Hydro-Probe XT
User Guide

To re-order quote part number:	HD0538
Revision:	1.4.1
Revision date:	May 2014

Hydronix Limited
7 Riverside Business Centre
Walnut Tree Close
Guildford
Surrey GU1 4UG
United Kingdom

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

Hydronix, Hydro-Probe, Hydro-Mix, Hydro-View and Hydro-Control are Registered Trade Marks of Hydronix Limited

Hydronix Offices

UK Head Office

Address:	7 Riverside Business Centre Walnut Tree Close Guildford Surrey GU1 4UG
Tel:	+44 1483 468900
Fax:	+44 1483 468919
Email:	support@hydronix.com sales@hydronix.com
Website:	www.hydronix.com

North American Office

Covers North and South America, US territories, Spain and Portugal

Address:	692 West Conway Road Suite 24, Harbor Springs MI 47940 USA
Tel:	+1 888 887 4884 (Toll Free) +1 231 439 5000
Fax:	+1 888 887 4822 (Toll Free) +1 231 439 5001

European Office

Covers Central Europe, Russia and South Africa

Tel:	+49 2563 4858
Fax:	+49 2563 5016

French Office

Tel:	+33 652 04 89 04

Revision history

Revision No	Date	Description of Change
1.0.0	October 2012	First Release
1.1.0	June 2013	Formatting Updates
1.2.0	August 2013	Corrosion protection section added to Chapter 2
1.3.0	February 2014	Figure 29 & 30 updated
1.4.0	April 2014	Figure 15 description updated
1.4.1	May 2014	Minor Formatting update

Table of Contents

Table of Figures

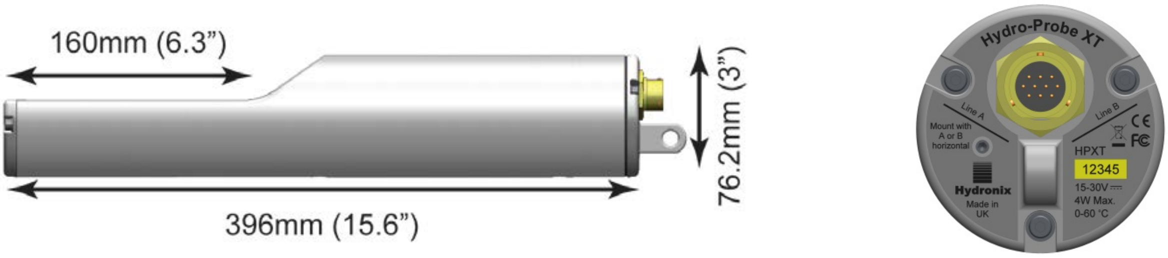


Figure 1: The Hydro-Probe XT

Available accessories:

Part No	**Description**
0023	Clamp ring
0024A	Flanged Mounting Sleeve (requires part number 0023)
0025	Standard mounting sleeve
0026	Extension mounting sleeve
0975	4m sensor cable
0975-10m	10m sensor cable
0975-25m	25m sensor cable
0116	Power supply – 30 Watt for up to 4 sensors
0067	Terminal box (IP66, 10 terminals)
0049A	RS232/485 converter (DIN rail mounting)
0049B	RS232/485 converter (9 pin D type to terminal block)
SIM01A	USB Sensor Interface Module including cables and power supply

Hydro-Com configuration and diagnostics software is available for free download from www.hydronix.com

1 Introduction

The Hydro-Probe XT is a digital microwave moisture sensor. It uses high speed digital signal processing filters and advanced measurement techniques to give a signal which gives a change that is linear with the change in moisture in the material being measured. The sensor must be installed into a material flow and will then give an online output of the moisture change in the material.

The sensor has two analogue outputs which are fully configurable and can be internally calibrated to give a direct moisture output which is compatible with any control system.

Typical applications include moisture measurement in biomass materials, grain, animal feed and agricultural materials. The shape of the sensor makes it ideally suited to measure the moisture content of materials in the following applications:

- Bins / Hoppers / Silos
- Conveyors
- Vibratory Feeders

Two digital inputs are available which can control the internal averaging function, allowing the sensor measurement, taken at 25 times per second enabling rapid detection of changes in moisture content in the process, to be averaged to enable easier use in the control system.

One of the digital inputs can be configured to provide a digital output which can provide an alarm signal in the event of a low or high reading, and this can be used to signal a high moisture alarm or alternatively to signal an operator that a storage bin needs to be refilled.

The Hydro-Probe XT is specially designed using suitable materials to provide many years of reliable service even in the most arduous conditions. However, as with other sensitive electronic devices, care should be taken not to subject the sensor to unnecessary impact damage, particular the ceramic faceplate which, whilst being extremely resistant to abrasion, is brittle and may be damaged if hit directly.

CAUTION – NEVER HIT THE CERAMIC

Care should be taken to ensure that the Hydro-Probe XT has been correctly installed and in such a manner to ensure representative sampling of the material concerned. It is essential that the sensor be installed as near as possible to the bin gate and that the ceramic faceplate is fully inserted into the main flow of the material. It must not be installed in stagnant material or where material can build-up on the sensor.

All Hydronix sensors are pre-calibrated in the factory so that they read 0 when in air and 100 when submerged in water. This is called the 'Unscaled Reading' and is the base value used when calibrating a sensor to the material being measured. As this normalises each sensor, if a sensor is changed then there is no need to redo the material calibration.

After installation the sensor should be calibrated to the material (see Sensor Integration and Calibration on Page 41). For this the sensor can be setup in two ways:

- *Calibration inside sensor:* Sensor is calibrated internally and outputs true moisture.
- *Calibration inside control system*: Sensor outputs an unscaled reading which is proportional to moisture. Calibration data inside the control system converts this to true moisture

2 Measuring techniques

The Hydro-Probe XT uses the unique Hydronix digital microwave technique that provides a more sensitive measurement compared to analogue techniques. This technique facilitates a choice of measurement modes. The default mode is Mode V which is the most suitable mode for agricultural and biomass materials.

3 Sensor connection and configuration

As with other Hydronix digital microwave sensors, the Hydro-Probe XT may be remotely configured using a digital serial connection and a PC running Hydro-Com sensor configuration and calibration software. For communication with a PC, Hydronix supply RS232-485 converters and a USB Sensor Interface Module (See page 29).

There are two basic configurations by which the Hydro-Probe XT can be connected to a batch 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. USB and Ethernet adapter options are also available

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

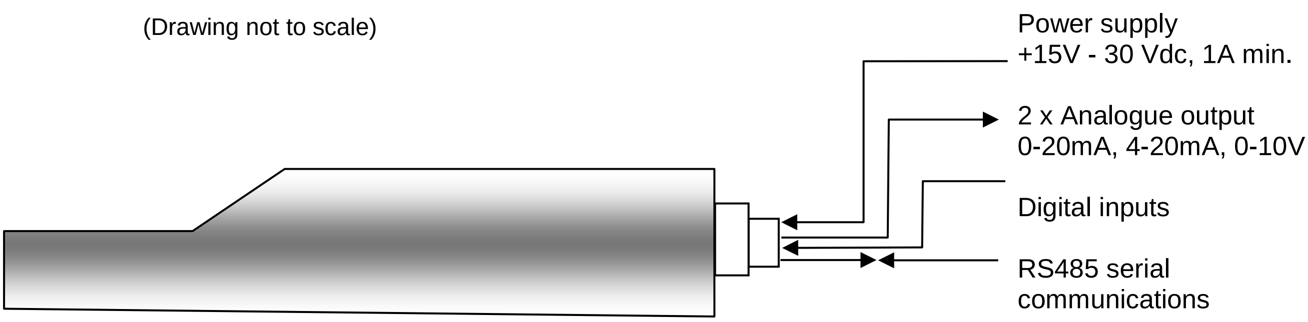


Figure 2: Connecting the sensor (overview)

1 General to all applications

Follow the advice below for good sensor positioning:

- The 'sensing area' of the sensor (ceramic faceplate) should always be positioned in the moving stream of material.
- The sensor should not obstruct the material flow.
- Avoid areas of severe turbulence. The optimal signal will be obtained where there is a smooth flow of material over the sensor.
- Position the sensor so that it may be easily accessible for routine maintenance, adjustment and cleaning.
- Care should be taken to prevent damage from excessive vibration by positioning the sensor as far as reasonably practical from vibrators. If fitting to a vibratory feeder, the advice from the manufacturer of the feeder should be followed, or alternatively contact the Hydronix support department.
- The sensor must be angled with the ceramic faceplate initially set to 60° to the flow (as shown below) to ensure that none of the material sticks to the ceramic faceplate. This is indicated on the label when the A or B line is perpendicular to the flow.

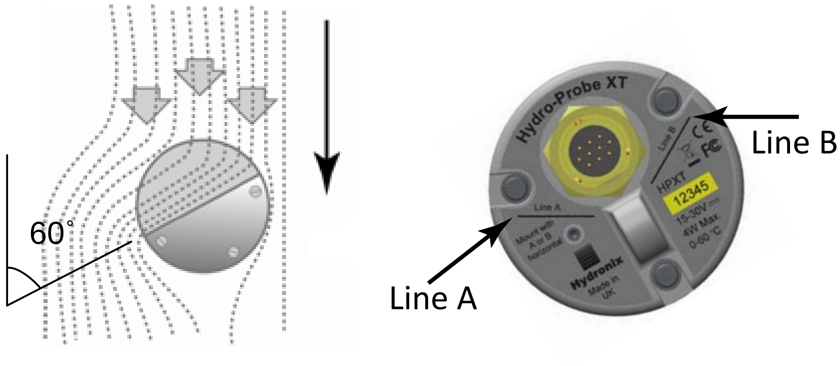


Figure 3: Hydro-Probe XT mounting angle and material flow

If there is a risk that high density material greater than 12mm in size may inadvertently enter the material flow it is advisable to protect the ceramic faceplate. A deflection plate should be fitted above the sensor (see Figure 4). The requirements of this must be determined by observation during loading.

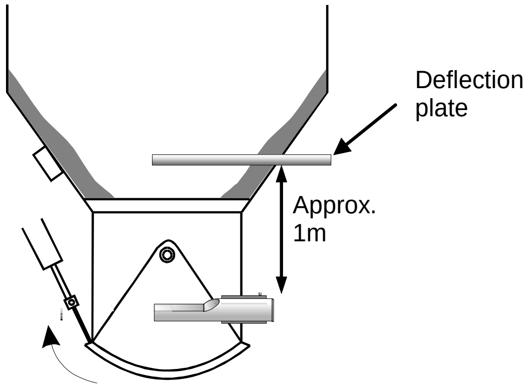


Figure 4: Fitting a deflection plate to prevent damage

2 Positioning the sensor

The optimum location for the sensor varies depending on the type of installation – a number of options are detailed on the following pages. Several different mounting systems can be used to fix the sensor as shown in Section 3.

2.1 Bin/silo/hopper mounting

The sensor may be mounted in either the neck of the bin or the wall and should be positioned in the centre of the flow of material, as shown below.

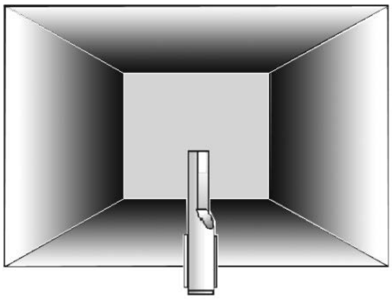


Figure 5: Overhead view of Hydro-Probe XT mounted in a bin

2.1.1 Neck mounting

The sensor should be located on the opposite side of the gate opening and centred within the neck. If it is fitted on the same side as the ram, it should be angled towards the centre.

- Ensure that the ceramic is not mounted closer than 150mm to any metalwork.
- Ensure the sensor does not obstruct the gate
- Ensure that the ceramic faceplate is in the main flow of material. Observe a test batch to identify the best position. To prevent obstruction of the material where space is limited, the sensor can be angled down to a maximum of 45° as shown below.
- Positioning the sensor under the bin will also help where space is limited. The sensor may require cleaning if it is used in sticky materials or if the sensor is fouled by weeds and other foreign bodies contained in the aggregates. In this case, mounting the sensor under the bin can be advantageous for ease of maintenance.

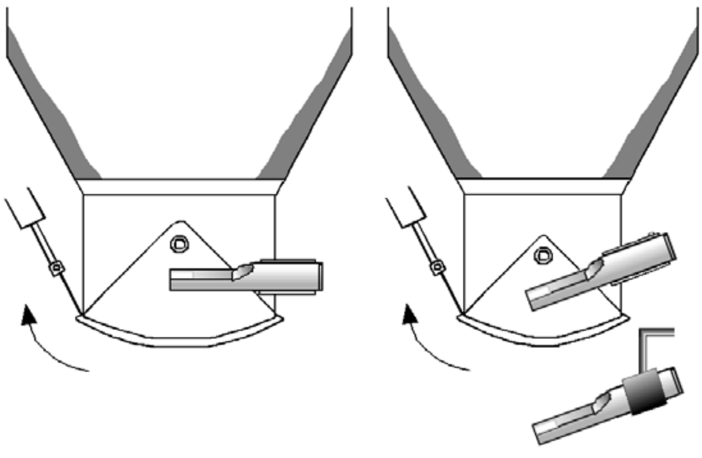


Figure 6: Mounting the Hydro-Probe XT in the neck of the bin

2.1.2 Bin wall mounting

The sensor can be placed horizontally in the bin wall, or if the space is limited, angled down to 45° as shown, using the standard mounting sleeve.

- The sensor should be placed in the centre of the widest side of the bin and, where possible, mounted on the opposite side to any vibrators (where fitted).
- Ensure the sensor ceramic is not mounted closer than 150mm to any metal work.
- Ensure the sensor does not obstruct the door-opening.
- Ensure the ceramic face-plate is in the main flow of the material.

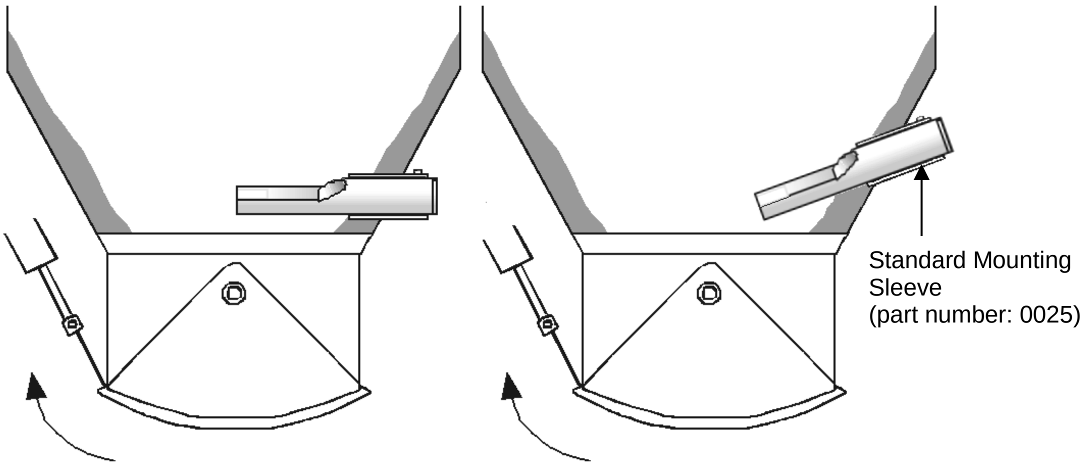


Figure 7: Mounting the Hydro-Probe XT in the bin wall

If the sensor does not reach the main flow of material, then an extension mounting sleeve should be used, as shown in Figure 8.

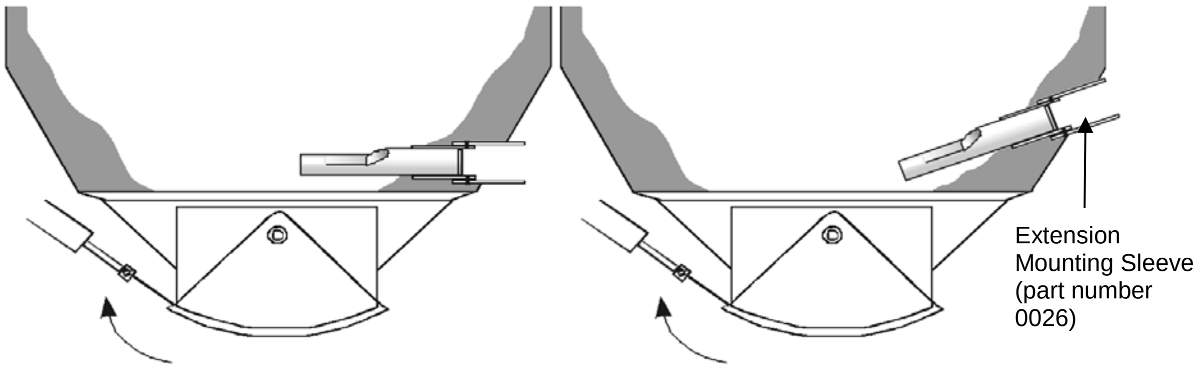


Figure 8: Mounting the Hydro-Probe XT in large bins

2.2 Vibratory feed mounting

With vibratory feeders, the sensor is normally fitted by the manufacturer – contact Hydronix for further information on positioning. It is difficult to predict where the flow of material occurs, but the location shown below is recommended.

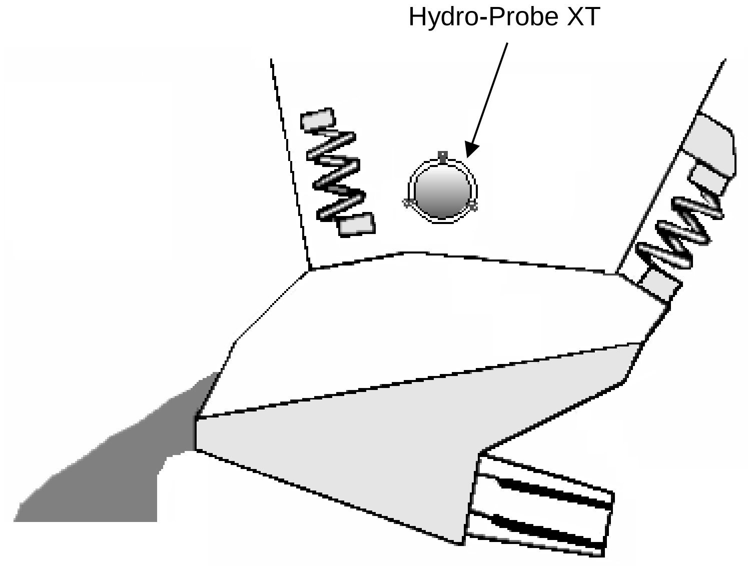


Figure 9: Mounting the Hydro-Probe XT in a vibratory feeder

2.3 Conveyor belt mounting

The sensor should be secured to a suitable fixing bar using a Flanged Mounting Sleeve and a Clamp Ring.

- Allow a 25mm gap between the sensor and the conveyor belt
- The minimum depth of material on the conveyor belt must be 150mm to cover the ceramic faceplate. **The sensor faceplate must always be covered in material.**
- To improve the flow characteristics and level of material on the belt, it may be beneficial to fit diverters onto the conveyor, as shown below. This can build up the material to a deeper level for good measurement.
- To aid calibration, a manual switch may be fitted alongside the belt to switch the average/hold digital input. This will enable the readings to be averaged over a period of time whilst collecting samples and so giving a representative unscaled reading for calibration (See Chapter 3 for connection details).

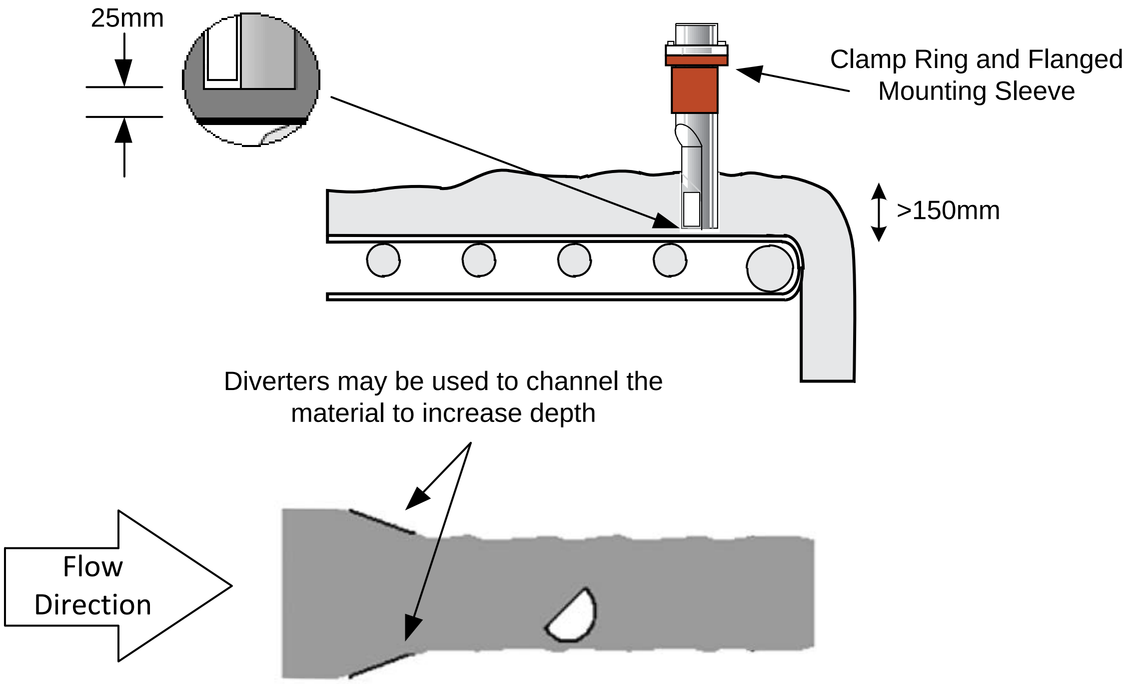


Figure 10: Mounting the Hydro-Probe XT on a conveyor belt

2.4 En-masse (chain) conveyor mounting

The sensor should be mounted using a Standard Mounting Sleeve in the side wall of the conveyor.

The main body of the sensor should be mounted at an angle of 60° to the flow.

- The probe should be positioned close to the bottom of the conveyor so as much material as possible can pass over the ceramic face
- The probe should be inserted so that the centre of the ceramic is in the centre of the flow
- The ceramic face should be completely covered by a minimum of 100mm depth of material at all times a measurement is required
- An accessible sampling point should be installed approximately 150mm downstream of the sensor
- To aid calibration, a manual switch should be fitted close to the sampling point to switch the average/hold input. This will enable the readings to be averaged over a period of time whilst collecting samples and so give a representative unscaled reading for the sample collected for calibration (see Chapter 3 for connection details)

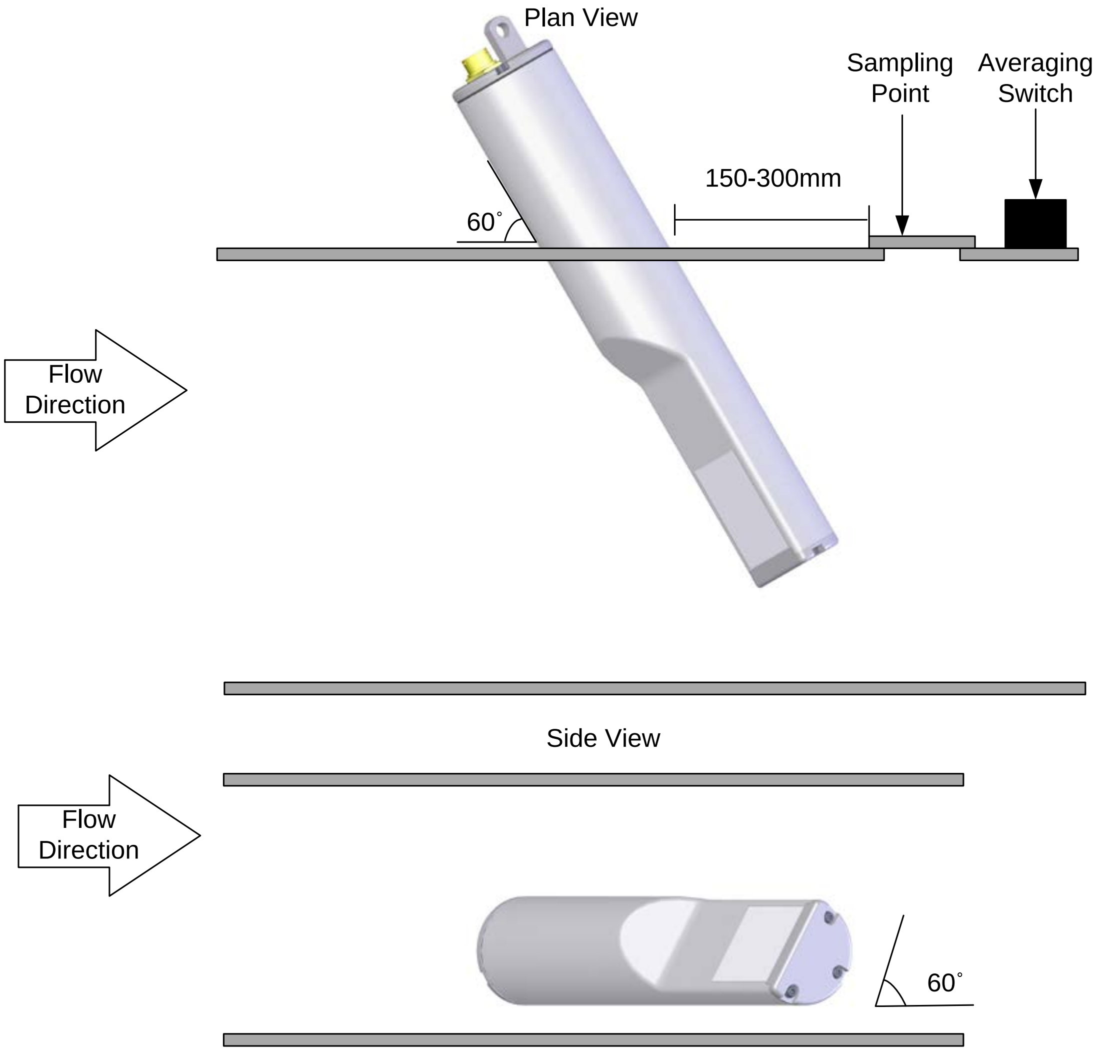


Figure 11 - Mounting the Hydro-Probe XT in an en-masse conveyor

2.5 Screw conveyor mounting

The sensor should be mounted either at the flute-less end of the conveyor or, if this is not possible, the last section of the flute should be removed. The sensor should be mounted using a Standard Mounting Sleeve in the side wall of the conveyor. The main body of the sensor should be mounted at an angle of 60° to the flow.

- The probe should be positioned close to the bottom of the conveyor so as much material as possible can pass over the ceramic face
- The probe should be inserted so that the centre of the ceramic is in the centre of the flow
- The ceramic faceplate should be completely covered by a minimum of 100mm depth of material during measurement
- An accessible sampling point should be installed approximately 150mm downstream of the sensor
- To aid calibration, a manual switch should be fitted close to the sampling point to switch the average/hold input. This will enable the readings to be averaged over a period of time whilst collecting samples and so give a representative unscaled reading for the sample collected for calibration. (see Chapter 3 for connection details)

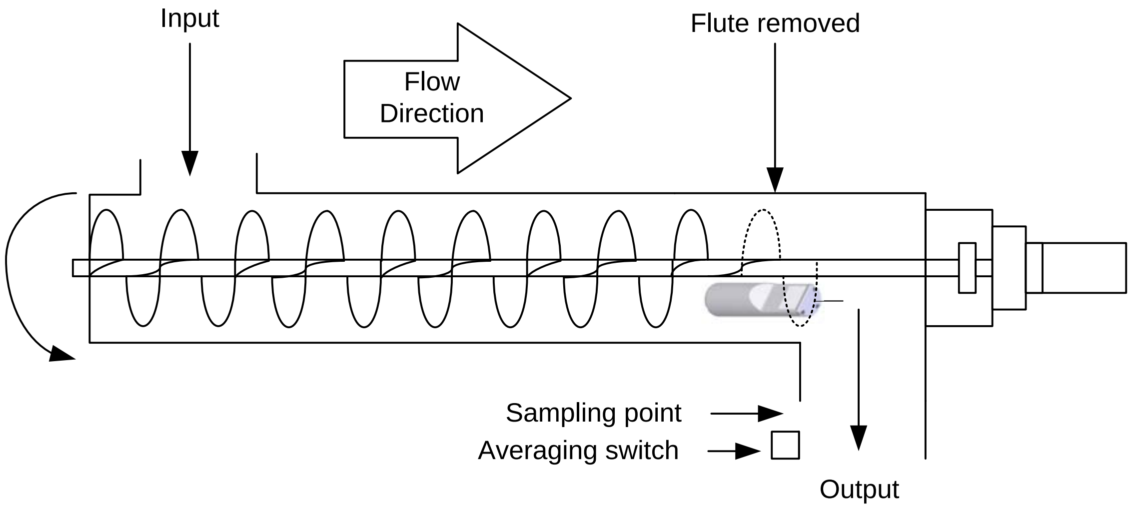


Figure 12 - Mounting the Hydro-Probe XT in a screw conveyor

3 Installing the Sensor

There are three mounting accessories available from Hydronix.

3.1 Standard mounting sleeve (part no 0025)

The Hydro-Probe XT can also be mounted vertically using the Standard Mounting Sleeve, however Hydronix would recommend using the Flanged Mounting Sleeve, see Figure 15

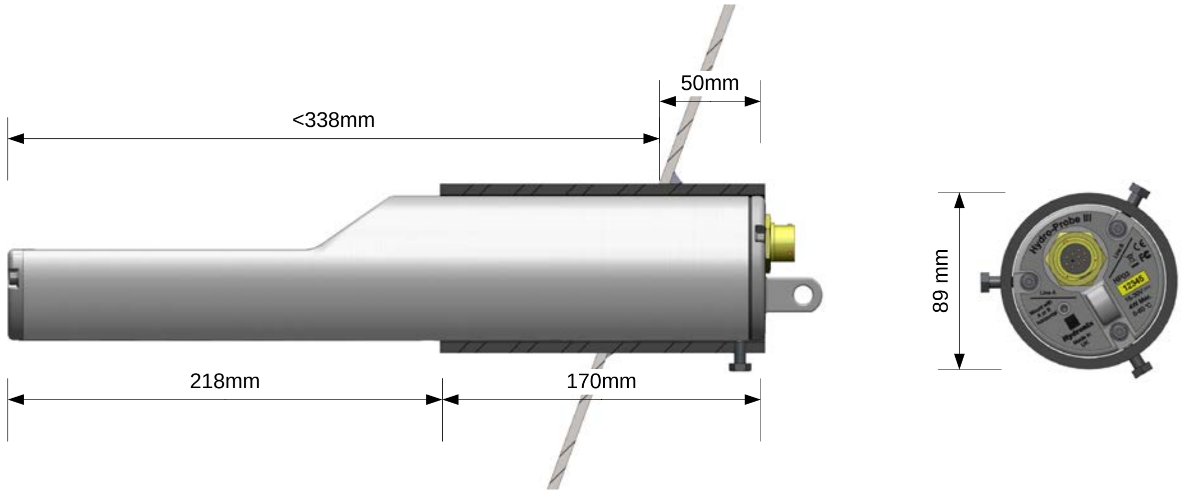
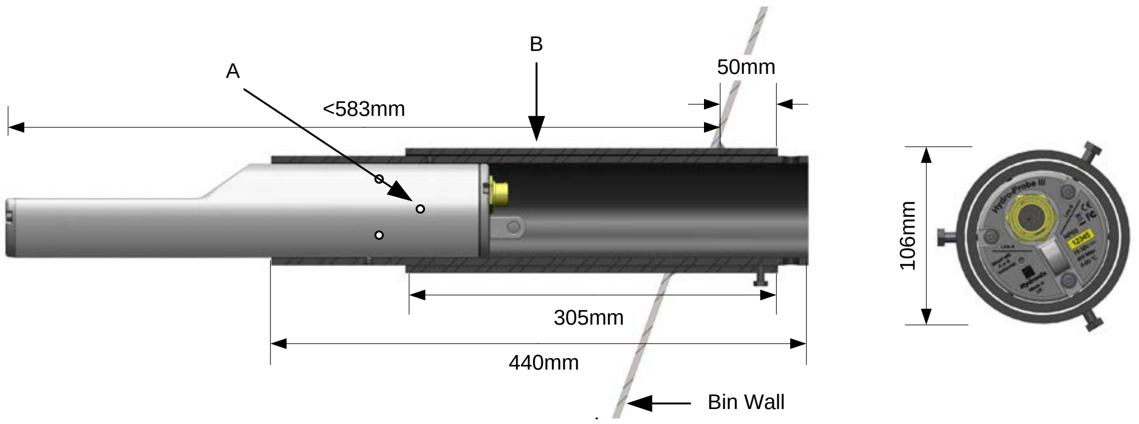


Figure 13: The standard mounting sleeve (part no 0025)

3.2 Extension mounting sleeve (part no 0026)

For installation in larger bins.



A – Sensor is secured to the inner sleeve by 6 hex screws (use Locktite or similar) on screw threads

B – Outer sleeve welded to bin

Figure 14: The extension mounting sleeve (part no 0026)

3.3 Flanged Mounting Sleeve (part no 0024A)

For installations where vertical mounting is required. Use with the Hydronix Clamp Ring, part number 0023. A 100mm diameter hole is required to insert the Flanged Mounting Sleeve.

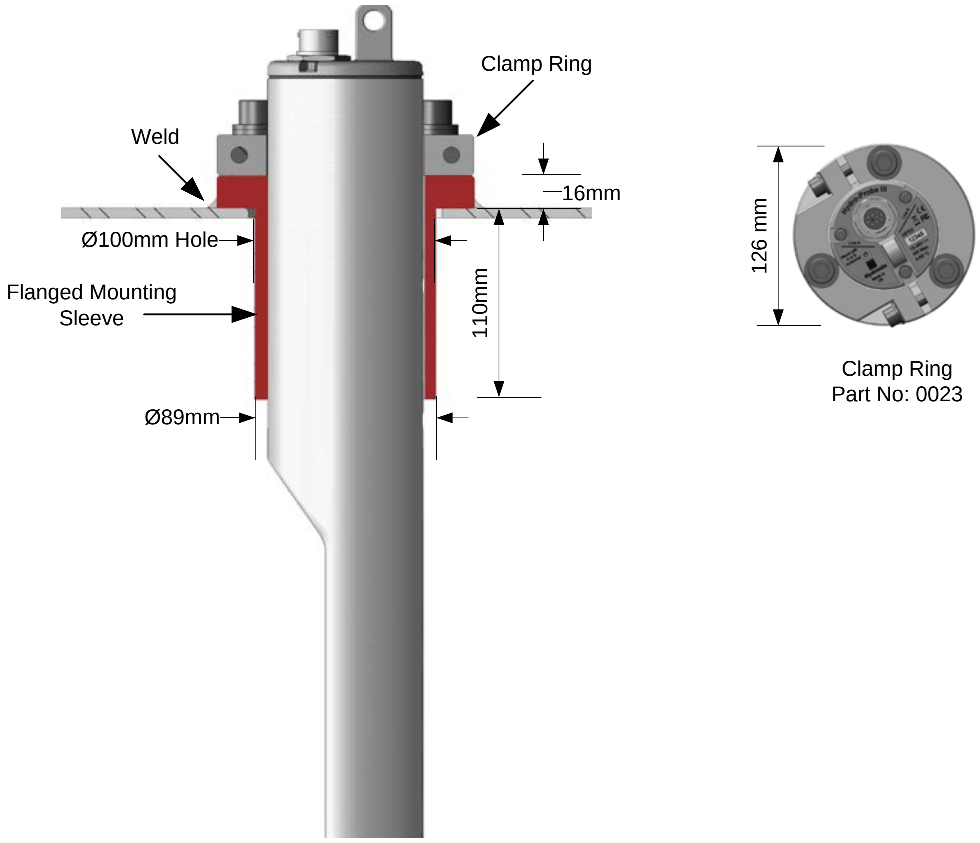


Figure 15: Flanged Mounting Sleeve (Part number 0024A)

4 Corrosion protection

In situations where corrosive materials are in use, there is potential for the cable connector to be damaged. It is therefore necessary to provide some protection to minimise the corrosion. Protection from this corrosion is possible with a few simple adjustments to how the sensor is installed.

It is always best to try and locate the sensor so no material comes into contact with the connection end of the sensor.

4.1 Sensor position

If the sensor is installed under a bin or silo, material can sometimes build up on the top of the sensor cable connector. If the material is corrosive then over time this may cause the connector to be damaged. To avoid this it is recommended that the sensor is positioned so the material does not fall onto the connector. If the sensor is installed too far into the flow of the material then the connector may come into contact with the flow.

Do not allow the cable and connector to be covered in the falling material. Position the sensor so the connector is not in the material flow, See Figure 16

The sensor must remain in the main flow of the material at all times to produce accurate measurements of the moisture.

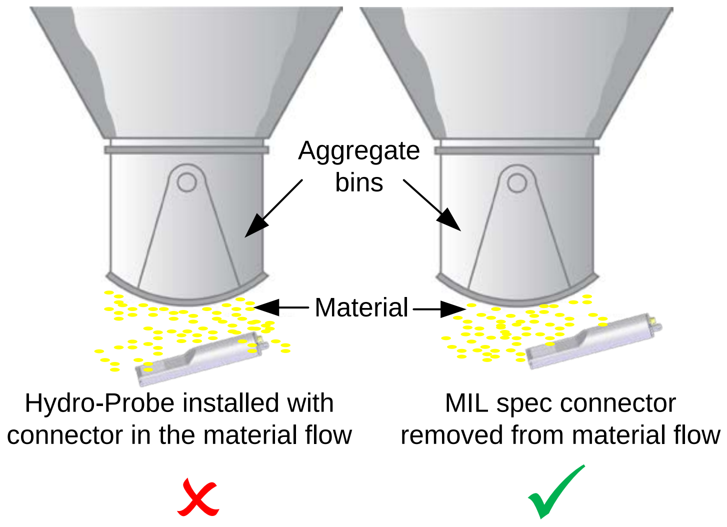


Figure 16: Hydro-Probe installed under an aggregate bin

4.2 Extension mounting sleeve

If it is not possible to stop the material coming into contact with the sensor's connector, install the sensor using an Extension Mounting Sleeve (Part number 0026). Position the sensor in the Extension Mounting Sleeve so that the connection end is completely pushed into the sleeve preventing material coming into contact with the connector. See Figure 17

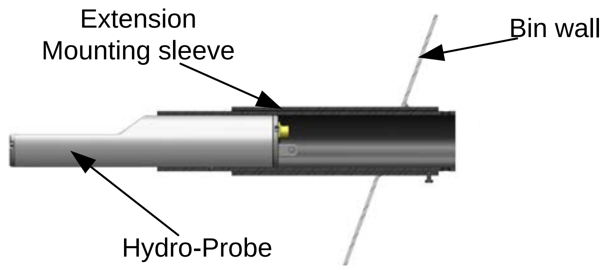


Figure 17: Hydro-Probe installed in an Extension Mounting Sleeve

4.3 Drip Loop

Some corrosion is possible if the moisture run off from the material reaches the connector. This will be increased if the moisture is allowed to run along the sensor cable and collect at the connector. This can be reduced by installing the cable with a drip loop. This will cause the moisture to drip off of the cable before it reaches the connector. See Figure 18

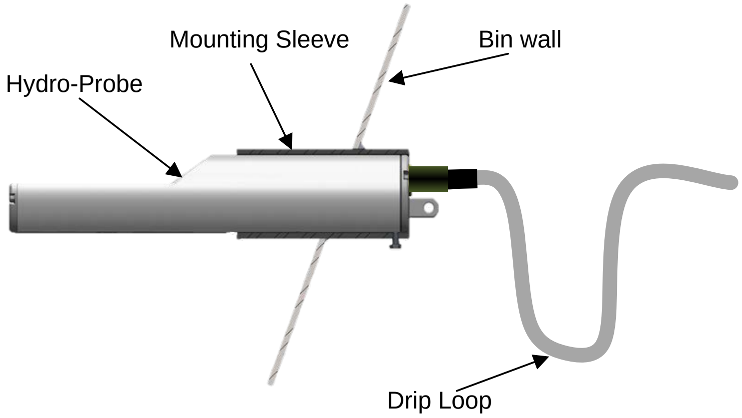


Figure 18: Hydro-Probe installed with a drip loop

4.4 Protection cover

Install a cover over the top of the sensor to deflect the material away from the connector. See Figure 19

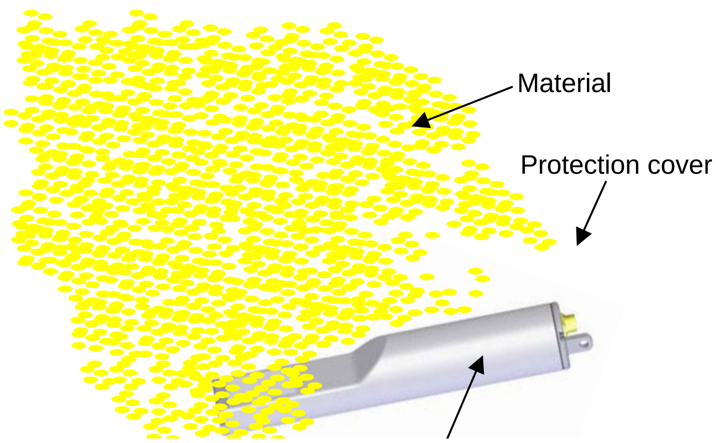


Figure 19: Deflector plate

If the connector is still getting wet or covered by the material self-amalgamating tape can be used to seal it and stop the water causing corrosion. It is however preferential to keep the material away from the connector as this will be the best method of stopping the possibility of corrosion.

Hydronix supplies cable 0975 for use with the Hydro-Probe XT and this is available in different lengths. Any extension cable should be connected to the Hydronix sensor cable using a suitable screened junction box. See Chapter 8 for cable details.

The Hydro-Probe XT is also directly backward compatible with older 0090A cables. When connecting to a 0090A cable it is not possible to use the 2^{nd} analogue output provided by the Hydro-Probe XT.

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 8).

Ensure that the RS485 cable is wired 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.

The sensor cable should **only** be grounded at the sensor end of the cable.

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 Configuration in Chapter 4 or the Hydro-Com User Guide HD0273 for further details. Using the 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.

Sensor cable (Part no 0975) connections (for new installations):

Twisted Pair Number	MIL spec pins	Sensor connections	Cable colour
1	A	+15-30V DC	Red
1	B	0V	Black
2	C	1st Digital input	Yellow
2	--	-	Black (Cut back)
3	D	1st Analogue Positive (+)	Blue
3	E	1st Analogue Return (-)	Black
4	F	RS485 A	White
4	G	RS485 B	Black
5	J	2nd Digital input	Green
5	--	-	Black (Cut back)
6	K	2nd Analogue Positive (+)	Brown
6	E	2nd Analogue Return (-)	Black
	H	Screen	Screen

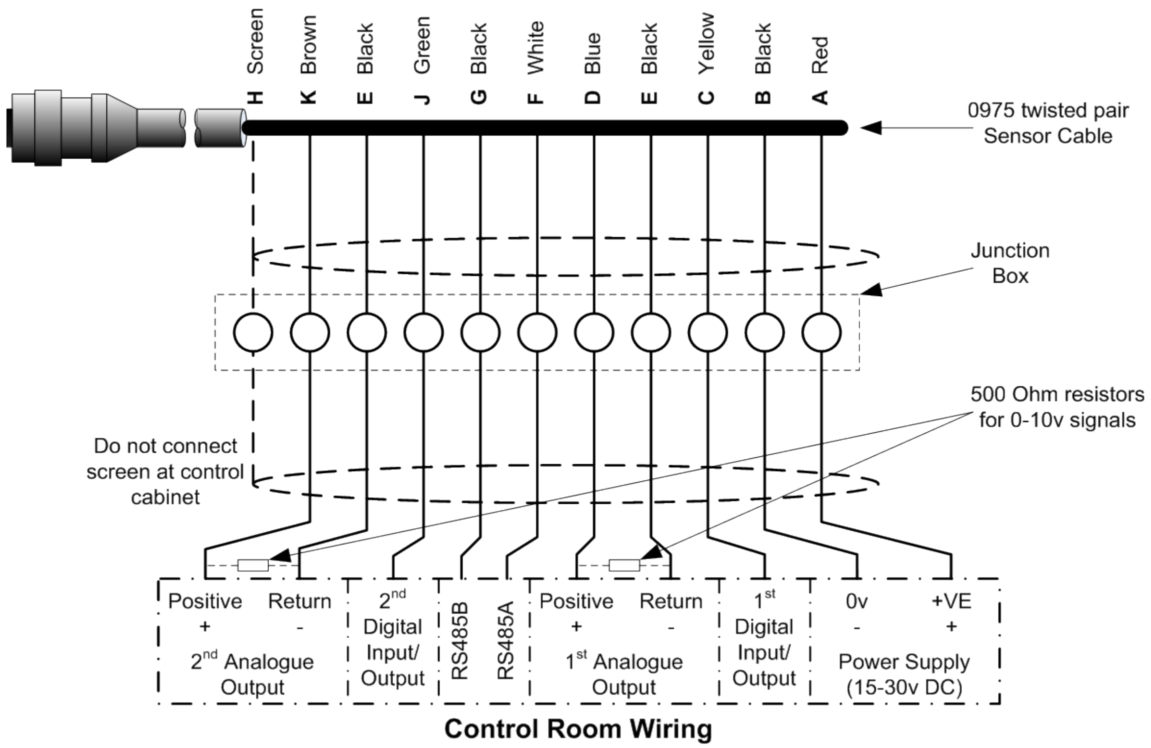


Figure 20: 0975 Sensor cable connections

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.

3 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.

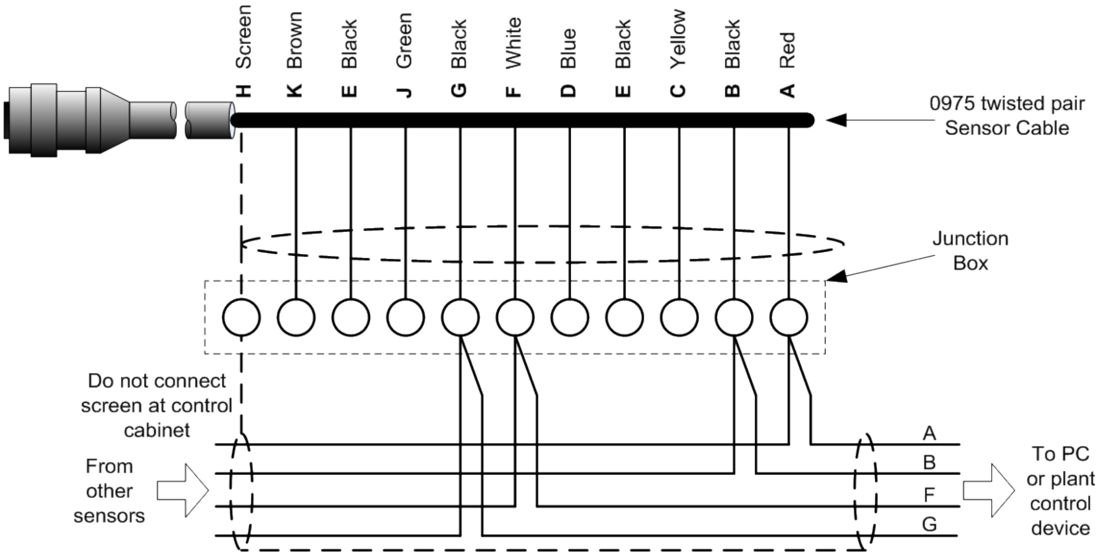


Figure 21: RS485 multi-drop connection

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 22.

Figure 22: Correct RS485 cable networks

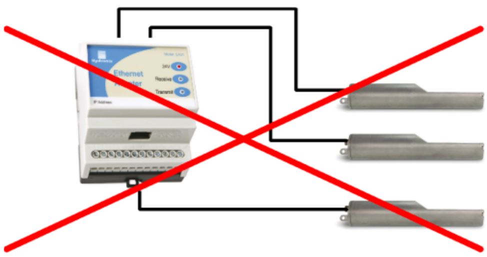


Figure 23: Incorrect RS485 cabling

4 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.

5 Digital input/output connection

The Hydro-Probe XT 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 Configuration from Page 33. 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 – 30v DC 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.

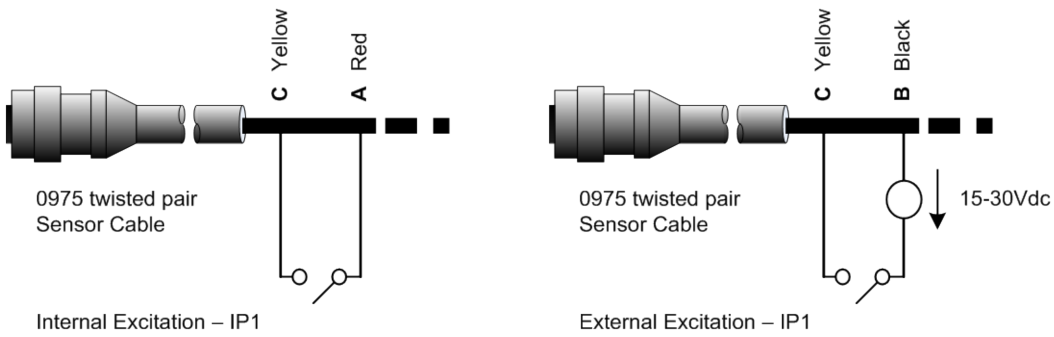


Figure 24: Internal/external excitation of digital input 1 & 2

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 3). Note that the maximum current sink in this case is 500mA and in all cases over current protection should be used.

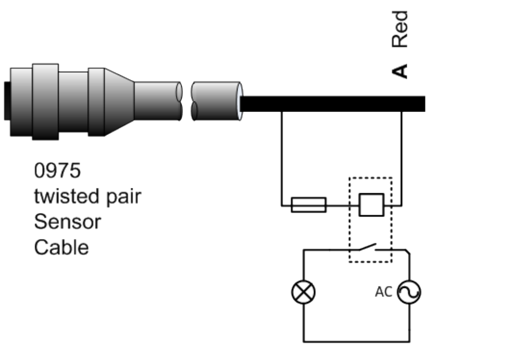


Figure 25: Activation of digital output 2

6 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.

6.1 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.

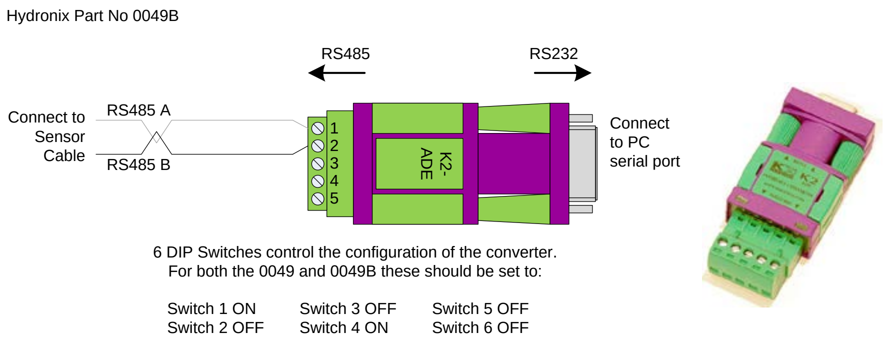


Figure 26: RS232/485 converter connections (0049B)

6.2 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.

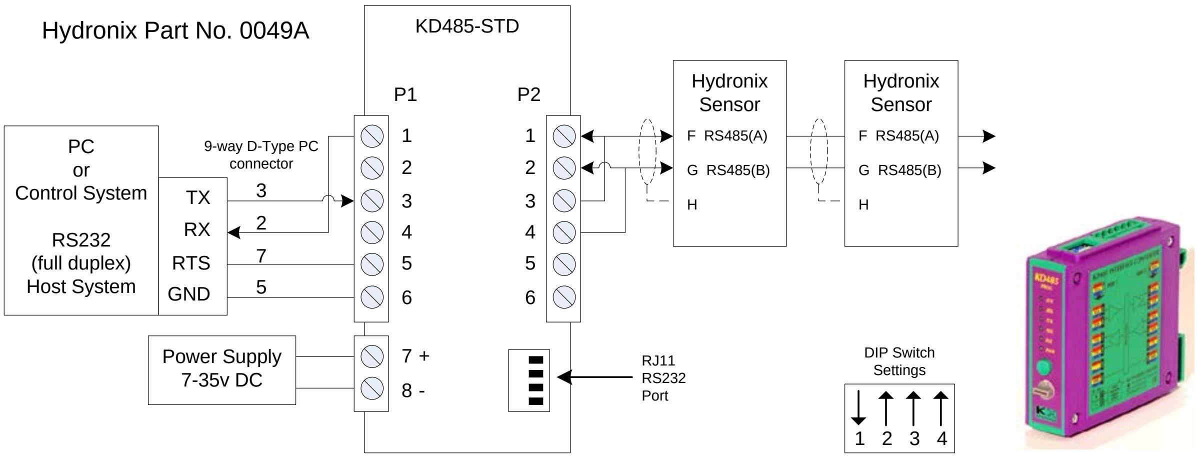


Figure 27: RS232/485 converter connections (0049A)

6.3 USB Sensor Interface Module (part no: SIM01A)

Manufactured by Hydronix, 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.

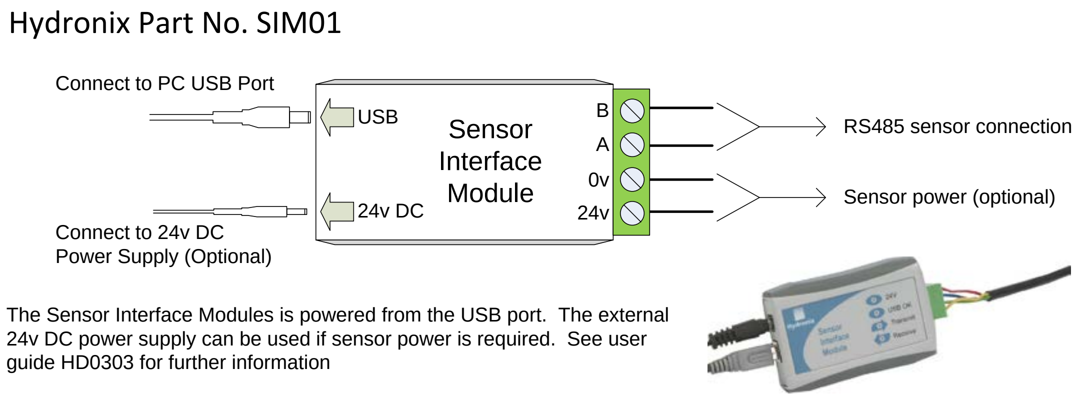


Figure 28: RS232/485 converter connections (SIM01A)

6.4 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

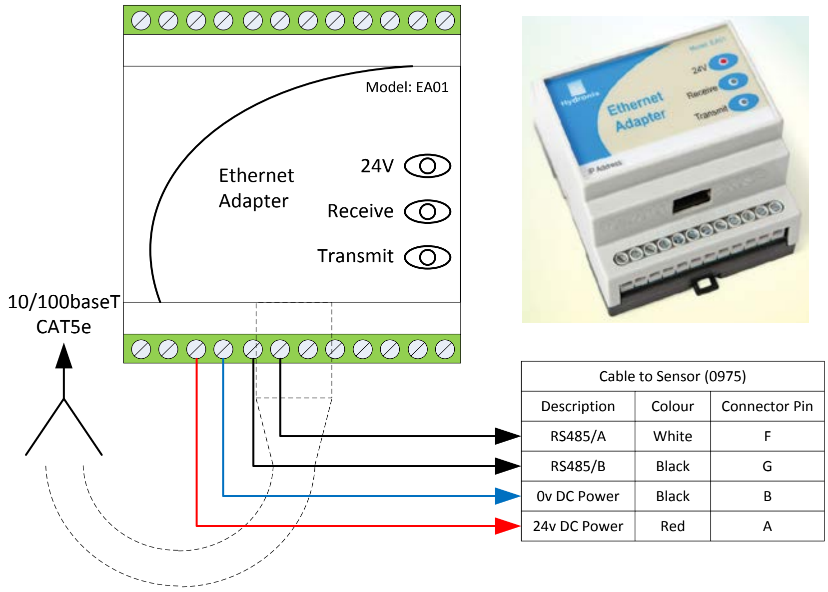


Figure 29: Ethernet Adapter Connections (EAK01)

Hydronix Part No: EPK01

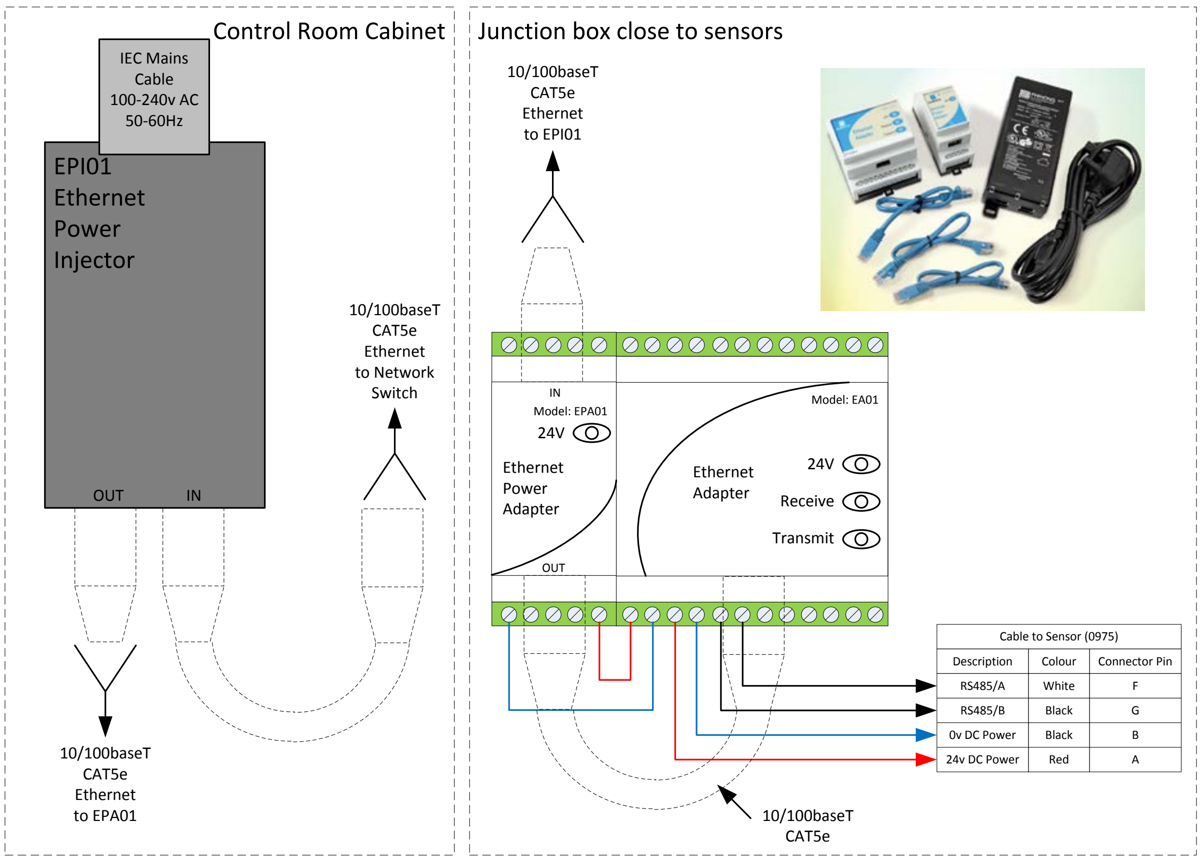


Figure 30: Ethernet Power Adapter Kit connections (EPK01)

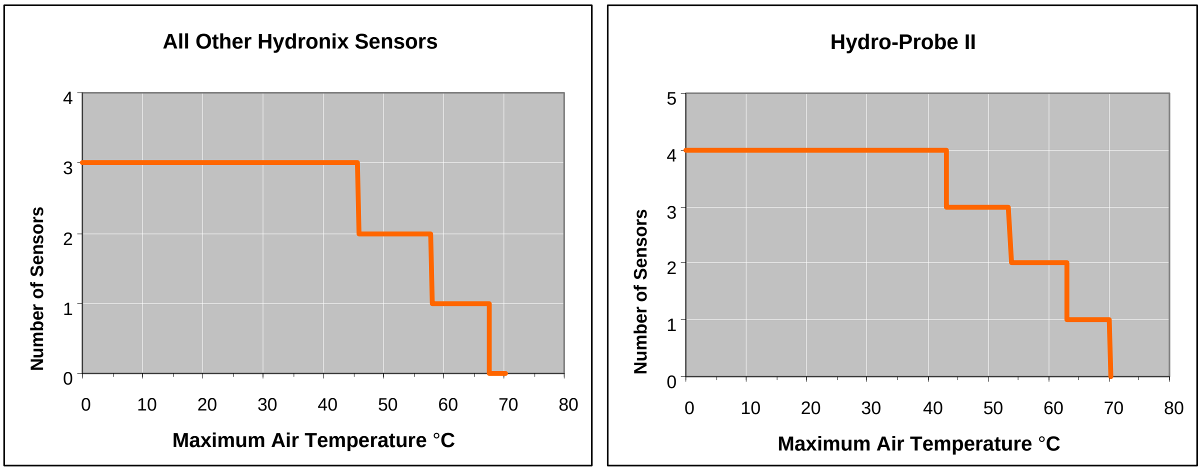


Figure 31: Maximum number of sensor connections dependent upon ambient temperature

NOTE: Operation above these limits may cause premature failure of the unit.

1 Configuring the Sensor

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

Both the Hydro-Com software and the User Guide can be downloaded free of charge from www.hydronix.com.

All Hydronix sensors operate in the same way and use the same configuration parameters. The parameter used will depend on the application. For example, averaging parameters are typically only used for batch processes.

2 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 input signal. The outputs may also be configured to represent different readings generated by the sensor e.g. moisture or temperature.

2.1 Output type

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

0 – 20mA: This is the factory default. The addition of an external 500 Ohm precision resistor converts to 0 – 10V DC.

4 – 20mA.

Compatibility: This is not used by the Hydro-Probe XT.

2.2 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'

2.2.1 Filtered Unscaled

This represents a value 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.

2.2.2 Average Unscaled

The Raw Unscaled variable processed for batch averaging using the averaging parameters. If averaging is required it is recommended to use the averaging functionality within the sensor. 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.

2.2.3 Filtered Moisture %

It is possible for the sensor to output a value that is proportional to the moisture content of a material. In such cases the sensor will require calibrating to the given material. The calibration requires the relationship between the unscaled readings of the sensor and the associated moisture percentage of the material to be defined (see Chapter 5).

Selecting 'Filtered Moisture %' will configure the sensor to output the calibrated moisture value.

2.2.4 Average Moisture %

If batch averaging is required it is recommended to use the averaging functionality within the sensor. The Average Moisture % is the 'Raw Moisture %' variable that has been processed for batch averaging using the sensor's 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.

Figure 32 may be used to assist in selecting the correct analogue output variable for a given system.

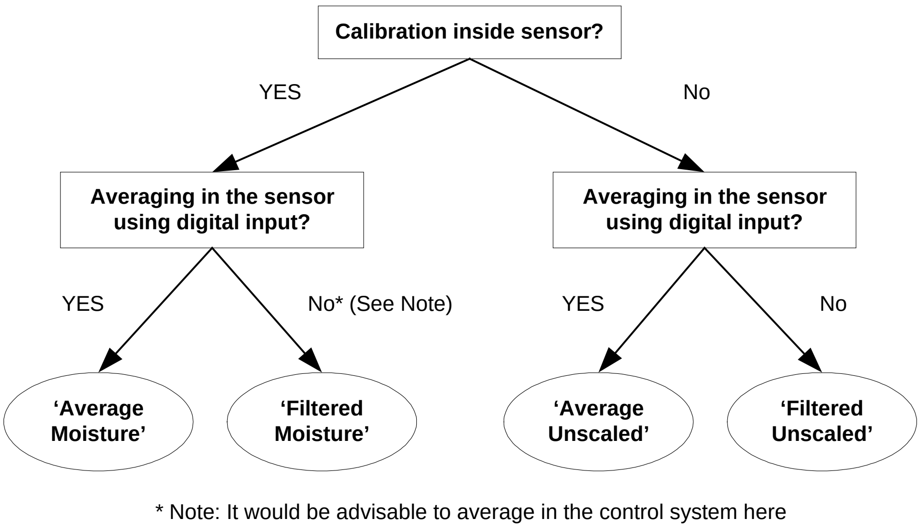


Figure 32: Guidance for setting output variables

2.3 Low % and High%

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.

3 Digital inputs/output setup

The sensor 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 used to control the start and stop period for batch averaging. When the input signal is activated, the 'Raw' 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. This may be used to provide a high and low level alarm .
ProbeOK:	This option is not used for this sensor.

An input is activated using 15 – 30V DC 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 in Figure 24.

4 Filtering

The default filtering parameters can be found on Page 61 or in Engineering Note EN0071.

The Raw Unscaled reading, which is measured 25 times per second, may contain a high level of ‘noise’ due to irregularities in the signal as the material flows. 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 applications because each will have different characteristics. 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. Each filter is described in detail below.

4.1 Slew Rate Filters

The Slew Rate Filters are useful for clipping large spikes or troughs in the sensor reading caused by mechanical interference in a process.

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. Options are: None, Light, Medium and Heavy. The heavier the setting, the more the signal will be ‘dampened’ and the slower the signal response.

4.2 Digital Signal Processing

The Digital Signal Processing Filters (DSP) remove excessive noise from the signal using an advanced algorithm. The filter reduces high frequency noise. The advantage of this filter is that the DSP filter will treat all signals within a meaningful frequency range as valid. The result is a smooth signal that responds rapidly to changes in moisture.

DSP filters are particularly useful in high noise applications such as a mixing environment. They are less appropriate for low noise environment.

Options are: None, Very Light, Light, Medium, Heavy, Very Heavy.

4.3 Filtering Time (Smoothing Time)

The Filtering Time smoothes the signal after it has first passed through the Slew Rate filters and then the DSP filters. This filter smoothes the whole signal and will therefore slow the signal response. The Filtering Time is defined in seconds

Options are: 0, 1, 2.5, 5, 7.5, 10 and a custom time of up to 100 seconds.

4.4 Averaging parameters

During averaging the sensor uses the Raw Unscaled value. All the filters are unused. 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 continuous processes.

4.4.1 Average/Hold delay

When using the sensor to measure the moisture content of a material as it is 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.

4.4.2 High Limit and Low Limit (Alarms)

The High Limit and Low Limit may be set for both the moisture % and the sensor unscaled value. The two parameters operate concurrently.

If the sensor reading falls outside of these limits during sensor average the data will be excluded from the average calculation.

The Bin Empty output will activate when the reading is below the Low Limit.

The Data Invalid output will activate when the reading is above the High Limit or below the Low Limit.

5 Alternative Measurement Techniques

The Hydro-Probe XT has the option of selecting alternative measurement modes. The modes have been carefully designed to ensure that the sensor may be configured for maximum sensitivity across a wide variety of materials.

The default measurement mode for the Hydro-Probe XT is ‘Mode V’. This mode has been designed for the best performance in agricultural, organic and biomass materials.

Options are: Mode V, Mode E and Standard Mode.

It is recommended that the modes are only changed after comparing the effectiveness of each mode in the specific application. In-situ trials may be conducted using the Hydronix Hydro-Com software to record data and compare the effectiveness of each mode.

5.1 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.

Mode V is often associated with agricultural and biomass materials. It is also suited to other variable or low density materials.

Mode E is designed to be used for measuring in similar materials to Mode V. Mode E is more sensitive than Mode V and therefore the sensor reading may become saturated at a lower moisture percentage. This may limit the maximum moisture percentage that the sensor can measure.

Standard Mode is recommended for sand and aggregates.

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

5.2 Effects of selecting different modes

Each mode will give a different relationship between the sensor’s 0-100 unscaled values and the calibrated 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 33). This assumes that the sensor remains capable of measuring across the full moisture range required and that the sensor is not configured to be impracticably 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. In Figure 33 below, calibration line A is less precise than calibration line B.

The ability to select the fundamental measurement technique allows the user to choose the technique that reduces the slope of the calibration line (see Figure 33, 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 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.

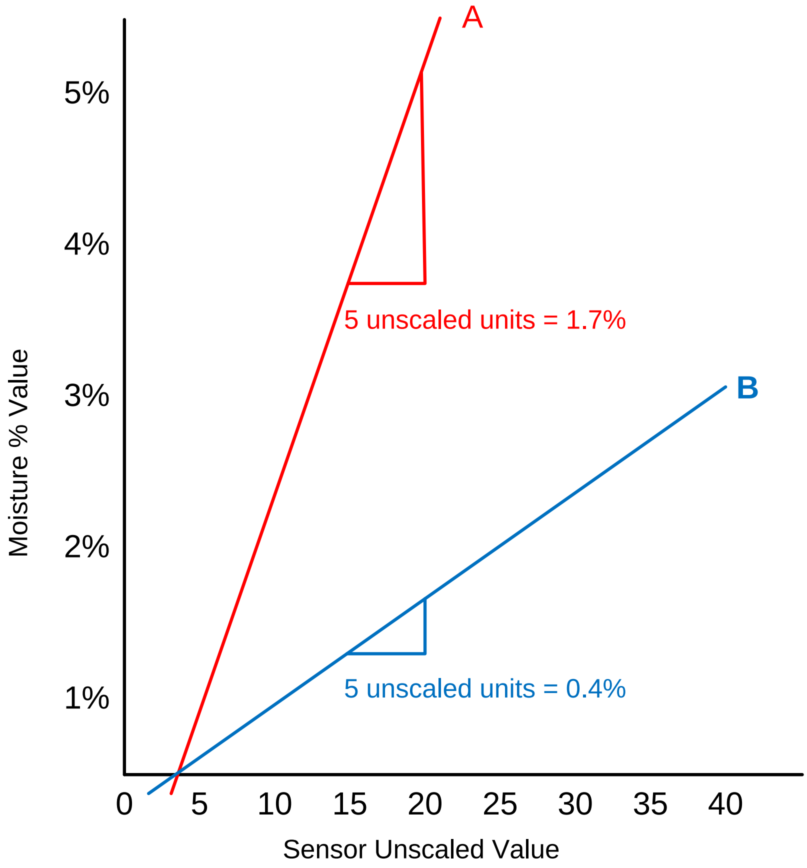


Figure 33: Relationship of moisture % to unscaled values

To determine which mode is the most appropriate it is recommend to run trials for a given material and 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.

Hydronix can supply additional software to assist with detailed analysis of the measurement modes and optimisation of the sensor filtering parameters if required.

Hydro-Com software and the user guide may be downloaded from 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 Calibration page 41).

For further information please contact the Hydronix support team at support@hydronix.com

1 Sensor Integration

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

- The sensor may be configured to output a linear value of between 0-100 unscaled units with a material calibration being performed in an external control system.

Or

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

Or

- The sensor could also be used as a target value

RS485 development tools are available from Hydronix for system designers who wish to develop their own interface.

2 Sensor Calibration

2.1 Introduction to material calibration

The raw output of a Hydronix sensor is an unscaled value ranging from 0 to 100 units. Each sensor is set so that a 0 unscaled value relates to the measurement in air and 100 relates to water.

The relationship between the change in moisture % to the change in unscaled value will not be the same for two different materials as shown in Figure 34. This is because each material has its own unique electrical characteristics. Calibration is the process of mapping the sensors unscaled readings to a value that represents the material moisture percentage.

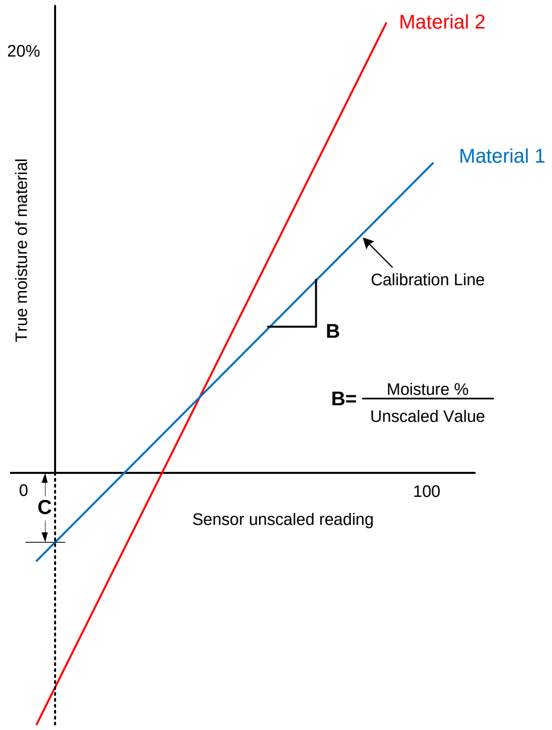


Figure 34: Calibrations for two different materials

The equation of the calibration line is defined by the Gradient (B) and the Offset (C), see Figure 34. These values are referred to as the calibration coefficients.

The Gradient (B) is the relationship between the change in Moisture % to changes in the Unscaled value.

Gradient = $\dfrac{\text{Change in Moisture \%}}{\text{Change in Unscaled Value}}$

The Offset (C) is the Moisture % value that corresponds to 0 Unscaled units.

The sensor will output 0 Unscaled units when in air. When loaded with dry material the Unscaled value will increase and the Moisture % value will rise to indicate 0% Moisture.

The SSD value is a third coefficient used to define absorbed water within a material, this is covered in section 2.2.

Using the coefficients the conversion from Unscaled to Moisture % is as follows:

Moisture % = **B** x (Unscaled Reading) + **C** – **SSD**

In rare cases when the measurement of the material exhibits non-linear characteristics, a quadratic term can be used in the calibration equation as shown below.

Moisture % = **A** x (Unscaled value)^2 + **B** (Unscaled value) + **C** – **SSD**

Use of the quadratic coefficient (A) would only be necessary in complex applications and for most materials the calibration line will be linear in which case **'A'** is set to zero

2.2 SSD coefficient and SSD moisture content

Saturated Surface Dry (SSD) is an offset adjustment typically used in aggregates and hard materials to define the % of moisture that is tightly bound to the material and not freely available. The use of the SSD offset allows the % of free water to be measured.

For applications where Total Moisture is required the SSD Value is left to zero.

Bound Moisture + Free Moisture = Total Moisture

In order to determine the moisture content of a material it is weighed, dried and re-weighed. In practice it is not possible to easily determine the point at which the material reaches its SSD condition. It is therefore often only practical to obtain an oven dried sample (Total Moisture).

SSD values are derived through more lengthy industry standard tests or supplied by the material supplier.

Oven dried moisture % (Total) - water absorption value % (SSD offset in the sensor) = surface moisture % (free moisture)

2.3 Storing calibration data

There are two ways of storing the calibration data, either in the control system or in the Hydro-Probe XT. Both methods are explained in the following sections.

Calibration inside the sensor will involve updating the coefficient values using the digital RS485 interface. True moisture can then be obtained from the sensor.

To communicate using the RS485 interface, Hydronix has developed communications software called Hydro-Com which is free to download from www.hydronix.com.

Both the Hydro-Com software as well as the Hydro-View IV (an advanced touch screen configuration and display unit) contain a dedicated material calibration page which allows a multiple point calibration to be generated for a material.

To calibrate outside of the sensor, the control system will require its own calibration function and the moisture conversion can then be calculated using the linear unscaled output from the sensor. For guidance on setting the output see Figure 32.

2.3.1 Calibration inside the Hydro-Probe XT

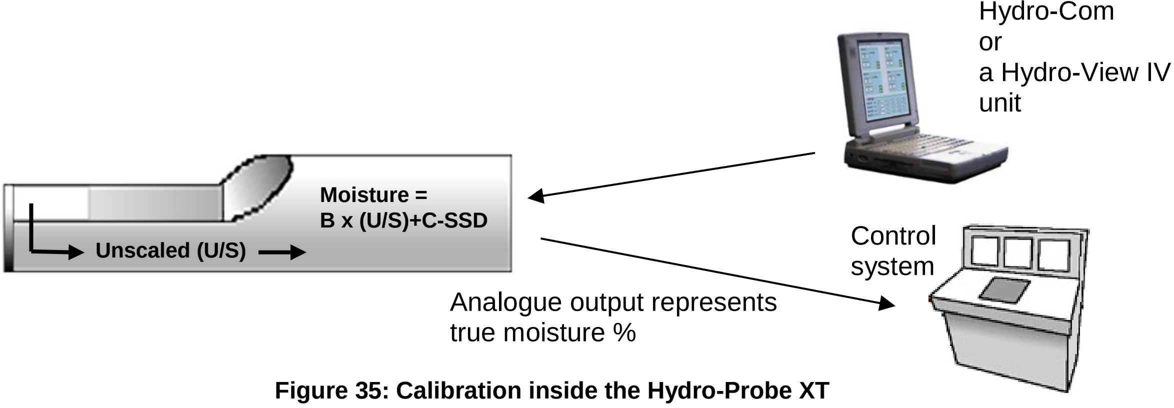


Figure 35: Calibration inside the Hydro-Probe XT

The advantages of calibrating inside the Hydro-Probe XT are:

- Advanced free software improving calibration accuracy, including diagnostics software.
- Control system does not need modification to calibrate the sensor.
- Ability to use Hydronix known calibration data for different materials.
- Calibrations can be transferred between sensors.

2.3.2 Calibration inside the control system

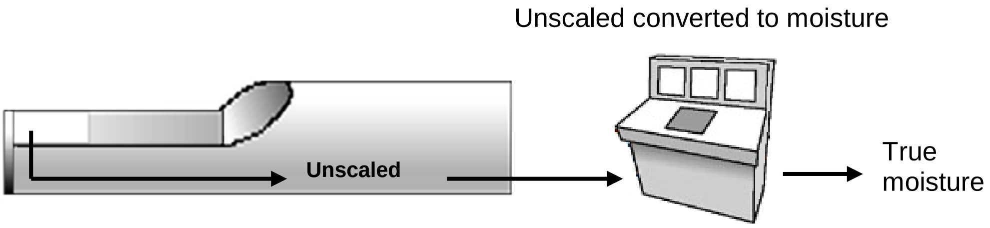


Figure 36: Calibration inside the control system

The advantages of calibrating inside the control system are:

- Direct calibration without the need for an additional computer or RS485 adapter.
- No need to learn how to use additional software.
- If it is necessary to replace the sensor, a replacement Hydronix sensor can be connected and valid results obtained immediately without connecting the sensor to a PC to update the material calibration.
- Calibrations can be switched automatically when materials change
- Calibrations can be easily transferred between sensors..

2.4 Calibration procedure

To determine the calibration line, at least two points (moisture tests) are required. Each point is derived by flowing material over the sensor and recording the sensor's unscaled reading, at the same time taking a representative sample of the material and drying it to determine its true moisture content. This gives a 'Moisture' and an 'Unscaled' value which can be plotted on a graph. With at least two points, a calibration line can be drawn.

The following procedure is recommended when calibrating the Hydro-Probe XT to the material. This procedure uses the Hydro-Com utility and the calibration information is stored inside the sensor. Whether the calibration data is stored within the sensor or the control system, the process is the same.

There are international standards for testing and sampling that are designed to ensure that the moisture content derived is accurate and representative. These standards will define accuracy of weighing systems and sampling techniques in order to make the samples representative of the flowing material. For more information on sampling please contact Hydronix at support@hydronix.com or refer to your particular standard.

2.4.1 Hints and safety

- Wear safety glasses and protective clothing to guard against ejection of material during the drying process.
- Do not attempt to calibrate the sensor by packing material on the face. The readings obtained will not be representative of those from a real application.
- Always sample where the sensor is located.
- Always take a reading of unscaled at the same time as sampling.
- Never assume that material flowing out of two gates in the same bin is the same moisture content and do not attempt to take samples from the flow in both gates to get an average value – always use two sensors and calibrate each sensor separately.
- Always average the sensor's readings. For best results use the digital input to control the sensor's internal averaging function, or average inside the control system.
- Ensure the sensor sees a representative sample of material.
- Ensure a representative sample is taken for moisture testing.

2.4.2 Equipment

- *Weighing scales* – to weigh up to 2kg, accurate to 0.1g
- *Heat source* – for drying samples, such as an electric hot plate or oven.
- *Container* – with resealable lid for storing samples
- *Polythene bags* – for storing samples prior to drying
- *Scoop* – for collecting samples
- *Safety equipment* – including glasses, heat resistant gloves and protective clothing.

NOTES: For full instructions on using Hydro-Com, refer to the Hydro-Com User Guide (HD0273).

The same principles apply with or without using Hydro-Com when calibrating.

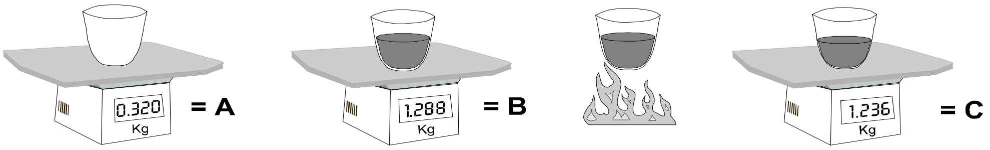
2.4.3 Procedure (Using Hydro-Com Software)

1. Ensure Hydro-Com is running with the calibration page open.
2. Create a new calibration.
3. Select the sensor to calibrate from the pull-down list in the sensor frame.
4. When collecting a sample the Average/Hold status next to the 'Average' reading from the sensor should read 'Averaging' in green. When not sampling it should read 'Hold'. The optimum installation is one where the digital input is wired into the bin-gate switch or a switch local to the sampling point.
5. When taking a sample in a batch system collect at least 10 small samples over the course of the batch from the flow to yield a bulk sample of around 4-5Kg of material. The material MUST be collected at a position close to the sensor and therefore the sensor reading relates to the particular batch of material passing the sensor.
6. When taking a sample in a continuous process the digital input should be wired to a switch local to the sampling point. When collecting the sample the operator should activate the switch and when the operator has finished collecting the sample the switch should be deactivated. Collect around 4-5Kg of material in a bucket.
7. Mix the sample and divide into 3 x 1kg samples. These samples should be placed in an air tight container. If the sample is hot it should be allowed to cool to room temperature and then any condensate moisture should be mixed back in to the sample.
8. Remove a representative sub-sample of at least 10 smaller increments to yield approximately 1 kg. Dry it thoroughly and calculate the moisture content using the moisture calculator. Take care not to lose any of the samples during the drying process. A good test to ensure the material is thoroughly dry is to stir it around to distribute the moisture and reheat.
9. Return to the computer and record the 'Average Unscaled' output, which should show the 'Hold' status.
10. Repeat step 7 for another 1kg representative sub-sample. If the moisture differs by more than 0.3% then one of the samples was not dried out completely and the test has to be restarted.
11. Record the average moisture of the two samples in the calibration table. The 'Moisture' and 'Unscaled' values make up one calibration point. Tick this point to include the values in the calibration.
12. Repeat steps 5 – 9 for additional calibration points. Choose a different time of day or different time of the year to ensure a wide range of moistures are samples.

    A good calibration is one where the calibration points cover the complete working moisture range of the material, and all points lie on, or near to, a straight line. If any calibration points are suspected to be wrong, then they can be excluded from calibration by deselecting their corresponding tick box. It is generally recommended that a spread of at least 3% will give the best results.

When the calibration is finished, update the new calibration coefficients to the correct sensor by pressing the 'Write' button. The B, C and SSD values in the sensor frame will then match those values in the calibration frame. The moisture % output from the sensor should represent true moisture of the material. This can be verified by taking further samples and checking the laboratory moisture against the sensor output.

2.4.4 Calculating the moisture content



$$\text{Moisture content} = \frac{(B - C)}{(C - A)} \times 100\%$$

Example

$$\text{Moisture content} = \frac{1288g - 1236g}{1236g - 320g} \times 100\% \qquad = 5.7\%$$

Moisture content may be referred to as a percentage of the wet weight or as a percentage of dry weight of the material. Industries that generally operate at higher moisture percentages will often use the wet method. For those operating at lower moisture values and where the calculations are often made to ascertain the true dry weight of material excluding moisture the dry method commonly used.

The calculation either divides by the wet weight (B) or the dry weight (C) to ascertain the percentage value.

Using the dry weight method, a 100% moisture value would indicate a 50% mass of dry material and a 50% mass of water. Using this method it is therefore possible to have a moisture value of more than 100%.

All Hydronix calculations are based on a dry weight method unless otherwise specified.

2.5 Good / bad calibration

A good calibration is made by measuring samples and taking readings over the full working moisture range of the material. As many points as practical should be made as more points provide higher accuracy. The graph below shows a good calibration with high linearity.

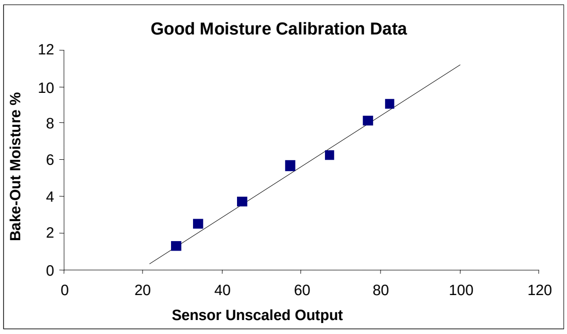


Figure 37: Example of good material calibration

2.5.1 Calibration inaccuracy is likely to result if:

- Too small a sample of material is used for measuring the moisture content.
- A very small number of calibration points are used (in particular 1 or 2 points).
- The sub-sample tested is not representative of the bulk sample.
- Samples are taken close to the same moisture content, like the calibration graph shown below (left). A good range is necessary.
- There is a large scatter in the readings as shown in the calibration graph below (right). This generally implies an unreliable or inconsistent approach to taking samples for oven drying or poor sensor positioning with inadequate material flow over the sensor.
- If the averaging facility is not used to ensure representative moisture reading for the entire batch.

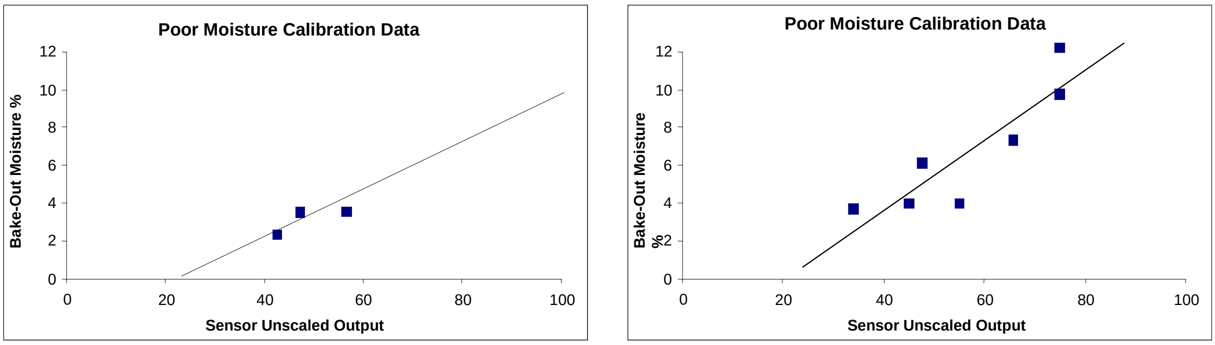


Figure 38: Examples of poor material calibration points

Chapter 6 Optimising Sensor and Process Performance

The sensor is a precise instrument and in many cases is more accurate than the equipment or sampling techniques used for calibration purposes. For best performance ensure that the installation follows the basic guidelines below and that the sensor is configured with suitable filtering parameters.

It may also be beneficial to adjust the sensor filtering and signal smoothing parameters as described in Chapter 4.

Selecting an alternative measurement mode (see Chapter 5) may give a more desirable signal response but before doing so the performance of each mode should be monitored using the Hydro-Com software.

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 material type or source 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 the same moisture content. Increased fine material often leads to a ‘stiffening’ of the material for the same moisture content. This ‘stiffening’ should not automatically be regarded as a reduction in moisture. The sensor will continue to measure moisture.
- **Material build up**: Avoid material build up on the Ceramic faceplate.

2 Routine maintenance

Ensure that the ceramic measurement faceplate is always free from build-up of material.

Fit the Standard Mounting Sleeve (part no 0025), the Extension Mounting Sleeve (part no 0026) or the Flanged Mounting Sleeve (part no 0024A) with Clamp Ring (part no 0023) for ease of adjustment or extraction.

DO NOT HIT THE CERAMIC FACEPLATE DURING MAINTENANCE

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 Hydronix technical support.

1 Sensor Diagnostics

1.1 Symptom: No output from sensor

Possible explanation	**Check**	**Required result**	**Action required on failure**
Output is working but not correctly	Perform simple test with hand on sensor	Milliamp reading within the normal range (0-20mA, 4-20mA)	Power down and re-power sensor
No power to sensor	DC power at junction box	+15Vdc to +30Vdc	Locate fault in power supply/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 at control system	Milliamp reading within the normal range (0-20mA, 4-20mA). Varies with moisture content	Check cabling back to junction box
No sensor output at junction box	Measure sensor output current at terminals in junction box	Milliamp reading within the normal range (0-20mA, 4-20mA). Varies with moisture content	Check sensor connector pins
Sensor MIL-Spec connector pins are damaged	Disconnect the sensor cable and check if any pins are damaged	Pins are bent and can be bent to normal to make electrical contact	Check sensor configuration by connecting to a PC
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. Correct the configuration	Digital RS485 connection is not working. Sensor should be returned to Hydronix for repair.

1.2 Symptom: Incorrect analogue output

Possible explanation	Check	Required result	Action required on failure
Wiring problem	Wiring at the junction box and PLC	Twisted pairs used for complete length of cable from sensor to PLC, wired in correctly	Wire correctly using specified cable in the technical specification
Sensor's analogue output is faulty	Disconnect the analogue output from the PLC and measure with an ammeter	Milliamp reading within the normal range (0-20mA, 4-20mA)	Connect sensor to a PC and run Hydro-Com. Check analogue output on the diagnostics page. Force the mA output to known value 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	Milliamp reading within the normal range (0-20mA, 4-20mA)	Replace analogue input card

1.3 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	+15Vdc to +30Vdc	Locate fault in power supply/ wiring
RS485 incorrectly wired into converter	Converter's wiring instructions and A and B signals are the correct orientation.	RS485 converter correctly wired	Check PC Com port settings
Incorrect serial Com Port selected on Hydro-Com	Com Port menu on Hydro-Com. All available Com Ports are highlighted on the pull down menu	Switch to the correct Com Port	Possible Com port number used is higher than 16 and therefore not selectable in the menu on Hydro-Com. Determine the Com Port number assigned to the actual port by looking at the PC device manager

Com port number is higher than 10 and is not available to use in Hydro-Com	The Com Port assignments in the PC's Device Manager window	Renumber the Com Port used for communication with the sensor, to an unused port number between 1 and 10	Check sensor addresses
More than one sensor has the same address number	Connect to each sensor individually	Sensor is found at an address. Renumber this sensor and repeat for all the sensors on the network	Try an alternative RS485-RS232/USB if available

1.4 Symptom: Near constant moisture reading

Possible explanation	**Check**	**Required result**	**Action required on failure**
Empty bin or sensor uncovered	Sensor is covered by material	100mm minimum depth of material	Fill the bin
Material 'hanging up' in bin	Material is not hanging up above sensor	A smooth flow of material over the face of the sensor when the gate is open	Look for causes of erratic flow of material. Reposition sensor if problem continues
Build-up of material on sensor face	Signs of build-up such as dried solid deposit on ceramic face	Ceramic faceplate should be kept clean by the action of material flow	Check angle of the ceramic in range of 30° to 60°. Reposition sensor if problem continues
Incorrect input calibration within control system	Control system input range	Control system accepts output range of sensor	Modify control system, or reconfigure sensor
Sensor in alarm condition – 0mA on 4-20mA range	Moisture content of material by oven drying	Must be within working range of sensor	Adjust sensor range and/or calibration
Interference from mobile phones	Use of mobile phones close to sensor	No RF sources operating near to sensor	Prevent use within 5m of sensor
Average/Hold switch has not operated	Apply signal to digital input	Average moisture reading should change	Verify with Hydro-Com diagnostics
No power to sensor	DC power at junction box	+15Vdc to +30Vdc	Locate fault in power supply/ wiring
No sensor output at control system	Measure sensor output current at control system	Varies with moisture content	Check cabling back to junction box
No sensor output at junction box	Measure sensor output current at	Varies with moisture content	Check sensor output configuration

	terminals in junction box		
Sensor has shut down	Disconnect power for 30 seconds and retry or measure current drawn from power supply	Normal operation is 70mA – 150 mA	Check operating temperature is within specified range
Internal failure or incorrect configuration	Remove sensor, clean face & check reading (a) with ceramic face open and (b) with hand pressed firmly on ceramic face. Activate Average /Hold input if required	Reading should change over a reasonable range	Verify operation with Hydro-Com diagnostics

1.5 Symptom: Inconsistent or erratic readings that do not track moisture content

Possible explanation	**Check**	**Required result**	**Action required on failure**
Debris on sensor	Debris, such as cleaning rags hanging over sensor face	The sensor must always be kept clear of debris	Improve material storage. Fit wire mesh grids to tops of bins
Material ‘hanging up’ in bin	Material is hanging up above sensor	A smooth flow of material over the face of the sensor when gate is open	Look for causes of erratic flow of material. Reposition sensor if problem continues
Build-up of material on sensor face	Signs of build-up such as dried solid deposit on ceramic face	Ceramic face should always be kept clean by the action of the material flow	Change angle of the ceramic in range 30° to 60°. Reposition sensor if problem continues
Inappropriate calibration.	Ensure calibration values are appropriate to working range	Calibration values spread throughout range avoiding extrapolation	Perform further calibration measurements
Ice forming in material	Material temperature	No ice in material	Do not rely on moisture readings
Average/Hold signal is not in use	Control system is calculating batch average readings	Average moisture readings must be used in batch weighing applications	Modify control system and/or reconfigure sensor as required
Incorrect use of Average/Hold signal	Average/Hold input is operating during the main flow of material from the bin	Average/Hold should be active during main flow only – not during jogging period	Modify timings to include main flow and exclude jogging from measurement.

Inappropriate sensor configuration	Operate the Average/Hold input. Observe sensor behaviour	The output should be constant with Average/Hold input OFF and changing with the input ON	Sensor output configured correctly for the application
Inadequate ground connections	Metalwork and cable ground connections	Ground potential differences must be minimized	Ensure equipotential bonding of metalwork

1.6 Sensor output characteristics

	Filtered Unscaled Output (values shown are approximate)				
	RS485	**4-20mA**	**0-20 mA**	**0-10 V**	**Compatibility mode**
Sensor exposed to air	0	4 mA	0 mA	0V	>10V
Hand on sensor	75-85	15-17 mA	16-18 mA	7.5-8.5 V	3.6-2.8V

1 Technical Specifications

1.1 Dimensions

Diameter: 76mm

Length: 396mm

1.2 Construction

Body: Cast Stainless steel

Faceplate: Ceramic

1.3 Penetration of field

Approximately 75 -100mm dependent upon material

1.4 Operating temperature range

0 – 60°C (32 – 140°F). The sensor will not work in frozen materials

1.5 Power supply voltage

15 – 30 VDC. 1 A minimum required for start-up (normal operating power is 4W).

1.6 Connections

1.6.1 Sensor cable

Six pairs twisted (12 cores total) screened (shielded) cable with 22 AWG, $0.35mm^2$ conductors.

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

Recommended cable types: Belden 8306, Alpha 6373

Maximum cable run: 200m, separate to any heavy equipment power cables.

1.6.2 Digital (serial) communications

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

1.7 Analogue outputs

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

1.8 Digital inputs / output

One configurable digital input 15 – 30 V DC activation

One configurable digital input/output – input specification 15 – 30 V DC, output specification: open collector output, maximum current 500 mA (over current protection required).

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

A: If there is more than one sensor 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: How often should I calibrate the sensor?

A: Recalibration is not necessary unless the gradation of the material changes significantly or a new source is used. However it is a good idea to take samples (see Calibration procedure on Page 45) regularly on site to confirm the calibration is still valid and accurate. Put this data in a list and compare them with the results of the sensor. If the points lie near to or on the calibration line then the calibration is still good. If there is a continuous difference you have to recalibrate.

Q: If I have to replace the sensor do I have to calibrate my new sensor?

A: Normally no, assuming the sensor is mounted in exactly the same position. Write the calibration data for the material to the new sensor and the moisture readings will be the same. It would be wise to verify the calibration by taking a sample as shown in Calibration procedure on Page 45, and checking this calibration point. If it lies near to or on the line then the calibration is still good.

Q: What should I do if there is little variation of moisture in my material on the day I calibrate?

A: If you have dried different samples and there is little variation in moisture (1-2%), then settle for one good calibration point by averaging the unscaled readings and oven dried moistures. Hydro-Com will allow you to produce a valid calibration until further points can be made. When the moisture changes by at least 2% then sample again and enhance the calibration by adding more points. .

Q: If I change the type of material I am using, do I need to recalibrate?

A: Yes, it is advisable to calibrate to each type of material.

Q: Which output variable should I use?

A: This depends on whether the calibration is stored in the sensor or the batch controller, and if the digital input is used for batch averaging. Refer to Figure 32 for more information.

Q: There seems to be a scatter in the points I have made in my calibration, is this a problem and is there something I can do to improve the calibration result?

A: If you have a scattering of points through which you are trying to fit a line, then there is a problem with your sampling technique. Ensure the sensor is mounted properly in the flow. If the sensor position is correct and the sampling is done as explained on Page 45 then this should not happen. Use an 'Average unscaled' value for your calibration. The averaging period can be set either with the 'Average/Hold' input, or using 'Remote Averaging'. See Hydro-Com User Guide (HD0273) for more information.

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

A: It is possible that some material is building up on the sensor face during the flow, and so despite there being a change in moisture of the material, the sensor only 'sees' the material in front of it and so the reading could stay reasonably constant until such time as this material falls off allowing the new material to flow over the sensor face. This would cause a sudden change in the readings. To check if this is the case, try hitting the sides of the bin/silo to knock off any fouling material and see if the readings change. Also, check the mounting angle of the sensor. The ceramic should be mounted at an angle which allows material to pass continuously. The Hydro-Probe XT sensor has two lines, marked A and B on the rear plate label. Correct alignment is where either line A or line B is horizontal, indicating that the ceramic is at the correct angle as suggested on Page 13.

Q: Does the angle of the sensor affect the reading?

A: It is possible that changing the angle of the sensor can affect the readings. This is due to a change in compaction or density of the material flowing past the measurement face. In practice, small changes in the angle will have a negligible effect on the readings, but a large change in the mounting angle (>10 degrees) will affect the readings and ultimately the calibration will become invalid. For this reason it is suggested that when removing any sensor and then refitting it, it should be positioned to the same angle.

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

A: The unscaled output for air will be less than the unscaled reading for 0% moisture of the material; hence the moisture output will read negative.

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

A: See Chapter 8.

The complete set of default parameters are listed in Engineering Note EN0071, available for download from www.hydronix.com

1 Default Parameters

1.1 Firmware version HS0089

Parameter	HPXT Default	
Output type	0-20mA (0-10V)	
Output variable 1	Filtered Unscaled	
Output variable 2	Material Temp	
High %	20.00	
Low %	00.00	
Input Use 1	Avg. / Hold	
Input/output Use 2	Unused	
Unscaled Type	Mode V	
Unscaled 2 Type	Mode E	
Smoothing time	1.0	
Slew rate +	Light	
Slew rate -	Light	
Digital Signal Processing	Unused	
Material calibration	***Moisture***	
A	0.0000	
B	0.2857	
C	-4.0000	
SSD	0.00	
Average hold delay	0.5 sec	
High limit (m%)	30.00	
Low limit (m%)	0.00	
High limit (us)	100.00	
Low limit (us)	0.00	
	Freq. Co	Ampl. Co
Electronics temp. coeff	0.0059	0.0637
Resonator temp. coeff	Set by test	Set by test
Material temp. coeff	0.00000	0.00000

1.2 Temperature Compensation

The temperature compensation settings are individual to the unit and set in the factory during manufacturing. These should not be changed.

In the event that these settings are required please contact Hydronix at support@hydronix.com.

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.

Document Number	Title
HD0273	Hydro-Com User Guide
HD0303	USB Sensor Interface Module User Guide
EN0071	Engineering Note – Sensor Default Parameters

INDEX