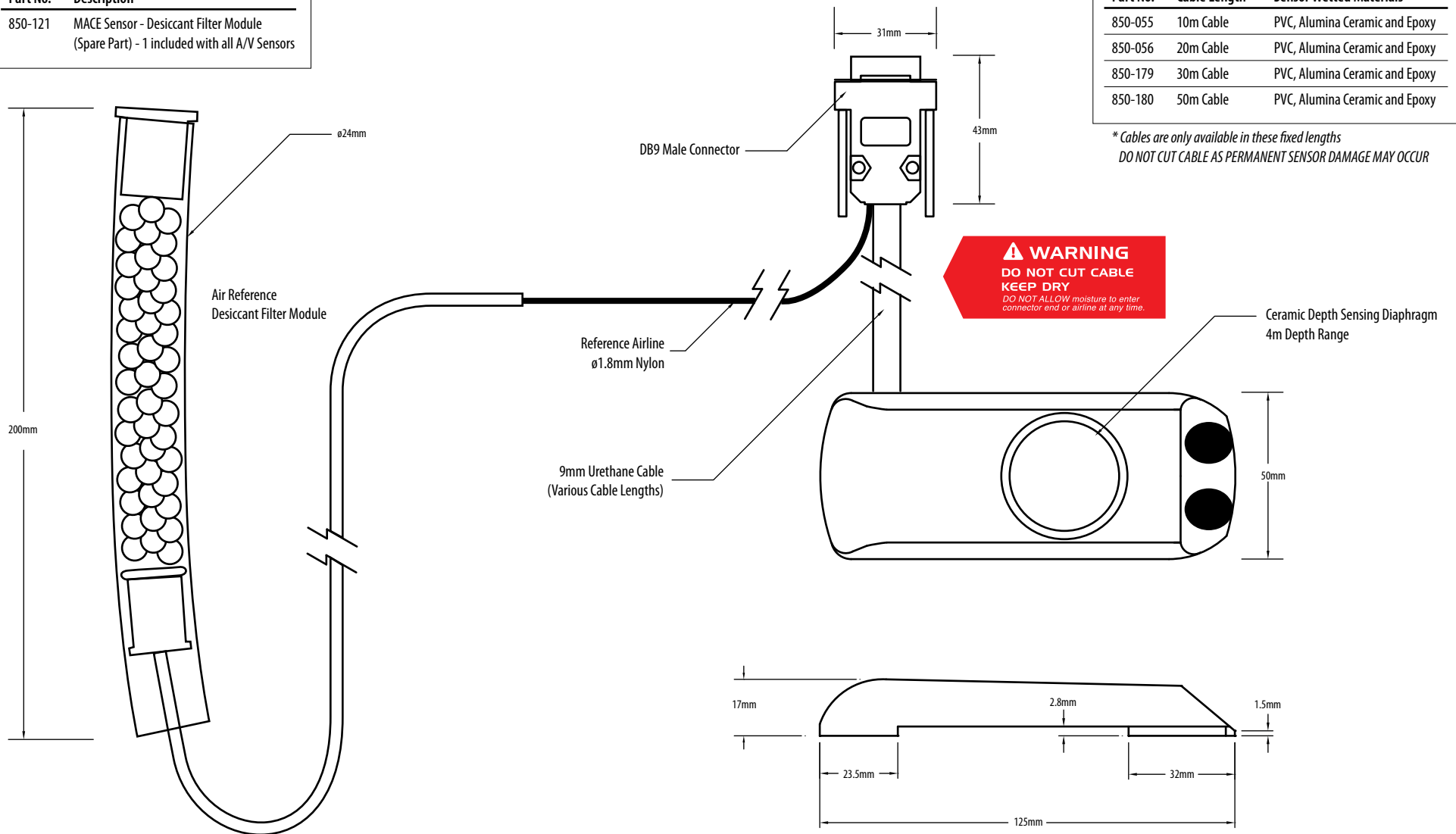
Appendix C - Engineering submittal drawings - continued

vii) MACE Doppler area/velocity sensor

Part No.	Description
850-121	MACE Sensor - Desiccant Filter Module (Spare Part) - 1 included with all A/V Sensors

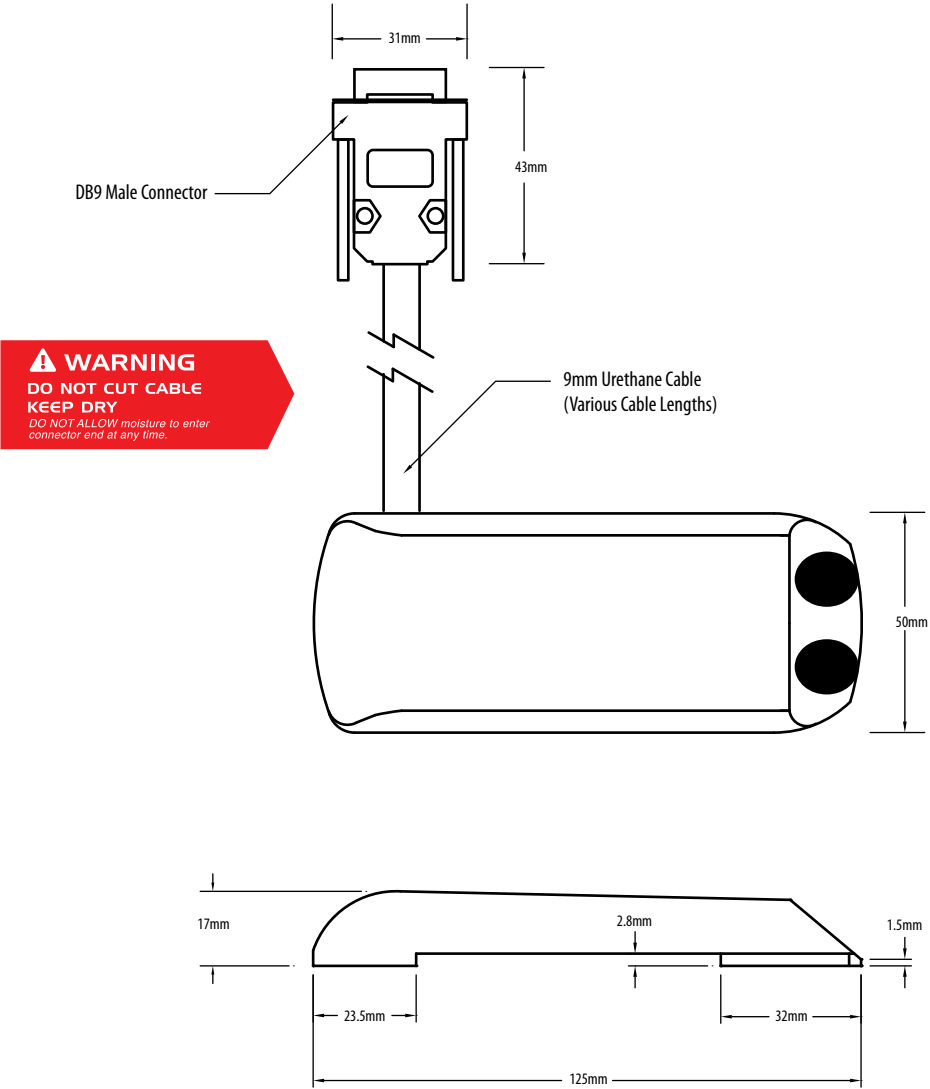
Part No.	Cable Length*	Sensor Wetted Materials
850-055	10m Cable	PVC, Alumina Ceramic and Epoxy
850-056	20m Cable	PVC, Alumina Ceramic and Epoxy
850-179	30m Cable	PVC, Alumina Ceramic and Epoxy
850-180	50m Cable	PVC, Alumina Ceramic and Epoxy

* Cables are only available in these fixed lengths
DO NOT CUT CABLE AS PERMANENT SENSOR DAMAGE MAY OCCUR



Appendix C - Engineering submittal drawings - continued

viii) MACE Doppler velocity sensor

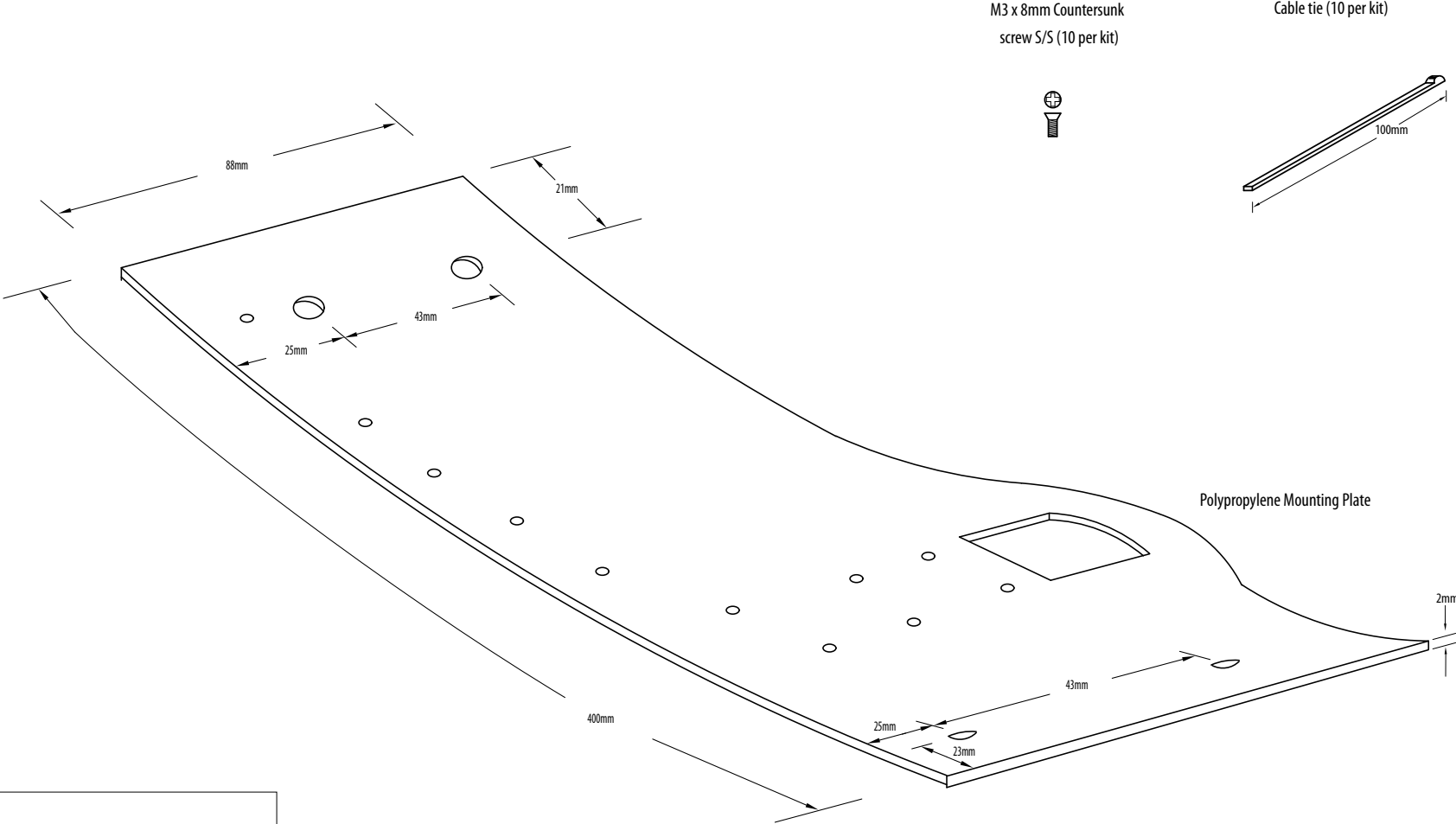


Part No.	Cable Length*	Sensor Wetted Materials
850-051	10m Cable	PVC and Epoxy
850-052	20m Cable	PVC and Epoxy
850-153	30m Cable	PVC and Epoxy
850-154	50m Cable	PVC and Epoxy

** Cables are only available in these fixed lengths
DO NOT CUT CABLE AS PERMANENT SENSOR DAMAGE MAY OCCUR*

Appendix C - Engineering submittal drawings - continued

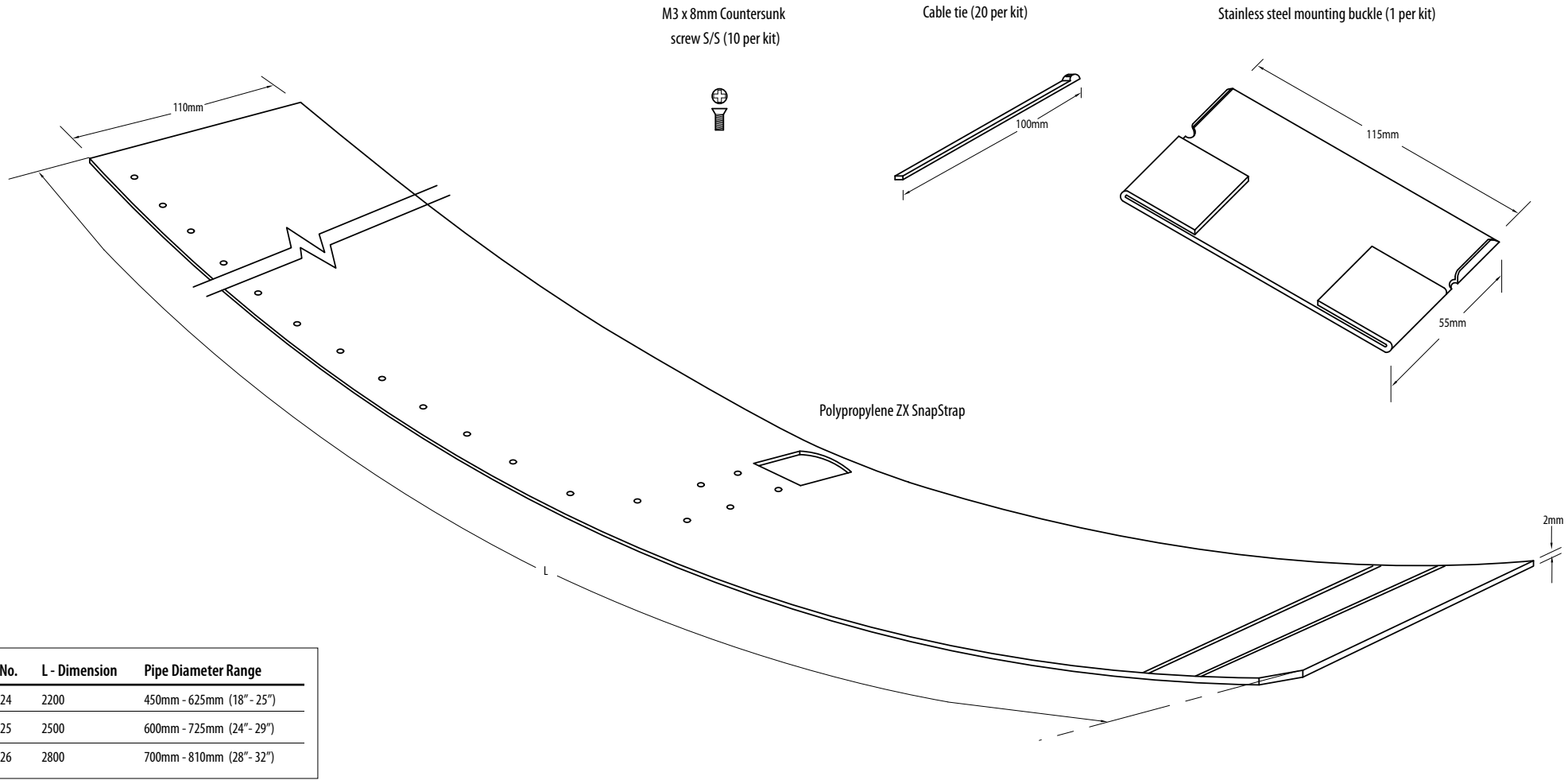
ix) Sensor mounting plate - polypropylene



Part No.	Description
850-344	Mounting Plate (Sensor) - Poly with Mounting Accessories

Appendix C - Engineering submittal drawings - continued

x) ZX SnapStrap - Large pipe sizes



Appendix C - Engineering submittal drawings - continued

xi) ZX SnapStrap - Small pipe sizes

