Operator's manual | 32301

Sensor cleaning &

regeneration center

32301OM E0312

swiss made

orbisphere
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p 1 of 24

Table of contents

2 of 24

3 of 24

1 Introduction

1.1 About this manual

The information in this manual has been carefully checked and is believed to be accurate. However, Hach Ultra Analytics assumes no responsibility for any inaccuracies that may be contained in this manual. In no event will Hach Ultra Analytics be liable for direct, indirect, special, incidental, or consequential damages resulting from any defect or omission in this manual, even if advised of the possibility of such damages.

In the interest of continued product development, Hach Ultra Analytics reserves the right to make improvements in this manual and the products it describes at any time, without notice or obligation.

1.2 Warranty information

All Orbisphere systems are warranted against defective materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing products of our manufacture which prove to be defective during the warranty period and which are returned to the factory, transportation charges prepaid. We are not liable for consequential charges. In case of components not of our manufacture, we grant only such warranty as we may receive from our suppliers.

Repairs inside a Sensor or Indicating Instrument must be performed by Orbisphere or its representatives. The above warranty may therefore be rendered null and void in the event of unauthorized opening. We reserve the right to make improvements to our products at any time without incurring any liability to purchasers of earlier models.

1.3 What you have received

a) The center and the manual

The model 32301 Sensor Cleaning and Regeneration Center is a multi-purpose device for Orbisphere's Electrochemical (EC) Sensors used to measure oxygen, hydrogen and ozone.

The 32301 performs two important functions:

- It offers a rapid and efficient method for cleaning sensor electrodes and, in the case of hydrogen sensors, a method of cathode rechloridization, or regeneration.
- It allows a simple check to be done on the circuitry of most Orbisphere sensors so you can be sure that the sensor is working correctly or, alternatively, so you can trace a fault.

These functions are treated separately in this manual. “Sensor cleaning function” on page 7 deals with the cleaning functions and “Circuit testing functions” on page 17 with the circuit testing functions.

b) Visual inspection

The Sensor Cleaning and Regeneration Center consists of two parts - the **Instrument** itself with its cleaning/chloridizing knob, sockets and switch, plus a **Regeneration Cell** made of black and white plastic with an attached red plastic-covered electric wire ending in a red banana plug.

4 of 24

Note :
Two additional banana plugs are supplied - one red, one black - to connect to your ohmmeter leads should they need to be adapted for use with the instrument when testing circuits.

Finally, if you are using an analyzer with a miniature oxygen sensor, your system should include a white plastic adapter which will permit you to use the regeneration cell with the smaller sensor head.

Two electric cables enter through the rear panel, one ending in the power plug and the other in a 10-pin LEMO plug. Electric power is required for the cleaning functions of the instrument. It is configured at the factory for either a 110 V or a 220 V power supply. Please check to see that the right voltage has been specified for your needs. Electric power is not needed for the test functions.

The cable ending in a 10-pin LEMO plug is used to connect the 32301 to a sensor for cleaning and circuit testing. Note that the sensor 10-pin LEMO receptacle on the panel fulfills the same function. In the case of sensors with detachable cables (i.e., 31000 series Sensors) you may use the 32301's cable, leaving your sensor cable in place, attached to your Instrument if necessary. For other sensors that do not have detachable cables, you may plug in the attached cable to the 32301's sensor receptacle.

The top panel is arranged as illustrated in "Model 32301 Instrument" on page 4. It

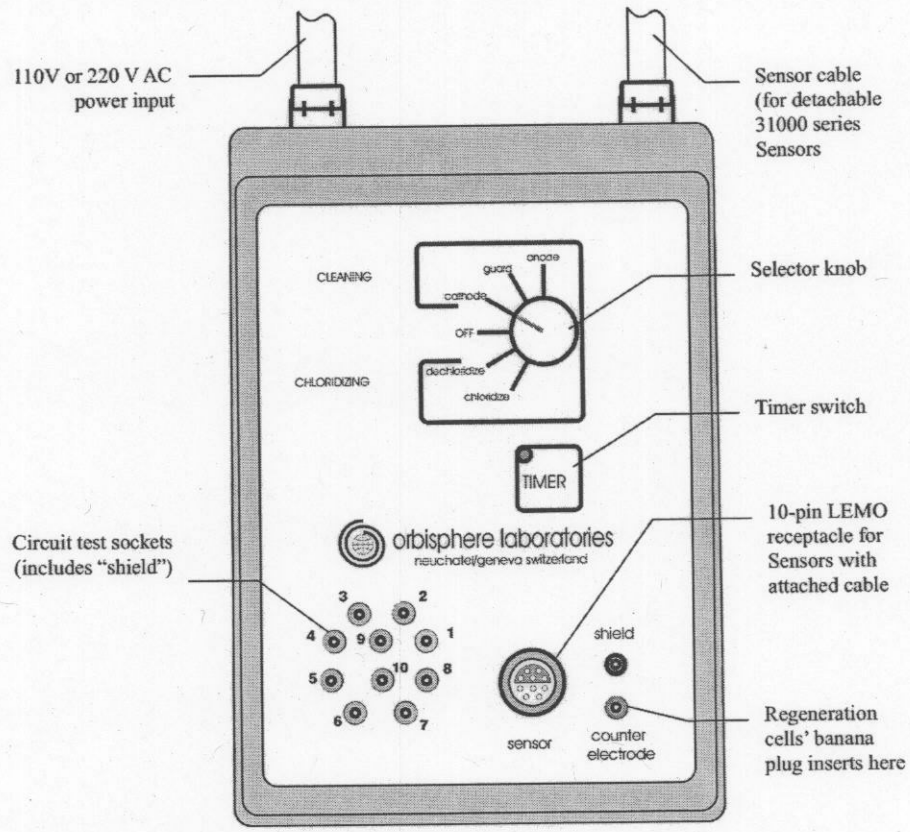

Fig 1 : Model 32301 Instrument

contains a **timer switch**, a **selector knob** and a **counter electrode socket**. The timer switch activates the cleaning function by sending a current through the sensor cell. After 60 seconds this cleaning current automatically switches off. The selector knob offers the choice of cleaning or chloridizing functions. In the case of oxygen or ozone sensors, the anode, cathode and guard ring electrode cleaning positions are available. The two

selector positions in the **chloridizing** section cover dechloridization and rechloridization of hydrogen sensors. Finally the counter socket takes the red banana plug on the end of the lead from the regeneration cell.

For electrical testing, there are eleven sockets to accept banana plugs. Each of the sockets is connected to one of the ten pins of a sensor LEMO plug (there is also a shield plug). By connecting an ohmmeter across two of the sockets, sensor resistances can be measured and the state of the sensor checked.

Looking now at the black and white plastic **regeneration cell**, you will see that when a sensor is to be cleaned the red banana plug on the end of the electric lead plugs into the **counter electrode** socket on the 32301's top panel.

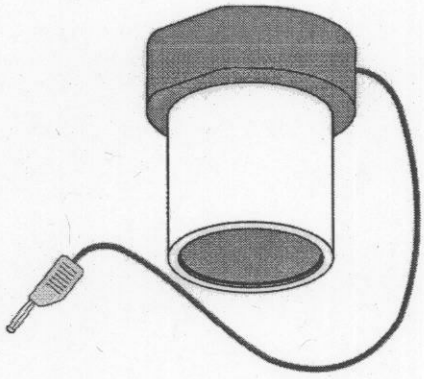

Fig 2 : Regeneration Cell - Including Connecting Wire and Banana Plug

The white tube of the cell fits over the sensor head with the rubber O-ring inside the tube acting as a seal. Most of the interior of the white tube is lined with a concentric tube of black carbon. This acts as a counter electrode during the cleaning process.

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2 Sensor cleaning function

2.1 Oxygen or ozone sensor cleaning

a) Which cleaning method to use

Although oxygen sensor cleaning is discussed throughout this section, the methods are equally valid for ozone sensors. The film that develops on the anode of an ozone sensor is more tenacious than that on an oxygen sensor, and therefore requires more repetitions of the cleaning procedure.

In the manual accompanying your oxygen or ozone analyzer you will find that alternative methods of cleaning are proposed: You have the option of using the Sensor Cleaning and Regeneration Center as described here, or you may use a purely chemical method.

For general purpose use, the Sensor Cleaning and Regeneration Center method is recommended. This method reverses the chemical reactions taking place at the electrodes during normal operation, removing unwanted deposits that can inhibit efficiency. It tends to increase the sensitivity of a sensor over a longer period and can lengthen the time required between sensor services.

However, experience has shown that certain circumstances require the use of the chemical cleaning method in addition to the Sensor Cleaning and Regeneration Center method. These circumstances are described below.

For Sensors used in simple media such as a power station water an occasional chemical cleaning may prove worthwhile from time to time. Since operating conditions vary considerably, only your own experience will allow you to establish whether chemical cleaning is necessary and how frequently it should be performed.

However, if after normal cleaning with the Sensor Cleaning and Regeneration Center your sensor is slow in reacting or is generally not operating as efficiently as normal, then carry out a chemical sensor service as described in the manual accompanying your Orbisphere system. Described briefly, the procedure involves an ammonia solution and may, if necessary, be followed by nitric acid (10 seconds only), followed by ammonia solution, then finish with a Sensor Cleaning and Regeneration Center treatment.

Where Sensors are in contact with more complicated media such as beer, fairly frequent chemical cleaning may be advisable or even essential. In such cases the same process mentioned as in above should be followed, namely cleaning with ammonia, optional nitric acid and ammonia followed by a Sensor Cleaning and Regeneration Center treatment. Again, cleaning frequency will only be established by experience.

b) When to clean your sensor

During operation, wear on the membrane and chemical reactions within the sensor require that a sensor service be carried out from time to time. In general, this standard sensor service - membrane and electrolyte change and electrode cleaning procedure - will restore correct performance to the sensor.

Since operating conditions vary considerably it is impossible to suggest a planned maintenance schedule. You will establish one yourself with experience.

The need for sensor servicing is indicated by:

- a noisy or drifting readout under constant oxygen concentration conditions
- an unreasonably long stabilization time for the oxygen signal either with the Sensor exposed to air or to changing oxygen concentration conditions
- difficulties with calibration

To confirm whether or not a sensor service is required, expose the sensor to the air and switch the instrument on to give an oxygen concentration readout. Observe what happens.

A full scale indication should appear on the display followed by a steady decay of the signal to 8 or 9 ppm (or equivalent) at room temperature. The exact value of this can be obtained from the solubility tables included with your analyzer's operator's manual. To use these tables you need to know the ambient temperature in °C (use the sensor if it has a temperature measurement facility, otherwise an accurate thermometer positioned near the sensor head) and the barometric pressure.

If the oxygen readout does not correspond exactly with the value found in the tables, try recalibrating the sensor using the procedures in your analyzer's Operator's Manual. If after calibrating, the required value does not display, or the displayed indication falls below the value and then gradually comes back up the scale, then carry out a sensor service.

c) How to use the 32301 for sensor cleaning

Pry off the membrane holding ring with the handle of the tweezers included in the recharge kit, or with the stainless steel removal tool supplied with the system.

Discard the membrane and shake out the electrolyte.

Key the prongs of the membrane support removal tool from the recharge kit into two of the holes in the membrane support and turn counterclockwise to remove the membrane support.

Note :
*Each support ring is individually machined at the factory to match its sensor. It is **ESSENTIAL** when servicing several sensors at a time to keep the appropriate membrane support ring with its respective sensor.*

Rinse the membrane support with water and leave it on its tool.

Rinse the electrolyte reservoir with water.

Fix the sensor vertically onto a clamp or stand, so that its head is facing upwards. If your sensor has a permanently attached cable, introduce the LEMO plug into the SENSOR receptacle on the Sensor Cleaning and Regeneration Center. Sensors with detachable cables may connect to the 32301's sensor cable.

Push the white part of the regeneration cell over the sensor head until it reaches a stop. Place the red banana plug into the COUNTER ELECTRODE socket on the Sensor Cleaning and Regeneration Center.

Pour standard Orbisphere model 2959 electrolyte into the regeneration cell so that its level is about half way up the black cleaning electrode.

Turn the selector knob to the **cathode** position. Press the **TIMER** switch. Its red warning light will come on and remain so for 60 seconds while cleaning takes place.

Observe the solution in the regeneration cell. Once switched on, the service center will generate bubbles (given off at the cathode) through the clear liquid. While it cleans, this has the effect of darkening the solution and should happen at once. If, at the end of the 60 seconds cleaning period, an abundant development of bubbles from the cathode is not obvious then press the **TIMER** switch once more. **This development of bubbles is a sign of a clean electrode**.

Turn the selector switch to **guard** and press the **TIMER** switch. Again watch for the evolution of bubbles and repeat the cleaning process if necessary.

Turn the selector switch to **anode** and press the **TIMER** switch. Here the bubbles may be more reluctant to come and you may need to press the **TIMER** switch several times before you are satisfied that the anode is clean enough. This is particularly true of ozone sensors and as before, bubble evolution is your indicator. If after five cleaning periods bubbles do not appear then pour out the cleaning liquid, remove the regeneration cell, and carry out a chemical cleaning of the sensor as described in your manual. Complete the cleaning with the Sensor Cleaning and Regeneration Center.

Go back to cathode and guard clean above.

Once the three electrodes are clean, disconnect the counter electrode and sensor from the Sensor Cleaning and Regeneration Center and empty the cleaning solution from the regeneration cell.

Rinse the interior of the regeneration cell and sensor with water.

Remove the regeneration cell from the sensor head and again rinse both well with water.

Visually inspect the three electrodes. They should appear clean and of a uniform color. If you notice any dark patches, particularly on the anode, repeat the electrochemical cleaning process until any such patches disappear.

d) Replace the membrane

Once cleaning is complete, the sensor can be prepared for its return into service.

Install the membrane support, finger tight, using its mounting tool.

Note :
The support has one smooth side with a groove, and one side that is raised in the center, as shown below:

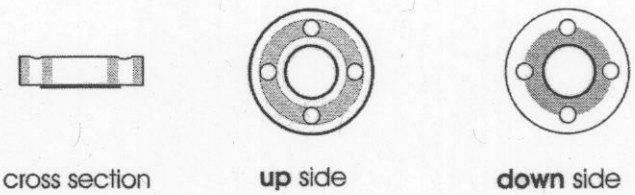

Fig 3 : Membrane Support

Make sure the smooth side with a groove faces out when installed. Because there is a danger of over tightening the plastic threads, Orbisphere has a safety feature that causes the membrane support to skip its threads harmlessly if over tightened. Should this occur, re-tighten more gently.

At this point, you should follow the sensor polishing instructions described in the **EC Sensor - Maintenance & Installation Manual** supplied with your system.

Described briefly, you should shake out a small amount of polishing powder on the cloth supplied with your recharge kit. Wet the powder with a small amount of water, and then place the sensor face down on the polishing cloth and polish in a circular motion. Once the electrodes are bright and shiny, remove the membrane support ring with its tool and rinse out the sensing head thoroughly with water, using a jet of distilled water if necessary to clean out the gap between the center electrode and guard ring.

Replace the membrane support with its tool.

Fill the sensor head with electrolyte either directly from the bottle or using the syringe and needle. It helps if you tilt the sensor slightly, filling the head from the lowest of the four

10/24

holes facing you. Do this slowly, forcing the air out through the top hole. Continue filling the reservoir, returning the sensor to vertical, until an overflow of electrolyte adheres to the surface of the sensor face.

Take the membrane mounting tool and check that the rubber face of the plunger is clean and smooth and can be pushed in and out without sticking. Place the membrane mounting ring into the groove around the plunger and push it in securely.

Lower the membrane mounting sleeve onto the sensor.

Using a pair of tweezers, take one transparent membrane from the plastic box in the recharge kit (the paper separating membranes can be discarded). Take care to handle the membrane by the edges only. Place the membrane on the sensor face. Adjust it carefully until well centered.

Lower the plunger, pausing when the plunger contacts the sensor face, then push until it comes to a stop. The membrane is mounted.

Remove the plunger and sleeve. Take care during removal not to disturb the membrane.

Inspect the membrane holding ring to be sure that it's properly seated and pushed in all the way on to the sensor head, and make sure that the membrane is smooth. If not, you may be able to complete the process by pushing down with your fingers to adjust its seating. If this does not have the desired result immediately, replace the membrane.

Note :
Black plastic holding rings last between 3 to 10 membrane changes. If a ring turns easily once installed on the sensor, it is worn and should be discarded and replaced. Likewise, the O-rings that form a seal between the membrane holding ring and sensor head wear out in time. If the ring turns easily, you should replace the seal.

Rinse excess electrolyte off the sensor with water.

The sensor can now be calibrated and returned into service.

e) Cleaning plastic parts of the Sensor

With time the white plastic parts of your sensor may become discolored. This in no way affects the functioning of the sensor: it merely looks unpleasant and you may wish to clean them. The Sensor Cleaning and Regeneration Center will not help you to do this and we suggest that you clean the dirty surface with concentrated (approximately 70% by weight, but no stronger) nitric acid.

The discoloration usually disappears immediately. Discard the acid and rinse well with water.

2.2 Hydrogen sensor servicing

a) When to carry out a sensor service

The hydrogen analyzer works on the principle that hydrogen molecules, passing through the membrane, generate an electric current at the platinum anode surface. For this to take place, an extremely clean metal surface is essential. If any film, grease or other impurity covers the platinum, the reaction is impeded and may even be stopped. In addition, the chemical reaction taking place on the silver cathode renders it less and less efficient with time. Both of these conditions lead to problems in measuring hydrogen content, and a sensor service is necessary to restore correct performance to the sensor.

The need for a sensor service is indicated by:

- a noisy or drifting readout under constant hydrogen concentration conditions
- an unreasonably long stabilization time for the hydrogen signal under constant or changing hydrogen concentration conditions
- difficulties with calibration

The appearance and persistence of any of these indications necessitate carrying out a complete sensor service as described below.

b) How to carry out a sensor service

A sensor service consists of the following operations:

1) Dechloridization of the cathode. This process removes the chloride film from the silver cathode surface.
2) Degreasing the sensor. This is only necessary under certain, fairly unusual, circumstances as described in “Degreasing the sensor (optional procedure)” on page 13.
3) Rechloridization of the cathode. Here a fresh layer of silver chloride is grown on the cathode surface. All Sensor Cleaning and Regeneration Center units can carry out this treatment.
4) Activation of the platinum anode. The anode surface is polished, and treated with concentrated nitric acid. The Sensor Cleaning and Regeneration Center is not used for this treatment.
5) Electrolyte and membrane replacement.

Each of these operations will now be described in some detail, even when the Sensor Cleaning and Regeneration Center is not used.

c) Dechloridization of the cathode

Pry off the membrane holding ring with the handle of the tweezers included in the recharge kit, or with the stainless steel removal tool supplied with the system.

Discard the membrane and shake out the electrolyte.

Key the prongs of the membrane support removal tool from the recharge kit into two of the holes in the membrane support and turn counterclockwise to remove the membrane support (remembering to keep the support matched to the sensor when servicing several sensors). Rinse the membrane support with water and leave it on its tool.

Rinse the electrolyte reservoir with water.

Fix the sensor vertically onto a clamp or stand so that its head is facing upwards.

De-chloridization can now take place. Move the selector knob to the **dechloridize** position.

With the sensor fixed on a stand or clamp, connect it either into the SENSOR receptacle (for sensors with permanently attached cables) or to the 32301's sensor cable.

Push the white part of the regeneration cell over the sensor head until it reaches a stop. Place the red banana plug into the COUNTER ELECTRODE socket on the Sensor Cleaning and Regeneration Center.

Pour dechloridizing solution into the regeneration cell so that its level is about half-way up the black cleaning electrode. The Orbisphere model 29011 chloridizing solution - supplied with your system - should be used.

Press the **TIMER** switch. Its red warning light will come on and remain so for 60 seconds while dechloridization takes place.

Observe the solution in the regeneration cell. From being a clear liquid it should fill with small hydrogen bubbles given off at the cathode. This has the effect of darkening the solution. If at the end of the 60 seconds dechloridizing period an abundant evolution of bubbles from the cathode is not obvious then press the **TIMER** switch once more and continue to do so until bubbles appear.

An abundant evolution of bubbles is a sign that dechloridization is probably complete.

Look closely at the cathode. It should now be silver-white with no darker patches. If this is not the case, throw out the dechloridization solution and replace with new solution, then continue to activate the dechloridizing process. Any darker patches will disappear with time.

With dechloridization of the cathode complete, disconnect the counter electrode and sensor from the Sensor Cleaning and Regeneration Center and empty the dechloridizing solution from the regeneration cell.

Rinse the interior of the regeneration cell and sensor with water.

An alternative chemical treatment, when the Sensor Cleaning and Regeneration Center is not available, is the following:

Fill the cathode reservoir with NH_4OH, and leave for several minutes. It is not necessary, though not harmful, to cover the platinum electrode. There is an immediate bleaching effect on the silver electrode, though it is rare for a uniformly white surface to result from this first application.

Discard the NH_4OH and rinse the reservoir with water.

Fill the reservoir with HNO_3 and rinse with water after only 10 seconds.

Repeat the treatment with NH_4OH and again rinse with water.

Now inspect the interior of the sensor. If the cathode is uniformly silver-white in color then proceed to the next stage. But if there are areas of the silver surface which are still dark in color then repeat the treatment with nitric acid and ammonia until a white surface is obtained. Avoid unnecessary repetitions of the nitric acid treatment, because these have the effect of shortening the life of the sensor.

d) Degreasing the sensor (optional procedure)

Under most operating conditions the sensor is not exposed to greasy samples, and with careful handling - particularly taking care not to touch the electrodes with fingers - no problems should be experienced with grease.

In such circumstances no sensor degreasing is necessary and you should proceed to the next section: “Rechloridization of the cathode” on page 13.

If, however, the sensor has been used with dirty samples or exposed in some way to grease, then the degreasing procedure described in this section should be followed. You will learn from experience whether in your particular case degreasing is necessary on a regular or occasional basis or not at all. Should you find, for instance, that after a regular service without degreasing, the Sensor is still not functioning correctly then try a further sensor service with degreasing.

The procedure consists of filling the sensor with model 2959 oxygen electrolyte, mounting any membrane, and then standing the sensor face down in boiling water for about ten minutes, shifting its position from time to time.

After boiling, allow the sensor to cool, and then remove the membrane and rinse the sensor head with tap water. The sensor head should be free of grease.

e) Rechloridization of the cathode

In this process, a fresh layer of silver chloride is grown on the cathode surface.

Place the sensor on a stand as before.

Plug the sensor into the SENSOR receptacle.

Place the white tube of the regeneration cell over the sensor head and push it down to a stop. A rubber O-ring inside the tube acts as a seal. Insert the red banana plug into the counter electrode socket.

Pour about 10 ml of model 29011 chloridizing solution into the regeneration cell. This will cover the sensor head to a depth of about 1 cm. Eliminate any bubbles of air adhering to the silver cathode by tapping the side of the cell.

Turn the selector knob to the **chloridize** position. Press the **TIMER** switch. Its red warning light will come on and remain so for about eight minutes while rechloridization takes place. During this period the cathode will turn from silver-white to a pale pink color which will gradually darken as the layer of silver chloride builds up.

Rechloridization is complete.

Pour out the rechloridizing solution and rinse the regeneration cell/sensor assembly with water.

Remove the regeneration cell from the sensor and again rinse the sensor head with water.

f) Activation of the platinum anode

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

WARNING

Do not to put acid on the newly chloridized cathode.

The polishing procedure is as follows:

Place the polishing cloth on a flat surface.

Note :
It is very important that the cloth be clean. After use, wash, rinse and dry thoroughly and store out of the way of dust.

Place a little of the polishing powder on the cloth and add enough distilled water to make a loose watery slurry.

Holding the sensor vertically and using a circular motion with light pressure, polish the sensor surface until both platinum anode and guard electrodes are brightly reflecting.

Remove the membrane support and thoroughly rinse this and the sensor head with water, paying particular attention to the gap between the platinum anode and guard electrodes. It helps if a fine pressurized jet of distilled water is available for this purpose. If possible, inspect the gap with a magnifying glass. If traces of polishing powder remain and cannot be removed by repeated applications of the water jet, they may be coaxed out with the edge of some clean, stiff paper.

The nitric acid treatment is as follows:

Install the membrane support, finger tight, using its mounting tool.

Note :
The support has one smooth side with a groove, and one side that is raised in the center, as shown below:

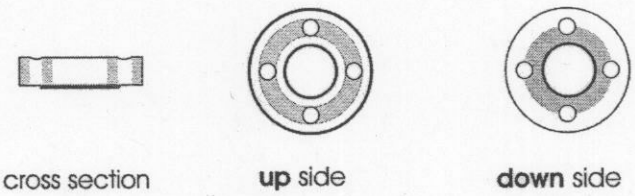

Fig 4 : Membrane Support

Make sure the smooth side with a groove faces out when installed. Because there is a danger of over tightening the plastic threads, Orbisphere has a safety feature that causes the membrane support to skip its threads harmlessly if over tightened. Should this occur, re-tighten more gently.

Fill the sensor reservoir with water-this helps protect the new silver chloride layer in case nitric acid leaks into the reservoir.

Place a drop at a time of concentrated (approximately 70% by weight) nitric acid on the center of the platinum electrode. This can be done either with a Teflon dropper bottle containing the acid, or by dipping a clean glass rod or pipette into the acid. Allow the acid to spread to the surrounding platinum guard electrode. The acid can be left on the platinum for as long as is convenient - about 30 seconds is recommended.

Wash off the acid, and repeat the procedure (applying drops of nitric acid) twice more.

Wash thoroughly with distilled water.

g) Refilling the sensor with electrolyte and replacing the membrane

Check that the membrane support is in place. Make sure that the smooth side with a groove (and not the stepped side) is facing outwards.

Refill the sensor with electrolyte (model 29010) through one of the holes in the white plastic membrane support until a convex meniscus is visible above the profile of the sensing face. Eliminate bubbles by tapping the side. It is best to incline the sensor slightly during the filling since bubbles of air are more easily displaced this way.

Place the membrane mounting ring into the groove around the membrane mounting tool's plunger and push it in securely. Check that the rubber face of the plunger which contacts the membrane is clean.

Lower the membrane mounting sleeve onto the sensor.

Take one transparent membrane from the plastic box in the recharge kit (the paper separating the membrane can be discarded). Take care to handle the membrane by the edges only. Place the membrane on the sensor face, and center it.

Lower the plunger, pausing when the plunger contacts the sensor face, then push until coming to a stop. The membrane is mounted.

Remove the plunger and sleeve. Take care during removal not to disturb the membrane.

Wash excess electrolyte off the outside of the sensor.

The sensor can now be calibrated and returned to service.

16/29

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17 of 24

3 Circuit testing functions

This part of the manual describes a series of tests which will allow you to check if the electronics of your sensor are functioning correctly.

The cause of such problems may be chemical, electronic or mechanical in origin. Since the tests described here are logical, quick and simple to carry out, you can rapidly discover whether or not a particular problem is of electronic origin or not. If it is, then the tests allow you to localize the problem and report it to your Orbisphere representative for repair. If it is not, then you know that the problem is of chemical or mechanical origin and should act accordingly. Chemical problems may merely necessitate a very thorough sensor service; mechanical problems might take the form of poor connections on the inlet side of the sample pipework.

For these tests it is not necessary to plug the Sensor Cleaning and Regeneration Center into the power supply.

Please carry out the tests in the order in which they are presented here. Ignore any instructions which do not apply to your system.

3.1 Preliminary checks

Power supply

Check that the voltage indicated on your indicating instrument corresponds with your power supply.

Sensor and membrane compatibility

Check that the model number engraved on the body of your Sensor corresponds with the model number shown below the display window of your indicating instrument.

Membrane

From your system manual, check which model number of membrane you should have for your particular model of Sensor.

LEMO connectors

Check that the sensor cable's LEMO plug and, if relevant, the corresponding receptacle of your indicating instrument are clean and dry, and that the pins are undamaged.

Batteries

With the indicating instrument switched on, check the display window to see if the LO BAT signal is illuminated. If it is, plug the instrument into the power and leave it for several hours to recharge. (It takes about 14 hours for the batteries to fully recharge.)

Power supply circuit

If the display is blank with the instrument plugged into the power and switched on, there may be a fault in the power supply circuit. To check this, unplug the instrument from the power and test with an ohmmeter across the two live pins of the power plug. A reading of infinity confirms a fault (blown fuse) which should be reported to your Orbisphere representative.

3.2 Oxygen and ozone sensor testing

For sensor testing you will require an ohmmeter with leads ending in banana plugs suitable to be plugged into the group of eleven sockets on the **TEST** panel of the Sensor Cleaning and Regeneration Center unit. Two such banana plugs are supplied with each unit. The numbers on these sockets correspond to the pin numbers on a LEMO-10 sensor plug (see illustration below).

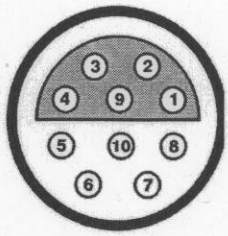

Fig 5 : LEMO-10 Plug

The Sensor Cleaning and Regeneration Center does not need to be plugged into the power for these tests. The LEMO plug of the sensor being tested must be plugged into the socket in the center of the Sensor Cleaning and Regeneration Center test panel.

a) Checking temperature measurement thermistors

Checking the values against those given in “Resistance between the sensor LEMO plug pins” on page 20, measure the resistances between

- pin 3 and pin 6 and, if applicable,
- pin 3 and pin 10.

A discrepancy greater than ±10% indicates a probable fault in the circuit.

b) Checking temperature compensation thermistors

Checking the values against those given in “Resistance between the sensor LEMO plug pins” on page 20, if applicable, measure the resistances between

- pin 2 and pin 8
- pin 1 and pin 2
- pin 1 and pin 8.

A discrepancy greater than ±10% indicates a probable fault in the circuit.

c) Checking connections within the sensor

Measure the resistance between all pins and the shield. The resistance should be infinite in every case since all connections are isolated from the sensor body.

Check that no short circuits exist in the sensor body by measuring between the following pins

pin 3 and pin 4 **pin 3 and pin 9** **pin 3 and pin 1**	Resistance should be infinite
pin 1 and pin 4 **pin 1 and pin 9**	A finite resistance can exist in these cases, but it must not be zero

To check for continuity between each of the electrodes and the corresponding pin on the LEMO plug it is necessary to empty the electrolyte reservoir then rinse it out and thoroughly dry it. In particular, it is essential that the gap between the cathode and the guard ring electrode be absolutely dry.

By touching each of the electrode surfaces very carefully in turn with one ohmmeter lead and the corresponding pin with the other, as follows:

- anode and pin 4
- cathode and pin 9
- guard electrode and pin 1

You should find a value of zero in each case.

Hence continuity exists.

WARNING

Be careful not to scratch the electrode surfaces.

A discrepancy in any of the above checks suggests a connection fault within the sensor and should be reported to your Orbisphere representative. Notice that it is particularly difficult to make a resistance free contact to the silver-silver chloride electrode (the anode of an oxygen sensor).

20 of 24

d) Resistance between the sensor LEMO plug pins

All values in the tables are in kilo ohms.

Sensor Model No.	LEMO-10 Pins	0°C	10°C	20°C	25°C	30°C	40°C
31110, 31120, 31123, 31130, 31131, 31140, 31141, 31330	3-6	351.0	207.9	126.7	100.0	79.4	51.0

Sensor Model No.	LEMO-10 Pins	0°C	10°C	20°C	25°C	30°C	40°C
31111, 31122, 31132, 31332	2-5	351.0	207.9	126.7	100.0	79.4	51.0
	7-8	351.0	207.9	126.7	100.0	79.4	51.0
	3-6	95.0	58.8	37.3	30.0	24.3	16.2
	3-10	19.6	11.9	7.49	6.00	4.83	3.19

Sensor Model No.	LEMO-10 Pins	0°C	10°C	20°C	25°C	30°C	40°C
31121	2-5	351.0	207.9	126.7	100.0	79.4	51.0
	7-8	351.0	207.9	126.7	100.0	79.4	51.0
	3-6	351.0	207.9	126.7	100.0	79.4	51.0

Sensor Model No.	LEMO-10 Pins	0°C	10°C	20°C	25°C	30°C	40°C
31121	2-5	351.0	207.9	126.7	100.0	79.4	51.0
	7-8	351.0	207.9	126.7	100.0	79.4	51.0

3.3 Hydrogen sensor testing

For sensor testing you will require an ohmmeter with leads ending in banana plugs suitable to be plugged into the group of eleven sockets on the **TEST** panel of the Sensor Cleaning and Regeneration Center unit. Two such banana plugs are supplied with each unit. The numbers on these sockets correspond to the pin numbers on a LEMO 10 sensor plug as illustrated below.

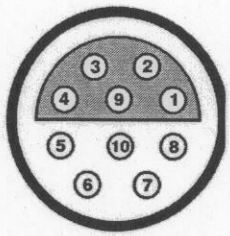

Fig 6 : LEMO-10 Plug

The Sensor Cleaning and Regeneration Center does not need to be plugged into the power for these tests. The LEMO plug of the sensor being tested must be plugged into the receptacle in the center of the Sensor Cleaning and Regeneration Center panel.

a) Checking temperature measurement thermistors

Checking the values against those given in "Resistance between the pins of the sensor LEMO plug" on page 22 for your particular model number of sensor, measure the resistances between

- pin 3 and pin 6; and, if applicable
- pin 3 and pin 10.

A discrepancy greater than ±10% indicates a probable fault in the circuit.

b) Checking temperature compensation thermistors

Checking the values against those given in "Resistance between the pins of the sensor LEMO plug" on page 22 for your particular model number of sensor and, if applicable, measure the resistances between

- pin 7 and pin 8
- pin 2 and pin 5
- pin 1 and pin 8

A discrepancy greater than ±10% indicates a probable fault in the circuit.

22/24

c) Resistance between the pins of the sensor LEMO plug

All values in the tables are in kilo ohms.

Sensor Model No.	LEMO-10 Pins	0°C	10°C	20°C	25°C	30°C	40°C
31230, 31231, 31240	3-6	351.0	207.9	126.7	100.0	79.4	51.0

Sensor Model No.	LEMO-10 Pins	0°C	10°C	20°C	25°C	30°C	40°C
31231	2-5	351.0	207.9	126.7	100.0	79.4	51.0
	7-8	351.0	207.9	126.7	100.0	79.4	51.0
	3-6	95.0	58.8	37.3	30.0	24.3	16.2
	3-10	19.6	11.9	7.49	6.00	4.83	3.19

d) Checking connections within the sensor

Measure the resistance between all pins and the shield. The resistance should be infinite in every case since all connections are isolated from the sensor body.

Check that no short circuits exist between wires in the sensor body by measuring between the following pins:

pin 3 and pin 4 **pin 3 and pin 9** **pin 3 and pin 1**	Resistance should be infinite
pin 1 and pin 4 **pin 1 and pin 9**	A finite resistance can exist in these cases, but it must not be zero

In all cases the value should be infinite.

To check for continuity between each of the electrodes and the corresponding pin on the LEMO plug it is necessary to empty the electrolyte reservoir then rinse it out and thoroughly dry it. In particular it is essential that the gap between the anode and the guard electrode be absolutely dry.

By touching each of the electrode surfaces very carefully in turn with one ohmmeter lead and the corresponding pin with the other, as follows

- Silver cathode and pin 4
- Platinum anode and pin 9
- Platinum guard electrode and pin 1

You should find a value of zero in each case. Hence continuity exists.

WARNING

Be careful not to scratch the electrode surfaces.

A discrepancy in any of the above checks suggests a connection fault within the sensor and should be reported to your Orbisphere representative for repair.

User notes

24/9/24

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