SCALE-TRON
Automation, sensors and weighing systems

AQUASENSE 2280D
MOISTURE SENSOR

USER MANUAL

Firmware: 1.0.3
GUI Ver. 1.0.3
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Call: 514-940-0337
Fax: 514-940-0342

Website: scaletron.com
E-mail: service@scaletron.com

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Scale-Tron Inc.
2113C St. Regis, Dollard Des Ormeaux, Quebec, H9B 2M9, Canada

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1.0 INTRODUCTION

1.1. Importance of Accurate Moisture Measurement

Your mix design assumes that aggregates, cement and water are present in the correct proportions. If your sand moisture decreases by 2% without being noticed, which can often happen in practice, the batching system will batch 2% more sand than you require and will add substantially less water than required, making a dry batch. If the operator corrects this by adding more water, the water/cement ratio will increase, reducing the strength of your product. If the moisture had been measured accurately, the proportions would all have been correct and there would have been no need to add more water.

The aggregate moisture sensor ensures that the batch is proportioned according to the DRY WEIGHT MIX DESIGN.

The AquaSense measures the moisture of fine aggregates such as sand and crushed stone. Its microwave technology eliminates the errors associated with resistance and capacitance methods, giving an accurate reading every time. The system is independent of impurities in the aggregate and does not require frequent recalibration. It is easily installed in any bin wall and is suitable for both digital display and direct connection to a computerized batching system.

Microwave energy is absorbed by water. By sending a microwave beam into moist aggregate and measuring the energy returned, the quantity of water in the material can be measured precisely. Accuracy is further enhanced by averaging the readings during material feed and holding the result for later use.

1.2. Wear & Impact Damage

The ceramic faceplate is guaranteed against wear for 5 years after purchase. Excessive wear over many years can damage the waterproof seal around the faceplate, however. Likewise, falling rocks and other objects can crack the faceplate. This type of damage is not covered under the warranty; if this type of damage is possible, you should protect the faceplate by welding an inverted piece of metal angled above it, but far enough above that material flow is not impeded.

Although the AquaSense is highly resistant to wear, some types of extremely abrasive material will cause wear over a period of time. This results in an 'off-zero error', noticeable as an equal error at all moisture levels.

All AquaSense parts are replaceable. The complete unit must be returned to us for replacement of the body, sensor, or faceplate.

1.3. Accuracy Checking

It is often desirable to know the measurement accuracy of the AquaSense sensor, in order to compare it with other sensors or to calculate the effects of errors on the process. This testing can give misleading results, however, and should never be used as proof of accuracy or to compare one system with another. The reason is that it is impossible to take a perfect sample every time. Usually the feed gate from which the material is batched is much bigger than the sensor and therefore the sensor cannot measure exactly the same material as is taken for the sample. For example, in a sand bin, the sand in one side may be wetter that that at the other side. The sensor measures sand from the middle of the gate while the manual sample is taken at the side. The sample, therefore, can be quite different from the measured material. This will appear from time to time as a large error in the comparative measurements. In these cases, it is usually the sensor that gives the best result

For best results, do not compare readings with oven dry tests; use the sensor to compensate for the moisture in the process and verify that the process has been improved. This is the best way to achieve maximum results.

1.4. Calibration

The AquaSense is factory calibrated to give accurate readings when used with the same type of sand, at the same density as when calibrated. The sand in most locations will give results within ±2% of the true value, but the readings should always be checked and recalibrated if necessary. Stone and other materials will usually require an adjustment but may require factory recalibration for the specific material in use. To be sure, submit a sample of 1 cu. ft. or more to Scale-Tron's test lab for proper setup & calibration. After installation, check operation by comparing results with an accurate moisture measurement system such as the "Oven Dry" weighing method (see section 4.0 of this manual). The popular "Speedy model ELE 23-7450" system can be used for an approximate check only, since its accuracy is poor when compared to the AquaSense or oven dry method.

Before making any corrections, you must collect and compare readings at both low and high moisture. Ideally, collect a set of readings varying from 2% to 10% moisture. Your calibration will only be correct within the range of moisture over which you take readings. We have made the adjustment procedure as simple as possible.

Refer to the **Performing a Calibration** section for a detailed procedure on calibrating your AquaSense sensor.

2.0 INSTALLATION

2.1. Mechanical

The AquaSense is designed for installation in the aggregate holding bin. It is essential to have at least 10 inches of unobstructed material in front of the faceplate when installed. This precludes use on conveyor belts in most cases, where only a thin layer of material exists. Call us if unsure.

Refer to the Drilling Template in the Appendix. The AquaSense must be positioned in the holding bin so that the sensing plate is in the material flow region. This region extends vertically above the outlet opening. It is also important for the faceplate to be at an angle of 30° to 60° to the direction of flow for best results. Do not install the AquaSense on the same bin wall as a vibrator; this will shorten the life of the electronic components and is not covered by warranty. Choose a location where the sensor will not be hit by the feed gate as it opens. Estimate the insertion length by holding a tape measure at right angles to the bin wall and measuring to the centre of the flow region.

Installation can be done with material in the bin, provided it is moist, although it will be easier if empty. Using the template provided (see appendix), mark and burn the central hole. Grind the edges to remove lumps. Using the template or the actual flange, mark the mounting holes. Mount the flange using four 1/2" mounting bolts which should be inserted from the inside of the bin, as shown in Fig. 1, to facilitate future replacement. Tighten the four bolts equally. If the bolts are sealed in place with silicone sealant or epoxy, water leakage and rusting will be prevented. Grease the threads. Alternatively, the bin wall can be drilled and tapped. If the bin is full, use a crowbar or trowel to make a recess slightly larger than required. Insert the AquaSense and tighten the clamping screw.
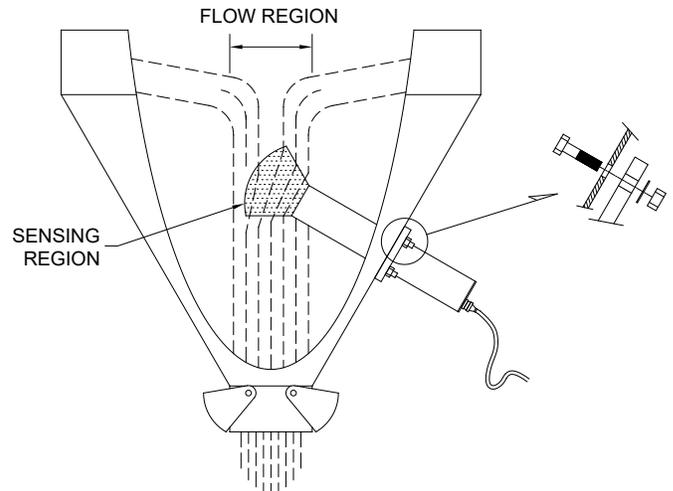
Figure 1: Typical installation

2.2. Electrical Connections

The AquaSense microwave moisture sensor, is connected via a quick release connector and cable, to an optional junction box. It operates from 24 VDC and has analog and RS232/485 outputs. The standard cable length are 10 ft., 20 ft. or 50 ft. and is pre-connected to the junction box to make installation as simple as possible.

The junction box has 12 terminals inside. Depending on the options chosen, and the intended use, various terminals will have connections made. Make the connections only for your specific application.

Below is a table of the terminals and function:

TERM.	CABLE WIRE COLOUR	FUNCTION
1	RED	Power, 24 VDC +
2	BLUE	Power, 24 VDC - (common)
3	BLACK	Digital I/O common
4	GREEN	Digital Input 1
5	ORANGE	Digital Output 1
6	WHITE	Common for RS232/485
7	RED/WHT	RS232 (Rx)
8	BLU/WHT	RS232 (Tx)
9	BLK/WHT	RS485 -
10	GRN/BLK	RS485 +
11	ORG/RED	Analog (4-20mA) common
12	WHT/BLK	Analog (4-20mA) output +
CASE	SHIELD	Ground

NOTE:

Care should be taken when grounding the AquaSense. Make sure a thick cable (at least #10 AWG) is run between the cabinet housing, the power supply for the AquaSense, and the bin structure where the AquaSense is to be mounted, to assure a low impedance path for any power surge. Also the ground from the AquaSense connection should be connected to the ground at its power supply.

2.2.1 Power connection
(All junction box models; 2257, 2266, 2267)

Regardless of the configuration & options present, the AquaSense sensor requires a 24VDC power source. Connect the 24VDC power source:

+24VDC to terminal 1

-24VDC to terminal 2
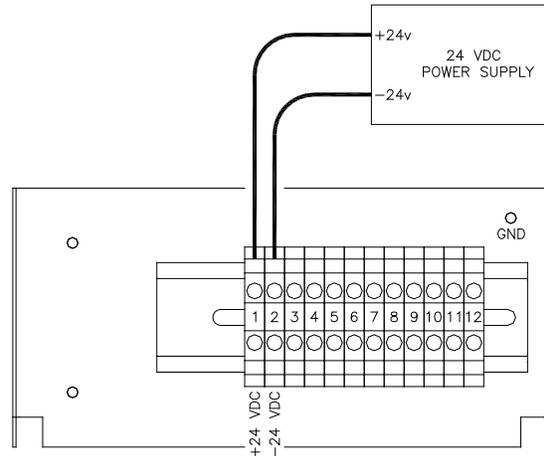
Figure 2: Power connection

2.2.2 Analog Output / Display
(All junction box models; 2257, 2266, 2267)

The AquaSense sensor may be connected to either a display or to the analog inputs of the controller. The display and controller may also be both connected at the same time, as shown. The controller may need some re-programming to display the readings properly. Consult with your controller's manual.

Terminals 11 & 12 supply a 4-20 mA or 0-20 mA analog signal for either a display or a controller, or both.

By adding a 250 Ohm resistor across the + and – terminals (11 & 12), the signal is converted to 0-5 volts for use with voltage inputs (e.g. 0-5 volts). Use a 500 ohm resistor for 0-10 volts.
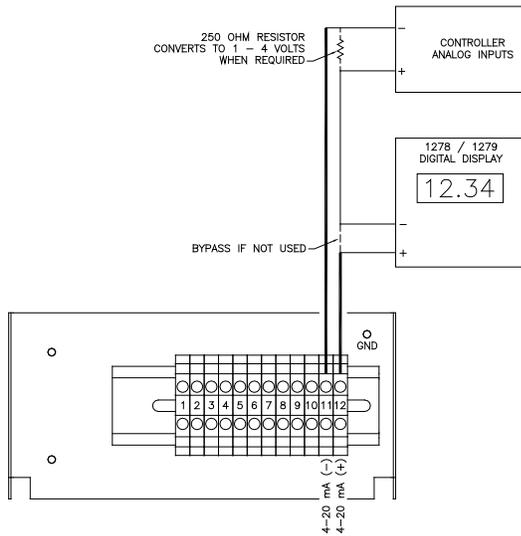
Figure 3: Analog connection

Power connections left out for clarity

2.2.3 Digital RS-232 Output & Programming Cable Connections
(All junction box models; 2257, 2266, 2267)

The AquaSense sensor is able to communicate via RS-232 connections. Connect to a PC or a controller as shown. This connection is used for programming and can be used for operation in single-drop mode. When multiple sensors are to be connected to a single port, use RS-485 mode.

Note: With RS-232, no hardware handshake connections are required, and the sensor must be at address #1.
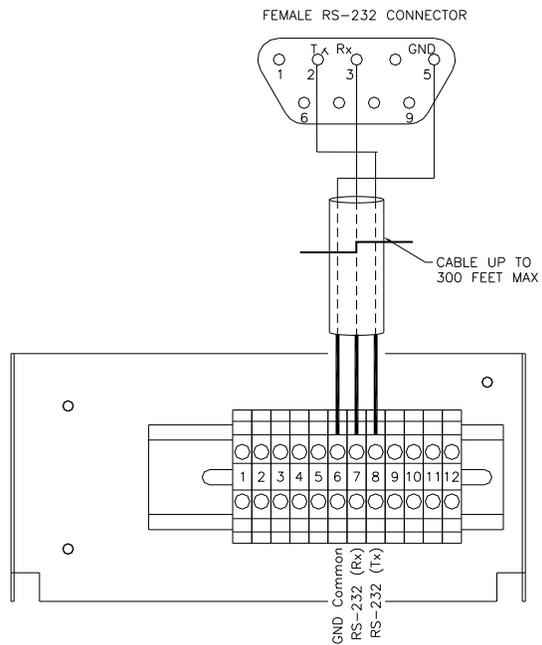
Figure 4: RS-232 output connections

Power connections left out for clarity

2.2.4 Digital RS-485 Output
(All junction box models; 2257, 2266, 2267)

The AquaSense sensor is able to communicate via RS-485 for long distances (up to 4000 feet) and multi-drop, up to 16 sensors on the same RS-485 cable.

The RS-485 connections can be used for normal operation as well as set-up & calibration; if the computer used for batching is also used for setup and calibration, connect as below. If the setup/calibration is done from a separate computer, connect this through a separate RS485 adapter in parallel with the batching computer/controller.

Connect:
SHIELD to pin 5 on the RS-485 / RS-232 converter.
NOTE: connect both incoming and outgoing cable shields at each junction box.
BLACK / WHITE to pins 1 & 3 on the RS-485 / RS-232 converter.
GREEN / BLACK to pins 2 & 4 the RS-485 / RS-232 converter.
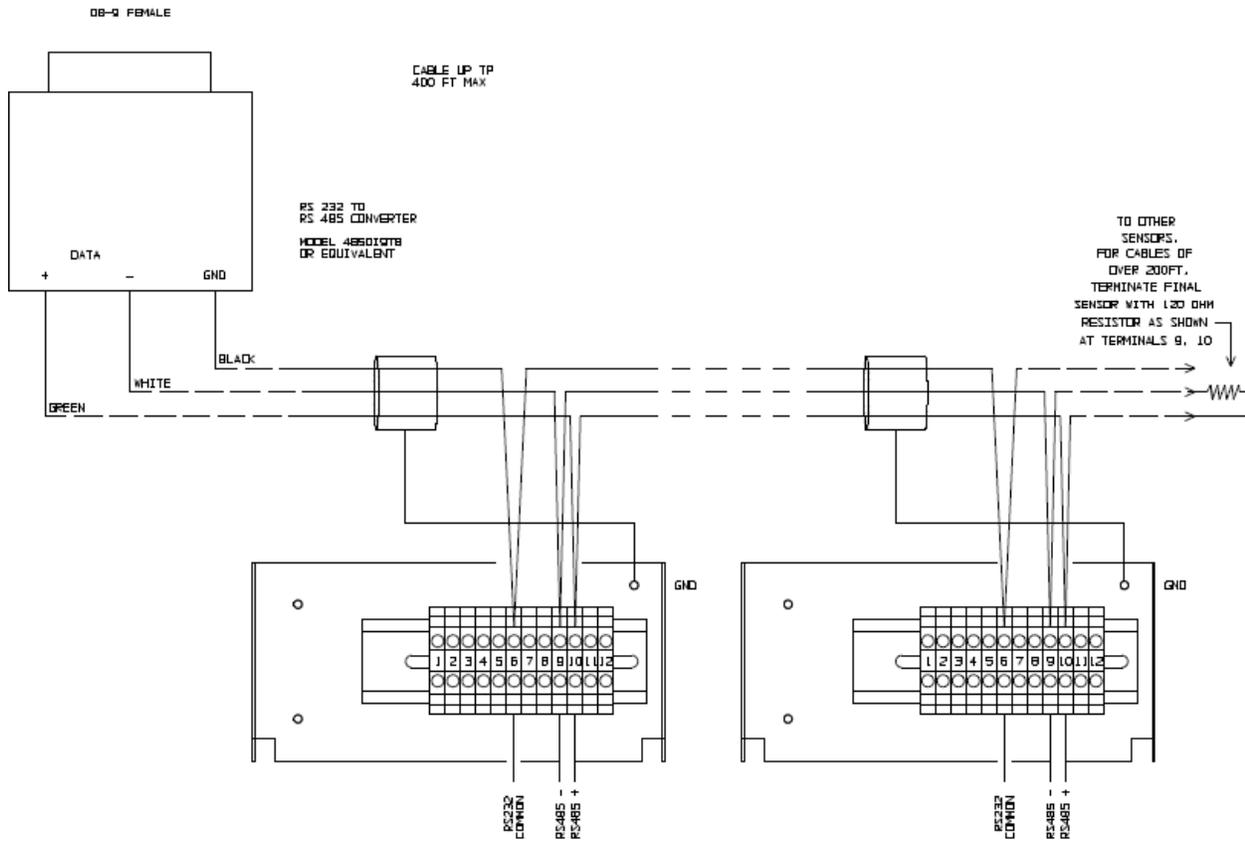
Figure 5: RS-485 output connections

Power connections left out for clarity

2.2.5 Sampling Connections (Batch Mode)
(Junction box models 2266, 2267 only)

The "Sampling Option" junction box (models 2266 & 2267) comes equipped with a mechanical relay to activate the internal signal averaging feature.

Connect the external feed gate solenoid to coil terminals A1 and A2 on the mechanical sampling relay, to provide a signal to the sensor when feed is operating.

Verify that the relay coil voltage matches your signal voltage and replace if required.
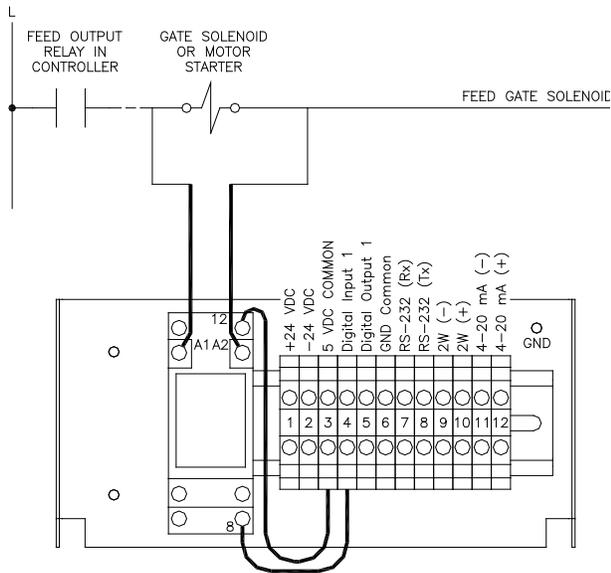
Figure 6: Sampling connections

Power connections left out for clarity

2.2.6 Bin Low Alarm & Sampling
(Junction box model 2267 only)

The "Bin Low Alarm & Sampling" junction box (Model 2267) comes equipped with a sampling relay plus a solid state relay that is activated when the level in the bin leaves the sensor faceplate uncovered.

Connect the external feed gate solenoid to the coil terminals A1 and A2 on the mechanical sampling relay, to provide a signal to the sensor when feed is operating.

For the bin empty output a solid state relay is wired to the sensor. It has an output capacity of 2 A for an external supply of 24/220VAC. Connect the unused solid state relay terminals in series with the external load to a fused supply.
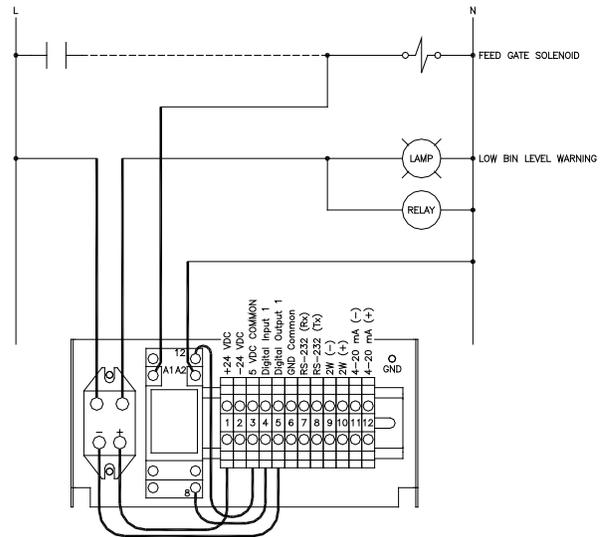
Figure 7: Bin Low Alarm & Sampling connections

2.2.7   Direct Cable Connection

The use of the supplied junction box is convenient. But some application may not allow the use of the junction box.

The cable is supplied in 10ft, 20ft and 50ft lengths. Other lengths are available by special order.

Following the previous sections, and referring specifically to the table in section 2.2, one can connect the AquaSense directly to their controller or display as required.

3.0 SOFTWARE & GUI INTERFACE

3.1. Initial Set-up

The following section describes the operation of each GUI screen/panel. The screens are organized in a manner similar to the tasks a user may perform.
Care was taken to make the screens as *User Friendly* as possible; however, the user must be aware of the features and mode of operation of the sensor in order to perform the desired task.

Note: before re-installing the GUI software, ensure that any previous version has been completely removed by use of the Uninstall menu in Control Panel / Programs and Features.

Insert the flash drive into a USB port on your PC or Laptop, and the AquaSense Initialization Setup application should start automatically.

Use the RS 232 protocol for the initial set-up.
Once the unit(s) are connected serially, and the cabling is verified, connect the RS232 or RS485 connector from the PC to the AquaSense.

3.1.1   Main Screen

Once the application is running, the Graphical User Interface (GUI) will appear.   The screen is organized with a main menu and several Tabs.

The "Monitor" tab is used to enumerate and discover the sensors.
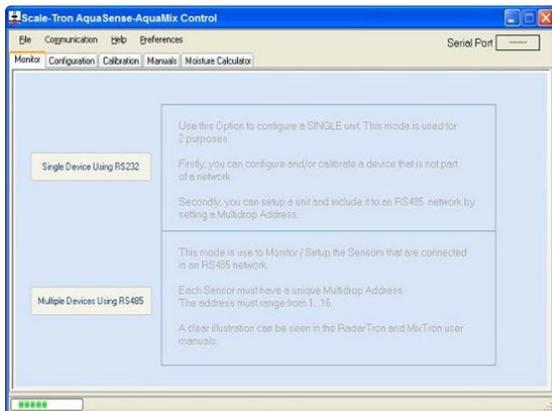
3.1.2   Opening a Connection

Before any communications can be performed, you must select the serial port that you will be using to configure/calibrate and monitor the sensors.

It is assumed that either an RS232 port (for a single unit) and/or an RS485 port (for multiple units), is available. Ensure they are connected & powered up.

If only a USB interface is available on the PC or Laptop, install a USB / RS232 or USB / RS485 adapter.   Follow the instructions for the adapter. Or, contact us for further details.
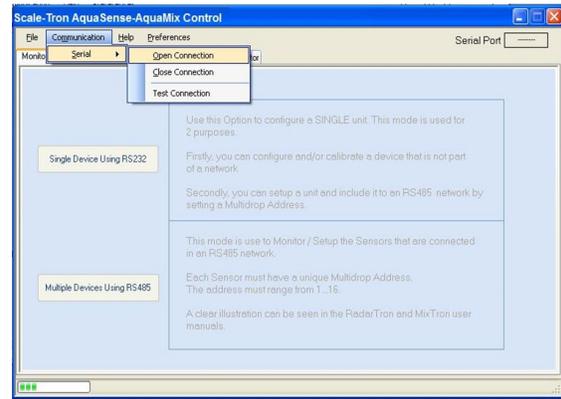
Notice that the Panels are grayed out

Select the CONNECTIONS menu, and select OPEN CONNECTION to choose a com port.

A dialog box will appear, and a pull-down list of available ports will appear. Select the appropriate COM port for your particular application.

If only 1 Sensor was connected, either COM1 or COM4 (both RS232) would have been selected. Note that most PC computers now have no built-in RS232 port, making a USB to serial adapter necessary. These usually appear as the highest port number (example 56). If not sure, try each port until communication is established.
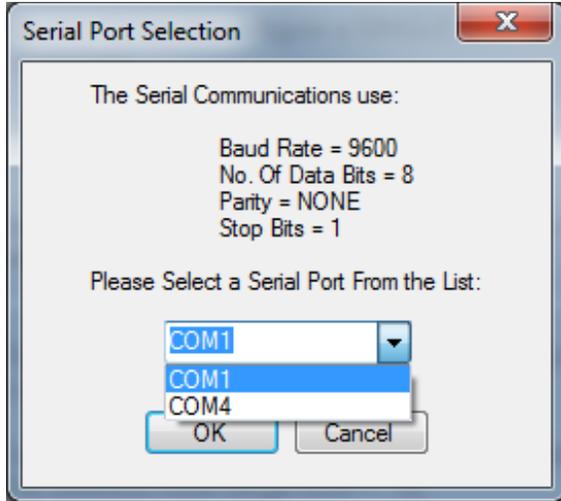
In this example COM1 is selected because the computer has a built-in serial port.

3.1.3   Main Screen Panel

Once the serial port is selected and the communications connection is opened, the main panel screen will become active.

At this point we are ready to discover the sensors. At this time, we will also assign address numbers to the sensors.

The examples show more than 1 sensor installed, which implies that the RS485 protocol is used; for this, click the *Multiple Devices Using RS485* button. If you are using the RS232 protocol, select the 'Single Device Using RS232' button.
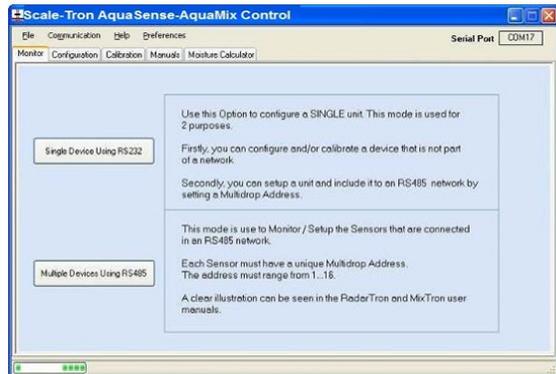
3.1.4   Start Discovery

A blank address list ranging from 1 to 16 is displayed. On initial set-up, it is unpopulated until the 'Discover Sensor(s)' button is pressed.

Press the *Discover Sensor(s)* button to start the discovery process.
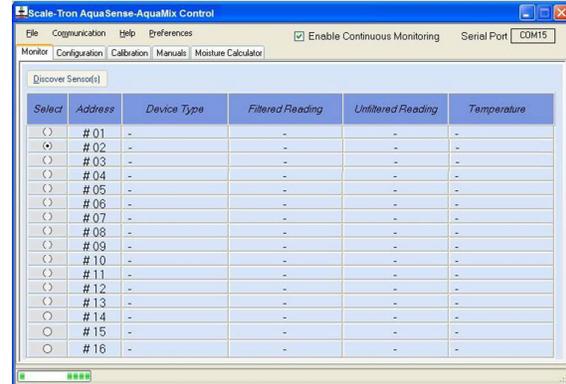
The system will then look for the connected sensor(s). This may take some time depending on the number of sensors connected. On average, 16 connected sensors would take about 10 seconds. This time may vary depending on your particular system.
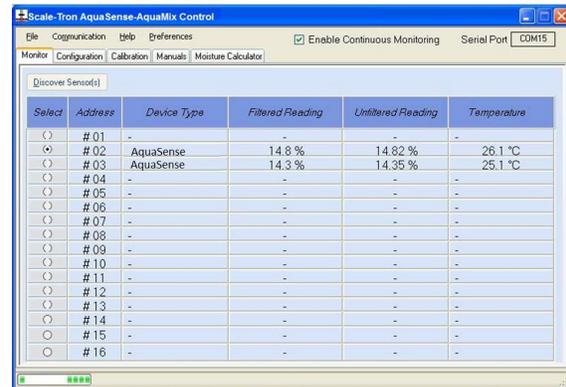
In the above example, 2 sensors have been discovered, identified, and are now ready for use.

If the Device Type shows "BL-Vx.x", this indicates that the sensor is operating without the firmware, which must be loaded. See section 5 for instructions on firmware download.

3.1.5   Selecting a Sensor

In order to configure and calibrate each sensor, the sensor must be selected by clicking the radio button on the left of the sensor row. Only one sensor can be accessed at a time.   When selected, the Configuration & Calibration tabs apply to only the selected sensor.
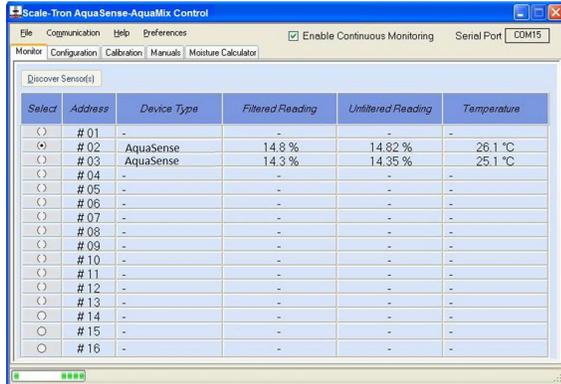
This screen is also used to monitor the sensors, once configured & calibrated. When enabled, this screen will display the data the sensors are receiving in real time.   Click on the *Enable Continuous Monitoring* checkbox at the top of this screen for real time device monitoring.   The sensor(s) will then poll (update) every 5 seconds.
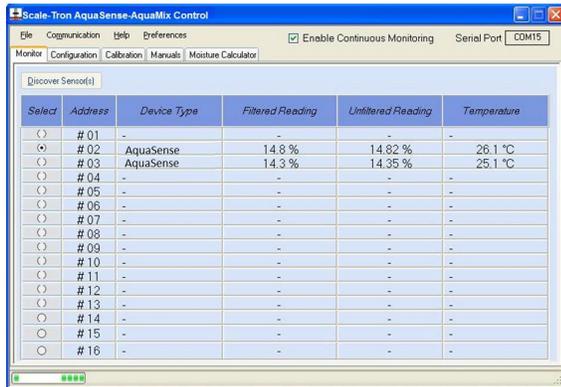
Note: If you move to another main tab, the auto-updating feature will reset and become disabled.

3.2. Configuration Screen

When one sensor is selected, clicking the Configuration tab will display the following screen where the main configuration parameters of the sensor can be setup/initialized.

For security, this screen is password protected. The password is **1515.** Enter this password when the dialog box appears.
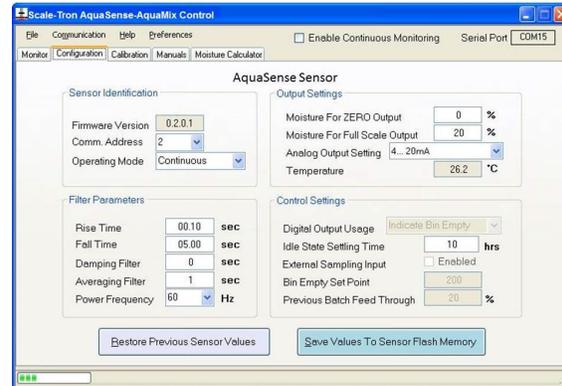
Sensor Identification:
Firmware Version:
The version of the software that is programmed in the sensor's hardware.

Comm. Address:
Sixteen different addresses can be entered to identify each unit in a serial multi-drop configuration. These values are numbered from 1 to 16. When connecting several units on the same bus, make sure that the addresses of the connected units are all different.   If 2 addresses are identical, communication will be subverted and the whole network will fail until the offending sensor is disconnected.

Operating Mode:
Use the drop down menu to switch between 'BATCH' and 'CONTINUOUS' modes.

Output Settings:
%Moisture for Zero Output:
Select and enter the moisture value, in %, which you want the analog and digital outputs to read for zero. This will normally be 0.0% moisture. The digital output will respond with the value you enter here but this value will define the lower end of the measurement range.

%Moisture for Full Scale Output:
Select and enter the moisture value, in %, which you want the analog and digital outputs to read for full scale. This is normally 20.0% moisture for sand used in concrete. The digital output will respond with the value you enter here but this value will define the high end of the measurement range.

Example: If you want to measure over a range of 20% to 40% moisture, enter 20% for the first value and 40% for the second value. The analog and digital signal will stay at "zero" output, which is either 0 mA on the 0-20 range or 4 mA on the 4-20 range, until the moisture value exceeds 20%. It will then rise in accordance with the moisture until the moisture reaches 40%, when it will read full scale (20mA) and not rise any further.

Analog Output Setting:
0-20mA, 0-5V, 0-10V.
4-20mA
Select your desired output range from the drop down menu.
Select a starting point of 0 mA, or 0V when using a termination resistor to create a voltage output (see section 2.2.2 for installation of the appropriate resistor).
Select the 4-20mA for the industrial standard current loop output (for use with PLCs and the 1278 / 1279 digital displays), or the equivalent in volts

Temperature:
Displays the current temperature of the sensor.

Filter Parameters:
Rise time:
First filter rise time delay in seconds. This value should normally be 0.4 seconds.

Fall Time:
First filter fall time delay in seconds. This value should normally be 5.0 seconds.

Averaging Filter:
(Continuous mode only)
The moisture signal must be smoothed to obtain a stable and usable reading. This is done in two stages by this parameter and **Damping** Filter (next). Averaging takes a running average over the selected number of readings at 0.1 second intervals. .The data is entered in seconds form 00.0 to 10.0.
Default: 10 seconds and is also the maximum value.

Damping Filter:
(Continuous mode only)
This is a "pseudo-averaging" filter, similar to a hardware R-C filter, and gives a higher weight to the most recent readings and lower weight to past readings. Rise time in seconds is set by this parameter.
Default: 5.

Power frequency:
Switches between 50Hz and 60Hz to suit the frequency at the site.

Control Settings:
Digital Output Usage:
(Batch mode only)
Bin Empty Bin empty relay activates when the sensor faceplate is uncovered.
Probe OK Relay activates if an internal fault (such as a memory problem, or hardware fault) occurs.

Idle State Settling time:
The time, in hours, that the sensor will take to revert back to the true measured moisture from the last 'sampled' value while the feed system is idle (in between Sampling and Averaging) when in Batch mode.

External Sampling Input:
(Active when in **Batch mode** only**)**
Use the check box to enable or disable
Enabled Sampling input must be enabled for averaging to take place.
Disabled Averaging is independent of the sampling input.

Bin Empty Set Point (A/D Counts):
(Batch mode only)
This value is the internal setting used in checking for a bin empty condition.

Previous Batch Feed Through:
(Batch mode only)
This value determines the percentage of the previous batch reading that is added to bias the current one. A value of 20% is best for batch feed times of 10 seconds or less, and reduces the variability due to averaging a small number of readings. When batch feed times are 10 – 20 seconds, the value should be reduced to 10% or less. For feed times of greater than 20 seconds, use 0%

3.3. Calibration Screen

When one sensor is selected for calibration, selecting the Calibration tab will display the following screen. The main calibration parameters of the sensor can be setup/initialized using this Screen.

For security, this screen is password protected. The password is **1515**. Enter this password when the dialog box appears.

When changing any parameter, or all of them, don't forget to click the **Save** button. This is independent from the Calibration button and allows you to save other parameters without having to do a calibration – but it will not save any changes unless you use it!
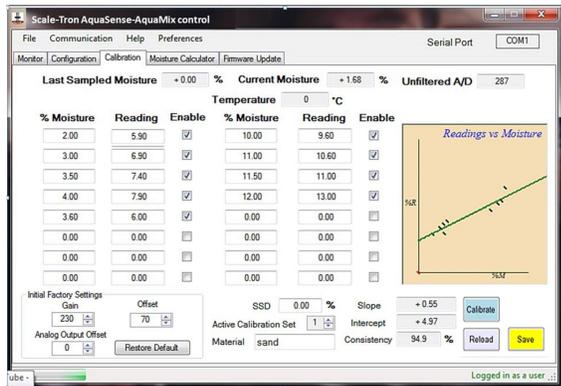
In order to activate the *Calibration Screen* you must first select an active sensor. Refer to section 3.1.5 to select the sensor.

You can set/use up to 8 calibration pairs (sets) for use with different materials. For use with only one material, use the default, Set 1. To change calibration sets, use the pull down menu.

The column on the left is considered the 'low' moistures values, while the right are considered the 'high' moisture values. When samples are tested, their tested moisture values can be added to the appropriate field and saved. Click on the box, and enter the low moisture value from the test in the '%Moisture box', and add the 'Current Moisture %' value from the Current moisture box on the screen to the 'Reading' box. Repeat as often as required to obtain a good set of calibration pairs.

These values can be enabled or disabled depending on the consistency value at bottom right.

Use the mouse or tab key to navigate through the fields.

Last Sampled %M: Indicates the latest moisture value recorded during normal use, prior to entering calibration mode.

Current %M: Is the value of the moisture currently in contact with the faceplate and is continuously updated.

Unfiltered A/D: This is the raw analog value from the sensor. In normal use, this should be within the range of 0 – 1023. This value is for factory presetting purposes only.

Temperature: Current temperature of the material that the probe is monitoring. (Temperature is displayed in °Celsius).

Projected Moisture %: Shows the new moisture value calculated from the readings entered and enabled, based on the current input from the sensor, as a check on progress of your recalibration. If you know the actual moisture at the sensor, the projected value should move closer to this value as readings are entered.

Initial Factory Settings: Gain and Offset are the internally stored values which have been set during initial setup and calibration. They determine the range of readings that will be accepted by the internal electronics, to be used by the firmware to calculate moisture. If these values are changed, and the unit produces undesired results, press the **Restore Defaults** button to reset these values back to the factory settings.

Analog Output Offset: A fine adjustment to the analog output, allowing it to be matched to a display, for example. The Last Sampled and Current Moisture values on the screen are not affected by this adjustment and the adjustment can make the external reading device (usually the batch control system) read the same as the calibration screen.

Restore Default: Replaces the calibration values with factory default values.

Note: *This also sets Analog Output Setting to the 4-20mA selection. If you had this set to any other selection, ensure you check and set this to the appropriate selection.*

SSD: This is the internal moisture value used to compensate for material absorption. The sensor measures the bulk moisture of the material, including internal moisture. When measuring the moisture of samples using the oven-dry method, the objective is to measure the surface moisture. If commercial moisture balances are used for this task, they usually heat the sample until all the moisture is evaporated, including internal moisture. When this is the case, an adjustment is necessary to allow the sensor to show surface moisture. The entered internal moisture value will be subtracted from the calculated moisture value, giving a displayed value that is lower than the bulk moisture value by the entered amount on all subsequent readings.

SSD (Saturated Surface Dry) is defined as the condition of an aggregate where the interior of the particles are "saturated" (i.e. absorption would no longer take place) but the surface of the particle is otherwise dry. In this condition, the aggregate will not affect the free water content of a composite material. The aggregate will not lose water or gain water in the mix.

When the sensor is calibrated with SSD moisture values from oven-dry tests, it will read the SSD or surface moisture value, which is the correct value for use in batching; no further correction for absorption is necessary.

Active Calibration Set:
This is the identifier for each of the 10 pairs of calibration parameters (slope, intercept, and moisture absorption). The default is 01, for use with one material only. Should you need to calibrate for more than one material, when other materials are used in the same bin and sensor, enter the new calibration set number <u>before</u> entering the new moisture values by scrolling onto it and entering a number between '01' and '10'. Two digits must be entered for the new set to become active. Some values may already exist; however, when calibrating for a new material, all entries should be disabled, erased or overwritten with new values to prevent them from affecting the new calibration.

Material:
This label can be changed / renamed to suit the material in the bin. Click the text field to change the name.

Slope and Intercept: These are the calibration parameters which are updated during the calibration procedure. There is a set of two parameters for each "calibration set". Normally only one material is

stored in the bin and only one calibration is required, but there are 10 sets of calibration parameters available for different materials stored in the bin in which the sensor is reading. These additional sets can be selected through the digital interface. See Calibration set number.

Consistency: This value is a measure of goodness-of-fit of the calibration points. A value closer to 100% means that points chosen (by enabling them in column "E") are a better choice to be used in recalculating the new calibration parameters.

Note: This value drops quickly if even one set of values is inconsistent with the others. In this case, check the values and determine which one(s) are scattered and disable them (by entering zero under the "E" column). A value of 90% or higher will give acceptable results in general.

Calibrate: As new entries of moisture and reading are made and enabled, they can be seen on the graph and the Consistency value will change. Calculation of slope and Intercept will take place but no change in moisture values will occur until the Calibrate button is clicked. A confirm box will appear when the Calibrate button has been pressed; repeating a calibration action does not alter the results, which is a change from previous versions. The Calibrate button saves the calibration results in the sensor's internal memory and displays the corrected results in the Last Sampled and Current Moisture boxes. A "Calibration Successful" box confirms that the save was performed as requested. Also the bottom left bar should show "Save Successful" and the Current Moisture box should show the previous Projected Moisture value. If it does not update, try again.

Reload: Restores the last saved set of calibration entries to the table displayed on the screen. These entries will replace anything just entered <u>and not saved</u>. Once you Save to Sensor, the previous values are replaced with the ones in the current table, with their Enable boxes checked or unchecked, exactly as they were when saved. This is what can be reloaded.

Save: Saves all non-calibration parameters to the sensor's internal memory. A "Save Successful" message should appear in the bottom left bar.

Performing a Calibration

Calibration Set: Up to 10 different materials can be used, each with its own calibration. Usually only one material is used with each bin/sensor, requiring one calibration. If more than one is used, first select the Active Calibration Set to be used for the material being calibrated.

Calibration Values: For each material, 8 sets of calibration values can be entered to calibrate the unit. Each set can be enabled / disabled at any time by checking on or off on the corresponding "**E**" column for each set.

Columns are grouped as **%Moisture, Reading** and **Enable**.

"%Moisture" is the actual moisture of the material (from oven dry or similar tests), and **"Reading"** is the reading of the sensor. "**Enable**" is used to enable or disable the two values.

Select the row or rows of sampled values you wish to use, if already entered, or enter them by scrolling onto the proper fields.
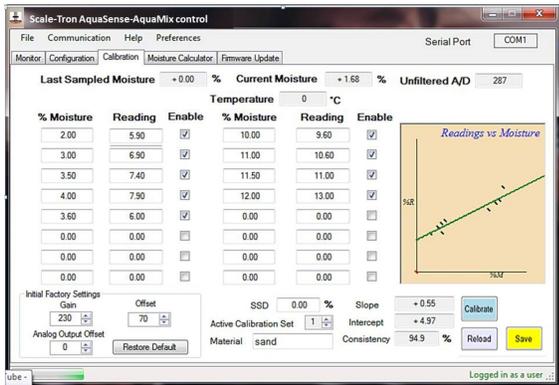
This enable/disable feature allows you to store sample information in the permanent sensor memory, for future use. For example, samples can be taken and entered over a period of several days but no calibration needs to be performed until enough readings have accumulated. Each set of new readings can be added to the previously saved readings

Example: A moisture sample is taken and a moisture of 3.50% was obtained in the lab. At the time this calibration sample was taken, the reading of the sensor was 3.28%. Under "%M" in the first row, enter the moisture of 3.50, and under "Reading", enter 3.28. If you wish this value to be included for

calculating calibration parameters, check the enable column entry to activate the row.

Repeat for each set of actual moisture values and sensor readings, over as wide a moisture range as possible. Do not click the Calibrate button until all sets have been entered and the Consistency has been verified.

Enter at least two sets of values, but preferably at least five for best accuracy, as shown. You can keep the original calibration results (top line of each section) if they are relevant to your new calibration, but normally you should eliminate these from your new calibration by overwriting the values or disabling them both by clicking the "Enable" check box. Once the new values are entered, check the Projected Moisture value, which will show the new value of the current sensor reading for comparison with the old value shown in the Current Moisture box. Before accepting the values, check the Consistency value. If under 90%, identify the reading with the greatest error, furthest from the line shown on the graph, and disable it by clicking the "Enable" check box. The disabled readings show as red points on the graph and the enabled ones are black. The more sets of values entered, the better it will be, as more statistical data is used to calculate. Watch the new consistency value every time a value is entered and enabled.
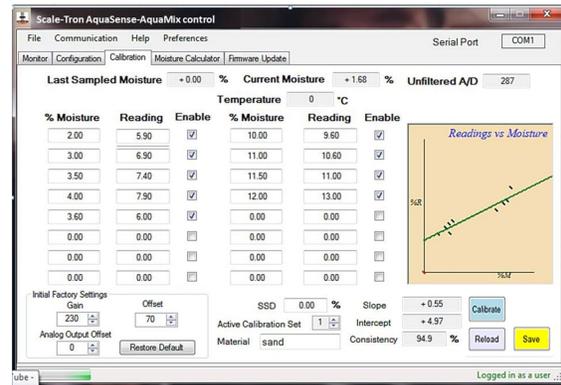
After Calibrate is pressed, the Projected Moisture value will replace Current Moisture value as shown above (unless sensor reading is changing) and the readings will be saved to the sensor's internal memory.

Note: *when calibrating for a new material, all previous entries should be disabled, erased or overwritten with your new values to prevent them from affecting the new calibration. The calibration will be accurate only over the range of measurements that have been taken. If only two sets of values are entered and one set differs significantly between the % Moisture and Reading values, expect a large and possibly wrong calculation of slope and intercept. Three or more sets are recommended.*

If unsure that the calibration is correct, do not save the values. If there is uncertainty about the calibration, you can retrieve the previous calibration parameters by pressing the "Reload Sensor Values" button. This will restore the original calibration, provided you have saved them in permanent memory.

If everything else fails, click the Restore Default button and repeat your calibration.

3.4. Updating the sensor firmware
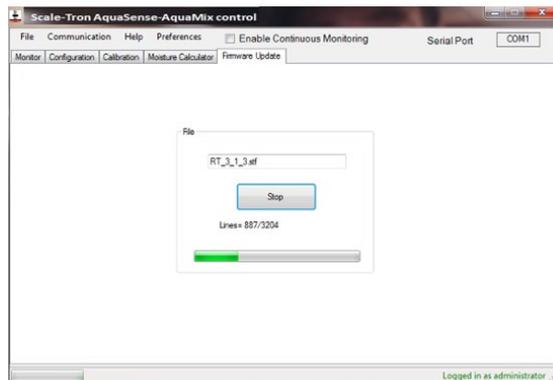
To update the firmware, you must already have firmware version 3.1.1 or higher on the sensor and a new firmware file must be present on the computer used for the calibration software. This file will have the subscript ".stf". For older versions, the sensor must be returned to Scale-Tron for update; following this update it will be possible to update on-site in the following manner:

Click on the Firmware Update tab and in the Filename box, enter the location of the file or browse to the relevant folder and filename. Click Update to transfer this file to the sensor. When successful, the message "File successfully uploaded" will appear.

Click Yes to confirm. The process should start and will indicate its progress on the progress bar, along with the lines transmitted to the device. Once finished, a message will pop up indicating the result of the upload. The previous setup and calibration values should have been retained unless some of these values were revised in the new version.

4.0 "Oven Dry" Test
(To obtain Percentage Moisture)

Periodically, it may be required to perform an actual test to determine the moisture content of the various materials being used. The AquaSense GUI offers a tab to quickly calculate the % moisture based on "before and after" samples. These results can then be added to the calibration set to further refine the calculated moisture.

Click on the "Oven Dry" tab for calculating the percent moisture. The screen will display the 4 basic steps to obtaining the moisture content.
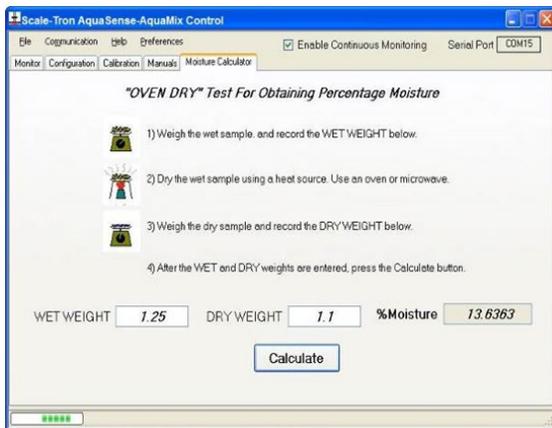
EQUIPMENT REQUIRED:
Scale, capacity 1 to 10 kg x 1 g graduations.
Baking tray 12" square.
Stove, microwave oven or heater.

In a concrete plant, the best way to obtain samples is during batching. Before starting, note the moisture display reading. Prepare a clean container (a bucket is ideal) and use a scoop to take as many scoopfuls as possible from the material coming out of the gate while it flows. Repeat the reading and verify that the change from the previous reading is no more than + 0.1%. If the moisture varies too much, repeat this step until repeatable readings are obtained. Dump and refill the container each time.

For other applications, try to obtain as representative a sample as possible, given the process.

Mix the material in the container thoroughly, and then mix it again. It takes twice as long as you would think to mix the sample properly. Remove and bag a quantity suitable for the test below.

Ideally, follow the ASTM standard moisture test. If this is not possible, proceed as follows:

- Place the baking tray on the scale and tare it (adjust the weight to zero).

- Weigh 1 to 2 lb (500 to 1000g) of material into it, taking care to be accurate.

- Place the tray on the stove or microwave oven and heat the material until totally surface dry, stirring frequently. Be very careful to ensure that no material is spilled during stirring; place a paper under the heater if possible and return spills to the tray. It is not necessary or desirable to bake the sand to red heat; merely boil off the surface moisture to approximate "saturated, surface dry" conditions. You can test for emission of steam by holding a cold glass plate over the tray; when it fails to mist, no steam is present and saturated surface dry conditions have been obtained.

- When cool, return the tray to the scale and re-weigh. Calculate the true "Dry Weight" moisture from the following formula:

$$\% \text{ MOIST.} = \frac{\text{WET WEIGHT - DRY WEIGHT}}{\text{DRY WEIGHT}} \times 100$$

EXAMPLE:

If WET WEIGHT = 2.000 kg, DRY WEIGHT = 1.815 kg,

$$\% \text{ MOIST.} = \frac{2.000 - 1.815}{1.815} \times 100 = 10.2 \%$$

5.0 Part Numbers and Accessories

Below is a list of parts, for replacement, and assorted accessories available for you AquaSense unit.

Part Number	Description	
1X3-2280D	AquaSense Unit (Just the sensor, no flange, power supply, junction box, etc.)	
1FB-1406-FLANGE	Mounting Flange – to mount to a bin wall	
	Bin Wall plate – With studs, to fit Mounting Flange, welds onto and strengthens bin wall	
R-2316	Power Supply, to power up to 10 AquaSense Sensors (110 – 240VAC)	
1X3-1278	Indicator Display, in enclosure	
1IN-1279	Indicator display for panel mounting	
1X3-2268-232	RS-232 Programming Cable	
1X3-2268-485	RS-485 Programming Cable	
1MO-BB-9SPOP2	RS-232 Isolator (9-pin adapter, self powered)	
1MO-BB-485OI9TB	RS-485/232 Converter (Includes power supply)	
1MO-BB-232USB	RS-232/USB Converter (Connects to USB port)	
1MO-BB-NSOTL4	RS-485/USB Converter (Connects to USB port)	
1X3-2257	Junction Box, No Options	
1X3-2266	Junction Box, with Sampling Relay / Option (specify voltage)	
1X3-2267	Junction Box, with Sampling and Bin Low level relays / Option	
All above Junction boxes require a connection cable, as described below		
1X3-2256-10	Connection Cable – 10ft	
1X3-2256-20	Connection Cable – 20ft	
1X3-2256-50	Connection Cable – 50ft	
1X3-2256-XX	Connection Cable – XXft, Substitute the XX for the # of feet required	
All Above connection cables come with the connector installed.		

6.0 APPENDIX

6.1. Features

- 1/10 to 1/4% accuracy, depending on type of material. Generally better accuracy than oven dry tests

- Analog 0-20 mA, 4-20 mA, 0-10V, digital RS232 & RS485 multidrop outputs.

- Calibration via RS232/RS485 connection to Windows software on external control computer, laptop, etc.

- Multiple material calibrations allow different material to be used in the same bin with same sensor.

- Thick, tough ceramic faceplate and stainless steel body are guaranteed for 5 years, last a lifetime.

- Waterproof, sealed body and connector.

- Simple one-hole mount. Length of body allows correct installation without extra fixtures or welding.

- Pre-calibrated for your chosen material, to allow immediate use with fair results in most cases. Note that calibration is always required for best results, since all natural materials differ from place to place.

- Safe – meets all applicable regulations

- Software ignores erratic readings from loose material during flow and averages readings during flow period, eliminating errors due to dry or wet spots, for use on either current or following batch with good results.

- For continuous feed, can give running average.

- Gradual update when no batching occurs, to adapt to changing moisture prior to next batch.

- Empty bin detection holds previous readings and gives output signal for alarm etc.

- Three display possibilities: separate digital display or via RS232 or RS485 to computer or PDA.

- Temperature of material available through digital output.

6.2. Specifications

Measuring range: 0 – 20% moisture, calibrated for sand. Other ranges and materials on request. Can be calibrated for surface or total moisture, "wet" or "dry" calculation basis.

Material limits: From powder to ¼" granule size. Readings become more erratic as size increases.

Sensing volume: 2" X 2" X 4" at 4% moisture.

Analog output: 0-20mA, 4-20mA, 0-10V etc. by use of external resistor.

Digital RS232 & RS485 connection: Bidirectional, industry standard protocol and command structure supports up to 16 sensors on the same RS485 line.

RS232/RS485 Display & setup: Windows software displays readings, and allows access to setup and calibration menus.

Material calibration storage: Up to 10 separate sets of material calibration parameters.

Power: 11 - 30VDC, 100mA

Sampling input: Dry contact or relay from feed gate signal. Optional replaceable relay in junction box.

Bin low output: Open collector transistor to drive relay or PLC input. Optional 140VAC 6A solid-state relay in junction box.

Temperature range: Full accuracy: 0-50°C (32-120°F) Reduced Accuracy: 0-80°C (32-175°F)

Construction: 304 stainless steel body and flange with shatterproof extra hard alumina ceramic faceplate.

Size: 3-1/2" (89mm) diameter, 20" (508mm) long with 6" (152mm) adjustable flange for correct positioning.

Ø3.75 Hole
(Cut in bin wall)

Ø0.62
For $\frac{1}{2}$" Bolts

Ø4.75
Bolt Center
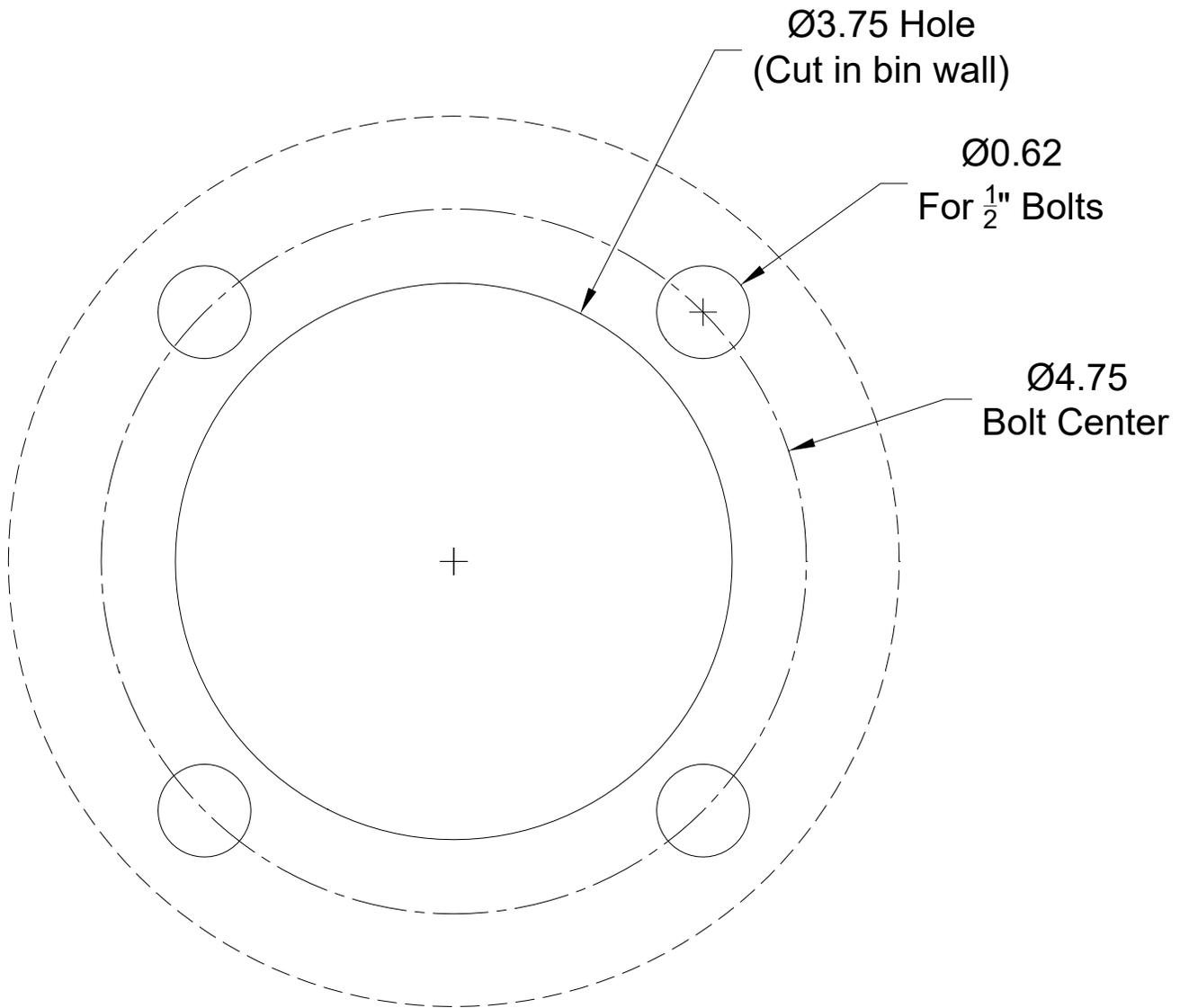
Figure 13: AquaSense Mounting & Drilling guide

MOISTURE SENSOR CALIBRATION CERTIFICATE

Sensor Serial No._____   Date: _____

Calibrated in Material Type:_____

Requested Moisture Range of Operation: _____% to _____%

Moisture based on "DRY" Method:

Moisture% = $\underline{\text{100x (Weight Wet – Weight Dry)}}$
Weight Dry

Results of Lab Tests:

SATISFACTORY   ERRATIC READINGS   NON-LINEAR

INSUFFICIENT SENSITIVITY   REQUIRES RECALIBRATION DURING OPERATION

Comments: _____
_____

Output Range:

Minimum Limit: 0_____% Moisture gives output of   4.0mA   Default ☐

0.0V   Default ☐

_____   Default ☐

Maximum Limit: 20_____% Moisture gives output of   20.0mA   Default ☐

10.0V   Default ☐

5.0V   Default ☐

_____   Default ☐

Display Unit Model 1278 / 1279 Supplied with Sensor

0_____% Moisture at an input of 4.0mA

20_____% Moisture at an input of 20.0mA

Tested and Certified by: _____

SCALE-TRON INC.
AQUASENSE GUARANTEE

BREAKDOWN

Scale-Tron Inc. hereby guarantees that any AquaSense product which fails electrically within ten (10) years after purchase will be repaired or replaced at no charge to the owner. (Excluding shipping)

WEAR

Scale-Tron Inc. also guarantees that should the body, faceplate or flange, fail due to excessive wear within ten (10) years after purchase, it will be rebuilt or replaced at no charge to the owner.

This guarantee is valid only if the installation instructions in the owner's manual are followed and the device is not installed on the same surface as a vibrator or other device which creates repetitive shock loads. The warranty claim will be refused if the damage is found to be due to negligence in the installation or use of the device.

Units must be properly protected for shipping and shipped prepaid to our Dollard des Ormeaux plant, together with the name of the owner's representative and a description of the fault. Scale-Tron Inc. is not responsible for damage caused by shipping, if not packed properly and shipped in the original or equal container.

Scale-Tron Inc.
2113C St. Regis, Dollard Des Ormeaux, Quebec, H9B 2M9
Tel: (514) 940-0337
service@scaletron.com

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SCALE-TRON

2113C St. Regis, Dollard Des Ormeaux, QC, H9B 2M9, Canada
Phone: 1 514 940 0337

Website: www.scaletron.com
Email: service@scaletron.com