

# ABB

## The Company

We are an established world force in the design and manufacture of instrumentation for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

As a part of ABB, a world leader in process automation technology, we offer customers application expertise, service and support worldwide.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

The UKAS Calibration Laboratory No. 0255 is just one of the ten flow calibration plants operated by the Company and is indicative of our dedication to quality and accuracy.

EN ISO 9001:2000



Cert. No. Q 05907

EN 29001 (ISO 9001)



Lenno, Italy – Cert. No. 9/90A

Stonehouse, U.K.



Information in this manual is intended only to assist our customers in the efficient operation of our equipment. Use of this manual for any other purpose is specifically prohibited and its contents are not to be reproduced in full or part without prior approval of the Technical Publications Department.

### Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

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## 1 Introduction

### 1.1 Purpose

This instruction manual describes the installation and maintenance of the AP300 Series Industrial pH and Redox (ORP) Electrode Systems.

### 1.2 Sensors and Systems

There are three main sensor types:

- AP301 Standard twist-lock – insertion, flow-through, immersion
- AP302 Screw in – insertion, immersion
- AP304/5 Ball valve insertion, hot-tap

### 1.3 Sensor Descriptions

#### 1.3.1 AP301

Model AP301 sensors are twist-lock general purpose insertion, flow-through or immersion style. The sensor body is molded from chemically resistant PPS (Ryton).

The sensor can be adapted to 1 inch fittings by a threaded Ryton twist-lock adaptor.

An optional PVC electrode guard protects the electrode in immersion applications.

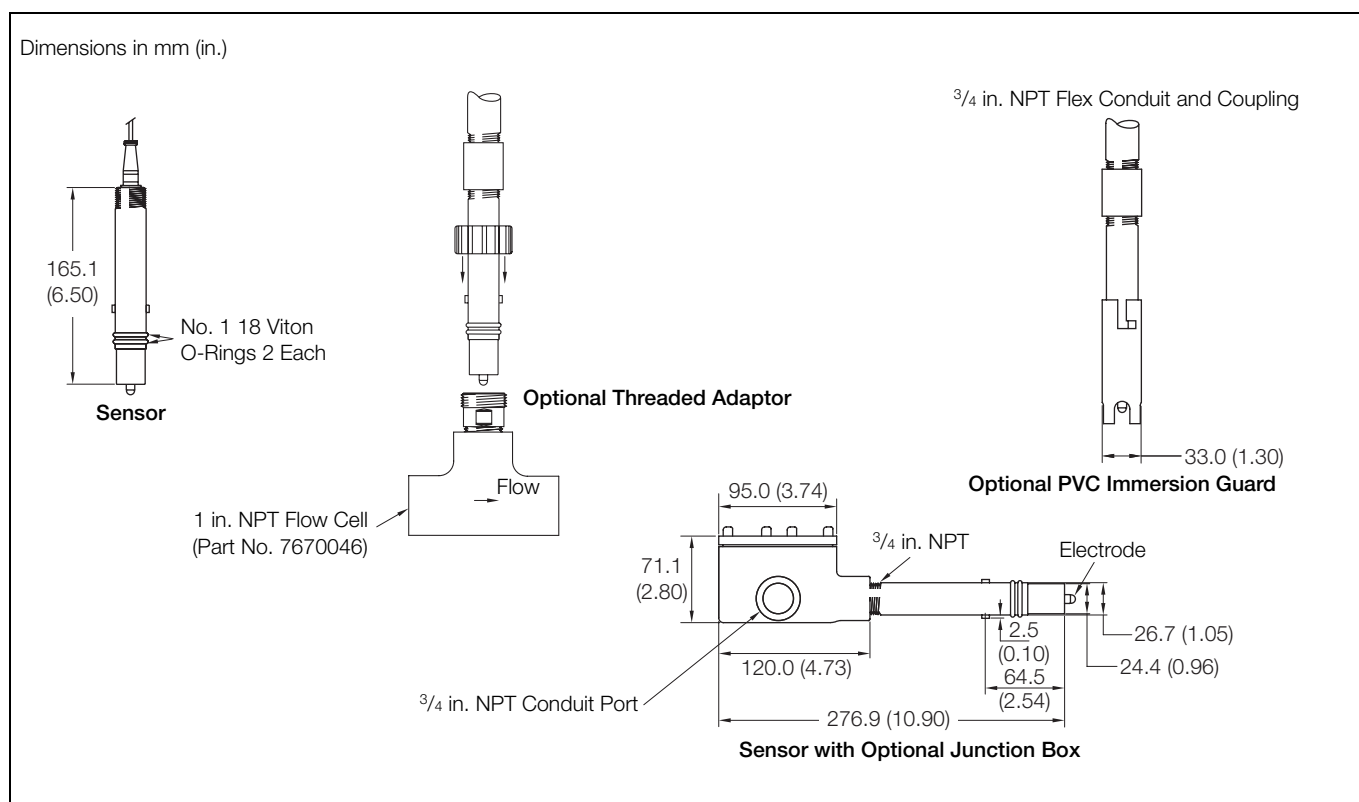


Fig. 1.1 AP301 Sensors and Dimensions

**1.3.2 AP302/3 Sensors**

These sensors are threaded style suitable for immersion, insertion and flow-through applications.

Mounting thread size: 3/4 inch NPT.

The sensor body is chemically resistant PVDF (Kynar).

- AP302 models have no sensor guard (flush) for use with flat glass. This provides a flow-cleaned configuration.
- AP303 models have a notched sensor guard. The guard provides an integral protection for normal bulb-style glasses.

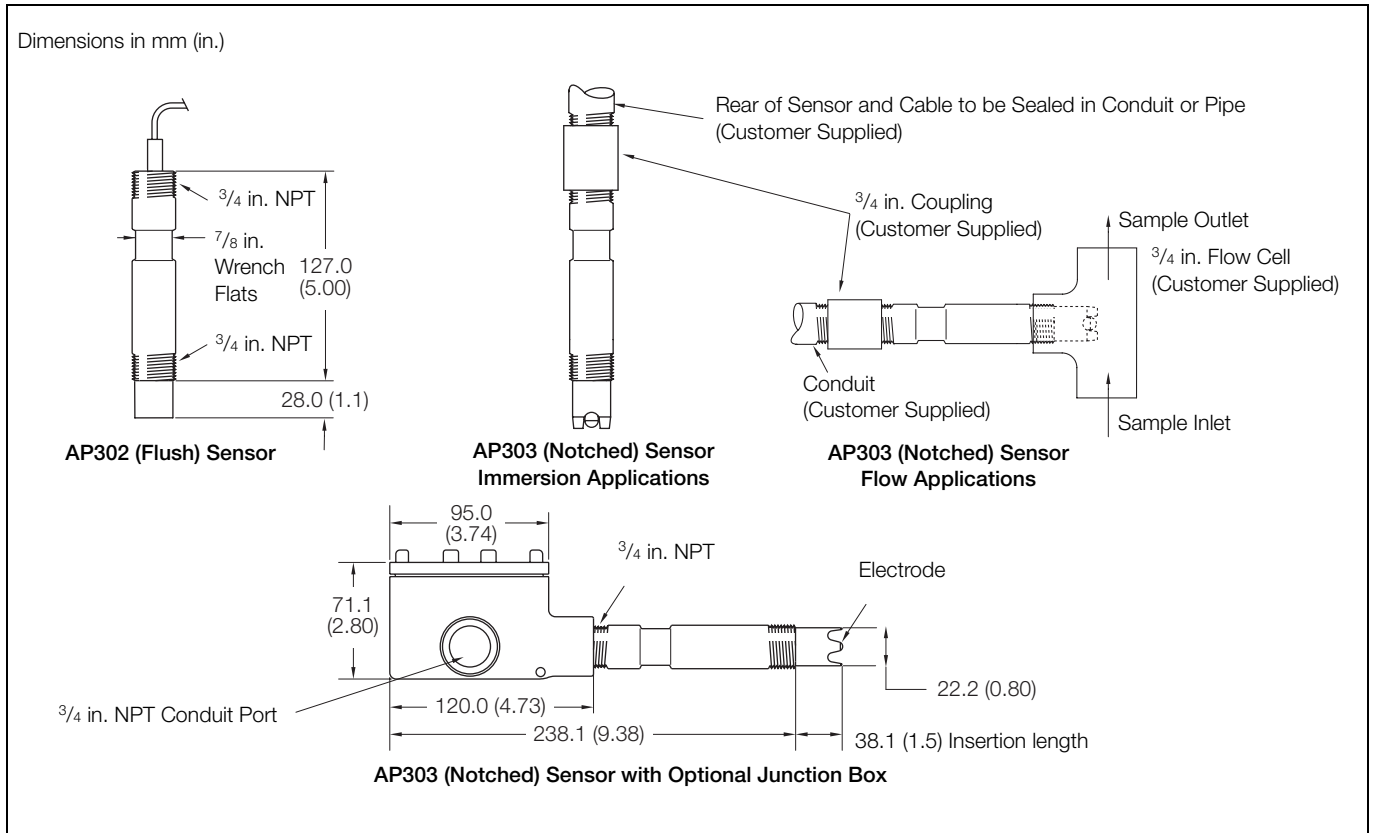


Fig. 1.2 AP302/3 Sensors and Dimensions

**1.3.3 AP304/5 Sensors**

These sensors are hot tap, ball valve insertion types. They enable sensor maintenance or replacement without interrupting the process.

An integral safety anti-blowout tip is incorporated into the sensor design preventing accidental sensor removal. Unlike chain restraints, this safety-by-design is an integral part of the construction.

The sensor is inserted through a standard 1 1/4 in. full port or 1 1/2 in. ball valve. Ease of disassembly aids sensor replacement.

Connection to the ball valve is by compression fitting which is available in either hand-tight with 1 1/4 in. NPT threads or wrench-tight with 1 in. NPT threads.

- AP304 models have no sensor guard (flush).
- AP305 models have a notched sensor guard.

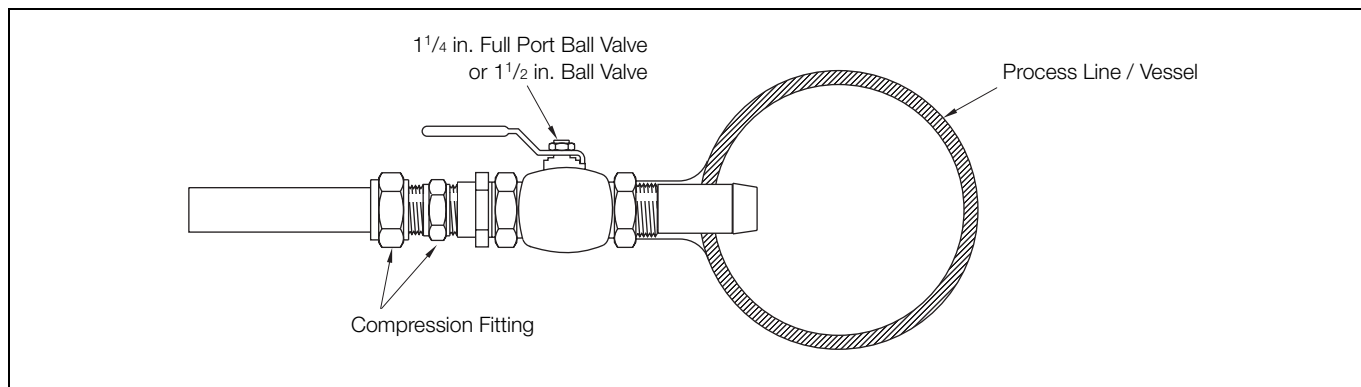


Fig. 1.3 AP304 Ball Valve Dimensions

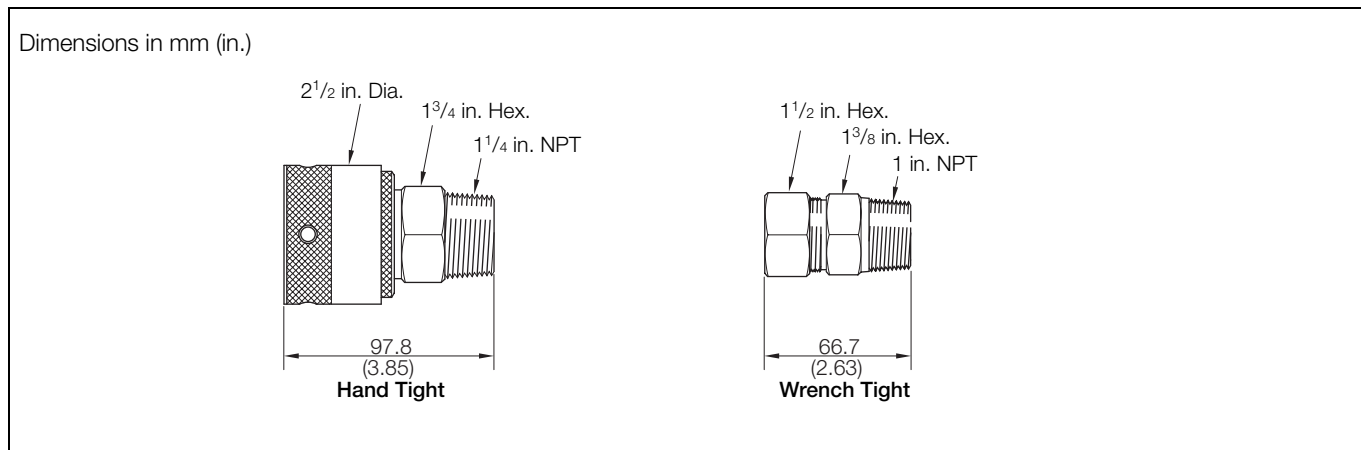


Fig. 1.4 AP304/5 Compression Fitting Dimensions

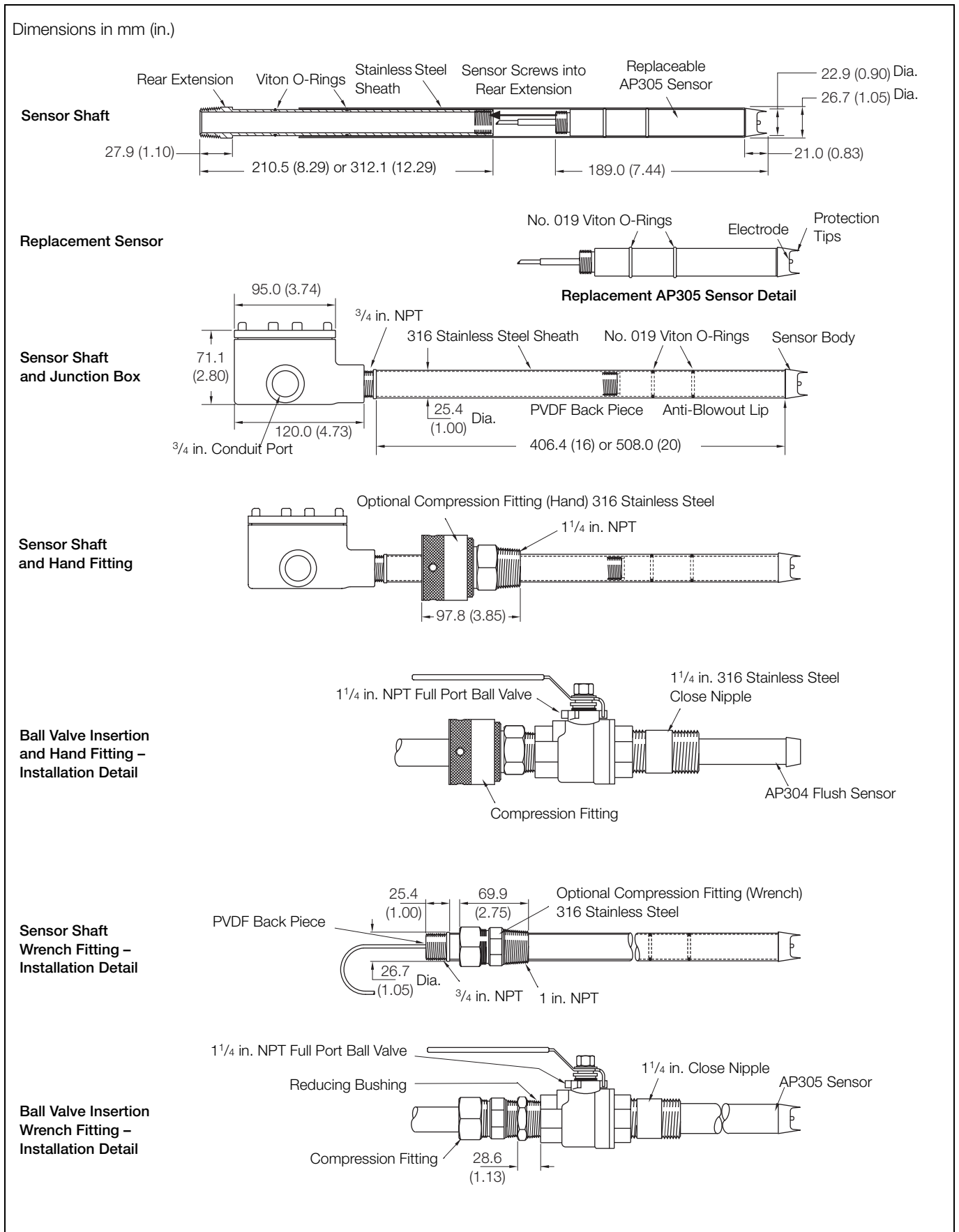


Fig. 1.5 AP304/5 Sensors and Overall Dimensions

## 2 Mechanical Installation

### 2.1 Recommended Installation

Do not use sensors with notched sensor guards on in-line applications where fouling of the sensor is to be expected, e.g. fibrous coatings. Use an in-line flush sensor body with flat glass sensor, mounted at 90° for optimal self-cleaning.

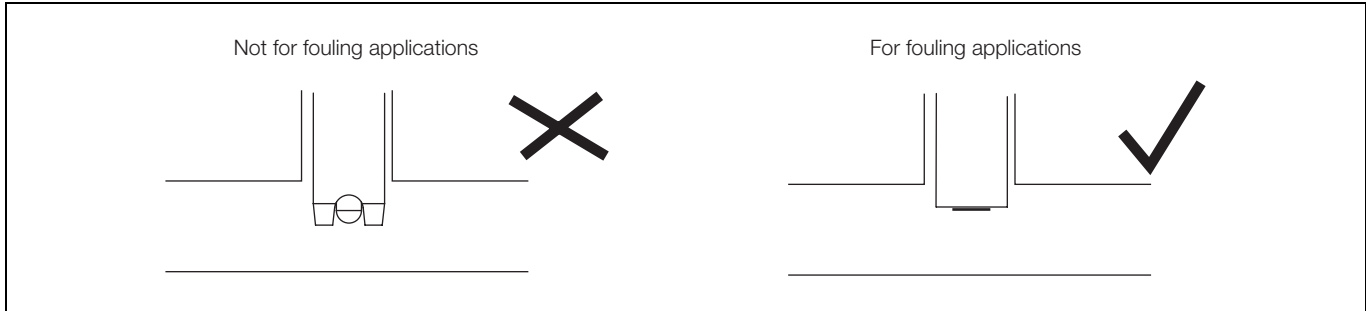


Fig. 2.1 Recommendations for Fouling Applications

#### Note.

- The flow of sample passing the sensor helps to keep the sensor clean.
- Sensors should be positioned such that they are always immersed in the sample.

**2.1.1 AP301 Sensors**  
**Insertion/Flow-through Type**

**Warning.** Depressurize and drain the process line before inserting or removing the sensor to prevent spillage.

1. Slide the adaptor sensor retaining ring down from the wired end of the sensor.
2. Lubricate sensor O-rings before insertion. Insert the sensor into the adaptor and tighten the retaining collar to prevent the sensor from being blown out when the process lines are pressurized.
3. Do not overtighten the threaded sensor adaptor as the inner diameter of the fitting can be compressed making sensor insertion or removal impossible. Use teflon tape or other sealing compounds on the adaptor threads and tighten only as tight as necessary to stop leakage around the threads.
4. Sensors are sometimes mounted upright into a tee in a line that is not full. The sensor can then be suspended above the liquid or may become air-locked. Both occurrences will cause erratic and erroneous measurement. Most of the time this can be prevented by rotating the sensor to ensure that it is fully immersed in the sample.

**Immersion Type**

1. The use of an immersion guard is recommended to protect the glass sensor.
2. Levels in many tanks, sumps and channels vary. The sensor must be immersed to the lowest representative level to ensure the sensor is always immersed in sample.
3. Sensor cables on immersion sensors should be of adequate length for the BNC to be attached to an extension cable outside the immersion area.

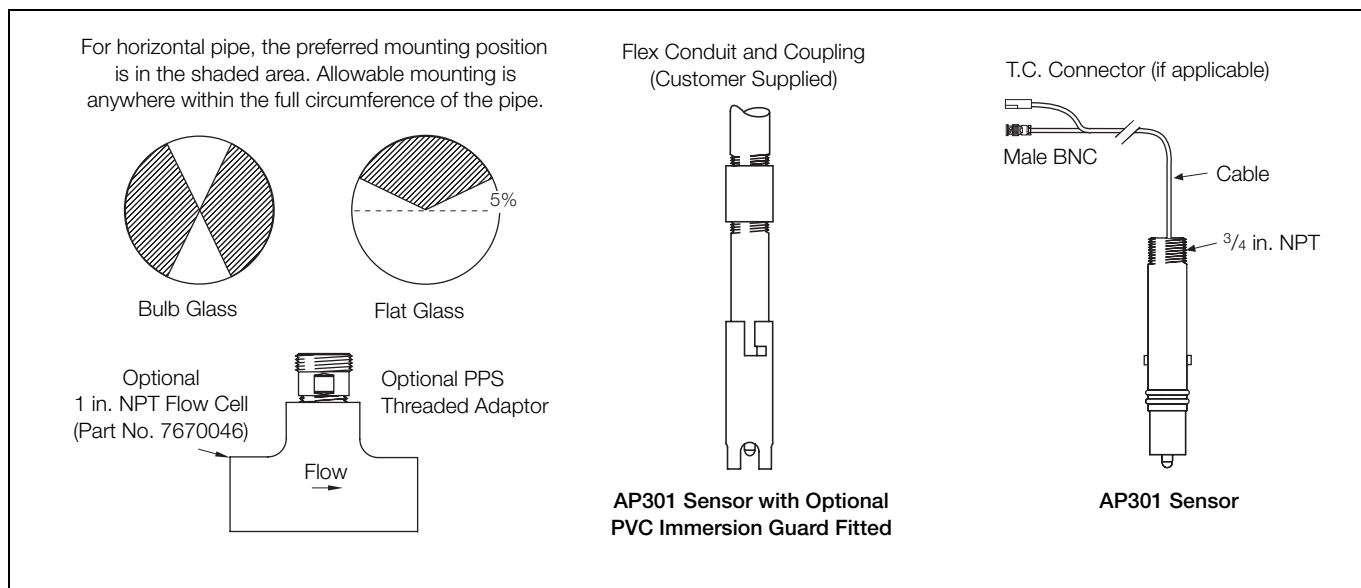


Fig. 2.2 Installing the AP301

**2.1.2 AP302/3 Sensors**

**Insertion/Flow-through Type**

1. Process lines must be shut down and depressurized before inserting or removing sensors.
2. Teflon tape or other sealing compounds must be applied to the sensor threads to prevent leakage. Overtightening the sensor threads may cause internal damage to the sensor.
3. Sensors are sometimes mounted upright into a tee in a line that is not full. The sensor can then be suspended above the liquid or may become air-locked. Both occurrences may cause erratic and erroneous measurement. This can be prevented by rotating the sensor and flow cell to ensure it is fully immersed in the sample.

**Immersion Type**

1. Levels in many tanks, sumps and channels vary. The sensor must be immersed to the lowest representative level, to ensure it is always immersed in sample.
2. Sensor cables on immersion sensors should be of adequate length for the BNC to be attached to an extension cable outside the immersion area.

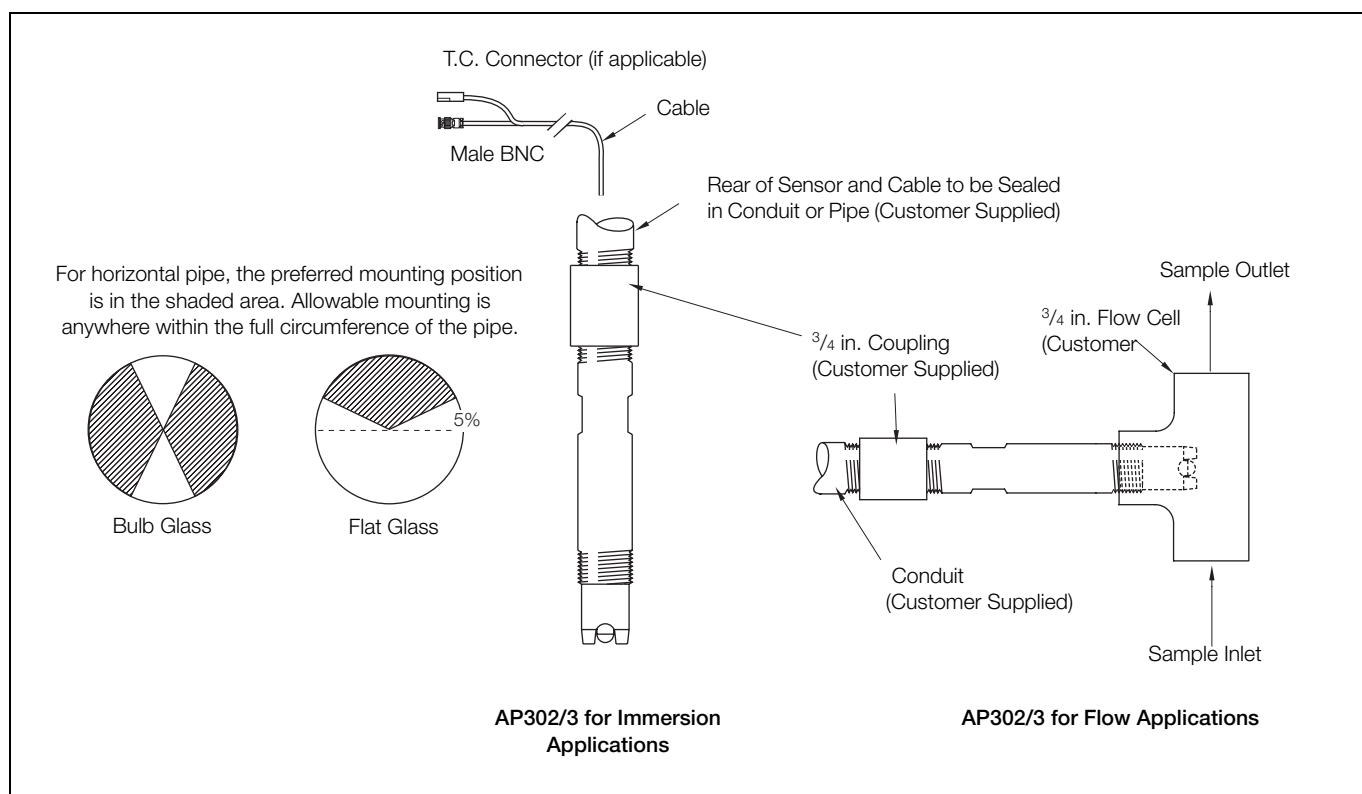


Fig. 2.3 Installing the AP302/3

2.1.3 AP304/5 Sensors

**Warning.**

- To avoid operator injury if the probe ejects to its end stop, keep a safe distance when releasing the compression fitting.
- Undo the compression fitting slowly as the probe can slide out to its end stop under process pressure.
- It is hard to insert the probe above a process pressure of 80 psi.
- Process pressure must not exceed 6 bar (87 lb in<sup>-2</sup>) @ 25 °C (77 °F) continuous. Retract sensors during process start-up to prevent damage due to pressure surges or water hammer.
- Insert the sensor only as far as necessary to achieve representative flow. Over-insertion may damage the sensor and/or cause slow response.
- Fully retract the sensor before closing the valve and fully open the valve before inserting the sensor.

To install the AP304/5 Sensor:

1. Fit choice of ball valve onto the process line or vessel.
2. Fit compression fitting onto the ball valve – see Fig. 2.4.

*Continued on page 10...*

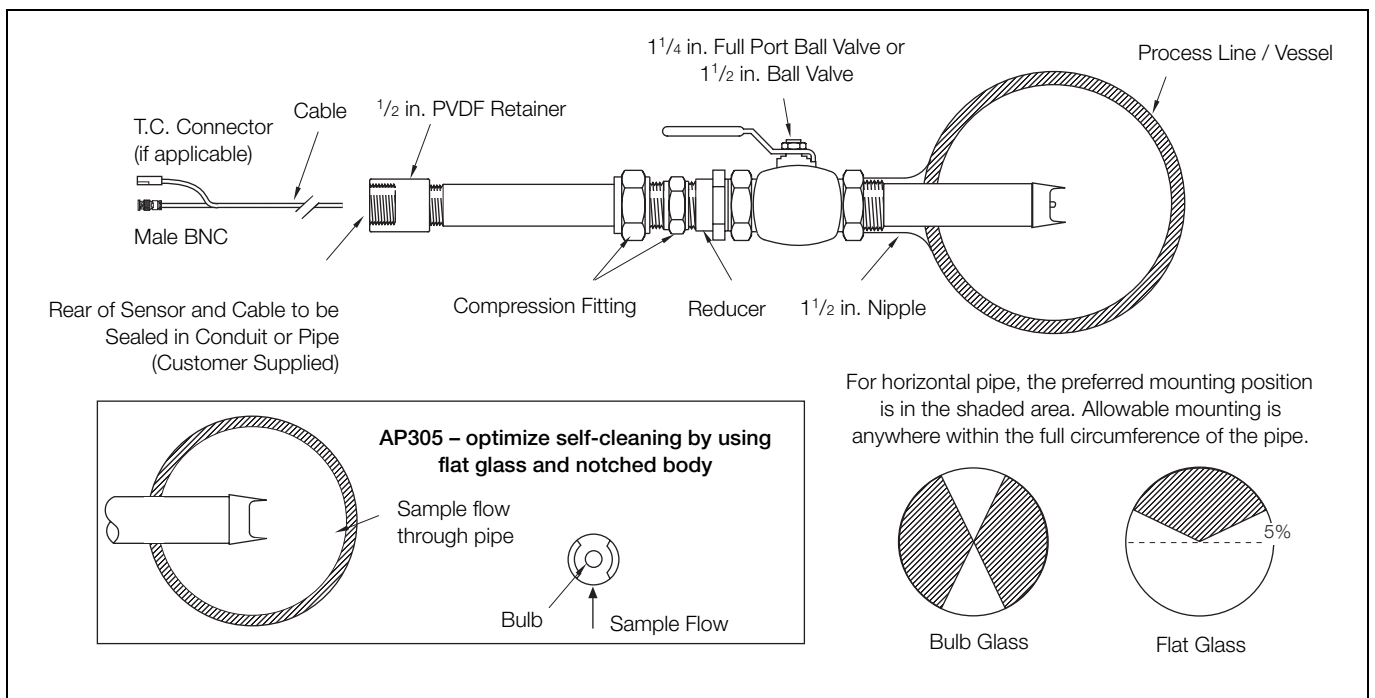


Fig. 2.4 Installing the AP304/5 – Ball Valve and Compression Fitting

3. Measure and record the following distances – see Fig. 2.5:
  - outside of pipe/vessel to the reducer at the back end of the valve (A).
  - length of compression fitting after insertion into the reducer (B).
  - pipe/vessel wall thickness (C).
  - sensor insertion depth (D).
4. Add together measurements from step 3 and, measuring from the tip of the sensor, mark off total onto the shaft of the sensor.
5. Insert the sensor into the ball valve. Tighten onto the ball valve on reducer.
6. Open the ball valve fully and gently push the sensor into the valve until the mark made at 4 reaches the compression fitting.
7. Tighten the outer compression joint (manually or using a wrench depending on type of fitting chosen).
8. A mark can also be made distance B from the tip of the probe. This can then be used to tell when the valve can be closed when retracting the probe.

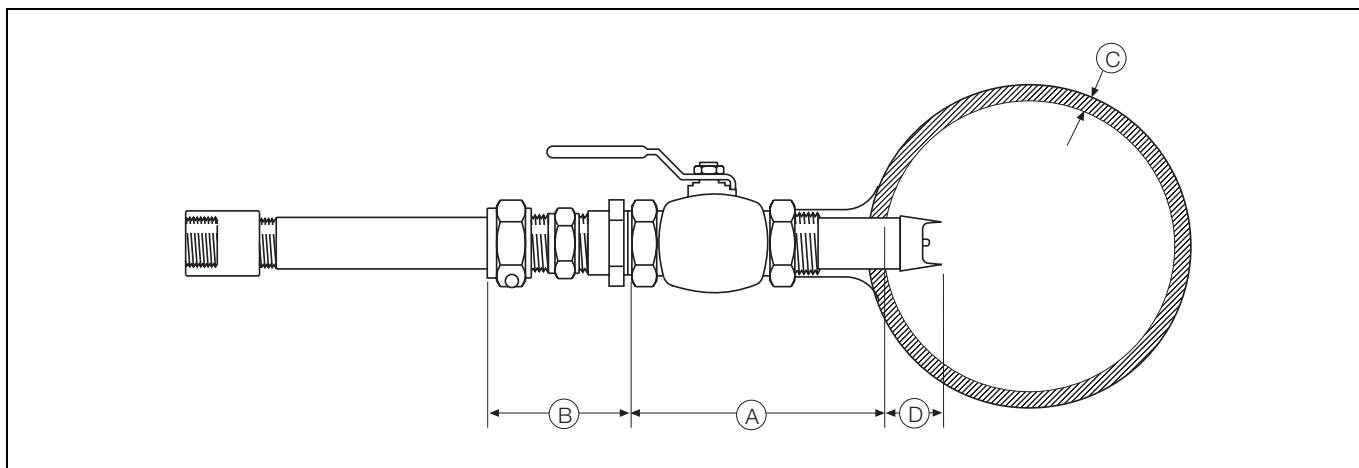


Fig. 2.5 Installing the AP304/5 – Installation Measurements

### 3 Electrical Connections

#### 3.1 Sensor Connections

All sensors are supplied with either an integral cable in the following lengths:

- 3 m (10 ft)
- 6 m (20 ft)
- 9 m (30 ft)

or with a detachable cable and fitted junction box.

Terminations are shown in Fig. 3.1.

Each version allows for tagged sensor terminations enabling connection to a wide variety of process pH/redox (ORP) analyzers. Alternatively, the sensor can be supplied with detachable BNC and Molex connectors for pH/redox (ORP) and temperature compensation (if applicable).

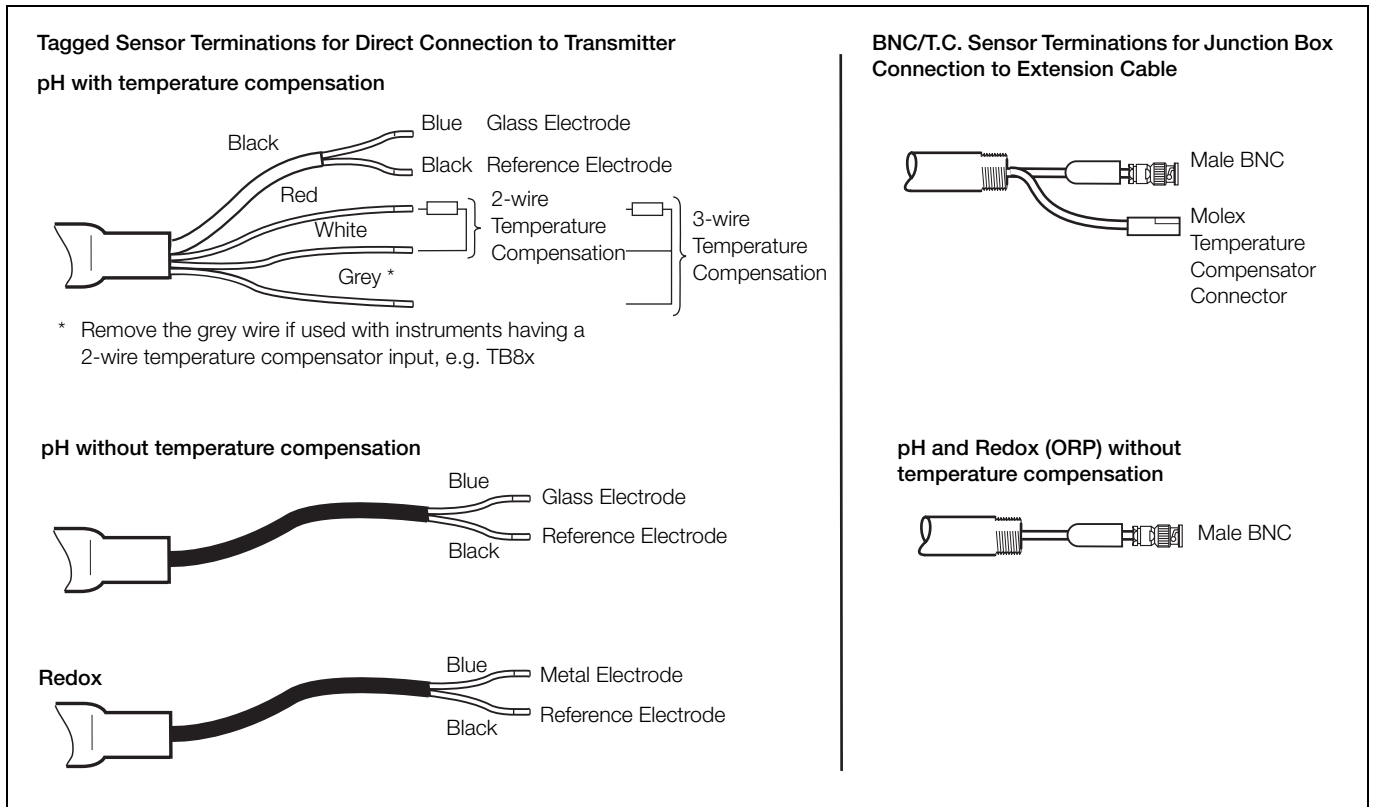


Fig. 3.1 Cable Terminations

### 3.2 Extension Cables

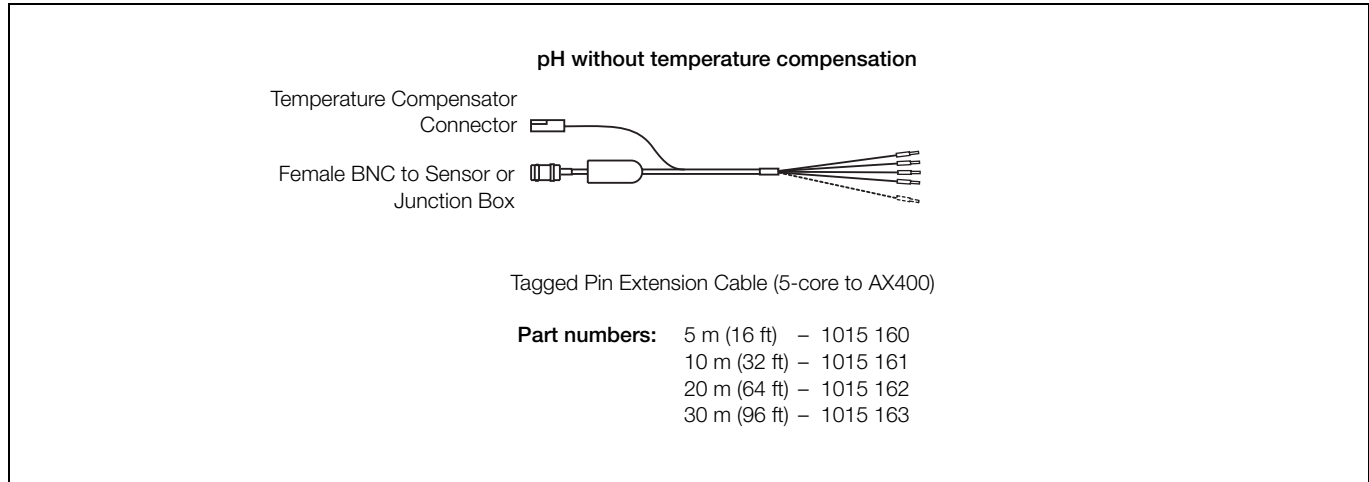


Fig. 3.2 Extension Cables

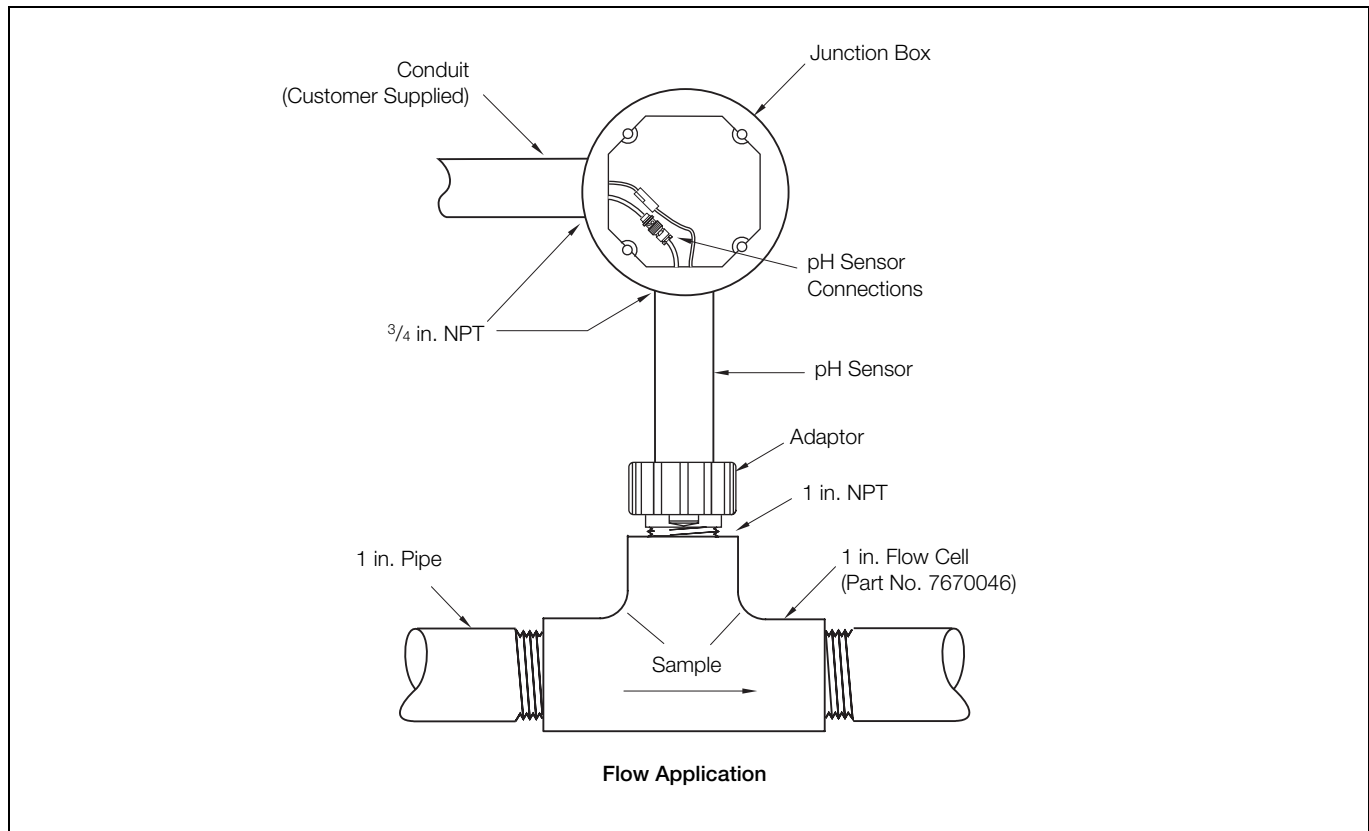


Fig. 3.3 Extension Cables – Typical Installations

## 4 Calibration

### 4.1 pH Sensor

When the sensor has been correctly connected and all electrical connections have been made to the associated pH transmitter, it is ready for calibration by either immersing the sensor (using suitably sized beakers) either:

1. in a calibration solution (buffer) of known pH value for a single-point calibration,  
or
2. sequentially in two separate calibration solutions of known pH values for a two point calibration.

For sensors already in use:

1. Remove the electrode from the process or sample.
2. Wash the visible electrode surface with demineralized water.
3. Proceed as described in the paragraph above.

To have agreement with a measured sample, there may be times when a process calibration is necessary.

1. Perform a buffer calibration.
2. Ensure that the sensor is returned to the process for at least 10 minutes before performing a process calibration.
3. To minimize solution temperature effects, measure the sample at the same temperature as the process.

Refer to the instruction manual for the pH transmitter for full details of the calibration procedures.

**Warning.** Before removing a sensor from a flow line, ensure that all isolating valves have been closed.

**Caution.** It is important when buffering to ensure that the visible surfaces of the electrodes have been cleaned using demineralized water. Also ensure when moving from one buffer solution to the next to wash the electrodes and dry them carefully using a soft tissue.

### 4.2 Redox (ORP Sensor)

When the sensor has been correctly connected and all electrical connections have been made to the associated Redox (ORP) transmitter, it is ready for calibrating. Follow the calibration procedure in the transmitter instruction manual.

For sensors that are connected to transmitters that do not have Redox (ORP) sensor calibration capabilities, it is possible to check the response as follows:

1. Prepare standard 4 and 7 pH buffer solutions. Add one gram (heaped spatula) of analar quinhydrone to 100 ml of each buffer solution. Let them stand for 30 minutes.
2. Immerse the sensor in each solution in turn and note the mV value when stable.

The values obtained should be within  $\pm 15$  mV of the values below:

pH Buffer	mV
4	+259
7	+82

## 5 Maintenance

### 5.1 General Cleaning

**Warning.** Before removing a sensor from a flow line, ensure that all isolating valves have been closed.

To ensure accurate monitoring, keep the sensor free of contaminants by periodic cleaning, the frequency of which depends on the particular application.

Methods of removing various types of deposit are detailed below. Replace the sensor if its performance does not improve after cleaning.

#### 5.1.1 General Sludge and Loosely Adhering Matter

Rinse off the excess matter and wipe the sensor with a soft cloth or tissue before calibrating.

#### 5.1.2 Heavy, Non-Greasy Deposits

For example: lime, salts, etc. Immerse the sensor in 1 to 2 M hydrochloric acid until the deposit has dissolved. Rinse the sensor with water and allow to settle in buffer solution before calibrating.

#### 5.1.3 Greasy or Organic Deposits

Wipe the glass membrane with a detergent or acetone-based solvent. Rinse with water before calibrating.

### 5.2 Fault Finding

Listed below are some common symptoms of sensor malfunction together with possible cures.

#### Short scaling (Low Slope) or sluggish response

1. Glass sensor membrane dirty or coated – refer to Section 5.1 for cleaning.
2. Poor insulation on cable connectors, possibly due to moisture – dry connectors with warm air.

Replace the sensor if no improvement is seen. It may also be necessary to replace the extension cable if used.

#### No response to pH buffer or sample

1. Check the sensor has been correctly wired to the transmitter as detailed in Section 3.1, page 11 and the relevant transmitter instruction manual.
2. Check the glass sensor membrane is not broken or cracked.

#### Unstable readings or drift

1. Check the sensor has been correctly wired to the transmitter as detailed in Section 3.1, page 11 and the relevant transmitter instruction manual.
2. Dry or dirty reference junction – clean the junction as detailed in Section 5.1.

Replace the sensor if no improvement.

#### Stable but incorrect readings

1. Recalibrate using fresh buffer solutions.
2. Check temperature compensation settings are correct – manual temperature is correct, or automatic temperature compensation is reading correctly.
3. If the sensor responds correctly to pH changes, but there is an offset of <1.0 pH to >0.2 pH, perform a one-point process calibration (see Section 4.1, page 13).

**Note.** All the above symptoms could be caused by a faulty extension cable. Check and replace it, if necessary.

### 5.3 Storage of the Electrode

**Caution.** Failure to ensure that the glass membrane and reference junction do not dry out may irreversibly affect the response of the electrode.

If it is necessary to remove the electrode from the sample line, fill the retained protective cap with buffer solution and cotton wool, or equivalent, and fit it to the sensor.

## 6 Spares and Accessories

Threaded lock-nut adapter, PPS (Ryton) 4TB9515-0120  
(1 in. NPT)

PVC Immersion/Dip Guard 4TB5205-0120

Junction box (requires cable gland) 4TB5023-0162

Cable gland 4TB9515-0244

### Flow Cells

1 in. NPT (for adapter) + 7670 046

1 in. NPT (for process connection)

1 in. NPT (for adapter) + 7670 043

1 in. BSPT (for process connection)

### Pipeline Adapters

1 in. BSPT to 1/2 in. BSPT polypropylene 7601 420

1 in. BSPT to 1/2 in. NPT polypropylene 7601 430

### Extension Cables

Tagged pin extension cables (5-core 1015/16X for AX460 and AX466)

5 m (16 ft) 1015 160

10 m (32 ft) 1015 161

20 m (64 ft) 1015 162

30 m (96 ft) 1015 163

### Buffer (Box of 25)

4 pH 0400/110

7 pH 0400/120

0 pH 0400/130

## 7 Specification

### General

#### pH measuring range

Standard (yellow glass)	0 to 14 pH
Low Temperature (blue glass)	0 to 10 pH

#### Redox (ORP) measuring range

-2000 to 2000 mV

#### Temperature range

Body	0 to 105 °C (32 to 221 °F)
Bulb glass	0 to 105 °C (32 to 221 °F)
Flat glass	5 to 100 °C (41 to 212 °F)
Blue glass	-5 to 60 °C (23 to 140 °F)
Redox (ORP)	0 to 105 °C (32 to 221 °F)

#### Pressure maximum

6 bar (90 psi) @ 25 °C (77 °F)

#### Temperature compensator (pH sensors only)

Integral Pt100 or Balco 3 k $\Omega$

#### Wetted materials

pH electrode	Glass
Redox (ORP) electrode	Platinum
Junction	PTFE
Body AP301	PPS (Ryton)
Body AP302/3 and AP304/5	PVDF (Kynar)
Flow cell	PVC
Immersion guard	PVC
AP304 and AP305 shaft and valve	Stainless steel

#### pH glass types

Bulb	general duties
Flat	in-line, self-cleaning
Blue	low temperature

#### Reference system

Ag/AgCl-3.5M KCl in gel matrix

#### Reference junction

Porous PTFE

SS/AP300 Issue 4

# PRODUCTS & CUSTOMER SUPPORT

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- for the following industries:
  - Chemical & Pharmaceutical
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- Positioners

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- Zirconia Oxygen Analyzers, Katharometers, Hydrogen Purity and Purge-gas Monitors, Thermal Conductivity

## Customer Support

We provide a comprehensive after sales service via a Worldwide Service Organization. Contact one of the following offices for details on your nearest Service and Repair Centre.

### UK

ABB Limited  
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Fax: +44 (0)1453 829671

### USA

ABB Inc.  
Tel: +1 215 674 6000  
Fax: +1 215 674 7183

### Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification.

Periodic checks must be made on the equipment's condition. In the event of a failure under warranty, the following documentation must be provided as substantiation:

1. A listing evidencing process operation and alarm logs at time of failure.
2. Copies of all storage, installation, operating and maintenance records relating to the alleged faulty unit.

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