

# Hydro-Probe Orbiter II

## User Guide

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## CUSTOMER RESPONSIBILITY

The customer in applying the product described in this documentation accepts that the product is a programmable electronic system which is inherently complex and which may not be completely free of errors. In doing so the customer therefore undertakes responsibility to ensure that the product is properly installed commissioned operated and maintained by competent and suitably trained persons and in accordance with any instructions or safety precautions made available or good engineering practice and to thoroughly verify the use of the product in the particular application.

## ERRORS IN DOCUMENTATION

The product described in this documentation is subject to continuous development and improvement. All information of a technical nature and particulars of the product and its use including the information and particulars contained in this documentation are given by Hydronix in good faith.

Hydronix welcomes comments and suggestions relating to the product and this documentation

## ACKNOWLEDGEMENTS

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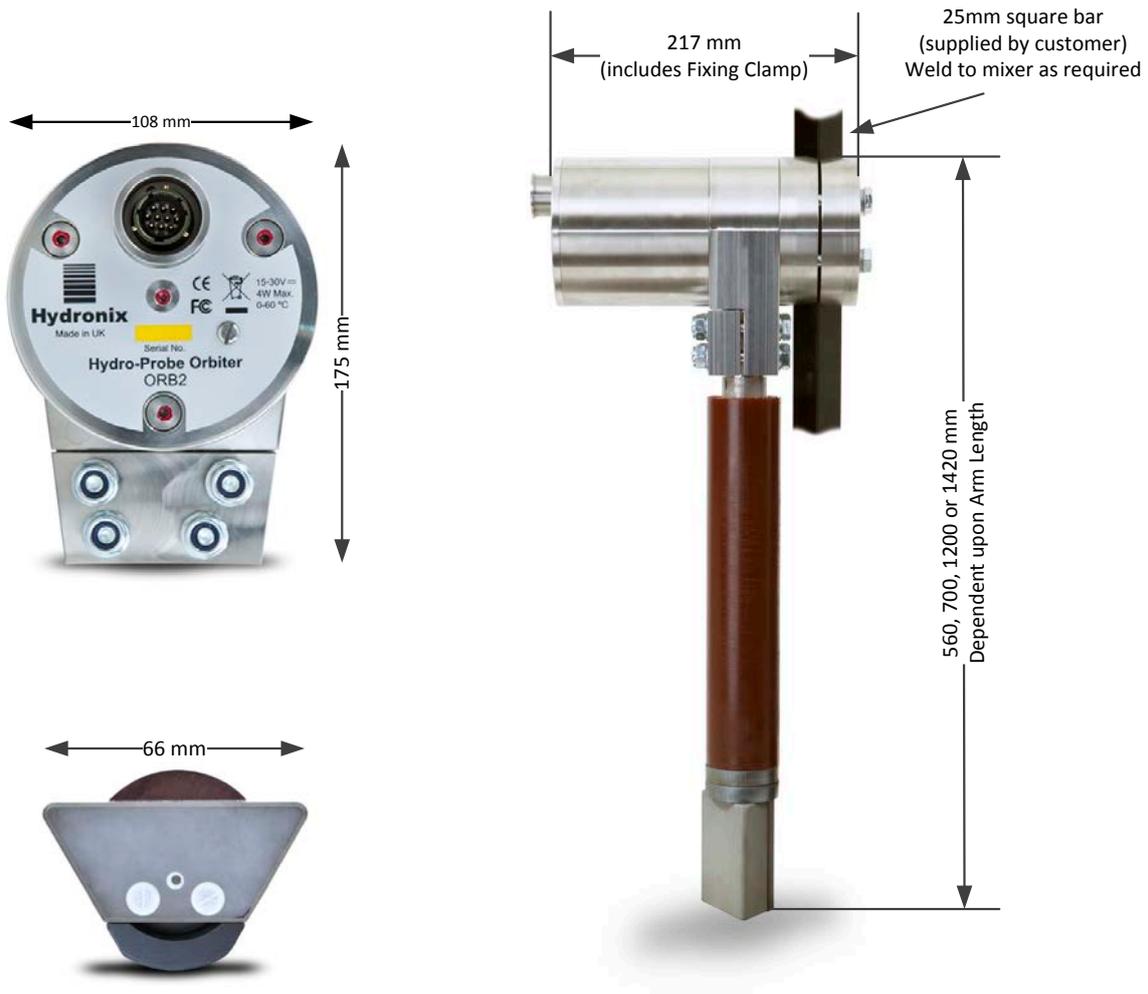
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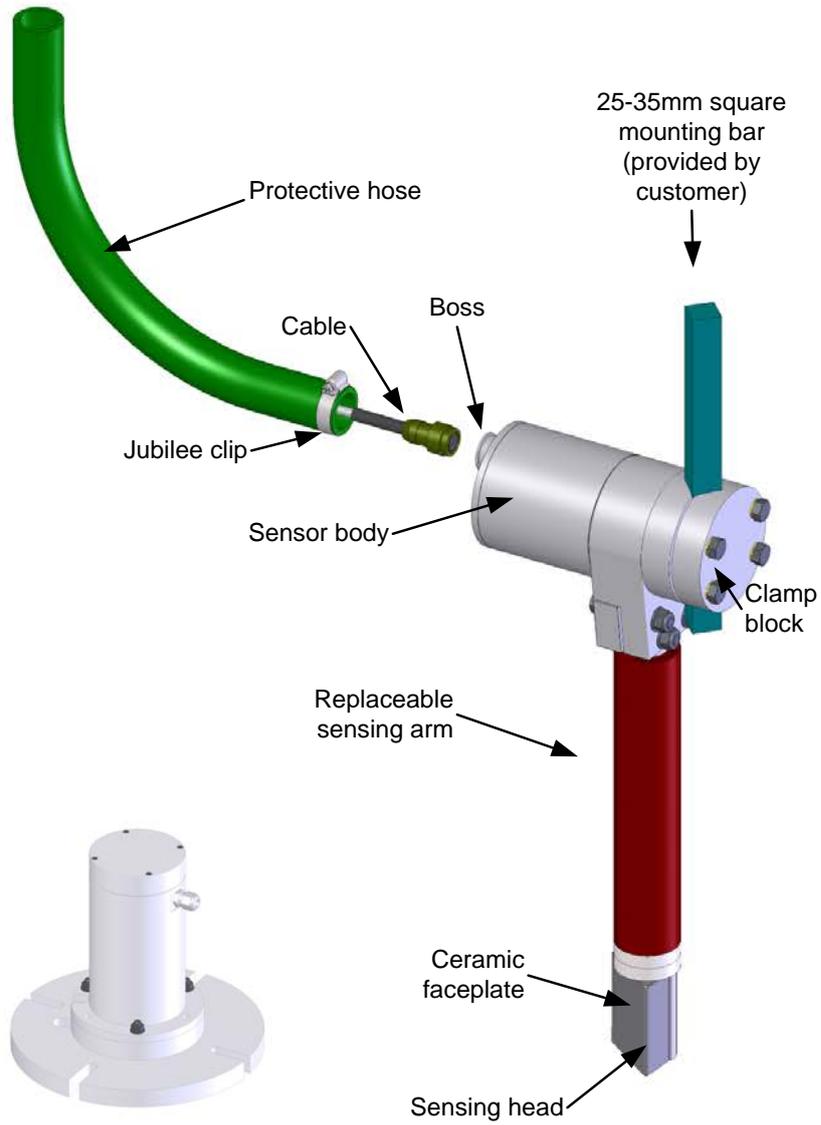
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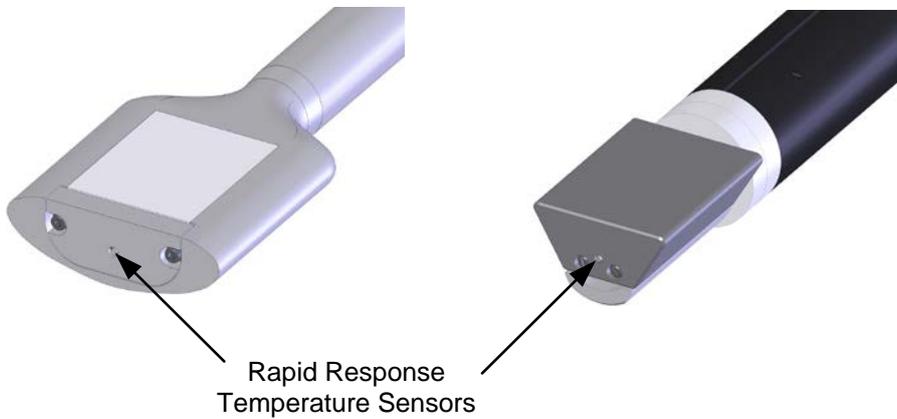
Hydro-Probe Orbiter Dimensions  
(with ORBA2 Arm)



Rotating Connector Assembly

ORBA1 Sensing Arm

ORBA2 Sensing Arm



The Hydro-Probe Orbiter is a digital sensor typically designed for measuring the moisture and Brix content in many process control applications. The unit is comprised of two parts, the sensor body and an easily replaceable arm with a sensing head that provides a rapid and representative measurement of both moisture content and temperature of the material. Utilising the latest digital technology, the Hydro-Probe Orbiter combines accuracy and speed to provide a meaningful reading that is unachievable with static mounted sensors.

The main sensor electronics are housed in the sensor body, separate from the hard wearing replaceable sensing arm and head. This provides many distinct advantages with the following key features and benefits:

- Small streamlined sensing head cuts cleanly and smoothly through the material without a build-up, providing a smooth and clean signal
- Rapid response temperature measurement provided by a thermally-insulated temperature sensor in the sensing head.
- Easily replaceable sensing arm and hardened wear head, with an easy calibration procedure for matching a new microwave sensing head and arm to the main electronics.

## 1 Safety

Please read this manual and all warnings. Install the unit accordingly or severe electrical damage may occur to you or the device.

CAUTION - NEVER HIT THE CERAMIC



Care should also be taken to ensure that the Hydro-Probe Orbiter II has been correctly installed and in such a manner to ensure representative sampling of the material concerned.



Make sure all connections are correct before the power is switched on.

## 2 Suitable applications

The Hydro-Probe Orbiter may be easily mounted statically in rotating pan mixers. For static pan mixers such as Turbo or Planetary mixers, the Hydro-Probe Orbiter is installed in conjunction with the Hydronix Rotating Connector.

Alternatively the sensor can be mounted next to a process flow such that the ceramic faceplate is in the flow of material being measured.

## 3 Measuring Techniques

The Hydro-Probe Orbiter uses the unique Hydronix digital microwave measurement technique that provides a more sensitive measurement when compared with analogue techniques.

This is further enhanced by a range of new sensor Measurement Modes that are available in this sensor and which can give better results when used in different materials.

## 4 Sensor Connection and Configuration

The Hydro-Probe Orbiter may be remotely configured using a digital serial connection and a PC running Hydro-Com diagnostics software. For communication with a PC Hydronix supply RS232-485 converters and a USB Sensor Interface Module (See “Hydronix Interface Units” on page 41).

There are two basic configurations in which the Hydro-Probe Orbiter can be connected to the mixer control system:

- Analogue output - A DC output is configurable to:
  - 4-20 mA
  - 0-20 mA
  - 0-10 V output can be achieved using the 500 Ohm resistor supplied with the sensor cable.
- Digital control - an RS485 serial interface permits direct exchange of data and control information between the sensor and the plant control computer or Hydro-Control system.

The sensor may be configured to output a linear value of between 0-100 unscaled units with the recipe calibration being performed in the control system. Alternatively it is also possible to internally calibrate the sensor to output a real moisture value.

## 5 Rotating Connector Option

An optional Rotating Connector is available which allows the Hydro-Probe Orbiter II to be installed inside a static pan mixer. This requires access through the centre of the top of the mixer.

The Rotating Connector provides a simple way of connecting the plant wiring outside of the mixer to the sensor wiring within the mixer through an 8 way connector to allow all relevant signals from the sensor to be accessed.

## 6 Arms

The Hydro-Probe Orbiter II has a replaceable sensing arm which is available in various lengths. The standard lengths are 560mm, 700mm, 1200mm or 1420mm (note that this length refers to the overall height of the Hydro-Probe Orbiter, as shown in the product diagram on page 11). For installations requiring the ORBA1 arm, other lengths can be made to order.

An additional feature with the 700mm sensing arm is a reinforcement collar that fits over the top of the arm, see Figure 2. This is included to increase the strength of the arm.

It is recommended that wear protection is used at all times on the Orbiter Arms. Protection accessories are available from Hydronix and supplied as standard with ORB2 sensors. This protection must be inspected and maintained periodically to prevent failure of the arm.

For accurate and representative moisture measurement the sensor ceramic faceplate must be in contact with the moving stream of material. It is important that no material can build up over the sensor face to obscure the sensor readings.

Follow the advice below for good sensor positioning:

- Provide a small inspection lid in the mixer cover so that, during mixing and when the mixer is empty, the movement of the sensor and its ceramic face may be observed without having to raise the main cover plate.
- Avoid areas of severe turbulence. The best signal will be obtained where there is a smooth flow of material over the sensor. Mount the sensor so that it does not get hit directly by flow from any mixing stars or wirlblers.
- The sensor should be positioned where it will see a continuous sample of the flowing material.
- Position the sensor away from any electrical interference (See “Chapter 3” on page 37).
- Position the sensor so that it may be easily accessible for routine maintenance, adjustment and cleaning.

## 1 Orbiter Arm options

There are two designs of Orbiter Arm available, ORBA1 and ORBA2. Each design is available in multiple lengths and the ORBA1 also has a high temperature option. The design used will depend on the material being measured and the installation. The ORBA2 is the latest model and is recommended for all mixing applications.

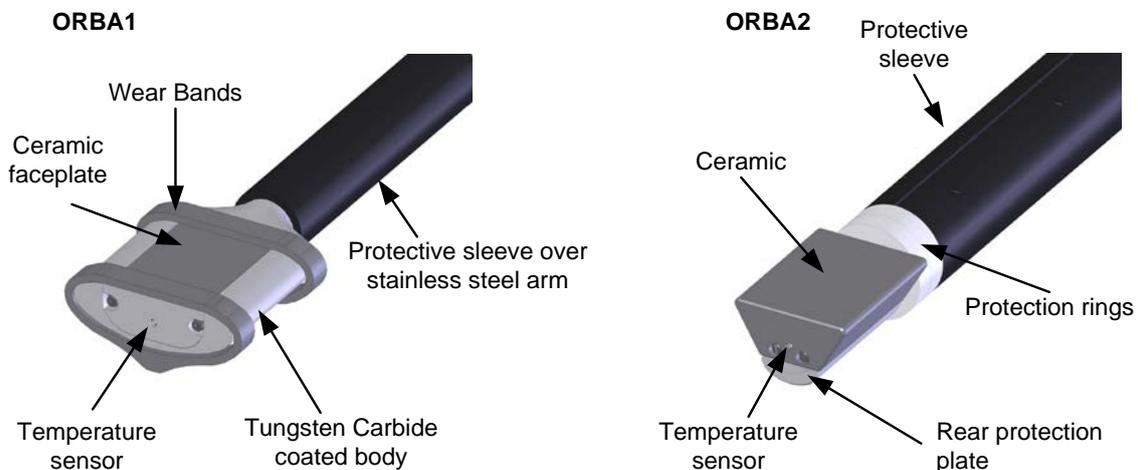


Figure 1: The two Orbiter Arm types

### 1.1 Protection of Orbiter Arms

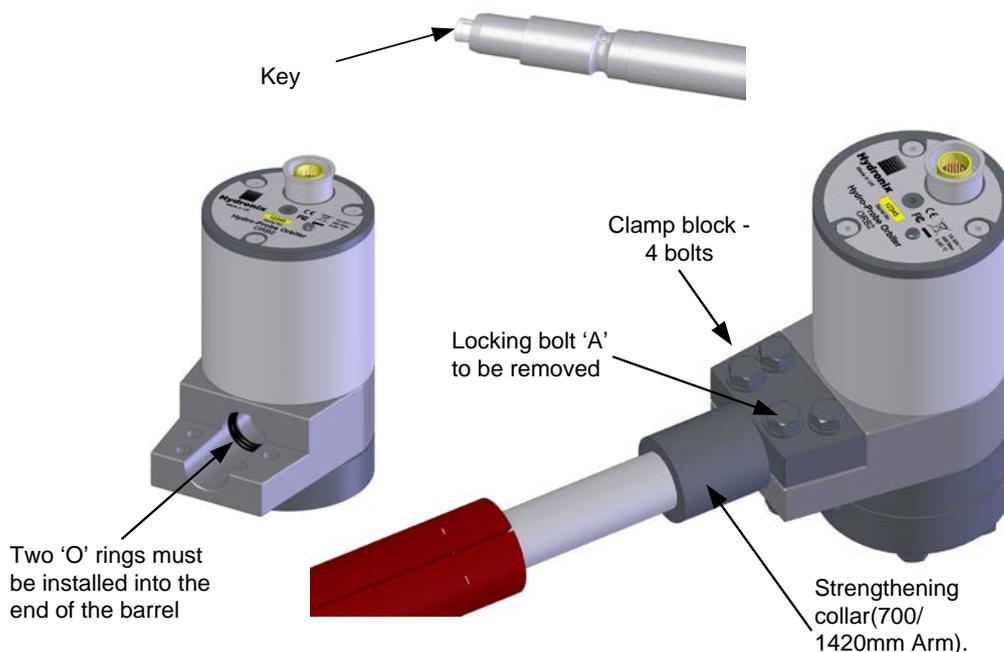
It is always recommended to fit and maintain protective sleeves (also known as arm guards) to the arm tube.

For ORBA2 arms, in addition to the protective sleeve it is important to install protection rings where the protective sleeve meets the ceramic. Steel rings are supplied as standard with the ORBA2 arm but for use in harsh environments, ceramic protection rings are available. All ORBA2 arms are supplied with protection rings and a rear protection plate fitted.

## 2 Assembly of Arm and Head Unit

The Sensing Arm and electronics Head Unit are shipped unattached. They need to be connected before installation into the mixer.

- Place the Head Unit on a clean, flat surface.
- Loosen the 4 Sensing Arm clamp bolts on the Head Unit and remove the locking bolt (A).
- Fit the two 'O' rings. These need to be located inside the clamp blocks up against the step as shown in Figure 3.
- Ensure that the key on the electrical connector at the top of the Sensing Arm is on the same side as the ceramic faceplate. The connector can be rotated by hand if required.



**Figure 2: Installation of sensing arm into sensor head unit**

- Place the Sensing Arm on the same clean, flat surface with the ceramic faceplate facing upwards, aligned with the hole in the head unit and the keyway on the connector.
- For ease of fitting, apply a small amount of grease to the connector end of the arm or around the two 'O' rings.
- Gently locate the connector at the top of the Sensing Arm in the hole in the Head Unit, so that the connector lines up with its socket in the Head Unit. Push the Sensing Arm home into the Head Unit.
- Replace locking bolt 'A'.
- Tighten the 4 arm clamp bolts so that it is still possible to rotate the arm by hand - these are not fully tightened until the Sensing Arm has been aligned so that the ceramic faceplate is at the correct angle after the Hydro-Probe Orbiter has been installed in the mixer.

If the Sensing Arm is a replacement then a recalibration procedure will need to be carried out. See "Chapter 7" on page 63.

### 3 Selecting the best position for mounting the sensor

The small, stream-lined ceramic faceplate on the Sensing Arm needs to be positioned so that it cuts cleanly and smoothly through the material, without build-up, thereby providing a smooth and clean signal.

In selecting the optimum position, the following considerations need to be taken into account:

- The cabling arrangement from the sensor to the Rotating Connector
- The sensor should be attached along the scraper blade arm approximately 1/4 to 1/3 of the distance in from the wall of the mixer (see Figure 15). Select a position where the flow of material is the smoothest, and as far as possible free from the turbulence created by the mixer blades. The ceramic faceplate of the Sensing Arm should be angled at 55° to the centre of the mixer, which can be set using the aligner provided (see Figure 16 for further information).
- The Head Unit may be mounted underneath or above the scraper blade arm (Figure 3). In both cases the Head Unit should be as far out of the mix as possible in order to keep it reasonably clean and minimise wear.
- The Sensing Arms are available in multiple lengths. The sensor should be mounted such that there is a 50mm gap between the underside of the Sensing Arm and the mixer floor (Figure 13).
- A protective cover can be placed over the Head Unit to protect the sensor from falling materials and prevent unnecessary build-up of materials on the Head Unit (Figure 4).

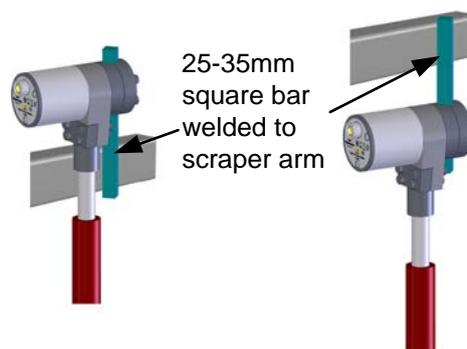


Figure 3: Fixing the sensor above or under the scraper blade arm

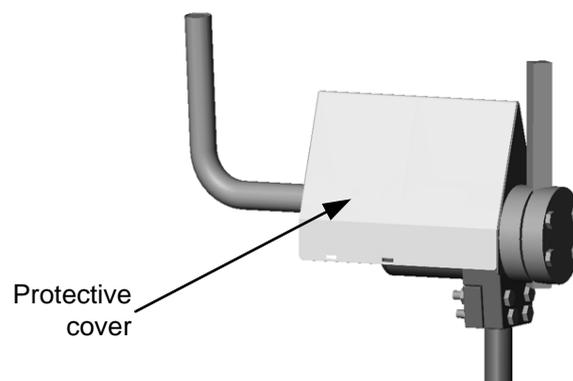
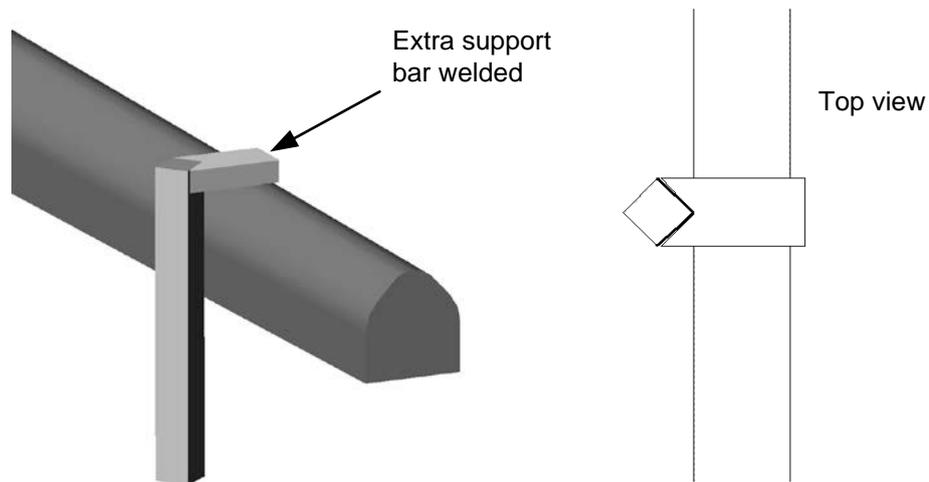


Figure 4: Protective cover placed over the sensor body

## 4 Mounting in a static pan mixer

Figure 5 shows how the square mounting bar may be welded to the scraper blade arm or an alternative arm.

When installing the sensor in a static pan mixer, the sensor cable must be routed via a Rotating Connector which is fitted to the centre of the mixer top (See Using a Rotating Connector on page 26 for more details).



**Figure 5: Square mounting bar welded to scraper blade arm**

## 5 Mounting in a rotating pan mixer

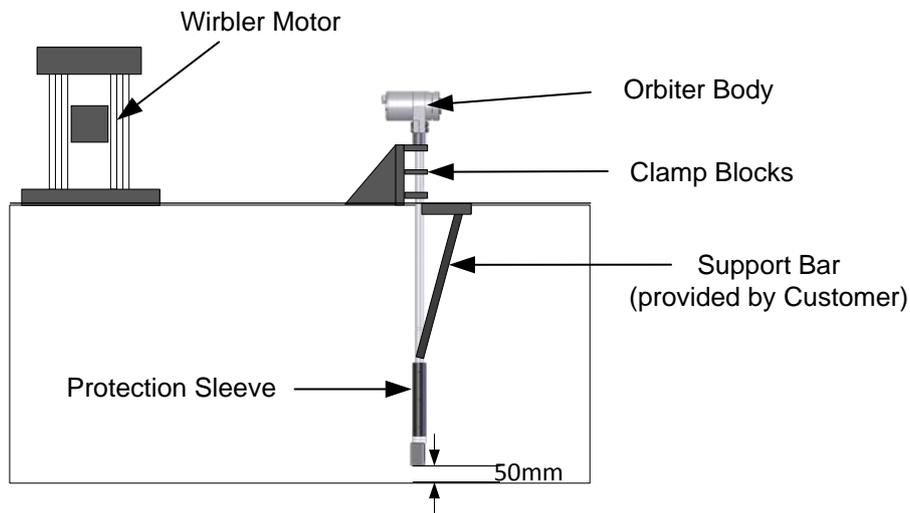
The Hydro-Probe Orbiter should be installed so that the head unit is outside of the mixer. This will protect the head unit from debris and damage.

The unit can be attached to the mixer using the mounting bar clamp blocks supplied with the head unit, see Figure 12. A square bar needs to be firmly welded vertically to a rigid support bar on top of the mixer, see Figure 7. The head unit is clamped to the square bar using the clamping blocks, the height can be adjusted to give the required clearance from the bottom of the pan.

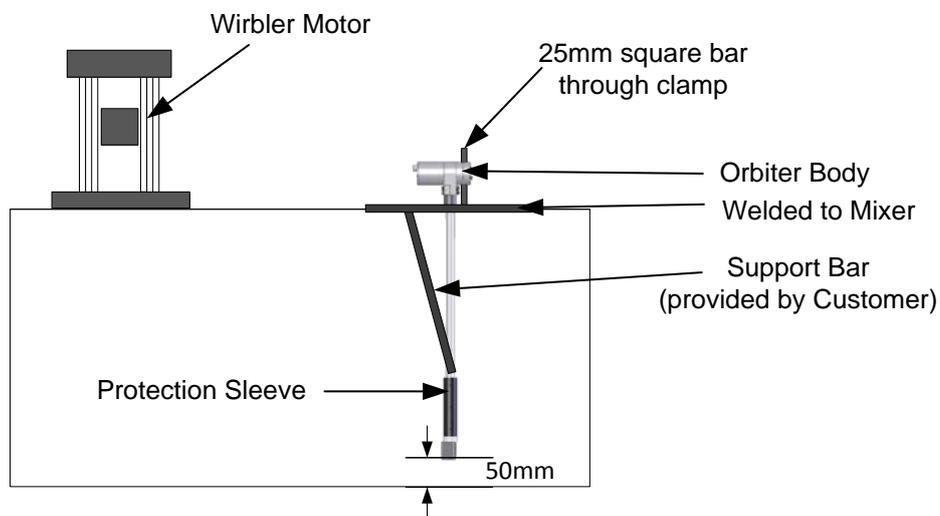
Alternatively the head unit can be fixed using, customer supplied, clamp blocks that are welded to the top of the mixer, see Figure 6.

When the 1420mm orbiter arm is in use a customer supplied support is required to increase the stability of the arm. The support will need to be attached firmly to the top of the mixer and to the orbiter arm above the protection sleeve, see Figure 6.

The sensing head should be positioned in an area where the flow of material is the smoothest. Normally this is a quarter or a third of the distance in from the outer edge of the mixer wall. (Figure 15).



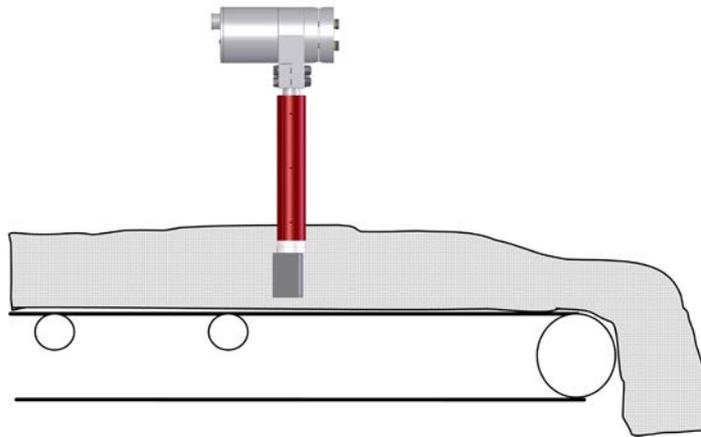
**Figure 6: Sensor mounted above mixer using clamp blocks**



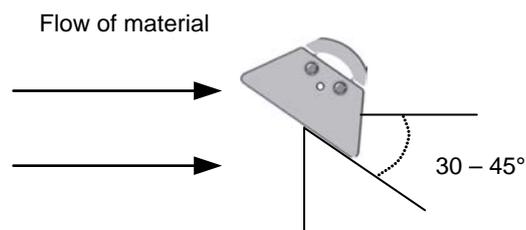
**Figure 7: Sensor mounted above the mixer using the clamp bar**

## 6 Mounting on a conveyor belt

The sensor may be fitted in a similar manner as in a mixer, with the sensing face angled at approximately  $35^\circ$  to the flow of the material.



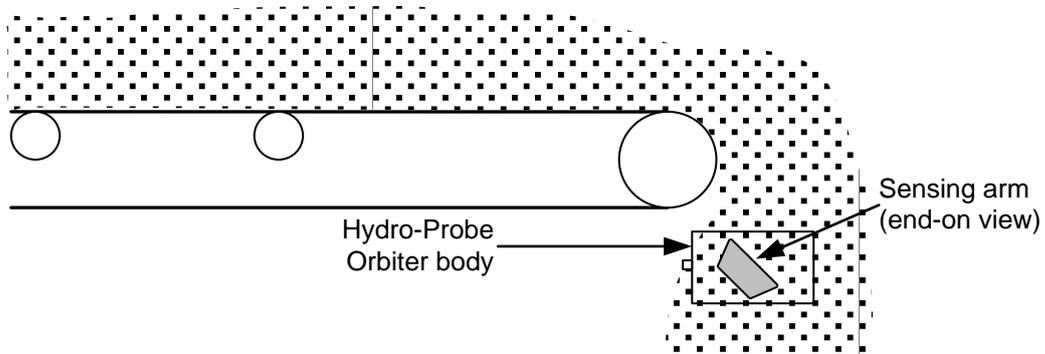
**Figure 8: Mounting the Hydro-Probe Orbiter II on a conveyor belt**



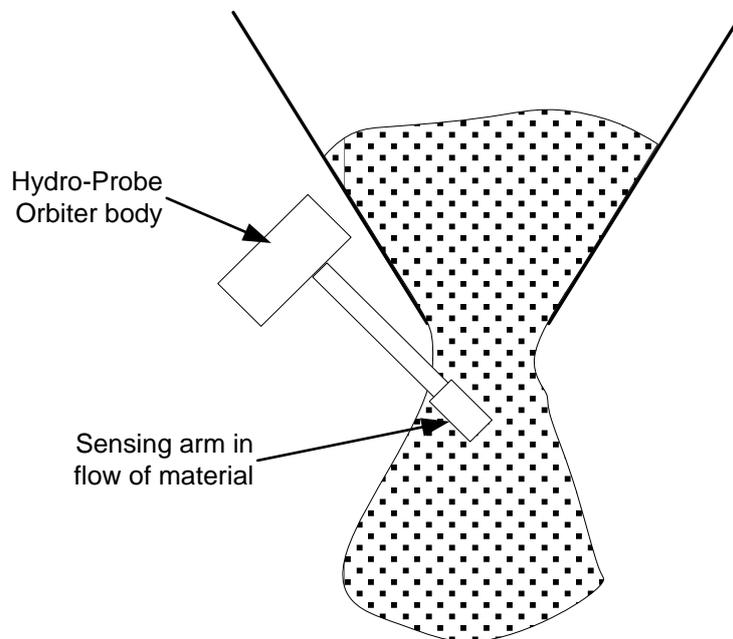
**Figure 9: Orientation of the Hydro-Probe Orbiter II ceramic in a flow of material**

## 7 Mounting in a free fall application

Fitting should be as indicated in the following figures.



**Figure 10: Mounting the sensor at the end of a conveyor**



**Figure 11: Mounting the sensor in a silo outlet**

## 8 Fitting the square mounting bar

A 25-35mm square bar should be very firmly welded to the appropriate scraper blade arm, or alternative mixer arm, depending on the mixer configuration. It should be suitably reinforced to provide a rigid fixing that will withstand the forces generated on the sensing head and arm whilst moving through the material. Ensure that the bar is perpendicular to the floor in both planes.

It may be preferable, such as in turbo mixers where each arm is sprung loaded, to construct a separate arm fixed to the central part of the mixer.

Undo and remove the 4 bolts securing the pair of clamp blocks to the head unit (for clamping the unit to the square bar), and remove the pair of clamp blocks as shown in Figure 12. Depending on the configuration, the clamp blocks can be rotated for either vertical or horizontal fixing to the square bar.

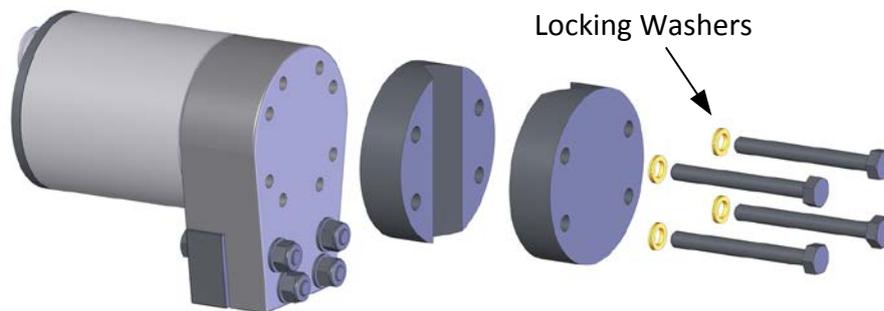


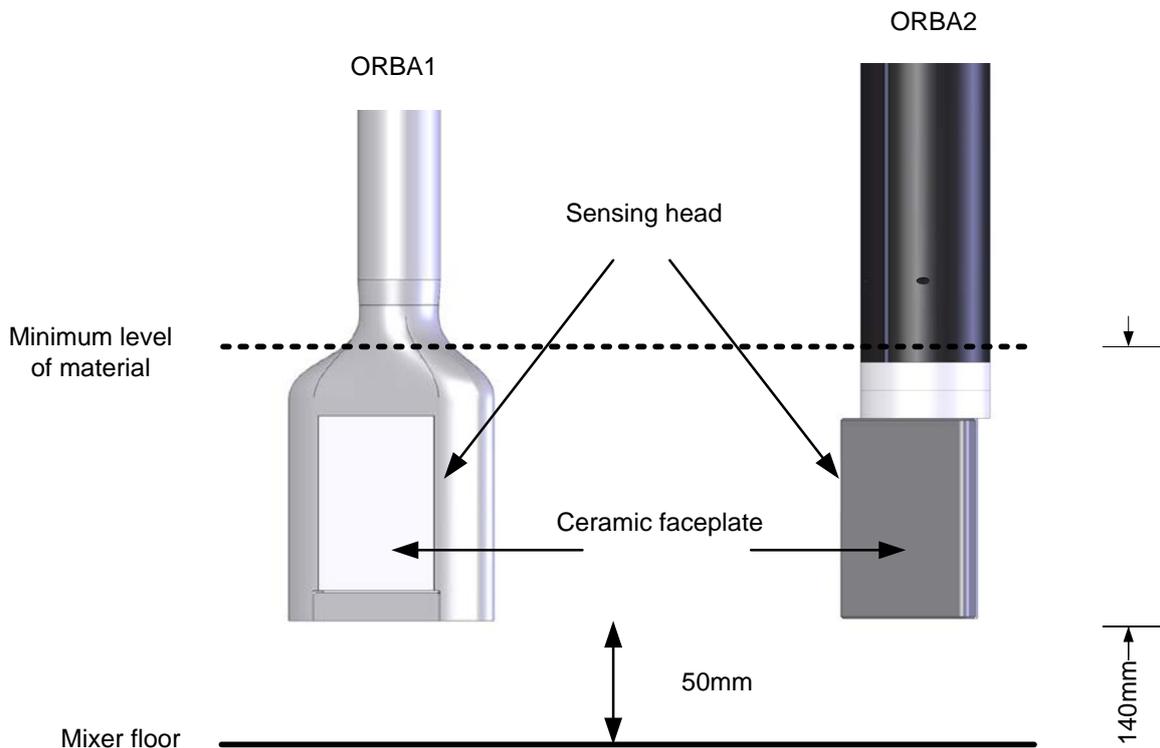
Figure 12: Removing the mounting bar clamp blocks ready for fitting to the mixer

## 9 Mounting the sensor and making final adjustments

The height may be adjusted by slackening the clamp blocks and sliding the body up and down the square support bar.

The recommended height for typical applications is 50mm above the floor of the mixer (Figure 13). This height can be set using the angle aligner, which has a width of 50mm.

The correct length of arm should be selected to allow the sensing head to sit a minimum of 50mm above the floor of the mixer and to ensure that the ceramic faceplate is in the full flow of the mix.

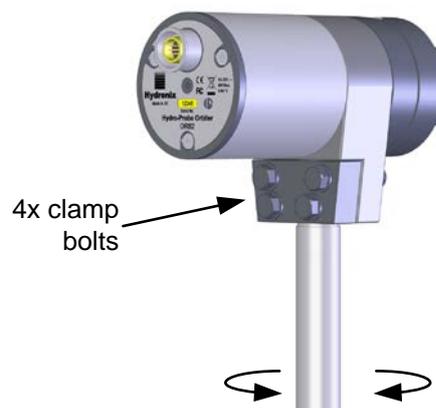


**Figure 13: Height setting of the sensing arm**

When adjusted to the desired height, securely tighten the clamp block bolts to a torque of 60Nm (44lb/ft). It is essential to ensure the locking washers are fitted to the clamp bolts so that the sensor is securely retained on the square bar

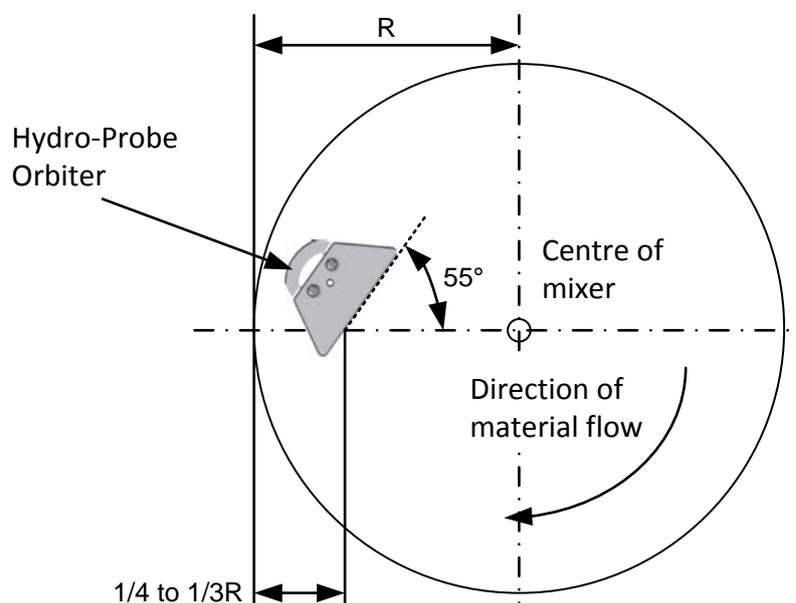
## 10 Sensing head angle adjustment for optimum performance

With the 4 arm clamp bolts loose, the sensing arm can be rotated through an angle of approximately  $300^\circ$  (Figure 14). The sensing arm is fitted with a mechanical stop to protect the internal cables from being over-rotated. If this stop prevents the faceplate from being adjusted properly, then remount the Hydro-Probe Orbiter II main body on the square bar at a different angle. This will then allow the arm to be adjusted correctly. Care should be taken not to twist the arm without having the lock bolt inserted to prevent damage to the internal cables.



**Figure 14: Adjusting the sensing head angle**

The angle of the sensing head face should be adjusted to provide consistent compaction of material against the ceramic measuring face and at an angle that avoids build-up of material on the sensing head.



**Figure 15: Setting the sensor angle for optimum performance**

- An angle of  $55^\circ$  generally provides good results. Use the angle aligner provided to set the angle (Figure 16).
- It has been found in some rotating pan mixers an angle of approximately  $65^\circ$  to the mixer centre is more appropriate to prevent too much build-up of material.
- Ensure all clamp bolts are tightened to a torque of 28Nm (21 lb/ft) after adjustment.

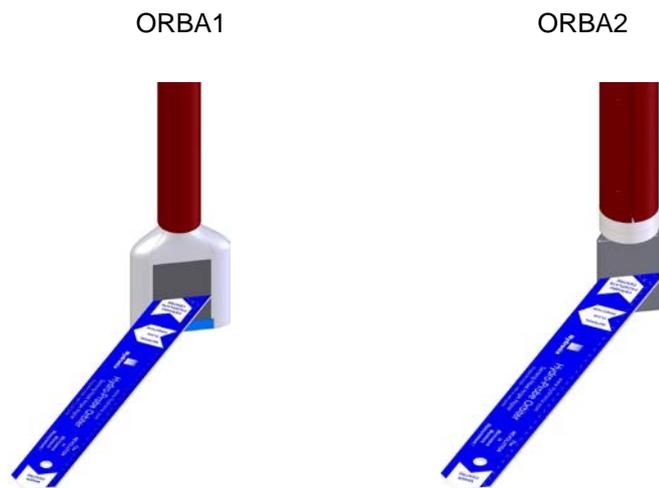


Figure 16: The Hydronix angle aligner for sensor face alignment

**IMPORTANT:**

*If the alignment of the sensing arm is changed inside a mixer, the resultant density change of material passing the sensing head will have an effect on the measurement. It is therefore necessary to recalibrate the recipes before the continuation of batching.*

## 11 Using a Rotating Connector

The Rotating Connector can be fitted to the centre of the mixer lid and is available in two different types with different mounting options.

- Type A  
This type is designed for a threaded central shaft in the middle of the top of the mixer.
- Type B  
The type B Rotating Connector has an internal bearing and is designed for mounting on the top of a mixer where the internal slip ring cannot be supported.

***If you have a different configuration of mixer that is not suitable for type 'A' or 'B' please contact Hydronix for further advice and possible alternative connection methods.***

More information on selection of the Rotating Connector can be found in "Appendix B Rotating Connector Selection" on page 79. Wiring information can be found in "Chapter 3 Electrical Installation and Communication" on page 37.

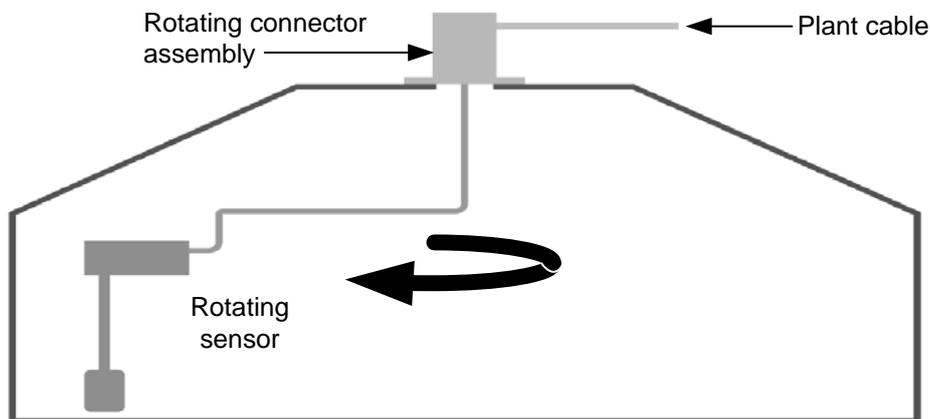
### 11.1 Cabling to the sensor

The static plant cabling is connected to the Hydro-Probe Orbiter II by means of a Rotating Connector assembly.

Electrical connectivity is achieved with the use of a high quality 8-Pole Rotating Connector for providing power, RS485 and analogue outputs.

The cabling arrangements will be different for each type of mixer. Therefore this manual focuses on mounting in the two main different types of mixer applications.

The routing and fixing of the cable in the mixer, together with the fixing of the Rotating Connector, might require a certain amount of improvisation.



**Figure 17: Connecting the Hydro-Probe Orbiter II to the Rotating Connector**

Two different types of Rotating Connector assemblies, referred to as types 'A' and 'B' are available to suit different types of mixer.

The connection details for the plant cabling to the terminal blocks inside the Rotating Connector assembly are the same in all cases.

## 11.2 Type 'A' Rotating Connector assembly

### 11.2.1 Suitable applications

Suitable for mixers with a threaded, hollow central shaft through the gearbox where the motor is not positioned centrally, i.e. planetary mixers such as OMG.

Rotation is via the mixer threaded rotating shaft.

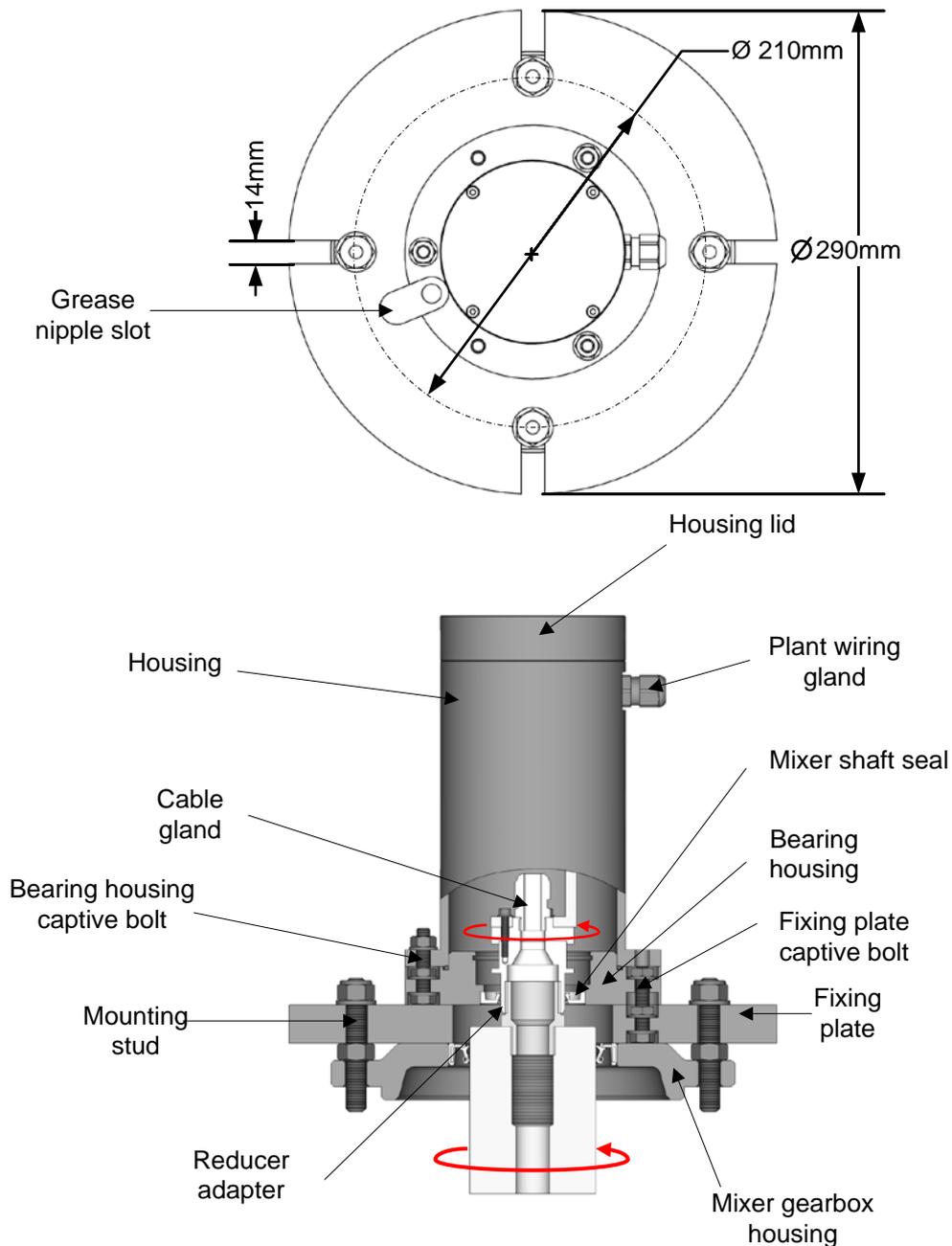


Figure 18: Type 'A' Rotating Connector assembly

### 11.2.2 Mounting

Mounts directly on the top of the mixer using a mounting flange.

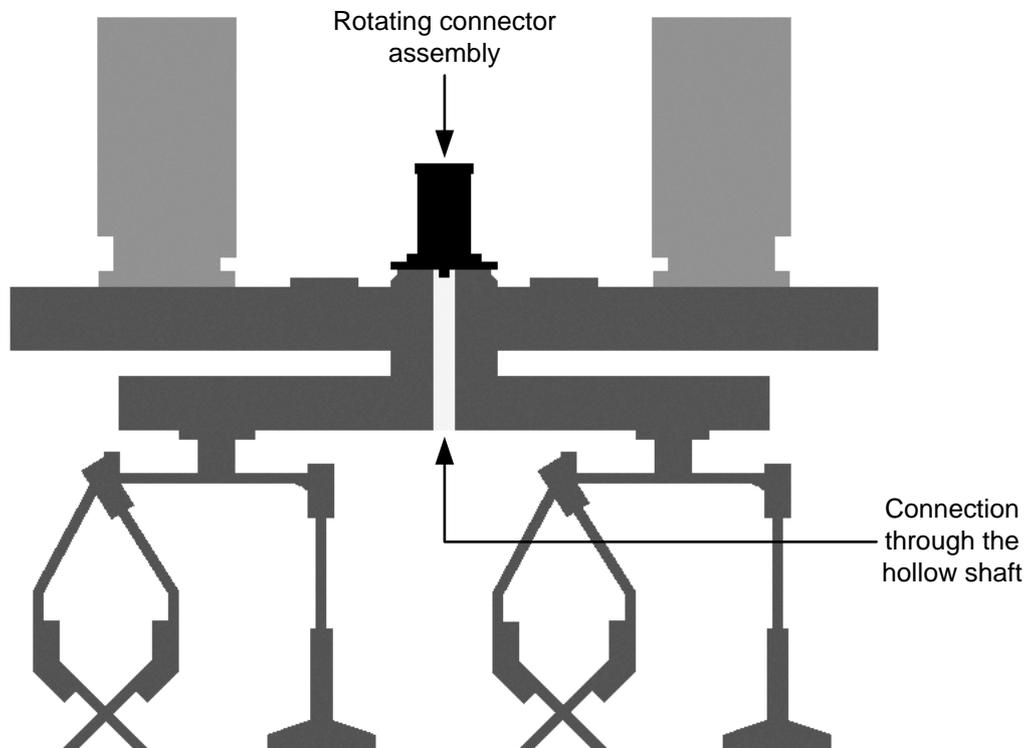


Figure 19: Connection to the Rotating Connector through the gearbox

### 11.2.3 Connections

Connects directly to the mixer central threaded hollow shaft by means of threaded adapters supplied

### 11.2.4 Threaded Adapters

On some mixers threaded adapters enable the Rotating Connector holder to be directly attached to the gearbox shaft. Two brass reducers are available depending on the type of mixer. One is a 1" BSP male to 1/2" BSP male adapter and the other is a 1" BSP male to 3/4" BSP male adapter. The construction using either adapter is shown in Figure 18.

### 11.2.5 Cabling arrangements

The routing of the cable and method of fixing it will be largely determined by the clearance between the underside of the gearbox and the highest point of the mixer blade arms, as depicted below in Figure 20. The cable should be protected by feeding it through a length of 32mm ID rubber hose.

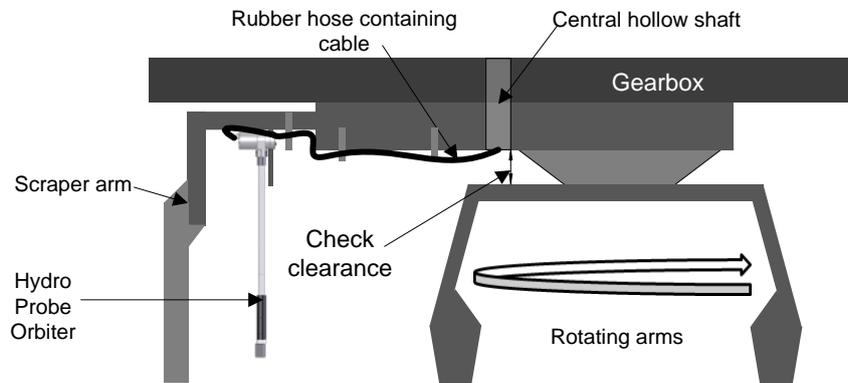


Figure 20: Checking the clearance between the revolving arm and the ceiling of the mixer

### 11.2.6 Fitting with good clearance

The clearance should be sufficient to ensure the rotating arms do not snag the protective hose.

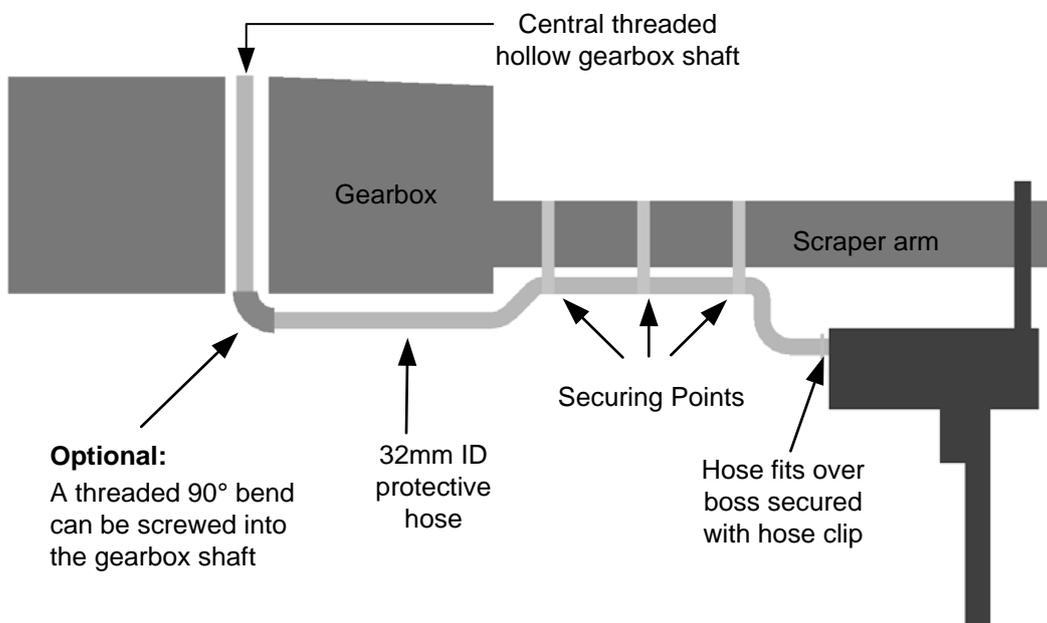
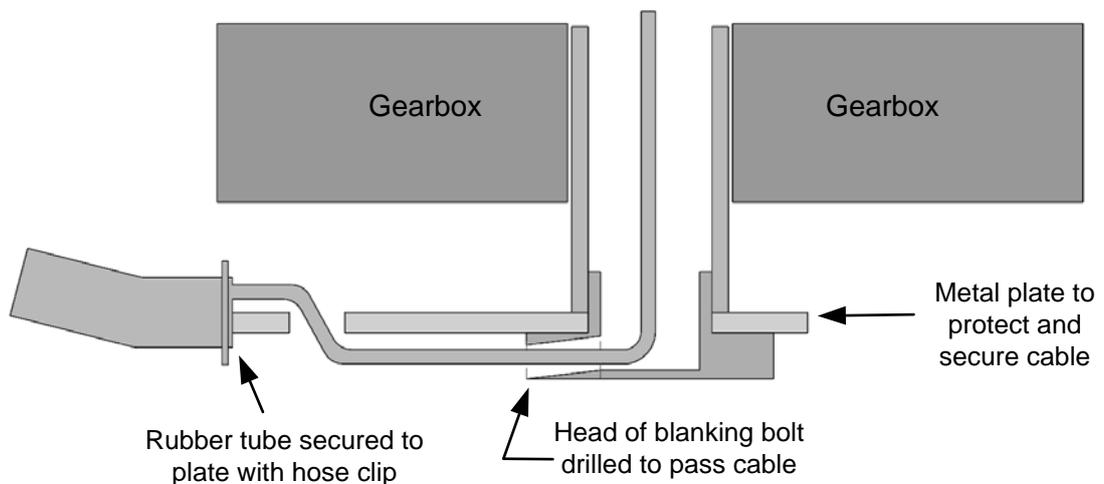


Figure 21: Fitting the cable with good clearance

- The cable is sheathed with 32mm internal diameter rubber hose
- Rubber hose fits over the boss covering the connector on the Hydro-Probe Orbiter electronics body and is secured by a hose clip
- Metal straps to be welded or bolted as appropriate to provide securing points for the rubber hose and cable. Suggested details in Figure 21.

### 11.2.7 Fitting where minimal clearance exists

One suggested method of fitting the cable when there is very small clearance is by using a small thin plate that can be fixed in place using the existing blanking bolt in the ceiling of the mixer. If the head of the bolt is drilled, the cable can be passed through and up the gearbox shaft. The plate is used to protect the cable near to the centre of the mixer where planetary blades run a risk of hitting the cable.



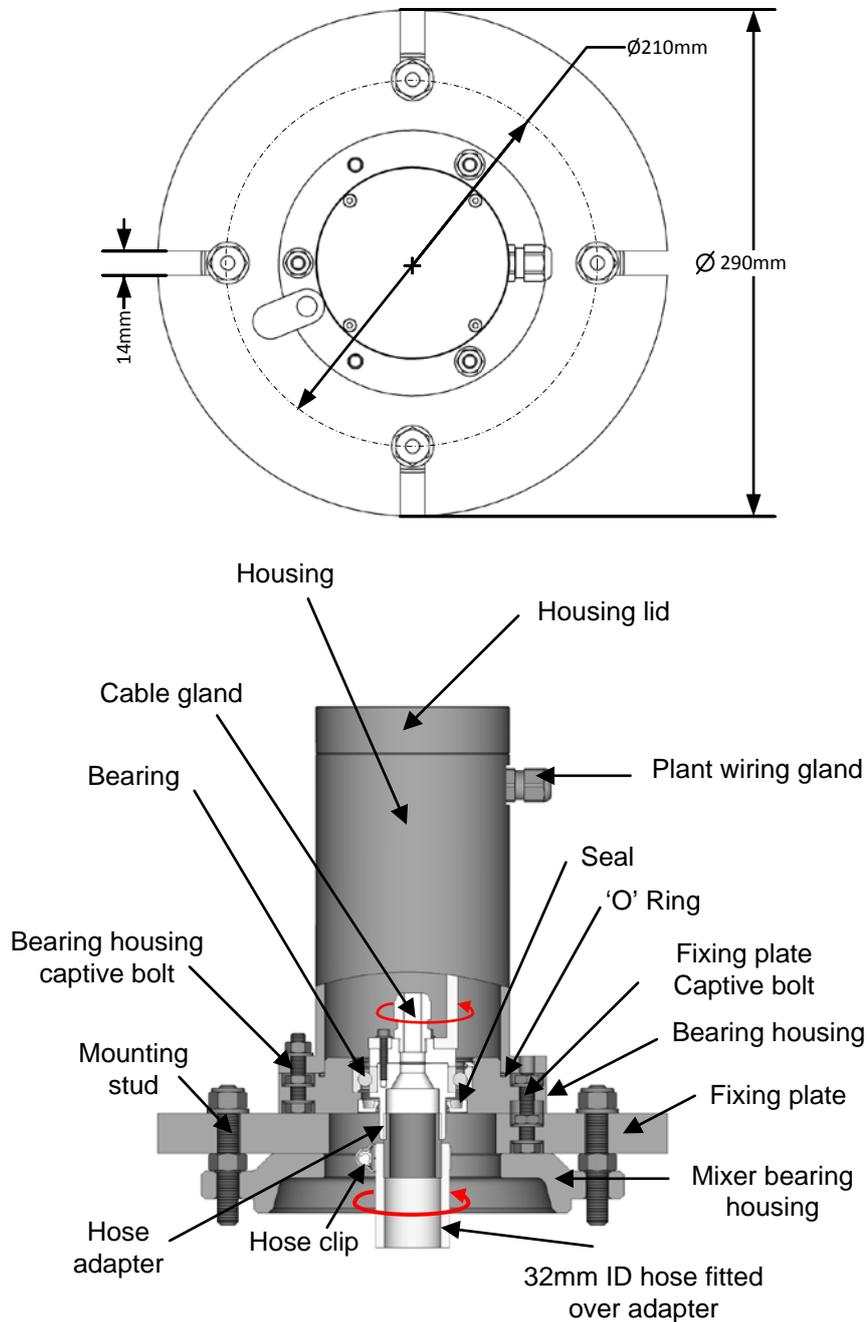
**Figure 22: Fitting the cable where minimal clearance exists**

### 11.2.8 Fitting Rotating Connector type 'A'

- Remove blanking bolts from both ends of the gearbox shaft.
- Screw the correct brass threaded adapter into the end of the shaft.
- Remove four of the bolts securing the cover plate to the gearbox.
- Screw four threaded studs into the bolt holes and secure using the nuts supplied.
- Ensure the captive bolts for securing the bearing housing are fitted to the fixing plate. See Figure 18.
- Mount the fixing plate to the stud on top of the mixer allowing the grease nipple to protrude through the slot provided.
- Ensure that the captive bolts for securing the Rotating Connector housing are in place.
- Fit and secure the bearing housing to the fixing plate using the captive bolts.
- Mount the slip ring sub-assembly on to the brass thread adapter and tighten. Secure with 3 nuts.

### 11.3 Type 'B' Rotating Connector assembly

In this assembly, the Rotating Connector sub assembly is fitted to a bearing protected by a seal, as shown in Figure 23. Rotation is via the protective hose.



**Figure 23: Type 'B' Rotating Connector assembly**

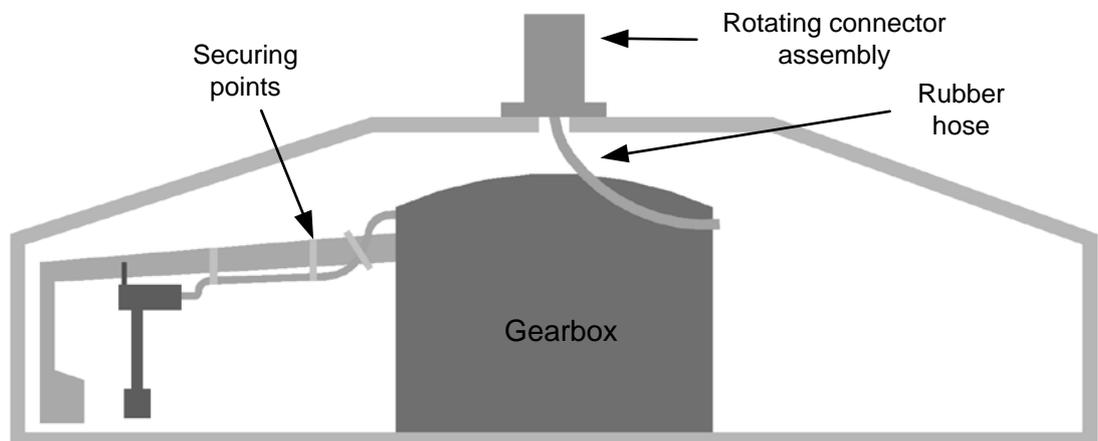
### 11.3.1 Suitable applications

Suitable for turbo pan mixers where the motor is fitted to the underside of the mixer. The cable is taken through a central hole in the top lid of the mixer.

Several options exist for routing the cable, but the important requirement is the ability to remove the cover lid to the gearbox for maintenance and blade adjustment.

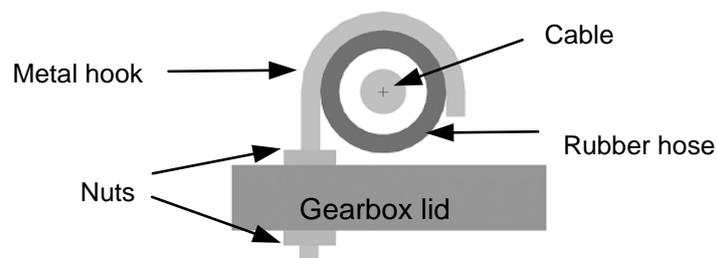
### 11.3.2 Routing of cable

These are suggested options only and fitting must be customized to suit each installation. The cable should be routed through the protective 32mm internal diameter rubber hose and should be connected directly onto the fixed terminal block. As mentioned above, it is important to be able to remove the cover lid to the gearbox, so a longer length of cable is advised which can be wrapped with enough length to still remove the cover whilst connected. A suggested method may be to secure the hose along the top inside edges of the blades as shown in Figure 24.



**Figure 24: Routing the cable to the Rotating Connector for turbo type pan mixers**

Alternatively, the hose can be wrapped around the edge of the gearbox lid using a series of hooks as shown in Figure 25. This would provide a simpler way of both detaching and attaching the hose and cable during times of maintenance. The hose can be squeezed into and out of the hook.



**Figure 25: Securing the cable**

### 11.3.3 Installing Rotating Connector type 'B'

The procedure described below will be broadly similar in principle irrespective of the routing option selected.

- Drill or cut a central hole in top cover lid, approximately 50mm diameter.
- Using the Fixing Plate as a template, mark and drill the four fixing bolt holes.
- Ensure that the 3 fixing plate captive bolts are installed and the nuts are tightened to hold them in place.
- Mount the Fixing Plate on the mixer top cover.
- Ensure that the 3 bearing housing captive bolts are installed and the nuts are tightened to hold them in place and mount this on top of the Fixing Plate, positioning the Rotating Connector over the hole and easing any spare cable back through the rubber hose. Secure by tightening nuts on the three bolts from the Fixing Plate.

### 11.4 Connecting the sensor cable

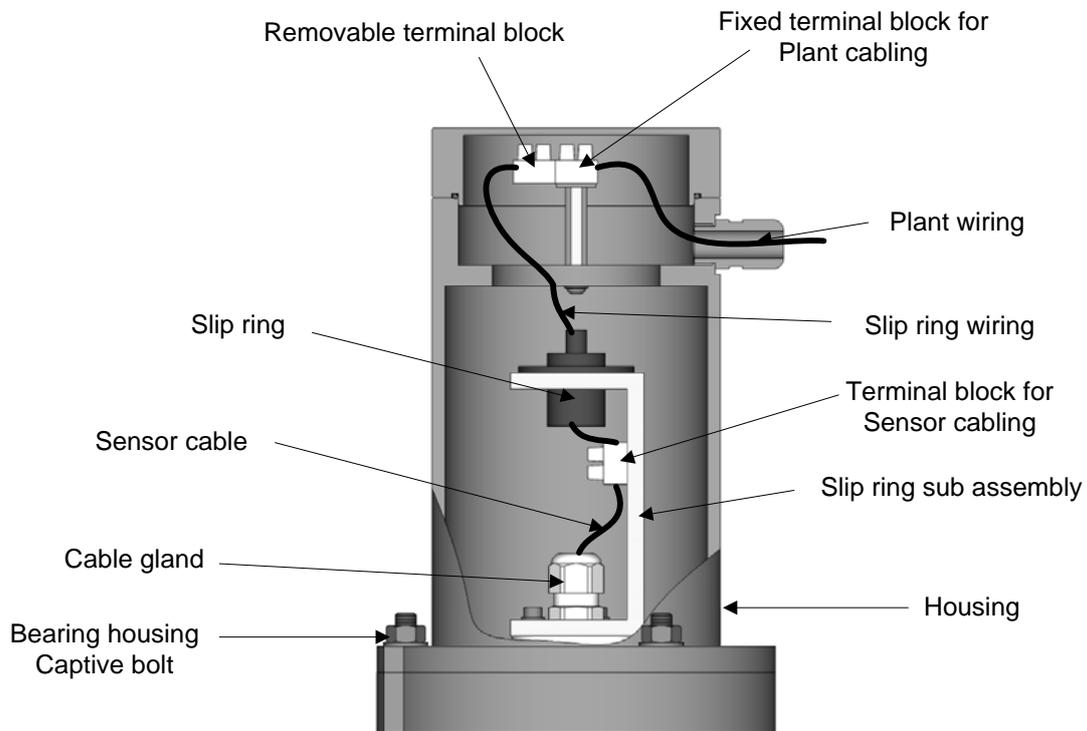
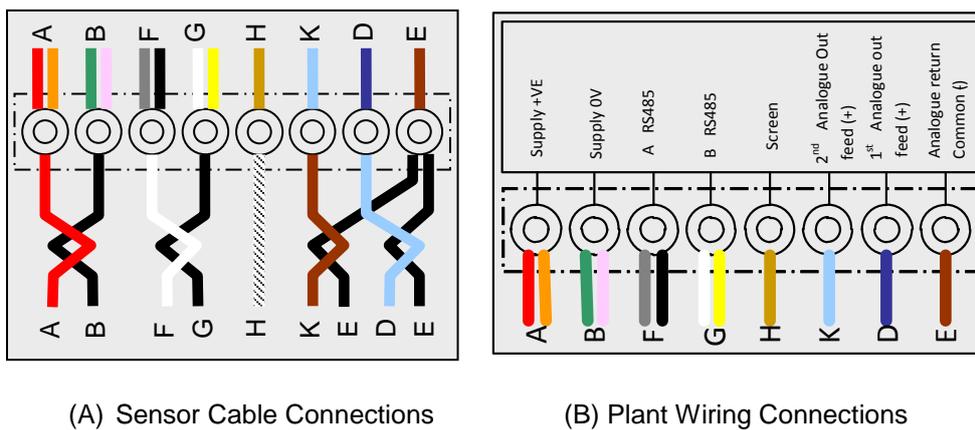


Figure 26: Sensor connections for all types of Rotating Connector.



(A) Sensor Cable Connections

(B) Plant Wiring Connections

Figure 27: Wiring diagrams

Connection Port	Slip Ring Wire Colour	Sensor Wire Colour	Connection Type
A	Red/Orange	Red	Supply +VE
B	Green/Mauve	Black	Supply 0V
F	Grey /Black	White	A RS485
G	White/Yellow	Black	B RS485
H	Khaki	Screen	Screen
K	Light blue	Brown	Second analogue (+)
D	Dark blue	Light Blue	1 <sup>ST</sup> Analogue (+)
E	Dark brown	Black (From both analogue circuits)	Analogue return Common (-)

**Table 1: Sensor cable to slip ring connections**

#### 11.4.1 Connection - Rotating Connector type “A”

- With the cable connected to the Hydro-Probe Orbiter and the housing removed, feed it up through the rotating shaft and slip ring sub-assembly gland and cut to the correct length. Ensure the cable and its protective hose do not interfere with the mixer arms. Tighten the gland.
- Cut back the cable sheath and crimp on bootlace ferrules. 8 conductors are required, unused conductors should be cut back.
- Connect to the terminals as per the diagram in the Rotating Connector, see Figure 27.
- Install the housing over the slip ring sub assembly and bolt down using the bearing housing captive bolts.
- Feed the plant cabling through the housing cable gland and cut to length. Wire the plant cable to the fixed terminal block as per the diagram in the lid, see Figure 27. Connect the removable terminal block plug from the slip ring sub-assembly.
- Fit the Rotating Connector lid and screw down.

#### 11.4.2 Connection - Rotating Connector type “B”

- With the cable connected to the Hydro-Probe Orbiter and the housing removed, feed up through the cable gland and cut to the correct length.
- Cut back the cable sheath and crimp on bootlace ferrules. 8 conductors are used so any unused conductors should be cut back
- Connect to the terminals as per the diagram in the Rotating Connector, see Figure 27.
- Install the housing over the slip ring sub assembly and bolt down using the bearing housing captive bolts.
- Feed the plant cabling through the housing cable gland and cut to length. Wire the plant cable to the fixed terminal block as per the diagram in the lid, see Figure 27.
- Connect the removable terminal block plug from the slip ring sub-assembly.
- Fit the Rotating Connector lid and screw down.



Hydronix supplies cable part number 0975 for use with the Hydro-Probe Orbiter II, and this is available in different lengths. Any extension cable required should be connected to the Hydronix sensor cable using a suitable screened junction box. (See “Chapter 9 Technical Specifications” on page 71 for cable details).

The Hydro-Probe Orbiter II is also directly backward compatible with older 0090A cables (as used with the previous sensor model). When connecting to a 0090A cable it is not possible to use the 2nd analogue output provided by the Hydro-Probe Orbiter II.

For Hydro-Probe Orbiter II installations using both Analogue Outputs, it is necessary to use Sensor Cable part number 0975.

It is recommended to allow the sensor to stabilise for 15 minutes after applying power before use.

## 1 Installation guidelines

Ensure that the cable is of a suitable quality (See “Chapter 9 Technical Specifications” on page 71).

Ensure that the RS485 cable is taken back into the control panel. This can be used for diagnostic purposes and takes the minimum of effort and cost to connect at the time of installation.

Route the signal cable away from any power cables, in particular t1.2.0he mixer power supply.

Check that the mixer is properly grounded.

***Note that an M4 threaded hole provided on the back of the Hydro-Probe Orbiter II for a ground connection if required.***

The sensor cable should only be grounded at the mixer.

Ensure that the cable screen is not connected at the control panel.

Ensure that there is continuity of the screen through any junction boxes.

Keep the number of cable joins to a minimum.

## 2 Analogue outputs

Two DC current sources generate analogue signals proportional to separately selectable parameters (e.g. filtered unscaled, filtered moisture, average moisture, etc). See “Chapter 4 Configuration” on page 47 or the Hydro-Com User Guide HD0273 for further details. Using Hydro-Com or direct computer control, the output may be selected to be:

- 4-20 mA
- 0-20 mA - 0-10 V output can be achieved using the 500 Ohm resistor supplied with the sensor cable

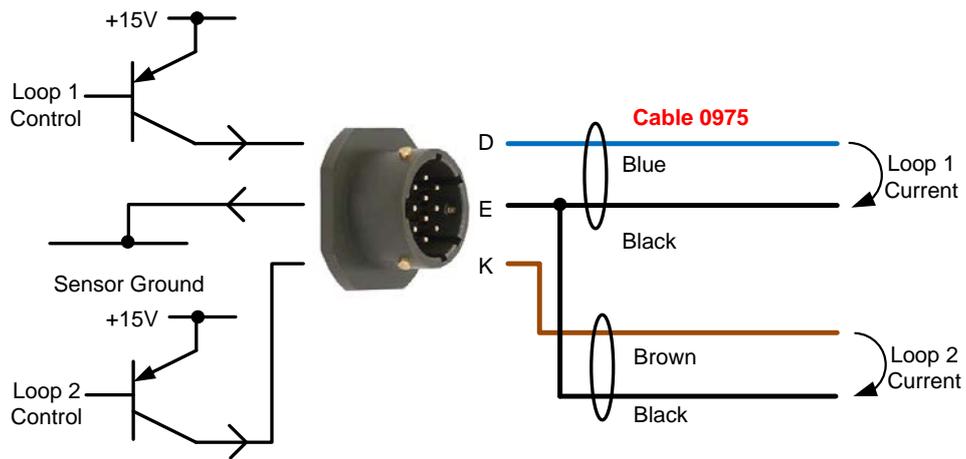


Figure 28: Current loop operation

### 3 The 0975 Sensor Cable

The 0975 Sensor Cable supplied by Hydronix pre-assembled with a MIL-Spec connector and ready to install in a junction box or control panel.

Twisted Pair Number	MIL Spec pins	Sensor connections	Cable Colour
1	A	Power (+15-30v DC)	Red
1	B	Power (0v)	Black
2	C	1st Digital Input	Yellow
2	--	--	Black (Cut back)
3	D	1st Analogue Output Feed (+)	Blue
3	E	1st Analogue Output Return (-)	Black
4	F	RS485 A	White
4	G	RS485 B	Black
5	J	2nd Digital Input/Output	Green
5	--	--	Black (Cut back)
6	K	2nd Analogue Output Feed (+)	Brown
6	E	2nd Analogue Output Return (-)	Black
	H	Screen	Screen

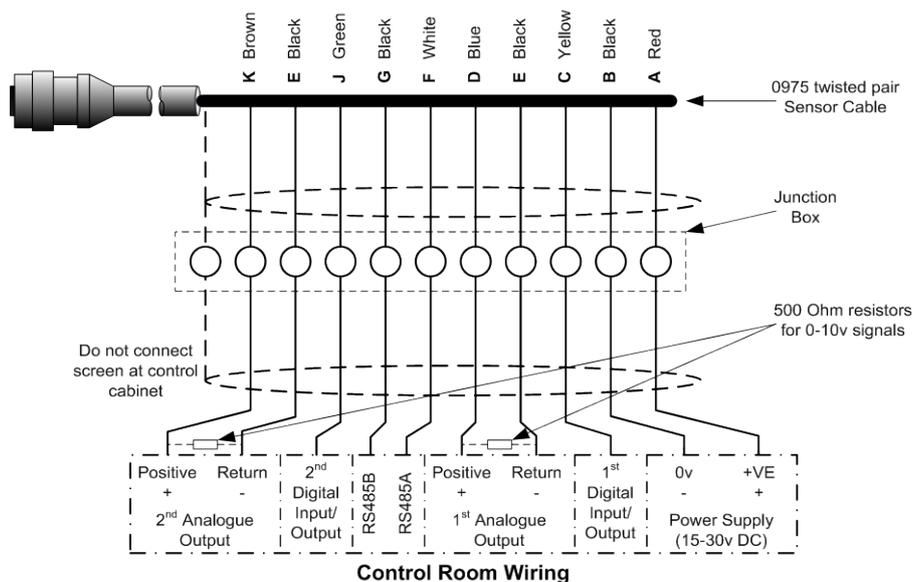


Figure 29: 0975 Sensor cable connections

**Note:** The cable screen is grounded at the sensor. It is important to ensure that the plant where the sensor is installed is properly grounded.

### 4 RS485 Multi-drop connection

The RS485 serial interface allows up to 16 sensors to be connected together via a multi-drop network. Each sensor should be connected using a waterproof junction box.

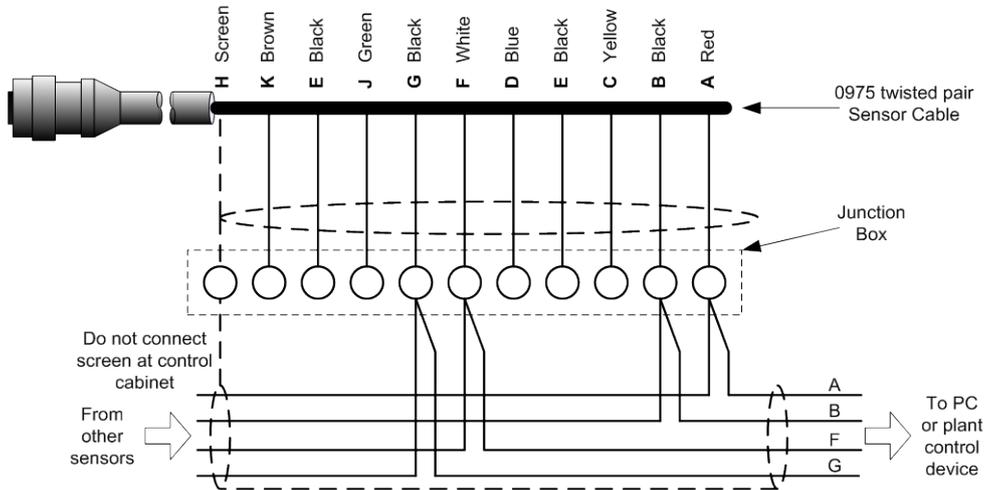


Figure 30: RS485 multi-drop connection

When designing the cabling for the sensor network, standard installation practices for RS485 networks is that the cable should run in a bus topology rather than as a star topology. This means that the RS485 cable should run from the control room to the first sensor before linking on to any other sensors in turn. This is shown in Figure 31 (Diagram shows Hydro Probe II. All sensors are connected using the same configuration)



Figure 31: Correct RS485 cable network

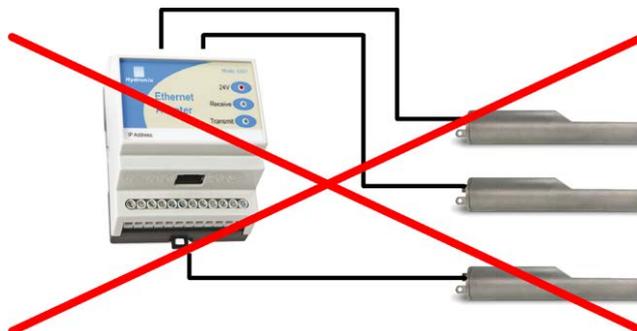


Figure 32: incorrect RS485 cabling

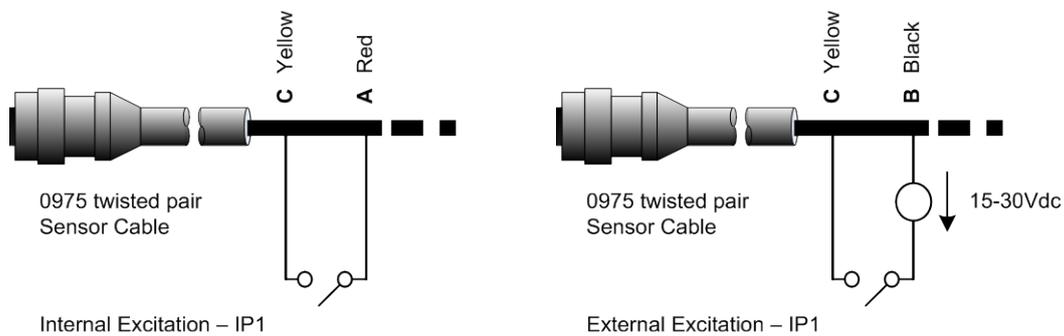
## 5 Hydronix Interface Units

For connection to any of the current range of Hydronix controllers and interface units please refer to the documentation supplied with the relevant unit.

## 6 Digital input/output connections

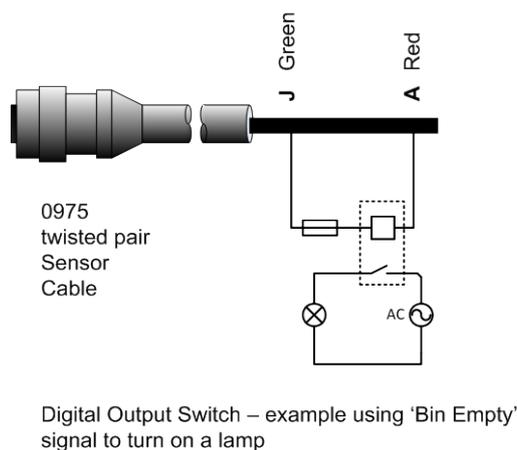
The Hydro-Probe Orbiter II has two digital inputs, the second of which can also be used as an output for a known state. Full descriptions of how the digital inputs/outputs can be configured are included in “Chapter 4 Configuration” on page 47. The most common use of the digital input is for batch averaging, where it is used to indicate the start and end of each batch. This is recommended as it provides a representative reading of the full sample during each batch.

An input is activated using 15 - 30 Vdc into the digital input connection. The sensor power supply may be used as an excitation supply for this, or alternatively an external source may be used as shown below.



**Figure 33: Internal/external excitation of digital input 1 & 2**

When the digital output is activated the sensor internally switches pin J to 0V. This can be used to switch a relay for a signal such as 'bin empty' (see Chapter 4). Note that the maximum current sink in this case is 500mA and in all cases over current protection should be used.



**Figure 34: Activation of digital output 2**

## 7 Connecting to a PC

A converter is required to connect the RS485 interface to a PC. Up to 16 sensors may be connected at any time.

RS485 line termination will not normally be required in applications with up to 100 m of cable. For longer lengths connect a resistor (approximately 100 Ohm) in series with a 1000pF capacitor across each end of the cable.

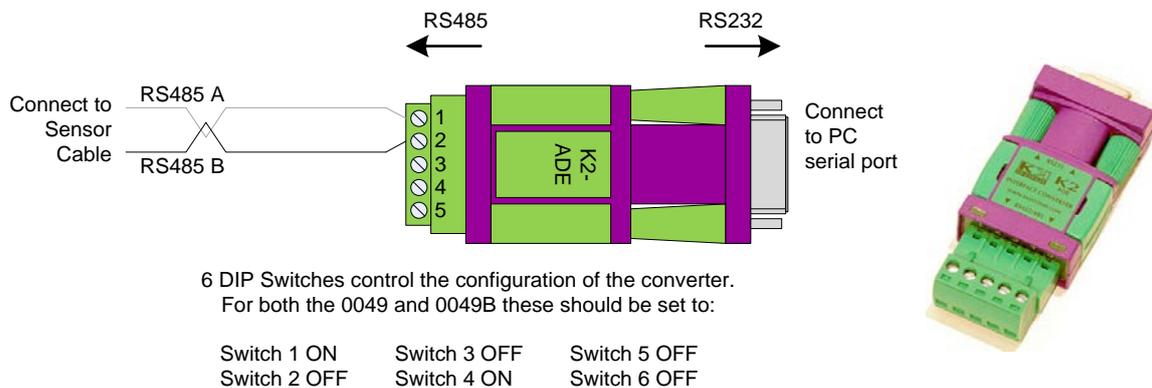
It is highly recommended that the RS485 signals be run to the control panel even if they are unlikely to be used as this will facilitate the use of diagnostic software should the need arise.

There are four types of converter supplied by Hydronix.

### 7.1 RS232 to RS485 converter - D type (Part no. 0049B)

Manufactured by KK systems, this RS232 to RS485 converter is suitable for connecting up to six sensors on a network. The converter has a terminal block for connecting the twisted pair RS485 A and B wires and can then be connected directly in to the PC serial communication port.

Hydronix Part No 0049B



**Figure 35: RS232/485 converter connections (0049B)**

### 7.2 RS232 to RS485 converter - DIN rail mounting (Part no. 0049A)

Manufactured by KK systems, this powered RS232 to RS485 converter is suitable for connecting up to 16 sensors on a network. The converter has a terminal block for connecting the twisted pair RS485 A and B wires and can then be connected to a PC serial communication port.

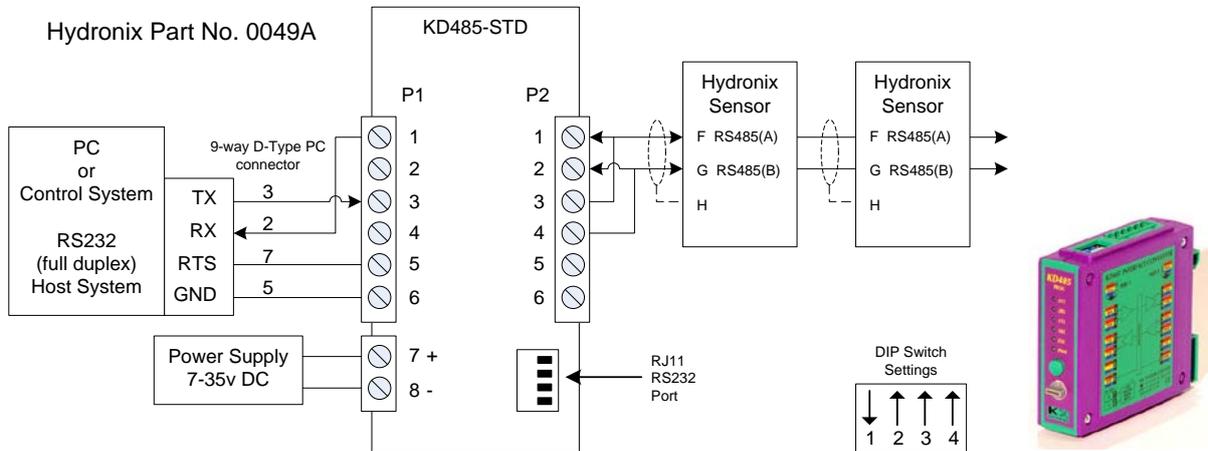
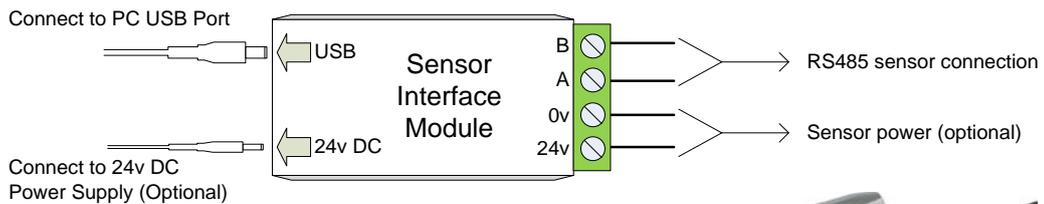


Figure 36: RS232/485 converter connections (0049A)

### 7.3 USB Sensor Interface Module (Part no. SIM01A)

Manufactured by Hydrionix, this USB-RS485 converter is suitable for connecting up to 16 sensors on a network. The converter has a terminal block for connecting the twisted pair RS485 A and B wires, and then connects to a USB port. The converter does not require external power, although a power supply is supplied and can be connected providing power to the sensor. See USB Sensor Interface Module User Guide (HD0303) for further information.

#### Hydrionix Part No. SIM01



The Sensor Interface Modules is powered from the USB port. The external 24v DC power supply can be used if sensor power is required. See user guide HD0303 for further information

Figure 37: SIM01A USB to RS485 converter connections (SIM01A)

### 7.4 Ethernet adapter kit (Part no. EAK01)

Manufactured by Hydronix, the Ethernet adapter is suitable for connecting up to 16 sensors to a standard Ethernet network. An optional Ethernet Power Adapter Kit (EPK01) is also available which eliminates the need for additional expensive cables to be run to a remote location which does not have local power. If this is not used then the Ethernet adapter will require a local 24v power supply.

Hydronix Part No. EAK01

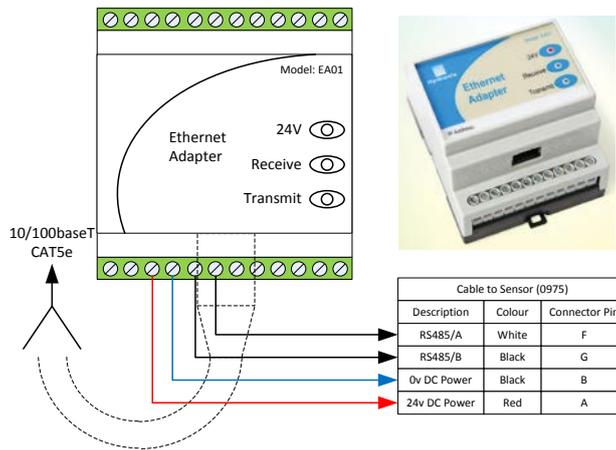


Figure 38: Ethernet adapter connections (EA01)

Hydronix Part No. EPK01

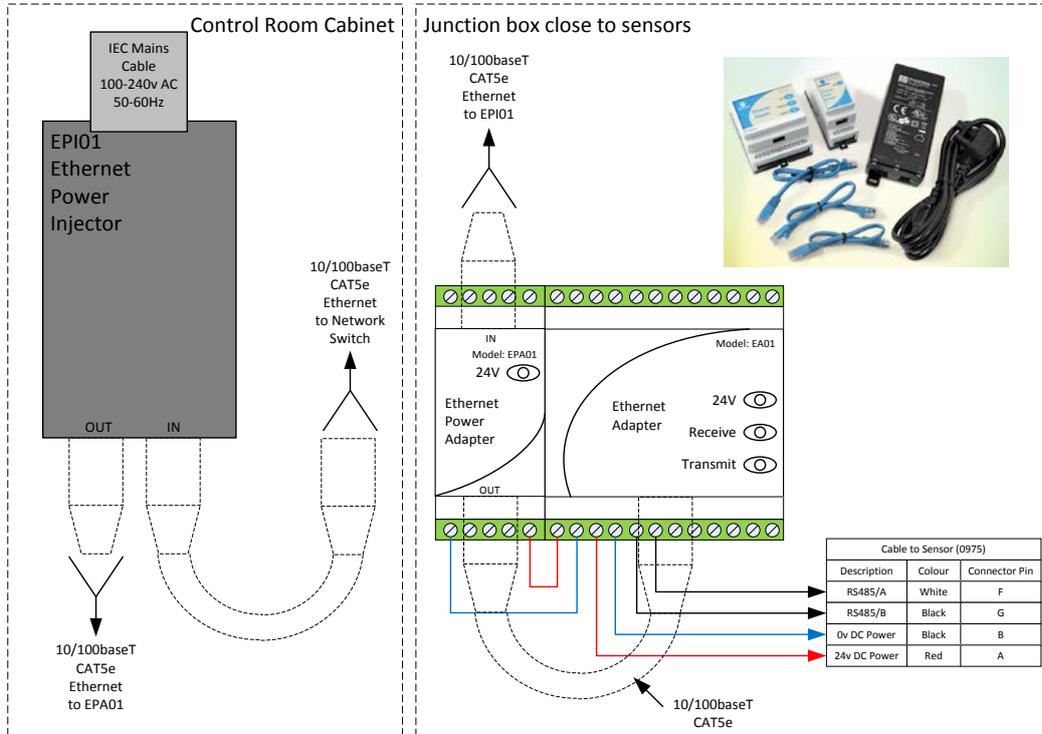


Figure 39: Ethernet Power Adapter Kit Connections (EPK01)

When the Ethernet Power Kit is used, the number of sensors that can be powered from the included power supply is dependent on the type of sensor and the ambient temperature of the Ethernet Power Adapter Module (EPA01). The number of sensors is shown in Figure 40.

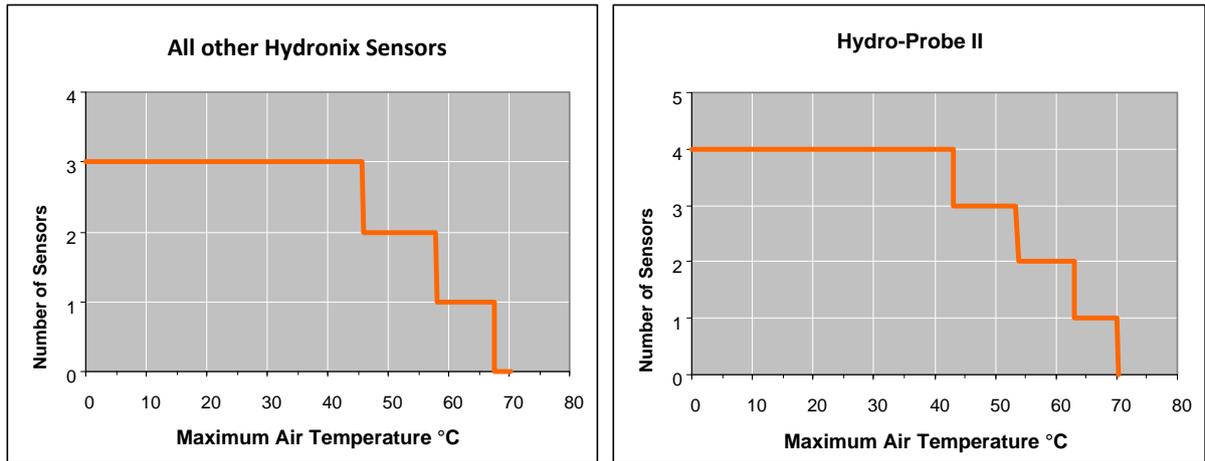


Figure 40: Maximum number of sensors that can be powered from EPA01



The Hydro-Probe Orbiter II has a number of internal parameters which can be used to optimise the sensor for a given application. These settings are available to view and change using Hydronix Hydro-Com software. Information for all settings can be found in the Hydro-Com User Guide (HD0273).

Both Hydro-Com software and the Hydro-Com User Guide can be downloaded free of charge from [www.hydronix.com](http://www.hydronix.com).

All Hydronix sensors operate in the same way and use the same configuration parameters. However, not all the functions are used in mixer sensor applications. (Averaging parameters, for example, are typically used for batch processes).

## 1 Analogue output setup

The working range of the two current loop outputs can be configured to suit the equipment to which it is connected, for example a PLC may require 4 - 20 mA or 0 - 10V DC etc. The outputs can also be configured to represent different readings generated by the sensor e.g. moisture or temperature.

### 1.1 Output type

This defines the type of analogue outputs and has three options:

#### 1.1.1 0 - 20mA

This is the factory default. The addition of an external 500 Ohm precision resistor converts to 0 - 10V DC.

#### 1.1.2 4 - 20mA

An optional output supported by most current based loops. This output type allows for detection of a broken wire (if the loop current is at 0mA).

#### 1.1.3 Compatibility

This configuration must only be used if the sensor is to be connected to a Hydro-Control IV or Hydro-View. A 500 Ohm precision resistor is required to convert to voltage.

### 1.2 Output variable 1 and 2

These define which sensor readings the analogue output will represent and has 4 options.

**NOTE: This parameter is not used if the output type is set to 'Compatibility'**

#### 1.2.1 Filtered Unscaled

The Filtered Unscaled represents a reading which is proportional to moisture and ranges from 0 - 100. An unscaled value of 0 is the reading in air and 100 would relate to a reading in water.

#### 1.2.2 Average Unscaled

This is the 'Raw Unscaled' variable processed for batch averaging using the averaging parameters. To obtain an average reading, the digital input must be configured to 'Average/Hold'. When this digital input is switched to high, the raw unscaled readings are averaged. When the digital input is low, this average value is held constant.

### 1.2.3 Filtered Moisture %

If a moisture output is required, the 'Filtered Moisture %' can be used, which is scaled using the A, B, C and SSD coefficients and the 'Filtered Unscaled' reading (F.U/S) such that:

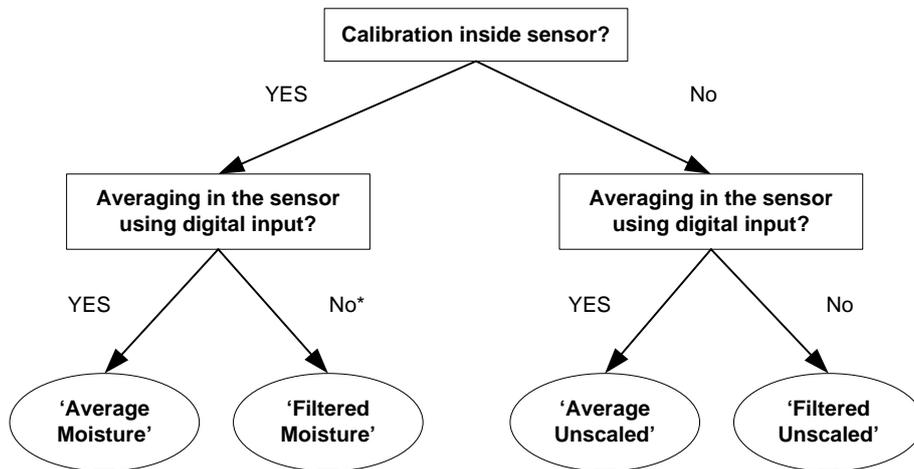
$$\text{Filtered Moisture \%} = A \times (\text{F.U/S})^2 + B \times (\text{F.U/S}) + C - \text{SSD}$$

These coefficients are derived solely from a material calibration and so the accuracy of the moisture output is dependent upon how good the calibration is.

The SSD coefficient is the Saturated Surface Dry offset (water absorption value) for the material in use and allows the displayed percentage moisture reading to be expressed in surface (free) moisture only.

### 1.2.4 Average Moisture %

This is the 'Raw Moisture %' variable processed for batch averaging using the averaging parameters. To obtain an average reading, the digital input must be configured to 'Average/Hold'. When this digital input is switched high, the Raw Moisture readings are averaged. When the digital input is low this average value is held constant.



\*It would be advisable to average in the control system here

Figure 41: Guidance for setting the output variable

## 1.3 Low % and High %

**NOTE:** These parameters are not used if the output type is set to 'Compatibility'.

These two values set the moisture range when the output variable is set to 'Filtered Moisture %' or 'Average Moisture %'. The default values are 0% and 20% where:

0 - 20mA      0mA represents 0% and 20mA represents 20%

4 - 20mA      4mA represents 0% and 20mA represents 20%

These limits are set for the working range of the moisture and must be matched to the mA to moisture conversion in the batch controller.

## 2 Digital inputs/output setup

The Hydro-Probe Orbiter II has two digital inputs/output; the first can be configured as an input only. The second can be either an input or output.

The first digital input can be set to the following:

- Unused: The status of the input is ignored
- Average/Hold: This is not applicable to a mixer application, but may apply in chutes or other flush mount applications. It is used to control the start and stop period for batch averaging. When the input signal is activated, the 'Filtered' values (unscaled and moisture) start to average (after a delay period set by the 'Average/Hold delay') parameter). When the input is then deactivated, averaging is stopped and the average value is held constant so that it can be read by the batch controller PLC. When the input signal is activated once again, the average value is reset and averaging commences.

Moisture/Temperature: Allows the user to switch the analogue output between the unscaled or moisture (whichever is set) and temperature. This is used when the temperature is required whilst still using only one analogue output. With the input active, the analogue output will indicate the appropriate moisture variable (unscaled or moisture). When the input is activated, the analogue output will indicate the material temperature (in degrees centigrade). Temperature scaling on the analogue output is fixed - zero scale (0 or 4mA) corresponds to 0°C and full scale (20mA) to 100°C.

The second digital input/output can also be set to the following outputs:

- Bin Empty: This output is energised if the unscaled value goes below the Low Limits defined in the Averaging section. This can be used to signal to an operator when the sensor is in air (as the sensor's value goes to zero in air) and can indicate a vessel empty state.
- Data Invalid: This output is energised if the unscaled value goes outside of any of the limits defined in the averaging section, so it could be used to provide a high and low level alarm output.
- ProbeOK: This option is not used for this sensor.

## 3 Filtering

See “Appendix A Default Parameters” on page 77 or Engineering Note EN0050 for the default filtering parameters.

The raw unscaled reading, which is measured 25 times per second, contains a high level of 'noise' due to irregularities in the signal from the mixer blades and pockets of air. As a result, this signal requires a certain amount of filtering to make it usable for moisture control. The default filtering settings are suitable for most applications, however they can be customised if required to suit the application.

It is not possible to have default filtering settings that are ideally suited to all mixers because every mixer has a different mixing action. The ideal filter is one that provides a smooth output with a rapid response.

The raw moisture % and raw unscaled settings should not be used for control purposes.

The raw unscaled reading is processed by the filters in the following order; first the slew rate filters limit any step changes in the signal, then the Digital Signal Processing filters remove any high frequency noise from the signal and finally the smoothing filter (set using the filtering time function) smoothes the whole frequency range.

The Digital Signal Processing filter implements a sixth order low pass Butterworth filter that attenuates signals above a defined cut-off frequency. The advantage of this filter over smoothing is that the signals below the cut-off frequency are allowed through, for example, the change of the moisture in the material, but signals above the cut-off frequency are attenuated. The result of this is a smooth signal that responds rapidly to changes in moisture.

The smoothing filter applies to the whole of the frequency range of the signal, and so as well as smoothing the noise in the signal, it also smoothes the response to the changes in moisture. This results in a signal that responds slowly to those changes in moisture. The advantage is that where the mixer cycle itself introduces a low frequency noise on the signal, the smoothing filter can remove this at the expense of the response time.

### 3.1 Slew rate filters

These filters set rate limits for large positive and negative changes in the raw signal. It is possible to set limits for positive and negative changes separately. The options for both the 'slew rate +' and the 'slew rate -' filters are: None, Light, Medium and Heavy. The heavier the setting, the more the signal will be 'dampened' and the slower the signal response.

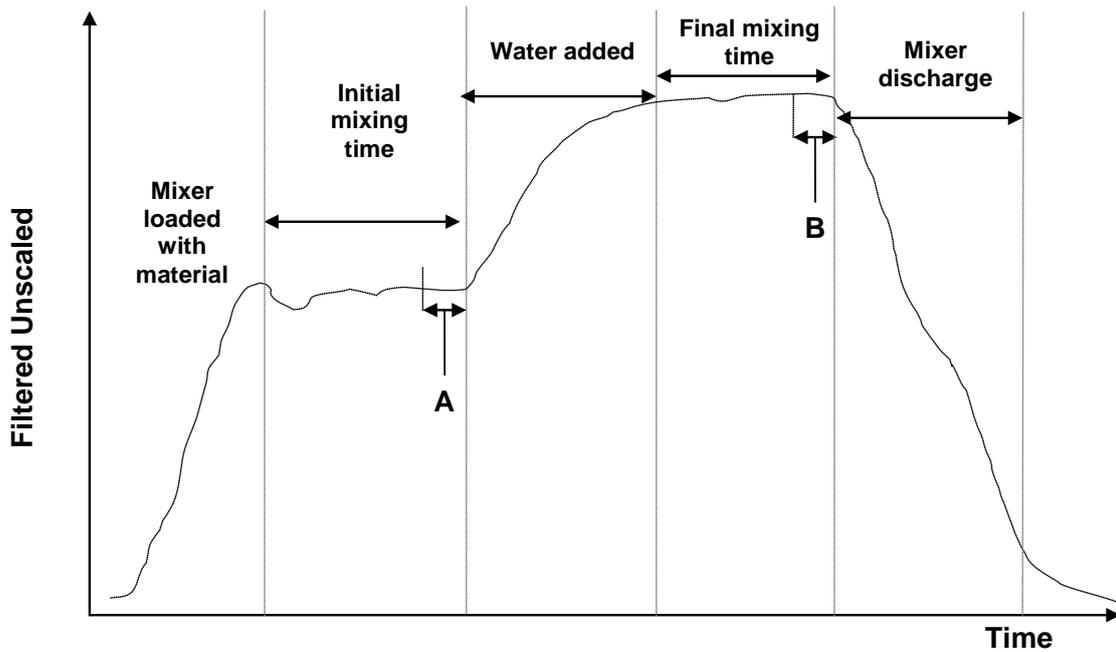
### 3.2 Digital Signal Processing

The signal is passed through a Digital Signal Processing filter. This removes noise from the signal using an advanced algorithm. Settings are None, Very Light, Light, Medium, Heavy and Very Heavy.

### 3.3 Filtering time

This smoothes the signal after it has passed through the slew rate and Digital Signal Processing filters. Standard times are 0, 1, 2.5, 5, 7.5, and 10 seconds, although it is possible also to set this up to 100 seconds for specific applications. A higher filtering time will slow the signal response.

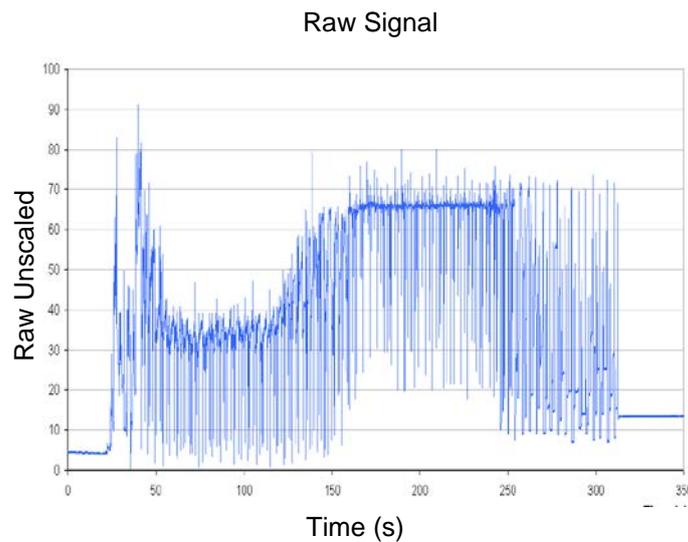
Figure 42 shows a typical moisture trace during a batching cycle of concrete. The mixer starts empty and as soon as material is loaded, the output rises to a stable value, Point A. Water is then added and again the signal stabilises at Point B, at which point the batch is complete and the material is discharged. The main points to note with this signal are the points of stability because these signify that all the materials (aggregates, cement, colourings, chemicals etc.) are completely mixed together, i.e. the mix is homogeneous.



**Figure 42: Typical moisture trace from a mixer**

The degree of stability at points A and B can have a significant effect on accuracy and repeatability. For example, most automatic water controllers measure the dry moisture and calculate how much water to add to the mix, based on a known final reference in a particular recipe. Therefore it is vital to have a stable signal in the dry mix phase of the cycle at point A. This enables the water controller to take a representative reading and make an accurate calculation of the water required. For the same reasons, stability at the wet end of the mix (Point B) will give a representative final reference indicating a good mix when calibrating a recipe.

Figure 42 shows an ideal representation of moisture over a cycle. The output of this is the 'Filtered Unscaled' reading. The next graph (Figure 43) shows raw data recorded from a sensor over an actual mix cycle, clearly indicating the large spikes caused by the mixing action.

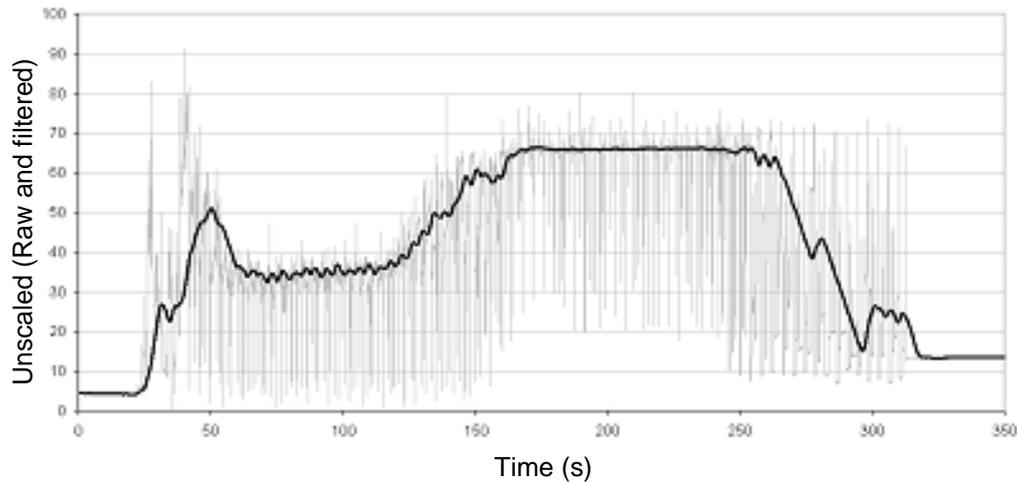


**Figure 43: Graph showing the raw signal during mix cycle**

The following two graphs illustrate the effect of filtering the same raw data shown above. Figure 44 shows the effect of using the following filter settings which create the 'Filtered Unscaled' line on the graph.

- Slew rate +: Medium
- Slew rate -: Light
- Filtering time: 1 second

Applying Filter: Slew Rate + = Light, Slew Rate - = Medium  
Filtering time: 1 second

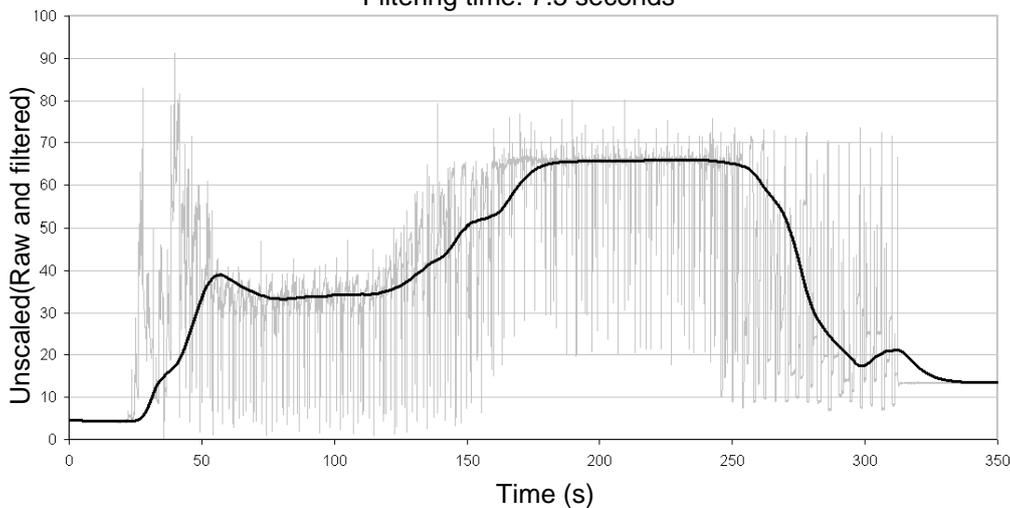


**Figure 44: Filtering the Raw signal**

Figure 45 shows the effect of the following settings:

- Slew rate +: Light
- Slew rate -: Light
- Filtering time: 7.5 seconds

Applying filter: Slew Rate += Light, Slew Rate -= Light  
Filtering time: 7.5 seconds



**Figure 45: Filtering the Raw signal (2)**

In Figure 45 it is clear that the signal at the dry phase of the mix cycle is more stable which is more advantageous when making the water calibration.

For most mixer applications, the filter settings can be left at the default values which will adequately filter out the noise, with the aim of providing a smooth signal. Should there be a requirement to change the filtering then the aim is to provide as fast a response as possible whilst maintaining signal integrity. Signal stability is important, and mixing times have to be set appropriately in accordance with the mixer due to the variation in efficiency of mixers.

### 3.4 Averaging parameters

These parameters determine how the data is processed for batch averaging when using the digital input or remote averaging. They are not normally used for mixing applications or continuous processes.

#### 3.4.1 Average/hold delay

When using the sensor to measure the moisture content of aggregates as they are discharged from a bin or silo, there is frequently a short delay between the control signal issued to begin the batch and the material beginning to flow over the sensor. Moisture readings during this time should be excluded from the batch average value as they are likely to be unrepresentative static measurements. The 'Average/Hold' delay value sets the duration of this initial exclusion period. For most applications 0.5 seconds will be adequate but it may be desirable to increase this value.

Options are: 0, 0.5, 1.0, 1.5, 2.0 and 5.0 seconds.

#### 3.4.2 High limit and low limit

This refers to both moisture % and unscaled units. It is used to set the valid range for meaningful data whilst calculating the average value. When the sensor reading falls outside these limits it is not included in the average calculation and at the same time the 'Data Valid' label changes to 'Data Invalid'. If the data falls below the lower limit, the 'Bin Empty' condition is activated for those sensors whose digital output can be configured to indicate this.

## 4 Alternative Measurement Techniques

The Hydro-Probe Orbiter II (ORB2) has the option of selecting alternative measurement techniques (Not available on ORB1).

There are three measurement modes supported by the HS0089 firmware, Standard Mode, Mode V and Mode E. In most cases Standard Mode will give excellent results and the sensor parameters may be left in their factory settings.

### 4.1 Standard Mode

This is the standard measurement mode which is currently used in most Hydronix sensors. It is best to use this mode if there are no reasons to choose one of the alternative modes. This mode should work best for aggregates and concrete applications. Standard Mode uses only the change in the resonant frequency of the sensor to measure changes in moisture.

### 4.2 Modes V and E

Modes V and E combine the change in the resonant frequency with the change in the amplitude of the microwave resonator to determine the change in moisture. The two modes respond differently to changes in moisture and density. Either mode V or E may be more appropriate for certain materials or applications. When to use an alternative mode is described below.

### 4.3 When to use alternative measurement techniques

The most appropriate mode will be determined by the requirements of the user, the application and the material being measured.

Precision, stability and density fluctuations as well as the working moisture range are all factors that may determine the choice of measurement mode.

Standard Mode is often associated with flowing sand and aggregates and concrete mixer type applications.

Modes V and E are often associated with lower density materials such as grain or other organic materials. They are also associated with any material that has a variable bulk density that correlates to moisture content. Modes V and E may also be beneficial for high intensity mixing applications of high density material and for other mixing applications with distinct changes in density over time (including aggregates and concrete).

The objective is to choose the technique that gives the most desirable (often smoothest) signal response and most accurate moisture determination.

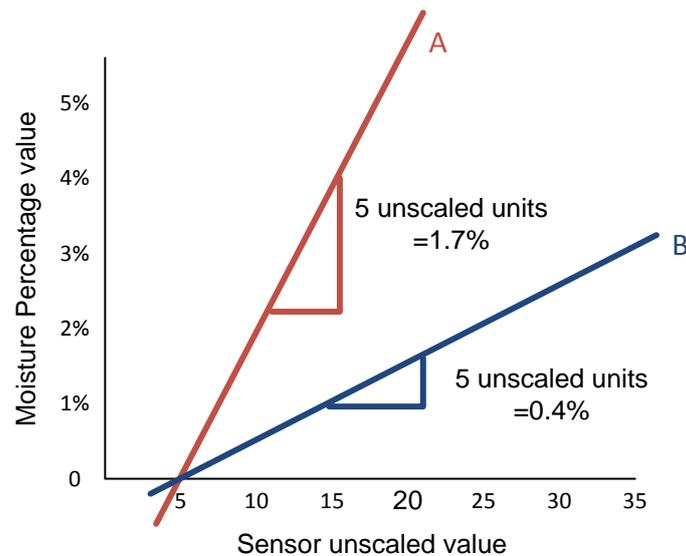
### 4.4 Effects of selecting different modes

Each mode will give a different relationship between the sensor's 0-100 unscaled values and the moisture percentage.

When measuring in any material it is usually beneficial that a large change in unscaled sensor readings equates to a small change in moisture levels. This will give the most precise calibrated moisture reading (see Figure 46). This assumes that the sensor remains capable of measuring across the full moisture range required and that the sensor is not configured to be impractically overly sensitive.

In certain materials such as organic products the relationship between unscaled values and moisture means that a smaller change in unscaled values gives a large change in the moisture value when operating in Standard Mode. This makes the sensor less precise and too sensitive, which is undesirable.

If this were plotted with moisture on the Y axis and sensor unscaled values on the X axis, the calibration line is very steep (see Figure 46). The ability to select the fundamental measurement technique allows the user to choose the technique that most flattens the relationship between unscaled values and moisture (see Figure 46, line B). The mathematical algorithms employed in the sensor have been specially devised to respond in a different manner dependant on the material being measured. All modes will all give a stable linear output however line 'B' will give better precision and accuracy. Modes V and E will also be less susceptible to density fluctuations.



**Figure 46: Relationship of unscaled values to moisture**

To determine which mode is the most appropriate it is recommended to run trials for a given material, mixer type or application. Before doing so it is recommended that you contact Hydronix to seek advice on our recommended settings for your given application.

Trials differ dependant on the application. For a measurement taken over time it is recommended to record the sensor's output from each of the different measurement modes in the same process. Data can easily be recorded using a PC and the Hydronix Hydro-Com software, these results may then be plotted in a spreadsheet. When viewed in graph form it is often self-evident which mode gives the desired performance characteristics.

For further analysis, including sensor filtering analysis Hydronix can also offer advice as well as software to enable the experienced user to achieve the best possible settings for a sensor.

Hydro-Com software and the user guide may be downloaded from [www.hydronix.com](http://www.hydronix.com).

When using the sensor to obtain an output signal that is calibrated to moisture (an absolute moisture measurement) it is recommended to calibrate using the different measurement modes and to compare results (See "Chapter 5 Sensor Integration and Calibration" on page 57).

For further information please contact the Hydronix support team at [support@hydronix.com](mailto:support@hydronix.com).



## 1 Sensor integration

The sensor may be integrated into a process in one of two ways :-

The sensor may be configured to output a linear value of between 0-100 unscaled units with a material or recipe calibration being performed in an external control system. This is the preferred configuration for mixing applications.

*Or*

internally calibrated using the Hydro-Com sensor configuration and calibration software to output an absolute moisture percentage value.

## 2 Sensor calibration

### 2.1 Absolute moisture percentage calibration

This method requires the user to ascertain the relationship between the unscaled values of the sensor and the material moisture percentage (Figure 46). Detailed instructions on how to configure and calibrate the sensor are available in the Hydro-Com user guide.

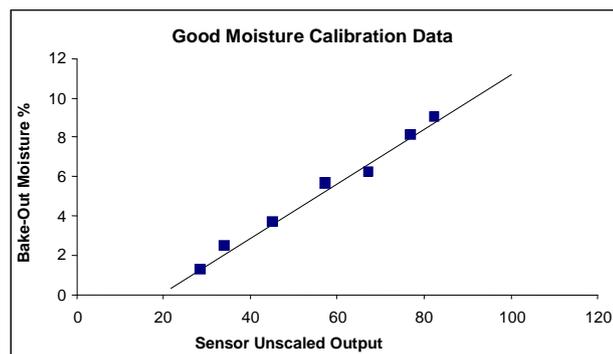


Figure 47: Example of a good moisture calibration

### 2.2 Calibrating in an external control system

This configuration is recommended for mixing applications.

The sensor's averaging and/or filtering and signal smoothing functions may be applied to the unscaled value and output directly to an external control system.

For many mixing applications the object of controlling the moisture addition is to ensure that a repeatable moisture target is achieved batch after batch. Often this target point is derived through experience and monitoring the process. In order to achieve repeatability it is not necessary to give the final moisture target a moisture percentage value in order to perform the water addition calculation or progressively add water to a set target.

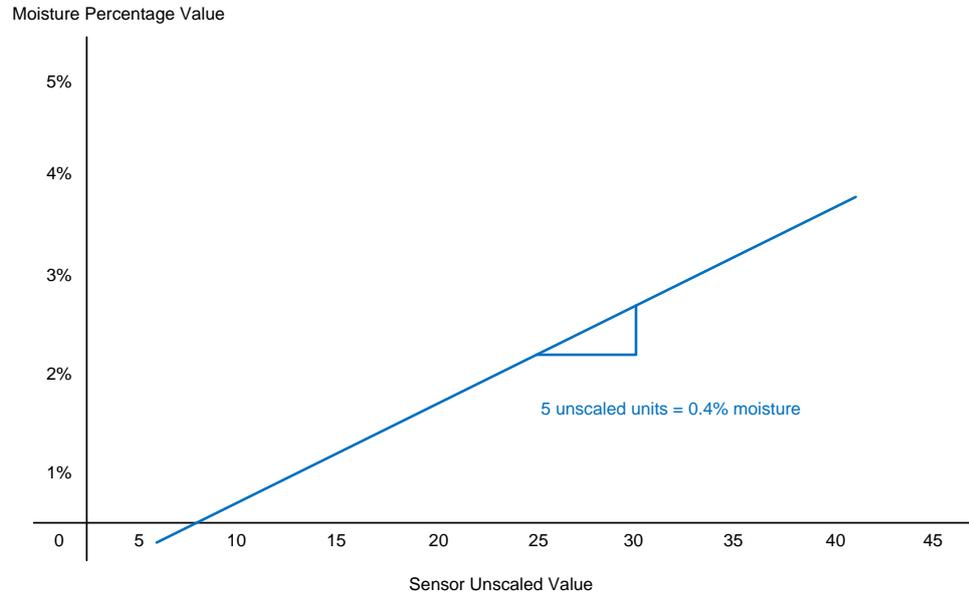
Water addition is in one of two ways :-

#### 2.2.1 Calculation based water addition

A moisture reading is taken in the homogenous dry material and a calculation is made of the amount of water required to achieve the required target. This method requires a calibration routine to determine the ratio between a change in the sensor's unscaled values to a change in moisture percentage. This effectively calculates a gradient of unscaled values to moisture percentage (see Figure 48). Because the sensor's output are

linear and fully temperature stable, once this gradient is known the control system can calculate from any dry reading the water required to reach a given target for a known recipe. The calculations and target are often calculated in terms of unscaled units only. Whilst it is possible to perform a moisture sample test on the final product to determine its moisture content this is often impractical and the theoretical value or recipe design value is used.

See “Chapter 6 Optimising Sensor and Process Performance” on page 59 for more advice on controlling this process.



**Figure 48: Gradient of unscaled values to moisture percentage**

### 2.2.2 Progressive Water Feed

Referred to as AUTO-Mode when using the Hydronix Hydro-Control water controller.

This method continuously adds water until a set target has been achieved. Water addition rates and determination of stability at the target point should be considering in the control algorithm.

This method is less affected by variable batch sizes and varying ratios of ingredients in the mixer

For further advice on any of these methods please contact the Hydronix support team: [support@hydronix.com](mailto:support@hydronix.com)

For most applications the default measurement mode, filtering and signal smoothing settings of the sensor will be suitable.

A more desirable output may be achieved by adjusting the filtering and signal smoothing parameters in the sensor (See “Filtering” on page 50).

Selecting an alternative measurement mode (See “Alternative Measurement Techniques” on page 53) may give a more desirable signal response, but before doing so, it is worth considering the application advice set out below. It is also recommended that you contact the Hydronix support team, support@hydronix.com

For many applications it is also worth reviewing the application process. The sensor itself is a precise instrument, it's practical performance in a given application is largely a function of the application itself. For example, in a mixing application the sensor will output a stable signal once the material is homogenous. If the mixing equipment is not capable of achieving homogeneity (or of achieving this in the allotted time) the sensor signal will be conducive of the heterogeneity of the material (usually a variable or undulating reading).

Other key factors worth considering are :-

## 1 General to all Applications

- Power Up: It is recommended to allow the sensor to stabilise for 15 minutes after applying power before use.
- Positioning: The sensor should be in contact with a representative sample of the material.
- Flow: The sensor should be in contact with a consistent flow of material.
- Material: If the ratio of ingredients or additives of the underlying material or blend changes this may affect the moisture reading.
- Material particle size: If the particle size of the material being measured changes this may affect the rheology of the material for a given moisture content. Increased fine material often leads to a 'stiffening' of the material for a given moisture content. This 'stiffening' should not automatically be construed as a reduction in moisture. The sensor will continue to measure moisture.
- Material build-up: Avoid material build up on the Ceramic Faceplate.

## 2 Mixing Applications

The moisture reading from the sensor can only indicate what is happening in the material or mixer. The speed of the reading, or the time taken to reach a steady reading when the materials are homogeneous, reflects the effectiveness of the mixer. By taking some simple precautions the overall performance can be considerably improved and the cycle time reduced with consequent financial savings.

Look at the mixing process. Check how the water disperses. If added water sits on top of the material for a time before dispersing, then spray bars may be required to disperse the water into the mixer more quickly to shorten the mixing time. Spray bars are more effective than single water inlets. The wider the area the water sprays, the faster it will mix into the material.

It is also possible to add water too quickly during a mixing process. Adding water faster than the mixer's ability to blend the added water into the mix may increase the overall mixing time. Ensuring that a mixer is properly maintained with blade clearances as per the manufactures specifications will increase the efficiency of the mixer.

The user may also find it beneficial to understand the ability of a pan mixer to mix both horizontally and vertically. The speed of the vertical mixing action (which cannot be seen so easily by eye) can be recorded by a floor mounted moisture sensor. This is the difference in time

between the time that the water addition was made and the time that the sensor registers an increase in moisture at or near the mixer floor.

### 3 Concrete Mixing

This section is specific to concrete mixing but may also be relevant to other mixing applications.

#### 3.1 Ingredients

If the aggregate masses are not corrected for high moisture contents, then the aggregate/cement ratio will change considerably, having an adverse effect on consistency and concrete performance.

If the aggregates are very wet, as may be the case at the beginning of the day due to water draining in the storage bin then there may be more water in the aggregates than the mix requires.

The moisture content of the aggregates should be above the saturated surface dry (SSD).

Hot cement can affect consistency (workability) and thus water demand.

Changes in ambient temperature can affect water demand.

Where possible, the cement addition should follow within a few seconds after the commencement of the addition of sand and aggregates. Combining the materials together in this way will greatly assist the mixing process.

#### 3.2 Consistency

The Hydro-Probe Orbiter II measures moisture, not consistency.

Many factors affect consistency, but may not affect moisture content. These might include:

- Aggregate grading (coarse/fine ratio)
- Aggregate/cement ratio
- Admixture dosage dispersion
- Ambient temperature
- Water/cement ratio
- Ingredient temperature
- Colours

#### 3.3 Mix Times and Batch Sizes

Minimum mix times are a function of the mix design (ingredients and mixer) not just the mixer so different mix designs may require different mix times.

Keep batch sizes as consistent as possible e.g. 2.5m<sup>3</sup> + 2.5m<sup>3</sup> + 1.0m<sup>3</sup> is not as good as 3 x 2.0m<sup>3</sup>.

Keep the dry mix time as long as possible. It is possible to reduce the wet mix time if the final homogeneity is not as critical.

#### 3.4 Control System Calibration and Integration

There are several methods in which the sensor may be used to control water addition in to a mixing process. The Sensor Integration and Calibration Chapter on page 57 covers this topic in detail.

The suggestions below refer to the method of calculation based water addition only. The calculation and control of the water addition may be either done by the Hydronix Hydro-

Control water controller or by a third party control system. The advice below is based on generally accepted principles, however, third party control systems may differ in their approach and advice should be sought from the supplier.

Maximum repeatability of viscosity will be achieved by ensuring that the dry weight of materials in the mixer are correctly proportioned, this may require weight correction on the weighed weights of materials that vary in moisture content to correct for moisture. For this the Hydro-Probe sensor is recommended.

When calculating the water to be added to the mix, the accuracy of the calculation is affected by the total batch weight, e.g. 2 different batch sizes of the same moisture content will require 2 different amounts of water to be added in order to achieve the same moisture percentage. Failure to correct for moisture in the aggregates leads to varying total batch weights and less accuracy in the calculation. This also results in under yielding and is consequently an inefficient use of cement.

A different calibration may be required for large variations in batch weights (e.g. half batches).

When performing a calibration it is advised that both the dry and wet mix times are extended to ensure that both are homogeneous.

Calibrate when conditions and ingredients are typical e.g. not first thing in the morning when the aggregates are very wet, or when the cement is hot.

When using a calibration-based water addition method, it is essential to obtain a correct dry reading.

The dry mix time must be long enough to obtain stability of the signal.

## 4 Routine maintenance

Ensure the ceramic is cleaned and checked regularly for wear. Wear protection should be fitted and replaced if worn. If replacing the arm, O-Rings must be fitted between the arm and the head unit.

Ensure there is no permanent build-up of material over the sensing head and arm. If the angle of the face of the sensing head is correctly adjusted, then the continual movement of fresh material against it should normally keep it clean.

At the end of the shift, or if there is a significant gap in production, it is advisable to hose or wipe the arm and head to ensure no hard build-up occurs.

It is recommended that a high pressure water cleaning system is used to clean the sensor. However, although the Hydro-Probe Orbiter is waterproof, its seals will not prevent the ingress of water from high pressure equipment nozzles that are held in close proximity to the sensor. Keep all high pressure water sprays at least 300mm away from the sensor and Rotating Connector.

**CAUTION - NEVER HIT THE SENSING ARM**



The sensing arm is a replaceable item. The wear life of the arm is dependent on the materials in which it is used, the mixer, and of course on the amount of use.

Wear life may be extended by taking precautions as set out in the previous chapter. However, periodically, either through accidental damage or excessive wear, it may be necessary to replace the head and arm.

## 1 Removing the sensing head and arm

Undo the clamp bolts securing the sensor body to the square support bar.

Remove the entire sensor body and arm and take to a clean environment.

Lay the sensing arm on a clean flat surface.

Undo the arm clamp nuts on the sensor body and pull out the worn sensing arm.

Attach the new sensing arm by following the installation instructions in this guide (See “Assembly of Arm and Head Unit” on page 16).

## 2 Fitting the Hydro-Probe Orbiter back into the mixer

Follow the instructions in “Mounting the sensor and making final adjustments” on page 23, ensuring both the height from the mixer floor and the angle of the sensing head are set correctly.

## 3 Calibrating a new arm to the sensor electronics

Recalibration is necessary after fitting a new arm to the sensor electronics. For mixer applications, a calibration called AutoCal is sufficient, although there are other ways in case the customer has no facility for this.

## 4 AutoCal

During any AutoCal, the ceramic face must be clean, dry and free from obstruction. This calibration can be performed in three ways

### 4.1 Using Hydro-Com PC utility

The sensor should be connected to a computer running Hydro-Com software, available free from the Hydronix website. The configuration section of this program has an AutoCal facility. Once selected, the AutoCal will be completed in approximately 60 seconds and the sensor is ready for use in the mixer.

### 4.2 Using the Hydro-Control

The Hydro-Control V or the Hydro-Control VI water control units have the capability to perform an AutoCal calibration in the sensor configuration page.

On the Hydro-Control V, from the main window this can be accessed by the following: MORE > SETUP > (enter pass-code 3737) > DIAG > CONF > CALIB. Note this feature is only available on Hydro-Control V firmware versions 4.1 and later.

On the Hydro-Control VI the AutoCal function is controlled from the Sensor Configuration pages

### 4.3 Using the Hydronix AutoCal Dongle

The AutoCal Dongle as shown in Figure 49, has been designed for applications where there is no RS485 serial link and the customer is using the analogue output from the sensor. This calibration is completed by connecting the dongle in-line between the cable and the sensor body, as shown in Figure 50.



Figure 49: The Hydronix AutoCal Dongle

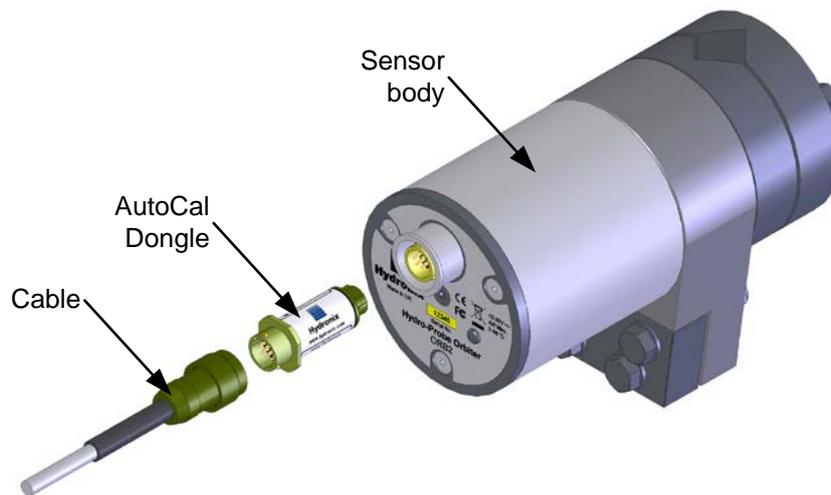


Figure 50: Connecting the Hydronix AutoCal Dongle for calibration

The simple procedure outlined below should take less than one minute to complete:

- i) Ensure the ceramic face plate is facing upwards and is completely clean and dry.
- ii) Connect the Autocal Dongle to the sensor body and cable as shown in Figure 50. The Autocal Dongle should begin flashing (red) bright-dim-bright for 30 seconds.
- iii) After 30 seconds the Autocal Dongle should start flashing on-off-on.

***At this stage it is important to keep away from the ceramic faceplate***

- iv) After approximately 20 seconds the Autocal Dongle should illuminate constantly. The calibration is finished and the Hydro-Probe Orbiter is ready to be fitted back into the mixer. Disconnect the Autocal Dongle and reattach the cable for normal use.

If the Autocal Dongle continues to flash on-off-on as in stage 3, then the calibration was unsuccessful due to variation during its measurement stage (stage 4). If this is the case, disconnect the Autocal Dongle from the sensor body and cable, and repeat steps 1 - 4.

## 5 Air and water calibration

The calibration is performed by making separate readings in air. With the sensor connected to a computer (See “Hydronix Interface Units” on page 41), the Hydro-Com utility can be used to make the measurements and update the sensor in the configuration section.

The air reading should be made with the face-plate clean, dry and free from obstructions. On the appropriate tab of the application software press the New Air or High button. The software will make a new air measurement.

The water reading should be carried out in a bucket filled with a clean brine solution. This solution should be made up from water with 0.5% by weight of salt (e.g. 10 litres of water to be mixed with 50gm of salt). The level of water needs to cover the ceramic face-plate, and at least 200mm of water is needed in front of the ceramic. It is suggested that the sensor is held in the bucket offset to one side with the face towards the centre of the bucket (see Figure 51: Air-water calibration), hence the measurement is carried out with a full bucket of water in front. Press the New Water or Low button. The software will make a new water measurement.

Once both readings are made, the sensor can be updated by pressing the update button in the application software and it is then ready for use.

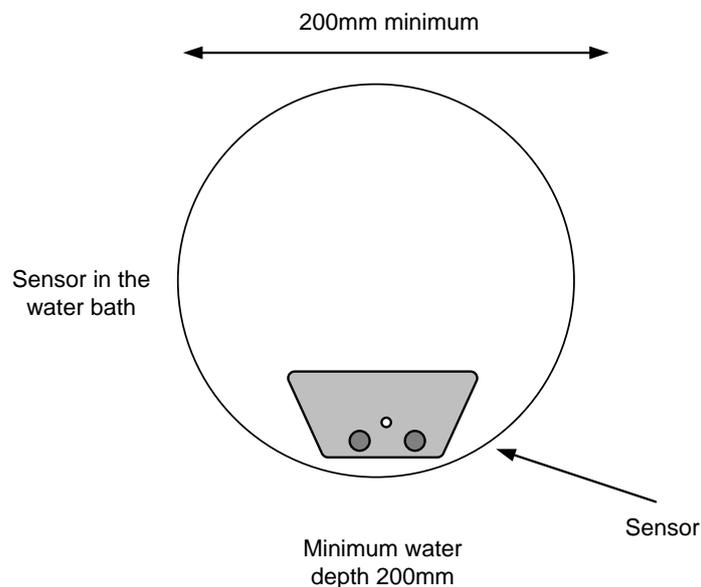


Figure 51: Air-water calibration

**IMPORTANT:**

***Once the alignment of the sensing arm is changed inside a mixer, the resultant density change of material passing the sensing head will have an effect on the reading. This would apply when a new arm is fitted, despite pointing the faceplate in the same approximate direction as the previous installed arm. It is therefore necessary to recalibrate the recipes before continuing batching.***



The following tables list the most common faults found when using the sensor. If you are unable to diagnose the problem from this information, please contact your local distributor or the Hydronix technical support team on +44 (0) 1483 468900 or by email: support@hydronix.com.

## 1 Symptom: No output from sensor

Possible explanation	Check	Required result	Action required on failure
Output is not working correctly.	Perform simple test with hand on sensor.	Readings correspond with those listed in Sensor Output Characteristics page 69	Power down and re-power sensor.
No power to sensor.	DC power at junction box.	+15v DC to +30v DC.	Locate fault in power supply or wiring.
Sensor has temporarily locked up.	Power down and re-power sensor.	Sensor functions correctly.	Check power.
No sensor output at control system.	Measure sensor output current in analogue output wiring (disconnect from control system).	Current reading within the range 0-20mA or 4-20mA. Reading varies with moisture.	Check cabling back to junction box.
No sensor output at junction box.	Measure current flow at terminals in junction box (disconnect site wiring).	Current reading within the range 0-20mA or 4-20mA. Reading varies with moisture.	Check Rotating Connector if used, otherwise check sensor connector pins.
No sensor output at Rotating Connector.	Measure current flow at terminals in Rotating Connector (disconnect site wiring).	Current reading within the range 0-20mA or 4-20mA. Reading varies with moisture.	Check sensor connector pins.
Sensor MIL-Spec connector pins are damaged.	Disconnect the sensor cable and check if any pins are damaged.	Connector pins are bent.	Pins can be carefully bent back to the correct location.
Internal failure or incorrect configuration.	Connect the sensor to a PC using the Hydro-Com software and a suitable RS485 converter.	Digital RS485 connection is working.	Sensor should be returned to Hydronix for repair.
Incorrectly inserted Sensing Arm	Remove Sensing Arm, check connection pins and then re-insert Arm	Current reading within the range 0-20mA or 4-20mA. Reading varies with moisture.	Check Sensing Arm connector pins

## 2 Symptom: Incorrect analogue output

Possible explanation	Check	Required result	Action required on failure
Wiring problem.	Wiring at the junction box, in the Rotating Connector and at the control system input.	Twisted pairs used for complete length of cable from sensor to control system are wired correctly.	Wire correctly using specified cable in the technical specification.
Sensor's analogue output is faulty.	Disconnect the analogue output from the control system and measure with an ammeter.	Current reading should be within the range 0-20mA or 4-20mA.	Connect sensor to a PC and run Hydro-Com. Check analogue output on the diagnostics page. Force the output to a known value (eg. 10mA) and check this with an ammeter.
PLC analogue input card is faulty	Disconnect the analogue output from the PLC and measure the analogue output from the sensor using an ammeter	Current reading should be within the range 0-20mA or 4-20mA.	Replace analogue input card
Incorrectly inserted Sensing Arm	Remove Sensing Arm, check connection pins and then re-insert Arm	Current reading within the range 0-20mA or 4-20mA. Reading varies with moisture.	Check Sensing Arm connector pins

### 3 Symptom: Computer does not communicate with the sensor

Possible explanation	Check	Required result	Action required on failure
No power to sensor	DC power at junction box	+15v to +30v DC	Locate fault in sensor power supply wiring
RS485 incorrectly wired into converter	Converter's wiring instructions RS485 and A and B are correct	RS485 converter correctly wired	Check PC COM port settings
Incorrect serial COM port selected in Hydro-Com	COM ports listed on communications menu	Switch to the correct COM port	Possible COM port number is higher than 16 and therefore not selectable. Determine the COM port number assigned by looking at the Device Manager
COM port number is higher than 16 and is not available for use in Hydro-Com	The COM port assignments in the PCs device manager window	Renumber the COM port used for communication with the sensor to an unused port number between 1 and 16	Check sensor addresses
More than one sensor has the same address	Connect to each sensor individually	Sensor is found at an address. Renumber this sensor and repeat for all other sensors on the network	Try an alternative communication device if available

### 4 Sensor Output Characteristics

	Filtered Unscaled output (values are approximate)				
	RS485	4-20mA	0-20mA	0-10v	Compatibility Mode
Sensor exposed to air	0	4mA	0mA	0v	>10v
Hand on sensor	60 - 90	12 - 18mA	11 - 18mA	6 - 9v	3.6 - 2.8v



## 1 Mechanical Dimensions

ORB2 Housing: 156 x 225 mm

Sensing arm: 104.5 x 34 mm (length of arm to suit mixer, usually 560 mm or 700mm)

## 2 Construction

Body: Stainless steel (AISI 304)

Sensing arm: Hardened stainless steel with shaped ceramic sensing face

## 3 Penetration of field

Approximately 75 – 100 mm dependent on the material.

## 4 Operating temperature range

0 – 40° C - ORBA2

0 – 60° C - ORBA1

0 – 100° C. ORBA1-HT

The sensor will not measure ice.

## 5 Supply Voltage

+15v to 30v DC. 1A minimum required for sensor start up (nominal operating power is 4W).

## 6 Connections

### 6.1 Sensor cable

Six pairs twisted (12 cores total) screened (shielded) cable with 22 AWG, 0.35mm<sup>2</sup> conductors.

Screen (shield): Braid with 65% minimum coverage plus aluminium/polyester foil

Recommended cable types: Belden 8306, Alpha 6373

Maximum cable run: 100 m separate to any heavy equipment power cables

### 6.2 Digital (serial) communications

Opto-isolated RS485 2 wire port – for communications including changing operating parameters and sensor diagnostics.

### 6.3 Analogue output

Two configurable outputs 0 - 20mA or 4 - 20mA current loop source available for moisture and temperature. Also may be converted to 0 – 10 V DC.

## 6.4 Digital inputs/outputs

Two lines available for batch averaging, start/stop, or temperature multiplexing. One line may also be used as an output status flags indicating 'out of range', 'bin empty' or 'probe ok'.

## 6.5 Grounding

Ensure equipotential bonding of all exposed metalwork. In areas of high lightning risk, correct and adequate protection should be used.

The sensor cable shield is connected to the sensor body so it should not be connected in the control room panel to avoid earth loops.

Q: *Hydro-Com doesn't detect any sensors when I press search.*

A: If there are many sensors connected on the RS485 network, ensure that each sensor is addressed differently. Ensure the sensor is correctly connected, that it is powered from a suitable 15-30Vdc source and the RS485 wires are connected through a suitable RS232-485 or USB-RS485 converter to the PC. On Hydro-Com ensure the correct COM port is selected.

Q: *What should I set the analogue output variable to if I want to monitor moisture in the mix?*

A: It is recommended that the analogue output is set to 'Filtered Unscaled'. This variable is proportional to moisture and the moisture outputs from the sensor are calculated directly from this value. The Filtered Unscaled output is a direct measurement from the microwave response which is scaled between 0 and 100, and filtered to reduce the noise on the signal.

Q: *Why does the sensor output negative moisture when the mixer is empty?*

A: The moisture output from the sensor is calculated using the 'Filtered Unscaled' reading and the calibration coefficients in the sensor, A, B, C and SSD, such that

$$\text{moisture\%} = A(\text{US})^2 + B(\text{US}) + C - \text{SSD}$$

(Where US = unscaled)

These factors are normally used for bin applications with the Hydro-Probe II, but are used in the exactly the same way with the Hydro-Probe Orbiter II. With these factors unchanged (A=0, B=0.2857, C=-4, SSD=0) and the mixer empty (air measurement = 0 unscaled) then it can be shown that the moisture is -4%.

Q: *What calibration is required for my Hydro-Probe Orbiter II?*

A: When using a mixer sensor for concrete production it is normal to connect the sensor to a batch controller or Hydro-Control unit, which manages the moisture during batching. The sensor is not calibrated directly. Instead a series of recipe calibrations within the batch controller are made for each different mix design, each carrying their own reference to which concrete of the correct consistency can be made. Each mix design should have its own recipe because each combination of materials has an effect on the microwave response.

Q: *Do Hydronix sensors have to be calibrated to an exact moisture percent?*

A: Although possible, for most applications exact moisture of the mix is not necessary. All that is needed is a reference target that is known to produce a good mix. Therefore, in the majority of situations, the analogue output from the sensor is set for Filtered Unscaled (0 - 100). A set point is recorded at the end of each batch and stored in the recipe where it is used as the final target.

Q: *If I make a mix with the same quantities of dry materials but with different colours, do I need to have a different recipe?*

A: Yes, pigments whether they are powder or liquid additives affect the measurement and as a result every different colour will require a different recipe and calibration.

Q: *If I make regular half batches of a particular mix, do I need to have a separate recipe for this?*

A: A variation in batch quantities can have a small effect on the amplitude of the output which may benefit from a separate recipe and calibration. The sensor cannot discriminate when it is exposed to material or not. Therefore, in all cases, when reduced batches are made and moisture control is required, it is very important to check if the sensor surface is continually covered by material by looking into the mixer during mixing. As a rule, the accuracy of the signal is not guaranteed if the batch is at, or less than, half the capacity of the mixer.

Q: *If I change the Sensing Arm on my sensor, do I have to recalibrate the sensor?*

A: Yes, the sensor should be re-calibrated as per the instructions in "Changing the Sensor Arm" on page 63. Depending on the calibration method used, If there is any difference in consistence of the final mixes, then the recipes will need to be recalibrated.

Q: *If I have to exchange the sensor in my mixer do I have to recalibrate my recipes?*

A: It is prudent to check the recipe calibrations if your sensor has been moved or exchanged.

Q: *The sensor readings are changing erratically, not consistent with the changes in moisture in the material. Is there a reason for this?*

A: In this case the installation should be completely checked. Is the ceramic cracked? Is the sensor mounted flush and are the mixer blades adjusted as recommended in the routine maintenance section. If the problem persists then check the output when reading only air, and check also by placing sand over the sensor. If the output is still erratic then the sensor could be faulty and you should contact your dealer or Hydronix for technical support. If the readings are OK but appear erratic during mixing then try and connect to a PC and run Hydro-Com to check the configuration filter settings. Default settings can be found on "Default Parameters" page 77.

Q: *My sensor takes a very long time to detect the water that goes into the mixer. Can I speed this up?*

A: This could indicate that the mixer has a poor vertical mixing action. Look at how the water goes into the mixer. Try to spray the water into the mixer in as many places as practical. Check the filter settings and if they are too high reduce the filtering time. This should not be done to the detriment of the signal stability, as unstable signals may affect the amount of water calculated and hence the quality of the final mix. In some cases it has been found that the configuration of the paddles in the mixer has been misaligned. Be sure to check the specifications on your mixer to be certain of the proper mixing action.

Q: *My water controller is a dribble feed system which progressively adds water to reach a final set point. What filter settings do I need for this?*

A: Dribble feed systems do not need to have a stable signal at the end of a dry mixing time and so it should not be necessary to filter as much as you would if you were calculating a one off amount of water to add. The sensor needs to respond as quickly as possible because the moisture reading has to keep up with the water going in otherwise too much water can be put in without being detected. Recommended settings would be light for both slew rate filters, with a minimum filtering time of 2.5 seconds, maximum 7.5 seconds.

Q: *How can I reduce my mix cycle times?*

A: There is no single, simple answer to this. The following could be considered:

"Look at how the mixer is charged with material. Can the materials be loaded in a different sequence that will save some time?

"Is it possible to wet the incoming aggregates with a large percentage of the total water at the instance material goes into the mixer. This would reduce the dry mixing time.

"Are you continuing to mix the material for a long time after the moisture signal is stable? If so you need only to mix up until you reach stability for 5-10 seconds.

"If you want to save time on the dry or the wet mixing times, always maintain a long enough dry mixing time as this is the most important factor for determining the water.

"You can take out some of the wet mixing time as this may be less important as the correct amount of water has already gone into the mixer, if you do this then be aware that the final released mix may not be homogeneous.

"When running mixes using lightweight aggregates, be certain to keep the lightweight as close to or above the SSD. This will help reduce mixing time because less pre-wet water is being used.

"When using a Hydro-Control , check also to see if there are timers being used after the mixer is charged (prior to the start signal) and after the mix complete (prior to the mixer discharge). These timers are not needed.

Q: *Is the mounting position of the sensor important?*

A: The mounting position of the sensor within the mixer is very important. Refer to "Mechanical Installation" on page 15.

Q: *What is the maximum length of cable I can use?*

A: See "Chapter 9 Technical Specifications" on page 71.



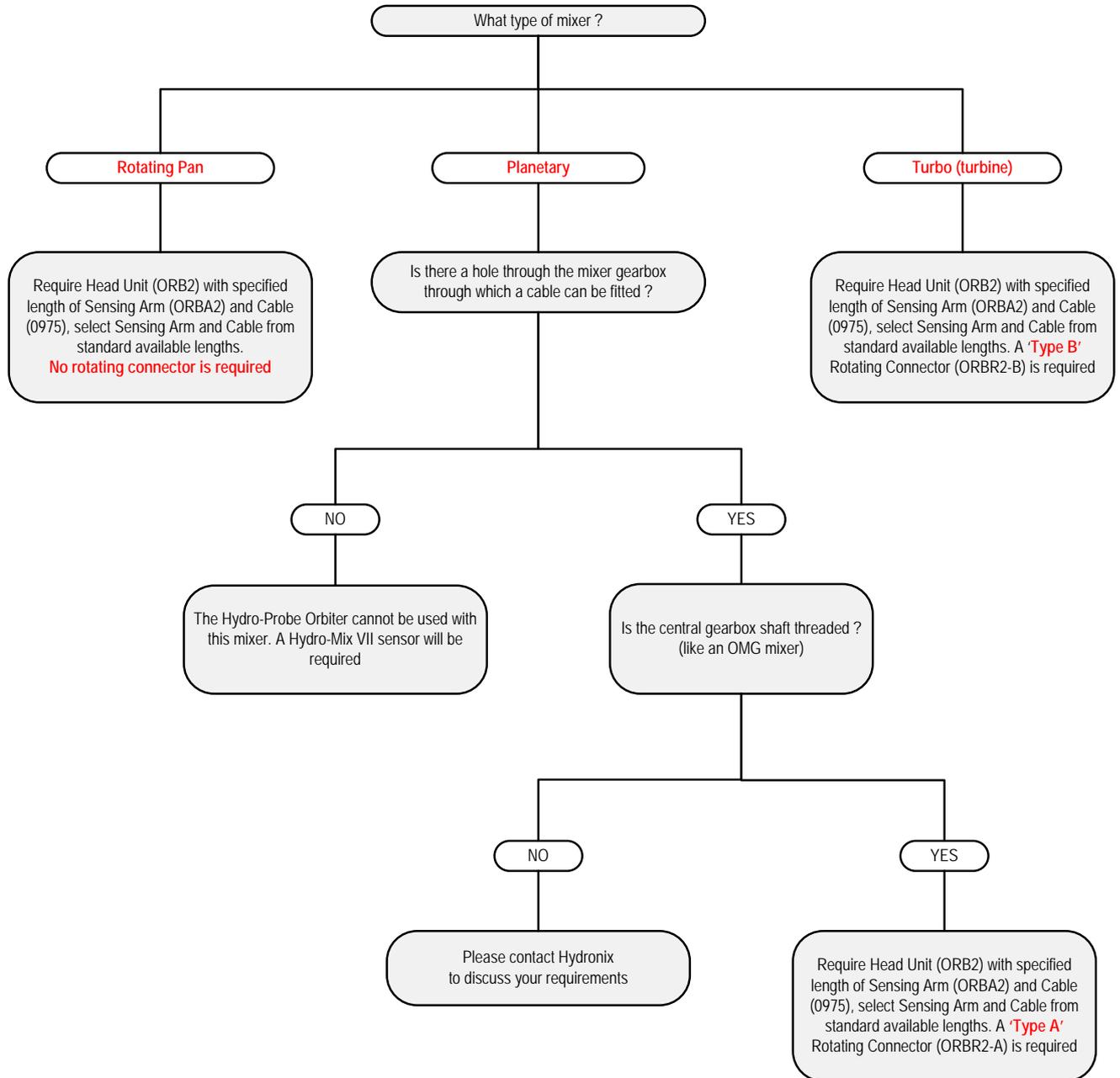
The complete set of default parameters are shown in the tables below. This information is also listed in Engineering Note EN0050, available for download from [www.hydronix.com](http://www.hydronix.com)

## 1 Default parameters

Parameter	Range/Options	Default Parameter
<b>Input/Output configuration</b>		
Output type	0-20mA 4-20mA Compatibility	0-20 mA (0-10v)
Output variable 1	Filtered Moisture % Average Moisture % Filtered Unscaled Filtered Unscaled 2 Average Unscaled Material Temperature	Filtered Unscaled
Output variable 2	Filtered Moisture % Average Moisture % Filtered Unscaled Filtered Unscaled 2 Average Unscaled Material Temperature	Material Temperature
High %	0-100	20.00
Low %	0-100	0.00
Input Use 1	Average/Hold Moisture/Temp Unused	Average/Hold
Input/Output Use 2	Unused Moisture/Temp Bin Empty Data Invalid Probe OK	Unused
<b>Moisture calibration</b>		
A		0.0000
B		0.2857
C		-4.0000
SSD		0.0000
<b>Signal processing configuration</b>		
Smoothing Time	0.0, 1.0, 2.5, 5.0, 7.5, 10.0, Any	7.5 sec

Digital Signal Processing	Very Light, Light, Medium, Heavy, Very Heavy, Unused	Unused
Slew rate +	Light, Medium, Heavy, None	Light
Slew rate -	Light, Medium, Heavy, None	Light
<b>Averaging Configuration</b>		
Average/Hold Delay	0.0, 0.5, 1.0, 1.5, 2.0, 5.0	0 sec
High limit (m%)	0-100	30.0
Low limit (m%)	0-100	0.0
High limit (US)	0-100	100.0
Low limit (US)	0-100	0.0
<b>Temperature compensation</b>		
Electronic temp. co-eff		-0.0035
Electronic Amp co-eff		-0.15
Resonator temp. co-eff	Dependant on arm	Dependant on arm
Material temp. co-eff	0.00000	0.00000

# 1 Selection Chart for the Rotating Connector





## 1 Document Cross Reference

This section lists all of the other documents that are referred to in this User Guide. You may find it beneficial to have a copy available when reading to this guide.

<b>Document Number</b>	<b>Title</b>
HD0273	Hydro-Com User Guide
HD0303	USB Sensor Interface Module User Guide
EN0050	Sensor Default Parameters



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