

DL5000 Dissolved Oxygen (D.O.) Probe User's Manual

70-82-25-114

5/02

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About This Document

Abstract

This manual provides description, specification, installation, mounting, maintenance and troubleshooting information for the Honeywell DL5000 Dissolved Oxygen (D.O.) Probe.

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Symbol Definitions

The following table lists any symbols used in this document to denote certain conditions.

Symbol	Definition
	Earth Ground. Functional earth connection. NOTE: This connection shall be bonded to Protective earth at the source of supply in accordance with national and local electrical code requirements.

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1. Introduction

1.1 Overview

This document provides description, specification, installation, mounting, maintenance, and trouble shooting information for the Honeywell DL5000 Dissolved Oxygen (D.O.) probe. This probe can be used with the DL424, DL425, or the 7020 Series Dissolved Oxygen analyzers.

1.2 Probe Description

The Honeywell probe is housed in either PVC or Stainless steel casing. One end has a 1" NPT male thread for mounting. The sensor extends from the housing and is covered by a protective guard (of the same material as the casing) which allows sample entry while preventing physical damage.

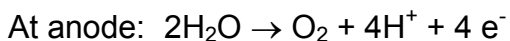
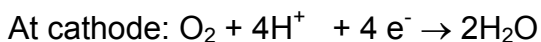
The probe has permanent electrolyte which is sealed at the rear with an expansion chamber to compensate for pressure changes. The sensor assembly is permanently potted into the housing and is not field replaceable. Operational service in wastewater applications should consist of an occasional wash to remove any large deposits at the sensor end. This can usually be accomplished without removing the protective guard. If the protective guard is removed, additional care must be taken to minimize the chance of puncturing a hole in the probe membrane. See Probe Maintenance section for proper cleaning procedures.

Physically the probe consists of three electrodes and a thermistor for temperature measurement and compensation. Two electrodes are interspaced on a supporting substrate and covered with an electrolyte; these electrodes are connected as anode and cathode. The third or reference electrode is mounted in the center of the electrode support and is also in contact with the electrolyte. The anode and cathode perform the oxygen generation and reduction functions while the reference electrode maintains the correct electrochemical potential.

1.3 Operating Principal

When the probe is placed into the sample stream, oxygen diffuses through the membrane and is reduced at the cathode, and an equal amount of oxygen is generated at the anode. The diffusion continues until the oxygen partial pressure on both sides of the membrane is equal and a balance exists. The electrical circuit is designed such that the current necessary to maintain this equilibrium is converted to read out the dissolved oxygen concentration in the solution.

The reactions are as follows:



Result: No net reaction

2. Specifications and Model Selection Guide

2.1 Specifications

Normal Operating Temperature Range:	2 – 60 °C (35.6 – 140°F)
Storage Temperature:	2 – 60 °C (35.6 – 140°F) (See Attention)
Maximum Flow Rate:	No dependence on stirring or flow. However, a minimal flow of 100 ml/min is expected to provide a “flowing” sample. for flow through mounting: 300 ml/min for in-line mounting: 5 gal/min (18.9 liter/min) in a 1” Schedule 40 Line for submersion mounting: Not applicable
Maximum Pressure:	30 psi (207 kPa) for PVC probe 50 psi (345 kPa) for SS probe
Response time:	90% in 60 seconds (after Probe Warm-up)
Probe Accuracy	in parts per billion (ppb) measurements: ±5% or 2 ppb whichever is greater at calibration conditions, after stabilization in parts per million (ppm) measurements: ±0.2 ppm at calibration conditions, after stabilization
Probe Materials of Construction:	PVC or Stainless Steel with a 20 ft. (6.1m) waterproof cable. The PVC model is also available with a 100 ft.(30.48m) waterproof cable.
Probe Dimensions (same for PVC & SS):	8 .62” long X 1.315” OD (219 X 34 mm)
Probe Weight:	PVC 1.24 lb (0.6 kg) SS: 3.5 lb (1.5 kg)

ATTENTION

Probe membrane must be kept wetted both in the process and during storage. See Storage under Maintenance section.

The silicone membrane surrounding the D.O. probe is permanent. If this membrane is removed by user for any reason, the warranty on the D.O. probe is voided

2.2 Model Selection Guide

Instructions

- Select the desired key number. The arrow to the right marks the selection available.
- Make one selection from Tables I & II using the column below the proper arrow.
A dot (•) denotes unrestricted availability.

Key Number I II
 [-----] [---] [-----]

KEY NUMBER

DESCRIPTION	Selection	Availability	
		PPB	PPM
DL5000 Dissolved Oxygen Probe - Parts Per Billion	DL5PPB	↓	
DL5000 Dissolved Oxygen Probe - Parts Per Million	DL5PPM		↓

TABLE I - Probe Construction:

Material of Construction	Mounting	Cable Length			
PVC	Integral	None	100	•	•
316 Stainless Steel			200	•	
PVC	Remote	20'	300	•	•
316 Stainless Steel			400	•	
PVC	Remote	100'	700	•	•

TABLE II - Options

Tagging	None	00__	•	•
	Linen Customer I.D. Tag: 3 lines w/22 characters/line	LN__	•	•
	Stainless Steel Customer I.D. Tag 3 lines w/22 characters/line	SS__	•	•
Extended Warranty Against Manufacturing Defects	Standard Warranty	__00	•	•
	1 Year Extended Warranty	__W2	•	•
	2 Years Extended Warranty	__W3	•	•

3. Installation

3.1 Mounting and Wiring

The following section describes the installation of the Honeywell D. O. probe.

DL424/425 Integral Mounting

Table 3-1 Integral Mounting Procedure (Figure 3-1)

Step	Procedure
1	Connect the probe to the process source (using the appropriate mounting from those supplied for the DL5000). Make sure that the final position of the installed electronics module allows the display to be easily viewed by personnel.
2	Apply a thin film of silicon grease on the ID of the electronics module's probe mounting cavity.
3	Align the slots on the electronics module with those on the probe and press down to connect the electronics to the probe.
4	Tighten the locking screw on the bottom rear of the electronics module.

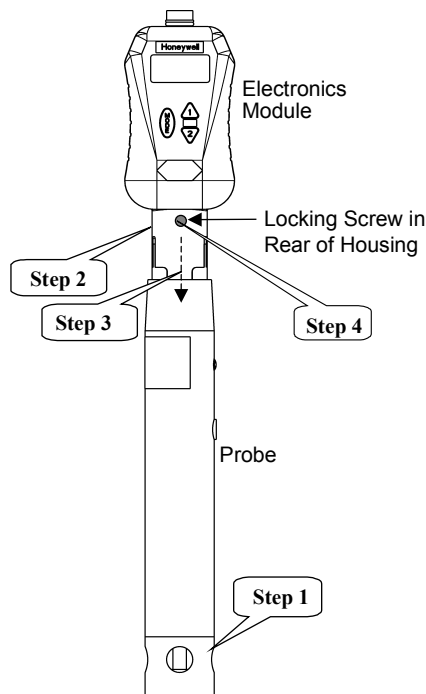


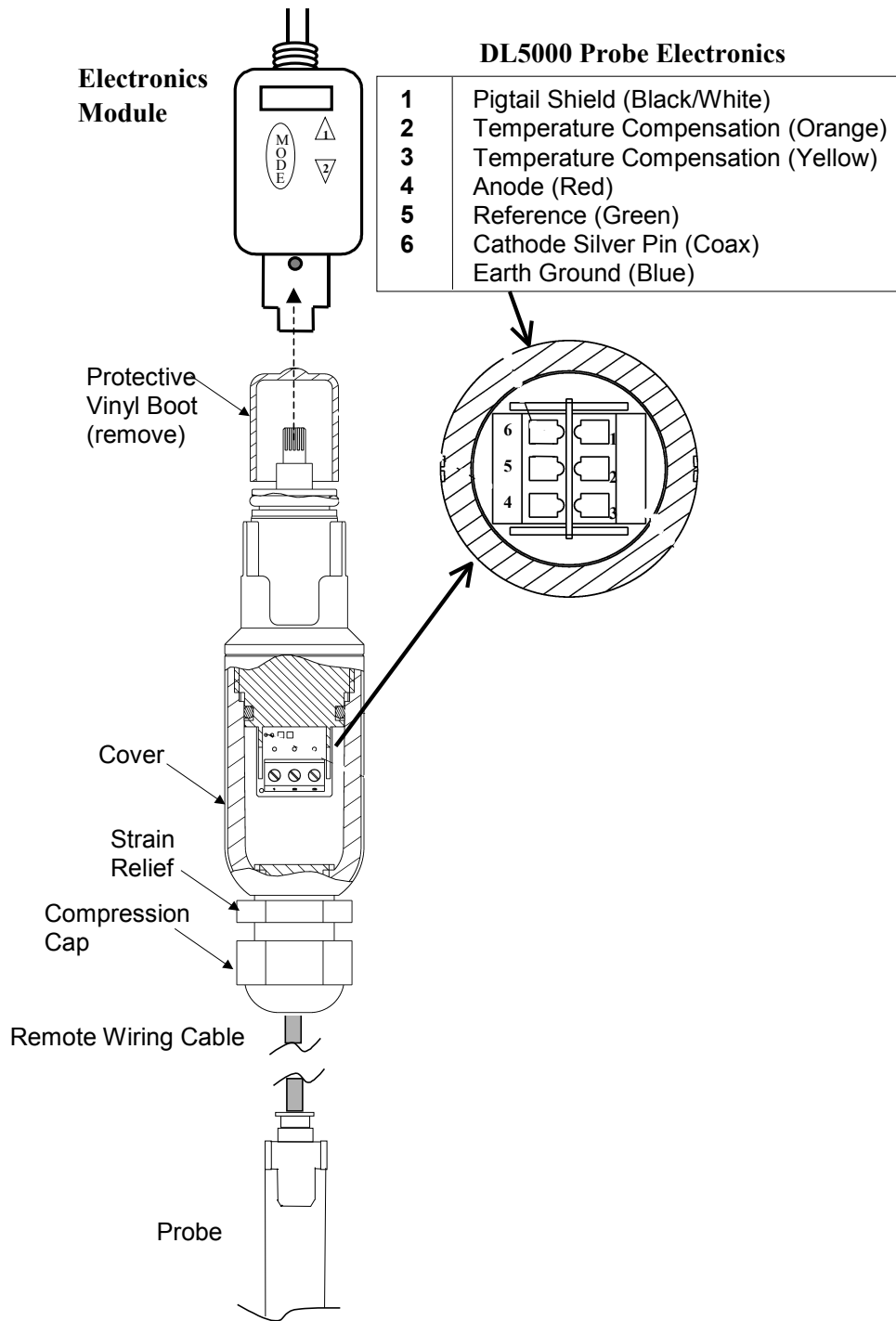
Figure 3-1 Integral Mounting

DL424/425 Remote Mounting

When the DL424 or DL425 module is specified with Table II = 6, a remote connector assembly (part number 51500768-005) is supplied loose. The remote cable connector is used to connect the DL5000 probe cable to the DL424/425 module. Table 3-2 gives the mounting procedure.

Table 3-2 Remote Mounting and Wiring Procedure for DL5000 Probes

Step	Procedure (Refer to Figure 3-2)
1	Turning counterclockwise, remove strain relief/cover combination from the remote connector assembly.
2	Remove the protective plastic bag from the end of the probe cable. Be careful to keep bare fingers away from coax cable termination.
3	Loosen and remove compression cap from strain relief fitting. Carefully push cable end through cap and strain relief fitting so that these parts are strung back along cable jacket.
4	Connect cable leads as follows: See Figure 3-2. Terminal 1 = Pigtail Shield Lead (Black/White) Terminal 2 = Temperature Compensation Lead (Orange) Terminal 3 = Temperature Compensation Lead (Yellow) Terminal 4 = Anode (Red) Terminal 5 = Reference (Green) Terminal 6 = Cathode Silver Pin (Coax) Earth Ground = Blue
5	Slide cover along cable and tighten by hand onto the remote connector assembly.
6	Slide cap along cable and tighten onto cable jacket with small wrench until cable cannot slide within strain relief rubber bushing.
7	Remove red protective vinyl boot from opposite end of connector assembly.
8	Apply a thin film of silicon grease to the ID of electronics module's remote mounting cavity.
9	Plug remote connector assembly into DL424/425 module aligning polarity tab of module housing and mating groove on connector.



**Remote Electronics for
Module DL5000 Dissolved Oxygen Probes**

Figure 3-2 Remote Wiring

Series 7020 Remote Mounting and Wiring

When connecting the probe to the Series 7020 Analyzer, the probe wiring should always be kept separated from the AC power wiring. After the analyzer and probe have been securely mounted, the probe should be connected to the analyzer.

Before wiring, remove the protective insulator tape from the green lead. **To make wiring easier on the 7020 Series analyzer**, loosen the screw at the bottom of the terminal board and remove the terminal block from the panel while wiring.

Figure 3-3 gives the sequence for connecting and disconnecting the probe from the 7020 Series analyzer.

CAUTION

When installing the probe the wiring must be done in the order shown in Figure 3-3, even if the analyzer is not powered. This is because the battery backup card is continuously supplying a voltage (bias) to the terminals.

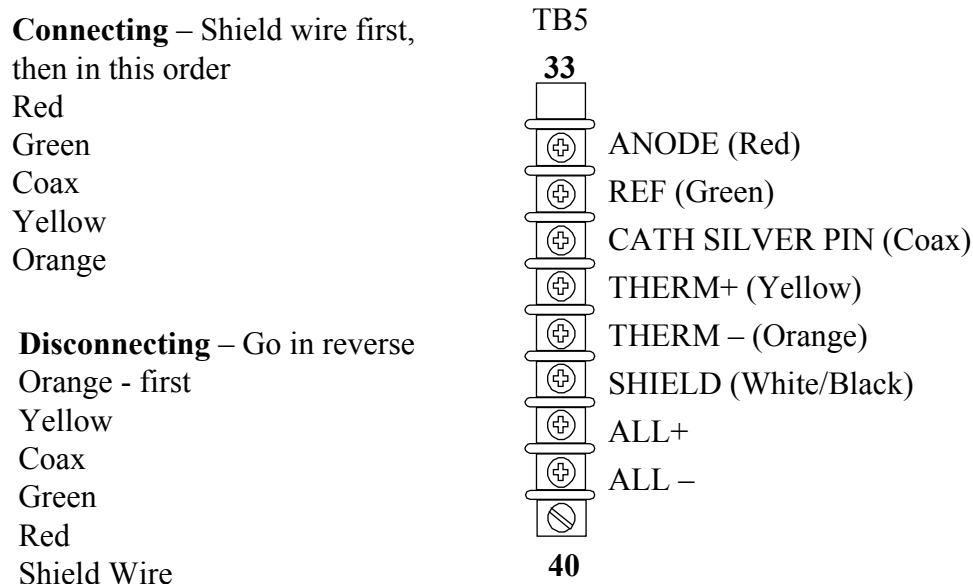


Figure 3-3 Connect/Disconnect Sequence for the Series 7020 D.O. Analyzer

Probe System Check

When the probe is connected for the first time, replaced or just disconnected and reconnected, a conditioning period of 24 hours is needed before the probe can make an accurate measurement. During this time period, the probe must be kept wetted by either putting it in the process water or in a container of water exposed to air. For ppb applications, it is recommended that process conditions are used. Once the 24 hour period has elapsed, the probe can be calibrated. The calibration instructions are as follows:

1. Remove probe from either the process or container of water and put in ambient air. If probe was in process wastewater, clean probe first per cleaning instructions under the maintenance section.
If the probe is in a ppb process, expose the probe to air for 2 - 4 hours before doing an Air calibration.
2. Perform an Air calibration or Sample calibration. Make sure probe temperature is stable before performing an Air calibration. If temperature is not stable, the Air calibration will fail.

ATTENTION

Do not perform an Air calibration on a windy day or during freezing temperatures. The temperature will not stabilize on a windy day and freezing temperatures will cause the probe's electrolyte to freeze and the membrane to crack.

3. At completion of a successful air or sample calibration, put probe into process water.

After the initial calibration, the probe should only be removed from the process for periodic cleaning and calibration. The recommended **cleaning** schedule for ppb applications is monthly and for ppm applications it is bimonthly. If the probe's response has slowed or readings are lower than expected prior to the recommended cleaning schedule, the probe may need to be cleaned more frequently. The recommended **calibration** schedule for ppb and ppm applications is monthly. If individual plant maintenance schedules require it, the probe may be calibrated more frequently.

System Check for Probe with Model 7020

Perform a system check upon completion of all wiring. AC noise in the various analyzer output connections may affect the bias amplifier resulting in a DC current in the reference lead. This DC current will cause dissolution on the silver reference electrode over time resulting in a shortened probe life.

See Appendix A in the 7020 Operator manual for directions on Noise testing.

3.2 Probe Mountings

Wastewater Submersion

Various mounting are available for the Honeywell D.O. probe. Figure 3-4 shows the probe mounting kit for Wastewater Submersion. Except for the 1" schedule 40 PVC pipe or conduit, this kit contains all pieces needed to mount the probe to 1-1/2" diameter safety railings. The length of the pipe or conduit governs the depth of the probe immersion while the angle piece governs the horizontal distance. To minimize debris build-up, place the probe into the process at a 45 ° angle from the horizontal pipe railing. The cable can be routed though the supporting pipe or tied to its side.

If the kit is not used and plastic pipe is preferred, use 1" to 1 1/2" coupling. The use of the pipe is suggested to avoid whipping of the pipe when used in flowing or turbulent water.

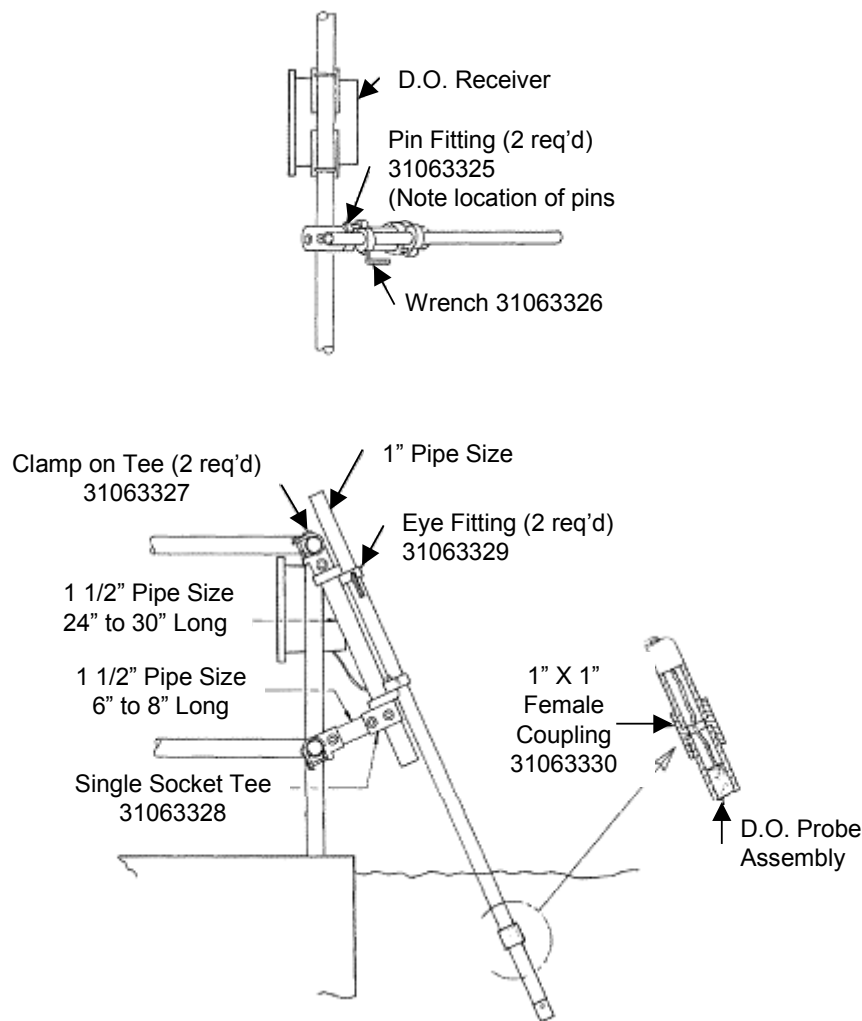


Figure 3-4 Waste Water Mounting

In-line Flow Mounting

In applications where the probe goes directly into the process pipeline, the in-line flow mounting is available. This mounting is diagrammed in Figure 3-5.

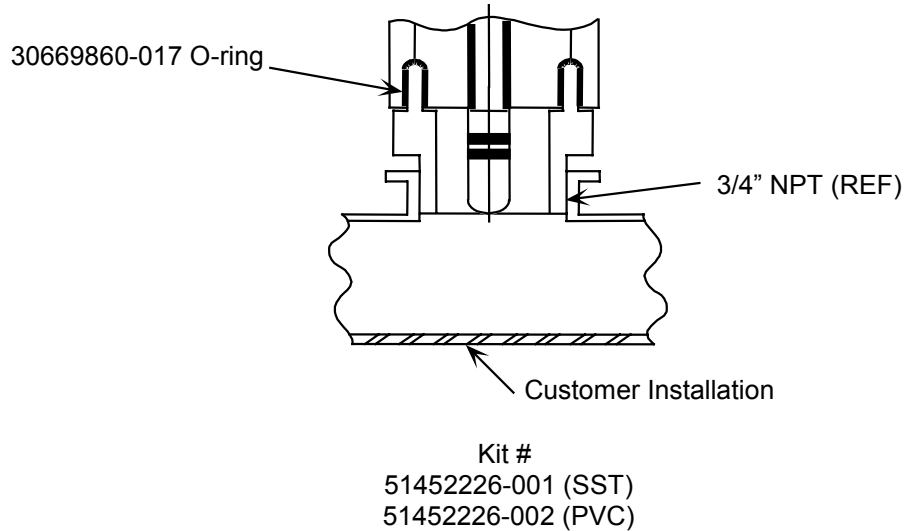


Figure 3-5 In-Line Mounting Kit

Flow Through Mounting

In most low ppb applications, the Pure Water Flow Through mounting is recommended. This assembly is usually pipe clamp mounted close to the sampling port. A single 1" pipe clamp is normally all that is needed for physical mounting. Inlet and outlet fittings are designed to mate to 1/4" O.D. tubing.

ATTENTION

When assembling the flow through kit, extreme caution must be used when installing or removing the probe flow assembly from the probe. The assembly threads can cut the membrane if they contact it (especially the stainless steel assemblies).

In ppb applications, the integrity of the sample lines feeding the ppb probe is of extreme importance. Since the oxygen level in air is usually three orders of magnitude greater than the sample level, oxygen can leak into the sample lines without any indication of liquid leaking out, resulting in erroneous readings. To reduce risk of leaks, use a minimum number of fittings in the sample lines and make sure each fitting is tightened.

The sample should be discharged to Atmospheric pressure (open drain).

The flow through mounting is diagramed in Figure 3-6.

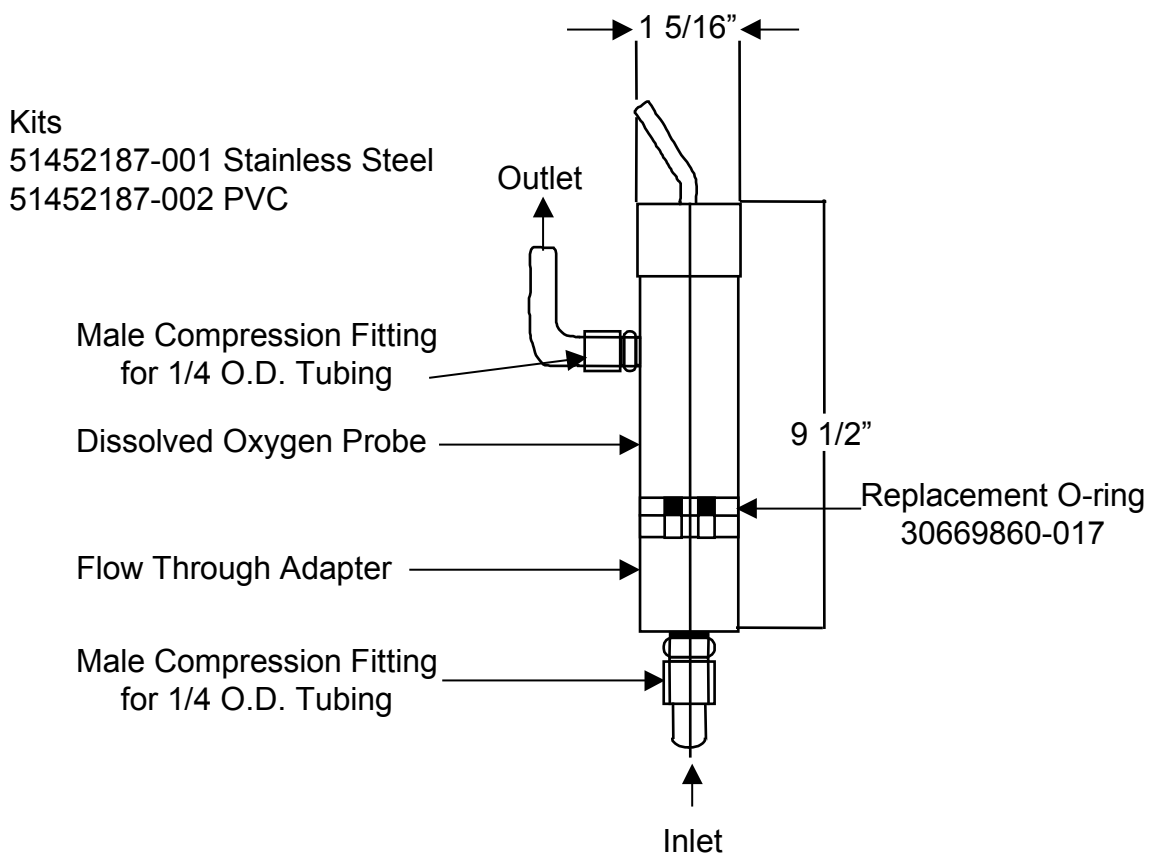


Figure 3-6 Flow Through Mounting

Mounting Recommendation for Easy Calibration in Boiler Control Loop

A "Trap" arrangement should be plumbed in the incoming flow to the DO probe so that if flow is shut off or an "Upstream" pipe opened, water will remain around the tip of the probe. Keeping it moist on the outlet side, an arrangement such as a "TEE" should be made to assure that when the 3-way valve is opened (for Air Calibration), the water within the probe flows out. "Cracking" the fittings on the inlet side will achieve the same result as a 3-way valve, but repeated "Cracking" will cause wear on the parts and any additional handling may shorten the life of the probe.

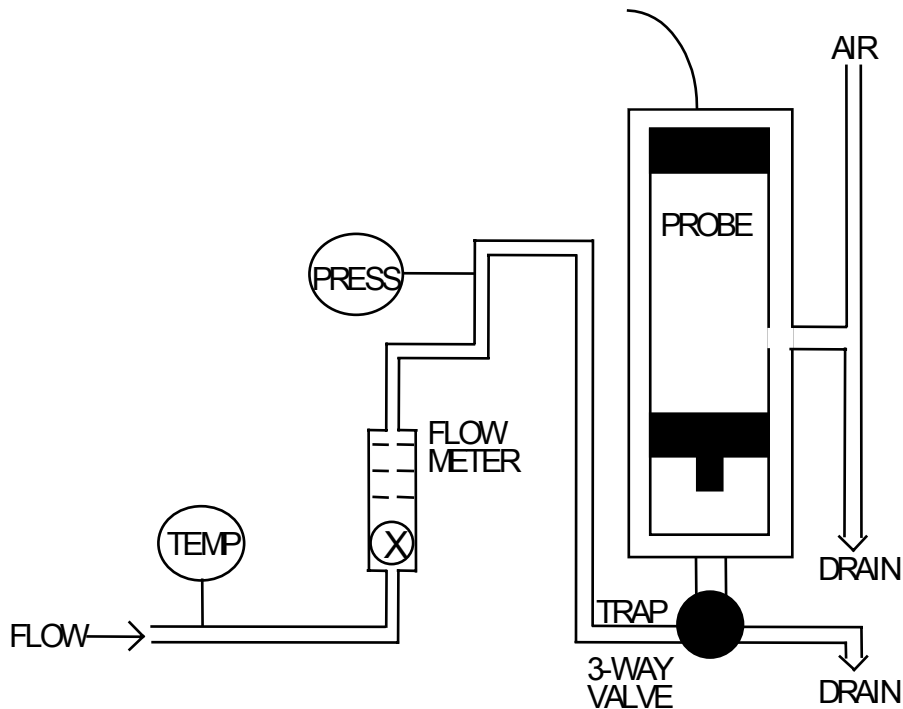


Figure 3-7 Mounting Recommendation for Easy Calibration in Boiler Control Loop

To avoid drying out the probe sensor when the sampling point is shut off, a water trap should be made in the inlet piping

4. Maintenance

4.1 Introduction

The Honeywell D. O. probe requires no internal probe maintenance. However, like all other probes, it does need to be cleaned periodically. After a long period of use, the oxygen transfer may cease due to a coating buildup. This buildup may consume or block the oxygen, increase the response time and / or reduce the probe accuracy. Cleaning the probe is easy and is normally accomplished by agitating the probe in a container of fluid. The cleaning fluid can vary from water to a 10% HCl solution depending on the type of buildup or fouling encountered.

Inert Fouling:

(ex. hair, grease, and solids) This type of fouling normally occurs in wastewater applications; however, rust-like contaminants may occur in ppb applications. When a significant amount of this debris is deposited on the probe, the response time of the probe slows down. Normal cleaning practices should restore probe to correct operation.

Biologically Active Slime:

This type of fouling consists of biologically active slime adhering either loosely or tightly to the probe or the protective cap or both. This slime can be visible or invisible and may produce a sticky feel to the probe and / or cap's surface area. This type of fouling is usually characterized by the following performance: the signal drifts slowly downward for several hours (or days) and then drops precipitously toward zero in a matter of a few hours or less. Proper air calibration can be restored only after very careful wiping of the probe tip or a 30 second rinse in a 10% HCl solution. The time between cleanings can be extended by relocating the probe to a cleaner environment (nearer the effluent) or relocating the probe to where the water is flowing faster. After these actions are taken, a cleaning schedule should be established.

ATTENTION

Never use a brush to clean a Honeywell D.O. probe as it can cause a tear in the probe membrane rendering it inoperable. This type of abuse is not covered under probe warranty.

4.2 To Clean

Cleaning should consist of the simplest of the following required to re-establish proper performance: 1.) Rinsing with water 2.) rinse with mild detergent followed by water 3.) rinse with 10% HCl followed by mild detergent followed by water. If the probe must be wiped, carefully use a paper towel or cotton swab. After cleaning is completed, place the probe back into the process and allow 60 minutes before a calibration.

4.3 O-Ring Replacement

To replace the O-ring shown in Figure 3-6:

1. Place the o-ring over the threads of either the flow through or in-line fitting.
2. Silicone grease may be used to assist in O-ring installation.
3. Attach the adapter to the probe. **Be careful not to touch the probe membrane.**

4.4 Probe Storage

Short term

The Honeywell probe arrives from the factory with a red cap on the end of the probe. This cap contains a 3% solution of Isopropyl alcohol and water. The water keeps the probe wetted until it is put into the process. The alcohol minimizes the growth of bacteria.

Long term

If the probe remains on the shelf for longer than 6 months, the solution inside the cap must be replaced. To do this, remove the side mounted, threaded pipe plug using a 3/16 hex key wrench. Fill the hole with a fresh solution of 3% Isopropyl alcohol and water, and replace the hex screw. This procedure keeps the probe wetted and minimizes incidence of bacteria.

4.5 Packing Probe for Shipment or Storage

When removing the probe from service for storage or shipment, replace the red cap that came with the probe. Fill the probe as described in Storage – Long term. This prevents damage caused by long-term contact with the other probe leads.

5. Troubleshooting

5.1 Diagnostic Error Messages DL424/425

When a diagnostic error or status condition occurs, the Online Display alternates between measured DO and a text message.

Table 5-1 Online Diagnostic Errors

What you see	What it is	What to do
CnFG	Configuration or Calibration data is defective.	Reset unit or cycle power. Second occurrence will show FALt .
FALt	Unit electronics are defective.	Replace electronics module.
<i>These errors may occur when on-line DO Concentration or on-line Temperature is displayed.</i>		
dOHI	Measured DO is > 20 ppm/200 ppb	Bring process to within limits
dOLO	Measured DO is < 0.00 ppm/ppb	Bring process to within limits
PrbE	Probe is defective, wrong type, or not connected. Probe current is excessive with probe voltage near 0 volts. Forces the output to burnout level (greater than 22 mA).	Check for an electrical short between the anode and the cathode. Check the reference electrode connection. When the source of the error is removed, the error will clear and the output will return to normal operation.
T HI	Measured temperature is > 60 °C	Bring process to within limits
T LO	Measured temperature is < 2.0 °C	Bring process to within limits

What you see	What it is	What to do
<p>bErr</p>	<p>Probe Bias Error: Probe current has exceeded expected probe current by 33% for at least 20 seconds.</p> <p>If the excessive current condition continues after a manual probe bias , the PrbE error is generated. If excessive current is not present then the bErr remains.</p> <p>Application related shift in probe bias voltage</p>	<p>Remove the probe from process and do a probe bias calibration. In ppm applications in processes containing CO₂, the probe may be left in the process and the Bias can be manually adjusted.</p> <p>Remove the probe from the process and do an Air Calibration</p>
<p><i>These errors may occur during Air, Sample and Probe Bias calibration and abort the calibration process.</i></p>		
<p>FAIL</p>	<p>These error messages are preceded by the message "FAIL"</p> <p>ArnG Air Calibration failed due to a measured probe current not in the acceptable range</p> <p>Stbl Air Calibration failed due to input measurement instability</p> <p>bErr Bias voltage calibration failed due to unacceptable input current. Replace Probe.</p>	<p>Press Mode to return to online display.</p>

5.2 Troubleshooting 7020 Analyzer

The Honeywell 7020 Series Operator manual contains many tips for troubleshooting the 7020 Series analyzer. Consult the **Matrix of Potential Problems and Solutions** under Section 5.2 in the Operator manual for information on your particular problem.

In addition, the appendix section of the Honeywell 7020 Series Operator manual provides information on various subjects related to the D.O. probe, including the following topics:

- **Excess AC noise can result in a shorten probe life.** To ensure that there is no excess noise on the probe leads, use the procedure in Appendix A in the 7020 manual – Noise Testing to test your probe installation.
- **If a D.O. reading doesn't seem correct,** check that the probe and analyzer are working correctly by using the procedures provided in Appendix B in the 7020 manual – Probe and Analyzer Tests.
- **To confirm the D.O. measurement in air at a specific temperature,** consult Appendix E in the 7020 manual – Percent Saturation Readout to get the expected DO concentration in air or air saturated water at various temperatures. This information will confirm if the probe is giving a valid measurement in air.
- **If a leak is suspected in a ppb system,** consult Appendix F in the 7020 manual – Leak Detection in PPB Applications to understand how to use the D.O. probe to find a leak.
- **Want proof that a D.O. probe can go down to zero ppbs?** Consult Appendix G in the 7020 manual – Procedure for Low level ppb Dissolved Oxygen testing to confirm that your probe can get down to zero ppbs.

5.3 Processes Containing Carbon Dioxide

When measuring D.O. in a process containing carbon dioxide (e.g. beer or soda) special procedures are required to protect the probe. To remove the probe from the line:

1. Shut off sample line containing CO₂.
2. Purge the line containing the probe with fresh water at the same pressure for 15 minutes to remove the CO₂ from the D. O. probe.
3. Remove probe when convenient.

CAUTION

Not following this procedure will cause internal rupture of the membrane rendering the probe inoperable, un-repairable and void of any probe warranty. For optimum performance in this application, the bias voltage should be adjusted to measure 450 mV instead 600 mV. Review the Series 7020 operator manuals for adjusting the Probe Bias.

5.4 Leak Detection in PPB Applications

Before performing an air leak detection, it is necessary to determine that both the probe and analyzer are working properly.

First, check to see that the probe contains an O-ring. Per the probe directions, an O-ring must go into a probe that is used in ppb applications. This creates a tight seal between the probe and flow chamber.

MAKE SURE THIS O-RING IS IN THE PROBE.

1. Unless already in air, open the probe to air for 30 seconds.
2. Put it back into the process again.
3. Allow the DO to drift down to the 20-30 ppb range. The 20-30 ppb range was chosen because the reading was low enough that the drift was small with respect to the changes observed for various flow rates but high enough that changes could be observed.
4. At this range, vary the flow rate from 10 to 100 ml/min. These low flow rates were selected for two reasons. The first, the tester may only have a 0 - 100 ml/min flow indicator. The other reason, is a leak that exists at this low flow, will cause a change in the DO reading.
5. If the DO value at 10 ml/min exceeds the DO value at 100 ml/min, a leak is present in the sampling line.
6. Fixing the leak may require plastic tubing to be replaced with metal tubing, tape to be put on fittings, and/or fittings at the bottom of the probe to be tightened securely.
7. Now, repeat Steps 2 - 6 until the flow can be changed from >100 ml/min to 10 ml/min with no change in the DO value.

Sales and Service

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70-82-25-114 0502 Printed in USA

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