Smart Sensor

Version 7.03

User Manual

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Greenspan Customer Service

Technical Support When You Need It

The correct choice of sensor should be supported by professional advice to ensure long term success in the field. **Greenspan Technical Services** is dedicated to customer support and provides assistance in the selection, installation, deployment and commissioning of sensors with a full range of consulting services.

A full technical support and field advice service can be accessed by ringing **Customer Service** on +61 7 4660 1888 between 8am - 6pm, 5 days a week.

All requests for information will be serviced within 24 hours.

All Greenspan products are designed, developed and manufactured in Australia and can be supplied at short notice.

Warranty Details

Greenspan warrants all new Greenspan products against defects in materials and workmanship for **12 months** from the date of invoice. During the warranty period, we will repair or, at our option, replace at no charge a product that proves to be defective provided that it is returned, shipping prepaid, to Greenspan Technology Pty Ltd.

Greenspan's liability and obligations in connection with any defects in materials and workmanship are expressly limited to repair or replacement, and the sole and exclusive remedy in the event of such defects shall be repair or replacement. Greenspan's obligations under this warranty are conditional upon it receiving prompt written notice of claimed defects within the warranty period and it's obligations are expressly limited to repair or replacement.

This warranty does not apply to products or parts thereof which have been altered or repaired outside of the Greenspan factory or other authorised service centre, or products damaged by improper installation or application, or subjected to misuse, abuse neglect or accident. This warranty also excludes items such as reference electrodes and Dissolved Oxygen membranes that may degrade during normal use.

Greenspan Technology Pty Ltd will not be liable for any incidental or consequential damage or expense incurred by the user due to partial or incomplete inoperability of it's products for any reason whatsoever or due to inaccurate information generated by its products.

All Warranty service will be completed as soon possible. If delays are unavoidable customers will be contacted immediately.

The sensors should not be dismantled unless under instruction from Greenspan. Incorrect handling will void the warranty.

Contents

INTRODUCTION TO SMART SENSOR 1

What the SMART SENSOR Can Do

The SMART concept provides a standard modular platform for the complete range of Greenspan sensor products. It enables the sensor to stand alone with the processing power normally associated with much larger data acquisition systems. The intelligence built into the Greenspan Smart Sensor allows measurement, storage and processing of raw data on multiple channels within a compact, rugged and technically advanced recording unit, able to withstand harsh environmental conditions.

The processing power of the system is powerful enough to include complete linearity correction and temperature stability over a wide range, thereby maintaining its factory accurate calibration while in the field. Each sensor is band run in a temperature controlled oven which establishes the sensitivity of the individual parameters to ambient temperature variations. The data collected during this process is used as a basis to provide software error correction for parameters over the specified temperature range. This process provides error correction of an order of magnitude better than traditional technologies.

The Greenspan Smart Sensor includes a special low power sleep mode to conserve battery power and reduce battery physical size. An interface software application called SmartCom is supplied with the sensor to enable setting up, manipulation and retrieval of data. Processing of data files for graphing and analysis is provided by Aquagraph.

Various alarm and triggering functions can be selected to activate external equipment such as water samplers, modem phone connections and warning alarms.

The following range of sensors or combination of sensors can be optioned with the smart system:

- Pressure
- Electrical Conductivity
- Dissolved Oxygen
- Turbidity
- pH
- Temperature
- ORP

AN OVERVIEW OF THE LOGGER 2

The Hardware

Each SMART SENSOR may consist of the following hardware:

- A data logger, with RS-232 connection.
- An integrated sensor head
- A robust weather proof, environmentally neutral housing, (Stainless Steel or Delrin)
- A standard multicore connection cable
- A long life battery pack (optional)
- A long life battery pack **without cable** (optional)

The microcomputer inside the logger supports communications, logging and data storage. An internal lithium battery, maintains the logger data when main battery power is removed.

RS232 connection between the logger and PC consists of:

Cabled Sensor

- Communications
- Alarm/Trigger outputs
- 8 - 15 volt input

Non Cabled Sensor

- RS232 Connector is contained within the Battery Pack; unit is fully sealed.

Battery life will depend on the battery type as well as the frequency of logging. Connection to a computer will drain the battery supply more quickly due to the higher current imposed by the RS232 serial data communications and will considerably reduce battery life. Please refer to Power Consumption section or contact Greenspan for advice on battery requirements specific to each sensor.

An additional internal lithium battery maintains logger data at all times but does not sustain the logging state. This battery is not user accessible and will maintain data for up to 10 years.

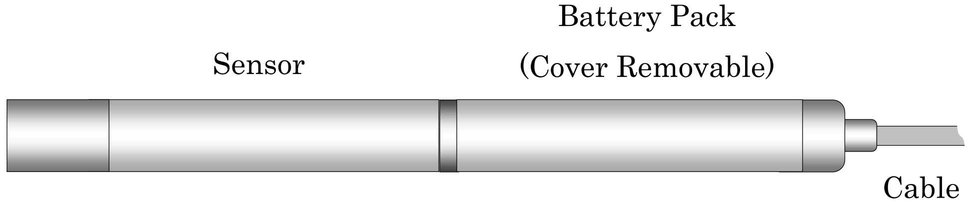


Figure 1. PS310 Example

There are two main connection options available for Smart sensor, a 7 pin male Hirschmann type (HS7) and an 18 pin Conxall (CX18). For each type a suitable communication cable is supplied. The standard RS232 connector on most PC 's is a male 9 pin DB9 type, therefore a matching female connector is required on the communications cable, (CC-700 or CC-300). Diagram 1 shows the wiring for this connector.

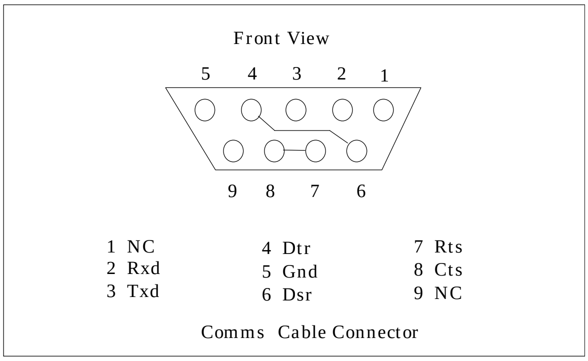
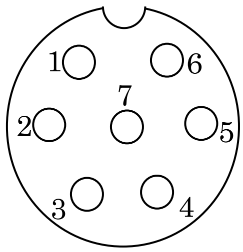


Diagram 1. DB9 Connector

Sensors fitted with an HS7 connector have flying leads for power connection and interface to the communication cable, CC-700. See Diagram 2 for sensor cable HS7 wiring.

Pin	Wire Colour	Function	Notes
1	Red	+12V	Red Flying lead
2	Yellow	TXD	
3	Violet	RXD	
4	White	DTR	
5	Green	GND	Black Flying Lead
6	Shield	SHLD	Yellow/Green Flying Lead
7	NA	NA	Not used



REAR VIEW
Connector HS7

Diagram 2. HS7 Connector, Sensor End

Sensors fitted with the CX18 connector are wired as follows:

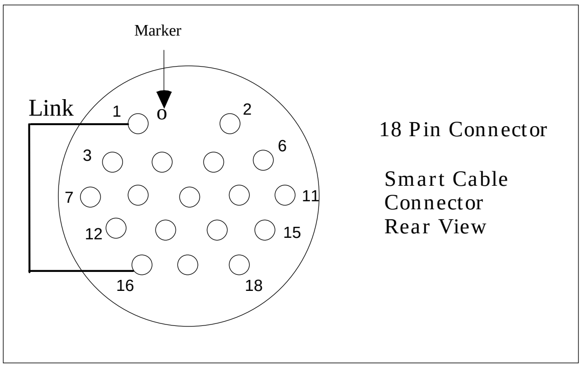


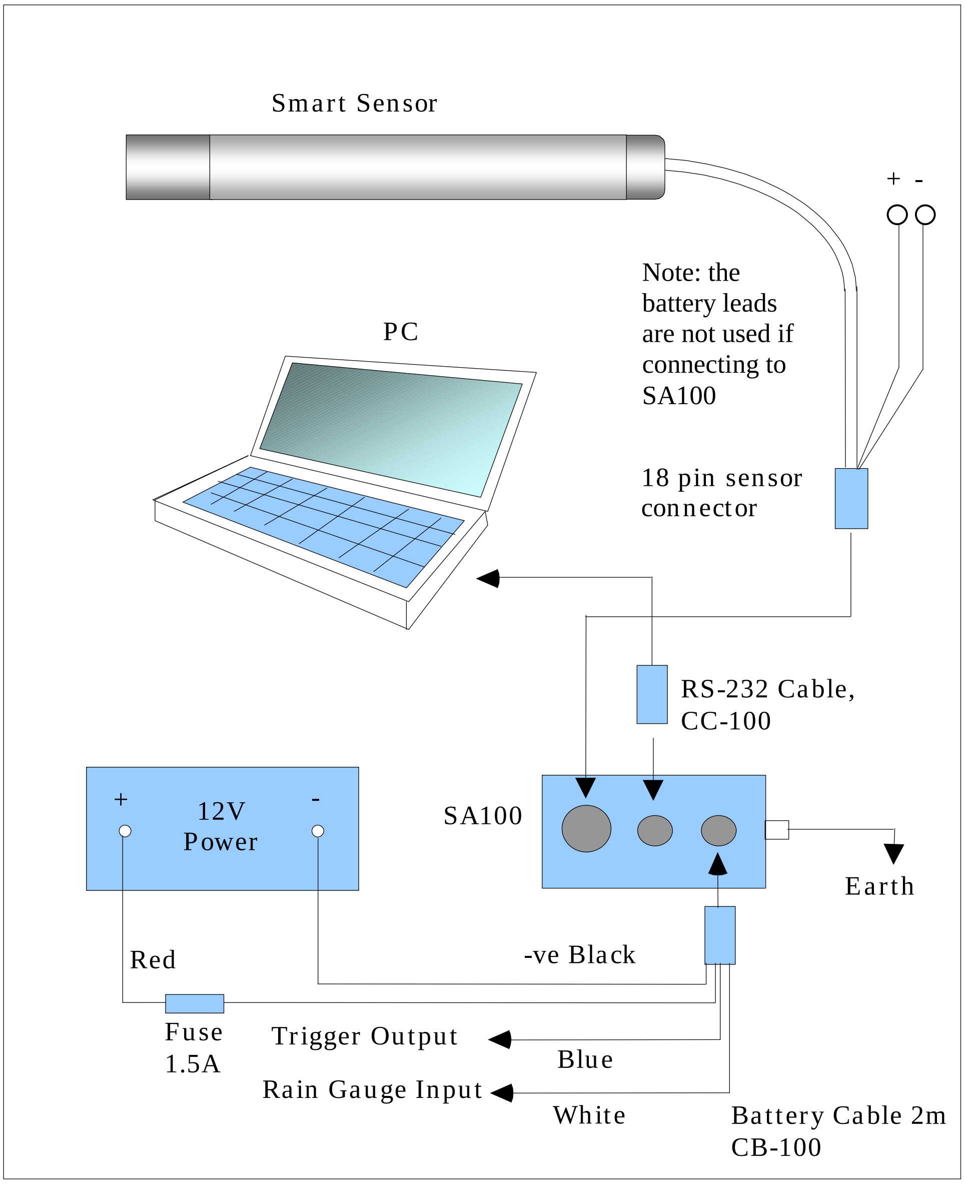
Diagram 3. CX18 Connector

Table 1

Function	Pin / Colour	Notes
Sampler out	Pin 5 / Blue	For use with SA/MA100
Rain Gauge in	Pin 4 / Brown	For use with SA/MA100
Power +ve	Pin 2 / Red	+12V, Red Flying Lead
ground	Pin 3 / Turquoise	Gnd, Black Flying Lead
Commstxd	Pin 13 / Yellow	
rxd	Pin 15 / Violet	
dtr	Pin 12 / White	
rts	Pin 14 / Grey	
dcd	Pin 8 / Orange	For use with MA100
ring	Pin 10 / Black	For use with MA100
Shield	Pin 18 / Shield	Yellow/Green Flying Lead
Cell Phone out	Pin 6 / Pink	For use with MA100
Ground	Pin 16 / Link and Green	
Ground	Pin 1 / Link	

For users that wish to connect to external adaptor boxes (SA100, MA100) the CX18 connector is required on the sensor cable and a communications cable (CC-100) is connected between the interface adaptor and sensor. See figure 2:

Figure 2. CX18 Connection



For further details on all pin connections please refer to Application Notes supplied with Interface Adaptors.

Interface Adaptor (Optional)

1. SA100 - This interface divides the 18 pin Smart Sensor output into separate connectors.

   - System Power, optional Rain Gauge and Output access,
   - Comms RS232
   - Status Indicator
   - Grounding wire

   The status indicator flashes to indicate microprocessor activity. The rate can be set in SmartCom.

2. MA100 - This interface provides the full complement of functions available on the Smart Sensor on nine individual connectors. These are:

   - Comms RS232
   - Sampler or Trigger output
   - Rain Gauge
   - Auxiliary or Pump Output
   - System Power Input,
   - Modem
   - Ext Modem, switched Cell Phone and Modem Power Outputs
   - External 4-20mA Inputs (2)

   The MA100 can be configured for use with a cell phone transmitter, cell to line interface and modem. All signal lines are protected (up to 2KV). against electromagnetic transients. The MA100 has the ability to determine if a modem or computer is connected and automatically switches the communication lines to either the modem port or the RS232 port. This feature ensures modem connection once the computer is removed. A communications cable with a standard DB9 connector suitable for most PC's is supplied along with power and other cable connectors for user connection. Spare connectors can be obtained from Greenspan.

   The unit is fused on all supply lines, including the auxiliary input switched supply. When the external inputs are activated an indicator will light to show channel use.

   A status indicator is configured in software at the factory to indicate microprocessor activity and will pulse at regular intervals. A second indicator will light up if pulsed by the sampler/pump output line when programmed.

   The housing is fully sealed to IP65 and includes internal moisture protection against condensation.

   For further detail on all connections, please refer to Application Note 010-APN-0006

The Software

The following software is required for running the SMART SENSOR:

1. SMARTCOM for Windows runs on a PC, and facilitates manipulation of system setup information, processing and data retrieval. The program requires at least 580K to run and is supplied on a CD disk along with support files. It is compatible with WIN95, WIN98, WIN2000 and NT operating systems. Mouse and keyboard operation is fully supported.
2. Internal firmware. The logger has a resident program that manages communications, data logging and data retrieval. It is not normally accessible by the user, however it may be upgraded in the field if required.
3. A utility program called AQUAGRAPH is also provided on the installation CD. This allows the user to view, graph and export the data. AQUAGRAPH may be accessed from within SMARTCOM. Online help is available from within the program.

GETTING STARTED 3

Powering Up

For connection to the external battery, connect the red wire to positive and the green wire to negative. The external battery leads are protected against incorrect polarity connection. When the external battery is connected it overrides the optional battery pack and consequently conserves its power.

If using a battery pack with spanner flats, place a 38mm spanner on the flats adjacent to the battery cover and unscrew the battery cover to reveal the battery compartments, install nine 3.6 Volt Lithium batteries, type BP108VAA into the battery housing. See Battery Pack section for further detail.

For external power a 12V gel cell rated at 5.2 A/Hr is recommended for long logging periods.

When using an external power supply ensure that the range does not fall outside the 8 to 15V range. If the voltage is below 8V, the logger may cease logging while voltages higher than 15V may damage the sensor.

The sensor will start logging automatically if the 'End Logging' was not activated before disconnecting the power from the logger.

During Log mode the Smart Sensor automatically enters a low power condition when the communications cable is removed from the PC, this ensures that minimal power is drawn from the battery between logged records. The system will return to normal power each time a reading is required, and then enter low power mode again. **Battery life will be significantly reduced if the Smart Sensor is connected to a PC for long periods**. It is good practice to replace the battery pack battery if in doubt and if long field logging sessions are undertaken.

Powering Off

If the Smart Sensor is to be placed in storage it is recommended that the logger be powered down and lithium batteries in the battery pack be removed. To turn off the logger after exiting from SmartCom, disconnect the communications cable and unscrew the battery cover. This exposes the battery compartment to allow removal of the batteries. Removing power will not affect any data remaining in storage so sensors could be downloaded away from the site if required.

Using SMARTCOM for Windows

Please refer to the accompanying User Manual, SmartCom for Windows for detailed operation of the software for use with Greenspan products.

INSTALLATION 4

Field Installation Instructions

The Greenspan Range of Pressure Sensors and Water Quality Sensors can be installed into a variety of applications including:

- Rivers, Lakes and streams
- Bore Hole and groundwater wells
- Tanks and Reservoirs
- Wet Wells for Water and Sewer Systems

In all field applications, mechanical, electrical and physical protection of the Sensor, cabling and associated fittings must be provided.

Consideration needs to be given for the protection against vandalism, animal damage, theft and extreme weather conditions.

Field Installation must ensure:

- The sensor is anchored or held in position or located so it is not subject to any movement during normal operations.
- Sensor is protected from direct sunlight to avoid high temperature fluctuations
- Sensor is protected against high turbulence and possible debris loading during flow events

Option 1: Non Turbulent Conditions

Where there is no possibility of the sensor being affected by turbulence it can be suspended into the water body using a stainless steel hanger cable. For example where the sensor is installed into a large water storage tank. The sensor will hang vertically into the tank and not be subject to movement from water movements. The stainless steel wire prevents loading of the sensor cable.

In Sewer Wet Well and Water Tank applications where high turbulence and debris loading may affect the sensor, the following minimum installation standards must be followed:

Option 2: High Turbulent Conditions

Where turbulence and water movement will act on the sensor it is recommended to mount the sensor in a stilling well or mounting cradle attached to the side of the well. This could simply be a length of PVC pipe bolted to the well wall in which the sensor is located or could be an extension pole with a sensor cradle at the lower end. Potential ragging and debris build up on the sensor & cable should be overcome by extending the stilling well to above the high water level or by cable tying the sensor cable up the cradle mounting arm. The movement of the sensor must be eliminated such that the sensor is not subject to twisting motion from swirling water during pumping, or from sideways movement due to ragging of the sensor. In all sewer wet well applications regardless of the mounting system used it is recommended to also utilise a stainless steel hanger cable* to prevent loading the sensor cable during installation, removal and maintenance. The stainless steel wire must be securely connected to the sensor using the hanger hook and the sensor cable should be cable tied at regular intervals up the stainless wire. An outer sheath of hose or tubing can be fitted over both cables to reduce ragging and debris build up on the cables. At the top of the well the stainless wire can be attached to a bolt or mounting point.

*Note, the stainless steel suspension, hanger cable can be provided by Greenspan. (Part No 7SK-100)

Warning:

Under no circumstances must the sensor be installed such that it can collide with the sides of the well, or other solid objects within the well. Sensor installation under these circumstances will lead to sensor damage that will not be covered under our normal warranty conditions. In these cases the sensor must be mounted into a cradle or stilling well as per Option 2.

Atmospheric Venting of Depth Sensors

Where an atmospheric vent tube is used it must be protected from moisture entry using the desiccant pack in the closed breather vent system. The vented cable must be terminated using the Greenspan Closed Vent System in accordance with manufacturer's recommendations.

Sensor Nose Cones

Sensor Nose Cones must be securely installed, checked and cleaned as required.

Excessively high turbulence in sewer wet wells can cause nose cones to become loose and unscrew themselves. In these applications the nose cone can be fitted with a rubber o-ring (supplied) to act as a thread locking device.

Other Considerations

When installing sensors with pH, ensure that pH electrode caps are removed. To do this, simply unscrew and remove the EC shroud if fitted, pinch the tip of the electrode cap in the fingers and pull. A slight twisting action may help if it is tight. After use, it is recommended the cap is filled with pH4 solution and replaced to prevent the electrode from drying out. Replace the EC shroud.

Environmental compatibility should be checked before using the sensors and advice sought from Greenspan if any doubt exists. The 316 stainless body can be used in a majority of situations but care should be taken against possible corrosion in high Chloride, Sulphate or Ferric solutions.

The body should always be totally immersed under the water to ensure that the sensor is at water temperature and to also avoid any possible anodic/cathodic action taking place on the stainless body at the water-air interface. At some sites it has also been noticed that clamps used to support the sensor made of a dissimilar metal to the 316 stainless body can cause spot corrosion due to electrolysis.

SENSORS 5

pH300 pH Sensor

Measurement Overview

The Greenspan pH300 sensor utilises a robust gel filled industrial pH electrode for field monitoring in a variety of environments.

The pH electrode consists of a pH sensitive glass membrane attached to a sealed insulating tube containing a solution of fixed pH in contact with a silver-silver chloride half cell. The potential developed across the membrane is compared to a stable reference potential e.g. a silver-silver chloride half cell in contact with an electrolyte containing chloride. Completion of the circuit is by means of a porous constriction (the salt bridge) which allows the reference electrolyte to slowly flow into the sample.

pH gives an indication of the acidity/alkalinity of a solution and is defined

as:

$$pH = -\log (H^+)$$

and covers a scale from 0 (acid) to 14 (alkaline) where H^+ is the hydrogen concentration in solution, at ordinary temperatures

$$H_2O = H^+ + OH^-$$

The concentration of each type of ion is 10^{-7}gm molecule/litre and hence the pH of pure water is:

$$pH = -\log 10^{-7} = 7$$

Signal Conditioning

An important consideration with using a pH sensor in field measurements is the likelihood of errors due to earth loops with other sensors. The pH electrode has a high input impedance, typically 10^{12} ohms and small stray electrical currents can cause very large errors in the output reading unless special precautions are taken with the sensor design.

The Greenspan design has paid special attention to this potential cause of errors with an innovative and low power signal conditioning circuit.

- The signal path is optically isolated using the latest balanced optical isolation techniques to ensure that there is no signal path from the electrode to the common power supply.
- A low power DC-DC transformer coupled between the common power supply and the electrode buffer amplifier ensures that there is no DC path between them.

The implementation of these features ensures that the pH sensor can be used with other sensors in a common water body and be attached to a common power source without causing erroneous readings due to cross coupling of earth loops.

The pH300 is automatically temperature compensated over the temperature range 0-50°C. The temperature compensation curve of a pH electrode is defined by the curve :

$$\frac{RT}{F} \text{Log}_{10}(H^{+})$$

R = 8.3143 Universal Gas Constant

F = 96487 Faraday Constant

T = Absolute Temperature 0°C + 273.150

An internal temperature sensor monitors temperature and utilises a lookup table which matches this curve, and compensates for temperature drift.

The electronic circuit has been designed to reach a full output reading in less than 2 seconds.

Field Deployment Considerations

The expected lifespan of gel type pH electrodes in good conditions is from 2 - 3 years, in poor conditions this may reduce to 12 - 18 months.

If performance is deteriorating or calibration is not being maintained and the sensor is of this age then replacement of the electrode may be required. Please contact Greenspan or your agent to arrange a quote and replacement.

In some environments there is an increased content of fats and oils, which can cause the salt bridge to become blocked and affect the accuracy or indeed the functioning of the sensor. The salt bridge wick is located immediately adjacent to the electrode bulb. The electrode bulb and salt bridge can often be restored by cleaning with a mild detergent solution or weak acid.

The pH electrode should always be stored in de-ionised water or pH4 solution. The pH electrodes are shipped from Greenspan with a plastic cap filled with pH4 solution. The plastic cap must be carefully removed prior to field installation of the sensor. The cap should be retained for future use if the sensor needs to be removed from site and stored, or moved to another location.

Immersion in pH4 buffer solution for 48 hours can often restore calibration if the moisture cap has been left off for some time and the bulb has been allowed to dry out.

Calibration

Please note Calibration is only available when logging is not active. All Calibration is performed using SmartCom for Windows.

Example:

To re-calibrate the pH sensor:

1. Select User Cal from Logger Control menu
2. Select the pH Channel.
3. Select 2 Decimal Places.
4. Select 2 point Span and Offset Calibration Type
5. Click Calibrate Channel button to enter Calibrate mode.
6. Remove the plastic cap from the pH bulb, if present. Spray clean the pH bulb with distilled water from a dispensing bottle. Gently dry with anti-static cloth.
7. Partly fill a pre-cleaned cap with fresh pH7 buffer and place onto pH bulb. Allow to stabilise for two minutes.
8. The screen will display a window requesting a low value, type in a new value to be read by the Smart Sensor for pH7. Click OK.
9. Remove the cap from the pH bulb, spray clean the pH bulb and cap with distilled water. Gently dry with anti-static cloth.
10. Partly fill the pre-cleaned cap with fresh pH4 or pH10 buffer depending on the intended field use of the sensor and place onto pH bulb. Allow to stabilise for two minutes.
11. The screen will display a window requesting a high value. Type in a new slope value to be read by the Smart Sensor for either pH4 or pH10 depending on the intended field use of the sensor. Click OK.
12. The Smart Sensor will calculate the new calibration curve based on this data.
13. If using the pH10 buffer cap, clean bulb as before and replace cap with pH4 for storage.

The pH sensor channel is now re-calibrated and ready for use.

Please Note: Sensors should not be re-calibrated unless laboratory standards are available as existing calibration data will be destroyed.

Temperature Sensor (all sensors except Turbidity)

Measurement Overview

The Smart Sensor utilises an internal temperature sensitive device to independently monitor the temperature of the sensor and the sample solution. The sensor provides a temperature output over the range 0-50°C on a separate channel. The signal is also used internally to normalise the EC output to 25°C and temperature compensate other channels such as EC and Pressure over the range 0-50°C.

The temperature calibration is factory set, we strongly recommend this channel is not re-calibrated by the customer due to difficulties involved in setting up accurate, stable temperature standards.

Calibration

The method presented here is included for completeness and assumes an accurate temp reference bath.

1. Ensure sensor is connected to power and computer.
2. Set up a low temperature stable bath (0-10°C)
3. Immerse the sensor in the bath (sensor should be completely covered) and allow two hours for sensor to stabilise to bath temperature.
4. Select User Cal from Logger Control menu
5. Select the Temperature Channel.
6. Select 2 Decimal Places.
7. Select 2 point Span and Offset Calibration Type
8. The screen should display a window to allow entry of the new low value, type in the new value to be read by the Smart Sensor for the low point, eg: (0005.00 for 5°C). Click OK.
9. Immerse the temp sensor in the hot water bath, (approx. 40- 50°C). Allow two hours for temperature to stabilise. Most sensors have the temperature reference device mounted internally and therefore require the airspace around them to equilibrate to case temperature.
10. The screen now displays a window to allow entry of the new high value, type in the new value to be read by the Smart Sensor for full scale, e.g. (0045.00, for 45°C), Click OK.
11. The Smart Sensor will calculate a new calibration curve based on this data.
12. The Temperature channel is now re-calibrated and ready for use.

Calibration should be checked every six months.

EC350 Electrical Conductivity Sensor

Measurement and Overview

Conductivity is the measurement of the ability of a solution to carry an electric current. It is defined as the inverse of resistance (Ohms) per unit square and is measured in units of Siemens/metre or micro-Siemens/centimetre.

The measurement of conductivity is used to determine the salt content (the salinity) of a solution. Salinity is proportional to conductivity and expressed in terms of the concentration of salt per unit volume (mg/l or ppt).

Electrical Conductivity readings are a function of the number of ions present and their mobility. The electrical conductivity of a liquid changes at a rate of 1.84% per degree Centigrade for neutral salt and is due to the ion mobility being temperature dependant. The temperature co-efficient of conductance (or the K factor) varies for different salts and can be in the range 0.5 to 3.0.

EC is a function of both salt concentration and temperature, and its value can be expressed as non-normalised or normalised. When the sensor is configured as non-normalised (Raw) the reading will vary with temperature even if the concentration of salt in the liquid does not change. Normalisation automatically compensates for temperature variations providing the salt concentration remains the same. Normalisation is referenced to 25°C which means that the raw and normalised readings are identical at this temperature.

Sensor Design

The Greenspan EC Sensor consists of the following primary elements:

- Toroidal sensing head (conductivity sensor)
- Temperature sensor
- Microprocessor controlled signal conditioning and logging device
- Data cable
- Stainless steel or Delrin body
- Delrin End Cap

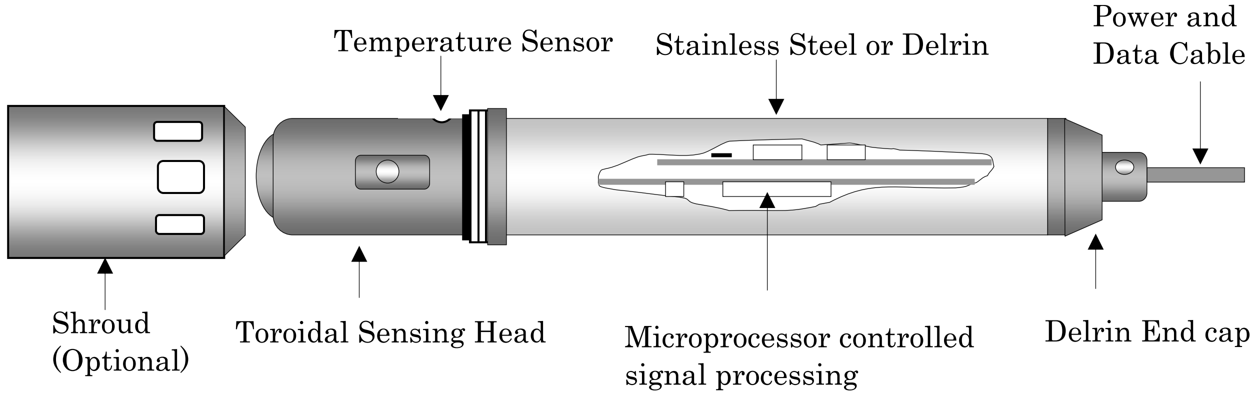


Figure 3. Electrical Conductivity Probe Primary Elements

Toroidal Sensing Head

The EC sensor uses an electromagnetic field for measuring conductivity. The black plastic head contains two ferrite cores configured as transformers within an encapsulated open ended tube. One ferrite core is excited with a 10 KHz sinusoidal voltage which generates an electromagnetic field that surrounds both ferrite cores. The degree of coupling between the cores is inversely proportional to the resistivity of the coupling medium.

An increase in charged ion mobility or concentration causes a decrease in the resistivity and a corresponding increase in the output of the EC sensor. The advantage of toroidal sensing is the elimination of system errors caused from electrode degradation.

Temperature Sensor

A separate temperature sensor monitors the temperature of the sample solution. The sensor provides both a temperature output and a signal to normalise and temperature compensate the EC output. The temperature output is displayed in SmartCom as Channel 2 on the monitor screen.

Normalisation

In solution with a constant dissolved salt content an un-normalised EC sensor's output decreases by 2% /°C. Therefore, if the temperature changes by say 3°C the error induced is 6%. The normalised Smart Sensor automatically normalises this error to 25°C by using factory loaded solubility algorithms over the range 0-35°C.

Field Deployment Considerations

The main benefit derived from utilising toroidal sensing technology for the measurement of EC is the reduction in fouling. The toroidal sensors create a magnetic field around the sensing head and as such it is necessary to maintain a space of at least 100mm around the head to ensure complete accuracy.

The sensor head should always be completely submerged and positioned such that the possibility of air bubbles becoming entrapped within the sensor hole is minimised. Large bubbles may cause errors if trapped.

For applications in harsh environments it is recommended that the optional Delrin casing be specified.

The sensor head should be periodically inspected for fouling, and can be cleaned with fresh water and damp cloth. The protective shroud is easily unscrewed from the head for quick access. Bottle brushes are commonly used for cleansing the sensor hole. In marine environments crustations may need removal at regular intervals.

Please note that EC sensors fitted with the protection shroud are calibrated in the factory with the shroud on. If the shroud is removed the calibration in water will be affected significantly. This is not a problem if the shroud is removed in air when checking calibration with the EC Calibrator supplied. Please ensure that the shroud is always fitted for normal use in water and only removed while cleaning and checking in air.

Calibration

It is recommended EC calibration is checked at least every 3-6 months. If re-calibration is required a method is presented here using Greenspan EC Calibrators. Alternatively sensors may be returned to an authorised Greenspan agent for re-calibration.

Quick Check and Re-Calibration Method

Introduction

The following procedures detail a quick method to check the calibration for both full scale and zero using the supplied loop calibrator CK-100.

(All sensors are supplied with a calibrator, for existing sensors an EC calibration kit 7CK-100 is available).

Note: For new EC sensors each calibrator is clearly marked with a serial number and calibration value specified at a temperature of 25°C for that sensor. Please check if your sensor is non-nomalised or normalised and use the appropriate method below.

Calibration/Checking Method

(For both Normalised and Non-Normalised sensors)

1. Remove the sensor from the water, unscrew the shroud and dry the EC head and temperature button. Let it temperature stabilise in air for at least two hours.
2. In SmartCom for Windows, select User Cal from Logger Control menu.
3. Select the EC Channel.
4. Select the appropriate Decimal Places for the range of the sensor under test then click OK.

100,000 uS and up	######.
10,000 uS and up	#####.#
1000 uS and up	####.##

5. Select 2 point Span and Offset Calibration Type.
6. The zero value is read in SmartCom **without** the loop calibrator. The screen should display a window to allow entry of the new low value, type in the new value to be read by the Smart Sensor for zero, eg: (0000.00), click OK.
7. For full scale loop the EC calibrator wires through the EC head and connect together.

NON-NORMALISED SENSORS

1. For **non-normalised** sensors note the EC reading in the Monitor screen of SmartCom, this value should be within **+/-1%** of the reference value marked on the supplied calibrator.

2. To re-calibrate the sensor this value may be entered into SmartCom as the high value. For example, for a 2000µS range sensor the calibrator may be marked as 1756.00µS. This is the value which is entered.

NORMALISED SENSORS

1. For **normalised** sensors note the temperature in the Monitor Current Values screen in SmartCom. **Note that for normalised sensors a 2 point calibration must be performed.**
2. Refer to the Normalisation Table and note the K factor for that particular temperature. For example: @19.6°C, K=1.110
3. Multiply the value marked on the EC calibrator body by the Normalisation factor. This result should be within **+/-1%** of the value in Monitor Current Values screen in SmartCom.

   for example:

   If the temperature from the monitor screen is 19.6°C and the EC value marked on the Calibrator body is 1950µS at 25°C, then from the table @19.6°C, K=1.110

   therefore:

   1950 x 1.110 = **2164 µS @19.6°C**

   Reading in Monitor Current Values screen should be **2164µS** (+/-1%)
4. To re-calibrate the sensor, this calculated value, (2164.00) may be entered into SmartCom as the high value.

Calibration of EC Calibrator to Sensor

Note this step is only required if EC calibrator has **not** already been calibrated to sensor. Please note this section assumes that the EC sensor has been **recently accurately calibrated**. There are two sections one for non-normalised sensors and one for normalised sensors.

NON-NORMALISED SENSORS

1. Ensure that the correct calibrator has been supplied for the sensor under test. ie. the serial number should be marked on the body.
2. Remove the sensor from the water, unscrew the shroud and dry the EC head and temperature button. Let it temperature stabilise in air for at least two hours.
3. The zero value is read in SmartCom **without** the loop calibrator. Check that the zero reading is correct.
4. For full scale connect EC calibrator through EC head hole.
5. Run SmartCom and note the EC value (in µS) in Monitor Current Values screen.
6. Write the EC value on body of calibrator. (The sensor serial number should already be recorded on the body).

NORMALISED SENSORS

1. Ensure that the correct calibrator has been supplied for the sensor under test. ie. the serial number should be marked on the body.
2. Remove the sensor from the water, unscrew the shroud and dry the EC head and temperature button. Let it temperature stabilise in air for at least two hours.
3. The zero value is read in SmartCom **without** the loop calibrator. Check that the zero reading is correct.
4. For full scale connect EC calibrator through EC head hole.
5. Note the air temperature in the Monitor Current values screen in SmartCom.
6. Refer to the Normalisation Table and note the factor for that particular temperature. For example: @19.6deg, factor = 1.110
7. Note the EC reading in SmartCom and divide by the Normalisation factor.

   For example: $EC = \frac{1950\mu S}{1.110} = \mathbf{1756\mu S\ @25°C}$

8. Write the calculated EC value **1756µS** on the body of the calibrator.

Electrical Conductivity to Salinity Conversion

A method for the calculation of Salinity values from EC is provided in the form of an Excel spreadsheet. Please contact Greenspan Technology if you require further information or would like to receive a copy of the conversion file on 3.5” disk.

NORMALISATION TABLE

Coefficient of conductance = 1.84% per deg C @ 25°C

Temp	Factor	Temp	Factor	Temp	Factor	Temp	Factor	Temp	Factor	Temp	Factor	Temp	Factor
0.0	1.852	5.0	1.582	10.0	1.381	15.0	1.225	20.0	1.101	25.0	1.000	30.0	0.916
0.1	1.846	5.1	1.578	10.1	1.378	15.1	1.223	20.1	1.099	25.1	0.998	30.1	0.914
0.2	1.839	5.2	1.573	10.2	1.374	15.2	1.220	20.2	1.097	25.2	0.996	30.2	0.912
0.3	1.833	5.3	1.569	10.3	1.371	15.3	1.217	20.3	1.095	25.3	0.995	30.3	0.911
0.4	1.827	5.4	1.564	10.4	1.367	15.4	1.215	20.4	1.092	25.4	0.993	30.4	0.910
0.5	1.821	5.5	1.560	10.5	1.364	15.5	1.212	20.5	1.090	25.5	0.991	30.5	0.908
0.6	1.815	5.6	1.555	10.6	1.360	15.6	1.209	20.6	1.088	25.6	0.989	30.6	0.906
0.7	1.809	5.7	1.551	10.7	1.357	15.7	1.206	20.7	1.086	25.7	0.987	30.7	0.905
0.8	1.803	5.8	1.546	10.8	1.354	15.8	1.204	20.8	1.084	25.8	0.985	30.8	0.903
0.9	1.797	5.9	1.542	10.9	1.350	15.9	1.201	20.9	1.082	25.9	0.984	30.9	0.902
1.0	1.791	6.0	1.538	11.0	1.347	16.0	1.198	21.0	1.079	26.0	0.982	31.0	0.900
1.1	1.785	6.1	1.533	11.1	1.344	16.1	1.196	21.1	1.077	26.1	0.980	31.1	0.899
1.2	1.779	6.2	1.529	11.2	1.340	16.2	1.193	21.2	1.075	26.2	0.978	31.2	0.897
1.3	1.773	6.3	1.525	11.3	1.337	16.3	1.191	21.3	1.073	26.3	0.977	31.3	0.896
1.4	1.768	6.4	1.520	11.4	1.334	16.4	1.188	21.4	1.071	26.4	0.975	31.4	0.894
1.5	1.762	6.5	1.516	11.5	1.330	16.5	1.185	21.5	1.069	26.5	0.973	31.5	0.893
1.6	1.756	6.6	1.512	11.6	1.327	16.6	1.183	21.6	1.067	26.6	0.971	31.6	0.891
1.7	1.750	6.7	1.508	11.7	1.324	16.7	1.180	21.7	1.065	26.7	0.970	31.7	0.890
1.8	1.745	6.8	1.503	11.8	1.321	16.8	1.178	21.8	1.063	26.8	0.968	31.8	0.888
1.9	1.739	6.9	1.499	11.9	1.318	16.9	1.175	21.9	1.060	26.9	0.966	31.9	0.887
2.0	1.734	7.0	1.495	12.0	1.314	17.0	1.173	22.0	1.058	27.0	0.965	32.0	0.885
2.1	1.728	7.1	1.491	12.1	1.311	17.1	1.170	22.1	1.056	27.1	0.963	32.1	0.884
2.2	1.723	7.2	1.487	12.2	1.308	17.2	1.168	22.2	1.054	27.2	0.961	32.2	0.883
2.3	1.717	7.3	1.483	12.3	1.305	17.3	1.165	22.3	1.052	27.3	0.959	32.3	0.881
2.4	1.712	7.4	1.479	12.4	1.302	17.4	1.163	22.4	1.050	27.4	0.958	32.4	0.880
2.5	1.706	7.5	1.475	12.5	1.299	17.5	1.160	22.5	1.048	27.5	0.956	32.5	0.878
2.6	1.701	7.6	1.471	12.6	1.296	17.6	1.158	22.6	1.046	27.6	0.954	32.6	0.877
2.7	1.696	7.7	1.467	12.7	1.293	17.7	1.155	22.7	1.044	27.7	0.953	32.7	0.876
2.8	1.691	7.8	1.463	12.8	1.289	17.8	1.153	22.8	1.042	27.8	0.951	32.8	0.874
2.9	1.685	7.9	1.459	12.9	1.286	17.9	1.150	22.9	1.040	27.9	0.949	32.9	0.873
3.0	1.680	8.0	1.455	13.0	1.283	18.0	1.148	23.0	1.038	28.0	0.948	33.0	0.871
3.1	1.675	8.1	1.451	13.1	1.280	18.1	1.145	23.1	1.036	28.1	0.946	33.1	0.870
3.2	1.670	8.2	1.447	13.2	1.277	18.2	1.143	23.2	1.034	28.2	0.944	33.2	0.868
3.3	1.665	8.3	1.444	13.3	1.274	18.3	1.141	23.3	1.032	28.3	0.943	33.3	0.867
3.4	1.660	8.4	1.440	13.4	1.271	18.4	1.138	23.4	1.030	28.4	0.941	33.4	0.866
3.5	1.655	8.5	1.436	13.5	1.268	18.5	1.136	23.5	1.028	28.5	0.939	33.5	0.864
3.6	1.650	8.6	1.432	13.6	1.265	18.6	1.133	23.6	1.026	28.6	0.938	33.6	0.863
3.7	1.645	8.7	1.428	13.7	1.262	18.7	1.131	23.7	1.025	28.7	0.936	33.7	0.862
3.8	1.640	8.8	1.425	13.8	1.260	18.8	1.129	23.8	1.023	28.8	0.935	33.8	0.860
3.9	1.635	8.9	1.421	13.9	1.257	18.9	1.126	23.9	1.021	28.9	0.933	33.9	0.859
4.0	1.630	9.0	1.417	14.0	1.254	19.0	1.124	24.0	1.019	29.0	0.931	34.0	0.858
4.1	1.625	9.1	1.414	14.1	1.251	19.1	1.122	24.1	1.017	29.1	0.930	34.1	0.856
4.2	1.620	9.2	1.410	14.2	1.248	19.2	1.119	24.2	1.015	29.2	0.928	34.2	0.855
4.3	1.615	9.3	1.406	14.3	1.245	19.3	1.117	24.3	1.013	29.3	0.927	34.3	0.853
4.4	1.610	9.4	1.403	14.4	1.242	19.4	1.115	24.4	1.011	29.4	0.925	34.4	0.852
4.5	1.606	9.5	1.399	14.5	1.239	19.5	1.113	24.5	1.009	29.5	0.924	34.5	0.851
4.6	1.601	9.6	1.395	14.6	1.237	19.6	1.110	24.6	1.007	29.6	0.922	34.6	0.850
4.7	1.596	9.7	1.392	14.7	1.234	19.7	1.108	24.7	1.006	29.7	0.920	34.7	0.848
4.8	1.592	9.8	1.388	14.8	1.231	19.8	1.106	24.8	1.004	29.8	0.919	34.8	0.847
4.9	1.587	9.9	1.385	14.9	1.228	19.9	1.104	24.9	1.002	29.9	0.917	34.9	0.845
												35.0	0.844

PS310 Pressure Sensor

Measurement Overview

The PS310 Pressure Sensor utilises a ceramic based capacitive element as the transducer. This is designed to be of rugged construction and incorporates active electronics as an integral part of the transducer substrate to enhance reliability and accuracy.

The onboard microprocessor converts the transducer output voltage to a 16 bit digital signal and also measures the transducer temperature. This information is used to temperature compensate the sensor over the range 0 - 50°C. Both pressure and temperature are displayed in SmartCom in real units i.e. metres of depth and degrees centigrade.

Packaging and Cable

The sensor is packaged in Delrin and/or stainless steel and is fully O ring sealed and pressure tested. A special vented power and data transmission cable is supplied which ensures the pressure applied to the front face of the transducer is referenced to atmospheric pressure. Absolute measurement of pressure is also available which requires a special non vented transducer, in this configuration a standard non vented cable can be used.

Calibration

To check calibration, an accurate instrument for generating pressure is required. If this is not available please contact Greenspan for advice. We recommend that the calibration is checked every 6 months if possible or at least every 12 months.

To calibrate the Pressure Sensor:

1. Ensure sensor head is clean and that sensor is connected to power and computer. Allow the sensor to equilibrate to ambient temperature for at least an hour prior to calibration.
2. For gauge pressure sensors ensure that the vent tube has the sealing plug removed and the CVS-001 venting system is fitted.
3. For best accuracy in calibration orient the sensor in the direction in which it is intended to be used. For example, if the sensor is to be installed vertically suspended then calibrate with the sensor head facing down vertically.
4. Set up a reference pressure calibrator or Dead Weight Tester for full scale calibration.
5. In SmartCom for Windows, select User Cal from Logger Control menu.
6. Select the Pressure Channel.
7. Select 3 Decimal Places.
8. Select 2 point Span and Offset Calibration Type
9. The screen should display a window to allow entry of the new low value. With zero pressure applied, type in the new value to be read by the Smart Sensor for the low point, e.g. (000.000), click OK.

10. Connect the sensor to the pressure calibrator and set the pressure gauge value to close to the full scale range value of the sensor.

11. The screen now displays a window that allows for entry of the new high value, type in the new value to be read by the Smart Sensor for full scale, eg: (020.000, for 20 metre range), click OK.

12. The Smart Sensor will calculate a new calibration curve based on this data. The Pressure channel is now re-calibrated and ready for use.

DO300 Dissolved Oxygen Sensor

Measurement Overview

The DO sensor works on the principle of oxygen in solution diffusing through a silicon membrane to the sensor. The oxygen sensor measures the gas concentration and gives a proportional voltage output. A 16 bit analog to digital conversion circuit provides digital data to the microprocessor which calculates a temperature compensated output equal to 0–20 ppm or 0-200% of dissolved oxygen.

Temperature is also provided on board with a range of 0 – 50°C displayed as a separate channel output in SmartCom.

The sensor is designed for long term immersion in hostile environments and achieves this through the use of a patented silicon membrane diffusion rod. This method provides an acceptable response time, under environmental conditions, to changes in DO, (typically 40 minutes to a step change of 90% of previous reading, or to within 2% of actual within 60 minutes), and requires minimal flow.

Field Deployment Considerations

As with all sensors, fouling can occur in the environment. The DO rod can be cleaned carefully with a tissue or soft brush and warm water. Sensors can normally be left in situ for several months without requiring cleaning. The sensor calibration should be checked every three months preferably using standard calibrating techniques. Generally, only the full-scale reading should require re-calibration.

Do not remove the black plastic tip on the DO membrane as it is factory fitted and not designed to be removed, doing so may damage the sensor.

Quick DO Calibration Method

This details a simplified method to re-calibrate the DO sensor at full scale in air.

The zero is considered to be stable and should not require adjustment.

The method is accurate to within 2% or 0.2ppm.

Determine whether your sensor requires percentage saturation calibration or ppm calibration and use appropriate method below.

Preparation:

1. Remove the sensor from the installed site. Clean the diffusion rod with a jet of mild soapy water from a laboratory wash bottle. Leave to dry.
2. Allow temperature and oxygen concentrations to stabilise in air for 2-3 hours minimum.

% Saturation Calibration

1. In SmartCom for Windows, select User Cal from Logger Control menu.
2. Select the DO Channel.
3. Select 2 Decimal Places.
4. Select 1 point Span Calibration Type
5. The screen should display a window to allow entry of the new high value.
6. In air at a standard barometric pressure on 1013mb the sensor output should equal 100% saturation. For other barometric pressures apply the following formulae:

$$\frac{\text{Barometric pressure (local)}}{1013\text{mb}} \times 100\%$$

For example, at an atmospheric pressure of 960mb the output should be:

$$\frac{960\text{mb}}{1013\text{mb}} \times 100\% = 94.8\%$$

7. To re-calibrate enter the result as the high value in SmartCom Calibration. (eg.0094.80). Click OK.

PPM Calibration

1. In SmartCom for Windows, select User Cal from Logger Control menu.
2. Select the DO Channel.
3. Select 2 Decimal Places.
4. Select 1 point Span Calibration Type
5. The screen should display a window to allow entry of the new high value.
6. Note the temperature of the sensor from the Monitor screen in SmartCom.
7. From the DO to PPM table, look up the corresponding oxygen concentration for the indicated temperature.
8. As for the method previously the atmospheric pressure must be determined at the sensor location. (for example 990mb)
9. Apply the atmospheric pressure factor as described previously:

For example:

from table @25°C = 8.26 ppm

$$\frac{990}{1013} \times 8.26 = \mathbf{8.07}\text{ ppm}$$

10. To re-calibrate, enter the result, **8.07ppm** as the high value in SmartCom Calibration. (eg.0008.07)

DO Temperature to PPM Table @ 101.3kPa

Temp °C	ppm	Temp °C	ppm	Temp °C	ppm
0	14.62	17	9.66	34	7.06
1	14.22	18	9.47	35	6.95
2	13.83	19	9.28	36	6.84
3	13.46	20	9.09	37	6.73
4	13.11	21	8.91	38	6.62
5	12.77	22	8.74	39	6.51
6	12.45	23	8.58	40	6.41
7	12.14	24	8.42	41	6.31
8	11.84	25	8.26	42	6.21
9	11.56	26	8.11	43	6.12
10	11.29	27	7.97	44	6.02
11	11.03	28	7.83	45	5.93
12	10.78	29	7.69	46	5.83
13	10.54	30	7.56	47	5.74
14	10.31	31	7.43	48	5.65
15	10.08	32	7.30	49	5.56
16	9.87	33	7.18	50	5.47

TS300 Turbidity Sensor

Measurement Overview

The Greenspan Turbidity Sensor utilises a high gain infrared optical system to detect the back scatter intensity of suspended particles.

The optical system transmits a beam of 880nm wavelength. The effective working area around the sensor is approximately 300mm forward and 50mm circumference, however this is dependant on the calibrated range.

The Sensor is packaged in a 316-grade stainless steel or Delrin tube, with O ring sealed Delrin end fittings. This design is rugged and well proven and can withstand the harsh conditions found in any field environment.

The external optical surface is coated with a special polymer which resists fouling from algae growth. It does not eliminate the problem but increases the time between cleaning.

Advanced digital filtering techniques are used to achieve a high level of rejection of ambient light and stray signals from the measurement of data. Standard RS232 output is provided.

Sensor Maintenance

Protection of the lens surface is vital to maintain the accuracy of the calibration.

Note that regular cleaning of the lens will, in time, remove the polymer coating applied during manufacture. Please contact Greenspan if you wish new coatings to be applied. The lens can be cleaned using a wash bottle filled with a warm detergent solution. Be very careful not to scratch the lens, use only soft materials combined with gentle rubbing.

Calibration Introduction

Simple calibration checking can be performed in the field by using calibration reference cups, **Model TR100** available from Greenspan. These are easily slid over the optics of the sensor and an indication is given immediately if calibration has changed or how much adjustment is required to correct it.

A **re-calibration** method for field and laboratory is also provided using the TR100 and SmartCom.

Standardisation is the process of setting the zero of the instrument. A simple method is to immerse the optics of the sensor in a darkened vessel of pure filtered water.

Calibration adjustment compensates for such things as component characteristic changes or re-calibration of the range. Calibration is carried out by comparing known NTU values to the displayed reading of the instrument. New values if required are then entered in SmartCom.

Output of the sensor is calibrated in terms of NTU (Nephelometric Turbidity Units).

Quick Turbidity Check and Calibration Using TR100

Function

To check the calibration of the turbidity sensor in the field or laboratory without the necessity for complex reference measuring equipment and solutions.

The turbidity sensor is easily checked in SmartCom using the zero and full-scale calibration cups supplied in the calibration kit **TR100**. Each cup has a serial number engraved on the base that allows it to be matched with individual sensors. This number should be recorded on the reference sheet supplied with the TR100.

NOTE: An individual cup will not measure the same turbidity value on different sensors. The cup must be calibrated to an individual sensor prior to use. See 'Turbidity Cup Calibration'.

Checking Method

1. Gently remove any debris which may have accumulated on the sensor head with a moist soft cloth, avoid scratching the turbidity lens. Dry the lense.
2. Remove the protective cap on the high and low turbidity calibration cups and pour 2.5ml or 1/2 teaspoon of silicone oil into each and allow them to form a level, bubble free layer over the calibration suspension in the base of the cups.
3. Slide the low value turbidity calibration cup over the sensor head until it reaches the bottom, (some silicone oil may overflow). Rotate the cup, while keeping firm contact on the bottom, to line up the alignment mark on the cup with the mark on the sensor head.
4. Once the cup and sensor are in place and aligned, remove your hands from the sensor and allow the assembly to stand in a vertical position (with the cup on the bottom) while taking the reading.

   NOTE: Air bubbles trapped between the sensor lens and the calibration suspension will cause high and erratic readings. Be sure to use an adequate amount of silicone oil to prevent this from occurring and ensure no air bubbles are present prior to installing the cup. It is also important not to break contact with the interface prior to reading the calibration point.
5. Check that the reading in SmartCom Monitor Current Values mode is within **2%** of the recorded value assigned to that sensor for that calibrator cup.
6. Repeat steps 3-5 for the full scale calibrator cup.
7. If calibration error is less than 2%, remove the cup and wipe the sensor head clean of oil with a soft cloth. Calibration is OK.
8. If the error is greater, re-calibration is necessary - see 'Re-Calibration' section. Alternatively contact a Greenspan authorised agent for re-calibration of the sensor.

Re-Calibration using TR100

1. Ensure the Turbidity head is clean and the sensor is connected to power and a computer.
2. Ensure that the sensor turn on time is not set more than 6 seconds while taking a reading.
3. In SmartCom for Windows, select User Cal from Logger Control menu.
4. Select the Turbidity Channel.
5. Select 1 Decimal Places.
6. Select 2 point Span Calibration
7. The screen should display a window to allow entry of the new low value.
8. Use the same method for checking the low value cup reading as previously described.
9. Type in the new value to be read by the Smart Sensor as the low point, eg: (00000.0), click OK.
10. The screen now displays a window to allow entry of the new high value.
11. Use the same method for checking the high value cup reading as previously described.
12. Type in the new value to be read by the Smart Sensor for full scale, eg: (00092.0, for 100NTUrange), click OK.
13. The Smart Sensor will calculate a new calibration curve based on this data.
14. Thoroughly clean the sensor with water. The Turbidity channel is now re-calibrated and ready for use.

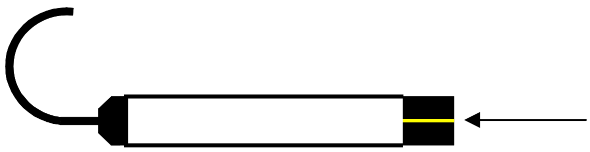
Calibration of Turbidity Cups

Function

Each cup and sensor must be matched prior to use in checking. If this was not done at the factory, then the matching can be performed by the customer on the bench using the following procedure. Note that this assumes that the sensor is accurately calibrated. Once matched the pair should remain stable indefinitely.

Method

1. Gently remove any debris which may have accumulated on the sensor head with a moist soft cloth, avoid scratching the turbidity lens. Dry the lense.
2. Ensure that the sensor has been accurately calibrated, if not, refer to the Re-Calibration section of this document.
3. Engrave a permanent alignment mark laterally, anywhere around the sensor head. See below. Be careful not to scratch the sensor lens.



4. Clean and dry the sensor head with a soft cloth.
5. Remove the protective cap on the high and low turbidity calibration cups and pour 2.5mL or ½ teaspoon of silicone oil into each and allow them to form a level, bubble free layer over the calibration suspension in the base of the cups.
6. Slide the low value turbidity calibration cup over the sensor head until it reaches the bottom, (some silicone oil may overflow). Rotate the cup while keeping firm contact on the bottom, to line up the alignment mark on the cup with the mark on the sensor head.
7. Once the cup and sensor are in place and aligned, remove your hands from the sensor and allow the assembly to stand in a vertical position (with the cup on the bottom) while taking the reading.

   NOTE: Air bubbles trapped between the sensor lens and the calibration suspension will cause high and erratic readings. Be sure to use an adequate amount of silicone oil to prevent this from occurring and ensure no air bubbles are present prior to installing the cup. is also important not to break contact with the interface prior to reading the calibration point.

8. Note the reading in SmartCom Monitor Current Values mode and record the reading of the sensor onto the Turbidity Reference Table in the calibrator kit, using a waterproof pen. Also, record the serial numbers of the turbidity sensor and turbidity cup. These may be changed or removed later with metholated spirits if the calibration is redone.

9. Repeat steps 5-8 for the full scale calibrator cup.
10. Remove the cup and wipe the sensor head clean of oil with a soft cloth.

Note that the same cup may be used on different sensors of the same range with correspondingly different readings being obtained. Each reading is valid for that particular sensor and all are recorded on the Turbidity Reference Table provided in the TR100 kit.

CTDP300 Multiparameter Sensor

Overview

This sensor combines the functionality of the Conductivity, Temperature Pressure (Depth) and pH parameters into one housing. All the specifications are the same as for the individual sensors with the added convenience of a single sensor housing. This simplifies setup procedures and allows for multi-channel logging parameters to be controlled from one software location.

The sensor housing is slightly larger in diameter than for the other sensors (60mm) and the inclusion of pH and depth necessarily increases the length by approximately 100mm, however the inline tubular shape is still maintained for easy deployment in shafts and bore holes.

Sensor Maintenance

As discussed in the section on pH300 sensors it is vital that the sensor bulb is not allowed to dry out or become fouled in greasy environments. Please refer to the earlier notes for cleaning and restoration methods.

Calibration

Please refer to the individual sections in this manual for each parameter of the CTDP for the methods of calibration.

Sensor Design

The electronics are mounted within a stainless steel or Delrin body and all transducers are fitted to one end. Access to the pH electrode is provided to allow cleaning and calibration as required. To remove the pH bulb cap, squeeze the tip with the fingers and twist - it may be firm.

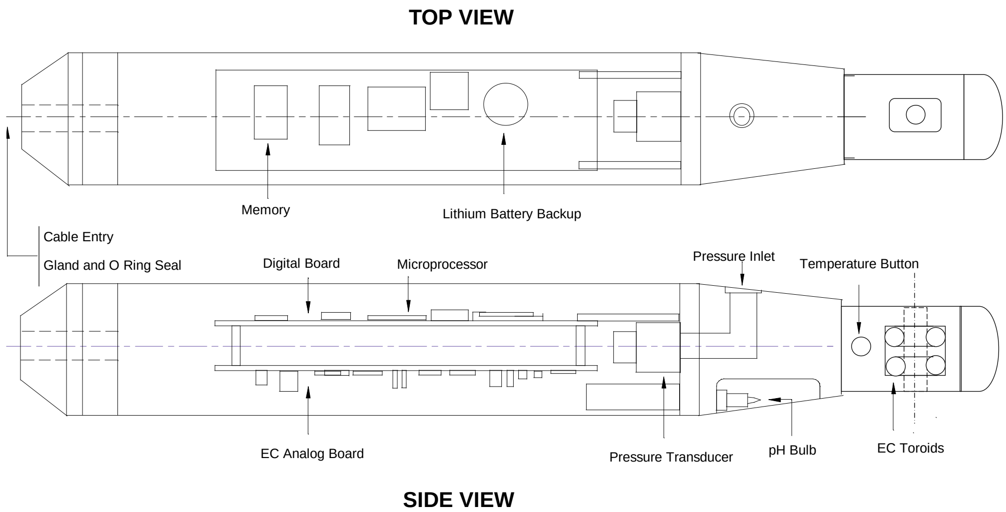


Figure 4. Sensor Design

Note: The pressure transducer can be configured for either absolute or gauge. For gauge sensors a vent tube to atmosphere is included in the cable.

CTD350 Multiparameter Sensor

Overview

This sensor combines the functions of Conductivity, Temperature and Pressure (Depth). The specifications are the same as for the individual sensors except for the addition of combined transducers in the sensor head. Please refer to the previous sections for further detail.

Calibration

Please refer to the individual sections in this manual for each parameter of the CTD for the methods of calibration.

CS302/304/305 Combination Sensor

Overview

The combination sensor provides the functions of up to four parameters in the one housing.

	CS302	CS304	CS305
1	*Ammonium (Not Available)*	EC	Pressure
2	DO	DO	DO
3	Temperature	Temperature	Temperature
4	pH	pH	EC

All the sensors on the CS302, CS304 and CS305 are protected by a removable shroud. This allows easy access for cleaning and calibration. The EC sensor on the CS304 and CS305 is mounted at the extremity of the device and the shroud is unscrewed and slid over the head when removing.

The specifications are the same as for the individual sensors except for the addition of combined transducers in the sensor head. Please refer to the previous sections for further detail.

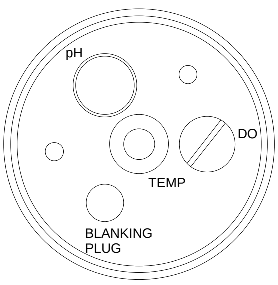
Calibration

Please refer to the individual sections in this manual for calibration methods of each parameter.

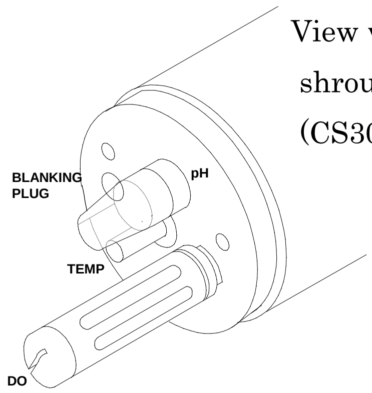
Sensor Head Design

The transducers are mounted in a Delrin head block designed to fit a 60mm body. The following illustration shows the positioning. Note, only the DO sensor is field serviceable. Do not remove the black plastic tip on the DO membrane of the CS304 and CS305 as it is factory fitted and not designed to be removed, doing so may damage the sensor.

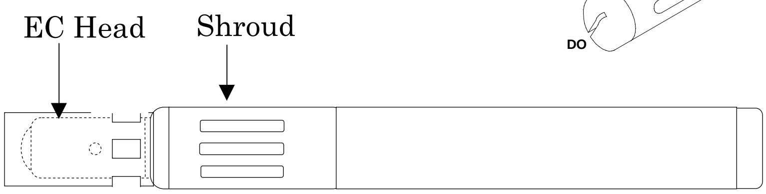
Figure 5.



Location of sensors (CS302)



View with protective shroud removed (CS302)



CS304 with shroud in place

ORP300 Oxidation/Reduction Sensor

Overview

Oxidation and reduction (redox) reactions govern the behaviour of many chemical constituents in drinking water, process and waste waters as well as most aquatic environments.

Reactions involving ions are both pH and Eh(mV) dependent, therefore chemical reactions in aqueous media can often be characterised by pH and Eh acting together with the activity of dissolved chemicals.

The higher the redox reading, the greater the level of corrosion that can occur with non protected metals.

The Sensor

A standard commercial Platinum ORP sensor is utilised by the ORP300 to measure ionic absorption in solution.

The principle means of detection is by measuring the difference in potential between an inert indicator electrode and a reference electrode. At redox equilibrium, the potential difference between the ideal indicator electrode and the reference electrode equals the redox potential of the system.

Electrodes made of platinum are most commonly used for Eh measurements. The standard hydrogen reference electrode is fragile and impractical for routine field use. The Greenspan ORP300 uses a silver:silver-chloride electrode and these are commonly used.

Calibration

It is not possible to calibrate Eh electrodes over a range of redox potentials (as is done with pH electrodes). Instead standard solutions that are stable with known redox potentials for specific indicator electrodes, are used to check response.

There are two main solutions used for measuring redox potentials, Light's solution and ZoBell's solution.

The table below shows the theoretical potential of platinum ORP electrodes using two different common reference electrodes in the ORP standard Light's solution and ZoBell's solution.

Comparison Table

Reference	Standard Hydrogen Electrode (SHE)	Greenspan Ag/AgCl Electrode
Light's Solution	+675mV	+465mV, +/10mV
ZoBell's Solution	+428mV	+229mV Saturated KCl

To determine the Eh of a sample relative to the silver/silver chloride electrode at a specified temperature, calculate:

$$Eh = (229 - (2.2\ (T - 25)))\ mV$$

Where T = measured temperature of solution in °C

The following procedure describes a calibration checking method for ORP300:

1. Set up test vessel with ZoBell's solution.
2. Rinse ORP electrode in DI water and gently dab dry with anti-static tissue.
3. Place sensor in ZoBell's solution and allow one hour to stabilise.
4. In SmartCom for Windows note the temperature reading and calculate the expected Eh reading.
5. If the reading error in Monitor Current Values screen is greater than +/- 10mV, select User Cal from Logger Control menu.
6. Select the ORP Channel.
7. Select 2 Decimal Places.
8. Select 1 point Span Calibration Type.
9. The screen will display a window to allow new values to be entered, type in the new calculated high value (Eh) to be read by the Smart Sensor for ORP. Click OK.
10. Remove the sensor from solution and thoroughly clean in fresh distilled water, wipe carefully with an anti-static tissue.
11. The Smart Sensor will calculate the new calibration curve based on this data.

The ORP sensor is now re-calibrated and ready for use.

Reference

1. Standard Methods 19th ED. 1995, 2-76, Oxidation and Reduction Potential Measurement in Clean Water.

Maintenance

The sensor may be cleaned using a soft cloth and warm water, encrustation's or barnacle growth may have to be removed with a scraping action. Care is required when cleaning the head as the electrode must not be damaged.

Greenspan recommends calibration is checked every six to twelve months.

Greenspan offers a re-calibration service if required. To restore electrodes after long periods of use, fill a small plastic cap that can be fitted over the sensor electrode with a solution of 6N HNO_3 (Nitric Acid) for 5 min after bringing to a boil, or fill with warm (70°C) aqua regia for 1-2 min. *

Alternatively treat with chromic acid solution followed by 6N HCl and rinse in water. Care is required handling any cleaning solutions.

(*Ref: 1 – Standard Methods)

SL300 Smart Logger

Overview

The SL300 Smart Logger is a stand-alone, four-channel data logger. The logger is based upon the same type of logger used in all Greenspan 300 series Smart Sensors. SmartCom software allows for setup, logging and data recovery**.** Three input channels accept a standard 4-20mA output from a sensor and a rain gauge channel (input 4) is available that accepts a switch closure type input.

Installation

Installation is carried out at each site with the following recommendations and procedures.

BATTERY

1. Select a suitable gel cel battery (typically 12V@1.2A/Hr).
2. Connect the red wire of battery cable to the +ve on the battery.
3. Connect the black wire of the battery cable to the –ve of the battery.
4. Connect the 2 way connector to the Power input on the SL300

EARTHING

If a weather cabinet is used to house the logger, it is recommended that it is earthed at an appropriate point and a ground connection is made to the GND on the battery. This will ensure that the lightning protection, incorporated into the SL300 is functional.

COMMS

Connect the comms cable between the RS232 connector on the SL300 and the comm port on the PC. The cable required is a Female DB9 to a Male DB9 type available from Greenspan, part number 087-0088.

SENSOR CONNECTION

The three **sensor** cable wires, RED, GREEN and BLUE from a Greenspan 4-20mA sensor are fitted to the six way connector terminal according to Figure 6. Note orientation of connector to socket. If all three sensor inputs are being used the Red wires from the sensor are connected together and the Green wires are connected together. Fit six-way connector to Sensor input on SL300.

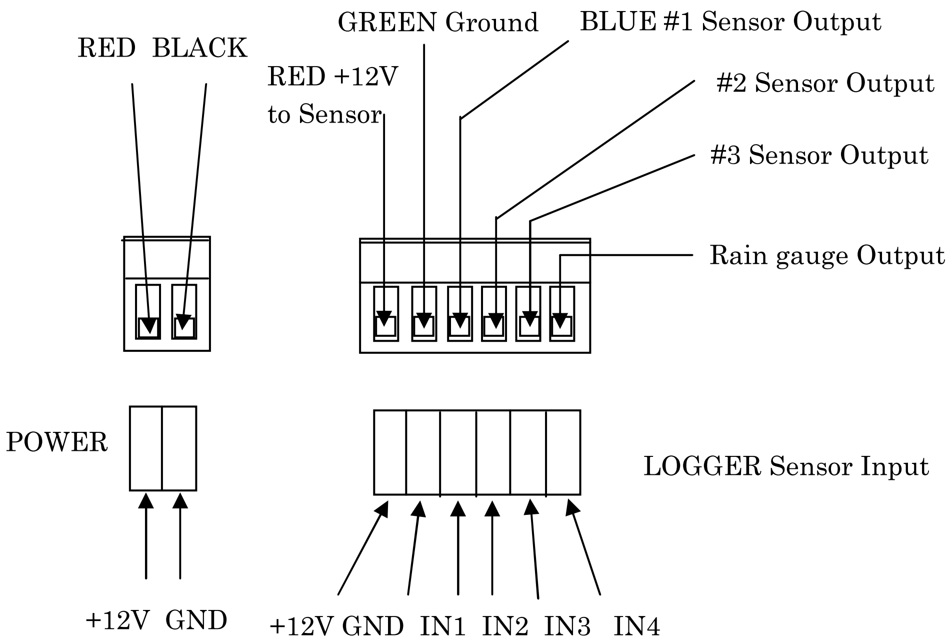


Figure 6. Sensor Connector

Calibrate Channel

On the SL300 the connection to the sensor is as follows:

If the sensor requires power from the SL300 (Three Wire Interface) then it must be connected to the +12v pin, the GND pin and one of the input pins (Pins IN1 - IN3 are input for sensor, and IN4 is for Rain gauge). To each of these inputs 4 - 20mA may be applied for calibration. (Ensure IN * makes a loop with ground; GND). If the sensor is already powered (Two Wire Interface) then the connection is only needed between +12v and one of the inputs.

When the sensor is connected and the user has chosen the channel, the required accuracy and the method in which to calibrate, click on the Calibrate Channel Button. Depending on the method selected, the user will be prompted with a dialog box, where they are to enter the calibration value they require. If the user selected "1 point span" then they will be prompted to enter the "Full Scale Value". If the "1 point offset" is used then the user will be prompted to enter the "Low Scale Value". When "2 point span and offset is used, then the user will first be prompted to enter the "Low Scale Value" and then the "Full Scale Value”.

Example:

Problem:

If the user wanted to calibrate their sensor so that one of the channels read 0 metres when the input was 4mA and 10 metres when at 20mA.

Solution:

First select User Cal Tab from the logger control window. Then select the channel the user wishes to calibrate and the accuracy they require. Choose the 2 point span and offset method and click the Calibrate Channel Button. As mentioned before the user will be prompted with the "Low Scale Value". In this case it will be zero and set the input on "IN*" to 4mA and click OK. User Cal will then ask the user to enter the "Full Scale Value". Now set the input to 20mA and type in 10m in the dialog, then click OK. This will then re-calibrate the sensor so that the range from 0 - 10metres will correspond to the range of 4 -20mA.

Battery Pack (optional)

Overview

The Greenspan range of Smart Sensors may be factory fitted with a non-rechargeable long life battery pack. This enables the sensor to be independent of above surface power supplies, (no cable connection) and allows for discreet applications. It also functions as a backup power supply in the event of a surface disturbance to the main supply.

The unit is designed to allow easy access to the battery compartments for cell replacements and is housed in a cylindrical body of approximately the same dimensions as the sensor housing, thus doubling the length of the sensor.

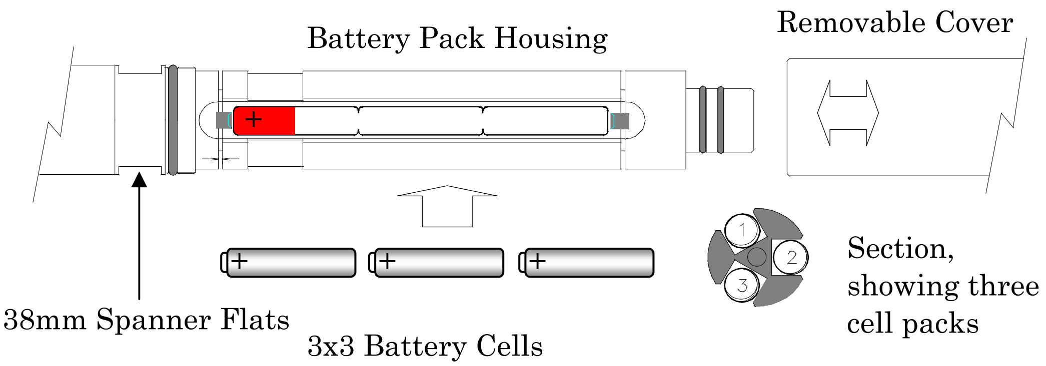


Figure 7. Battery Pack

For battery packs with spanner flats, place a 38mm spanner on the flats adjacent to the battery cover (see figure 7) unscrew the battery cover and slide back along the cable. Battery packs without the spanner flats do not require a spanner and the battery cover may simply be unscrewed.

Important Battery Information

The type of battery used in the battery pack is Li/Mn02, Lithium Thionyl Chloride 3.6V AA cells. A total of nine batteries are required for each sensor battery pack. This configuration supplies a maximum 10.8 volts at 5.2A/Hr and a useful field life, depending on sensor type and logging frequency, of up to 12 months.

WARNING **REPLACE ONLY WITH BATTERIES SUPPLIED BY GREENSPAN TECHNOLOGY, TYPE BP108VAA. DO NOT SUBSTITUTE.**

Replacement

Batteries are removed by unscrewing the housing cover, as indicated above and gently levering the battery cells until they slip out. Replacement batteries must be inserted correctly or damage to batteries will occur. Align the +ve on the battery cells with the red indicator on the housing and push batteries in. See figure 7. Batteries are subject to leakage after depletion. The leakage is Thionyl Chloride, a toxic, corrosive non-flammable liquid that can cause damage to equipment and personal injury if in contact with the skin or eyes. Please replace batteries when depleted.

When installing replacement batteries within the battery housing it is necessary to push firmly on the cover until it clicks home over the O rings, after this it can be easily tightened on the thread by hand.

Caution

Do not dispose of batteries in fire, dispose of in appropriate manner.

Do not short circuit

Do not expose to water

Do not crush or puncture

Do not charge

Do not over-discharge

To maintain the maximum possible life of the cells before replacement it is strongly recommended that an external power supply is connected to the sensor when downloading data. The power drawn when downloading is at its greatest level, therefore battery depletion will be much more rapid.

POWER CONSUMPTION 6

The Smart Sensor is designed to draw as little power as possible in order to provide the longest logging capability with the smallest practical battery size.

The following information is required to calculate battery lifetime:

Scan Time (from Location Properties (General))

Turn On Time (from Location Properties (General))

Sensor Sleep Current = < 200uA (0.2 mA)

Sensor On Current, (when a measurement is taken):

Table 1

Pressure Sensor, PS310	32 mA
Turbidity Sensor, TS300	110 mA
Electrical Conductivity, EC350	60 mA
pH Sensor, PH300	32 mA
ORP Sensor, ORP300	32 mA
Dissolved Oxygen Sensor, DO300	32 mA
Conductivity/Pressure, CP300, CTD350	70 mA
Conductivity/Pressure/ Temp/pH, CTDP300	70 mA
Temp/DO/pH, CS302	85 mA
EC/Temp/DO/pH, CS304	82 mA
PS/EC/DO/Temp, CS305	40 mA
SL300 Smart Logger	35 mA

First, calculate the Scan /Log current:

$I_{AV} = ((I_{ON} \text{ x } (TOT + 1)) / S_T) + I_S$

Where: I_{AV} = Scan/Log Current (mA)

I_S = Sleep Current (0.2 mA)

I_{ON} = Sensor On Current (mA), (from Table 1)

TOT = Turn On Time (sec)

S_T = Scan Time (secs)

eg: For a Scan Time of 15 min (15x 60 = 900 secs) the Scan/Log current is:

I_{SL} = ((32 x (01 + 1)) / 900) + 0.2

= 0.201 mA

To determine the battery life:

Battery Hours = Battery capacity (mA/Hr) / I_{SL}

eg: For a 5.6 A/Hr gel cell battery:

Battery Hours = 5600 / (0.201)

= 27,860 hours

To convert battery hours to days:

Days = Battery Hours / 24

eg: Days = 27,860/24

= 1,160 days or 3 years

Due to the discharge effect of the battery and field temperature conditions the actual duration is approximately 1/2 this total.

Memory Capacity

It must be remembered that the memory capacity of the sensor is a limiting factor in the actual time a sensor can operate unattended.

For example, a standard 512K byte memory can store 42,600 records.

(R X Rt) / 60 / 24 / 30 = months

Where: R = Number of Records available

Rt = Record Time (mins)

eg: 42,600 X 30/60/24/30 = 29 months or 2.4 years.

For 1Mb memory capacity a total of approximately 83,000 records are available if one channel is used.

eg: 83,000 X 30/60/24/30 = 57 months or 4.7 years.

Therefore, the realistic, unattended, logging time is dependant on battery capacity, memory capacity and the frequency of logging.

TROUBLESHOOTING 7

If difficulty in establishing communication with the logger is found then please:

Check

- Is supply voltage correct, 10.8 Volt internal battery fully charged or 8-15 Volt external supply connected.

- Are cable connections correct, red wire to +12V, black wire to ground?

- This test checks that the sensor is not drawing excessive power:
  1. Connect a milliammeter in series with the sensor power supply line
  2. Connect the sensor to a PC and execute SmartCom
  3. Enter Monitor Current Values mode, the current should be as per Table 1, Section 6. Please note that a brief increase is seen when the Status Indicator on the SA or MA interface is activated.
  4. Escape Monitor mode, the current should be approx. 20mA
  5. Quit SmartCom, the current should settle to approx. 200µA or less but every second will momentarily read greater than 200µA.

- Communications, RS232 DB9 connector making good contact, check for bent pins on PC.

- Sometimes communication can be re-established by temporarily interrupting power to the unit. This performs a hardware reset.

- If error screens appear when attempting communication ensure that all files necessary for SmartCom are included in the same sub directory. Check the files against the master CD listing on screen depending on the chosen operating system.

- If a sensor battery pack is used, ensure that the battery compartment cover is properly closed to prevent water penetration when immersing.

- If the sensor has a waterproof connector option ensure that the weather cap is installed when immersed.

SPECIFICATIONS 8

- DS5001/2 microprocessor controlled
- 64K of program memory in ROM
- 512K to 1Mbyte of battery backed data storage, providing approximately 42,600 to 83,000 date and time stamped readings for a single channel.
- Real time clock accurate to 5 seconds a month
- Sampling interval 5 sec to 1 Hour
- Record interval 5 sec to 24 Hours
- Sensor Turn On Time is 2 seconds
- 16 Bit analogue to digital converter
- ASCII data output
- Alarm functions for high and low levels, battery levels, sampler and memory full
- Ability to upgrade firmware in the field
- Mobile phone alarm output and four telephone numbers
- Up to four input channels
- Range of logging options: event logging
  averaging
  time
- Intelligent interface software SmartCom for Windows for PCs
- Graph, view and convert utility Aquagraph, accessible from SmartCom.
- Reverse polarity and transient protection
- Optional 10.8V on board battery pack

SENSOR SPECIFICATIONS 9

Pressure

Standard Ranges Available:

- Pressure: 0-1m, 0-2.5m, 0-5m, 0-10m, 0-20m, 0-40m, 0-75m, 0-100m, 0-200m (Gauge)
- 0-10m, 0-20m, 0-40m, 0-75m, 0-100m (Absolute)
- Temperature: 0-50°C

Other ranges available on request

Operational Parameters:

Pressure Over-Range:

Range (m)	Max. Over Range (m)	Range (m)	Max. Over Range (m)
1	40	40	250
2.5	60	75	400
5	60	100	400
10	100	200	400
20	180		

Linearity:

- Pressure: +/- 0.02% FS (Combined linearity, hysteresis and repeatability)
- Temperature: +/- 0.2°C

Accuracy:

- Pressure: +/- 0.12% FS (over temp range 0-50°C)
- Temperature: +/- 1°C

Supply Voltage:

8-15V

- Reverse polarity protected
- Surge current protected to 2kV

Quiescent Current:

- 130µA to 30mA

Turbidity

Standard Ranges Available:

- 0-100, 0-250, 0-500, 0-1000 NTU

Other ranges available on request

Linearity:

- ± 2% FS

Supply Voltage:

8-15V

- Reverse polarity protected
- Surge current protected to 2kV

Quiescent Current:

- 130µA-110mA

Dissolved Oxygen

Standard Ranges Available:

- Dissolved Oxygen: 0-20ppm or 0-200% saturated
- Temperature: 0-50°C

Other ranges available on request

Linearity:

- Dissolved Oxygen (ppm): ± 0.2ppm
- Dissolved Oxygen (% Sat): ± 1% FS
- Temperature: ± 0.2°C

Accuracy:

- Dissolved Oxygen (ppm): ± 0.3ppm (over range 5-35°C)
- Dissolved Oxygen (% Sat): ± 2% FS Saturation, (over range 0-50°C)
- Temperature: ± 1°C

Supply Voltage:

8-15V

- Reverse polarity protected
- Surge current protected to 2kV

Response Time:

- For 10ppm step change: 40 minutes to 90% of reading

Electrical Conductivity

Standard Ranges Available:

• EC:	0-1000, 0-2000, 0-5000, 0-10000, 0-20000, 0-60000 µS
• Temperature:	0-50°C

Other ranges available on request

Linearity:

• EC:	+/- 0.2% FS
• Temperature:	+/- 0.2°C

Temperature Stability*:

• Normalised	+/-0.35% FS *Variation of EC parameter over ambient temp range 0-35°C
• Non Normalised	+/-0.5% FS *Variation of EC parameter over ambient temp range 0-50°C

Accuracy:

• EC (normalised to 25°C):	+/- 1% FS (over temp range 0-35°C)
• EC (non-normalised):	+/- 0.7% FS (over temp range 0-50°C)
• Temperature:	+/- 0.2°C

Normalisation:

- EC normalised to solubility reference 1.84%/°C

Supply Voltage:

8-15V

- Reverse polarity protected
- Surge current protected to 2kV

Quiescent Current:

- 130µA-60mA

pH

Standard Ranges Available:

- pH: 0-14 pH
- Temperature: 0-50°C

Other ranges available on request

Operational Parameters:

- Temperature Range: 0-50°C

Linearity:

- pH: ± 0.1pH
- Temperature: ± 0.2°C

Accuracy:

- pH: ± 0.2pH
- Temperature: ± 1°C

Temperature Compensation:

- 0-50°C

Current Requirements:

- Quiescent, 130uA
- Maximum, 32mA

Supply Voltage:

11-14V

- Reverse polarity protected
- Surge current protection all inputs to 2kV

ORP

Standard Ranges Available:

- +/-500mV and +/-1000mV

Operational Parameters:

- Temperature Range: 0-50ºC

Linearity:

- ORP: +/-10mV
- Temperature: +/- 0.2°C

Accuracy:

- ORP: +/-2% of Span
- Temperature: +/-1°C

Supply Voltage:

11-14V

- Reverse polarity protected
- Surge current protected to 2kV

Current Requirements:

- Quiescent, 130uA
- Maximum, 32mA

SL300

Operational Parameters:

- For use with Greenspan 4-20mA sensors

Inputs:

- IN1-IN3 4-20mA
- IN4 Digital Input

Supply Voltage:

8-15V

- Reverse polarity protected
- Surge current protected to 2kV

Current Requirements:

- <35mA Monitor
- <25mA Comms
- <200uA Sleep

Memory:

- 512K or 42,600 Records

Fuse:

- Internal resetting

Dimensions:

- Length: 200mm
- Width: 90mm
- Height: 55mm

PRESSURE SENSOR

22 Palmerin Street, Warwick 4370 Qld Australia.

Tel: 0746 601888 Fax: 0746 601800

CERTIFICATE of CONFORMANCE

SMART SENSOR

Model No. **PS310**

Customer:

Ref:

Detail

Serial No.	**003014**	**Supply Voltage**		8 - 15 VDC
Range	0 - 5m H_2O	**Connection:**	**+ve**	Red
Linearity/Accuracy	See note 8		**gnd**	Turquoise
Cable Length	10 metres	**Alarm/Sam**	**out**	Blue
Sensor Type Gauge		**Rain Gauge**	**in**	Brown
Firmware Version	2C144	**Connection Code**		HS7V

For further connection detail please refer to **Connector Chart** supplied.

User Notes

1. AS1376 is used to convert kPa to metres of water.(1kPa = 102.15 mm water).
2. Do not attempt to dismantle the sensor as it will void the warranty. Contact your agent for technical advice.
3. The sensor is protected against reverse polarity connection.
4. The sensor is fitted with a lightning protector/surge device.
5. The sensor is compensated for temperature induced errors over the range 0 - 50°C.
6. High range sensors utilise a 1/4" Tapered BSP thread.
7. The sensor turn on time is 2 seconds and is factory set.
8. Linearity and Accuracy are as specified in User Manual.

Inspected By: .... / /