Hydro-Probe II
User Guide

To re-order quote part number:	HD0127
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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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Revision history

Revision No.	Date	Description of change
1.0.0	1996	Original version
1.2.0	June 2001	Updated address
2.0.0	February 2003	Complete revision to include new cables
2.1.0	May 2003	Correction of temperature coefficient
3.0.0	July 2006	Complete revision
3.1.0	August 2013	Corrosion protection section added to Chapter 2 Sensor cable updated to 0975

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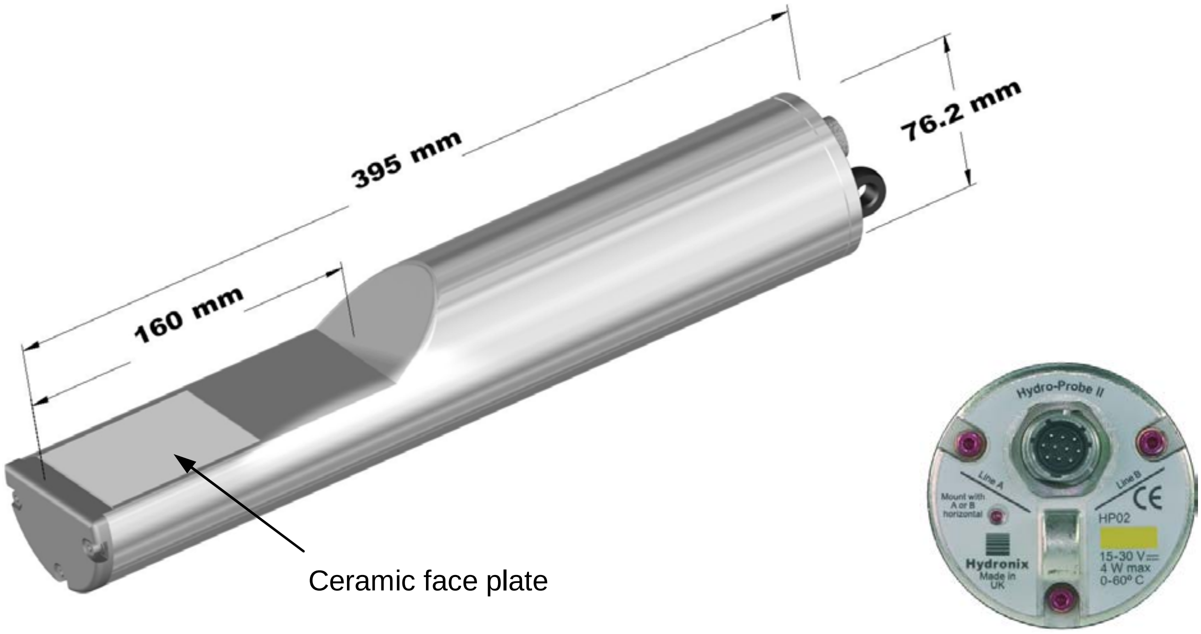


Figure 1 - The Hydro-Probe II

Available accessories:

0023	Clamp ring
0025	Standard mounting sleeve
0975	4m sensor cable
0975-10m	10m sensor cable
0975-25m	25m sensor cable
0069	4m compatibility cable (legacy cable and connector)
0116	Power supply – 30 Watt for up to 4 sensors
0067	Terminal box (IP566, 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 II digital microwave moisture sensor with integral signal processing provides a linear output (both analogue and digital). The sensor may be easily connected to any control system and is ideally suited to measure the moisture content of sand and aggregates in the following applications:

- Bins
- Hopper
- Silos
- Conveyors

The sensor takes measurements at 25 times per second, this enables rapid detection of changes in moisture content in the material. The sensor may be configured remotely when connected to a PC using dedicated Hydronix software. A large number of parameters are selectable, such as the type of output and the filtering characteristics. Digital input/output capability also enables the moisture to be averaged when material is flowing, essential for obtaining representative moisture for process control.

The sensor is constructed to operate under the most arduous conditions with a wear life of many years. The Hydro-Probe II should never be subjected to unnecessary impact damage as it houses sensitive electronics. In particular, the ceramic faceplate, although extremely hardwearing, is brittle and may crack if subjected to severe impact.

CAUTION – NEVER HIT THE CERAMIC

Care should also be taken to ensure that the Hydro-Probe II 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 a build-up may occur.

After installation the sensor should be calibrated to the material (see Chapter 5 'Material calibration'). 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

Calibration should be repeated at six-month intervals or whenever there are significant changes in material fines content, geology or size.

2 Measuring techniques

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

3 Sensor connection and configuration

As with other Hydronix digital microwave sensors, the Hydro-Probe II 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 page 27).

The Hydro-Probe II can be connected to the batch control system in three ways:

- Analogue output – A DC output is configurable to:
  - i) 4-20 mA
  - ii) 0-20 mA
  - iii) 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.
- Compatibility mode - this allows a Hydro-Probe II to connect to a Hydro-View unit.

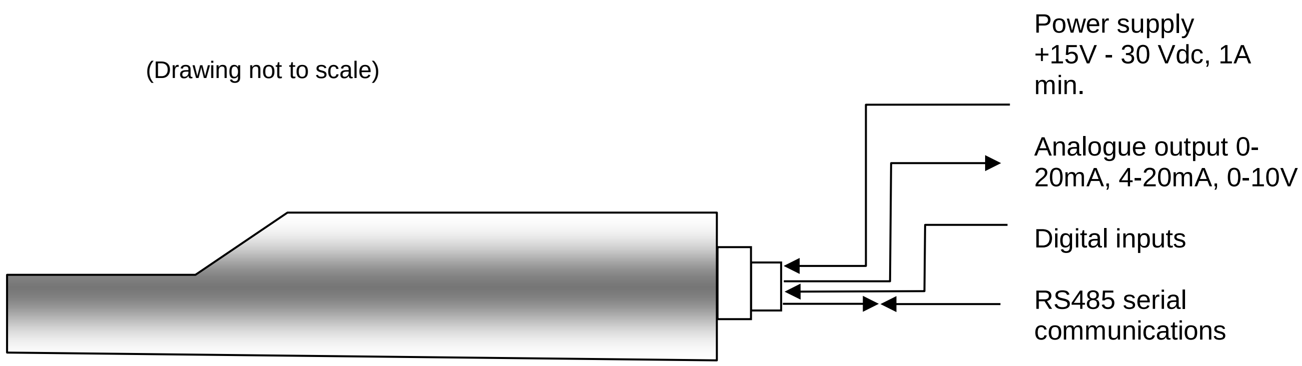


Figure 2 - Connecting the sensor (overview)

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.
- To prevent damage from excessive vibration, position the sensor as far as reasonably practical from vibrators.
- The sensor must be angled with the ceramic faceplate initially set to 30° (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 90 degrees to the direction of flow of material (parallel to the horizontal for a bin/silo/hopper).

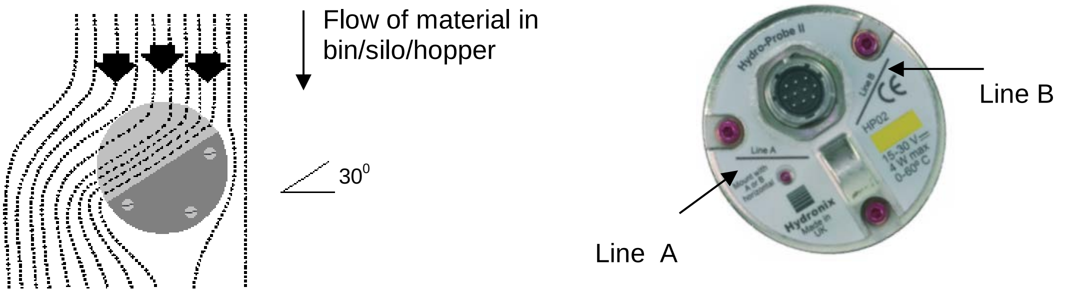


Figure 3 - Hydro-Probe II mounting angle and material flow

When filling a bin/silo/hopper using large aggregates (>12mm), the ceramic faceplate is susceptible to damage by direct or indirect impact. To prevent this, a deflection plate should be fitted above the sensor. The requirements of this must be determined by observation during loading.

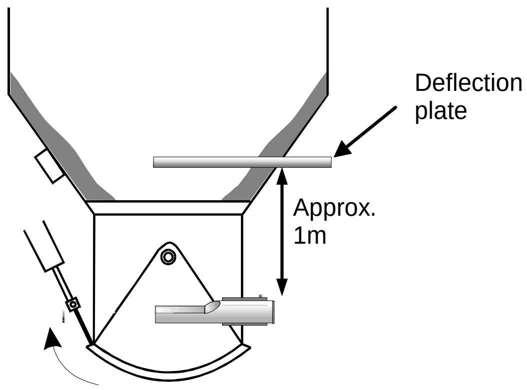


Figure 4 - Fitting a deflection plate to prevent damage

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 assemblies can be used to fix the sensor as shown on page 18.

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.

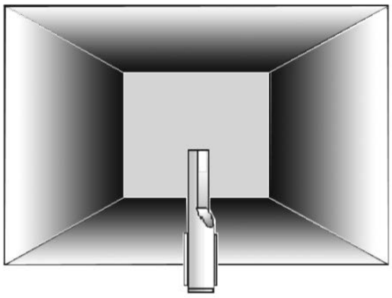


Figure 5 – Overhead view of Hydro-Probe II mounted in a bin

2.1.1 Neck mounting

The sensor should be located on the opposite side to the door-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 door-opening
- 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.

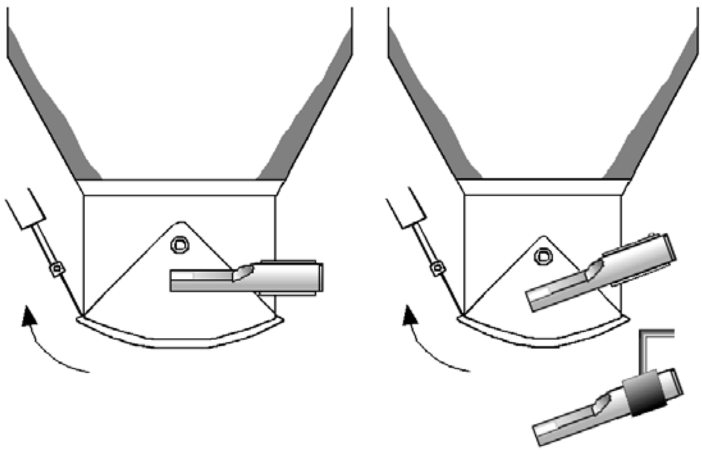
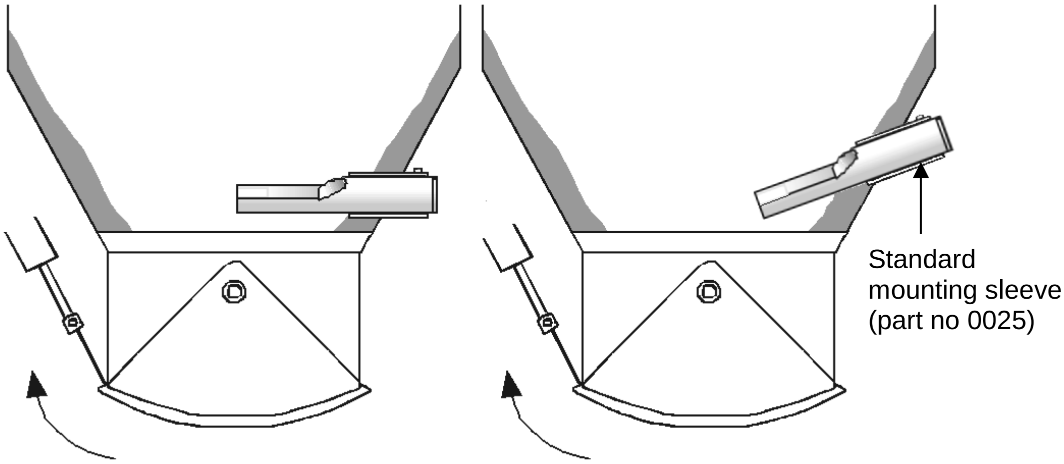


Figure 6 - Mounting the Hydro-Probe II in the neck of the bin

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 (part no: 0025).

- 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.



If the sensor does not reach the main flow of material, then an extension mounting sleeve (part no 0026) should be used, as shown below.

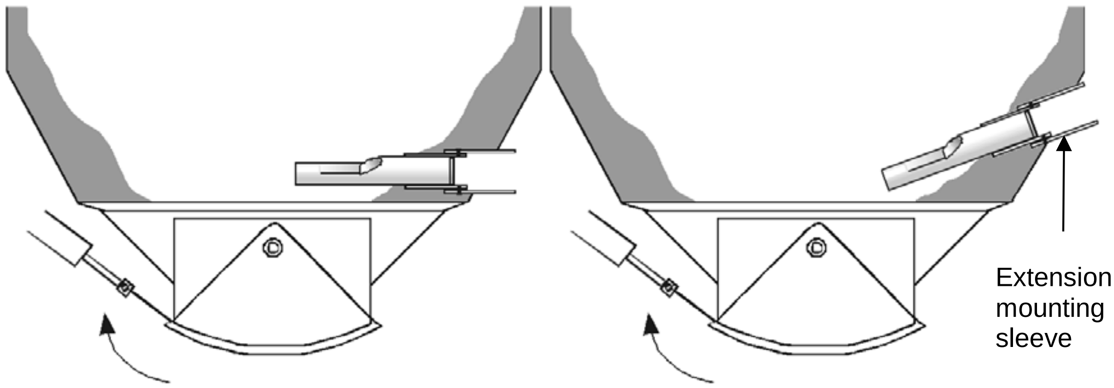
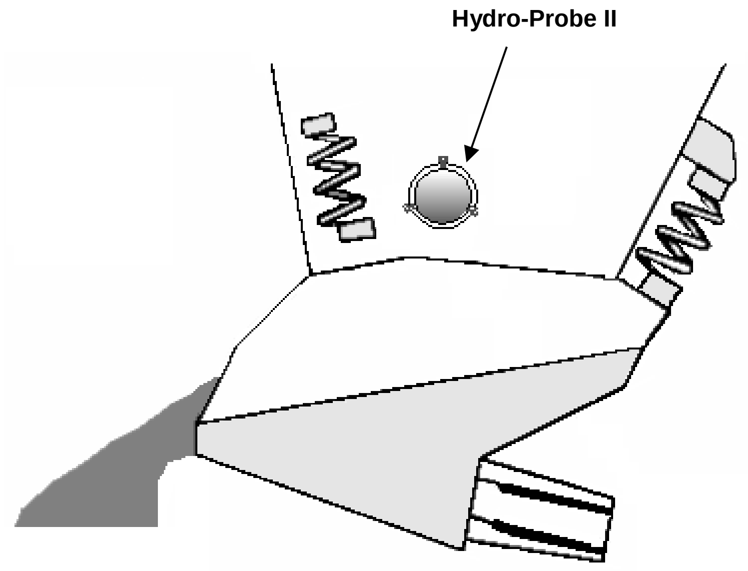


Figure 8 - Mounting the Hydro-Probe II in large bins

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.



2.3 Conveyor belt mounting

The sensor is secured with a standard mounting sleeve or clamp ring, welded to a suitable fixing bar.

- Allow a 25mm gap between the sensor and the conveyor belt
- Angle the ceramic faceplate 45° to the flow. This may need to be altered depending on the flow characteristics.
- The minimum depth of material on the conveyor belt must be 150mm to cover the ceramic. **The sensor 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 belt, as shown below. This can build up the material to a more sustainable 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).

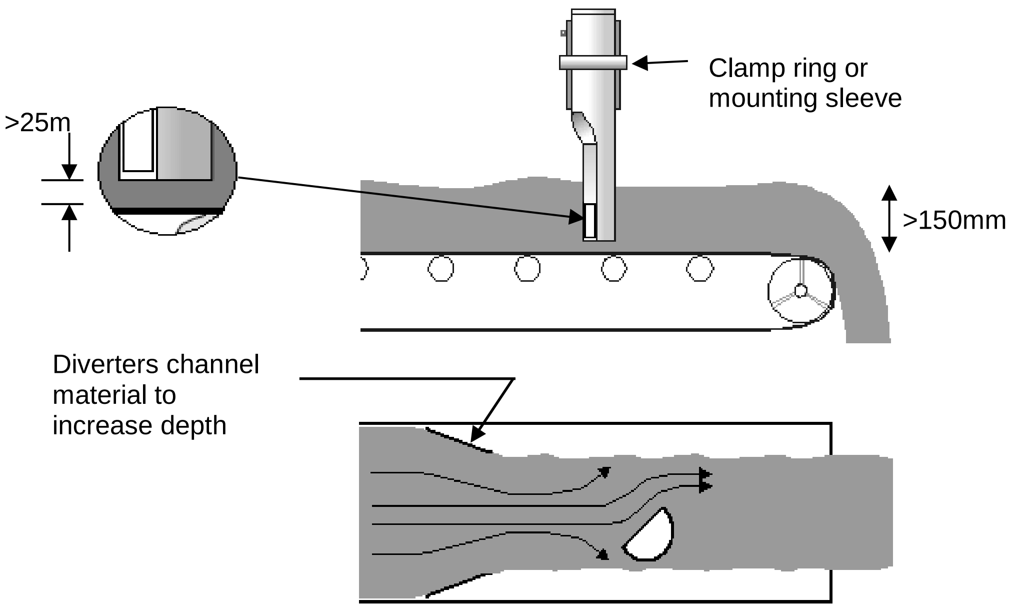


Figure 10 - Mounting the Hydro-Probe II on a conveyor belt

2.4 Mounting options

There are three mounting devices available from Hydronix.

2.4.1 Standard mounting sleeve (part no 0025)

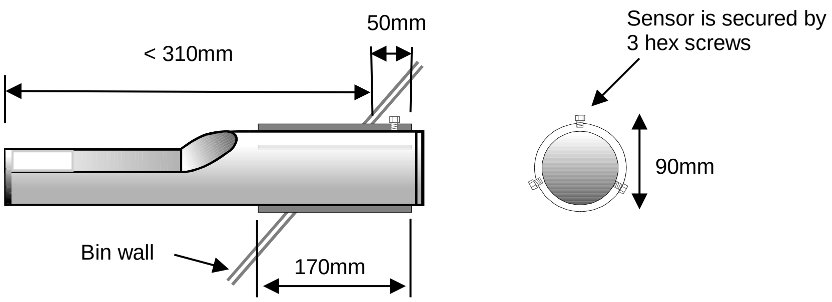
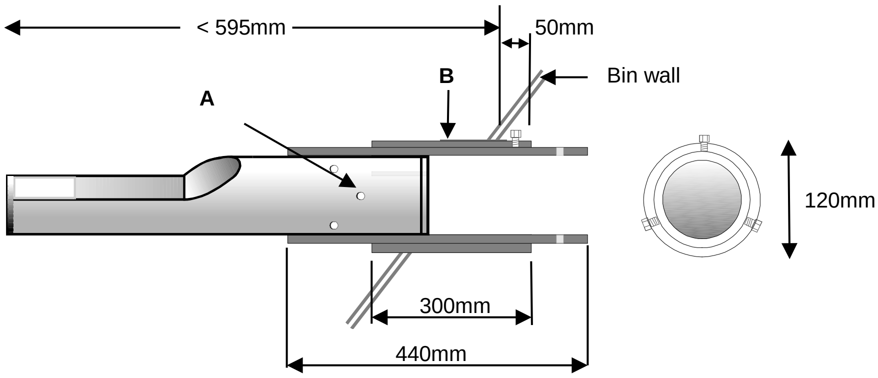


Figure 11 - The standard mounting sleeve (part no 0025)

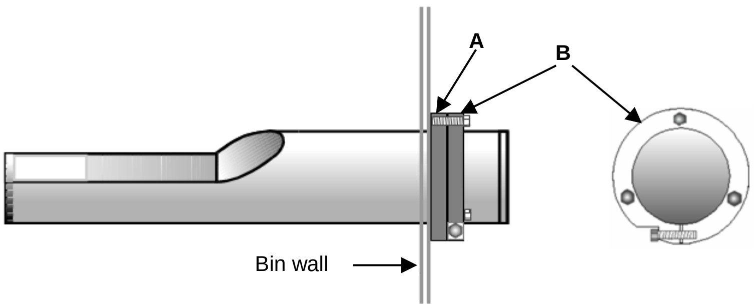
2.4.2 Extension mounting sleeve (part no 0026)



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 12 - The extension mounting sleeve (part no 0026)

2.4.3 Clamp ring (part no 0023)



A – Fixing plate (supplied by customer) welded to bin wall (thickness 12.5mm)
B – Clamp ring (part no 0023).

Figure 13 - The clamp ring (part no 0023)

3 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.

3.1 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 14

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

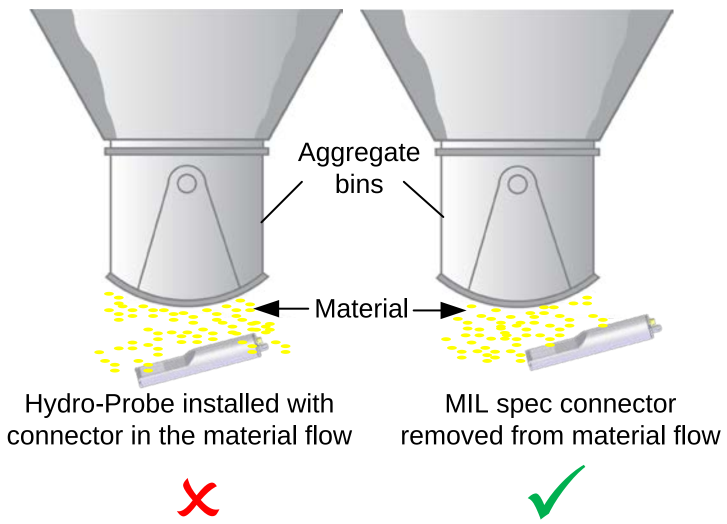


Figure 14: Hydro-Probe installed under an aggregate bin

3.2 Extension mounting sleeve

If it is not possible to stop the material coming into contact with the sensor's connector, install using an Extension Mounting Sleeve (Part number 0026). Install 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 15

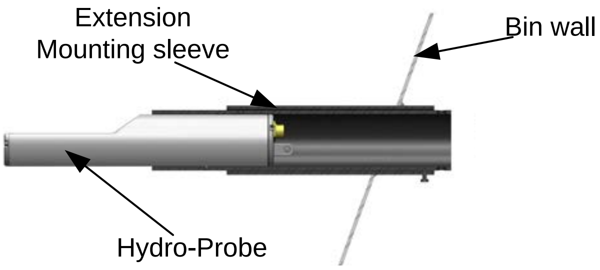


Figure 15: Hydro-Probe installed in an Extension Mounting Sleeve

3.3 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 16

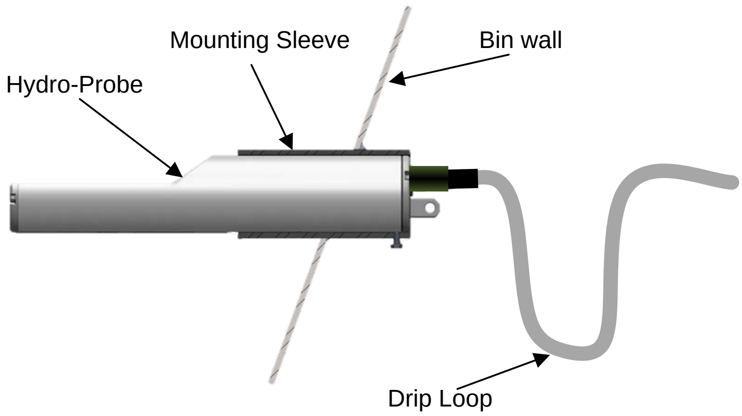


Figure 16: Hydro-Probe installed with a drip loop

3.4 Protection cover

Install a cover over the top of the sensor to deflect the material away from the connector. See Figure 17

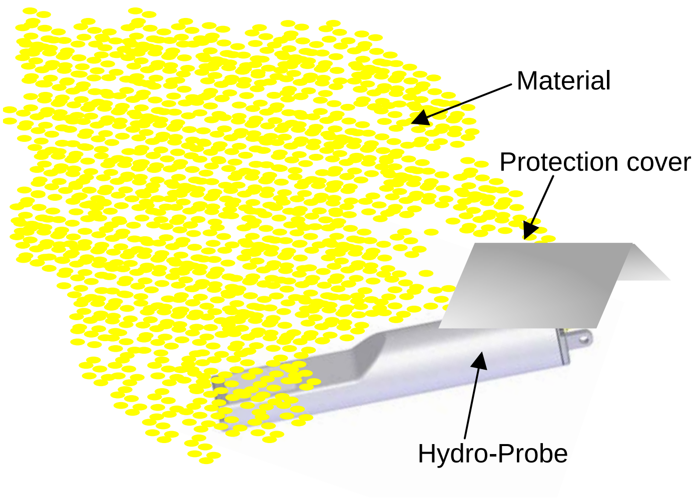


Figure 17: Deflector plate

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 try and keep the material away from the connector as this will be the best method of stopping the possibility of corrosion.

The Hydro-Probe II must be connected using the Hydronix sensor cable, available in different lengths to suit the installation. Any extension cable required should be connected to the Hydronix sensor cable using a suitable screened junction box. See Chapter 8, 'Technical Specification', for cable details.

1 Installation guidelines

- Ensure that the cable is of a suitable quality (see Chapter 8 'Technical Specification').
- 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.
- Use this RS485 link and a PC running Hydro-Com to check the analogue output connection. Forcing the current loop to a known value will verify correct function of the sensor output and the analogue input card.
- Route the signal cable away from any power cables.
- The sensor cable should **only** be grounded near to the sensor.
- 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.
- Maximum cable run: 200m, separate to any heavy equipment power cables.

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)
	H	Screen	Screen

Table 1 - Sensor cable (0975 / 0090A) connections

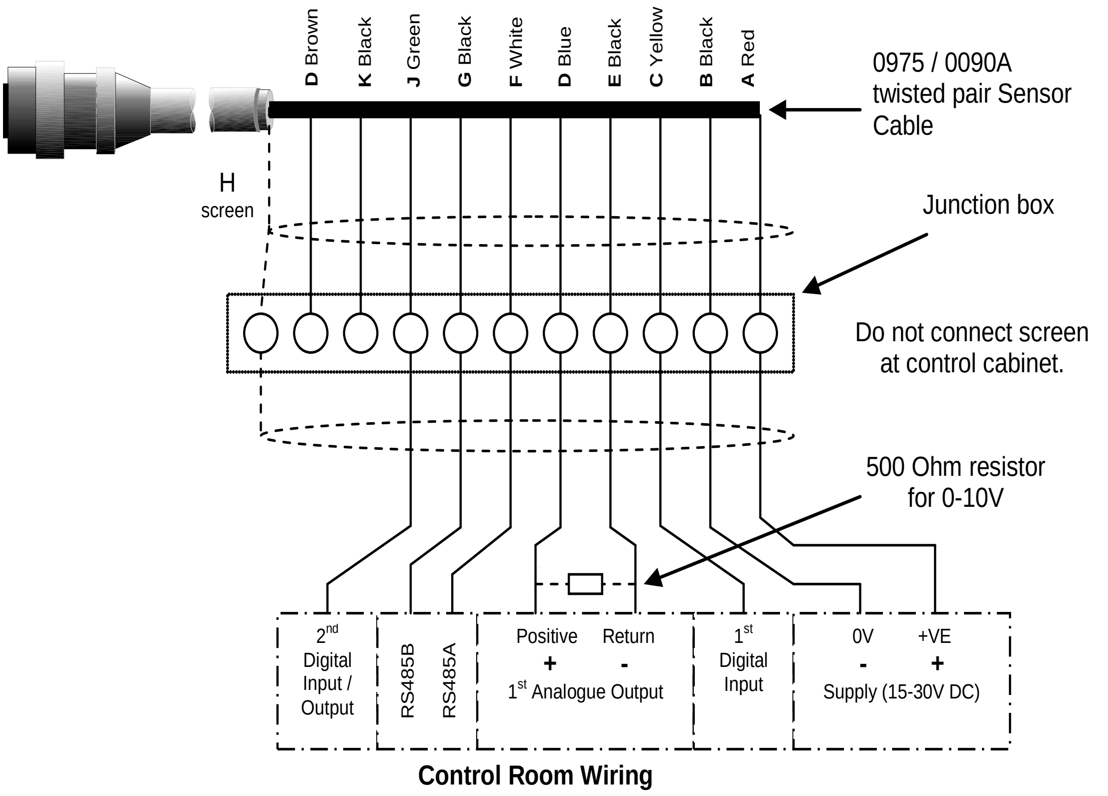


Figure 18 - Sensor cable connections

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.

2 Analogue output connection

A DC current source generates an analogue signal proportional to one of a number of selectable parameters (e.g. filtered unscaled, filtered moisture, average moisture, etc). See 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 – 10V output can be achieved using the 500 Ohm resistor supplied with the sensor cable)

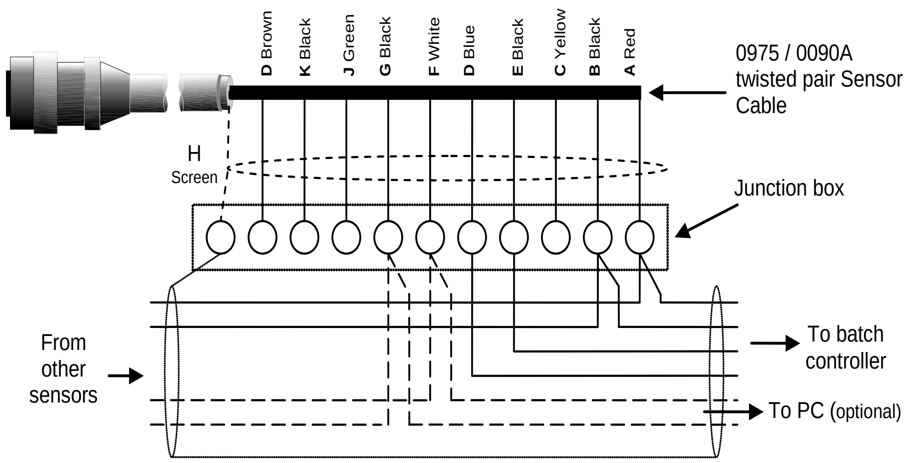


Figure 19 - Connecting the analogue output

3 Hydro-View (HV02/HV03) connection

To connect to a Hydro-View, the Hydro-Probe II needs to be set to compatibility mode. This mode allows the Hydro-Probe II to directly replace an existing Hydro-Probe (HP01). The 500 Ohm resistor supplied with the cable is required to convert the analogue current output to a voltage signal. This should be fitted as shown in the figure below.

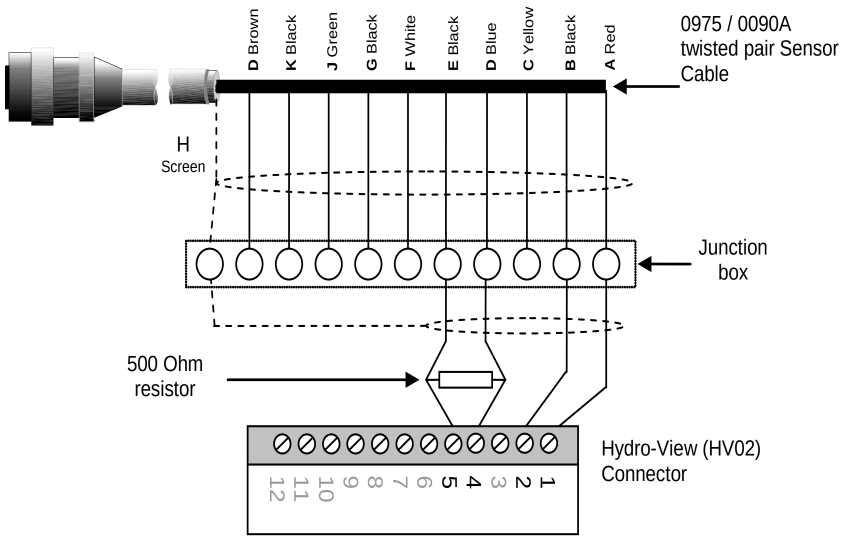


Figure 20 - Connecting to a Hydro-View

4 Digital input/output connection

The Hydro-Probe 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. 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.

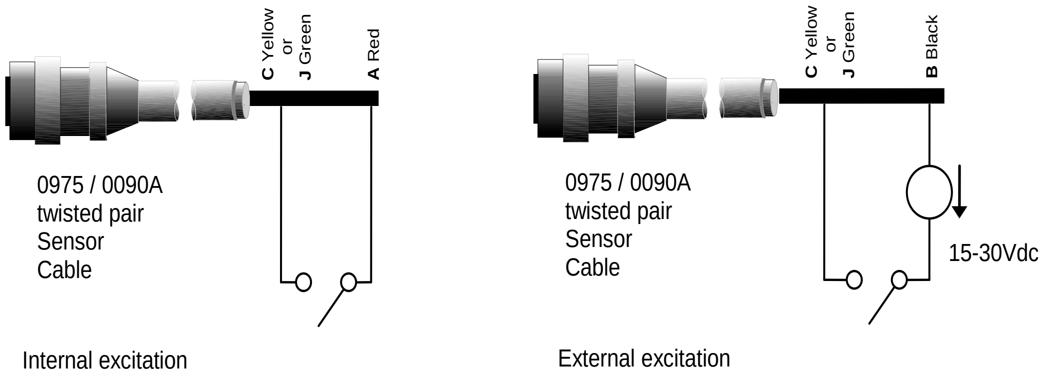


Figure 21 – Internal/external excitation of digital input 1 & 2

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.

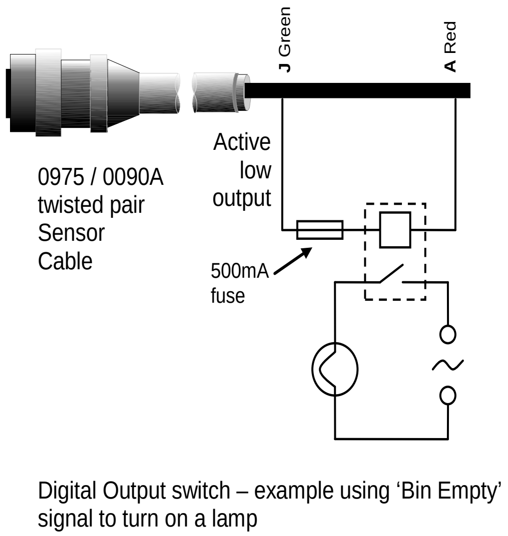


Figure 22 - Activation of digital output 2

5 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 suitable junction box.

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 a 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 it will facilitate the use of diagnostic software should the need arise.

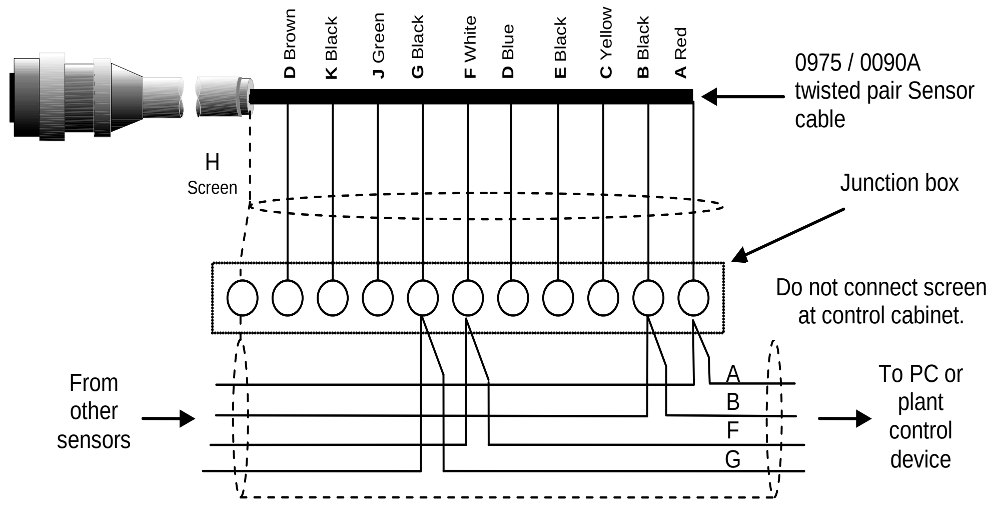


Figure 23 - RS485 multi-drop connection

6 Connecting to a PC

A converter is required to connect one or more sensors to a PC when checking diagnostics and configuring the sensor. There are three types of converter supplied by Hydronix.

6.1 RS232/485 converter – D type (Part no: 0049B)

Manufactured by KK Systems, this RS232/485 converter is suitable for connecting typically 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.

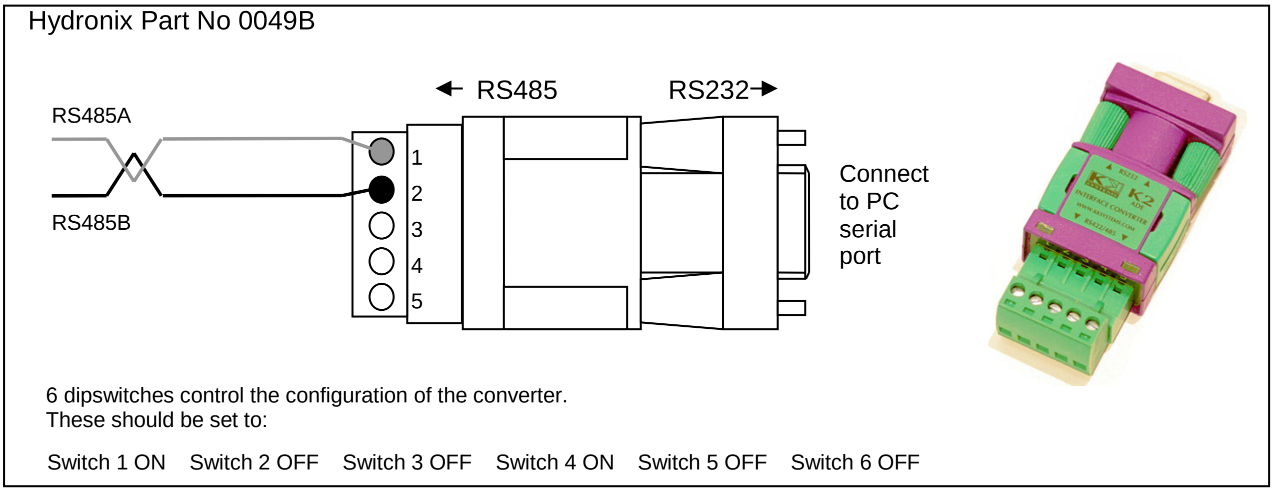


Figure 24 - RS232/485 converter connections (1)

6.2 RS232/485 converter – DIN rail mounting (Part no: 0049A)

Manufactured by KK Systems, this powered RS232/485 converter is suitable for connecting any number of 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.

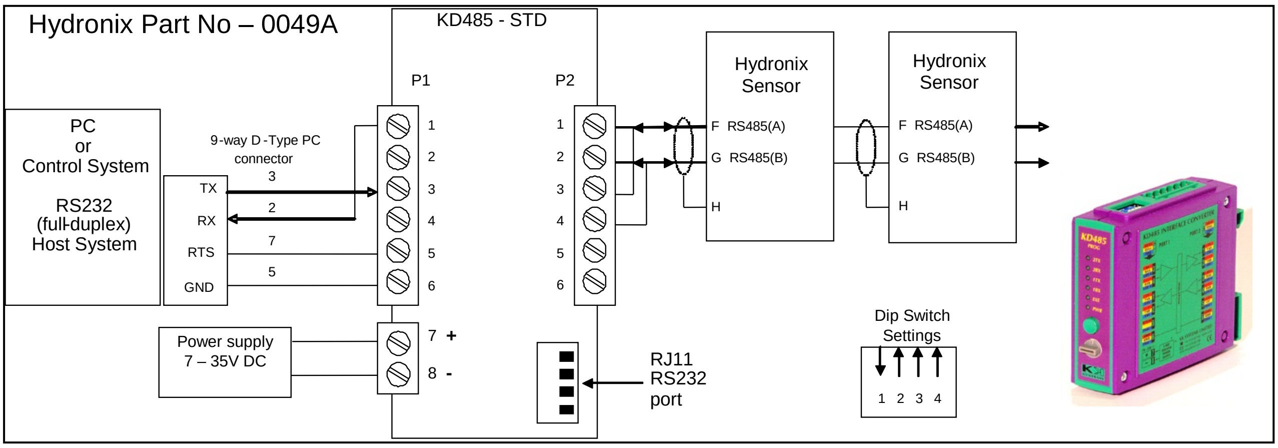


Figure 25 - RS232/485 converter connections (2)

6.3 USB Sensor Interface Module (Part no: SIM01A)

Manufactured by Hydronix, this USB-RS485 converter is suitable for connecting any number of 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.

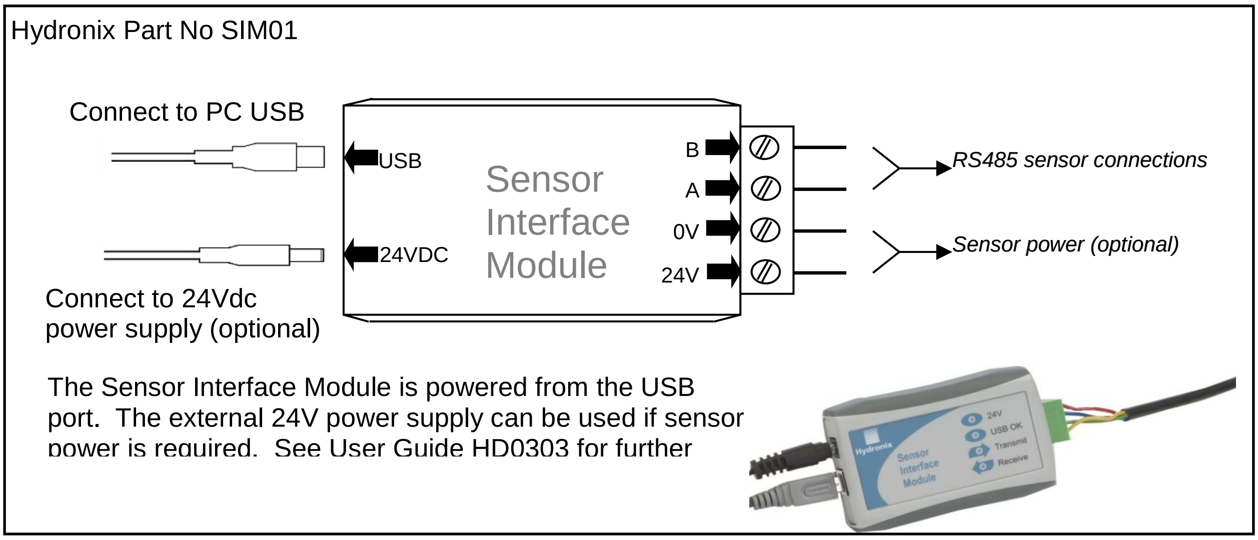


Figure 26 – SIM01 USB-RS485 convertor connections

The Hydro-Probe II may be configured using the Hydro-Com software which can be downloaded free of charge from www.hydronix.com as can the Hydro-Com User Guide (HD0273).

1 Configuring the sensor

The Hydro-Probe II has a number of internal parameters for configuring the analogue output, averaging, digital inputs/output and filtering. These can 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). The default parameters of the Hydro-Probe II can be found in Appendix A.

1.1 Analogue output setup

The Hydro-Probe II has one analogue output which can be configured to represent different readings generated by the sensor e.g. moisture or temperature.

The working range of the current loop output can be configured to suit the equipment to which it is connected, for example a PLC may require 4 – 20 mA or 0 – 10Vdc etc.

1.1.1 Output type

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

- 0 – 20mA: This is the factory default. The addition of an external 500 Ohm precision resistor converts to 0 – 10 Vdc.
- 4 – 20mA.
- Compatibility: This configuration must **only** be used if the sensor is to be connected to a Hydro-View. A 500 Ohm precision resistor is required to convert to voltage.

1.1.2 Output variable 1

This defines 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'.

1.1.2.1 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.

1.1.2.2 Average Unscaled

This is the 'Filtered 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 filtered unscaled readings are averaged. When the digital input is low, this average value is held constant.

1.1.2.3 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 :

Filtered Moisture %= A x $(F.U/S)^2$ + B x (F.U/S) + C – 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. See Chapter 5 for more details.

1.1.2.4 Average Moisture %

This is the 'Filtered 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 Filtered Moisture readings are averaged. When the digital input is low this average value is held constant.

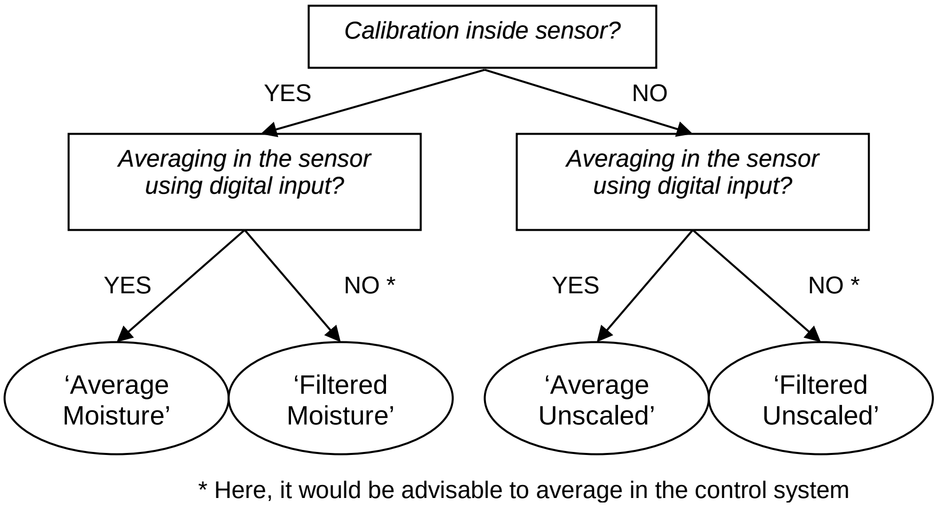


Figure 27 – Guidance for setting output variable

1.1.3 Low % and High%

These two values set the moisture range when the output variable is set to 'Filtered Moisture %' or 'Average Moisture %', and must be matched to the mA to moisture conversion in the batch controller.

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

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%

1.1.4 Digital inputs/output

The Hydro-Probe II has two digital inputs/output; the first of which can be configured as an input only, whereas 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 '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 inactive, 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 can be set to the following:

Moisture/Temperature: As above.

Bin Empty (output): This indicates that an aggregate bin is empty. It is activated when the signals (moisture % OR Unscaled) drop below the Low Limit averaging parameters.

Data invalid (output): This indicates that the sensor reading (moisture % and/or Unscaled) is outside the valid range set by ‘Low Limit’ and ‘High Limit’ averaging parameters.

Probe OK (output): Activated when electrical interference makes the measurement unreliable. For example, close proximity to mobile phones, power cables, welding equipment etc.

1.2 Filtering Parameters

In practice, the raw output, which is measured 25 times per second, contains 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.

To filter the raw unscaled reading, the following parameters are used:

1.2.1 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.

1.2.2 Filtering time

This smoothes the slew rate limited signal. 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.

1.3 Averaging parameters

These parameters determine how the data is processed for batch averaging when using the digital input or remote averaging.

1.3.1 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.

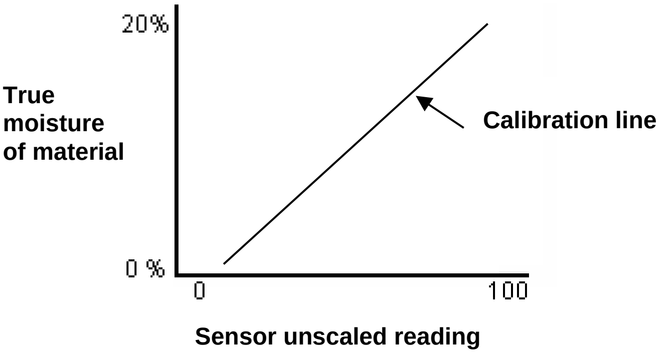
1.3.2 High limit and low limit

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.

1 Introduction to material calibration

Each material has its own unique electrical characteristic. The raw output of a Hydronix sensor is an unscaled value ranging from 0 to 100. Each sensor is set so that a zero (0) unscaled value relates to the measurement in air and 100 relates to water. The unscaled reading for example from a sensor measuring *fine* sand at 10% moisture content will be different from the unscaled reading (from the same sensor) when measuring *coarse* sand at 10% moisture content. For highest accuracy it is necessary to 'calibrate' the sensors for different materials. *A calibration simply correlates the unscaled reading to 'real' moisture values which have to be determined by drying samples.*

The range in moisture for sand can vary from typically 0.5% (the absorbed moisture value or Saturated Surface Dry value (SSD) which is obtained from material suppliers) to approximately 20% (saturated). Other materials can have an even greater range. Over this moisture range for most materials, the reading from a Hydronix sensor is linear. Therefore calibration is determining this linearity as shown below.



The equation of the calibration line is defined by a slope (B) and offset (C). These values are the calibration coefficients and can be stored inside the sensor if required. Using these coefficients the conversion to moisture % is:

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 reading)^2 + **B** (Unscaled reading) + **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 SSD coefficient and SSD moisture content

In practice it is only possible to obtain oven dried moisture (total moisture) values for calibration. If a surface moisture content (free moisture) is required the SSD coefficient (water absorption value) must be used.

Absorbed water + Free moisture = Total moisture

The SSD coefficient used in Hydronix procedures and equipment is the Saturated Surface Dry offset, which is the water absorption value of the material. This can be obtained from the aggregate or material supplier.

The moisture content of a sample is calculated by completely drying the sample in an oven or on a hot plate. This gives the total moisture content (oven-dried) as the 'total water', i.e. the absorbed water in the aggregate particles **and** the surface water, has been driven off.

The surface moisture content refers **only** to the moisture on the surface of the aggregate, i.e. the 'free water'. In concrete applications, only this surface water is available to react with the cement, which is why it is this value that is generally referred to in concrete mix designs

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

3 Storing calibration data

There are two ways of storing the calibration data, either in the control system or in the Hydro-Probe II. Both methods are shown opposite.

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 have a number of PC utilities, most notably Hydro-Com which contains a dedicated material calibration page.

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 27 – Guidance for setting output variable.

3.1 Calibration inside the Hydro-Probe II

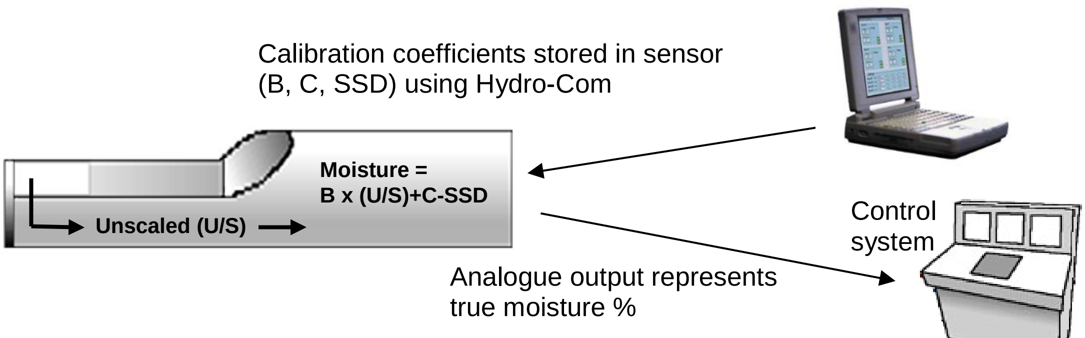


Figure 28 - Calibration inside the Hydro-Probe II

The advantages of calibrating inside the Hydro-Probe II 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.

3.2 Calibration inside the control system

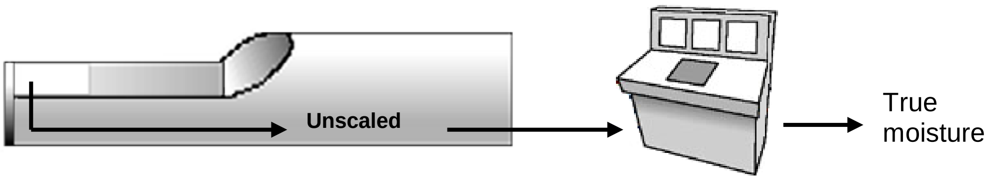


Figure 29 - Calibration inside the control system

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 between sensors easily.

4 Calibration procedure

To determine the calibration line, at least two points are required. Each point is derived by flowing material over the sensor and finding the sensor's unscaled reading, at the same time taking a sample of material and drying to find its true moisture content. This gives 'Moisture' and 'Unscaled' 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 II 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.

4.1 Hints and safety

- Wear safety glasses and protective clothing to guard against expulsion 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.
- Whilst recording the sensor unscaled output, always sample where the sensor is located.
- 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.
- Where possible, average the sensor's readings either in the sensor using the digital input, or inside the control system.
- Ensure the sensor sees a representative sample of material.
- Ensure a representative sample is taken for moisture testing.

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). Record all calibration data, record sheets are included in Appendix B

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

4.3 Procedure

1. Ensure Hydro-Com is running with the calibration page open.
2. Create a new calibration.
3. Select the correct sensor from the pull-down list in the sensor frame.
4. When batching, look at the Average/Hold status next to the 'Average' reading from the sensor. The optimum installation is one where the digital input is wired into the bin-gate switch. When the bin opens, the status should change to 'Average' and when closed it should show 'Hold'.
5. For the next batch, take a sample. Using the scoop, collect at least 10 sample increments from the flow to yield a bulk sample of at least 5kg[1]of material in the container. 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. Return to the computer and record the 'Average Unscaled' output, which should show the 'Hold' status.
7. Mix the collection of sample increments and 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.
8. Repeat step 7 for another 1kg representative sub-sample. If the moisture differs by more than 0.3%[2], then one of the samples was not dried out completely and the test has to be restarted.
9. 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.
10. 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.

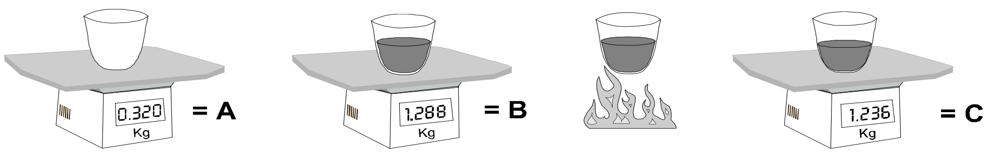
    A good calibration is one where the calibration points cover the complete working moisture range of the material, and all points lie on, or near to, a straight line. If any calibration points are suspected to be wrong, then they can be excluded from calibration by deselecting their corresponding tick 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.

Note 1) Standards for testing aggregates recommend that for representative sampling, at least 20kg of bulk material is requires (0-4mm material)

Note 2) Standards for testing aggregates recommend that for representative sampling, the difference in moisture should be no greater than 0.1%

4.4 Calculating the moisture content



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

Example

$$\textbf{Moisture content} = \frac{1288.7g - 1236.3g}{1236.2g - 320.3g} \times 100\% \quad = 5.7\%$$

(Note that moisture calculated here is based upon the dry weight.)

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.

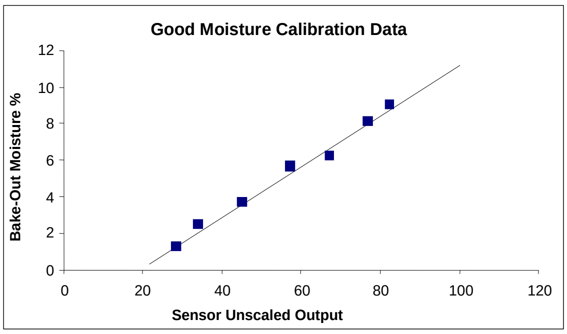
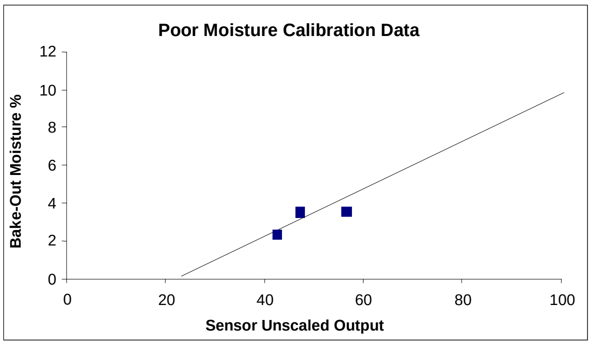


Figure 30 - Example of perfect material calibration

5.1.1 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.



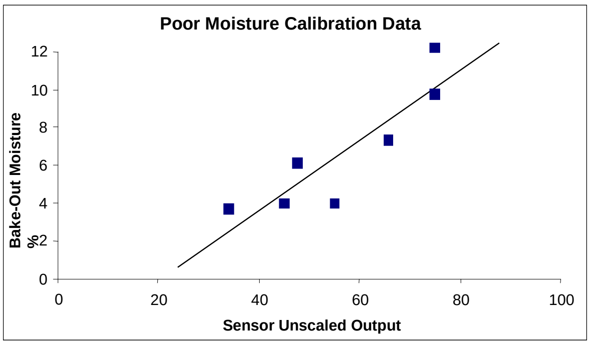


Figure 31 - Examples of poor material calibration points

6 Quick start calibration

For some materials it is possible to estimate the slope of the calibration line (the **'B'** coefficient/value). Using an approximate '**B**' value in a calibration will leave just one calibration coefficient to be found, the offset value **'C'.** This makes it possible to perform a 'quick start' or one-point calibration. This is useful when it is difficult to obtain a wide range of moisture values.

For sand and aggregates, the slope of the calibration line is largely depended on the type and particle size of the material, approximate gradients are shown in table 2.

For an accurate calibration over a wide range of moisture it is necessary to perform a full calibration across the full working moisture range of the material. See page 37 for details.

Aggregate size (mm)	Coefficient B (slope)
0-2	0.1515
0-4	0.2186
0-8	0.2857

Table 2 - Approximate coefficients for aggregates

The method used to perform a one-point calibration depends on the way in which the sensor is configured.

If the sensor is configured to output Unscaled values that are then converted to moisture values within the control system i.e., Filtered Unscaled or Average Unscaled (See 'Calibration inside the control system'; on page 35), the calibration routine will be the same as the control system manufacturers procedure.

If the sensor is configured to output a signal that is directly proportional to moisture i.e., Filtered Moisture % or Average Moisture % (See 'Calibration inside the Hydro-Probe II' on page 34), the Hydro-Com and Hydro-Cal software will automate the one point calculation.

Both systems are detailed below.

6.1 A: Quick-start calibration for external moisture calculation in the control system

If the sensor is configured to output an unscaled reading which is then converted to a moisture value in the control system (i.e. calibration parameters are stored inside the control system), the conversion to moisture may be performed in a number of different ways depending on the control system.

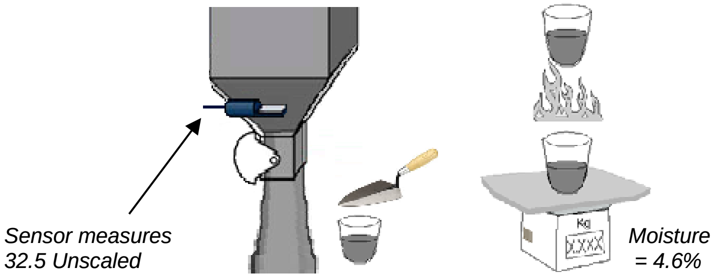
For example, the PLC conversion may use the raw count from the ‘analogue card’ which may not correspond to the 0 to 100 unscaled unit range that is used by the sensor.

In such cases the control system manufacturer should be contacted for advice on a similar quick-start calibration procedure. Hydronix have an application to aid development of calibration values. Please contact Hydronix directly for further information

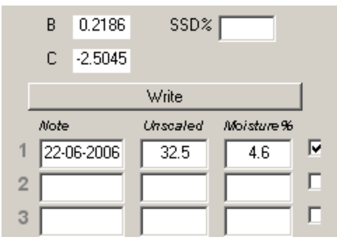
6.2 B: Quick-start calibration using Hydro-Com or Hydro-Cal

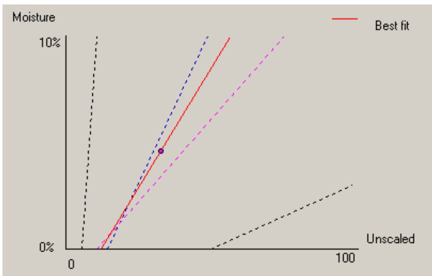
Hydro-Com or Hydro-Cal can automate the one-point calibration process when the sensor is configured to internally store the material moisture calibration.

1. Following steps 1-9 on page 36, take a sample of material and dry it, noting the values indicated below.



2. Enter the values into the Hydro-Com calibration and ensure the calibration rules are enabled using the tick box.





3. From this single point, a calibration line is drawn using the calibration rules. Hydro-Com will assign a slope value of 0.2186 which is the average slope value of the fine and standard sand sets. Calibration coefficients become:B = 0.2186, C = -2.5045

Writing these values to the sensor means that it can output moisture of the material.

Q: Hydro-Com doesn't detect any sensor 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: 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 Chapter 5) regularly on site to confirm the calibration is still valid and accurate. Put this data in a list (see Appendix B) 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. There are applications where customers have not had to recalibrate in 5 years.

Q: If I have to exchange the sensor in my sand bin 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 Chapter 5, 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. See also suggested calibration data for aggregates on page 38.

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

A: Depending on the sand type, recalibration may or may not be necessary as many of them work on the same calibration. The calibration rules contain two standard sand calibration sets, fine and normal grade sand. It would be wise to verify the calibration by taking a sample as shown in Chapter 5 and checking this calibration point. If it lies near to or on the line then the calibration is still good.

Q: What output variable should I set my sensor to?

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 27 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 in Chapter 5, 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, 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 II 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 in Chapter 2.

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: It should be noted that the material calibration coefficients are specific to the material. If the bin is empty the sensor is likely to be measuring air and so the material calibration will not be representative. Therefore the moisture output is meaningless.

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 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
Sensor has temporarily locked up	Power down and re-power sensor	Sensor functions correctly	Check power
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	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	Digital RS485 connection is not working. Sensor should be returned to Hydronix for repair

1.2 Sensor output characteristics

A simple test can be performed to check the output from the sensor in air and with the hand.

	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

1.3 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 output similar to as shown in table 2	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

1.4 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 10 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

1.5 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 terminals in junction box	Varies with moisture content	Check sensor output configuration
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

1.6 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 Technical Specification

1.1 Dimensions

Diameter: 76.2mm

Length: 395mm

1.2 Construction

Body: Cast stainless steel

Faceplate: Ceramic

1.3 Penetration of field

Approximately 75 -100mm dependent upon material

1.4 Range of moisture

For bulk materials the sensor will measure up to the point of saturation, typically 0-20% for construction materials

1.5 Operating temperature range

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

1.6 Power supply voltage

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

1.7 Analogue output

One configurable 0 – 20mA or 4-20mA current loop output (sink) available for moisture and temperature. The sensor output may also be converted to 0-10Vdc

1.8 Digital (serial) communications

Opto-isolated RS485 2 wire port – for serial communications including changing operating parameters and sensor diagnostics. Contact Hydronix for read/write access to sensor parameters and values

1.9 Digital inputs

One configurable digital input 15-30 V dc activation

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

2 Connections

2.1 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

500 Ohm resistor – The recommended resistor is an epoxy sealed precision resistor of the following specification: 500 Ohm, 0.1% 0.33W)

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

2.2 Grounding

The sensor body is connected to the cable shield. Ensure equipotential bonding of all exposed metalwork. In areas of high lightning risk, correct and adequate protection should be used.

2.3 Emissions

Total emissions are more than a factor of 100 below the limits quoted in Tables I and II of the Radio frequency Radiation Standard AS2772.1-1990.

CE **EEC Declaration of Conformity**

Electromagnetic Compatibility Directive 89/336/EEC.

Equipment type:	Hydro-Probe II: HP02
Conformity criteria:	Conducted emissions: EN55011:1991 Class A Group 2
Radiated emissions:	EN55011:1991 Class A Group 2
Radiated immunity:	EN61000-4-3:1996, DDENV 50204:1996
Conducted immunity:	EN61000-4-6:1996
Electrostatic discharge:	EN61000-4-5:1995
Fast transient/burst immunity:	EN61000-4-4:1995

The complete set of default parameters is shown in the table below. This applies to both firmware versions HS0029 and HS0046. This information is also listed in Engineering note EN0027 which can be downloaded from www.hydronix.com.

Parameter	Range/options	Default Parameters	
		Standard Mode	Compatibility Mode
Analogue output configuration			
Output type	0-20mA 4-20mA Compatibility	0 – 20 mA	Compatibility
Output variable 1	Filtered moisture % Average moisture % Filtered unscaled Average unscaled	Filtered unscaled	N/A
High %	0 – 100	20.00	N/A
Low %	0 – 100	0.00	N/A
Moisture calibration			
A		0.0000	0.0000
B		0.2857	0.2857
C		-4.0000	-4.0000
SSD		0.0000	0.0000
Signal processing configuration			
Smoothing time	1.0, 2.5, 5.0, 7.5, 10	1.0 sec	1.0 sec
Slew rate +	Light Medium Heavy Unused	Light	Unused
Slew rate -	Light Medium Heavy Unused	Light	Unused
Averaging configuration			
Average hold delay	0.0, 0.5, 1.0, 1.5, 2.0, 5.0	0.5 sec	0.5 sec
High limit (m%)	0 – 100	30.00	30.00
Low limit (m%)	0 – 100	0.00	0.00
High limit (us)	0 – 100	100.00	100.00
Low limit (us)	0 – 100	0.00	0.00
Input/Output configuration			
Input Use 1	Unused Average/hold	Average/hold	Unused

	Moisture/temp		
Input/output Use 2*	Unused Moisture temp Bin empty Data invalid Probe OK	Unused	Unused
Temperature compensation			
Electronics temp. coeff		0.005	0.005

* The second digital input/output is not available in the older firmware version HS0029

May be removed

Moisture Calibration Record Sheet

Hydronix

Refer to Hydro-Com User Guide HD0273 for full calibration information.

Instructions:

- Take a small sample of material where the sensor is located.
- Whilst taking samples read the unscaled sensor output from the sensor.
- Record the sensor unscaled reading, sensor moisture reading and lab moisture in the table below.
- Data may be used to recalibrate the sensor if there are consistent errors in moisture (>0.5%) between the current moisture output from the sensor and the lab moisture.

Material	
Location	
Sensor S/N	

			Readings from sensor		**Lab. moisture**	**Sensor/Lab moisture difference**
Operator name	**Date**	**Time**	**Unscaled**	**Moisture**		

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
EN0027	Sensor Parameter Default Values

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