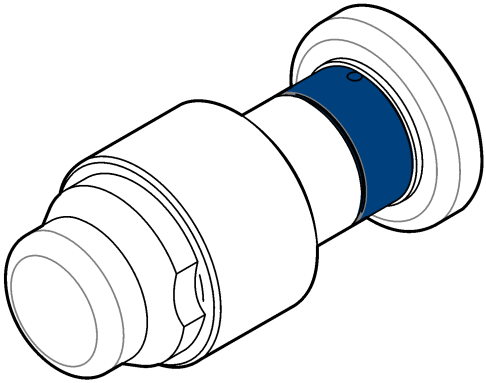
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ORBISPHERE Model GA2X00 O_2 EC Sensor

04/2025, Edition 8

User Manual



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Section 1 Specifications

Specifications are subject to change without notice.
The product has only the approvals listed and the registrations, certificates and declarations officially provided with the product. The usage of this product in an application for which it is not permitted is not approved by the manufacturer.

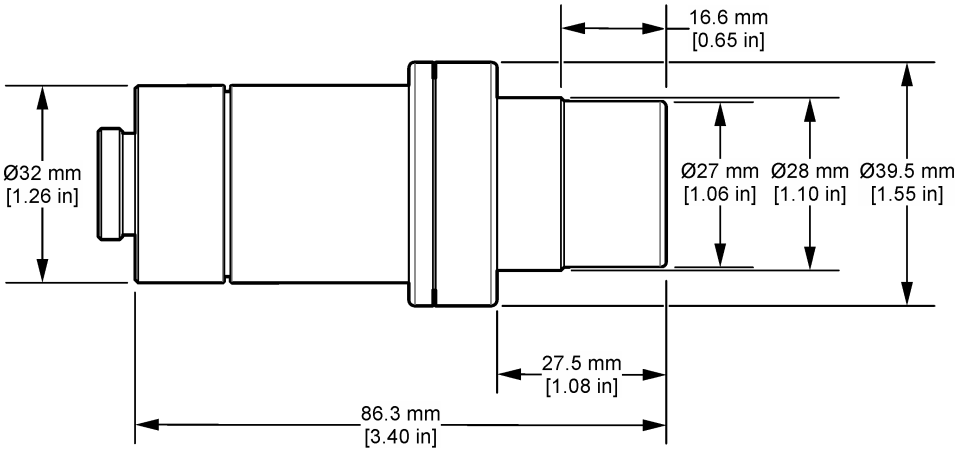
1.1 Sensor specifications

Table 1 ORBISPHERE family of GA2X00 oxygen sensors

Specification	Details—Non-ATEX sensors	Details—ATEX sensors
Type	Electrochemical oxygen sensor	
Dimensions (Ø × L)	32 × 86.3 mm (1.26 × 3.40 in.) Refer to Figure 1.	
Weight	300 g	
Pressure resistence	40 bar maximum with default PPS collar (100 bar with stainless steel collar)	
Materials	Stainless steel	Stainless steel or hastelloy
	Sensor head: Kalrez® O-rings Sensor bottom: Viton® O-rings[1]	EPDM and Kalrez® O-rings Sensor head: Kalrez® O-rings Sensor bottom: Viton® O-rings or Kalrez® O-rings
Other	Smart capability	Intrinsically safe
Certification	CE	CE, Ex II 1 G, Ex ia IIC T6

Note: *Unlike the GA2400 non-ATEX sensors, the intrinsically safe GA2800 ATEX sensors have no smart capability to store calibration data. However, all GA2800 ATEX sensors have the ATEX conformity information engraved on the sensor itself.*

Figure 1 Sensor dimensions



[1] Viton and Kalrez are trademarks of DuPont Corporation.

1.2 Sensor configurations

Table 2 Beverage

Application	Sensor	Membrane Cartridge	Protection Cap
Beer with ORBISPHERE 3650 Portable	GA2400-S00	2958A-A (optimized response time) 2952A-A (optimized maintenance interval)	33051-SP
Beer in-line	GA2400-S00	2952A-A	33051-SG
Wort in-line	GA2400-S00	29552A-A	33051-S0
Wort with ORBISPHERE 3650 Portable and special flow cell 32007W.xxx	GA2400-S00	29552A-A	33051-S0
ORBISPHERE 6110 Total package analyzer (TPA)	GA2400-S00T	2956A-A	33051-ST
De-aerated water	GA2400-S00	2956A-A or 2952A-A	33051-S0 33051-SG (if exposed to CIP)

Table 3 Pure water applications (Power - Electronics)

Application	Sensor	Membrane Cartridge	Protection Cap
On-line dissolved oxygen traces in pure water	GA2400-S00	2956A-A	33051-S0
Dissolved oxygen traces with 3655 Portable	GA2400-S00	2956A-A	33051-S0

Table 4 ATEX

Sensor	Membrane Cartridge	Protection Cap
GA2800-SVS	2956A-A or 29552A-A	33051-SG
GA2800--SKS	2956A-A or 29552A-A	33051-SG
GA2800--HVS	2956A-A or 29552A-A	33051-H0
GA2800--HKS	2956A-A or 29552A-A	33051-H0

1.3 Sensor membrane specifications

1.3.1 Oxygen sensors (Table 1)

Table 5 Membrane specifications - Oxygen sensors (1)

Specification	2956A-A	2958A-A	29552A-A	2952A-A
Recommended applications	Corrosion control, De-aerated water	Beverage, Lab. applications	In line wort, Air/O_2 injection, Sewage treatment	Corrosion control, In line beverage, De-aerated water
Material	PFA	Tefzel®[2]	PTFE	Tefzel®
Thickness [µm]	25	12.5	50	25
Calibration gas	Air	Air	Air	Air / Pure O_2
Dissolved measurement range	0 ppb to 20 ppm	0 ppb to 40 ppm	0 ppb to 80 ppm	0 ppb to 80 ppm

[2] Tefzel is a trademark of DuPont Corporation.

Table 5 Membrane specifications - Oxygen sensors (1) (continued)

Specification	2956A-A	2958A-A	29552A-A	2952A-A
Gaseous measurement range	0 Pa to 50 kPa	0 Pa to 100 kPa	0 Pa to 200 kPa	0 Pa to 200 kPa
Accuracy	The greater of ±1% of reading or ± 0.1 ppb[3], or ± 1 ppb[4], or ± 0.25 Pa	The greater of ±1% of reading or ± 1 ppb, or ± 2 Pa	The greater of ±1% of reading or ± 2 ppb, or ± 5 Pa	The greater of ±1% of reading or ± 2 ppb, or ± 5 Pa
Integrated radiation dose limit [rads]	2×10^4	10^8	N/A	10^8
Expected current in air @ 1 bar 25 °C [µA]	26.4	9.4	6.3	5.4
Expected current in pure O_2 [µA]	132	47	31.4	27
O_2 consumption in O_2 saturated water at 25 °C [µg/hour]	40	14	9.4	8
Temp. compensation range	– 5 to 60 °C			
Temp. measuring range	– 5 to 100 °C			
Response time[5]	7.2 sec.	9.5 sec.	90 sec.	38 sec.
Recommended min. liquid flow rate[6] [mL/min]	180	120	50	50
Recommended min. linear flow rate[6] [cm/sec]	200	100	30	30
Recommended gaseous flow rate [L/min]	0.1 to 3			

1.3.2 Oxygen sensors (Table 2)

Table 6 Membrane specifications - Oxygen sensors (2)

Specification	2935A-A	29521A-A	2995A-A
Recommended applications	Saturated to super saturated levels	Saturated to super saturated levels	In line hot wort (up to 70 °C)
Material	Halar®[7]	Tefzel®	Tefzel®
Thickness [µm]	25	125	12.5
Calibration gas	Air / Pure O_2	Air / Pure O_2	Pure O_2
Dissolved measurement range	0 ppb to 400 ppm	0 ppb to 400 ppm	0 ppb to 2000 ppm
Gaseous measurement range	0 Pa to 1000 kPa	0 Pa to 1000 kPa	0 Pa to 5000 kPa
Accuracy	The greater of ±1% of reading or ± 10 ppb, or ± 20 Pa	The greater of ±1% of reading or ± 10 ppb, or ± 20 Pa	The greater of ±1% of reading or ± 50 ppb, or ± 100 Pa

3 Accuracy is ± 0.1 ppb for 410, 510, 362x, 360x and 3655 instruments
4 Accuracy is ± 1 ppb for 366x and 3650 instruments
5 Response time at 25 °C for a 90% signal change
6 Liquid flow through an ORBISPHERE 32001 flow chamber, with protection cap and no grille
7 Halar is a trademark of Solvay Corporation.

Table 6 Membrane specifications - Oxygen sensors (2) (continued)

Specification	2935A-A	29521A-A	2995A-A
Integrated radiation dose limit [rads]	N/A	10^8	10^8
Expected current in air @ 1 bar 25 °C [µA]	0.9	0.7	0.2
Expected current in pure O_2 [µA]	4.7	3.8	0.9
O_2 consumption in O_2 saturated water at 25 °C [µg/hour]	1.4	1.3	0.3
Temp. compensation range	– 5 to 60 °C		
Temp. measuring range	– 5 to 100 °C		
Response time[8]	2.5 min.	18 min.	80 sec.
Recommended min. liquid flow rate[9] [mL/min]	25	25	5
Recommended min. linear flow rate[9] [cm/sec]	20	60	5
Recommended gaseous flow rate [L/min]	0.1 to 3		

Section 2 General information

In no event will the manufacturer be liable for damages resulting from any improper use of product or failure to comply with the instructions in the manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.

2.1 Safety information

The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

If the equipment is used in a manner that is not specified by the manufacturer, the protection provided by the equipment may be impaired. Do not use or install this equipment in any manner other than that specified in this manual.

2.1.1 Use of hazard information

⚠ DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

[8] Response time at 25 °C for a 90% signal change

[9] Liquid flow through an ORBISPHERE 32001 flow chamber, with protection cap and no grille

⚠ CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

2.1.2 Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

	This is the safety alert symbol. Obey all safety messages that follow this symbol to avoid potential injury. If on the instrument, refer to the instruction manual for operation or safety information.
	This symbol indicates the need for protective eye wear.
	This symbol indicates the need for protective hand wear.
	Products marked with this symbol indicates that the product contains toxic or hazardous substances or elements. The number inside the symbol indicates the environmental protection use period in years.
	Electrical equipment marked with this symbol may not be disposed of in European domestic or public disposal systems. Return old or end-of-life equipment to the manufacturer for disposal at no charge to the user.

2.2 Product overview

2.2.1 Operating principle

In its simplest form, the electrochemical sensor consists of one center electrode (cathode) and one counter electrode (anode) immersed in an electrolyte solution which is separated from the gaseous or liquid sample by a gas permeable membrane. An electronic circuit is linked to the anode and cathode. Through an applied voltage, current will flow between the anode and the cathode.

A guard ring electrode surrounds the center electrode in order to reduce the influence of other gases on the center electrode, and therefore improving analysis stability.

The sensor head is covered with a protection cap and, in some applications, a grille to protect the membrane. Materials used for the components of the sensors differ with the application.

Gas penetrating through the membrane into the cell dissolves in the electrolyte. It undergoes a reaction at the cathode, causing a measurable electric current to flow. This current is proportional to the amount of gas entering the cell, which in turn is proportional to the partial pressure of gas in the sample outside the cell.

The result is shown as gas concentration, which can then be displayed with a choice of several measuring units, according to instrument setup.

The sensor also includes “smart sensor technology”, implemented using an RS485 interface. This feature is not available for ATEX sensor C110E-T00.

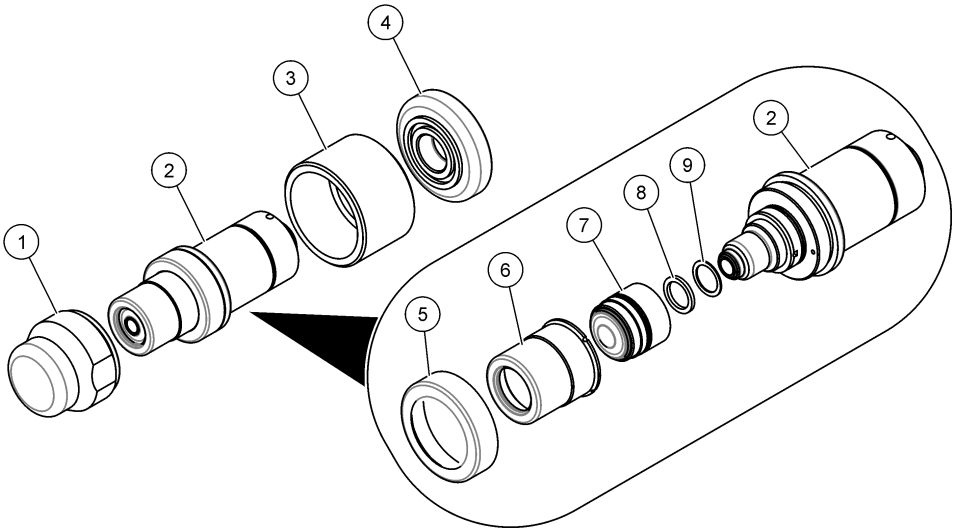
The sensor electronics perform four functions:

- Apply constant voltage to the anode
- Measure the current flowing through the sensor
- Compensate for temperature variation in the gaseous or liquid sample
- Convert the cell's electric current into an analog signal for sensor output

2.2.2 Sensor components

Refer to Figure 2 for the sensor components.

Figure 2 Sensor components

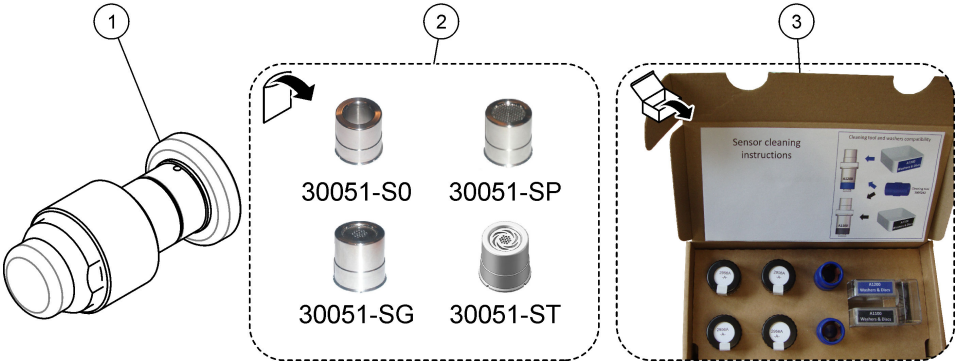


1 Storage cap	**6** Protection cap (illustrated without grille)
2 Sensor body	**7** Cartridge containing electrolyte and membrane
3 Sensor collar	**8** Cotton washer
4 Plastic base	**9** Silicone disc
5 Protection cap locking washer	

2.3 Product components

Make sure that all components have been received. Refer to Figure 3. If any items are missing or damaged, contact the manufacturer or a sales representative immediately.

Figure 3 Product components



1 Sensor	**3** Sensor recharge kit
2 Protection caps	

2.3.1 Electrochemical sensor

The sensor may be delivered separately or as part of an ORBISPHERE system, depending on the individual order.

The sensor will be delivered fitted with a plastic screw-on storage cap to protect the sensor head. This is held in place with a plastic collar.

A plastic screw-on base is also provided to protect the connection socket, and which also provides a suitable stand for the sensor during maintenance procedures, and when not in use.

2.3.2 Protection caps

Non-ATEX sensors (GA2400)

Two protection caps will be delivered with each sensor, one without a grille (part number 33051-S0) and one with a grille (part number 33051-SP).

A third protection cap (part number 33051-SG) is also available as an option and improves the maintenance interval for beer or soft drinks process applications.

A fourth protection cap (part number 33051-ST) is delivered for the 6110 TPA application.

ATEX sensors (GA2800)

Only one protection cap will be delivered with each sensor (part number 33051-SG or 33051-H0).

2.3.3 Sensor recharge kit

A recharge kit should have been ordered with the sensor as this will be required to initially make the sensor operational. It is also required for sensor cleaning and membrane replacement procedures.

Note: *There are two different versions of the recharge kit. One version for GA2X00/A110X sensors and one version for C1100 sensors. Refer to the documentation supplied with the kit for instructions on how to use the version of the recharge kit with the applicable sensor.*

The kit contains:

- four recharge cartridges with pre-mounted membrane and electrolyte. The type of membrane mounted in the cartridge will be specific to the kit ordered
- two anode cleaning tools
- two sets of five cotton washers and five silicone discs (only for 2956A-XXX)
  Note: *The box for GA2X00 sensors has a blue label and the box for A110X sensors has a black label.*
- one set of replacement O-rings and Dacron® mesh patches, applicable for GA2X00 and A110X sensors

The blue anode cleaning tool is used to clean the anode of any deposits or residue that may have formed. It is doubled-ended so it can be used for two membrane replacement processes, each end

being used once. Refer to the documentattion supplied with the recharge kit for instructions on how to use the anode cleaning tool for a GA2X00 sensor or for a A110X sensor.

The cotton washers provide additional protection against the formation of deposits and residue on the center electrode and anode, which prolongs the time period required between sensor maintenance.

The silicone discs are required for measurements in ultra-pure water or water containing ammonia.

The Dacron® mesh patches provide protection to the membrane when using a protection cap with a grille.

Section 3 Installation

⚠ CAUTION	
	Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

3.1 Sensor preparation

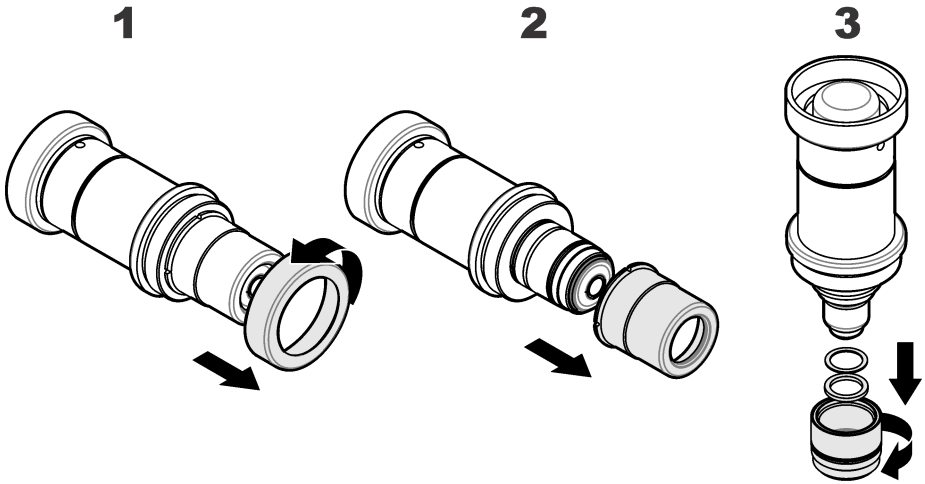
⚠ CAUTION	
	Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current safety data sheets (MSDS/SDS) for safety protocols.

Your sensor has been thoroughly cleaned and tested at the factory before shipment. It has been shipped with a cartridge containing a membrane and electrolyte pre-installed to protect the sensor head. This cartridge must be removed and replaced with a new one prior to first use to make it fully operational. The new cartridge is included in the sensor recharge kit.

- **Non-ATEX sensors (GA2400)**. The sensor has been delivered with two protection caps, one with a grille and one without. Ensure you use the correct protection cap for your application. Refer to Sensor configurations on page 4 for additional information.
- **ATEX sensors (GA2800)**. The sensor has been delivered with a single protection cap.

The following instructions detail the steps required to make the sensor operational.
Note: *It is advisable to perform this procedure with the plastic sensor base installed so as to avoid any damage to the connection socket and also to provide a suitable stand for the sensor when required.*

1. Hold the main body of the sensor and unscrew the protection cap locking washer by turning counter-clockwise. Remove it from the sensor and put to one side.
2. Pull/twist off the protection cap and put to one side.
3. Hold the sensor with the membrane facing down to avoid spilling any electrolyte, then carefully unscrew the shipment cartridge. Drain the old electrolyte into a sink and flush away. Discard the shipment cartridge and membrane. Remove the cotton washer and silicone disc from the top of the anode and discard.



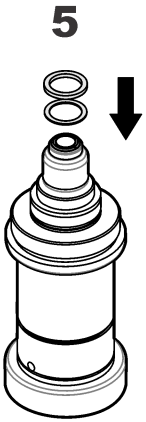
4. Rinse the sensor head under a tap for 15 seconds, aiming the jet of water directly onto the sensor head. Do not dry the center electrode area, as the gap between cathode and guard should be left filled with water.
5. Take a silicone disc from the recharge kit, hold it between thumb and forefinger and position it on top of the anode. Take a new cotton washer from the recharge kit. Hold it between thumb and forefinger and position it on top of the silicone disc.

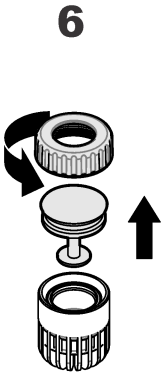
   Note: *During this step, it is very important to ensure your finger does not come into contact with the cathode (golden surface) as it could leave greasy deposits on the surface.*

   Note: *Make sure that no cotton fibres are placed on the golden surface of the cathode.*
6. Place the recharge cartridge container on a flat work surface and, keeping the container upright to avoid spilling any of the electrolyte inside, carefully unscrew the top. Remove the packing component from the center of the cartridge, making sure that the O-ring on top of the cartridge remains in place. If it comes away then replace it before continuing. If there are any visible bubbles in the electrolyte, remove them using a stirring motion with the packing component.

   Note: *The recharge cartridge container will be colored black for all applications except for the 6110 TPA where it will be colored white.*

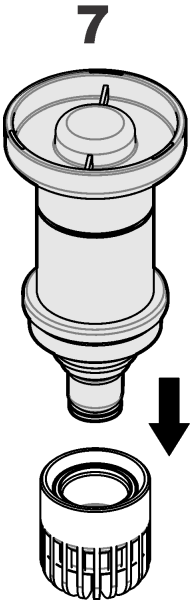


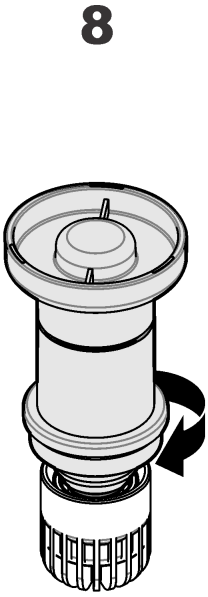


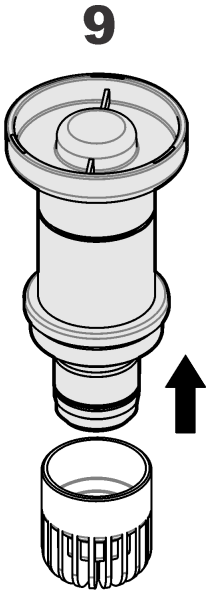


7. Hold the container steady between thumb and forefinger of one hand. Lower the sensor into the container until the top of the anode is covered with electrolyte. Leave for a few seconds to ensure the cotton washer has fully absorbed some of the electrolyte and that it is no longer dry.
8. Gently screw the sensor clockwise into the replacement cartridge, applying minimum pressure to avoid any damage to the screw threads.
9. Continue turning until the cartridge is attached to the sensor, and the sensor is automatically released from the container. The empty container, the screw top and packing component can be discarded.

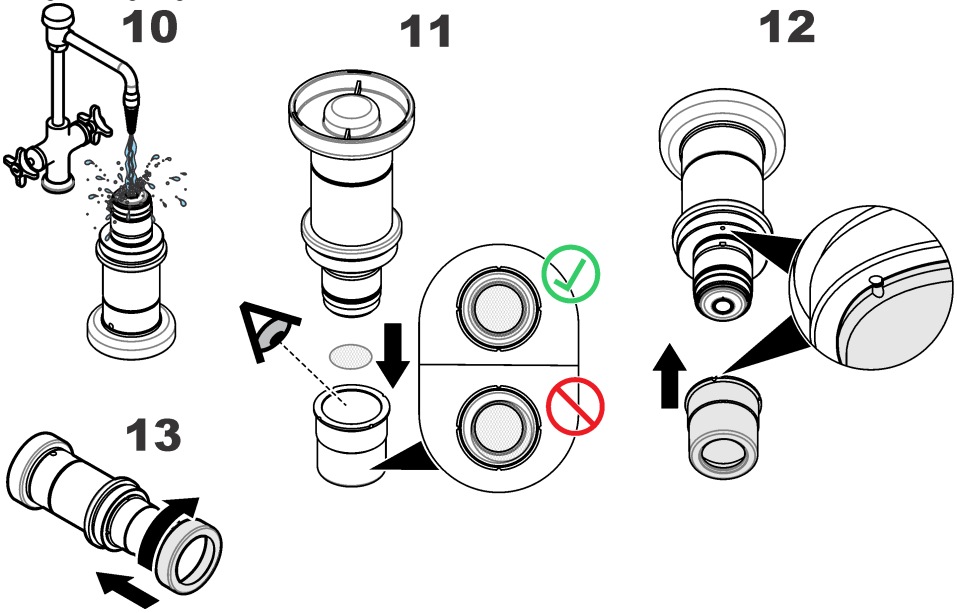
   Note: *It is normal that some of the electrolyte will overflow from the replacement cartridge and into the plastic container.*







10. Rinse the sensor under a tap for about 5 seconds to remove any excess electrolyte, then gently wipe with a soft tissue to ensure all parts are completely dry. Drain the overflow electrolyte from the container into a sink and flush away. Discard the used container.
11. If not using a protection cap with grille proceed to step 12. Otherwise take a new Dacron® mesh patch from the box of O-rings in the recharge kit. Place the mesh in the center of the protection cap. It is very important that the mesh is in the center of the protection cap and covering the entire grille. Lower the sensor onto the protection cap making sure not to disturb the mesh.
12. Push the protection cap firmly into place, making sure one of the four slots in the protection cap fits over the small locking pin (highlighted right). If it is necessary to turn the protection cap to fit over the locking pin, ensure you only turn it **clockwise** to avoid unscrewing the cartridge.
13. Finally, screw the protection cap locking washer back into place in a clockwise motion, and tighten finger tight.



3.2 Sensor installation

3.2.1 Sensor positioning information

Unless the sensor is part of the ORBISPHERE equipment that includes it, the sensor must be installed in an ORBISPHERE socket or flow chamber, that allows contact with the sample fluid to be analyzed.

The sensor and measuring instrument are connected by a cable and two 10-pin connectors. The standard sensor cable length is 3 meters though extension cables of up to 1000 meters are available. However, smart sensor technology is only available with distances of up to a maximum of 750 meters.

Note: *If the pressure sensor is used, the maximum cable length is 50 meters.*

Ensure that the sensor will be mounted:

- perpendicular to the pipe
- horizontal
- on a horizontal pipe section (or on flow-ascending vertical pipe)
- minimum of 15 meters away from the pump's discharge side
- in a place where the sample flow is stable and rapid, and as far as possible from:

- valves
- pipe bends
- the suction side of any pumps
- a CO_2 injection system or similar

Note: *There may be situations where not all the above conditions can be met. If this is the case, or you have any concerns, please consult your Hach representative to appraise the situation and define the best applicable solution.*

3.2.2 Sensor insertion

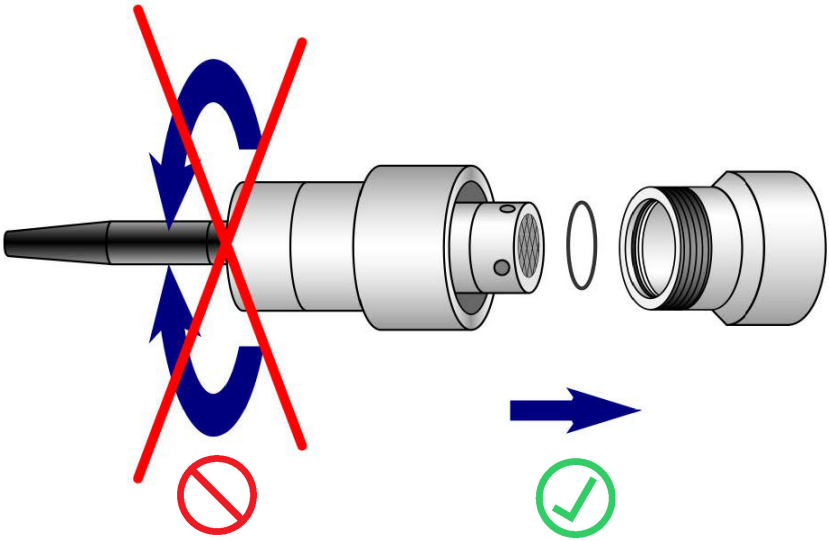
Note: *Check that the small O-ring at the bottom of the flow chamber is present during removal and installation of the sensor, as it may stick to the sensor head and fall.*

- Insert the sensor straight into the flow chamber or socket.
- Hand tighten the attaching collar.
- Connect the sensor cable.
- Check for leaks; replace O-rings if product leaks are visible.

Refer to Figure 4 for sensor installation into a micro volume flow chamber

Note: *Do not twist the sensor when inserting it into a micro volume flow chamber. This rotation may twist the membrane holding ring, thus changing the membrane position. This can modify the membrane measuring conditions, and affect measurement precision.*

Figure 4 Micro volume flow chamber



3.2.3 Sensor removal

- Shut off the sample flow and drain the sampling circuit of liquid or gas.
- Remove the sensor cable connected at the sensor end.
- Hold the sensor body in one hand to avoid rotation and unscrew the collar with the other hand.
- Pull the sensor straight out of the socket or flow chamber.
- Check that both O-rings remain in place inside the flow chambers.
- Install the sensor storage cap and sensor base (to protect the connection).

3.3 Accessories installation

3.3.1 External pressure sensor

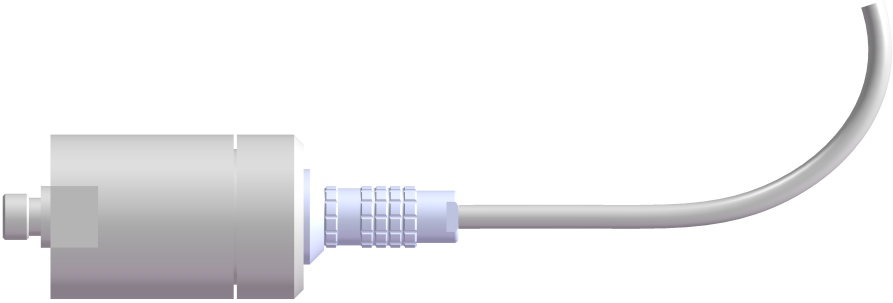
The system can be fitted with an external pressure sensor. This enables a measurement of fraction of gas under variable pressure conditions during gas phase measurement.

Note: *Do NOT exceed the pressure range of the sensor. This would permanently deform the sensor membrane, thus delivering incorrect pressure values in the future.*

The external sensor connects to the ORBISPHERE measuring equipment with a 1 meter cable and a 4 pin connector (an optional extension cable can be used, but total length should not exceed 50 m.).

The external pressure sensor can be installed in the 32002.xxx multi parameter flow chamber with the pressure sensor. Refer to Figure 5.

Figure 5 External pressure sensor



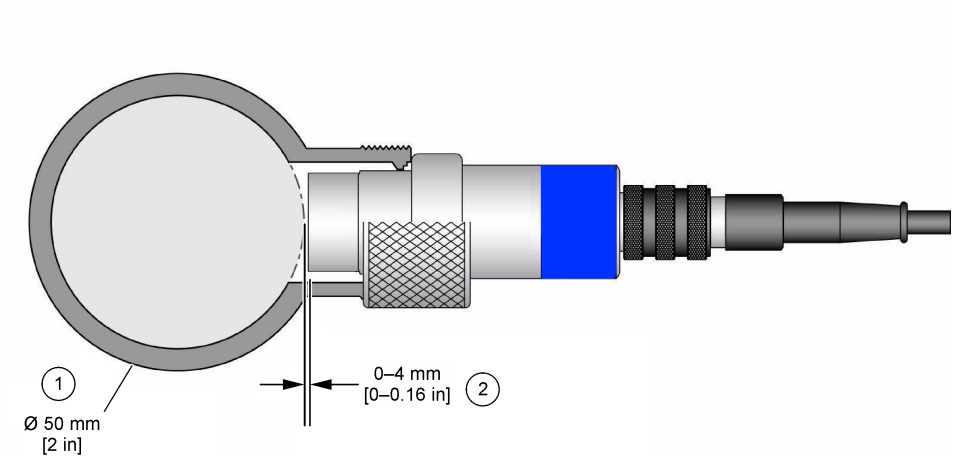
3.3.2 Weld-on stainless steel socket

The 29501 weld-on sensor socket can be used to install a sensor into a stainless steel pipe (min.Ø 50 mm or 2”). When welding the socket to the pipe, check that setback between the pipe’s inner diameter and the sensor tip does not exceed 4 mm. Refer to Figure 6.

Note: *Be sure to remove the two O-rings from the socket before welding and leave the sensor’s stainless steel cap screwed on during welding to prevent thread distortion.*

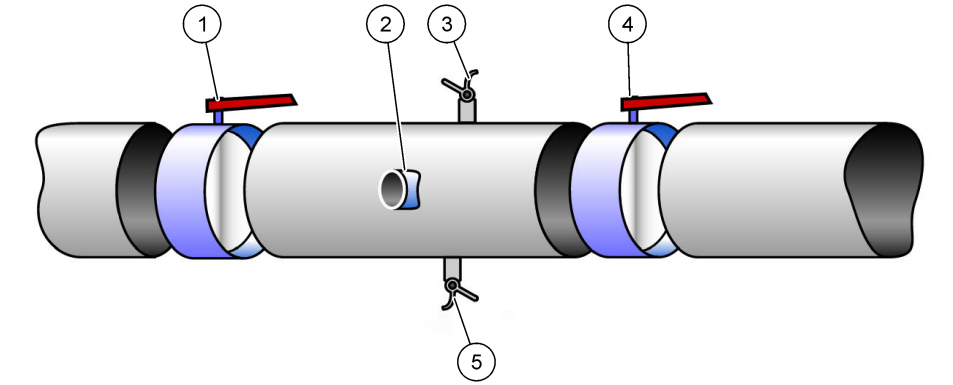
Recommendation: To facilitate sensor removal and installation, we suggest installing the socket in a location where the liquid can be drained quickly and easily. By creating a one meter long piece of pipe (shown below) with shut off valves at both ends, just a small volume of liquid needs to be drained to enable sensor removal. Also, a precise sensor and socket installation can be performed in the workshop, and this assembly can be placed in the production line with minimal down time. Refer to Figure 7.

Figure 6 Weld-on sensor socket



1 Pipe diameter	**2** Setback allowed from internal pipe diameter

Figure 7 Installation in-line



1 Shut off valve	**4** Shut off valve
2 Sensor socket	**5** Sampling valve
3 Sampling valve	

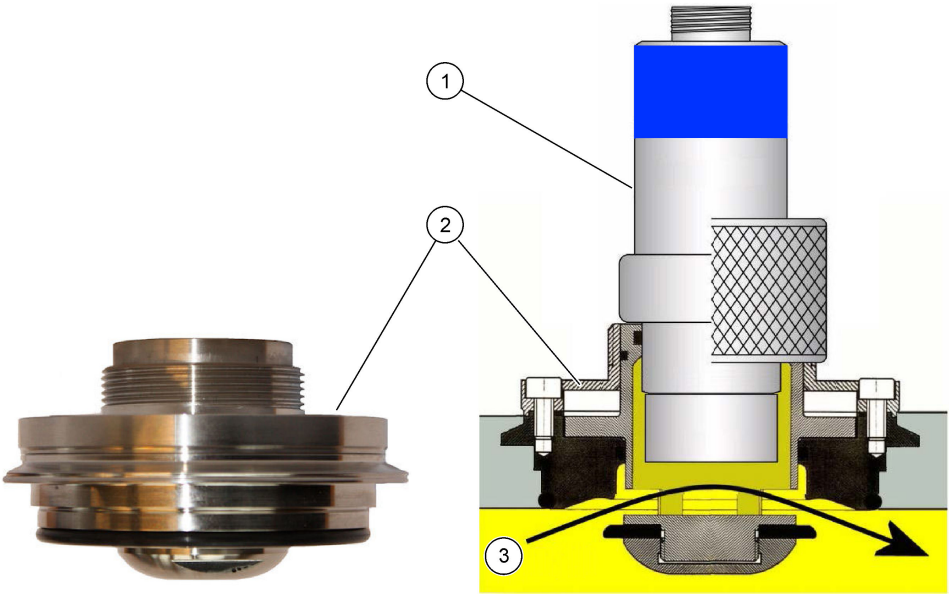
3.3.3 The 32003 insertion/extraction valve

The ORBISPHERE 32003 insertion/extraction valve allows for sensor removal and installation without having to drain the fluid in the line. It can withstand a pressure of up to 20 bars, with the sensor in place or not. Refer to Figure 8.

Sensor insertion is made by inserting the sensor into the housing and tightening the retaining collar until it stops. As the retaining collar is tightened, the valve will open to allow the sample to flow past the sensor head. Remove the sensor by unscrewing the collar and pulling the sensor out. As the collar is unscrewed, the valve will automatically close to avoid any sample spillage.

The diagram above right, shows the sensor in a sample line with the valve open allowing the sample to run past the sensor head.

Figure 8 ORBISPHERE model 32003 insertion/extraction valve



1 Sensor	**3** Sample flow
2 Valve	

3.3.4 The 33095 sensor housing

The ORBISPHERE 33095 sensor housing is also available for use with the GA2X00 sensor but requires that the sample flow be turned off prior to insertion or removal of the sensor.

Sensor insertion is made by inserting the sensor into the housing and tightening the retaining collar until it stops. Removal is made by unscrewing the collar and pulling the sensor out. Be sure that the sample flow has been turned off before inserting or removing the sensor.

3.3.5 Tuchenhagen Varivent® in-line access unit

Purchasing a Tuchenhagen Varivent in-line access unit, or an equivalent fitting with a 68 mm flange diameter from the fitting manufacturer, is required to make use of the ORBISPHERE model 32003 sensor housing device. Refer to Figure 9.

Figure 9 Tuchenhagen Varivent in-line access unit



3.3.6 ORBISPHERE flow chambers

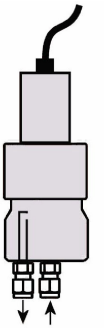
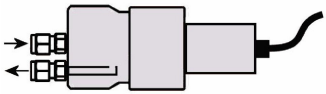
The ORBISPHERE 32001.xxx flow chambers are used to draw liquid and gaseous samples past the sensor. They are available in several materials, depending on the application. Refer to Table 7 and Figure 10.

They connect to 6-mm or ¼" stainless steel tubing by means of two Swagelok™ fittings. If necessary, copper or plastic tubing with low permeability can be substituted. Stainless steel tubing is normally enough to hold the assembly in place, but for a more stable installation, a large U-bolt can be used to mount the flow chamber to a support.

The dimensions of the sensor and flow chamber assembly are:

- Width: 50 mm (1.97 in.)
- Height: 210 mm (8.27 in.) (add 100 mm (3.94 in.) for connection length)

Table 7 Flow Chamber Orientation

Sample	Orientation of flow chamber	
Gaseous or liquid media	Vertically, with connections down and sensor up • Center connection is the inlet • Outer connection is the outlet	
Gaseous media, with occasional liquid or vapor	Horizontally, to allow for drainage • Center connection (inlet) must be up • Outer connection (outlet) must be down	

The connection diagram below is a recommended installation that allows for measuring and calibrating without having to disconnect a line manually. "A" and "B" represent 3-way valves.

For measuring, calibration gas inlets and outlets are shut off. During calibration, the flow is reversed to drive the remaining sample out. The calibration gas enters at the "sample out" port and exits at the "sample in" port. Refer to Figure 11.

Figure 10 ORBISPHERE flow chamber

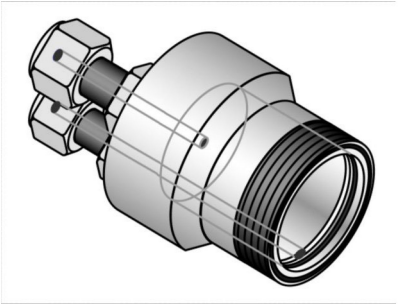
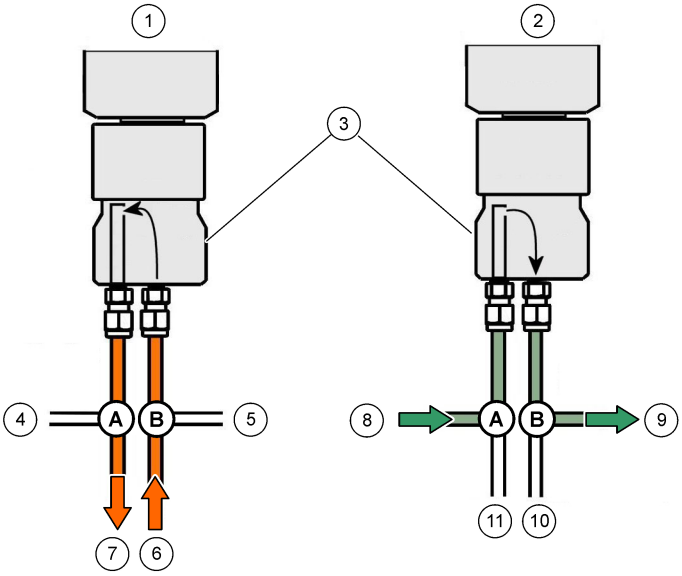


Figure 11 Flow chamber connections



1 Measuring	**7** Sample flow out
2 Calibration	**8** Calibration gas in
3 Sensor	**9** Calibration gas out
4 Calibration gas in shut off	**10** Sample flow in shut off
5 Calibration gas out shut off	**11** Sample flow out shut off
6 Sample flow in	

3.3.7 Multi-parameter flow chamber

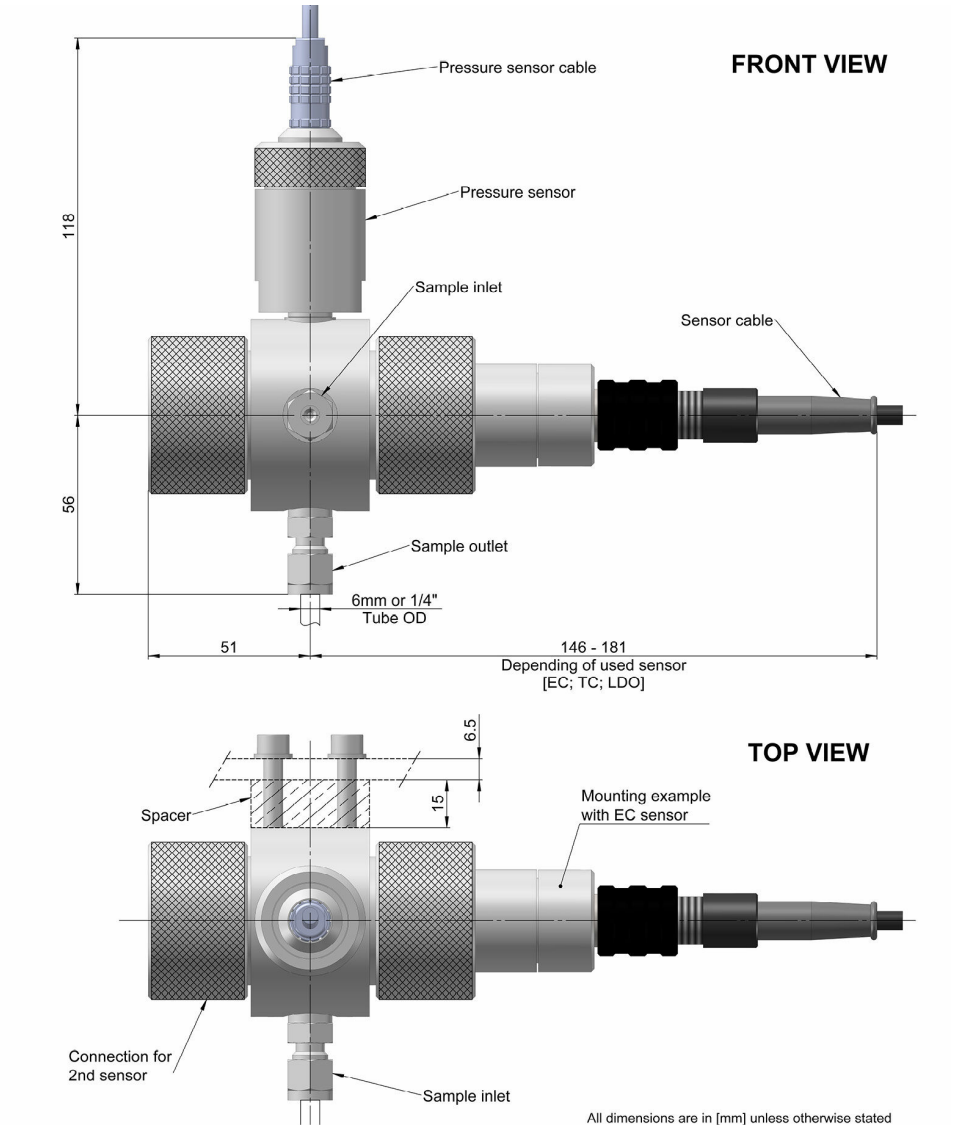
The ORBISPHERE 32002.xxx multi parameter flow chamber can accommodate one or two sensors and one sample pressure sensor. If only one gas sensor is used, the unused socket is plugged with the stainless steel plugs provided (model 28123). The flow chamber is connected to 6 mm or ¼" stainless steel tubing by two Swagelok™ fittings. If necessary, copper or plastic tubing with a very low permeability can be substituted. Refer to Figure 12.

Note: *The multi-parameter flow chamber is suitable only for gaseous media.*

The flow chamber should be mounted in such a way that the sample outlet port is located at the lowest point to allow condensation to escape with the outgoing gas. Attach the flow chamber to a vertical support with the screws supplied. The pressure sensor must be on top.

Note: *A user manufactured spacer (~15 mm thick) may be used between the flow chamber and support for improved access for sensor removal.*

Figure 12 Multi-parameter flow chamber



Section 4 Maintenance

⚠WARNING

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

4.1 Maintenance schedule

The following table shows the recommended schedule for membrane replacement. The table should only be used as a guideline, as maintenance intervals will vary depending on a number of different parameters (e.g. water chemistry, CIP frequency, oxygen levels, sample temperature, etc.).

Application	Membrane type	Membrane replacement
Water applications (> 10 ppb)	2956A	Every 3 to 6 months
Pure water applications (power and electronics < 10 ppb)	2956A	Every 3 to 6 months
Beer in-line	2952A	Every 3 to 6 months
Portable or lab applications	2952A or 2958A	Every 3 to 6 months
Wort in-line	29552A or 2995A	Every 1 or 2 months

4.2 Prerequisites for sensor maintenance

The following table lists the prerequisites for a sensor maintenance:

Part No.	Description
2959	Electrolyte for oxygen sensors, 50-mL bottle.
29781	Cathode polishing powder (part no.29331) and cloth (part no. 2934).
32301	Electrochemical cleaning and regeneration center (see below)
40089	Tweezers, for maintenance kits
DG33303	Cleaning tool for sensor polishing for A110X and C1100 sensors only
DG33629	Cleaning tool for sensor polishing for GA2X00 sensors only
DG33619	Regeneration Cell for GA2X00/A1100 or C1100 sensors
DG33620	Orbisphere EC sensor support for cleaning

Note: *If the sensor is being used in a high level hydrogen sample, this cleaning and regeneration center is* ***not required****. In all other cases it is a* ***prerequisite****.*

The ORBISPHERE 32301 is a very efficient cleaning and regeneration tool for electrochemical sensors. Refer to Figure 13. This tool reverses the electrochemical process that is taking place in the sensor cell during normal operation. This removes oxidation and at the same time regenerates the surface of the electrodes. In addition, the regeneration center offers a continuity tester for checking the sensor electronics.

Figure 13 ORBISPHERE 32301 cleaning and regeneration tool



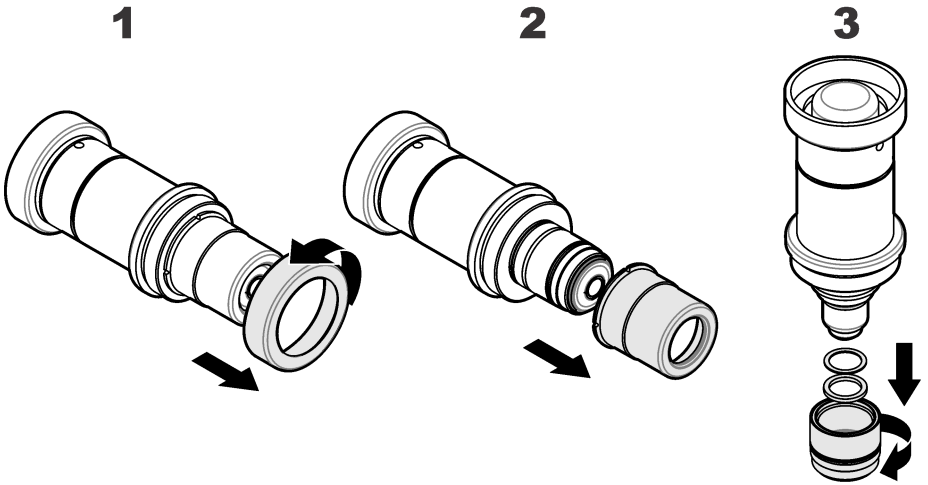
4.3 Membrane replacement and sensor head cleaning

⚠ CAUTION

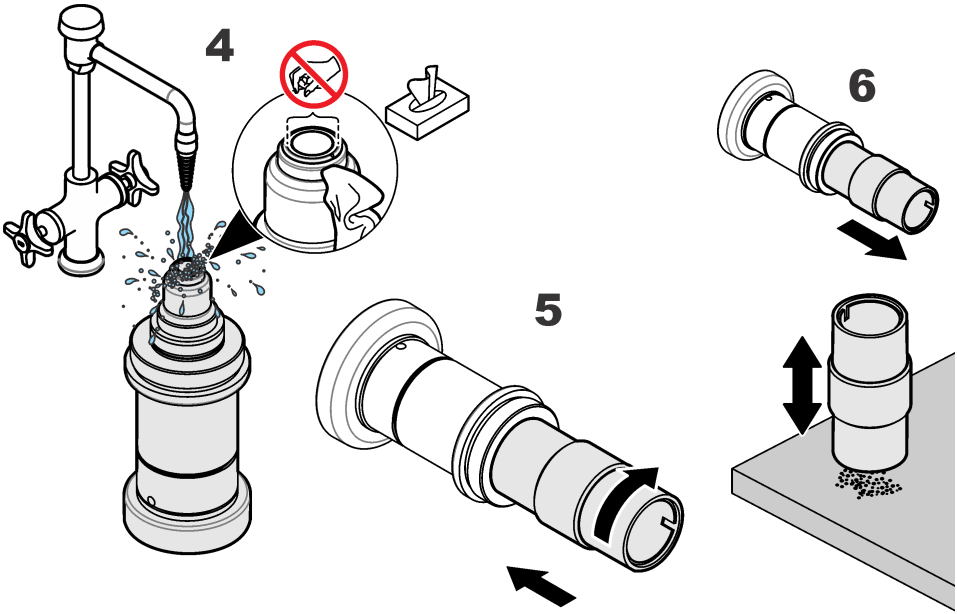
Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current safety data sheets (MSDS/SDS) for safety protocols.

A sensor recharge kit is required as it contains all the components necessary for this membrane replacement and sensor head cleaning process. Refer to Sensor recharge kit on page 9.
Note: *It is advisable to perform this procedure with the plastic sensor base installed so as to avoid any damage to the connection socket and also to provide a suitable stand for the sensor when required.*

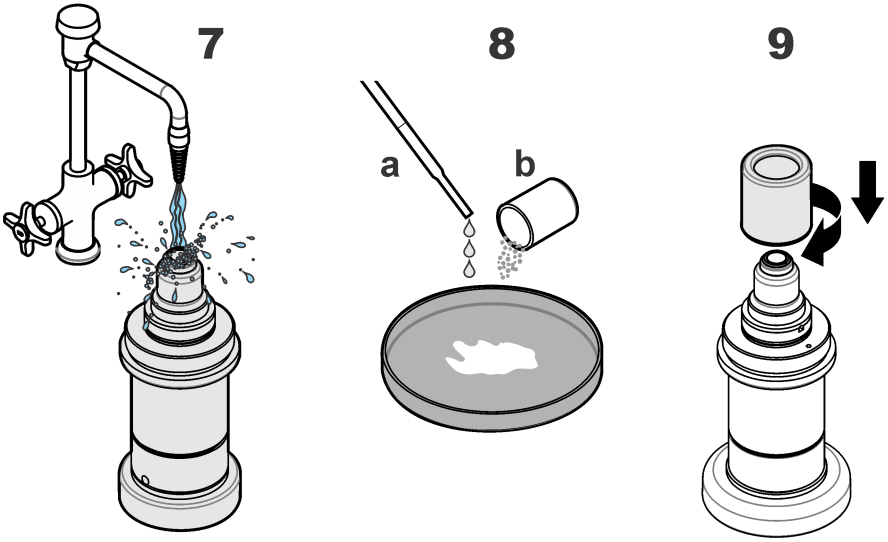
1. Hold the main body of the sensor and unscrew the protection cap locking washer by turning counter-clockwise. Remove it from the sensor and put to one side.
2. Pull/twist off the protection cap and put to one side. If you are using a protection cap with a grille, then remove the Dacron® mesh from inside the cap and discard it.
3. Hold the sensor with the membrane facing down to avoid spilling any electrolyte, then carefully unscrew the old cartridge. Drain the old electrolyte into a sink and flush away. Discard the old cartridge and membrane. Remove the cotton washer and silicone disc from the top of the anode and discard.



4. Rinse the sensor head under a tap for 15 seconds to remove any remaining electrolyte and shake dry. With a soft tissue gently clean around the guard area (indicated right) and then wipe off any excess moisture from the sensor to ensure all parts are completely dry. Repeat this rinse and dry process with the protection cap.
5. Clean the anode using the cleaning tool supplied. Place the tool over the sensor head. Clean by rotating the cleaning tool over the sensor head for a few seconds, **in a clockwise direction only**.
6. Remove the tool and tap it face down on a flat work surface to remove any powdery deposit. Check the sensor to ensure that all deposits have been removed from the anode. If not, repeat step 5. until the anode regains its bright silver appearance.



7. Rinse the sensor head under a tap for 15 seconds, aiming the jet of water directly onto the sensor head. Do not dry the center electrode area, as the gap between cathode and guard should be left filled with water.
8. On the clean polishing cloth (2934) do the steps that follow:
   a. Add a few drops of water.
   b. Spread a little of the polishing powder (29331) to form a grey, milky liquid.
9. Screw the polishing tool (DG33629) onto the top of the sensor.

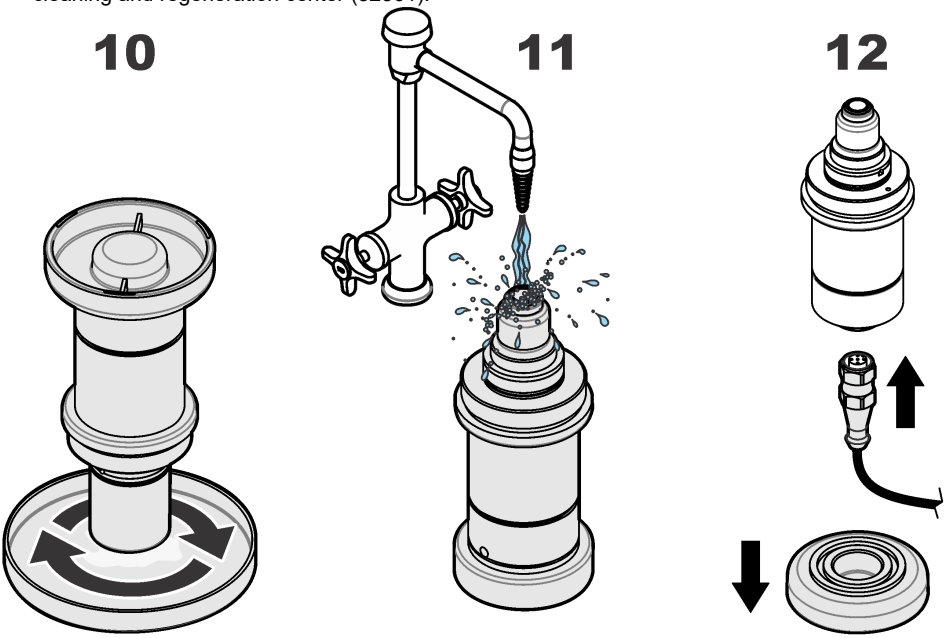


10. Polish the electrodes by moving the sensor face in a circular direction against the liquid in the polishing cloth for about 30 seconds.

11. Remove the polishing tool from the sensor. Remove any polish deposits by rinsing the sensor head under a tap for 30 seconds, aiming the jet of water directly onto the sensor head.

Note: *If the sensor is used in high level hydrogen sample, do not perform the following steps but continue at step 19.*

12. Remove the plastic base from the bottom of the sensor and connect the sensor to the sensor cleaning and regeneration center (32301).



13. Push the cleaning tool over the sensor head. Pour enough electrolyte (2959) into the cleaning tool until it completely covers all the electrodes.

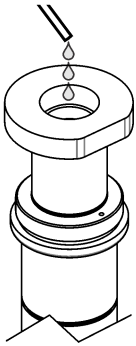
Note: *For DG33619 regeneration cell, screw the regeneration cell on the sensor head.*

14. On the sensor cleaning and regeneration center, turn the knob to the **Anode** position and press the **TIMER** switch. A red warning light will come on and remain on for 60 seconds while cleaning takes place.

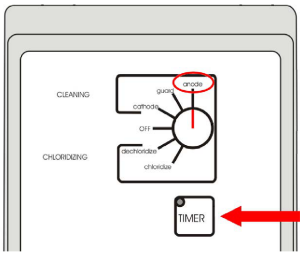
15. At the end of the 60 second cleaning process, check for an abundant stream of bubbles that should rise from the anode. If this does not happen, press **TIMER** again.

Note: *The development of bubbles is a sure sign of a clean electrode.*

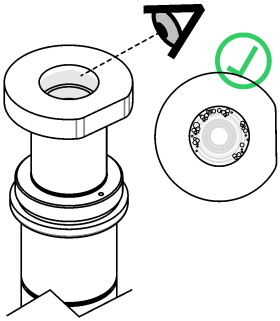
13



14



15



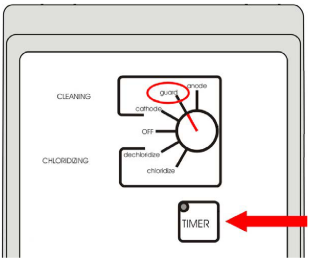
16. On the sensor cleaning and regeneration center, turn the knob to the **Guard** position and press the **TIMER** switch. Again, watch for the formation of bubbles and repeat the cleaning process if necessary.

17. On the sensor cleaning and regeneration center, turn the knob to the **Cathode** position and press the **TIMER** switch. Again, watch for the formation of bubbles and repeat the cleaning process if necessary.

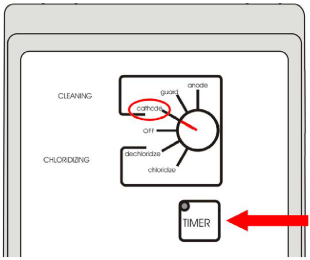
18. When cleaning is complete, unplug the sensor from the cleaning center and re-install the plastic sensor base for the rest of the procedure. Remove any remaining electrolyte by rinsing the sensor head under a tap for 60 seconds, aiming the jet of water directly onto the sensor head.

Note: *For DG33619 regeneration cell, unscrew the regeneration cell from the sensor head.*

16



17



18



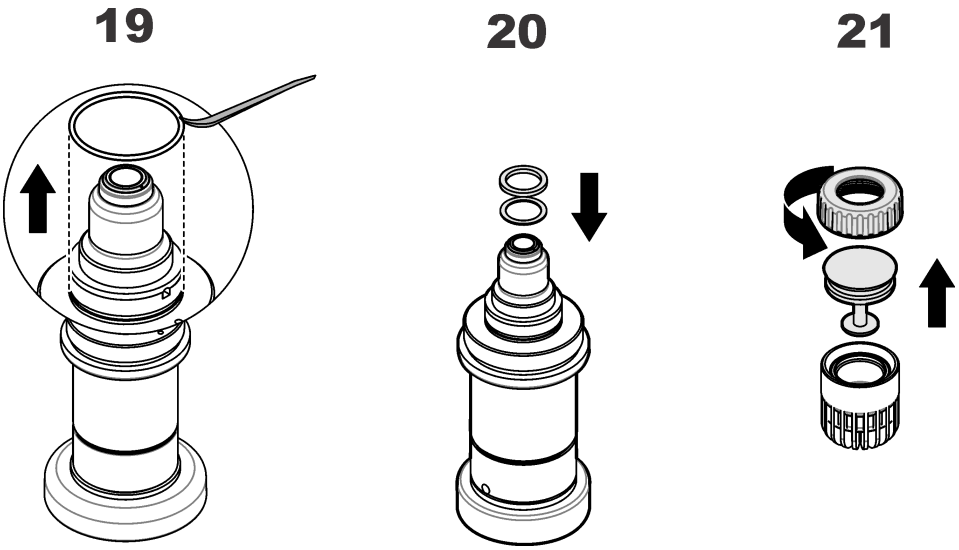
19. With the help of a pair of tweezers, remove the old O-ring from the sensor body. Replace the O-ring with a new one from the recharge kit.

20. Take a silicone disc from the recharge kit, hold it between thumb and forefinger and position it on top of the anode. Take a new cotton washer from the recharge kit. Hold it between thumb and forefinger and position it on top of the silicone disc.

Note: *During this step, it is very important to ensure your finger does not come into contact with the cathode (golden surface) as it could leave greasy deposits on the surface.*

21. Place the recharge cartridge container on a flat work surface and, keeping the container upright to avoid spilling any of the electrolyte inside, carefully unscrew the top. Remove the packing component from the center of the cartridge, and make sure that the O-ring remains in place on top of the cartridge. If it comes away then replace it before continuing. If there are any visible bubbles in the electrolyte, remove them using a stirring motion with the packing component.

Note: *The recharge cartridge container will be colored black for all applications except for the 6110 TPA where it will be colored white.*

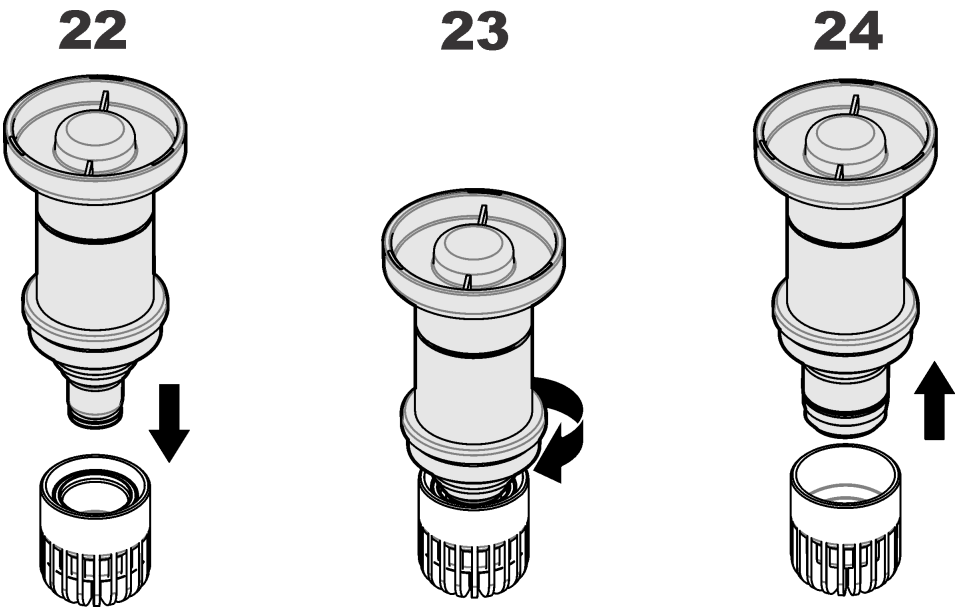


22. Hold the container steady between thumb and forefinger of one hand. Lower the sensor into the container until the top of the anode is covered with electrolyte. Leave for a few seconds to ensure the cotton washer has fully absorbed some of the electrolyte and that it is no longer dry.

23. Gently screw the sensor clockwise into the replacement cartridge, applying minimum pressure to avoid any damage to the screw threads.

24. Continue turning until the cartridge is attached to the sensor, and the sensor is automatically released from the container. The empty container, the screw top and packing component can be discarded.

Note: *It is normal that some of the electrolyte will overflow from the replacement cartridge and into the plastic container.*

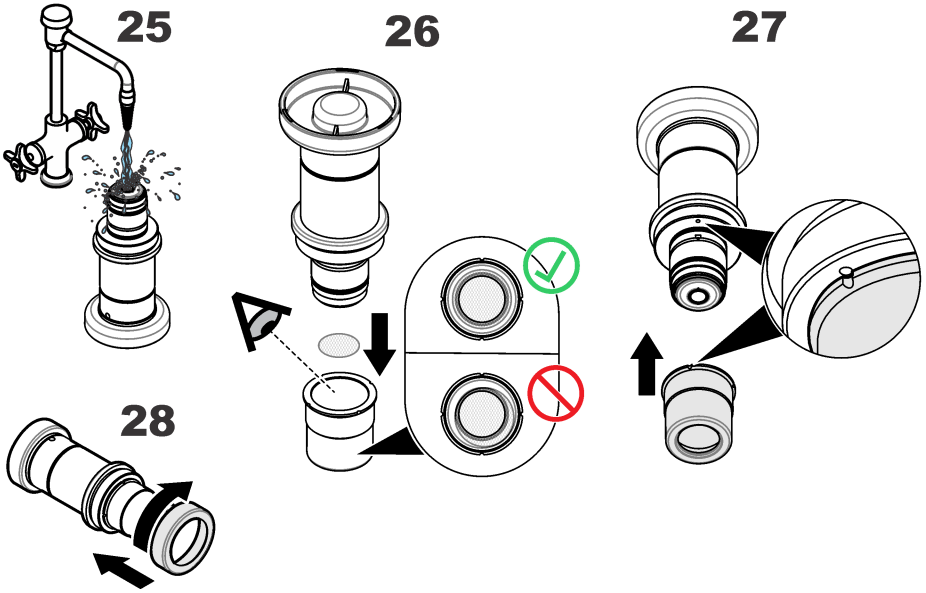


25. Rinse the sensor under a tap for about 5 seconds to remove any excess electrolyte, then gently wipe with a soft tissue to ensure all parts are completely dry. Drain the overflow electrolyte from the container into a sink and flush away. Discard the used container.

26. If not using a protection cap with grille proceed to step 27. Otherwise, take a new Dacron® mesh patch from the box of O-rings in the recharge kit. Place the mesh in the center of the protection cap. It is very important that the mesh is in the center of the protection cap and covering the entire grille. Lower the sensor onto the protection cap making sure not to disturb the mesh.

27. Push the protection cap firmly into place, making sure one of the four slots in the protection cap fits over the small locking pin (highlighted right). If it is necessary to turn the protection cap to fit over the locking pin, ensure you only turn it **clockwise** to avoid unscrewing the cartridge.

28. Finally, screw the protection cap locking washer back into place in a clockwise motion, and tighten finger tight.



4.4 Activation of the anode

In this process the central electrode (anode) is polished, and then treated with concentrated nitric acid.

⚠ CAUTION

Do not to put acid on the newly chloridized cathode.

1. Follow the sensor face polishing instructions described in the sensor operator manual supplied with the sensor.
2. Install the membrane support, finger tight, using the sensor mounting tool. Make sure the smooth side with a groove faces out when installed.
3. Fill the sensor reservoir with water. This helps protect the new silver chloride layer in case any nitric acid leaks into the reservoir.
4. Place a drop at a time of concentrated (approximately 70% by weight) nitric acid on the center of the anode. Allow the acid to spread to the surrounding guard electrode. It is recommended to leave the acid on the anode for about 30 seconds.
5. Wash off the acid, and repeat the procedure (applying drops of nitric acid) two more times.
6. Wash the sensor thoroughly with distilled water.

Section 5 Troubleshooting

5.1 Oxygen sensor

Problem	Probable cause	Possible solution
Sensor won't calibrate, even after cleaning and/or membrane change.	Instrument internal barometric pressure sensor needs calibration.	Calibrate using a certified barometer. Do not correct for sea level !
	Wet membrane interface.	Wipe dry with a tissue and re-calibrate.
	"H_2S insensitivity" option enabled.	Disable from the menu on the measuring instrument.
"0000" O_2 levels displayed.	Wrong reading scale "XXXX" selected for display unit.	Change reading scale by selecting "X.XXX, XX.XX or XXX.X" on the instrument.
Shorter than expected sensor operation in relatively high dissolved O_2 concentration.	High O_2 concentrations generate deposits more quickly.	Install a less permeable membrane. Turn off the analyzer when sensor is not in a low O_2 concentration.
Unexpected or inaccurate dissolved O_2 readings.	Air leak on product sample line.	Set flow rate to 100 mL/min. Wait until stable, then slowly double the flow rate. The stable value of dissolved O_2 reading must be the same as before. A variation related to flow rate is a clear sign of an air leak in the line.
	High residual current.	Place sensor in de-aerated sample and wait for low reading. Check concentration against low measurement limit (refer to Sensor membrane specifications on page 4). If concentration is significantly higher than low limit, try replacing the membrane.
Calibration is out of specification or response time is too slow.	Sensor incorrectly setup.	Check the sensor parameters on the instrument. Re-calibrate the sensor.
	Temperature measurement incorrect.	Control the temperature with an external reference. Re-calibrate the sensor.
	Barometric pressure incorrect.	Calibrate the barometric pressure sensor using the instrument. Re-calibrate the sensor.
	Cartridge incorrectly assembled on sensor.	Verify the cartridge assembly is firmly screwed onto the sensor and that the membrane is tight. Re-calibrate the sensor.
	Sensor electrodes are dirty.	Clean the sensor using the ORBISPHERE 32301 cleaning and regeneration center as explained in this section. Re-calibrate the sensor.
	Sensor maintenance is required.	Replace the membrane by installing a new sensor cartridge as explained in this section. Re-calibrate the sensor.

Section 6 Replacement parts and accessories

⚠ WARNING



Personal injury hazard. Use of non-approved parts may cause personal injury, damage to the instrument or equipment malfunction. The replacement parts in this section are approved by the manufacturer.

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Accessories

Description	Quantity	Item no.
Pressure sensor 0–50 PSIA / 0–3.5 bar absolute	each	DG33647
Pressure sensor 0–300 PSIA / 0–20 bar absolute	each	DG33650

Flow chambers and installation devices

Description	Item no.
Sensor socket for welding to SS pipe, with EPDM O-ring.	29501.0
Sensor socket for welding to SS pipe, with Viton O-ring.	29501.1
Flow chamber in stainless steel with 6-mm fittings. External pressure sensor (DG33647) 0-50 PSIA / 0-3.5 bar absolute included. EPDM O-rings included.	32001.010
Flow chamber in stainless steel with ¼-inch fittings. External pressure sensor (DG33647) 0-50 PSIA / 0-3.5 bar absolute included. EPDM O-rings included.	32001.011
Flow chamber in stainless steel (316) with 8 mm fittings. Supplied with EPDM O-rings.	32001.012
Flow chamber in Delrin with 6 mm fittings. Supplied with EPDM O-rings.	32001.030
Flow chamber in Delrin with ¼" fittings. Supplied with EPDM O-rings.	32001.031
Flow chamber in Hastelloy with 6 mm fittings. Supplied with EPDM O-rings.	32001.040
Flow chamber in Hastelloy with ¼" fittings. Supplied with EPDM O-rings.	32001.041
Flow chamber in Monel with 6 mm fittings. Supplied with EPDM O-rings.	32001.070
Flow chamber in Monel with ¼" fittings. Supplied with EPDM O-rings.	32001.071
Flow chamber in stainless steel (316) with 6 mm fittings. Supplied with Viton O-rings.	32001.110
Flow chamber in stainless steel (316) with ¼" fittings. Supplied with Viton O-rings.	32001.111
Flow chamber in Hastelloy with 6 mm fittings. Supplied with Viton O-rings.	32001.140
Flow chamber in Hastelloy with ¼" fittings. Supplied with Viton O-rings.	32001.141
Flow chamber in titanium with ¼" fittings (6 mm fittings not available in titanium) Supplied with Viton O-rings.	32001.151
Flow chamber in Monel with 6 mm fittings. Supplied with Viton O-rings.	32001.170
Flow chamber in Monel with ¼" fittings. Supplied with Viton O-rings.	32001.171
Flow chamber in Kynar with ¼" fittings. Supplied with Viton O-rings.	32001.181
Flow chamber in PTFE with ¼" fittings. Supplied with Viton O-rings.	32001.191

Flow chambers and installation devices (continued)

Description	Item no.
Multi parameter flow chamber in stainless steel with 6-mm fittings. External pressure sensor (DG33647) 0-50 PSIA / 0-3.5 bar absolute included. EPDM O-rings included.	32002.010
Multi parameter flow chamber in stainless steel with ¼-inch fittings. External pressure sensor (DG33647) 0-50 PSIA / 0-3.5 bar absolute included. EPDM O-rings included.	32002.011
Multi parameter flow chamber in stainless steel with 6-mm fittings. External pressure sensor (DG33650) 0-300 PSIA / 0-20 bar absolute included.	32002.020
Multi parameter flow chamber in stainless steel with ¼-inch fittings. External pressure sensor (DG33650) 0-300 PSIA / 0-20 bar absolute included.	32002.021
ProAcc sensor insertion device ; for use with Tuchenhagen adapter	32003GP
Flow chamber in Delrin for the 3655 portable instrument, with one meter of tubing.	32007D
Flow chamber in Delrin for the 3650 portable instrument. Includes check valve, 1 meter of inlet tubing, quarter turn flow valve, and outlet metal U-tube (6mm outside diameter).	32007F
Flow chamber in Delrin with 6 mm stainless steel Swagelok fittings for use with liquids with suspended particles. Supplied with EPDM O-rings.	32007W.030
Flow chamber in Delrin with ¼" stainless steel Swagelok fittings for use with liquids with suspended particles. Supplied with EPDM O-rings.	32007W.031
Flow chamber in acrylic with 1/8" Swagelok fittings for small volume liquid phase measurements.	32009
Flow chamber in acrylic with 1/8" Swagelok fittings for small volume liquid phase measurements, with port for 32562 external temperature sensor.	32011
Flow chamber used with 29981 Pharmapack. Must be ordered separately.	32017

Sensor replacement parts

Description	Item no.
GA2400 oxygen sensor, non-ATEX, stainless steel, maximum pressure 40 bar with default PPS collar (100 bar with 28104 stainless steel collar), with smart capability	GA2400-S00
GA2800 oxygen sensor, ATEX, stainless steel, viton o-rings, cap with grille	GA280E-SVS
GA2800 oxygen sensor, ATEX, stainless steel, kalrez o-rings, cap with grille	GA280E-SKS
GA2800 oxygen sensor, ATEX, hastelloy, viton o-rings, cap without grille	GA280E-HVS
GA2800 oxygen sensor, ATEX, hastelloy, kalrez o-rings, cap without grille	GA280E-HKS
Stainless steel sensor collar	28104
PPS sensor collar	28105
Delrin storage cap (sensor storage cap)	28129
Sensor support (base) for 31xxx, X110X and GA2X00 sensors	32205
Stainless steel 28mm cap for ORBISPHERE GA2X00 family EC sensors (without grille)	33051-S0
Stainless steel 28mm cap with grille for ORBISPHERE GA2X00 family EC sensors. For use in beer or soft-drinks processes and ATEX configurations.	33051-SG

Sensor replacement parts (continued)

Description	Item no.
Stainless steel 28mm cap with grille for ORBISPHERE GA2X00 family EC sensors. For use with 3625 package analyzer and 3650 instrument when measuring beer or soft-drinks.	33051-SP
Stainless steel cap with a 6 branch grille for ORBISPHERE GA2X00 family EC sensors. For use with 6110 Total Package Analyzer.	33051-ST
Hastelloy 28mm cap without grille for ORBISPHERE GA2X00 ATEX sensors.	33051-H0
Kit of 5 dacron mesh for protection cap with grille model 33051-SG or 33051-SP	33052

Recharge kits

Description	Item no.
Recharge kit of 4 pre-filled cartridges with premounted 2935A membranes for A1xxx and GA2x00 oxygen sensors. Includes o-rings, cotton washers and cleaning tools	2935A-A
Recharge kit of 4 pre-filled cartridges with premounted 29521A membranes for A1xxx oxygen sensors. Includes o-rings, cotton washers and cleaning tools	29521A-A
Recharge kit of 4 pre-filled cartridges with premounted 2952A membranes for A1xxx and GA2x00 oxygen sensors. Includes o-rings, cotton washers and cleaning tools	2952A-A
Recharge kit of 4 pre-filled cartridges with premounted 29552A membranes for A1xxx and GA2x00 oxygen sensors. Includes o-rings, cotton washers and cleaning tools	29552A-A
Recharge kit of 4 pre-filled cartridges with premounted 2956A membranes for A1xxx and GA2x00 oxygen sensors. Includes o-rings, cotton washers, silicone discs and cleaning tools	2956A-A
Recharge kit of 4 pre-filled cartridges with premounted 2956A membranes for A1xxx and GA2x00 oxygen sensors. Includes o-rings, cotton washers, silicone discs and cleaning tools. Special low concentrate electrolyte	2956A-A05
Recharge kit of 4 pre-filled cartridges with premounted 2958A membranes for A1xxx and GA2x00 oxygen sensors. Includes o-rings, cotton washers and cleaning tools	2958A-A
Recharge kit of 4 pre-filled cartridges with premounted 2995A membranes for A1xxx and GA2x00 oxygen sensors. Includes o-rings, cotton washers and cleaning tools	2995A-A
Recharge kit of 4 pre-filled cartridges with premounted 2956A membranes for A1xxx and GA2x00 oxygen sensors. Includes viton o-rings, cotton washers, silicone discs and cleaning tools	2956A-AV
Recharge kit of 4 pre-filled cartridges with premounted 2956A membranes for A1xxx and GA2x00 oxygen sensors. Includes kalrez o-rings, cotton washers, silicone discs and cleaning tools	2956A-AK
For 6110 TPA. Recharge kit of 4 pre-filled cartridges with premounted 2956A membranes for A1xxx and GA2x00 oxygen sensors. Includes o-rings, cotton washers, silicone discs and cleaning tools	2956A-AT
For 6110 TPA. Recharge kit of 4 pre-filled cartridges with premounted 2956A membranes for A1xxx and GA2x00 oxygen sensors. Includes o-rings, cotton washers, silicone discs and cleaning tools. Special low concentrate electrolyte	2956A-AT05
Recharge kit of 4 pre-filled cartridges with premounted 29552A membranes for A1xxx and GA2x00 oxygen sensors. Includes viton o-rings, cotton washers and cleaning tools	29552A-AV

Recharge kits (continued)

Description	Item no.
Recharge kit of 4 pre-filled cartridges with premounted 29552A membranes for A1xxx and GA2x00 oxygen sensors. Includes kalrez o-rings, cotton washers and cleaning tools	29552A-AK
Recharge kit of 4 pre-filled cartridges with premounted 29552A membranes for A1xxx and GA2x00 oxygen sensors.	29552A-AG

Other accessories

Description	Item no.
EPDM O-ring set for standard flow chambers (32001, 32002, 32007, 32009) and 29501 sensor socket. (34x2mm & 28x2 mm).	29006.0
Viton O-ring set for standard flow chambers (32001, 32002, 32007, 32009) and 29501 sensor socket. (34x2 mm & 28x2 mm).	29006.1
Kalrez O-ring set for standard flow chambers (32001, 32002, 32007, 32009) and 29501 sensor socket. (34x2 mm & 28x2 mm).	29006.2
Nitril O-ring set for standard flow chambers (32001, 32002, 32007, 32009) and 29501 sensor socket. (34 x 2 mm & 28 x 2 mm).	29006.4
Electrolyte for oxygen sensors, 50 ml. bottle. (EU)	2959H
Electrolyte for oxygen sensors, 50 ml. bottle. (US)	2959GP
Cathode polishing powder (part no.29331) and cloth (part no. 2934).	29781
Electrochemical cleaning and regeneration center	32301
Tweezers, for maintenance kits	40089
Cleaning tool for sensor polishing, for A110X and C1100 sensors only	DG33303
Cleaning tool for sensor polishing, for GA2X00 sensors only	DG33629
Regeneration Cell for GA2X00/A110X or C1100 sensors	DG33619
Orbisphere EC sensor support for cleaning	DG33620
Special tools for 31xxx	GD33264
Smart chip kit	33109



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