GREENSPAN

PH-1000A

pH SENSOR

PRODUCT USER MANUAL

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1 Introduction

1.1 System Description

Thank you for purchasing the Greenspan pH Sensor. This manual provides a guide to the configuraÐon, operaÐon and maintenance of the sensor to provide long term reliable and accurate monitoring.

The PH-1000 probe uses a combinaÐon, glass pH and reference electrode in the one body. This electrode is field replaceable by the user. When placed in an aqueous solution a voltage is developed which varies depending on the pH of the soluÐon. This voltage is compared against the voltage from the reference electrode which is stable. The reference consists of a specially coated wire in a salt filled cavity. This cavity makes electrical contact with the outside aqueous soluÐon through a small porous wick. A common cause for premature pH sensor failure is the chemical or biological contaminaÐon or fouling of the wick or salt filled cavity. Added protecÐon for the reference electrode is provided by a reference protecÐon ring constructed of porous PTFE that is impregnated with a special conducÐve gel. It is placed over the reference wick and should prevent most contaminants from reaching the wick, while sÐll allowing good electrical contact with the sample. If the low cost protecÐon ring is contaminated or fouled it can be simply replaced, extending the life of the combinaÐon electrode.

Designed for applicaÐons where an analogue output is required. The sensor provides a 3 wire 4-20mA output. The sensor requires power from a stable DC source between 11 and 13.2 Volts.

The Sensor is packaged in an Acetal body, with double o-ring seals for the cable and sensor head. This fully submersible sensor design is rugged and well proven and can withstand the harsh conditions found in remote field applicaÐons including groundwater, salty or acidic water condiÐons.

1.2 How to Use the Manual

Along with this manual, there are several other documents that may assist in the successful configuraÐon and operaÐon of the Greenspan PH-1000A Sensor. These should be maintained on file as a permanent reference as to the features, applicaÐons and use of the PH-1000A.

Greenspan PH-1000A – Specifications Brochure

Greenspan PH-1000A – Certificate of Conformance

Greenspan PH-1000A – Quick Start Guide

1.3 Certification

The pH probes are assembled and tested in accordance with Greenspan's ISO 9001 Quality CerÐfied System. Each Sensor is individually manufactured and cerÐfied against a traceable Standard.

Following calibraÐon the sensors undergo a range of additional control processes to ensure that all specificaÐons are consistent and documented.

The instrument is visually inspected, marked and labelled.
The complete sensor calibration record is archived for reference, and batch number information is kept on file for statistical analysis.
An individual Certificate of Conformance is issued to the customer.

1.4 Unpacking and Inspection

All Greenspan Sensors are made to order and are individually calibrated and inspected. This ensures that they leave the factory in a working condiÐon. On receipt, the customer should inspect the packaging and contents for any signs of damage during transportaÐon. The customer should also check that all items on the delivery note have been received.

Please contact the factory in case anything is missing or damaged. A full set of documentaÐon including CerÐficate of Conformance, Quick Start Guide, and User Manual will be provided with all equipment – either in hard copy format or in electronic format on the USB shipped with the goods.

1.5 Serial Number

Checking the Model Number and Range

Before installing your Greenspan PH-1000A sensor check the informaÐon on the label is correct to confirm you have received the instrument you have ordered. The label will look similar to this.

MODEL PH-1000A

RANGE 0 –14pH

S/N 012345

The customer is advised to keep a record of the serial numbers in case the sensor is lost or the label damage. Greenspan keeps records of all sensors sold including a calibraÐon history.

1.6 Warranty Policy

Greenspan warrants all new products against defects in materials and workmanship for **12 months** from the date of invoice. Products that prove to be defective during the warranty period will be repaired or replaced at the discretion of Greenspan.

Under Greenspan warranty condiĐons; it is the responsibility of the customer to cover shipping charges back to the factory. Upon repair/replacement Greenspan will cover the return shipping charges to the customer.

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 installaĐon or applicaĐon, 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 will not be liable for any incidental or consequenĐal damage or expense incurred by the user due to parĐal or incomplete operability of its products for any reason whatsoever or due to inaccurate informaĐon generated by its products.

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

Any sensor should not be dismantled unless under instrucĐon from Greenspan Technical Service staff. Incorrect handling will void the warranty.

1.7 Factory Service & Repair

The correct choice of sensor and assistance with field installaĐon can be provided by Greenspan and their sales offices. A correct choice of equipment, together with technical advice and field experience should result in long term success in the field. **Greenspan Technical Services** is dedicated to customer support and provides assistance in the selecĐon, installaĐon, deployment and commissioning of sensors with a full range of consulĐng services. All Greenspan products are designed, developed and manufactured in Australia and can be supplied at short noĐce.

If for some reason sensors are required to be returned to our factory or your sales representaĐve, please note the model and serial number, Describe the problem, including how and under what condiĐons the instrument was being used at the time of malfunction. Clean the product and cable. Decontaminate thoroughly if used in toxic or hazardous environment. Carefully pack product in original packaging if possible & include a statement cerĐfying product and cable have been decontaminated with supporĐng information. Products returned for repair must be accompanied by a completed GRA (Goods Return Advice) form. All sensors returned for service and repair work must be properly decontaminated prior to return. A cleaning charge may be applied to sensors that require further decontaminaĐon. Service work will not commence unĐl the quotaĐon has been accepted by the customer. A purchase order for all repair and service work will be required before work is carried out.

2 Sensor Overview

2.1 Theory of Measurement

The Greenspan PH-1000A sensor uses 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 aŁached to a sealed insulaÐng tube containing a soluÐon of fixed pH in contact with a silver-silver chloride half cell. The potenÐal developed across the membrane is compared to a stable reference potenÐal e.g. a silver-silver chloride half cell in contact with an electrolyte containing chloride. CompleÐon of the circuit is by means of a porous constricÐon (the salt bridge) which allows the reference electrolyte to slowly flow into the sample.

pH gives an indicaÐon of the acidity/alkalinity of a soluÐon and is defined as:

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

and covers a scale from 0 (acid) to 14 (alkaline) where H+ is the hydrogen concentraÐon in soluÐon, at ordinary temperatures.

E.g. pH of water

$$H2O = H+ + OH-$$

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

$$pH = -log\ 10-7 = 7$$

2.2 Instrument Details

Sensor Design

The Greenspan pH Sensor consists of the following primary elements:

Field replaceable pH electrode (fiŁ ed with reference protecÐon ring)

ProtecÐve Shrouds (removable for cleaning)

Temperature compensated electronics with 4-20mA output

Acetal Body

Moulded cable entry

FiŁ ed cable

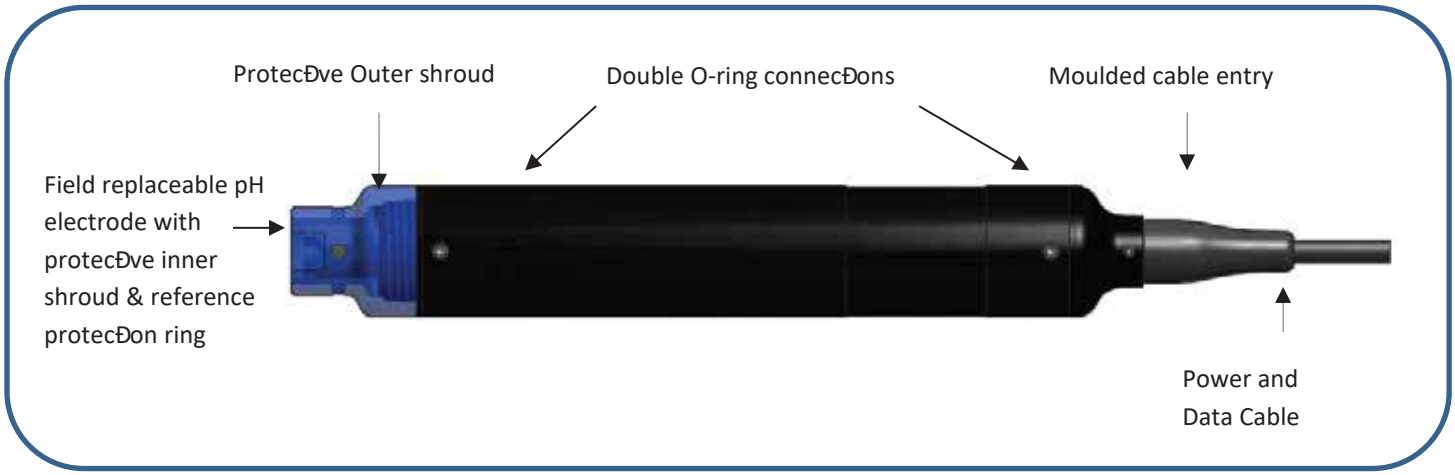
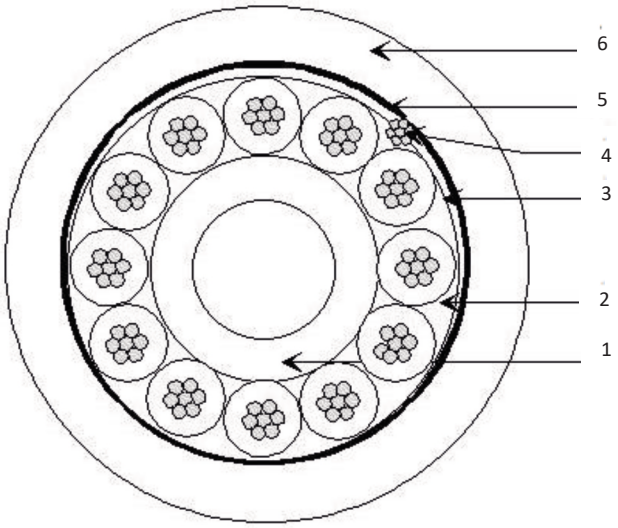


Figure 1 - PH-1000A Primary Elements

2.4 Cable Details

All Greenspan Sensors uĐlise a specially designed Polyurethane Cable. The cable contains 12 x conductors, 1 x drain wire, and an internal vent tube. The outer jacket is made from UV stabilized Polyurethane and is suitable for all external, underwater or harsh environment applicaĐons. This common cable construction is uĐlized for vented and non-vented sensors and all Greenspan Water Quality Sensors. Cables are generally factory fiŁed at Đme of manufacture in specified lengths. Cables can be joined or repaired in the field providing a waterproof connecĐon can be maintained. AlternaĐvely, cables can be terminated in waterproof juncĐon boxes where cabling to other devices or longer cable runs are required.



Cable Construction

1 –**Vent Tube**: Polyamide
(size ID x OD) 2.40 x 3.20 mm

2 - **12 x Conductors**
7 x 0.20 mm Tinned Copper
Section = 0.22mm2 AWG24
Insulation: Polypropylene
(size) = 1.10 mm ± 0.05 mm

3 - **Tape**: Polyester

4 – **Drain Wire**: 7x0.20 TinCu

5 - **Tape**: Polyester Aluminium

6 - **Jacket**: Polyurethane black,
(size OD) 8.05 mm ± 0.15

2.4.1 Mechanical Specifications

Specially Manufactured Greenspan Cable with 12 cores and Internal Vent
High chemical resilience and abrasive resistance
Conductor cross secĐon : AWG 24,
Electrical Resistance 9 ohm per 100m (per conductor)
OperaĐng temperature: 85°C (max.),
Bending radius (staĐc) : 6 ,
Bending radius (dynamic) 12.
Max OperaĐng voltage : 250V
Jacket PrinĐng (white colour each meter)
Conductor colour codes : green, yellow, white, black, brown,
turquoise, violet, pink, red, blue, grey
Tensile Strength is sufficient to self-suspend the Greenspan Sensor to depths of 300m.
Long term creep due to temperature effects or tensile loading is negligible.

The moulded cable is fiŁed to the sensor using a double o ring seal and located using 2 x grub screws. The length of the cable is not criĐcal to the long term calibraĐon and operaĐon of the sensor (provided the electrical requirements such as minimum supply voltage are maintained).

2.5 Options and Accessories

2.5.1 Cable Options

The sensor in its standard configuraÐon is supplied with a fixed moulded cable and bare wire terminal connecÐon. Special connectors can be fitted to the cables to suit specific applicaÐons, by request. Please contact your sales agent for pricing and further informaÐon.

2.5.2 Replacement Electrode Kit (Part #570-0230)

A kit containing a replacement combinaÐon electrode, spare reference protecÐon ring and cleaning tool is available. Contact your Greenspan sales representative for pricing and details.

2.5.3 Accessory Kit (Part # 5PH-AK1)

A kit containing a reference protecÐon ring and cleaning tool is available. Contact your Greenspan sales representaÐve for pricing and details.

2.5.4 Copper Inner Shroud (Part # 092-1034)

A protective copper inner shroud can be fitted to inhibit biological or marine growth on the sensor electrode. Contact your Greenspan sales representaÐve for pricing and details.

3 Sensor Operation

3.1 Wiring & Connections

The PH-1000A is a 3 wire, 4-20mA output sensor.

The following diagram illustrates the typical wiring arrangement for the PH-1000A

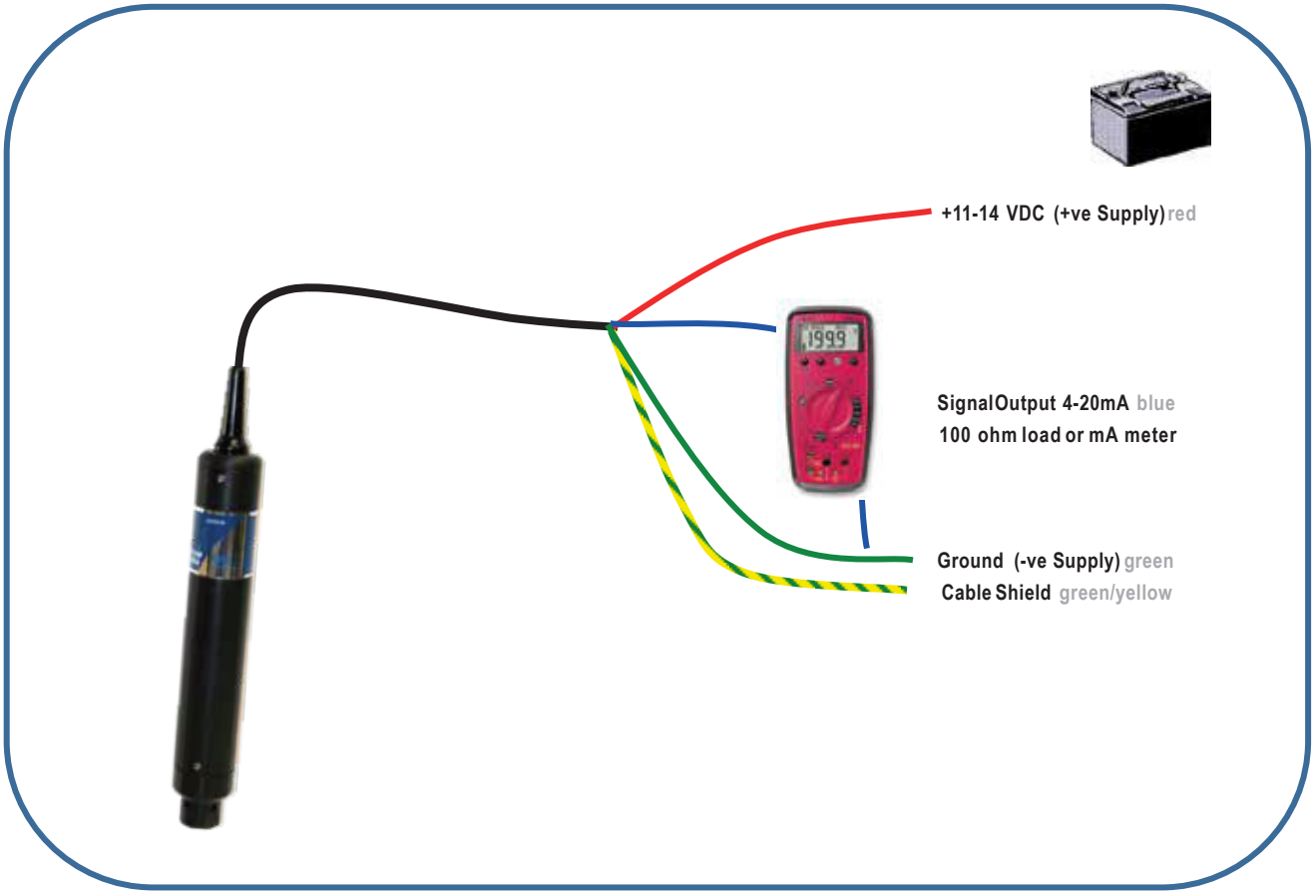


Figure 2 - PH-1000A Primary Elements

4 Calibration & Maintenance

To maintain high quality control over monitoring programs, it is recommended pH calibraÐon is checked every 3-6 months. The PH-1000A has no facility to adjust the analogue outputs. If any gain or offset correcÐon is required the factors should be entered into the datalogger or measuring device. Alternatively sensors may be returned to an authorised Greenspan agent for re-calibraÐon.

The sensor can be checked by use of known pH standards (buffer soluÐons).

4.1.1 Quick check

1. Remove the sensor from the water, ensure the sensor is clean. Dirty electrodes could be a key source of calibraÐon errors.
2. Connect the sensor to a DC power source and a meter to measure the sensor output.
3. Place the sensor in a low level pH buffer (eg. pH 4) so that the electrode is fully submerged and free from trapped air bubbles. Record the measured output value.
4. Carefully rinse the electrode in water and shake off any aŁ ached droplets.
5. Place the sensor in a high level pH buffer (eg. pH 10) so that the electrode is fully submerged and free from trapped air bubbles. Record the measured output value.
6. The pH sensor should output a value that is proporÐonal to the full scale range of the sensor.

4.1.2 Calculating Gain and Offset Correction Factors

Most dataloggers or SCADA devices have the ability to enter gain (or mulÐplier) and offset factors to correct for small changes in the sensor output. If the quick check values are outside allowable tolerances, correcÐon factors can be calculated and entered into the measuring device or used to post process any data recorded.

E.g. A quick check was done on a PH-1000A with the current output connected to an ammeter. The results recorded were 8.48 mA in pH 4.00 buffer and 14.82 mA in a pH 10.01 buffer.

Expected readings are calculated by:

Expected reading (mA) = (pH value x sensor output range / sensor pH range) + 4

i.e. Expected reading in pH 4 buffer = (4.00 x (20-4) / (14-0)) + 4

= 8.57 mA

Expected reading in pH10 buffer = (10.01 x (20-4) / (14-0)) + 4

= 15.44 mA

The gain correcÐon can be calculated with the formula-

Gain correcÐon = (expected reading at high pH – expected reading at low pH) /

(Reading at high pH – Reading at low pH)

Gain correcÐon = (15.44 – 8.57) / (14.82 – 8.48)

= 1.0836

The offset correcÐon can be calculated with the formula –

Offset correcÐon = expected value at low pH – (reading at low pH x Gain correcÐon)

Offset correcÐon = 8.57 – (8.48 x 1.0836)

= -0.619

5 Installation

5.1 Shipping and Storage Cap

The PH-1000A sensor is shipped with a rubber cap covering the pH electrode. This cap contains a small amount of 3M KCl soluÐon and is in place to prevent the electrode from drying out during shipping and storage. **This cap must be removed prior to installation.** The cap should be retained so that it can be placed back on the electrode if the sensor is to be removed.

5.2 Field Deployment Considerations

The sensor should always be completely submerged and posiÐoned such that the possibility of air bubbles becoming entrapped on the electrode is minimised. Trapped bubbles may cause errors in the output. The sensor should be periodically inspected for fouling, and can be cleaned with fresh water and damp cloth. In marine environments crustaceans may need removal at regular intervals.

The sensor should always be fully immersed to ensure the electronic module is at water temperature. Sensors should generally be installed such that they can be easily and safely removed for cleaning and servicing. For environmental applicaÐons the sensor can often be mounted inside a secÐon of PVC or steel pipe that enters the water body. The sensor can then be slid down inside the pipe unÐl the sensor head just protrudes into the water body. This provides a high degree of protecÐon for the sensor from environmental (sunlight, heat, flood debris etc) as well as from other influences such as caŁ le, vandalism etc. Most sediment transport occurs during storm events and flood condiÐons. ProtecÐon from floaÐng debris damage is an important consideraÐon along with adequate tethering of sensors.

Another widespread application is to hang the sensors in the water body from a fixed structure or a floaÐng buoy or pontoon. Generally in lakes or estuary applicaÐons the sensor can hang on its own cable, and be easily retrieved for rouÐne servicing.

5.2.1 Cabling Considerations

Care should be taken with installaÐon and field servicing to ensure the cable is not subjected to persistent pulling, snagging or severe compression. Cyclic loading of the cable should also be avoided through careful sensor deployment. AddiÐonal sÐlling wells or mounÐng brackets may be required to prevent sensor movement. Where cable runs are required which may be subject to environmental influence (heat, water movement, sunlight, flood debris etc) it is advisable to protect the sensor cable inside a slightly larger diameter conduit such as PVC, steel or polyethylene. This also allows the sensor cable to be pulled out – should a sensor change-over be required at the site. Maximum cable runs up to several hundred meters are possible without affecting electrical signals.

5.2.2 *Field Installation must ensure:*

The sensor is anchored or held in posiÐon or located so it is not subject to any movement during normal operaÐons.

Sensor is protected from direct sunlight to avoid high temperature fluctuaÐons.

Sensor is protected against high turbulence and possible debris loading during flow events.

The rubber storage cap is removed from the electrode.

5.2.3 *Other Considerations*

Environmental compaÐbility should be checked before using the sensors and advice sought from Greenspan if any doubt exists. The sensor uÐlises some 316 stainless components that are suitable in a majority of situaÐons but care should be taken against possible corrosion in high Chloride, Sulphate or Ferric soluÐons. The sensor should always be totally immersed to ensure that the sensor is at water temperature and to also avoid any possible anodic/cathodic action taking place on the components at the water-air interface. If using clamps to mount the sensor – these should be of a type that evenly clamps the sensor body without excessive loading that could damage the sensor body.

5.3 Guidelines for cleaning sensor

The sensor and electrode may be cleaned using a soft cloth, mild detergents and warm water. If the sensor shows signs of marine growth a light biocide can be used to clean and kill any biological growth on the sensor. Sensors are supplied with a removable shroud that provides added protecÐon for the electrode. This shroud unscrews for cleaning.

The sensor must be cleaned with the electrode in place. The sensor will be damaged by the ingress of water or other soluÐons into the electrode cavity. The electrode should only be removed when it is to be replaced. To assist in cleaning the glass electrode, the PH-1000A is provided with a special tool. A few drops of a mild detergent can be placed in the cleaning tool which is then pushed over the glass pH bulb. Carefully rotaÐng the tool by hand should remove most contamination. For heavy scaling or contaminaÐon a cleaner that contains some abrasive can be used. Rinse the electrode in clean water prior to installing sensor or checking calibraÐon.

5.4 Replacing Reference Protection Ring

The reference protecÐon ring can be removed and/or replaced (with the electrode still in place in the sensor) by unscrewing the plasÐc shroud on the end of the electrode. The white protecÐon ring can be slid off the glass electrode.

5.5 Electrode storage

PH electrodes should be stored in such a way to prevent the electrode from drying out. A rubber cap is provided with the electrode for this purpose. A small amount of liquid should be placed in this cap prior to the cap being placed over the electrode. 3M KCl is the preferred storage solution however, tap water should be used if not available. Soaking in pH 4 buffer soluÐon overnight may restore some electrodes that have been allowed to dry out, although some calibraÐon driÖ can be expected unÐl the electrode is fully re-hydrated.

5.6 Electrode replacement

IM PORTANT NOTE: **Applying power with no electrode fitted may damage sensor electronics. Always remove power from the sensorprior to removal of an electrode.**

PH electrodes will require periodic replacement. How long they last is dependent on the environment and to a lesser extent the cleaning and maintenance. In a typical environment, electrode life between 1 and 3 years is quite possible. The electrode is sealed in its mount with 2 o-rings on the electrode body. The electrode is removed by unscrewing it from the housing. Spanner flats are machined on the electrode to assist.

Take care when handling the pH electrode, that it is not handled by the gold contacts. ContaminaÐon of this area may degrade the performance and expected life of the electrode.

Prior to removal of an electrode the sensor must be thoroughly cleaned and dried. Care must be exercised to ensure that no liquids or other contaminants enter the electrode cavity. The PH-1000A sensor should not be stored or transported without an electrode. Immersion of a PH-1000A without an electrode will likely cause damage to the sensor.

With the old electrode removed the electrode cavity should be carefully inspected. A small ring of contaminaÐon may be present at the mouth of the cavity. This contamination should be removed with a clean cloth in such a way so that

the contaminaÐon is not pushed inside the cavity. Do not flush the cavity with water or other cleaning solvents as damage to the electronics inside the sensor could occur.

Once clean, a new electrode can be screwed into the electrode mount. It is recommended that the calibraÐon of the new electrode be checked prior to re-deployment.

6 Appendix A -Additional Information

6.1 PH-1000A Specifications

Measurement technique	Gel-filled glass electrode with internal Ag/AgCl reference Field Replaceable electrode
Sensor range (factory calibrated)	0-14 pH (4mA = 0pH, 20mA = 14pH)
Sensor output	Analogue 4-20mA
Accuracy	+/-0.2pH
Cable type	Polyurethane sheathed cable, OD 8mm, Aramid reinforced, moulded entry, bare wire connecÐon
Cable lengths	10, 20, 30, 50, 100, 150 m (32, 65, 100, 165, 325, 490 Ö)
Non-standard cable lengths	Yes (Extra cable moulding time may be required)
Power supply	11-13.2 VDC (at sensor)
Reverse polarity protecÐon	Yes
Surge current protected	To 2kV
Warm up time to stable reading	2 sec
Current consumpÐon	10mA to 30mA while turned on
OperaÐng temperature	0-50°C
Storage temperature	-5°C - +60°C
Depth raÐng (water column)	100m
Weight	500g plus cable weight (665g per 10m length)
Dimensions (L x OD)	364.20mm x 47mm (14.35" x 1.85")
WeŁ ed materials	Acetal, Teflon, 316 Stainless Steel, polyurethane, **viton**

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