



HydroSense3 Display Meter & Needle Sensor



SKT 800

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If you have any queries, please do not hesitate to contact our technical team by any of the methods above.

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1. INTRODUCTION

The HydroSense3 is a small meter designed to provide a readout from various sensors concerned with measuring soil moisture.

HydroSense3 is primarily intended for use with tensiometers, either electronic or 'septum' types. Tensiometers will measure the 'suction' required to get water from a given soil. This is the matric (or matrix) potential that binds water to soil particles and which must be overcome for plants to derive water from the soil. It is often measured in Bars and in soil is usually below zero (negative).

These tensiometers both use a small semiconductor pressure transducer to measure the pressure inside the tensiometer. In 'electronic' tensiometers the transducer is built in to the tensiometer. For 'septum tensiometer' types a 'needle sensor' is used to measure tensiometer pressure. This is essentially the same sort of semiconductor pressure transducer but connected to the tensiometer temporarily via a hypodermic needle through the tensiometer's rubber septum.

Measurements from both of these tensiometer types require a stable excitation voltage for the transducer, and the ability in the meter to measure the low level signals. HydroSense3 is designed for this.

Other popular types of soil moisture sensor will measure the volumetric water content of soil. Typical of these is the 'ThetaProbe' manufactured by Delta-T Devices. The HydroSense3 will read water content directly from the ML2x ThetaProbe.

HydroSense3 will read the soil moisture output in millivolts from other similar sensors made by various manufacturers.

Other types of soil moisture sensor such as Gypsum Blocks can be used with a suitable interface. Skye offer interfaces for several types of sensor made by other manufacturers.

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2. OVERVIEW OF OPERATION

Install the battery provided by removing the battery cover plate on the back of the HydroSense. Ensure that it is correctly fitted with the correct polarity.



Attach the sensor to be used via the 5-pin socket located at the top of HydroSense, by matching the sensor and plug using the locating pin, then screwing it finger tight. There is only one way the socket and plug will match, please be careful.

The HydroSense3 will introduce itself and check the battery at switch-on. It will go straight into 'Read Sensor' mode. The HydroSense3 will retain its last used setup - it will use the calibration factors of the sensor in use when it was previously switched off. This is probably the way the HydroSense3 will be most used.

In 'Read Sensor' mode, up to 100 spot readings may be stored by pressing the <store/next> button and the display may be frozen or held by pressing the <enter/hold> button (press again for normal reading).

Additionally the readings from the sensor can be displayed in two different units by pressing the <up> and <down> buttons. This toggles between the two calibration factors that can be set for each sensor. For example the reading from a given tensiometer can be seen in Hectopascals or Bar or any units that are chosen when the HydroSense3 is set up.

The menu structure is accessed by pressing <escape>. The various menu functions are detailed in later sections of the manual. Stored data can be reviewed, sensor calibrations entered etc., by entering a chosen 'menu option'. When menu options are being displayed this be referred to as 'menu mode'.

A long press of <escape/off> will switch off the HydroSense3.

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3. DETAIL VIEW

3.1 Display

A lot of information is available on the display. There is a general pattern of showing a reading or figure being edited on one line while a description of the function is displayed on the second.

In 'Read Sensor' mode, an 'H' at the end of the display line shows that the readout is 'held' or 'frozen' (press <enter/hold> to restore continuous readings). Also in this mode, a 'Z' indicates that a temporary zero offset is in use (switch HydroSense3 off and back on, or enter 'Needle Sensor Zero' mode to cancel it).

3.2 Keypad

There are six buttons, three with double function.



- A brief press to start the HydroSense3. Will have no effect after this.



- Long press will switch off the HydroSense3.
- Brief press will either stop the current process (without making any pending changes), or leave the current menu item to return to 'menu mode'. If the display is being 'held' or 'frozen' in 'Read Sensor' mode, pressing <escape> will restore regular display readings.



- pressing this will cause the display to be 'held' or 'frozen' from 'Read Sensor' mode.
- from 'menu mode' it will start the displayed menu option routine.
- from certain menu options where items are being edited, pressing <enter/hold> will cause the new value to be used and or stored.



- in 'Read Sensor' mode this will store the value currently being displayed in the next storage location (1 to 99 inclusive).
- in 'menu mode' this will move to display the next menu option.
- in menu options that involve a sequence of displayed items it will move to display the next item.
- in menu options that involve editing it will move the cursor to the next item to be edited.

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- in 'menu mode' this will move to display the previous menu option in the list.
- in a menu option that involves editing an item this will offer the previous character in the sequence.
- in an alphaNumeric editing option a long press (hold until a beep is heard) will set a 'space' character under the cursor. The up/down sequence continues from this position.



- in 'menu mode' this will move to display the next menu option in the list.
- in a menu option that involves editing an item this will offer the next character in the sequence.
- in an alphaNumeric editing option a long press (hold until a beep is heard) will set a 'space' character under the cursor. The up/down sequence continues from this position.

N.B.

In menu options that involve alphaNumeric editing, the sequence of characters is.....

'A to Z', 'a to z', 'space', '-', '/', 'µ', '%', '0 to 9', 'A to Z', etc.

In menu options that involve numeric editing, the sequence of numbers is.....

'0 to 9', '-', '.', '0 to 9', etc.

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4. FIRMWARE DETAIL

When <escape/off> is pressed in 'Read Sensor' mode (remember this is the mode that is entered at switch on) the HydroSense3 enters 'menu mode'. The <up>, <down> and <store/next> keys will scroll up and down through the following list of menu options:

- Read Sensor
- Sensor to Use
- Needle Sensor Zero
- Check Battery
- Display Records
- Erase Records
- Read Sensor Setup
- Write Sensor Setup
- AutoOff Period
- Message Duration
- Beeper Sounds
- Serial Number
- FirmWare Version
- Contact Skye
- The Skye Team

These menu options are described in more detail on the following pages.

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5. MENU OPTIONS

5.1 Read Sensor Mode



This is the mode that is automatically entered when the HydroSense is switched on. The HydroSense3 will show a 'Welcome' message, check the battery, perform internal zeroing and calibration before entering this mode and displaying the current readings.

The only way out is to press `<escape/off>`.

In this mode the display will show continuous readings from the sensor that is connected to the input socket, modified by the current calibration factors (sensor setup). The current calibration are those last set by the next menu option in the list - 'Sensor to Use'.

Warning - If these are not the correct calibration factors for the sensor connected, the readings will be wrong! The factors last used will be remembered even though the HydroSense3 is switched off. When this mode is started, from switch on or menu mode, the DESCRIPTION of the sensor in use will be displayed for a brief period (the length of time the message can display for is set in the 'Message Duration' menu option'). So, be sure to use meaningful descriptions of your sensors. If in doubt exit the routine and check in the next option 'Sensor to Use'.

The display can be held (frozen) at any time by pressing the `<enter/hold>` button. A moving letter 'H' will show in the top right part of the display to show that you are in 'Hold' mode. Restore regular display of readings by pressing `<enter/hold>` again (a brief press of `<escape>` will also cancel the hold function).

The displayed reading can be stored at any time by pressing the `<store/next>` button. The display will show a message to confirm storage.

N.B. The stored reading will be in the units displayed on the screen at the time of pressing `<store>`

If the Needle Sensor Zero is in operation, a 'Z' will be displayed in the bottom left corner of the display. This temporary offset is cancelled by switching off the unit, or by entering the 'zero needle sensor' and then pressing `<escape>`.

(Only the 'temporary' zero offset set in the 'Needle Sensor Offset' routine will be lost when the HydroSense is switched off).

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5.2 Sensor to use



In this menu option you select the sensor which is connected to the input socket. The sensors will have already been set up in the menu option "Wr Sensr Setup" - Write Sensor Setup.

There is the facility of having 25 pre-configured sensors, making it very easy and smooth to change from one sensor to another, for example from an electronic tensiometer to a needle sensor, or from one electronic tensiometer to another

5.3 Needle Sensor Zero



When a sensor is calibrated its zero offset value is recorded at the time and conditions of calibration (the zero offset is shown on the calibration certificate which accompanies the sensor). This value may change a little, with temperature for example, and this routine offers a way of precisely offsetting the zero of a sensor such as a Needle Sensor.

With this routine, the Needle Sensor is held in its normal operating position, but not attached to a tensiometer. This is a zero signal state.

The instructions to undertake this routine are shown on the display, but due to the fact that the display is only 2-lines and 14 characters per line, it isn't possible to show the instructions in one window.

The instructions are as follows:

The Needle Sensor must be connected to the HydroSense, but the Needle Sensor must be separated from the tensiometer. Hold the Needle Sensor vertically. The reading on the second line is the zero offset. Press <enter> to store. This offset will then be automatically applied to the readings.

Remember - entering a zero offset in this routine is temporary. It is lost at switch on/off. This routine has been included for those users who want/require extremely precise measurements. As there is always a slight variation in the offset value this routine needs to be undertaken every time the Needle Sensor is used, and this is why the value entered is not retained after the HydroSense is switched off.

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5.4 Check battery



The actual battery voltage is shown on the top line and the second line gives an indication of the battery status, ie 'low', 'medium' or 'good' and whether it is time to change the battery.

Battery Status	- 8.1 volts and above "Good Battery"
	- 6.9 to 8.0 volts "Medium Battery"
	- 6.0 to 6.8 volts "Low Battery"
	- 5.9 volts and below "Change Battery"


Typical battery life is 14 hours of use. This is calculated using Alkaline Manganese cells and low current sensors such as electronic tesniometers and needle sensors. Using sensors such as the Thetaprobe MLX2 will result in a lower battery life.

5.5 Display Records



If no data has been stored then the the message "No datapoints in memory" is displayed.

Alternatively, the data can be downloaded and read on a PC screen by purchasing the HydroSense Offloading Option.

Pressing <enter> displays the record number followed by the data on the top line. The second line alternates between the Sensor Number and the measurement units (as set up in the 'Write Menu'). The  moves you up and down the record numbers.

5.6 Erase Records



When this option is selected the first screen asks if you are sure. The second screen explains that <enter> will erase all records and the third screen informs you that <escape> will cancel the 'erase' function.


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If you choose <escape> a message informs you “records remain unaltered”.

5.7 Read Sensor Setups



This routine allows you to scroll through the configurations you have setup for each sensor that you intend to use and have setup in the following menu “Wr Sensr Setup”. There are up to 25 sensors possible.

Pressing <escape> in any of the screens returns you to the 'main menu' and pressing the  takes you to the previous or next window in the sequence.

Screen 1.

Using the up and down keys scrolls through the sensor numbers. Choose the sensor number you wish to view and press <enter>.

Screen 2

This tells you which sensor number you are viewing.

Screen 3

The top line shows you the sensor number with the description you have allocated to that sensor number on the second line. The top line will alternate with the 'sensor number' and the word 'description' to indicate that the second line is the description of the sensor number. Press <enter>.

Screen 4

This screen shows you the measurement units that you have allocated to the sensor number. The top line alternates with the sensor number and the words 'units (scale 1)'. The second line shows you the units, eg hectopascals. Press <enter>.

Screen 5

This screen shows you the number of units per mV for scale 1. When sensors are calibrated they are calibrated in units per mV. This figure is shown on the calibration certificate and will have been entered through the “Wr Sensr Setup”. Press <enter>.

Screen 6

This shows you the 'offset' in mV for scale 1. During the calibration procedure sometimes a small reading is observed from the pressure transducer. This is referred to as a 'zero offset' and needs to be subtracted from the true pressure reading when the sensor is deployed. This offset figure will have been entered in the “Wr Sensr Setup” routine. Press <enter>.

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Screen 7

This shows you the offset in the units shown in screens 4 & 5 for scale 1, that has been entered, to allow for the tensiometer length. (see appendix X). When tensiometers are full the water, there is a hydrostatic column of water. This needs to be compensated for in the final measurements, so a figure is entered during the setup procedure according to the length of tensiometer to be used. The top line alternates between 'sensor number', length offset Scale 1 and the word 'hectopascals'. The second line shows the offset value. Press <enter>. Please refer to Appendix X for a list of tensiometer lengths v. offset to enter.

Screens 8 to 11

Repeats procedures that are shown on screens 4 to 7 but for scale 2.

Screen 12

Shows the calibration excitation in mV that was applied during the calibration procedure. The top line alternates between the sensor number and the words "calib exctn mV". The second line shows the value in mV. Press <enter>.

N.B. This routine is only relevant to sensors, such as tensiometers, that have a transducer using the excitation voltage provided by the HydroSense3, and whose scaling is dependent on and ratiometric to this excitation. For sensors not requiring this (eg, Thetaprobe) 0.0 will be seen here.

Screen 13

This is the connection mode that is required for the type of sensor deployed. The top line alternates between sensor number and the words "connect'n mode". The second line shows the mode in use. Press <enter>.

For the vast majority of sensors this will be 'mode 3' - a fully differential input. Some sensors may require modes 4 or 5.

You are now back to the main menu options.

5.8 Write Sensor Setups.



Overview

The Hydrosense3 holds 25 Sensor Setups and calibration factors - these are built into the HydroSense and referred to as 1 to 25 inc. Each ID refers to the calibration factors and connections of a

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sensor that will be used with HydroSense3. This is also referred to as a Sensor 'setup'. Each setup will have two sets of scaling factors. These can be used to view the reading from the sensor in two different units, for example hectopascals and millibars. The Display can be switched between these with the Up/Down buttons.

The following shows an overview of the parameters to be configured in this routine:

Description	- 14 characters that will describe the sensor
Units for Scale 1	- Scale factors 1 - an alphaNumeric name of the units used, 12 characters
Units per mV - Scale factors 1	- the number of 'units' in a mV of sensor output for scale 1
Zero Offset mV - Scale factors 1	- the zero offset of the sensor - in mV for scale 1
Length offset - Scale factors 1	- Only applicable to electronic tensiometers. The signal to be offset due to the hydrostatic length of the tensiometer. This must be entered in the units of the scale - see calibration certificate for values of most units.
Units for Scale 2	- Scale factors 2 - an alphaNumeric name of the units used, 12 characters
Units per mV - Scale factors 2	- the number of 'units' in a mV of sensor output for scale 2
Units per mV - Scale factors 2	- the zero offset of the sensor - in mV for scale 2
Zero Offset mV - Scale factors 2	- the zero offset of the sensor - in mV for scale 2
Length offset - Scale factors 2	- Only applicable to electronic tensiometers. The signal to be offset due to the hydrostatic length of the tensiometer. This must be entered in the units of the scale - see calibration certificate for values of most units.
Connection Mode	- The Hydrosense3 has a fully differential input, but it can be electronically configured to best suit different sensors. The vast majority of sensors used with the HydroSense will need 'Mode3' - a full floating differential input. This will be the case for pressure transducer sensors and electronic probes such as the ThetaProbe. In such examples, the ground return path for the input currents is part of the sensor. For some inputs the sensor can be referenced to ground or a 2.5volt reference at the Hydrosense3 input - modes 4 and 5 respectively. Such modes may be required for a simple thermocouple or specialist sensors. Please contact Skye if in doubt.

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Excitation Voltage connection – Sensors that will use the excitation voltage from the Hydrosense3 are often calibrated for a fixed excitation voltage. For Skye sensors this is usually 5.000volts. The Hydrosense3 has a very stable and consistent excitation supply but it is not set to precisely 5.000 volts. To allow for this, the HydroSense will scale itself to allow for the difference between its internal excitation voltage and the voltage employed when the sensor was calibrated (range 3.000 to 10.600volts). Please enter the voltage used at the time of calibration in mV (see calibration certificate) or, if no allowance is required or wanted, enter zero here. Zero is the default value.

Press <enter> to start this routine.

Screen 1

Enter passcode.

This is a safety feature to stop any accidental changes being made to the sensor configurations.

The 'passcode' is the last 3 numbers of the serial number. This can be found either on the back of the instrument or in the menu option <serial number>.

Use the  keys to enter the individual numbers and  to move to the next position.

Pressing <next> will take you back to the first position, so that you can start again.

Press <enter> when the third number has been entered. Invalid entries will return a message "Invalid Code. Please reenter".

Screen 2

The top line shows you that you are in the *Edit Setup* routine and line 2 refers you to the sensor number you are setting up. The  keys move you to the next sensor number.

Press <enter>.

Screens 3, 4, 5 & 6

The next four screens display simple instructions of the procedure – editing the parameters (screen 3) one by one, <enter> (screen 4) saves the new entry (screen 5) and <escape> keeps the original entry (screen 6).

Screen 7 & 8

The top line displays the description that was previously applied to the sensor number you are editing. Confirmation of the sensor number flashes on the 2nd line with an indication that the description can be edited.

The cursor will be flashing on the top line under the first character. Use the  keys to enter or change the description.

Please take care when entering characters as there is no facility of going back. Pressing <escape> retains the original entry and takes you to the next parameter.

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See 'Keypad Detail' on page 4 for details of the alphanumeric sequence of the 'up' and 'down' keys.

Press <enter> to accept the new description or <escape> to retain the original description. A message informing you that entry has been accepted is displayed.

Screen 9 & 10

Setting the units for scale 1.

The top line either displays the measurement units that were previously entered for this sensor number or shows the default unit (see appendix 4 for a list of the default values for each sensor number) and is waiting for a description to be entered.

The 2nd line confirms the sensor number you are configuring.

The cursor will be flashing on the top line under the first character. Use the  keys to enter or change the description.

If you make a mistake then carry on inputting to the end of the line and pressing <next> will take you back to the beginning of the line.

See 'Keypad Detail' on page 4 for details of the alphanumeric sequence of the 'up' and 'down' keys.

Press <enter> to accept the new description or <escape> to retain the original description. A message informing you that entry has been accepted is displayed.

Screens 11 & 12

Here you are entering the Units per/mV for scale 1. This figure will be shown on the calibration certificate supplied with the tensiometer or needle sensor. **Please note that this is units per mV. If your certificate shows units per volt, then you need to convert volts to mV (there are 1000 mV in 1 volt).**

Example calibration certificates are shown in Appendices 7 & 8

The cursor will be flashing on the top line under the first character. Use the  keys to enter or change the value.

If you make a mistake then carry on inputting to the end of the line and pressing <next> will take you back to the beginning of the line.

See 'Keypad Detail' on page 4 for details of the alphanumeric sequence of the 'up' and 'down' keys.

Press <enter> to accept the new value or <escape> to retain the original value. A message informing you that entry has been accepted is displayed on the next screen.

Screens 13 & 14

Now you need to enter the zero offset in mV for scale 1. This will be indicated on the calibration certificate that is supplied with the sensor.

Again the top line is the value that is editable and the 2nd line alternates between the

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sensor number that is being configured and the parameter that is being configured.

The cursor will be flashing on the top line under the first character. Use the  keys to enter or change the description.

If you make a mistake then carry on inputting to the end of the line and pressing <next> will take you back to the beginning of the line.

See 'Keypad Detail' on page 4 for details of the alphanumeric sequence of the 'up' and 'down' keys.

Press <enter> to accept the new value or <escape> to retain the original value.

A message informing you that entry has been accepted is displayed on the next screen.

Screens 15 & 16

'Length Offset' is only relevant to tensiometers. (Press <escape> to move onto the next parameter if you do not have a tensiometer). A value needs to be entered here to compensate for the hydrostatic column of water. Please refer to Appendix 4 for the value to enter here.

The cursor will be flashing on the top line under the first character. Use the  keys to enter or change the description.

If you make a mistake then carry on inputting to the end of the line and pressing <next> will take you back to the beginning of the line.

See 'Keypad Detail' on page 4 for details of the alphanumeric sequence of the 'up' and 'down' keys.

Press <enter> to accept the new value or <escape> to retain the original value.

A message informing you that entry has been accepted is displayed on the next screen.

This completes the setup for the Sensor Number and scale 1.

You now need to set up the same Sensor Number for scale 2.

Having two scales for the same sensor can be very useful in some applications, ie hectopascals and millibar, or with a Thetaprobe ML2X %moisture and mV.

The following screens follow the same procedure as screens 9 to 16.

If you decide not to setup a second scale, then you will still need to work your way through the setup by pressing <escape> until the end of the Write Setup Routine is reached.

Screen 25 & 26

This parameter allows you to enter the Calibration Excitation **in mV** as shown on the calibration certificate. If the certificate shows this in volts, then you will need to convert the figure to mV for entry in the HydroSense

The cursor will be flashing on the top line under the first character. Use the  keys to enter the value.

If you make a mistake then carry on inputting to the end of the line and pressing <next> will

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take you back to the beginning of the line.

See 'Keypad Detail' on page 4 for details of the alphanumeric sequence of the 'up' and 'down' keys.

Press <enter> to accept the new value or <escape> to retain the original value. The next screen confirms your edit.

N.B. Only sensors such as Electronic Tensiometers & Needle Sensors that use excitation require this routine to be completed. Enter 0.0 if no compensation is required.

Screen 27 & 28

This relates to the Connection Mode. Please see above for an explanation of Connection Mode. Mode 3 is the default mode. Pressing the  keys changes the Connection Mode number. Pressing <enter> accepts the mode and the next screen confirms the mode you have chosen.

Subsequent Sensors


The above procedure will need to be followed for each sensor you wish to setup. You can have 25 sensors pre-configured to use. They can be a mixture of types, ie a Needle Sensor, electronic tensiometers, theta probe, echo probe.

Care and time should be taken in setting up the sensors. Once this has been achieved then the Hydrosense system will be very easy and quick to use.

5.9 AutoOff Period



This option allows you set the time which the HydroSense remains powered if there is no activity, ie no press of the keys. This is a power-saving feature and will help to prolong battery life.

Pressing the  keys scrolls you through the choices of 5mins, 10 minutes, 15 minutes, 20 minutes, 30 minutes, 45 minutes and 60 minutes. Press <enter> to make your selection or <escape> to keep the original time period.

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6.0 Message Duration



Here you can set the length of time the warning and information message screens are displayed before moving onto the next one. The time intervals are 7 seconds, 5 seconds, 4 seconds, 3 seconds, 2 seconds, 1 second, 0.75 seconds, 0.5 seconds.

Pressing the  keys changes the time interval. Pressing <enter> will accept your choice and <escape> will retain your original choice.

It is useful to have the 7 second interval whilst familiarising yourself with the HydroSense and setting up the sensors, and then change to a shorter interval when the system is in use.

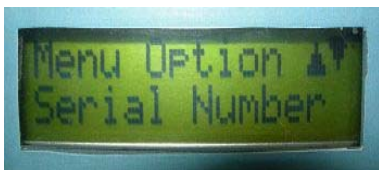
6.1 Beeper Sounds



Three choices here. No 'beep', 'minimal beep' and 'full key beep'. Try them and see!

Once again the  keys take you through the choices. Pressing <enter> accepts your choice and <escape> retains your original selection.

6.2 Serial Number



The serial number of your HydroSense. Only the <escape> key will work here!

6.3 Firmware Version



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This indicates the version of HydroSense and is only used by Skye for technical support purposes. Again only <escape> works here.

6.4 Contact Skye



Entering this option displays the Skye Instruments' email address, split over 2 lines due to the limitations of a 14 character LCD.

6.5 The Skye Team



In true Skye tradition, the Skye Designer always incorporates the Skye Team who were employed at the time of the design of your version of the HydroSense3.

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6. USE WITH OTHER SENSORS

Many different sensors can be used with the Hydrosense3.

Perhaps the most common will be soil dielectric measuring sensors such as the ThetaProbe MLX2.

The ThetaProbe MLX2 can be directly connected to the Hydrosense (using connection mode3). If the 'typical' scaling factors for dataloggers are entered into the HydroSense3 for the scale and zero factors, then percentage soil moisture can be read up to about 50% saturation (the ThetaProbe is excessively non linear beyond this range). The millivolt output can also be very precisely read by the Hydrosens3 for use with a look-up table or a spreadsheet from offloaded stored values.

Other dielectric sensor cans always be used with the HydroSense3, using their millivolt output signals.

HydroSense3

7. NEEDLE SENSOR (SKT 810)

The Skye Needle Sensor has been designed to be used with the HydroSense3 and Septum Tensiometers.

The Needle Sensor housing incorporates an electronic pressure transducer with connecting cable to the HydroSense3. The port of the pressure transducer fits into a machined luer fitting onto which is attached a hypodermic needle. A needle guide cover screws onto the body of the sensor.

The Needle Sensor is weatherproof and suitable for use outdoors as well as in glasshouses.

7.1 Operation

The Needle Sensor requires a 5v DC excitation and gives an output of typically 20mbar/mV over the range 0-850 mbar(hPa). The HydroSense has been designed for use with this sensor so no external power supply is required when using this sensor with the meter.

In use, the needle guide guides the Needle Sensor down the shaft of the septum tensiometer until the needle meets the septum stopper (a rubber diaphragm) of the tensiometer. More pressure is applied so that the needle pierces the septum stopper. This enables a pressure reading to be taken which is then displayed on the HydroSense Meter. After measurement remove the Needle Sensor by lifting it off in the same direction, taking care not to disturb the septum stopper. Repeat the procedure as required.

Remember to keep the septum stopper clean and free from grit and mud, etc as this will block the hole in the needle and affect readings.

7.2 Needle Replacement

The septum stopper in the tensiometer can be reused for up to 100 insertions of the needle. The syringe needle itself should have a life time of several hundred insertions as long as care is taken to keep the Needle Sensor vertical when piercing the septum stopper and not to go too fast!

The needle type is 16mm x 23g blue and can be purchased direct from Skye or your own/preferred supplier.

To replace the needle, unscrew the needle guide and remove the old needle by grasping it at the top on the colour bar. Give it a slight twist and the needle will come away from the luer fitting.

Keep the cover on the new needle and use this to fit the new needle, again apply a twist as you push it onto the luer fitting. Remove the needle cover and use this to house the old needle. Screw the

HydroSense3

needle guide back on.

Dispose of the old needle safely.

WARNING – TAKE CARE WHEN HANDLING THE NEEDLES AS THEY ARE EXTREMELY SHARP.



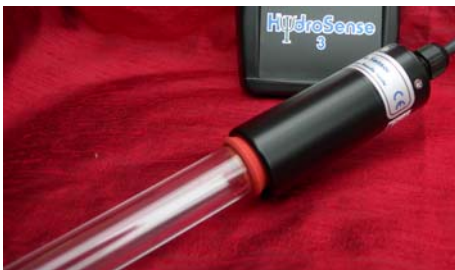
Unscrewing of the needle guide to expose the needle



Needle Guide unscrewed



Close-up view of the sensor body and needle



Sliding the Needle Sensor onto the Septum Tensiometer



The System

HydroSense3

8. PC OFFLOADING OPTION

This feature is purchased as an optional extra (SKT 820). Purchasing this interface and PC software enables the user to offload all stored records via the RS232 port on the HydroSense3 to a USB port on a PC. Also downloaded are the set-ups for all 25 sensors. Any sensors that haven't been setup will just show the default values.

8.1 Items Supplied

- a) PC to USB interface with connecting cable to 4 pin RS232 socket on the HydroSense3
- b) USB type A to USB type B cable for connecting interface to USB port of PC
- c) USB stick with PC software and device driver software

8.2 Installing the Device Driver

Plug the USB stick into a spare USB port of your PC.

Navigate to this drive and double-click the folder DRIVER.

Double-click the file CMD20828.EXE and follow the on-screen instructions.

The DRIVER folder also contains installation instructions for the different Windows operating systems, should you experience any problems.

8.2 Software Installation

The HydroSense3 PC software is found in the folder PC SOFTWARE on the USB stick. Double click this folder name and then double click SETUP. Follow the on-screen instructions.

Create an icon on your desktop



8.3 Operation

Connect the cable from the USB interface to the 4 pin socket on the HydroSense3. There is a slot on the 4 pin plug which lines up with a ridge on the 4 pin socket.

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Push and click the plug into place.

Switch on the HydroSense3 and make sure the meter is in MAIN MENU mode. Pressing <ESC/OFF> will return you to this mode if you are in another menu, ie READ.

DO NOT CONNECT THE HYDROSENSE TO THE PC UNTIL YOU HAVE COMPLETED THIS OPERATION.

Fit one end of the USB into the interface and the other end into a USB slot of your PC.

A message may appear on the PC task bar to say the device is being installed.

Double click the  icon on the PC desktop and click CONNECT.

If the USB port hasn't installed then HydroSense3 software will give instructions.

The following screen shows when communication has been made with the HydroSense3.



Click OFFLOAD DATAPOINTS.

Data will now be transferred from the HydroSense3 to the PC screen.

The following 'screen dump' is an example of what you will see on your screen.

HydroSense3



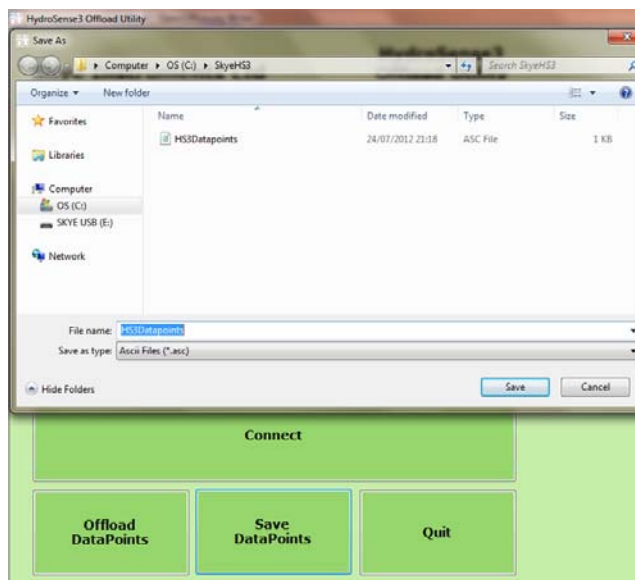
Skye Instruments Ltd HydroSense3 followed by the firmware version number, serial number of the instrument and the heading "Listing of Recorded Measurements"

Then follows a visual list of your data records: record number, sensor number, sensor description, measurement reading, units. Each factor is comma separated.

This is followed by a list of your 25 sensors with their configuration. Default settings are shown where no sensor has been setup.

To save the data to a file click SAVE DATAPOINTS.

The following screen is then displayed:



HydroSense3

Choose your filename and save the file to your preferred location.

Then click QUIT.

N.B.Quit closes the COM Port. If you need to download files again for some reason, then remove the USB connector for a few seconds and then re-connect.

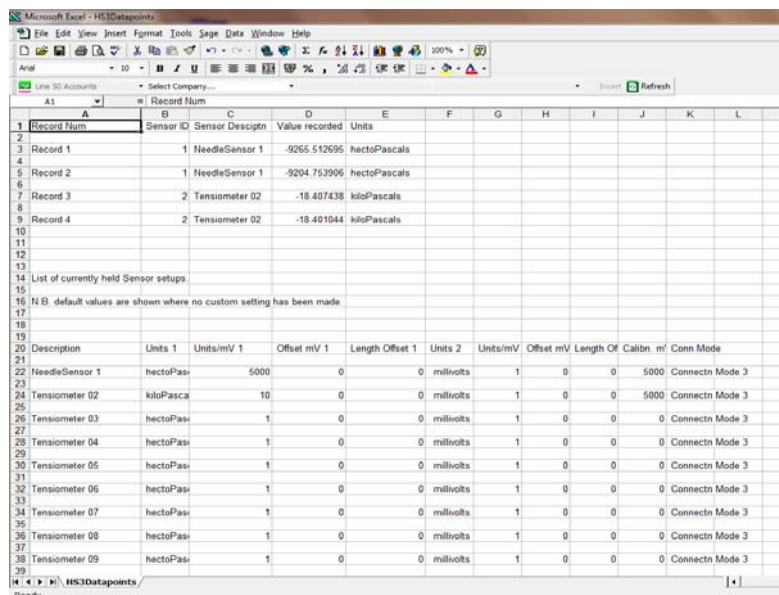
'Safely remove' the USB connector and switch off the HydroSense3

8.4 Accessing Saved Data

Open your spreadsheet programme, ie Excel and open the file you have just saved. The file has been saved with the .asc suffix (a text file), so make sure you select this in the 'file type' box.

Now import the file. You can choose to start the import at the first line of the data and thereby ignoring the heading text (or you can delete the rows after import). Make sure you select DELIMITED and COMMA SEPARATED in the file type choices.

You should then see a spreadsheet such as the following:



The screenshot shows a Microsoft Excel spreadsheet titled 'HS3DataPoints'. The data is organized into two main sections. The first section contains four data records, each with columns for Record Num, Sensor ID, Sensor Descriptn, Value recorded, and Units. The second section is a list of 25 sensors, with columns for Description, Units 1, Units/mV 1, Offset mV 1, Length Offset 1, Units 2, Units/mV, Offset mV, Length Of, Calibrn, m, and Conn Mode.

Record Num	Sensor ID	Sensor Descriptn	Value recorded	Units
Record 1	1	NeedleSensor 1	-9265.512695	hectoPascals
Record 2	1	NeedleSensor 1	-9204.753906	hectoPascals
Record 3	2	Tensiometer 02	-18.407438	kiloPascals
Record 4	2	Tensiometer 02	-18.401044	kiloPascals

Description	Units 1	Units/mV 1	Offset mV 1	Length Offset 1	Units 2	Units/mV	Offset mV	Length Of	Calibrn	m	Conn Mode
NeedleSensor 1	hectoPasc	5000	0	0	millivolts	1	0	0	5000		Connectn Mode 3
Tensiometer 02	kiloPasca	10	0	0	millivolts	1	0	0	5000		Connectn Mode 3
Tensiometer 03	hectoPasc	1	0	0	millivolts	1	0	0	0		Connectn Mode 3
Tensiometer 04	hectoPasc	1	0	0	millivolts	1	0	0	0		Connectn Mode 3
Tensiometer 05	hectoPasc	1	0	0	millivolts	1	0	0	0		Connectn Mode 3
Tensiometer 06	hectoPasc	1	0	0	millivolts	1	0	0	0		Connectn Mode 3
Tensiometer 07	hectoPasc	1	0	0	millivolts	1	0	0	0		Connectn Mode 3
Tensiometer 08	hectoPasc	1	0	0	millivolts	1	0	0	0		Connectn Mode 3
Tensiometer 09	hectoPasc	1	0	0	millivolts	1	0	0	0		Connectn Mode 3

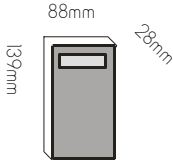
The data records are comma separated and each value is in a different column. Data records are shown first.

These are followed by a list of the 25 sensors, whether or not they have been configured. This gives a quick overview of how you have setup your sensors.

You can now manipulate your data as required and draw graphs,

HydroSense3

APPENDIX 1 HYDROSENSE3 SPECIFICATIONS

Enclosure:	Black ABS, Splashproof
Display:	Clear 14 Character LCD display on 2 lines
Auto-ranging:	Fully auto-ranging for ease of use
User menu options:	Read sensor, hold display, toggle units, battery test
Resolution :	20bit 'A to D' converter applied over 6 ranges (auto-ranging)
Sensor Input/Output:	compatible sensors include traditional electronic tensiometers, voltage o/p TDR probes, etc.
Excitation Voltage:	5V
Power:	1 x 9V PP3 battery. Up to 14 hour use (less with high current requiring sensors such as the MLX2 Thetaprobe)
Operating Range:	-20°C - +70°C 0 - 100% R.H
Connection:	5 pin Binder Panel-mounted Socket for sensors & 4 pin RS-232 output
Dimensions: 28mm	
Weight (inc battery):	290g

APPENDIX 2 – OFFSET VALUES FOR TENSIO METER SHAFT LENGTHS

Shaft Length	Length + 50% of ceramic bulb length	Static Pressure of Water Column
100 mm	125 mm	12.3 hPa
200 mm	225 mm	22.1 hPa
300 mm	325 mm	32.0 hPa
400 mm	425 mm	41.8 hPa
500 mm	525 mm	51.7 hPa
600 mm	625 mm	61.5 hPa
700 mm	725 mm	71.3 hPa
800 mm	825 mm	81.2 hPa
1000 mm	1025 mm	100.9 hPa

Table of various standard stem lengths with details of the static water pressure that must be subtracted to the apparent soil moisture pressure as indicated by the pressure transducer.

The formula to calculate other values is as follows:

$$1 \text{ mm H}_2\text{O} = 0.0984 \text{ hPa}$$

So that Static Pressure of Water Column (H Pa):

$$= (\text{Length of tensiometer shaft} + \text{length of ceramic bulb}) \times 0.0984$$

Please note that in highly saturated soils, or when standing in water, the effective length of the static water column is that length of the shaft that stands above the external water level.

APPENDIX 3 – OFFSET VALUES FOR MINI TENSIO METER SHAFT LENGTHS

Shaft Length	Length + 50% of ceramic bulb length	Static Pressure of Water Column
100 mm	112.5 mm	11.1 hPa
200 mm	212.5 mm	20.9 hPa
300 mm	312.5 mm	30.8 hPa
400 mm	412.5 mm	40.6 hPa
500 mm	512.5 mm	50.4 hPa
600 mm	612.5 mm	60.3 hPa
700 mm	712.5 mm	70.1 hPa
800 mm	812.5 mm	80.0 hPa
900 mm	912.5 mm	89.8 hPa
1000 mm	1012.5 mm	99.6 hPa

Table of various standard stem lengths with details of the static water pressure that must be subtracted to the apparent soil moisture pressure as indicated by the pressure transducer.

Assumes the tensiometer is installed vertically

The formula to calculate other values is as follows:

$$1 \text{ mm H}_2\text{O} = 0.0984 \text{ hPa}$$

So that Static Pressure of Water Column (H Pa):

$$= (\text{Length of tensiometer shaft} + \text{length of ceramic bulb}) \times 0.0984$$

Please note that in highly saturated soils, or when standing in water, the effective length of the static water column is that length of the shaft that stands above the external water level.

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APPENDIX 4 – DEFAULT SETTINGS FOR EACH SENSOR NUMBER

SENSOR NUMBER	DESCRIPTION	SCALE 1	SCALE 2
1	Needle Sensor	HectoPascals	mV
2	Tensiometer 02	KiloPascals	mV
3	Tensiometer 03	HectoPascals	mV
4	Tensiometer 04	HectoPascals	mV
5	Tensiometer 05	HectoPascals	mV
6	Tensiometer 06	HectoPascals	mV
7	Tensiometer 07	HectoPascals	mV
8	Tensiometer 08	HectoPascals	mV
9	Tensiometer 09	HectoPascals	mV
10	Tensiometer 10	HectoPascals	mV
11	Tensiometer 11	HectoPascals	mV
12	Tensiometer 12	HectoPascals	mV
13	Tensiometer 13	HectoPascals	mV
14	Tensiometer 14	HectoPascals	mV
15	Tensiometer 15	HectoPascals	mV
16	Tensiometer 16	HectoPascals	mV
17	Tensiometer 17	HectoPascals	mV
18	Tensiometer 18	HectoPascals	mV
19	Tensiometer 19	HectoPascals	mV
20	Tensiometer 20	HectoPascals	mV
21	Tensiometer 21	HectoPascals	mV
22	Tensiometer 22	HectoPascals	mV
23	Tensiometer 23	HectoPascals	mV
24	ThetaML2X Orga	% Moisture	mV
25	ThetaML2X Minl	% Moisture	mV

APPENDIX 5 CONVERSIONS BETWEEN UNITS OF PRESSURE OR SUCTION

1 bar = 0.9869 atmosphere (atm)

1 bar = 100 centibar (cbar)

1 bar = 1000 millibar (mbar)

1 centibar (cbar) = 10 millibar (mbar)

1 millibar (mbar) = 1 hectoPascal (hPa)

1 kiloPascal (kPa) = 10 hectoPascal (hPa)

1 atmosphere (atm) x 1013.25 = 1 millibar (mbar)

1 pounds / square inch (psi) x 68.946 = 1 millibar (mbar)

1 millimetres of mercury (mmHg) x 1.33322 = 1 millibar (mbar)

1 inches of mercury (inHg) x 33.864 = 1 millibar (mbar)

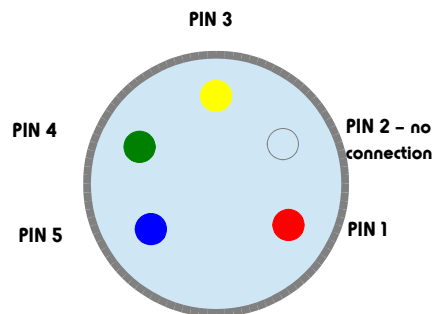
APPENDIX 6 INTERPRETATION OF SOIL SUCTION READINGS

0 hPa (mbar)	A reading of zero means that the soil is completely saturated with water. A zero reading for long periods indicates poor drainage conditions and may cause disease development.
10-100 hPa (mbar)	There is a surplus of water in the soil. Persistent low readings may indicate poor drainage conditions.
100-200 hPa (mbar)	There is plenty of both water and air in the soil for healthy plant growth. It is advisable to stop irrigation when these readings are reached, as additional water may drain away and be wasted.
200-400 hPa (mbar)	There is adequate water and air in the soil for plant growth. In sandy soils, irrigation may be advisable.
400-600 hPa (mbar)	There is adequate water and air in fine or clay soils for plant growth. In medium soils, irrigation may be advisable. In sandy soils irrigation is required.
600-800 hPa (mbar)	Readily available water is scarce except in heavy clay soils. Irrigation is required for fine and medium soils. Plant damage may occur in sandy soils.
800-1000 hPa (mbar)	It is not advised to let soils get this dry, as plant damage may not be reversible.

Note: These interpretations must be regarded as advisory only, and may be crop dependant.

APPENDIX 7 WIRING DETAILS

5 PIN SOCKET – INSIDE VIEW



Pin 1 - Red +ve

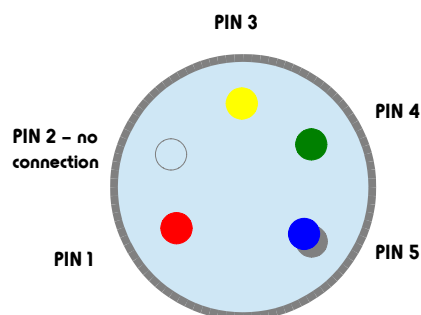
Pin 2 - no connection

Pin 3 - - output

Pin 4 - + output

Pin 5 - Blue - ve

5 PIN PLUG WIRING – INSIDE VIEW (NEEDLE SENSOR / ELECTRONIC TENSIO METER)



Pin 1 - Red +ve

Pin 2 - no connection

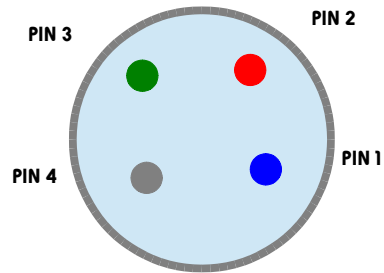
Pin 3 - -output

Pin 4 - +output

Pin 5 - Blue/Grey -ve & screen of the cable

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4 PIN SOCKET (RS232) – INSIDE VIEW



- Pin 1 – Blue TXD
- Pin 2 – Red +ve
- Pin 3 – Green RXD
- Pin 4 – Grey Ground

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APPENDIX 8 SAMPLE NEEDLE SENSOR CALIBRATION CERTIFICATE



SKYE INSTRUMENTS LTD
21,DDOLE ENTERPRISE PARK
LLANDRINDOD WELLS
POWYS LD1 6F U.K.
TEL:+44 (0)1597 824811
email:skyemail@skyeinstruments.com
website:www.skyeinstruments.com

CALIBRATION CERTIFICATE FOR SEPTUM TENSIO METER NEEDLE SENSORS

UNIT TYPE :-	SKT 810
SERIAL NUMBER :-	42998
DATE OF CALIBRATION :-	10/05/13
TEMPERATURE AT CALIBRATION :-	22 °C
CALIBRATION EXCITATION :-	5.000 Volts (5000.000 mV)
A/D UNIT :-	F5204
SENSITIVITY @5.000 volts :-	51.0 hPa /mV *
SENSOR ZERO OFFSET @5.000 volts :-	-0.12 mV
CONNECTION MODE :- (when used with the HydroSense)	3
CALIBRATED BY :-	
CHECKED BY :-	

*HectoPascals per millivolt of output.Based on mean value at mid scale value of 430hPa

Highlighted sections contains values that will be required in the "Write Sensor Setup".

APPENDIX 9 SAMPLE CALIBRATION CERTIFICATE FOR AN ELECTRONIC TENSIO METER



SKYE INSTRUMENTS LTD.
21, DDOLE ENTERPRISE PARK,
LLANDRINDOD WELLS,
POWYS LD1 6DF U.K.
TEL: +44 (0) 1597 824811
email: skyemail@skyeinstruments.com
website: www.skyeinstruments.com

CALIBRATION CERTIFICATE FOR ELECTRONIC TENSIO METERS

SENSOR TYPE	SERIAL NUMBER	SENSITIVITY hPa / mV	ZERO OFFSET mV
SKT600/I	42879	20.680	-0.039
SKT600/I	42880	20.789	0.135

DATE OF CALIBRATION :- 12/04/2013
.....

TEMPERATURE AT CALIBRATION :- 21°C
.....

CALIBRATION EXCITATION :- 5.000 volts (5000.000 mV)
.....

A/D UNIT :- F5204
.....

CONNECTION MODE:- 3
(for use with the HydroSense3)

CALIBRATED BY :- SKYE INSTRUMENTS LTD
.....


CHECKED BY :-
.....

Highlighted values will be required in the "Write Sensor Setup"

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APPENDIX 10 QUICK SETUP GUIDE

When the HydroSense3 is supplied on its own for use with previously purchased tensiometers / soil moisture sensors, then you will need to set up the HydroSense3 to use with these sensors. A quick set up guide is as follows:

- 1) Switch on the HydroSense3 by pressing <on> on the keypad.
- 2) The HydroSense is automatically in READ mode, so press <escape> on the keypad.
- 3) Using the  click down until you reach the following screen:



- 4) Click <enter>
- 5) Now go to page 10 of this manual. Read the 'overview introduction' and then follow the on-screen instructions as described on page 12 onwards.