pH Sensor

Version 4.01

User Manual

+61 7 4660 1888
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

1. MEASUREMENT OVERVIEW..... 3

2. SENSOR DESIGN 4
Signal Conditioning Circuits 4

3. CONNECTION DIAGRAM 5
Cable Considerations 5

4. CALIBRATION DERIVATION 6

5. CALIBRATION PROCEDURE 7

6. HOUSING 9
Disassembly 9
Re-assembly 9

7. SENSOR MAINTAINANCE 11

8. ELECTRODE REPLACEMENT 12

9. PACKAGING 14

10. FIELD CONSIDERATIONS 15

11. SPECIFICATIONS 16

12. CERTIFICATE of CONFORMANCE 17

MEASUREMENT OVERVIEW 1

The Greenspan pH 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 sealed to a glass 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 eg. a silver-silver chloride half cell in contact with a gel 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. The gel electrode is a sealed reference.

pH provides an indication of whether a solution is acidic or basic 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 normal room temperatures

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

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

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

SENSOR DESIGN 2

Signal Conditioning Circuits

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.

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 isolated using the latest balanced optical isolation techniques to ensure that there is no signal path from the electrode to the common power supply.

- In addition a low power DC-DC transformer is used to isolate the power supply.

The implementation of these features ensures that the pH sensor can be used with other sensors in a common water body while all sensors are attached to a common power source, ie. via a common multi-channel data logger.

The pH100 is automatically temperature compensated over the temperature range 0-50°C. The temperature compensation curve of a pH electrode is defined by the curve:

$$\frac{RT}{F} \; Log_{10}(H^+)$$

Where:

R = 8.3143 Universal Gas Constant
F = 96487 Faraday Constant
T = Absolute Temperature 0°C + 273.150

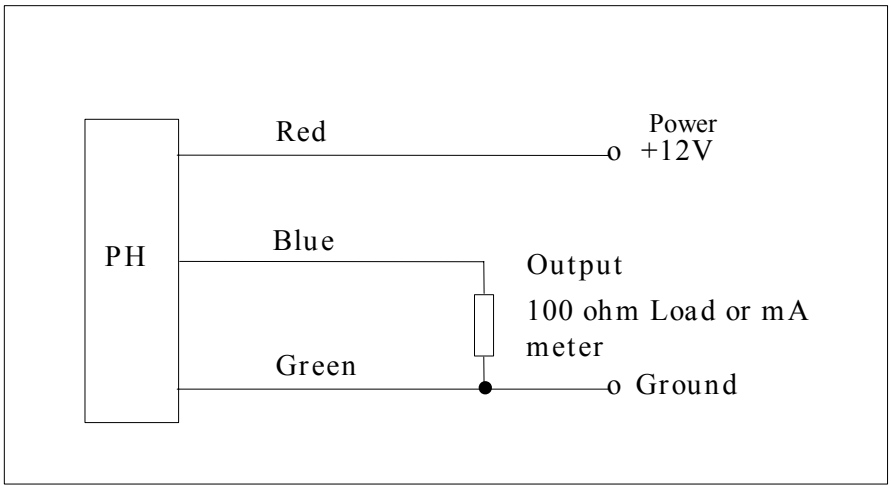
An internal thermistor circuit matches this curve, and compensates for temperature changes.

The sensor will reach full output reading in less than two seconds. If it is used with data loggers that have an adjustable power-on time feature, a a minimum of two seconds is recommended. It should be noted that this assumes that the sensor has reached equilibrium in the pH solution which may take up to five minutes.

CONNECTION DIAGRAM 3

The following diagram describes the wiring arrangement for the PH100

Diagram 1



Cable Considerations

The supply voltage range is 8-15V and the total current drawn is the sum of the quiescent current (45mA) and the full scale output current (20mA). The resistance of the cable is 9 ohms per 100 metres per conductor. Therefore for maximum supply voltage at full output, a 25m length of cable will give a voltage drop of :

$$45mA \times 9 \times \frac{25}{100} = 0.101V$$ for the green wire

$$(45mA+20mA) \times 9 \times \frac{25}{100} = 0.146V$$ for the active red wire

Therefore the total of these provides approximately 0.247 volts less across the sensor. That is, a 15V supply with 25m of cable will effectively provide 14.75V at the sensor.

The sensors are protected against reverse connection and high voltages of 2KV that may occur during lightning storms.

CALIBRATION DERIVATIONS 4

The Greenspan PH100 Sensor is calibrated to read 0 - 14 pH with an output range of 4 -20mA.

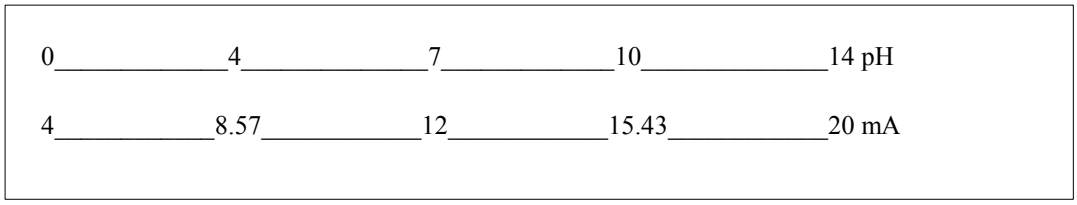
Span: 20mA - 4mA = 16mA, and Range is 0 - 14 pH

therefore; 16/14 = 1.143mA per pH

The relationship between output current and pH can be expressed as:

Current out = ((pH of solution x 1.143) +4) mA

Diagram 2.



this provides three values for use in the calibration:

4pH = **8.57mA**

7pH = **12.00mA**

10pH = **15.43mA**

Note that other reference solutions may be used for the calibration, and the ones above are provided for clarification only.

It is recommend for optimum performance that the sensor is calibrated over a temperature range of 15ºC to 30ºC.

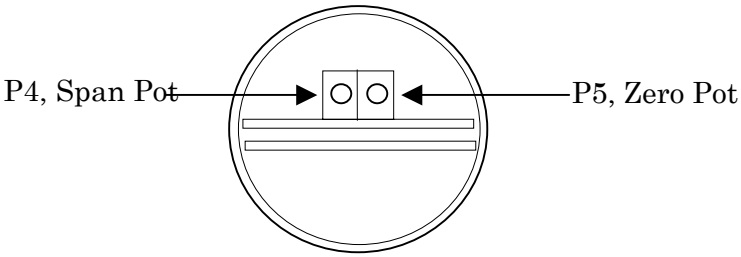
CALIBRATION PROCEDURE 5

The following steps describe a method for re-calibrating the sensor. Please note that calibration adjustment requires the sensor to be disassembled in order to access the potentiometers. It is the users' responsibility to ensure that the sensor is re-assembled correctly and seals are intact. Please refer to diagram 3 for calibration potentiometer identification.

Method

1. Setup pH7 and either pH4 or pH10 solutions.
2. Connect sensor output wires as per wiring diagram 1.
3. Apply +12V power.
4. Place sensor in pH7, allow two minutes to stabilise and adjust Zero Pot, P5 for **12.00mA** +/- 0.1mA.
5. Rinse sensor in clean water and wipe away excess with clean tissue being careful not to touch the bulb with fingers. Ensure no trapped air bubbles are present by tilting sensor and/or vessel.
6. *If your area of interest in measurement is at the low end*, place sensor in pH4 and allow two minutes for sensor to stabilise. Adjust Span Pot, P4 for **8.57mA** +/- 0.1mA.
7. *Alternatively, if your area of interest in measurement is at the high end*, place sensor in pH10 and allow two minutes for sensor to stabilise. Adjust Span Pot, P4 for **15.43mA** +/- 0.1mA.
8. Rinse sensor when changing solutions as before.
9. Place sensor in pH7 again and after two minutes check reading is **12.00mA** +/- 0.1mA. If not, adjust Zero Pot, P5.
10. As a final check, rinse sensor when changing solutions as before and place in pH4 or pH10, allow two minutes for sensor to stabilise and check reading is correct.

Diagram 3



Sensor End View

11. If stable readings cannot be obtained or if Zero Pot, P5 cannot be adjusted to the correct value, the unit may require fitting of a replacement pH electrode. Contact your Greenspan agent for fitting and calibration of replacement bulb or see Section 8, Bulb Replacement.
12. This completes the calibration, re-assembly is now required.

HOUSING 6

Disassembly

It is essential that cleanliness is maintained on the O ring assembly to ensure proper sealing action.

1. Loosen both screws on clamp retainer, see figure 1.

2. While being careful not to twist the cable wires remove the cable clamp with a spanner.

3. Loosen the end cap with a spanner and unthread from tube. Take care not to damage or contaminate the 'O-Ring'.

4. Carefully slide the circuit board from the tube to expose the calibration potentiometers.

5. Refer to Diagram 3, Re-Calibration Section, for calibration potentiometer positions.

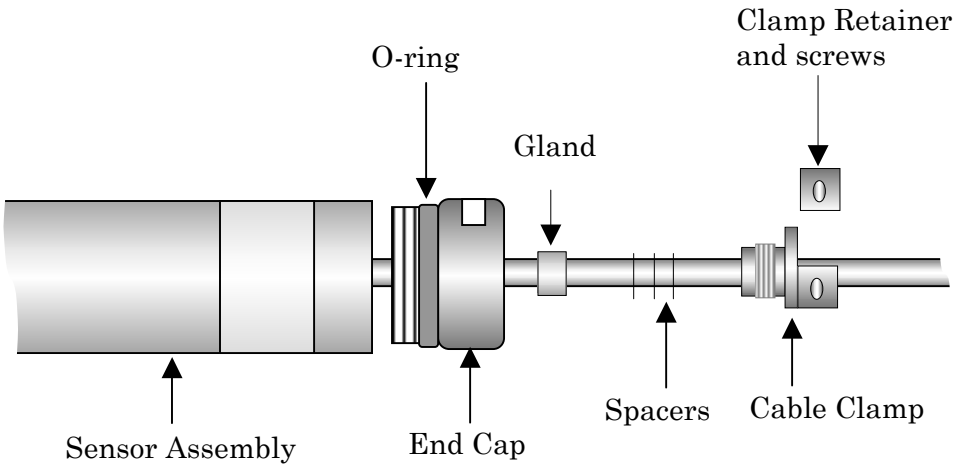


Figure 1. Assembly Parts

Re-assembly

1. A small amount of silicone grease applied to the O ring is recommended when assembling.

2. Ensure the plastic insulation sleeve is in place within the housing and insert the circuit board. (see note later).

2. Ensure 'O" ring and chamber is clean of debris and thread the end cap onto the tube.

3. Tighten the end cap to the tube with a spanner.

4. Tighten the cable clamp to the end cap to compress the cable gland around the cable. **Note this must be done with care to ensure a proper seal.**

5. Tighten both the retainer clamp screws.

Note: the inside of the metal housing is lined with a Mylar sheet for electrical insulation of the printed circuit board, ensure this is in place when inserting board.

SENSOR MAINTENANCE 7

The sensor electrodes should always be stored in pH4 solution. The pH electrodes are shipped from Greenspan with a black plastic electrode cover which is filled with pH4. 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. (Refer section 10, Field Considerations)

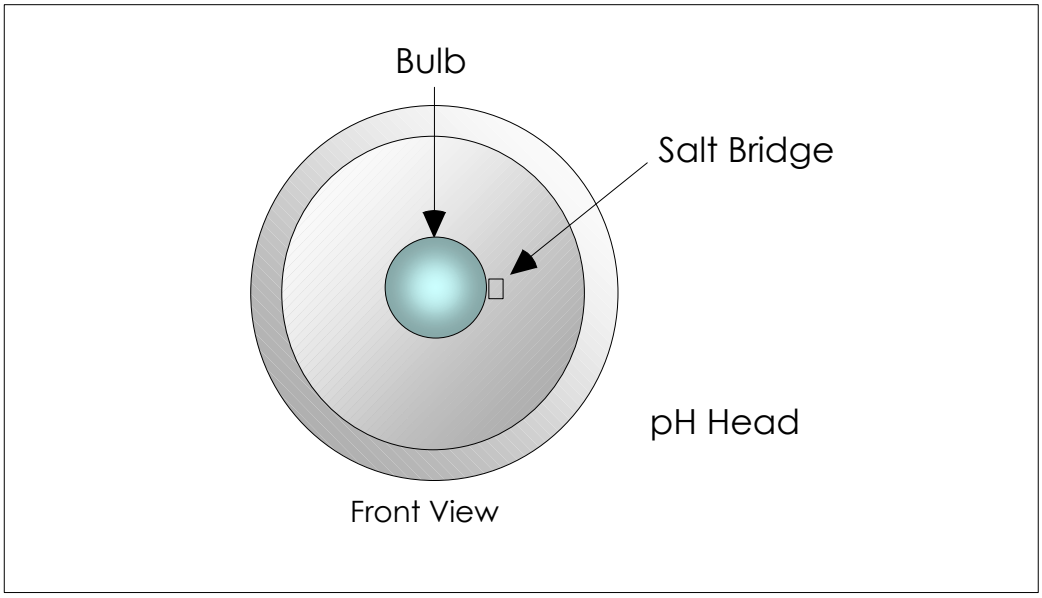
If the electrode is not kept moist it may dry out over a 36 hour period and cause erroneous readings. It may be possible to restore it by soaking the sensor in a pH4 solution for 12 hours.

Both the membranes and salt bridge must be kept as clean as possible at all times. Do not allow fats, oils or proteins to dry on the membrane or salt bridge. The membrane may be cleaned with weak solutions of detergents or bleach. Abrasive materials must not be used; a wash bottle or cotton bud is recommended. After cleaning, wash well with tap water and soak in pH4 solution before use.

Although the gel filled electrode has distinct advantages for long term field applications it has a limited lifetime. The expected lifespan of gel type pH transducers in good field conditions is from 2 - 3 years, in poor conditions this may reduce to 12 -18 months.

See Section 8, 'Bulb Replacement' or contact your Greenspan agent for further information.

Diagram 5



ELECTRODE REPLACEMENT 8

If it is necessary to replace the pH electrode the following procedure is recommended.

1. Contact Greenspan to purchase a replacement pH electrode kit. (PHK100)

2. Refer to Section 6, Housing - Disassembly

3. Once the sensor is disassembled, remove the circuit board assembly until the black pH electrode wires are exposed.

4. Carefully cut back the heat shrink covering the solder termination on the board. See diagram 6.

5. Unsolder the two cores of the black shielded wire attached to the pH electrode.

6. Place the pH head block, in the jaws of a vice, locating on the flats and unscrew the tube from the head block. It may be very tight!

7. With a spanner unscrew the pH electrode from the Delrin head block.

8. Remove the cap on the replacement pH electrode. Wrap thread with Teflon sealing tape.

9. Insert into head block and tighten. Note; do not over-tighten as this may damage the glass electrode.

10. Ensure all O rings and channels are clean and re-assemble tube to head block.

11. With the board external to the tube, solder bulb assembly to circuit board, shield to S9 and core to insulated pin G1 via R12. Ensure C8 is connected between G1 and S9. See diagram 6.

12. Apply a small amount of hot melt glue to cable for strain relief, do not glue solder joins. See diagram 6.

13. Reassemble inside tube. Note that the black insulation sleeve under the shield is conductive and must be kept separate from the signal wire.

14. Please refer to Section 5, Recalibration, before re-assembly.

15. Once calibration is complete, refer to Section 6, Housing - Re assembly.

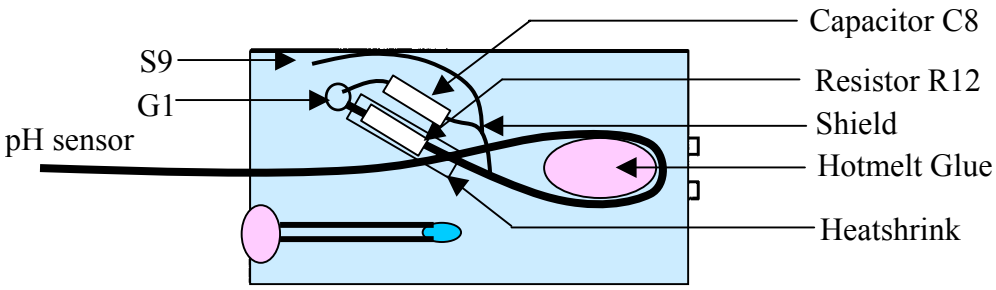


Diagram 6. Wiring to Board

Please note that Greenspan cannot accept responsibility for any problems that may arise from this procedure. Pressure testing of the seals is the responsibility of the user.

PACKAGING 9

The standard package includes:

- 316 stainless steel body
- Delrin sensor guard
- Delrin end cap with polyurethane cable

Integrity against moisture entry is gained via "O" ring glands and seals. The completed instrument is pressure tested for leaks before leaving the factory.

Media 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 or Ferric solutions or low oxygenated water.

The body should always be totally immersed under the water to ensure that the electronic module is at water temperature and also to avoid any possible anodic/cathodic action taking place on the stainless body at the water-air interface due to oxygen differences across the boundary. It has also been noticed at some sites that clamps used to support the sensors (316 stainless body) have occasionally caused spot corrosion due to electrolysis action. It is recommended plastic clamps be used.

An optional Delrin plastic body is available if there is concern with the suitability of 316 stainless steel.

FIELD CONSIDERATIONS 10

When installing the sensor, ensure that the pH electrode cap is removed. To do this, pinch the tip of the pH electrode cap with the fingers and pull. A slight twisting action may help if it is tight.

After removing the sensor from deployment it is recommended the pH electrode cap is filled with pH4 solution and replaced to prevent the pH electrode from drying out.

Experience has shown that the Greenspan pH sensor usually requires 1-2 monthly site visits to ensure that the electrode membrane is clean. (See cleaning notes).

A common approach is to take a standard pH buffer into the field such that the pH sensor can be dipped into the solution and checked for conformity against the manufacturers specifications. If it fails, the sensor should be withdrawn from service for recalibration and replaced with a newly calibrated unit.

If the sensor is deployed in marine or estuarine environments the lifespan of the sensor may be further reduced due to the growth of crustaceans on the sensing elements.

If performance is deteriorating or calibration is not being maintained and the sensor is of this age then replacement of the transducer may be required. Replacement pH bulb kits are available from Greenspan or your agent and can be installed by the user. Please refer to Section 8 of this manual.

SPECIFICATION 11

Specification	Model PH100
Standard Range available	0-14pH
Temperature Range	0 - 50°C
Resolution	0.001 pH
Accuracy	± 0.2 pH
Temperature Compensation	0 - 50°C
Supply Voltage	11-13VDC Reverse polarity protected Surge protected to 2kV
Quiescent Current	30 - 45mA
Warm up time to stable reading	02 Seconds
Output	4 - 20mA, 3 wire
Dimensions	length 226 mm, 32 mm OD
Wetted Materials	Passivated 316 Stainless steel, Delrin, Glass bulb
Load (min-max)	500 ohms at 14V 400 ohms at 12V
Storage Temperature	- 20 to +60°C

pH SENSOR

22 Palmerin Street, Warwick 4370 Qld Australia.
Tel: 07 4660 1888 Fax: 07 4660 1800

CERTIFICATE of CONFORMANCE

Customer:

Model No. **pH100**

Ref:

Serial No.		**pH1121**
Range		0 - 14 pH
Output	**FS**	20.00 mA
	Zero	4.00 mA
Linearity		+/- 0.2 pH
Type	**Std/LI**	Standard
Connection Code		BW

Supply Voltage		8 - 15 VDC
Connection	**+ve**	Red
	-ve	Green
	o/p	Blue
Cable Length		2 metres

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

Calibration is to standard solutions ref @ 20°C and manufactured according to Standard Methods, Ref ED19

Ref	**Actual**	**Sign**	**Date**
pH	mA		
pH	mA		
pH	mA		

1. The sensor is protected against reverse polarity.
2. Do not attempt to dismantle the sensor as it will void the warranty. Contact your agent for technical advice.
3. The sensor utilises a Gel filled pH electrode. They will generally last for 12-18 months in the field. They cannot be refilled with electrolyte and should be returned to the agent for replacing.
4. The glass bulb located inside the black shroud should be kept clean. Marine growth or silt deposit may affect sensor accuracy. Cleaning schedules are determined by site conditions and initially weekly visits are suggested for visual inspections. The pH probe should be cleaned with a weak soap solution either under pressure from a wash bottle or gently swabbed with a cotton bud.
5. The pH sensor should always be kept moist. Where it is stored or transported place pH4 solution into the cap provided and fit over bulb. If the sensor dries out it should be soaked in pH4 for 24 hours before use.
6. The sensor is compensated for temperature induced errors over the range 0 - 50° C.

Inspected By: ..... / /