

# Rugged pH/Redox (ORP) Sensor Systems with Rapid Temperature Response for Critical Processes

AP200 Series



# 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 Description

## 1.1 Introduction

This manual describes the installation and maintenance of the AP200 Series Process pH and Redox (ORP) Electrode Holder Systems.

## 1.2 Systems – Fig. 1.1

### 1.2.1 Typical Systems

- AP201 Insertion system
- AP202 In-line, flow-through system
- AP203 Dip (immersion) system

### 1.2.2 AP120 Series Electrodes Used with Holders

AP121/11000 General process	0 to 14 pH, 0 to 100°C
AP121/21000 High temperature	0 to 14 pH, 0 to 130°C
AP121/31000 Low temperature	0 to 10 pH, –5 to +50°C
AP121/60000 Redox (ORP) platinum	0 to 100°C

See Section 6, page 15 for full details

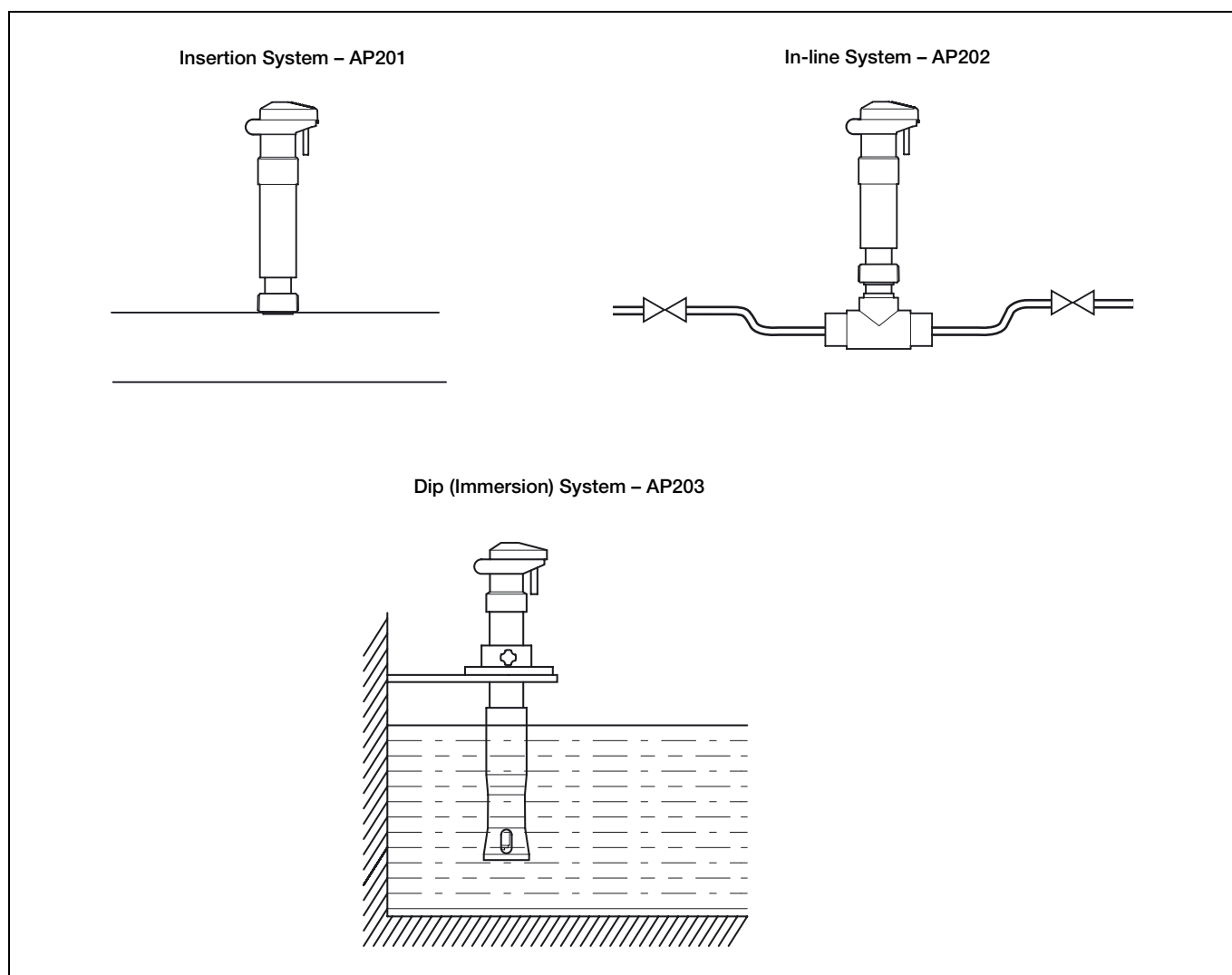


Fig. 1.1 System Schematics

## 2 Mechanical Installation

### 2.1 Installing the Systems

#### 2.1.1 Model AP201 Insertion System – Fig. 2.1

This system is designed to mount directly into a pipeline or tank. Mounting adaptors are available:

7690 130	PPS Ryton™ R 1¼ in. adaptor	7690 128	R 1in. Stainless Steel adaptor
7690 134	Polypropylene 1¼ in. NPT adaptor	7690 132	DN25 Straight-weld socket
7690 129	Polypropylene R 1¼ in. adaptor	7690 133	DN25 Angled-weld socket
7690 131	1in. NPT Stainless steel adaptor		

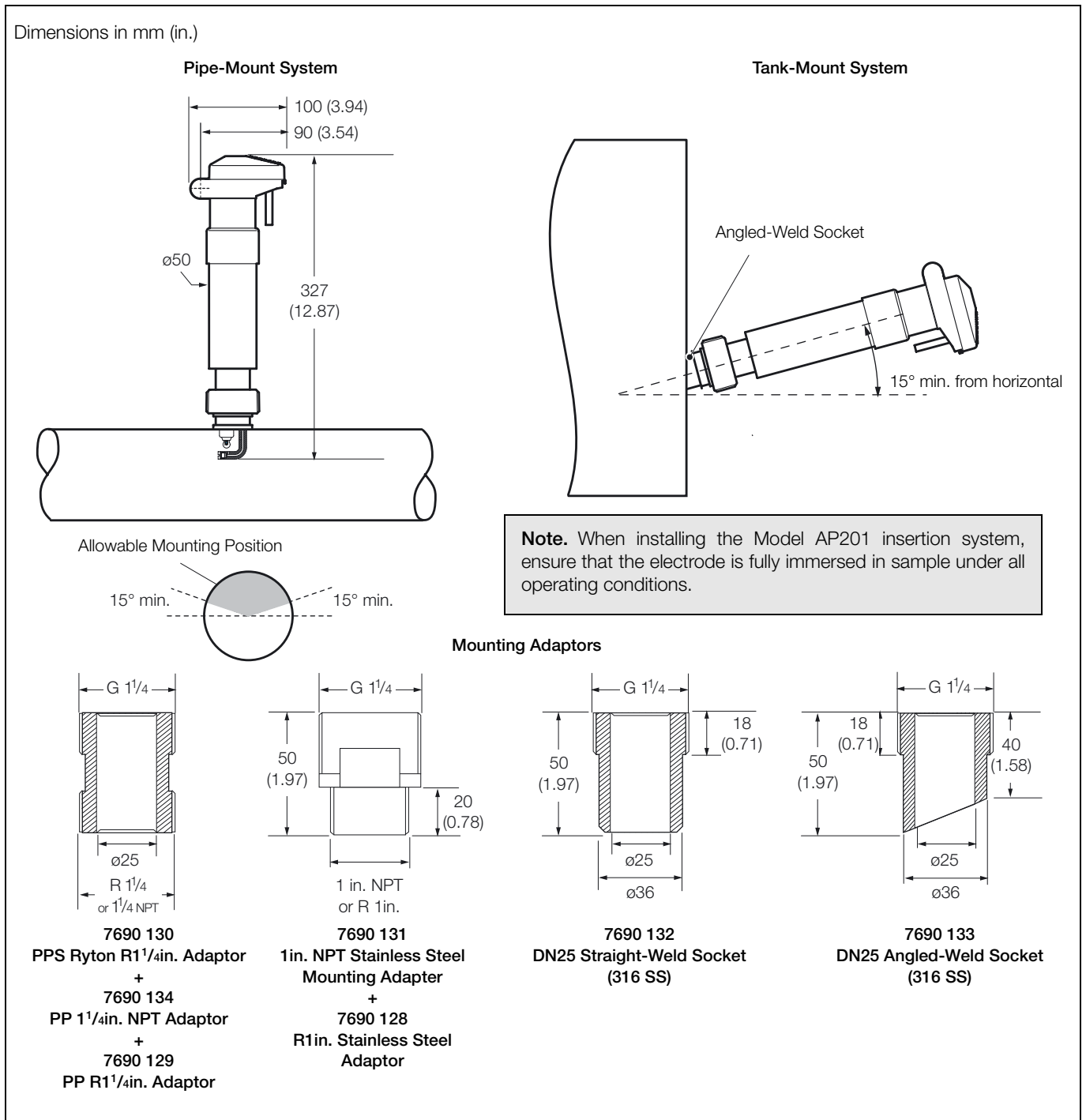


Fig. 2.1 Model AP201 Insertion System

**2.1.2 Model AP202 Inline System – Fig. 2.2**

This system is supplied with an inline tee-piece for mounting the system directly into a pipeline. Allow sufficient height above the system to enable the sensor to be withdrawn from the tee-piece.

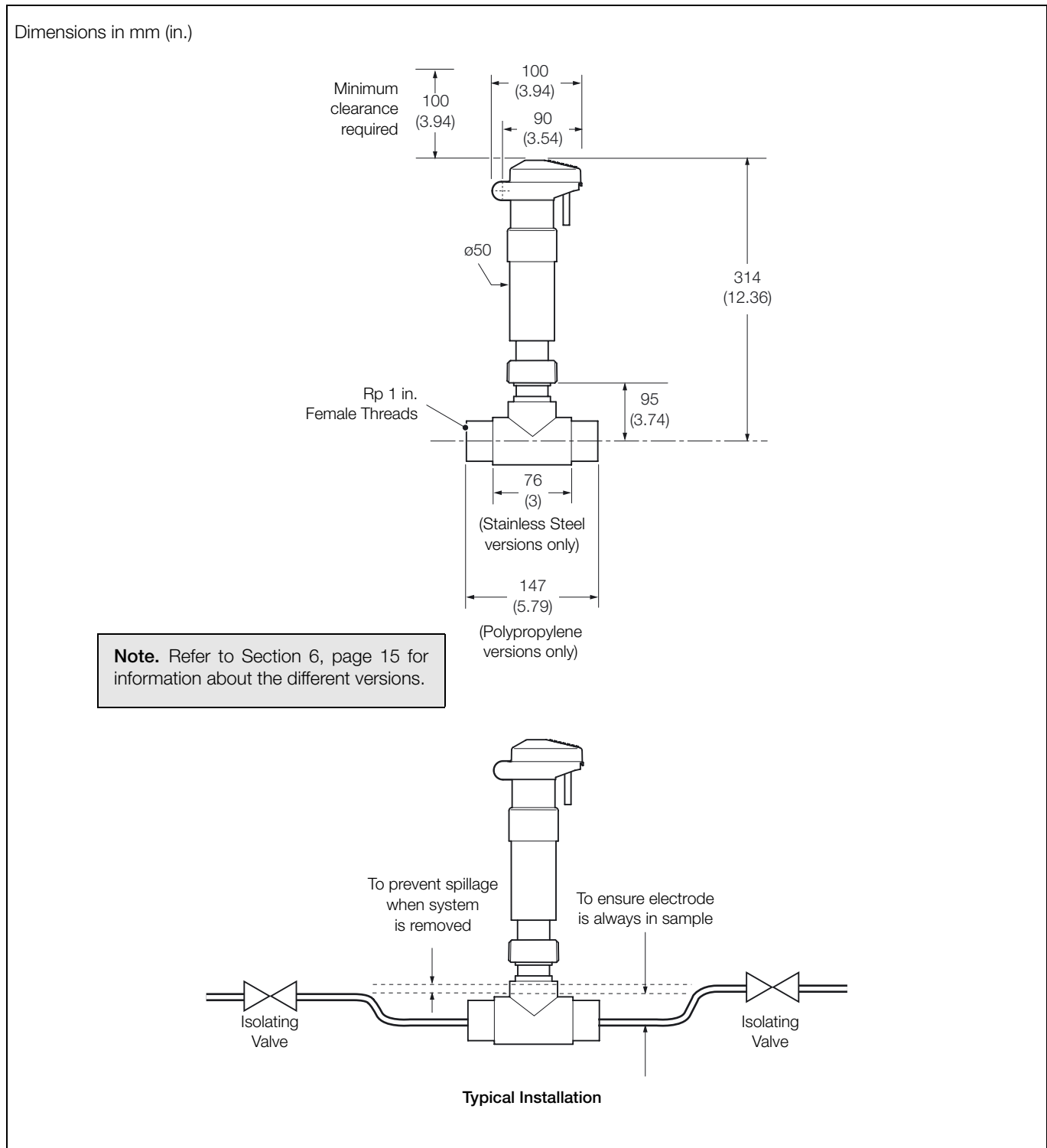


Fig. 2.2 Model AP202 Inline System

**2.1.3 Model AP203 Flanged Dip (Immersion) System – Fig. 2.3**

This system is designed to be installed over an unpressurized tank or channel. A sliding flange is supplied to enable adjustment of the immersion depth. A suitable mounting bracket or support must be supplied by the user.

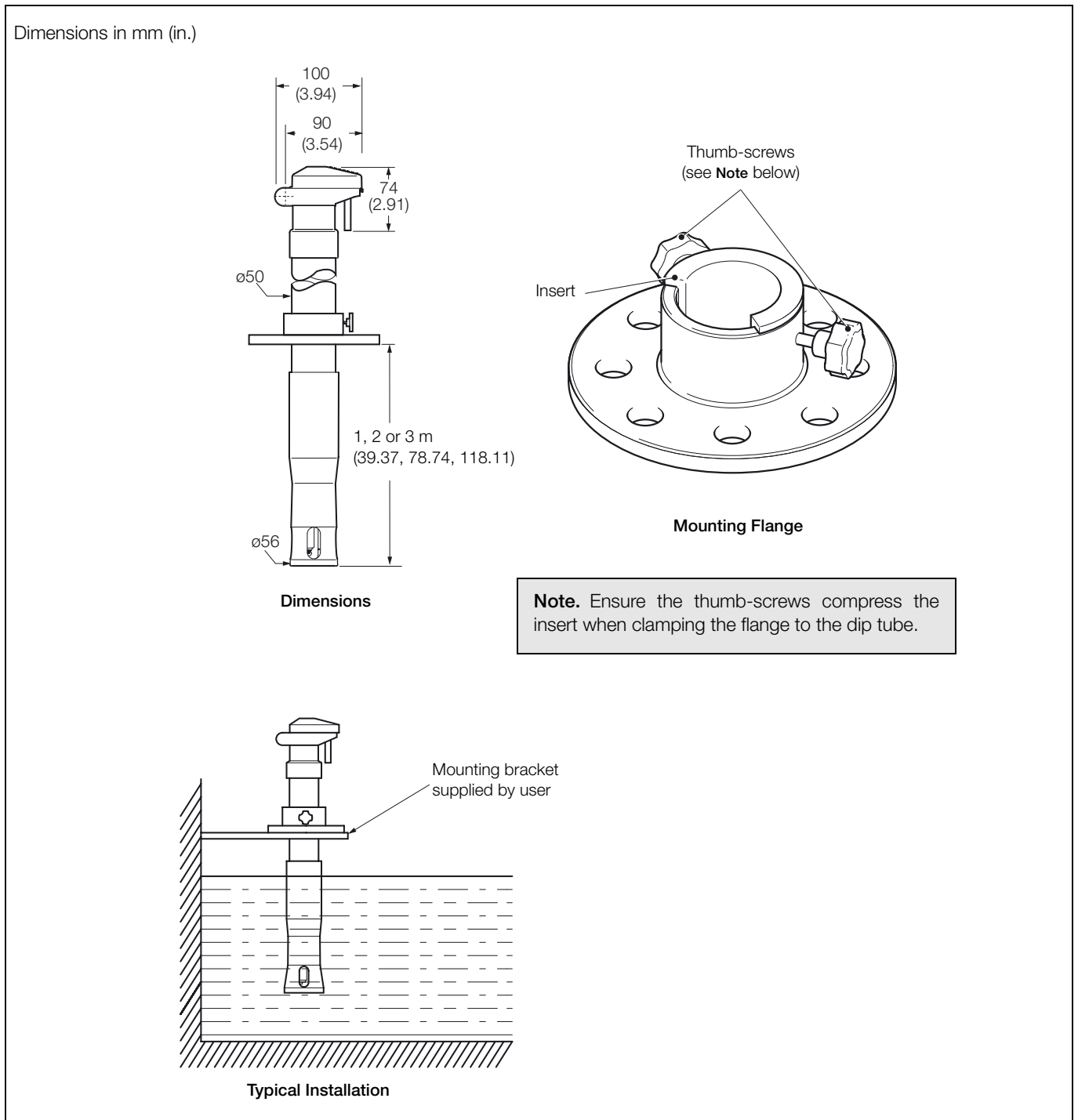


Fig. 2.3 Model AP203 Flanged Dip (Immersion) System

## 2.2 Removing the Sensor Holder

### 2.2.1 Models AP201 Insertion and AP202 Inline Systems – Fig. 2.4

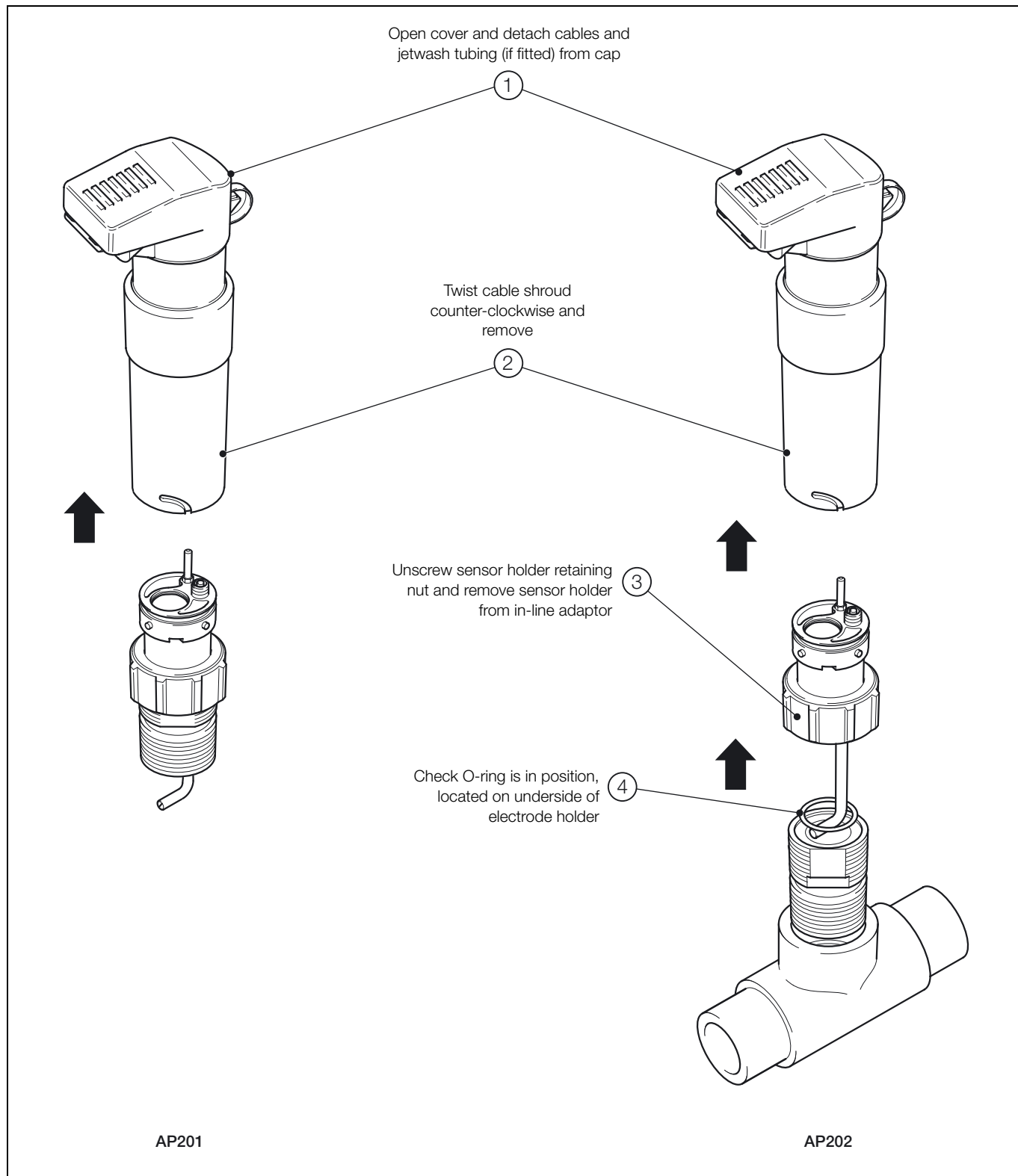


Fig. 2.4 Models AP201 and AP202 – Removing the Sensor Holder

2.2.2 Model AP203 Flanged Dip (Immersion) System – Fig. 2.5

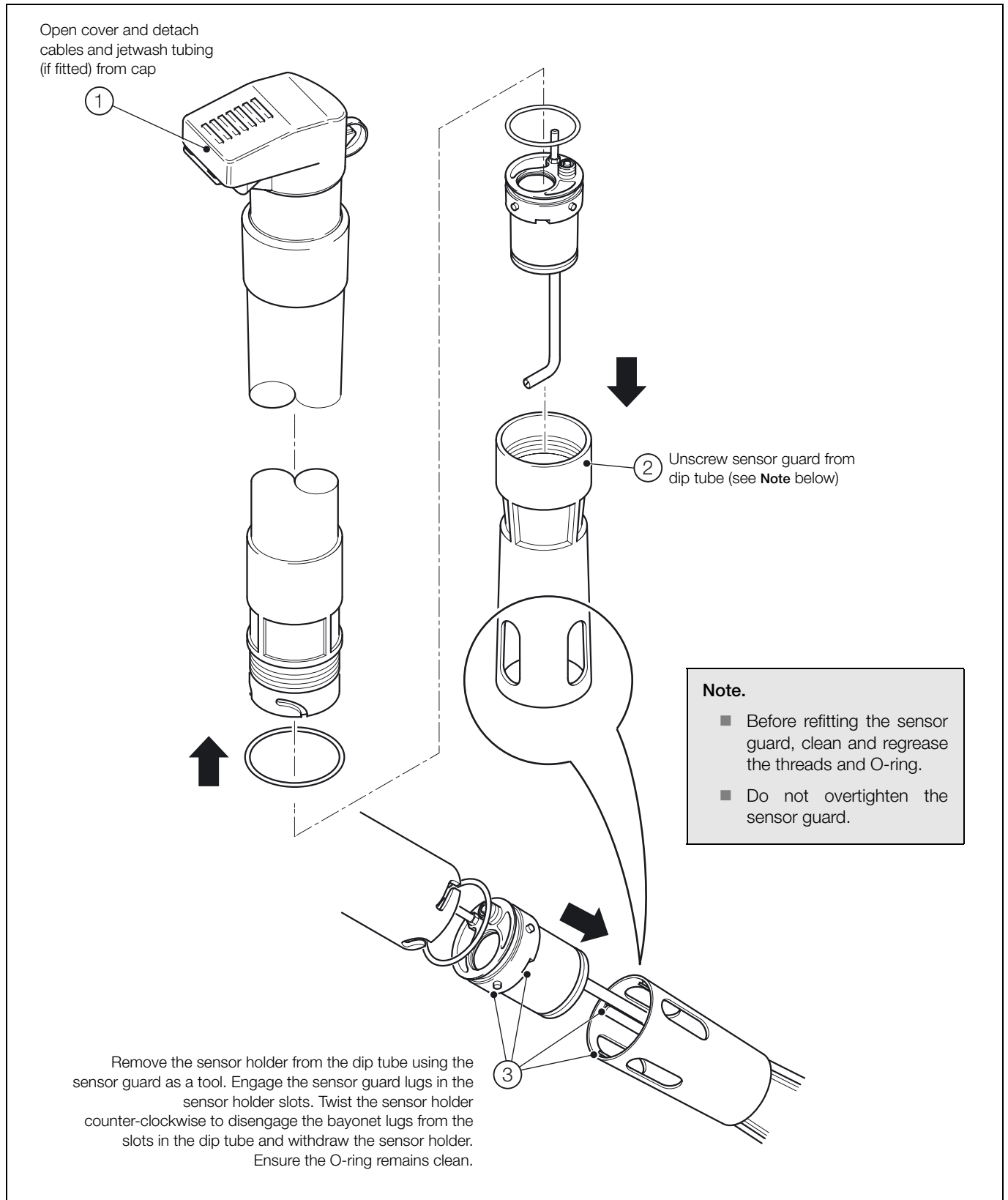


Fig. 2.5 Model AP203 – Removing the Sensor Holder

### 2.3 System Assembly – Fig. 2.6

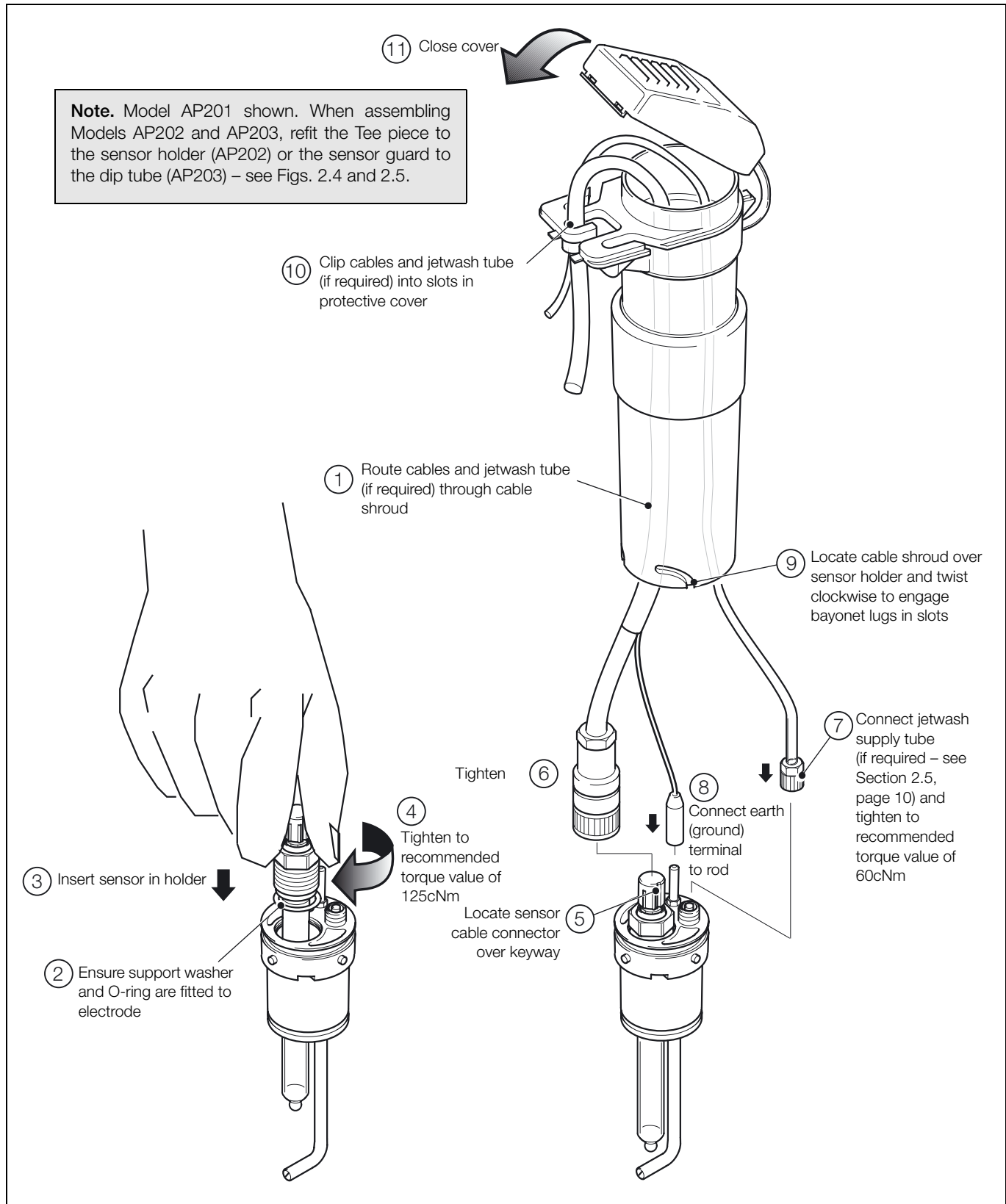


Fig. 2.6 System Assembly

### 2.4 Jetwash System – Figs. 2.7 to 2.8

**Note.** Installation must be carried out in accordance with local water company and council bylaws.

The jetwash system enables automatic cleaning of both the measuring element and the reference junction by spraying either water or a cleaning solution at them in situ, thus reducing system maintenance requirements.

An external pump or solenoid valve is required, controlled by a pH analyzer with auto-cleaning control functions.

**Note.** For optimal performance, the pressure of the jetwash system should be 2 to 3 bar (30 to 45 psi) greater than the process pressure.

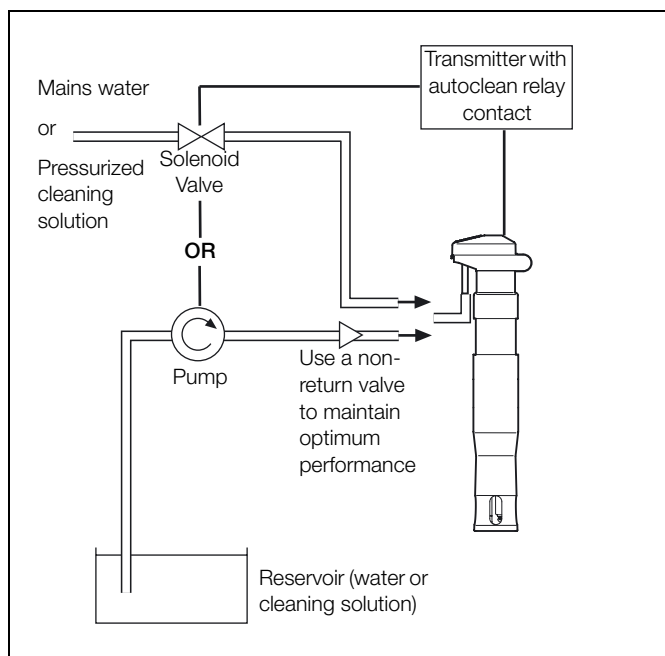


Fig. 2.7 Typical Jetwash Installation

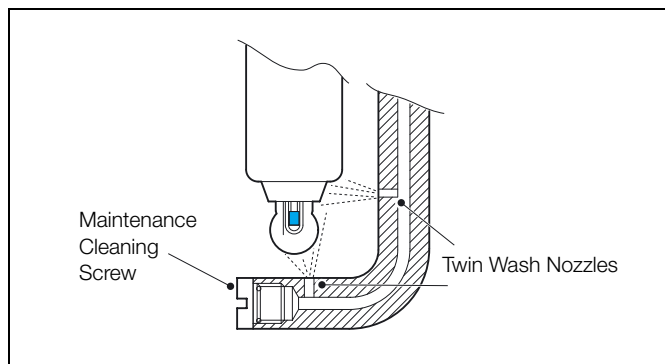


Fig. 2.8 Location of Jetwash Nozzle

#### Cleaning Solutions

The spray jet tube is available in 316 stainless steel. Some typical cleaning solutions are:

Coating	Cleaning Agent
Grease and Oils	Alkaline detergents or water-soluble solvents such as alcohols
Resins	Dilute alkalis
Limestone/Carbonates	1M nitric acid
Metal hydroxides	1M sulphuric or nitric acid
Cyanides	
Heavy biological	Mixture of 1M sulphuric or nitric acid and pepsin (saturated)
Proteins	
Fibres	Pressurized water with or without wetting agents
Light biological	Pressurized water
Latex (see <b>Note</b> below)	Pressurized cold water

**Note.** If removed from the process the latex must be completely removed quickly before it hardens.

### 2.5 Jetwash System Assembly – Fig. 2.9

The system is supplied with a blanking plug fitted to the jetwash tubing connector. If the jetwash system is to be used, remove the plug and fit the jetwash supply tube as shown in Fig. 2.9.

**Note.** Recommended tubing is 6mm OD semi-rigid polyethylene tube (part no. 0212035).

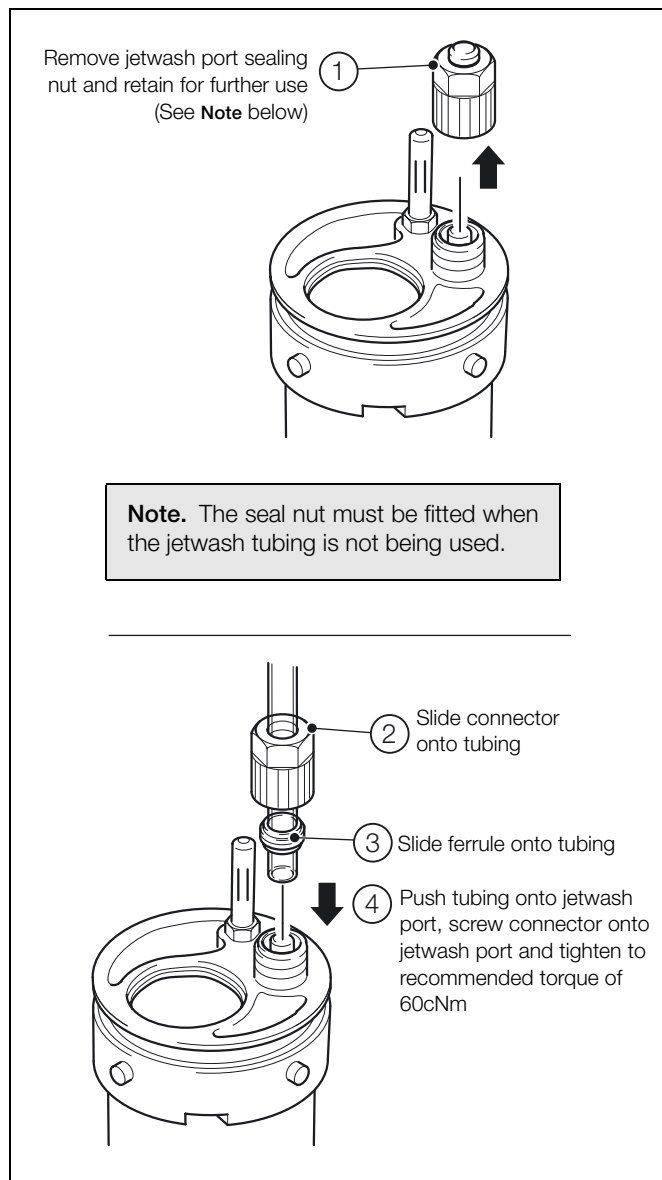


Fig. 2.9 Fitting Jetwash Supply Tubing

### 3 Electrical Installation

#### 3.1 Analyzer Connections – Fig. 3.1

System cable connections are identified in Fig. 3.1 to enable connection to the appropriate terminal on the analyzer.

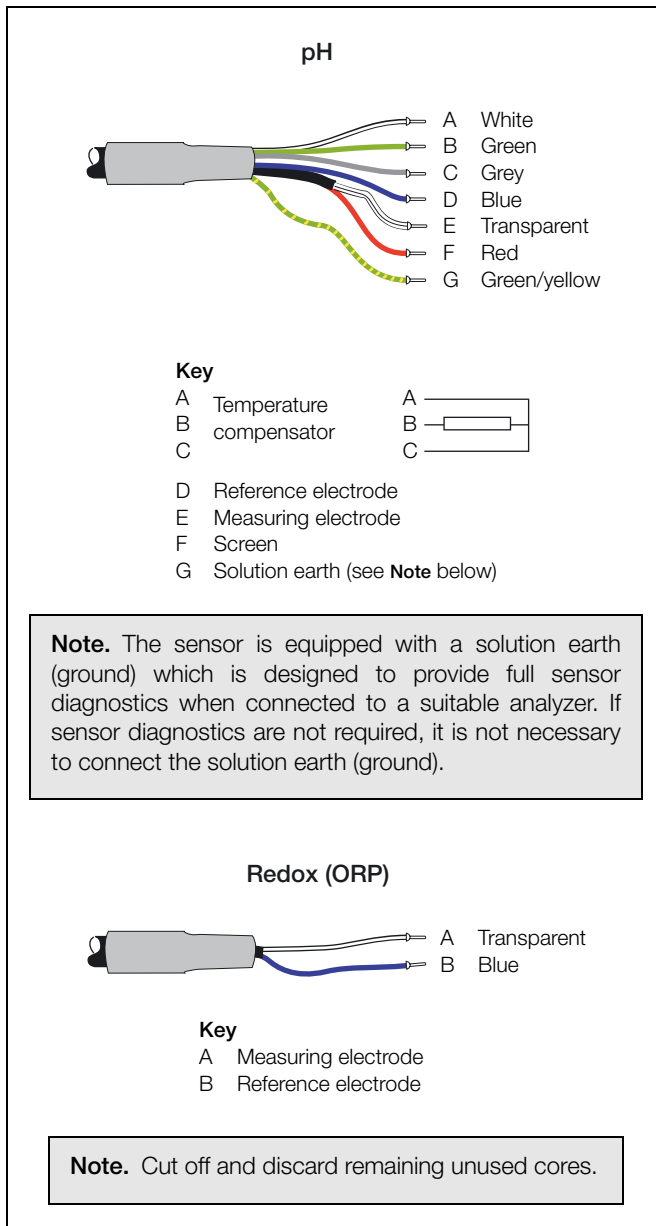


Fig. 3.1 Cable Termination

#### 3.2 Shortening the Connection Cable – Fig. 3.2

The connection cable is supplied in various standard lengths. If it is necessary to shorten the cable, prepare the cable ends as shown in Fig. 3.2.

The cable comprises:

1. an outer insulating layer
2. an inner braided shield
3. a shielded coaxial core
4. four insulated wires

**Note.** Do not allow the shielding to contact any other bare wires.

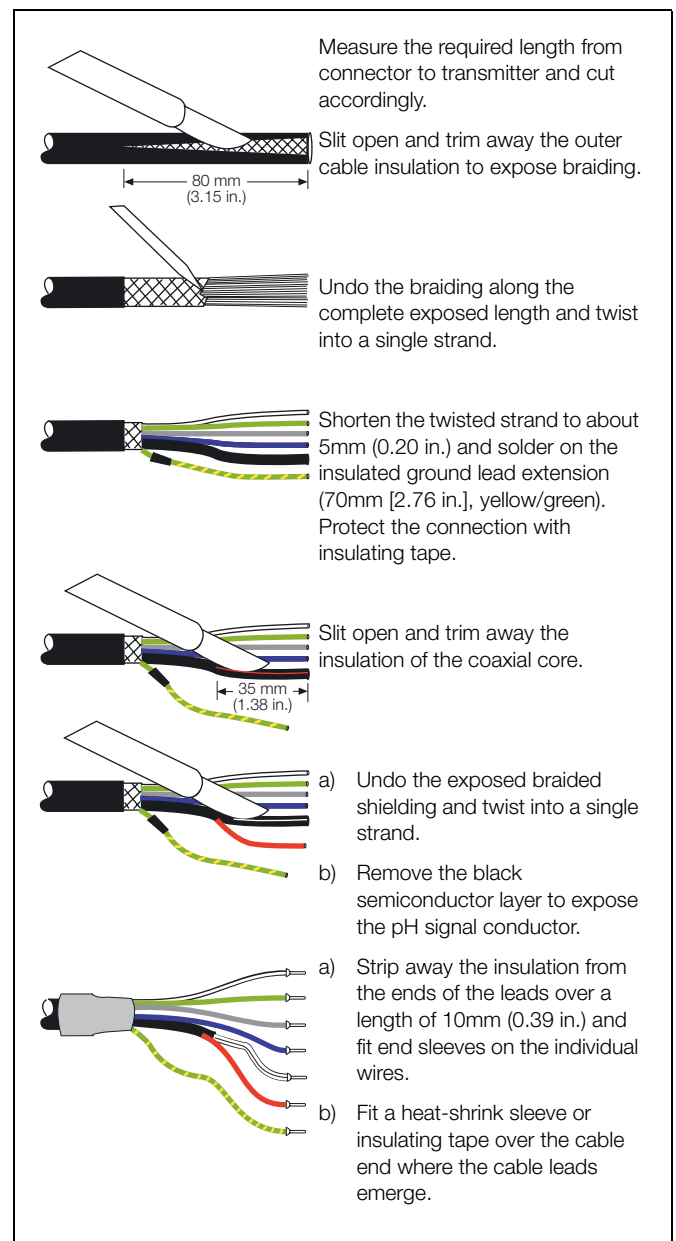


Fig. 3.2 Shortening the Connection Cable

### 3.3 Extending the Connection Cable – Fig. 3.3

If it is necessary to extend the cable, a suitable junction box and the correct length of 6-core cable are required. Connect the junction box as shown in Fig. 3.3.

**Note.**

- Junction box (part no. 7690/049) is recommended.
- 6-core cable, part no. AA101/0XX (where XX is the cable length, from 0.5 to 50 meters, in increments of 0.5 meters) is recommended.
- Cable AA101/0XX is identical to that fitted to the sensor. See Fig. 3.2 for cable end preparation instructions.

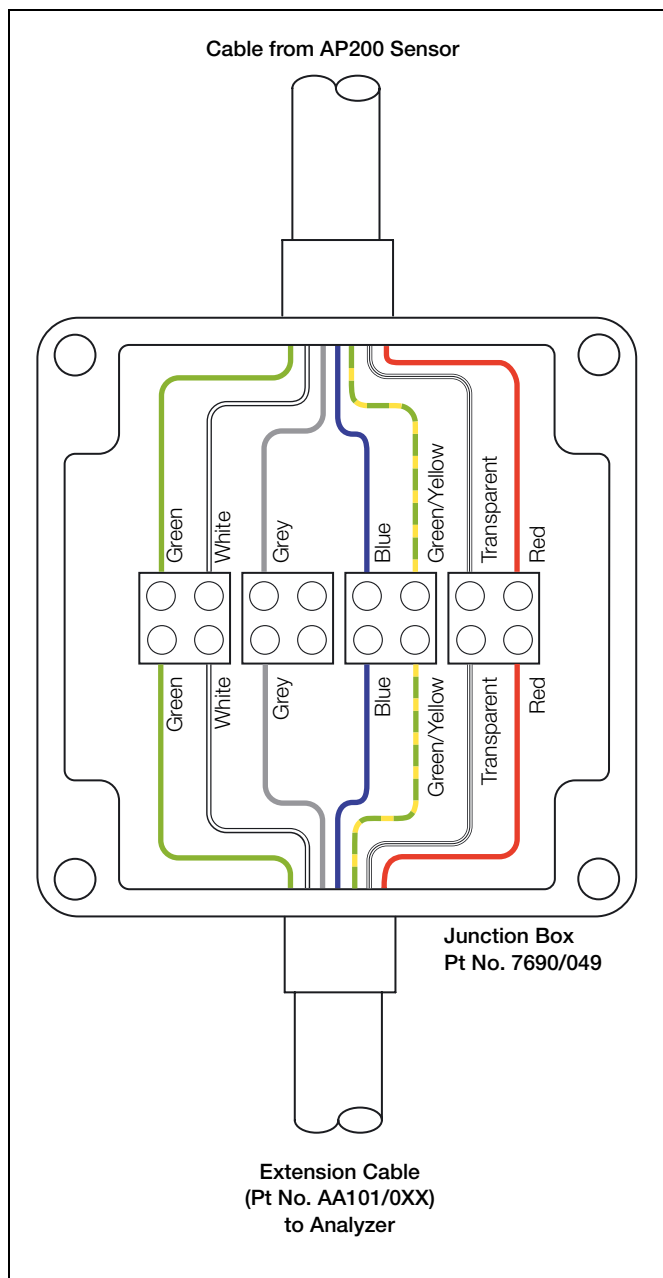


Fig. 3.3 Extending the Connection Cable

### 3.4 Jetwash System Connections

The electrical supply to the jetwash system pump or solenoid valve is connected to the analyzer relay used for automatic cleaning – see Fig. 3.4. The analyzer controls the frequency of the wash sequence and the duration for which the cleaning solution flows.

The analyzer outputs are held during a cleaning sequence.

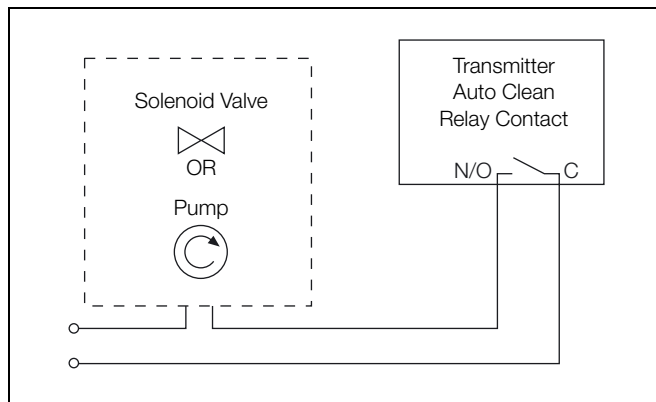


Fig. 3.4 Electrical Connections for Jetwash Systems

## 4 Calibration

### 4.1 Method

When the electrode system has been correctly connected and all electrical connections made to the associated pH analyzer, the system is ready for calibration by 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. 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 electrode 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 analyzer for full details of the calibration procedures.

**Warning.** Close all isolating valves before removing an electrode from a flow line.

### 4.2 Buffer Solutions

Recommended buffer solutions are shown in Table 4.1.

Buffer Solution	Part No.
4pH 0.05M potassium hydrogen phthalate	0400 110
7pH Disodium hydrogen phosphate/monopotassium dihydrogen phosphate mix	0400 120
9pH 0.05M borax	0400 130

Table 4.1 Recommended Buffer Solutions

#### Note.

- Ensure that the visible surface of the electrode has been cleaned using demineralized water.
- When moving from one buffer solution to the next, wash the electrode using demineralized water and dry it carefully using a soft tissue.

Table 4.2 shows the change in pH value that occurs with a change in the temperature of the recommended 4, 7, and 9 pH buffer solutions.

°C	0	10	20	25	30	40	50	60	70	80	90
<b>pH</b>											
<b>4</b>	4.00	4.00	4.00	4.01	4.01	4.03	4.05	4.08	4.12	4.16	4.21
<b>7</b>	7.11	7.06	7.01	7.00	6.98	6.97	6.97	6.97	6.99	7.03	7.08
<b>9</b>	9.48	9.35	9.23	9.18	9.13	9.05	8.98	8.93	8.90	8.88	8.84

Table 4.2 Buffer pH Value / Temperature (°C)

### 4.3 Redox (ORP Sensor)

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

For sensors that are connected to analyzers 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 (3.5 Flu oz.) 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 following:

pH Buffer	mV
4	+259
7	+82

## 5 Maintenance

### 5.1 General Cleaning

**Warning.** Close all isolating valves before removing an electrode from a flow line.

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

Automatic cleaning using the optional jetwash system and controlling the cleaning solution using a suitable controller or analyzer, will reduce the amount of manual cleaning.

Methods of removing various types of deposit are detailed below. Replace the sensor if the performance of the sensor 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 with demineralized water before calibrating.

#### 5.1.3 Greasy or Organic Deposits

Wipe the glass membrane with a detergent or acetone-based solvent. Rinse with demineralized 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 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. Sensor incorrectly connected – see Section 3.1, page 11 and the analyzer user guide for connection details.
2. Glass sensor membrane broken or cracked – replace sensor.

#### Unstable readings or drift

1. Sensor incorrectly connected – see Section 3.1, page 11 and the analyzer user guide for connection details.
2. Dry or dirty reference junction – clean junction as detailed in Section 5.1. Leave to soak in a buffer solution for several hours.

Replace sensor if no improvement is seen.

#### Stable but incorrect readings

1. Incorrect calibration – recalibrate using fresh buffer solutions.
2. Incorrect temperature compensation settings – enter correct manual temperature or check that automatic temperature compensation is reading correctly.
3. Sensor responds correctly to pH changes, but there is an offset of <1.0 pH and >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 Storing the Electrode

**Note.** Allowing the glass membrane and reference junction to dry out irreversibly affects 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 Specification

### All Systems

#### Materials

Shaft and cap	Polypropylene
Sensor body	Ryton™ PPS
Ground rod/Spray tube	316 Stainless steel

#### Jet-wash facility

Non-return function	Integral one-way valve
Spray tube connection	6mm compression fitting
Recommended operating pressure	Min. 1 bar (15 psi) over process pressure

#### Certification

The systems comply with SEP (Safe Engineering Practice) level Pressure Equipment Directive 97123/EC

### AP201 Insertion System

#### Maximum Temperature

130°C (266°F)	PPS and steel adapters
90°C (194°F)	Polypropylene adapter

#### Maximum Pressure

6 bar (90 psi)

#### Process Connections

Union nut G	1 <sup>1</sup> / <sub>4</sub> in. (BSP)
PPS process adapter	R1 <sup>1</sup> / <sub>4</sub> in. (tapered BSP male)
PP process adapters	R1 <sup>1</sup> / <sub>4</sub> in. 1 <sup>1</sup> / <sub>4</sub> in. NPT
Stainless steel adapters	R1 in. (tapered BSP male) 1 in. NPT
Stainless steel sockets	Angled DN25 Straight DN25

### AP202 Flow-through System

#### Materials

Flow-cells	Polypropylene Stainless steel
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#### Maximum Temperature

90°C (194°F)	Polypropylene flow cell
130°C (266°F)	Stainless steel flow cell

#### Maximum Pressure

6 bar (90 psi)

#### Process Connections

Union nut	G1 <sup>1</sup> / <sub>4</sub> in. (BSP)
Flow-cell inlet & outlet	Rp1 in. (BSP female) or 1 in. NPT

### AP203 Immersion (Dip) System

#### Materials

Guard, shaft and cap	Polypropylene
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#### Maximum Temperature

90°C (194°F)

#### Maximum Pressure

Not applicable

#### Process Connections

Sliding flange	Composite DIN & ANSI DN50 / ANSI 2 in.
Immersion lengths	1m (3.3 ft) 2m (6.6 ft) 3m (10 ft)

### AP120 Combination Sensor

#### Measuring Ranges

AP121/0 General Process	0 to 14pH 0 to +100°C (32 to 212°F)
AP121/1 High Temp/Alkali	0 to 14pH 10 to 130°C (50 to 266°F)
AP121/2 Low Resistance	0 to 10pH -5 to 50°C (23 to 122°F)
AP121/6 Pt Redox (ORP)	± 2000mV 0 to 130°C (32 to 266°F)

#### Reference Electrode System

Primary electrolyte	Solid, Ag-free Gel with KCl charge
Inner reference system	Ag/AgCl
Junction annular	PTFE, sterilizable
Nominal zero point, E <sub>0</sub>	7 pH
Minimum conductivity	> 50 µS/cm

#### General Data

Temperature Sensor	(pH only) Integral Pt100
Temperature response	T <sub>90</sub> <70s
Electrode shaft length	120mm
Max. pressure	6 bar (90 psi)
Ingress protection	IP67/NEMA 6P (exceeds NEMA4X)
Connection head	Sterilizable VP (VarioPin) connector with PG13.5 thread

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## 7 Spares

### 7.1 Model AP201 Insertion System – Fig. 7.1

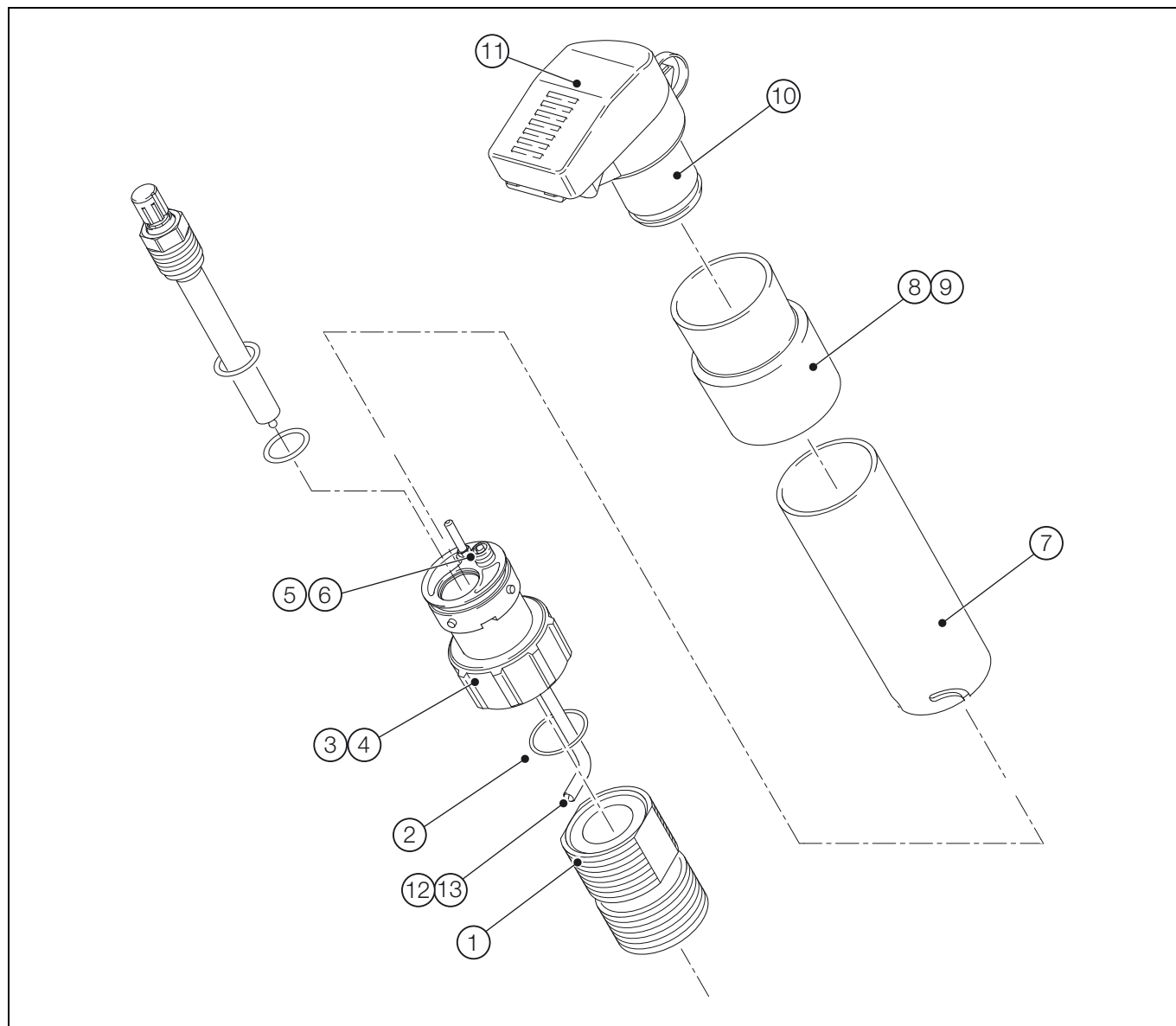


Fig. 7.1 Model AP201 Insertion System Spares

Item	Part No.	Description	Qty
①	7690130	Adaptor R1¼ in. PPS *	1
②	0211209	O-Ring 1½ in. ID x 0.103 in. CH Viton	1
③	7690160	Cable Shroud, Molded	1
④	7690135	Sensor Collar PPS	1
⑤	0216561	Knurled Nut, M10, Polyamid, 6mm ID	1
⑥	0216560	Compression Ferrule, Polyamid, 6mm ID	1
⑦	7690160	Cable Shroud	1
⑧	7690218	Adaptor Sleeve, Protective Cover	1
⑨	0212843	Double-Sided, Self-Adhesive Tape 38W	A/R

Item	Part No.	Description	Qty
⑩	7690140	Protective Cover	1
⑪	7690145	Protective Lid	1
⑫	7690086	Cleaning Screw	1
⑬	0211029	O-Ring 3mm. ID x 1.5mm CH Viton	1
	7690040	Service Pack Comprising:	1
	0211161	O-Ring 11.6 mm ID x 2.4 mm CH Viton	1
	0211209	O-Ring 1½ in. ID x 0.103 in. CH Viton	1
	0211351	O-Ring 37.77 mm ID x 2.62 mm CH Viton	1
	0211353	O-Ring 46 mm ID x 2 mm CH Viton	1

\* Refer to Fig. 2.1 for alternatives

7.2 Model AP202 Inline System – Fig. 7.2

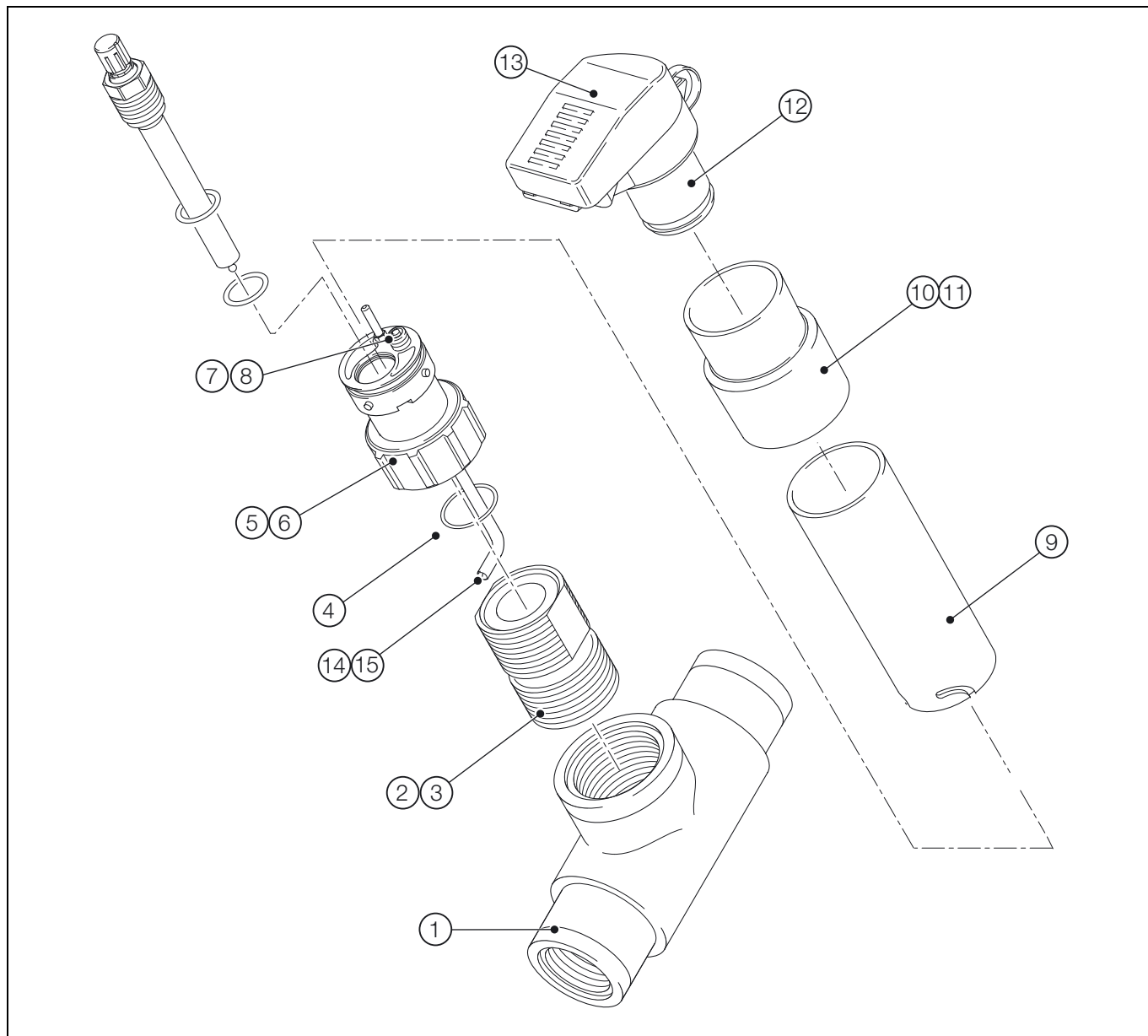


Fig. 7.2 Model AP202 Inline System Spares

Item	Part No.	Description	Qty
①	7690150	Tee-piece*	1
②	0212730	PTFE Thread Sealing Tape	A/R
③	7690130	Adaptor 1 1/4 in. BSP in PPS**	1
④	0211209	O-Ring 1 1/16 in. ID x 0.103 in. CH Viton	1
⑤	7690135	Sensor Collar PPS	1
⑥	7690163	Split Ring	1
⑦	0216561	Knurled Nut, M10, Polyamid, 6mm ID	1
⑧	0216560	Compression Ferrule, Polyamid, 6mm ID	1
⑨	7690160	Cable Shroud	1

\* Contact ABB for alternatives

\*\* Refer to Fig. 2.1 for alternatives

Item	Part No.	Description	Qty
⑩	7690218	Adaptor Sleeve, Protective Cover	1
⑪	0212843	Double-Sided, Self-Adhesive Tape 38W	A/R
⑫	7690140	Protective Cover	1
⑬	7690145	Protective Lid	1
⑭	7690085	Cleaning Screw	1
⑮	0211029	O-Ring 3mm. ID x 1.5mm CH Viton	1
	7690040	Service Pack Comprising:	1
	0211161	O-Ring 11.6 mm ID x 2.4 mm CH Viton	1
	0211209	O-Ring 1 1/16 in. ID x 0.103 in. CH Viton	1
	0211351	O-Ring 37.77 mm ID x 2.62 mm CH Viton	1
	0211353	O-Ring 46 mm ID x 2 mm CH Viton	1

7.3 Model AP203 Flanged Dip (Immersion) System – Fig. 7.3

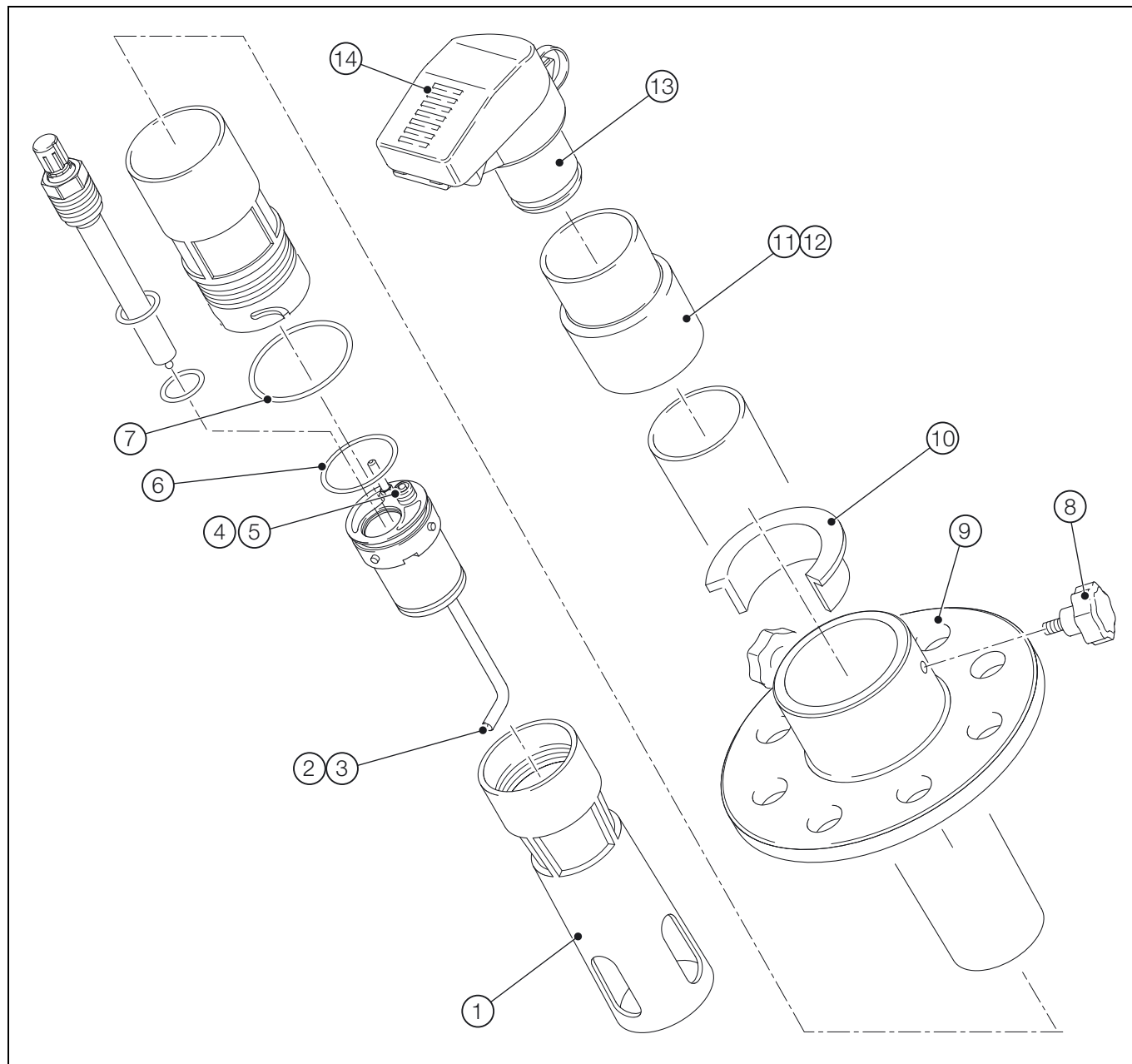


Fig. 7.3 Model AP203 Flanged Immersion (Dip) System Spares

Item	Part No.	Description	Qty
①	7690210	Protective Dip Cage	1
②	7690085	Cleaning Screw	1
③	0211029	O-Ring 3mm. ID x 1.5mm CH Viton	1
④	0216561	Knurled Nut, M10, Polyamid, 6mm ID	1
⑤	0216560	Compression Ferrule, Polyamid, 6mm ID	1
⑥	0211351	O-Ring 37.71mm ID x 2.62mm CH Viton	1
⑦	0211353	O-Ring 46mm ID x 2mm CH Viton	1
⑧	0216126	Knob, Scallop M5 x 15mm Black	2
⑨	7690212	Ind Dip Non-Seal Flange	1

Item	Part No.	Description	Qty
⑩	7690213	Ind Dip Flange Insert	1
⑪	7690218	Adaptor Sleeve, Protective Cover	1
⑫	0212843	Double-Sided, Self-Adhesive Tape 38W	A/R
⑬	7690140	Protective Cover	1
⑭	7690145	Protective Lid	1
	7690040	Service Pack Comprising:	1
	0211161	O-Ring 11.6 mm ID x 2.4 mm CH Viton	1
	0211209	O-Ring 1 <sup>1</sup> / <sub>16</sub> in. ID x 0.103 in. CH Viton	1
	0211351	O-Ring 37.77 mm ID x 2.62 mm CH Viton	1
	0211353	O-Ring 46 mm ID x 2 mm CH Viton	1

# Notes



# PRODUCTS & CUSTOMER SUPPORT

## Products

### Automation Systems

- for the following industries:
  - Chemical & Pharmaceutical
  - Food & Beverage
  - Manufacturing
  - Metals and Minerals
  - Oil, Gas & Petrochemical
  - Pulp and Paper

### Drives and Motors

- AC and DC Drives, AC and DC Machines, AC Motors to 1kV
- Drive Systems
- Force Measurement
- Servo Drives

### Controllers & Recorders

- Single and Multi-loop Controllers
- Circular Chart and Strip Chart Recorders
- Paperless Recorders
- Process Indicators

### Flexible Automation

- Industrial Robots and Robot Systems

### Flow Measurement

- Electromagnetic Flowmeters
- Mass Flowmeters
- Turbine Flowmeters
- Wedge Flow Elements

### Marine Systems & Turbochargers

- Electrical Systems
- Marine Equipment
- Offshore Retrofit and Refurbishment

### Process Analytics

- Process Gas Analysis
- Systems Integration

### Transmitters

- Pressure
- Temperature
- Level
- Interface Modules

### Valves, Actuators and Positioners

- Control Valves
- Actuators
- Positioners

### Water, Gas & Industrial Analytics Instrumentation

- pH, Conductivity and Dissolved Oxygen Transmitters and Sensors
- Ammonia, Nitrate, Phosphate, Silica, Sodium, Chloride, Fluoride, Dissolved Oxygen and Hydrazine Analyzers
- 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  
Tel: +44 (0)1453 826661  
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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**ABB** has Sales & Customer Support expertise  
in over 100 countries worldwide

[www.abb.com](http://www.abb.com)

The Company's policy is one of continuous product  
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