AquaDP

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TPS
PRECISION MEASUREMENT™

Congratulations!

You have purchased the latest in Handheld Dissolved Oxygen-pH-mV-Temperature instrumentation. We trust that your new **Aqua-DP** will give you many years of reliable service.

The **Aqua-DP** is a breeze to operate. This manual has been designed to help you get started and contains some handy application tips. If at any stage you require assistance, please contact either your local TPS representative or the TPS factory in Brisbane.

The manual is divided into the following sections:

1. **Table of Contents**
   Each major section of the handbook is clearly listed. Sub-sections have also been included to enable you to find the information you need at a glance.

1. **Introduction**
   The introduction has a diagram and explanation of the display and controls of the **Aqua-DP**. It also contains a full listing of all the items that you should have received with your **Aqua-DP**. Please take the time to read this section, as it explains some of items that are mentioned in subsequent sections.

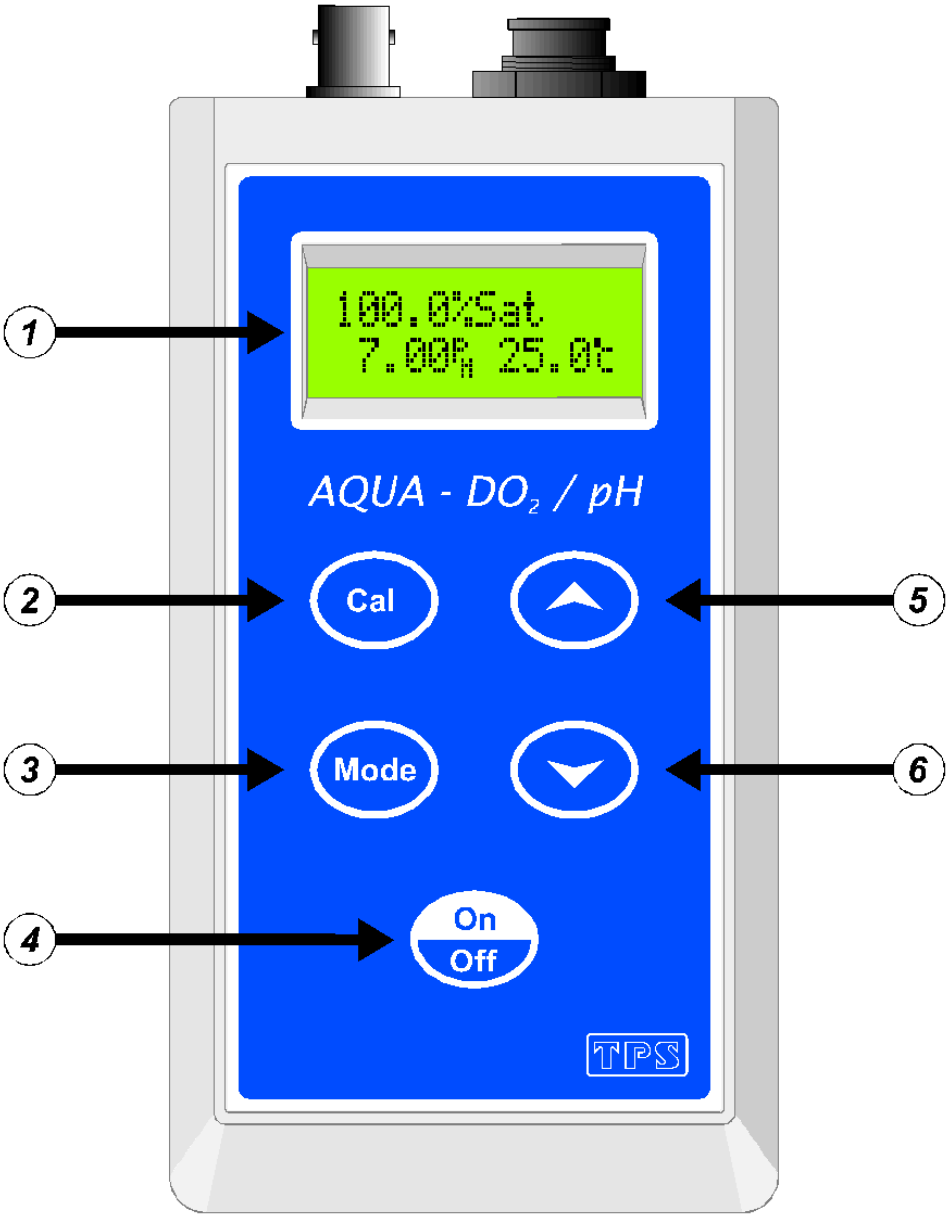
1. **Main Section**
   The main section of the handbook provides complete details of the **Aqua-DP**, including operating modes, calibration, troubleshooting, specifications, and warranty terms.

1. **Appendices**
   Appendices containing background information and application notes are provided at the back of this manual.

Contents

1. Introduction

1.1 Aqua-DP Display and Controls


1
100.0%Sat
7.00pH 25.0t
AQUA - DO2 / pH
2
Cal
5
3
Mode
6
4
On
Off
TPS

Display

24 character alpha-numeric display. Can show any of the following combinations readouts simultaneously (see section 2).

DO_2 + pH + Temp	DO_2 + mV + Temp	DO_2 + Temp
pH + Temperature	mV + Temperature	Temperature only
Salinity Correction Setting		

A unique “Large Digit” mode nearly doubles the size of the digits (section 2).

User-friendly prompts and error messages are also provided.


Used to calibrate all parameters. See sections 3, 6, 6 and 6.

Also used to select pH buffers for automatic pH buffer recognition. See section 8.


Hold this key for 2 seconds to toggle between % Saturation and ppM (mg/L) Dissolved Oxygen modes. See section 2.


Switches the **Aqua-DP** on and off.

Hold this key for 3 seconds to invoke Battery Saver mode. See section 9.



and

These keys toggle the **Aqua-DP** between Large Display mode and Dual Display mode. See section 2.

NOTE: The digits in Large Display mode are made by combining the two rows of the display. This results in a small gap approximately half way up the digits.

1.2 Unpacking Information

Before using your new **Aqua-DP**, please check that the following accessories have been included:

		Part No
1.	**Aqua-DP** Dissolved Oxygen-Temperature Instrument	123143/1 123143/3 123143/5
2.	Oxygen sensor, YSI	123400
3.	Oxygen sensor cable: *(see cable label for part No)*	1, 3 or 5m cable
4.	Membrane kit for oxygen sensor	123301
5.	pH Sensor: *(see cable label for part No)*	1, 3 or 5m cable
6.	pH7.00 Buffer, 200mL	121387
7.	pH4.01 Buffer, 200mL	121381
8.	Manual	

*Options that may have been ordered with your **Aqua-DP:***

1.	Extended cable (ordered by the metre)	130040
2.	Carry Case	130057

TPS

1.3 Specifications

	Ranges	Resolution	Accuracy
Dissolved Oxygen	0 to 250.0 % Saturation 0 to 25.0 ppM	0.1 % Saturation 0.1 ppM	±0.3 % Saturation ±0.1 ppM
pH	0 to 14.00 pH	0.01 pH	±0.01 pH
mV	0 to ±999 mV	1 mV	±1 mV
Temperature	-10.0 to 120.0 ^{O}C (Dissolved Oxygen sensor limited to 45 ^{O}C)	0.1 ^{O}C	±0.2 ^{O}C

Additional Dissolved Oxygen Specifications

Temperature Compensation Dual automatic system for:
1. Membrane permeability
2. Solubility in ppM mode

Sensor Zero Range 0 to 7%

Sensor Span Range 70.0 to 135.0%

Calibration One-touch automatic calibration in Zero and in Air.

Additional pH Specifications

Temperature Compensation Automatic, 0 to 50.0 ^{O}C

pH Input Impedance >3 x 10^{12} Ω

pH Asymmetry Range -1.00 to 1.00 pH

pH Slope Range 85.0 to 105.0%

Auto pH Buffer Recognition pH4.01, pH6.86, pH7.00 pH9.18, pH10.01

Additional mV Specifications

Temperature Compensation Not applicable for mV

ORP Input Impedance >3 x 10^{12} Ω

ORP Asymmetry Range -60 mV to +60 mV

Auto Standard Recognition +229mV (Zobell Solution)

Additional Temperature Specifications

Temperature Sensor Offset Range -10.0°C to +10.0°C

General Specifications

Display 24 Character alphanumeric LCD, with full text prompts and error messages.

Power 9V Alkaline Battery for 70 hours operation.

Battery Saver On : Auto switch-off after 5 minutes
Off : Continuous use

Dimensions 165 x 85 x 35 mm

Mass Instrument only : Approx 280g
Full Kit : Approx 2.0kg

Environment Temperature : 0 to 45 °C
Humidity : 0 to 95 % R.H.

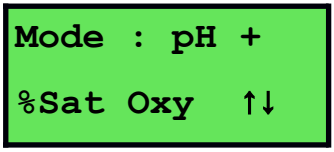
2. Operating Modes

2.1 Selecting the Desired Combination of Parameters

The **Aqua-DP** can display Dissolved Oxygen readings in units of ppM (mg/L) or % Saturation. Additionally, it can display either pH or mV.

To select which combination of these two parameters to display…

1. Press and hold Mode for 2 seconds.
2. The Mode menu is now displayed, for example…



Press the ▲ or ▼ keys repeatedly to select the desired combination of…

- pH + % Saturation Dissolved Oxygen
- pH + ppM (mg/L) Dissolved Oxygen
- mV + % Saturation Dissolved Oxygen
- mV + ppM (mg/L) Dissolved Oxygen

3. Press Mode to save the selection and return to normal display.

2.2 Selecting the Desired Operating Mode

Once the desired ***combination*** has been selected, press the Mode key to select the desired operating ***mode***. The sequence is shown in the following table…

Dissolved Oxygen, pH/mV & Temperature Mode	100.0%Sat 7.00 25.0
Dissolved Oxygen data is shown on the top, pH or mV data is shown on the bottom left and Temperature is shown on the bottom right. Calibration is not available in this mode. Large digit readout is not available in this mode.	
↓ Mode	
Dissolved Oxygen Mode	100.0%Sat 25.0
Dissolved Oxygen data is shown on the top line and Temperature data is shown on the bottom line. Select this mode to calibrate Dissolved Oxygen. The "**S**" is shown after the "**ppM**" units when the Salinity correction value is set to greater than 0.0ppK (see section 7). Press ⌃ or ⌄ to toggle between dual readout or large digit readout.	
↓ Mode	
pH or mV Mode	7.00pH 25.0
pH or mV data is shown on the top line and Temperature data is shown on the bottom line. Select this mode to calibrate pH or mV. Press ⌃ or ⌄ to toggle between dual readout or large digit readout.	
↓ Mode	

Continued over the page…

Mode selection, continued…

Temperature Mode	25.0
Temperature data only is shown on the top line. Select this mode to calibrate Temperature. Press ⏶ or ⏷ to toggle between regular readout or large digit readout.	
↓ Mode	
Salinity Correction Setting Mode	36.0ppK
The Salinity Correction setting is shown on the top line. Select this mode to set the Salinity Correction value to the salinity of the sample to be measured. This setting is only applicable to ppM (mg/L) Dissolved Oxygen readout. See section 7. Press ⏶ or ⏷ to toggle between regular readout or large digit readout.	
↓ Mode	
Back to Dissolved Oxygen, pH/mV & Temperature mode	

Note: The decimal point is replaced by a " ***** " if a Dissolved Oxygen, pH, mV or Temperature calibration has failed (see sections 3, 6, 6 and 6), if the unit is initialised (see section 10), or if the unit has lost its factory calibration (see section 11.1).

3. Dissolved Oxygen Calibration

A " * " in place of the decimal point indicates that the Dissolved Oxygen readout is not calibrated, or a past calibration has failed. The " * " will be removed once an Air calibration has been successfully performed.

3.1 Calibration

1. Switch the **Aqua-DP** on.
2. Select the desired % Saturation or ppM Mode (see section 2). Each mode should be calibrated separately for optimum accuracy.
3. Plug the Dissolved Oxygen sensor into the sensor socket.
4. Ensure that temperature has already been calibrated (see section 6). NOTE: If the decimal point in the temperature reading is replaced by a " * ", then the temperature readout is not calibrated.
5. Rinse the Dissolved Oxygen sensor in distilled water and blot dry.
6. **Zero Calibration**
   (a) Place the sensor into an oxygen-free solution. This solution may be prepared by dissolving 2g of Sodium Sulphite in 100mL of distilled water. A 50g bottle of Sodium Sulphite powder is supplied with a new Dissolved Oxygen sensor for this purpose (part number 123302).
   (b) Allow the reading to stabilise at or near zero. This may take 2-3 minutes.
   (c) Press and hold the Cal key for 2 seconds to calibrate.
   (d) Discard the oxygen-free solution after use.
   (e) A " * " will not be removed from the display after a Zero Calibration.
7. Rinse the Dissolved Oxygen sensor in distilled water and blot dry.

8. **Air Calibration**

   (a) Hang the Dissolved Oxygen sensor in air. The tip of the sensor should be pointing downwards.

   (b) Allow the reading to stabilise. After a zero calibration, this may take up to 5 minutes.

   (c) Press and hold the Cal key for 2 seconds to calibrate.

   (d) A " * " in the display will be replaced by a decimal point after a successful air calibration.

9. The **Aqua-DP** is now calibrated for Dissolved Oxygen and is ready for use in the mode that was selected during calibration.

   NOTES:

   When taking sample measurements, always ensure that there is adequate flow of solution past the membrane for accurate, stable readings. See section 12.1.6.

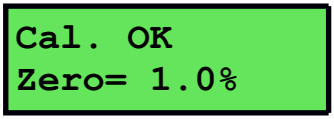
   If salinity-corrected ppM Dissolved Oxygen readings are required, set the salinity correction value before taking sample measurements. See section 7.

3.2 Dissolved Oxygen Calibration Notes

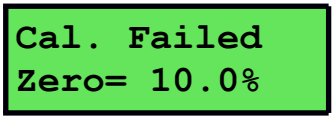
1. A zero calibration should be performed at least monthly. In applications where there is a low level of dissolved oxygen, a zero calibration may have to be done weekly.
2. An air calibration should be performed at least weekly. Of course, more frequent calibration will result in greater confidence in results.
3. All calibration information is retained in memory when the **Aqua-DP** is switched off, even when the battery is removed.
4. The salinity correction value is ignored during zero and air calibration. There is therefore no need to re-set the salinity correction value when calibrating Dissolved Oxygen.

3.3 Dissolved Oxygen Calibration Messages

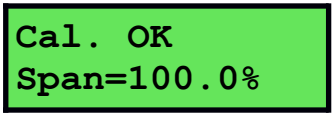
1. If a zero calibration has been successfully performed, the **Aqua-DP** will display the following message, and then display the zero response of the sensor.



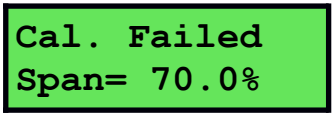
2. If a zero calibration has failed, the **Aqua-DP** will display the following message, then the failed zero value of the sensor.



3. If an air calibration has been successfully performed, the **Aqua-DP** will display the following message, and then the span value of the sensor.



4. If an air calibration has failed, the **Aqua-DP** will display the following message, and then the failed span value of the sensor.

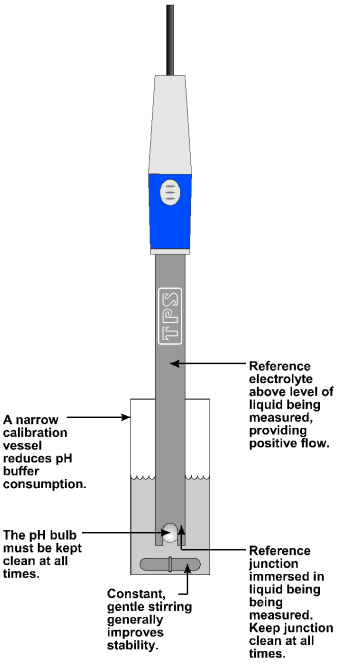


4. pH Calibration

A " * " in place of the decimal point indicates that the pH readout is not calibrated, or a past calibration has failed. The " * " will be removed once a full two-point pH calibration has been successfully performed.

4.1 Calibration

1. Switch the **Aqua-DP** on.
2. Select pH Mode (see section 2).
3. Plug the pH sensor into the BNC socket (this is the metal socket). For automatic temperature compensation, plug the Dissolved Oxygen sensor into the Dissolved Oxygen socket (this is the 6-pin plastic socket). If the Dissolved Oxygen sensor is not connected, then the **Aqua-DP** will use manual temperature compensation.
4. Ensure that temperature has already been calibrated, or manually set (see sections 6.1 and 6.4). NOTE: If the decimal point in the temperature reading is replaced by a " * ", then the temperature readout is not calibrated.
5. Remove the wetting cap from the pH sensor.
6. Rinse the pH sensor in distilled water and blot dry.
7. Ensure that you are using the buffers which have been selected for automatic buffer recognition. See section 8 for a detailed explanation.
8. Place the pH sensor into a small sample of pH7.00 (or pH6.86) buffer, so that the bulb and reference junction are both covered. See the diagram over the page. The Dissolved Oxygen sensor can be placed into the same sample, or a separate beaker of water that is at the same temperature as the buffer.



DO NOT place the sensor(s) directly into the buffer bottle. Discard the used buffer after use.

9. When the reading has stabilised, press and hold the Cal key for 2 seconds to calibrate. If a 1 point calibration has been performed, a "*" will not be removed until a full 2 point calibration has been performed.
10. Rinse the pH sensor in distilled water and blot dry.
11. Place the pH sensor into a small sample of pH4.01, pH9.18 or pH10.01 Buffer, so that the bulb and reference junction are both covered, as per the diagram in step 8. **DO NOT** place the sensor directly into the buffer bottle. Discard the used buffer after use.

    pH9.18 and pH10.01 buffers are unstable once the bottles have been opened. Discard immediately after use.

12. When the reading has stabilised, press and hold the Cal key for 2 seconds to calibrate. The " * " will now be replaced by a decimal point, if calibration was successful.
13. The **Aqua-DP** is calibrated for pH and is ready for use in this mode.

4.2 pH Calibration Notes

1. A 1-point calibration should be performed at least weekly. In applications where the sensor junction can become blocked, such as dairy products, mining slurries etc, a 1-point calibration may have to be done daily.
2. A full 2-point calibration should be performed at least monthly. Of course, more frequent calibration will result in greater confidence in results.
3. All calibration information is retained in memory when the **Aqua-DP** is switched off, even when the battery is removed.
4. The **Aqua-DP** displays the value of the pH buffer that it has attempted to recognise at calibration. Ensure that the buffer value displayed corresponds to the buffer that you are using.

4.3 pH Calibration Messages

1. If a 1-point calibration has been successfully performed, the **Aqua-DP** will display the following message, and then display the asymmetry and slope of the sensor. If the meter has not been calibrated at two points at this stage, the slope is set to 100.0%.

1 point 7.00 Cal. OK	then:	Asym= 0.10pH Slope=100.0%

2. If a 1-point calibration has failed, the **Aqua-DP** will display the following message, then the failed asymmetry value of the sensor.

1 point 7.00 Cal. Failed	then:	Asym= 1.50pH

3. If a 2-point calibration has been successfully performed, the **Aqua-DP** will display the following message, and then the asymmetry and slope of the sensor.

2 point 4.01 Cal. OK	then:	Asym= 0.10pH Slope= 99.5%

4. If a 2-point calibration has failed, the **Aqua-DP** will display the following message, and then the failed slope value of the sensor.

2 point 4.01 Cal. Failed	then:	Slope= 70.0%

5. Millivolt Calibration

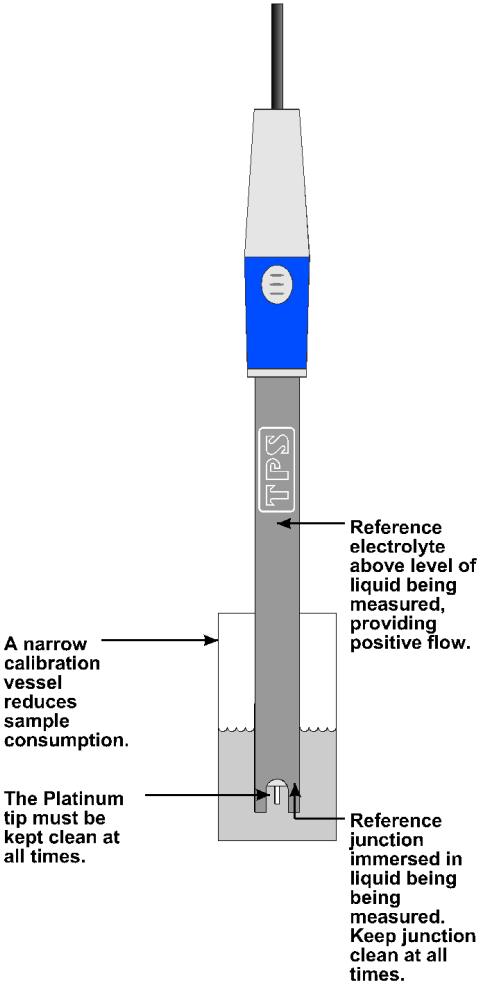
This calibration procedure is only applicable for calibrating a Redox sensor in +229mV Zobell solution.

A " * " in place of the decimal point indicates that the mV readout is not calibrated, or a past calibration has failed. The " * " will be removed once a one-point mV calibration has been successfully performed.

5.1 Calibration

1. Switch the **Aqua-DP** on.
2. Select mV Mode (see section 2).
3. Plug the ORP sensor into the BNC socket (this is the metal socket). Automatic temperature compensation is not applicable to mV mode, so it is not necessary to connect the Dissolved Oxygen sensor.
4. Remove the wetting cap from the ORP sensor.
5. Rinse the ORP sensor in distilled water and blot dry.
6. Ensure that you are using the buffers which have been selected for automatic buffer recognition. See section 8 for a detailed explanation.
7. Zobell Redox standard can be made with a 1:1 mixture of Part A and Part B. 10mL of each should suffice. This solution produces +229mV of Redox potential. **Caution: Zobell solution is poisonous and should be handled with care.**

8. Place the sensor into Zobell solution so that the platinum tip and reference junction are both covered as per the diagram below.



Discard the used standard after use.

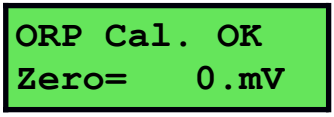
9. When the reading has stabilised, press and hold the Cal key for 2 seconds to calibrate. The " * " will now be replaced by a decimal point, if calibration was successful.
10. The **Aqua-DP** is calibrated for mV and is ready for use in this mode.

5.2 Millivolt Calibration Notes

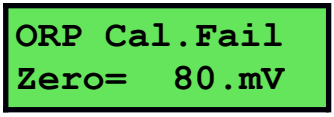
1. Calibration should be performed at least weekly. In applications where the sensor junction can become blocked, such as dairy products, mining slurries etc, a 1-point calibration may have to be done daily.
2. All calibration information is retained in memory when the **Aqua-DP** is switched off, even when the battery is removed.

5.3 Millivolt Calibration Messages

1. If calibration has been successfully performed, the **Aqua-DP** will display the following message, and the offset of the sensor. For example…



2. If calibration has failed, the **Aqua-DP** will display the following message, and the failed offset value of the sensor. For example…

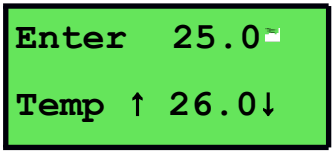


6. Temperature Calibration

A " * " in place of the decimal point indicates that the Temperature readout is not calibrated, or a past calibration has failed. The " * " will be removed once Temperature has been successfully calibrated.

6.1 Calibration

1. Switch the **Aqua-DP** on.
2. Select Temperature mode (see section 2).
3. Plug the Dissolved Oxygen sensor into the sensor socket.
4. Place the sensor into a beaker of room temperature water, alongside a good quality mercury thermometer. Stir the sensor and the thermometer gently to ensure an even temperature throughout the beaker.
5. When the reading has stabilised, press and hold the Cal key for 2 seconds.
6. The reading from the sensor is now displayed on the top line, and the value you are going to set is on the bottom line. For example…



7. Press the ▲ and ▼ keys until the bottom line shows the same temperature as the mercury thermometer.
8. Press the Cal key to calibrate the temperature readout.

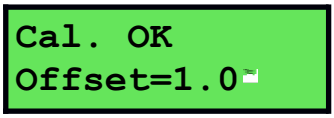
   Alternatively, press the Mode key to abort temperature calibration.

6.2 Calibration Notes

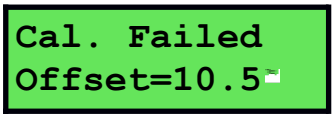
1. Temperature calibration information is stored in memory when the meter is switched off, even if the battery is removed.
2. Temperature does not need to be re-calibrated unless the Dissolved Oxygen sensor is replaced or the meter is initialised.

6.3 Calibration Messages

1. If a temperature calibration has been successfully performed, the **Aqua-DP** will display the offset value of the sensor. For example…

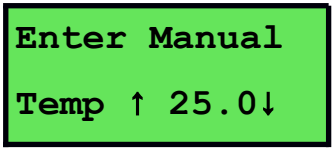


2. If a temperature calibration has failed, the **Aqua-DP** will display the failed offset value of the sensor.



6.4 Manual Temperature Setting

1. Switch the **Aqua-DP** on.
2. Select Temperature mode (see section 2).
3. Manual temperature setting is only available if the Dissolved Oxygen sensor is not connected.
4. Press and hold the Cal key for 2 seconds. The current Manual Temperature Setting is now displayed, for example…



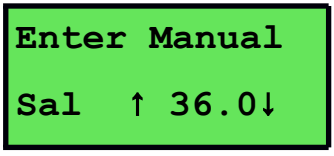
5. Press the ▲ and ▼ keys until the bottom line shows the temperature which you wish to set. This value should be the same as the temperature of the solution you are measuring.
6. Press the Cal key to set the temperature.

7. Setting the Salinity Correction Value

The salinity of the sample affects the Dissolved Oxygen reading in ppM mode. As the salinity increases, the solubility of Oxygen decreases. The Dissolved Oxygen sensor is not able to detect the salinity of the sample, so the operator must enter this value manually for salinity-corrected ppM Dissolved Oxygen readings.

To set the salinity correction value:

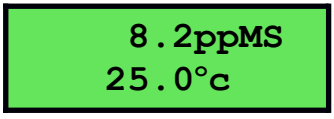
1. Measure the salinity of the sample solution. For best results, use a good quality salinity meter, such as a TPS model Aqua-C or WP-84. Note the reading.
2. Switch the **Aqua-DP** on.
3. Press the Mode key until the meter is in Salinity mode (see section 2). The currently selected salinity correction value is displayed.
4. Press and hold the Cal key for 2 seconds.
5. The display should now look like this:



6. Press the ↑ and ↓ keys until the bottom line shows the salinity value obtained in step 1.
7. Press the Cal or Mode key to set the salinity correction value.

NOTES:

1. For non-salinity corrected readings in ppM mode, simply set the salinity correction value to 0.0.
2. If the salinity correction value is set to above zero, an "**S**" is added to the display in ppM mode, to signify that salinity correction is being applied. For example…



3. The salinity correction value is ignored during zero and air calibration. There is therefore no need to re-set the salinity correction value when calibrating Dissolved Oxygen.

8. Selecting Buffers for Auto Buffer Recognition

The **Aqua-DP** is factory set to automatically recognise pH4.01, pH7.00 and pH9.18 buffers. However, some users may prefer to use pH6.86 instead of pH7.00 and pH10.01 instead of pH9.18. The following procedure describes how to set which of these buffers are automatically recognised at calibration.

1. Switch the meter **OFF**.
2. Press and HOLD the Cal key while switching the meter back on.
3. Release the Cal key when the message, "**Buffer 1 Select**" is displayed.
4. The display will now show the currently selected primary buffer, for example…

7.00pH ↑↓Select	▲ or ▼ ↔	6.86pH ↑↓Select

5. Use the ▲ or ▼ keys to alternate between pH7.00 and pH6.86 buffers.
6. Press the Mode key to save the primary buffer.
7. After the message, "**Buffer 2 Select**", the display will now show the currently selected secondary pH buffers, for example…

4.01/9.18pH ↑↓Select	▲ or ▼ ↔	4.01/10.0pH ↑↓Select

8. Use the ▲ or ▼ keys to alternate between pH9.18 and pH10.01 buffers (the display shows pH10.0 for the latter but this buffer is stored as pH10.01).
9. Press the Mode key to save the secondary pH buffers.
10. The buffer recognition setting is kept in memory when the meter is switched off, even if the battery is removed.

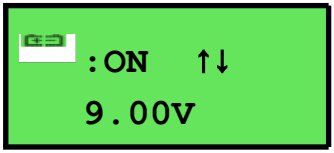
9. Battery

9.1 Battery Saver Function

The **Aqua-DP** is equipped with a battery saver function. If no button has been pressed for five minutes, the unit beeps and flashes the display for 20 seconds, and then shuts off. This function can be disabled for continuous use.

To enable or disable the battery saver function:

1. Switch the **Aqua-DP** on.
2. With the meter already switched on, press and HOLD the On/Off key for 3 seconds.
3. The battery saver menu is now displayed. For example…



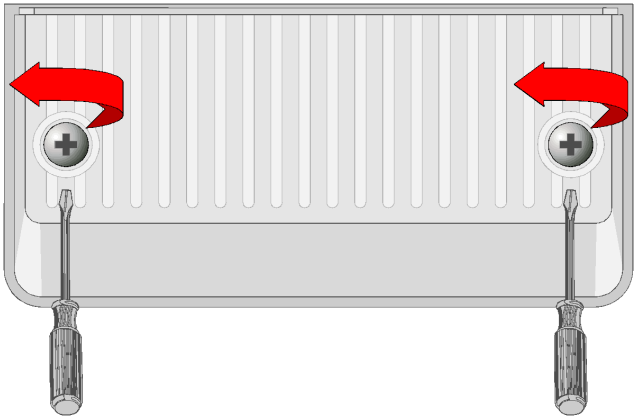
4. In this mode, use the ▲ or ▼ keys to toggle the battery saver function on or off.

   NOTE: The display also shows the battery volts. This gives the operator an idea of how much battery life is remaining. The ⊟ symbol flashes when the battery volts drops below 7.50 volts. At 6.00 volts the meter turns itself off.

5. When you have set the battery saver function to the desired position, press the Mode key to return to normal measurement mode.

9.2 Changing the Battery

1. Turn the instrument over and locate the 2 battery cover screws on the rear. See the diagram below.



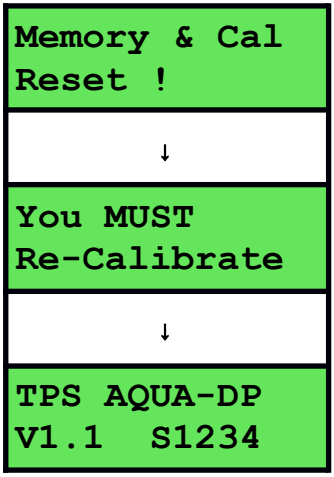
2. Raise the fold out stand (so it is out of the way) and then fully loosen both screws. It is not necessary to pull the screws all the way out. Lift off the battery cover.
3. Replace the battery with a new alkaline 9V battery.
4. Re-fit the battery cover and tighten the screws. **Do not over-tighten**.

10. Initialising the Aqua-DP

If the calibration settings of the **Aqua-DP** exceed the allowable limits, and the unit cannot be re-calibrated, then it may need to be initialised to factory default values. This action may be required if an sensor is replaced.

To initialise the **Aqua-DP**…

1. Switch the **Aqua-DP** off.
2. Press AND HOLD the ⏏ key while switching the **Aqua-DP** on.
3. The following messages are now displayed…



4. The meter then displays Dissolved Oxygen, pH and Temperature. Note that the decimal points have been replaced with a " * ", to indicate that the unit requires re-calibration.

11. Troubleshooting

11.1 General Error Messages

Error Message	Possible Causes	Remedy
Factory Cal. Fail **See Handbook**	The EEPROM chip which contains the factory calibration information has failed.	The unit must be returned to TPS for service.
Memory Failed **Calib. Lost** **Memory Reset !** **You MUST Re-Cal.**	User calibration settings have been lost or corrupted.	Re-calibrate the instrument. Both a Zero and an Air calibration are required for Dissolved Oxygen (section 3), a 2 point calibration for pH (section 4) and a 1 point calibration for temperature (section 6).
Meter displays the word **OFF**, and switches off.	Battery is below 6.00 volts.	Replace the battery.
Meter will not turn on.	Battery is exhausted.	Replace the battery.
Flashing  symbol.	Battery is below 7.50 volts.	Replace the battery soon. Note that the unit will switch itself off when the battery falls below 6.00 volts.

11.2 Dissolved Oxygen Troubleshooting

Symptom	Possible Causes	Remedy
Unit fails to calibrate, even with new sensor.	Calibration settings outside of allowable limits due to previous failed calibration.	Initialise the unit. See section 10.
Zero calibration fails (Zero is greater than 7.0%) Air calibration fails (Span is less than 70% or	1. Membrane is leaking or broken. 1. Gap between membrane and gold cathode is dry. 2. Incorrectly fitted membrane.	Replace membrane and refill sensor. Undo the barrel 3 turns, then re-tighten to re-flush the filling solution. Membrane should be smooth and convex with no wrinkles.

greater than 135%). Unstable or inaccurate readings.	 3. Sensor is empty. 4. Sensor is faulty.	Re-fit membrane if necessary. Replace membrane and re-fill sensor. Return sensor to factory for repair or replacement
Blackened Silver anode	Sensor has been exposed to sulphides or other chemical poisoning.	Return to the TPS factory for cleaning and service.
Tarnished or scratched Gold cathode.	Sensor has been chemically poisoned or physically damaged.	Return to the TPS factory for cleaning and service.
Meter reads **OVR ppM** or **OVR%S**.	1. Sensor has not yet polarised. 1. Sensor is faulty	Wait for 2-3 minutes for the sensor to polarise after the **Aqua-DP** is switched on. Return sensor to factory for repair or replacement.

For complete details on the operation, care and maintenance of your YSI Dissolved Oxygen sensor, see the separate leaflet that is supplied with the sensor.

11.3 pH Troubleshooting

Symptom	Possible Causes	Remedy
Unit fails to calibrate, even with new sensor.	Calibration settings outside of allowable limits due to previous failed calibration.	Initialise the unit. See section 10.
1 Point calibration fails (Asymmetry is greater than +/-1.00 pH).	1. Reference junction blocked.	Clean reference junction, as per instructions supplied with the sensor.
	1. Reference electrolyte contaminated.	Flush with distilled water and replace electrolyte.
2 Point calibration fails (Slope is less than 85.0%).	1. Incorrect primary buffer.	Ensure that you are using the buffers which the **Aqua-DP** has been set to automatically recognise (See section 8).
	1. Glass bulb not clean.	Clean glass bulb as per instructions supplied with the sensor.
	2. Sensor is aged.	Attempt rejuvenation, as per instructions supplied with the sensor. If not successful, replace sensor.
	3. Connector is damp.	Dry in a warm place.
	4. Buffers are inaccurate.	Replace buffers.

Continued over the page…

pH Troubleshooting, continued...

Unstable readings.	1. Reference junction blocked. 1. Glass bulb not clean. 2. Bubble in glass bulb. 3. Faulty connection to meter. 4. Reference junction not immersed. 5. KCl crystals around reference junction, inside the electrolyte chamber.	Clean reference junction, as per instructions supplied with the sensor. Clean glass bulb as per instructions supplied with the sensor. Flick the sensor to remove bubble. Check connectors. Replace if necessary. Ensure that the bulb AND the reference junction are fully immersed. Rinse electrolyte chamber with warm distilled water until dissolved. Replace electrolyte.
Inaccurate readings, even when calibration is successful.	Reference junction blocked.	Clean reference junction, as per instructions supplied with the sensor.
Displays 7.00 for all solutions.	Electrical short in connector.	1. Check connector. Replace if necessary. 1. Replace sensor.
Displays 4-5 pH for all solutions.	Glass bulb or internal stem cracked.	Replace sensor.

11.4 ORP Troubleshooting

Symptom	Possible Causes	Remedy
Unit fails to calibrate, even with new sensor.	Calibration settings outside of allowable limits due to previous failed calibration.	Initialise the unit. See section 10.
Calibration fails (Zero is outside ±60mV range).	1. Reference junction blocked.	Clean reference junction, as per instructions supplied with the sensor.
Unstable readings.	1. Reference junction blocked. 2. Platinum tip not clean. 3. Faulty connection to meter. 4. Reference junction not immersed.	Clean reference junction, as per instructions supplied with the sensor. Clean platinum tip as per instructions supplied with the sensor. Check connectors. Replace if necessary. Ensure that the platinum tip AND the reference junction are fully immersed.
Inaccurate readings, even when calibration is successful.	Reference junction blocked.	Clean reference junction, as per instructions supplied with the sensor.
Displays 0mV for all solutions.	Electrical short in connector.	1. Check connector. Replace if necessary. 2. Replace sensor.

11.5 Temperature Troubleshooting

Symptom	Possible Causes	Remedy
Displays "**OVRºC**" when Dissolved Oxygen sensor is plugged in.	1. Faulty Dissolved Oxygen cable or sensor. 1. Faulty instrument.	Fit new cable or sensor as required. Return instrument to factory for repair.
Temperature inaccurate and cannot be calibrated.	1. Faulty connector, cable or sensor. 1. Faulty instrument.	Check the connector, cable and sensor and replace as necessary. Return instrument to factory for repair.

12. Appendices

12.1 Dissolved Oxygen Sensor Fundamentals

The sensor used is the amperometric type of Clark Sensor and is suitable for the measurement of oxygen pressures in the range 0 to 100 cm of mercury. While the sensor actually reads partial pressure of oxygen, the circuit is calibrated to be read in percentage saturation or parts per million (Milligrams/litre). The operation of the Clark type sensor relies on the diffusion of oxygen through a suitable membrane into a constant environment of potassium chloride. Solution measurements are best performed with a reasonable flow past the membrane. At sufficiently high flow rates, the oxygen current is totally independent of the flow (a few cm/sec is sufficient). The cell must not be shaken however or unstable readings will result from electrolyte surge bringing new oxygen from the reservoir to the working cathode surface.

12.1.1 Operating Principle

The Clark oxygen sensor consists of a gold cathode and a silver/silver chloride anode, placed in an electrolyte solution. This solution is contained behind a plastic membrane. In this case the plastic is 0.001 inch PTFE (Teflon) sheet. It must be realised that using membranes of very different thicknesses will result in an error in the temperature compensation that is applied in the instrument for the membrane permeability. This coefficient is +4.2%/^{o}C at 25^{o}C for this thickness membrane.

A polarising voltage of about 800 millivolts is applied between the two electrodes. The gold electrode is placed close to the membrane and because of the polarising voltage, oxygen diffusing through the membrane will be reduced at the gold electrode.

Equation : $O_2 + 2H^+ + 2\text{ electrons} \rightarrow H_2O_2$

This reduction process will produce a current through the oxygen sensor. A load resistor (actually a thermistor in this case) situated in the sensor itself, converts this current into a voltage proportional to the oxygen partial pressure. The thermistor provided within the body of the sensor has a temperature coefficient of -4.2%/^{O}C. This gives an accurate temperature compensation for the temperature/permeability effect of the membrane, over a range of about 5 to 45 ^{O}C about a centre value of 25^{O}C. Note this

compensation is not for the solubility effects. A separate sensor also built into the tip of the sensor achieves this.

12.1.2 Maintenance Of The Membrane

The membrane does not require replacement as long as it remains intact. If punctured or suspected of leaking around the edges, it must be replaced.

Oils, fats or other greasy build-ups will reduce the sensitivity of the sensor, eventually making it fail to calibrate. When this occurs, it may be easier and more effective to change the membrane rather than clean it.

Please see the separate instruction leaflet supplied with the Dissolved Oxygen sensor for details on how to change the membrane.

12.1.3 Sensor Storage

The Dissolved Oxygen sensor should be kept moist when not in use to prevent the thin film of electrolyte behind the membrane from drying out. To achieve this, the sensor can be stored with the tip in water. Alternatively, the probe tip can be inserted back into the plastic calibration cap. It's important to ensure that the sponge disc inside the calibration cap is kept moist with distilled water.

For long term storage of several weeks or more, the Dissolved Oxygen sensor is best stored dry. When the sensor is stored in this way, the membrane should be replaced and the sensor refilled before use.

12.1.4 Notes On Units Of Dissolved Oxygen

The terms "Oxygen Concentration" and "Oxygen Partial Pressure" frequently give rise to some confusion.

Oxygen Concentration is the absolute quantity of oxygen present per unit mass of the liquid.

Oxygen Partial Pressure is the oxygen fraction of the total pressure of all of the gases present.

For any one liquid system, Oxygen Concentration and Oxygen Partial Pressure are proportional. However, if the solubility of oxygen in the liquid should change owing to increased quantities of solutes, etc., then the ratio of the Concentration to the Partial Pressure must change. Thus, if one saturates distilled water and a 25% solution of Sodium Chloride with air at atmospheric pressure (25°C) both solutions will have almost exactly the same Oxygen Partial Pressure, namely 15.5 cm of mercury. However, the dissolved Oxygen Concentration parts per million (milligrams per litre) will be 8.2 in the distilled water and 2.01 in the salt solution. This is a rather extreme example, as ocean water is only 3.6% saline. It does however stress the importance of correct interpretation of the salinity.

The Clark Sensor measures the partial pressure of oxygen diffusing through a membrane. The current is a linear measure of this partial pressure, assuming sufficient liquid flow conditions.

With air at sea level, the 20.9% oxygen exerts about 15.5 cm of Mercury pressure. Water in equilibrium with air and with no oxygen demand (C.O.D., B.O.D. etc.), is saturated and has this dissolved oxygen partial pressure. If we define 100% Saturation in Partial Pressure terms, then 15.5 cm. Hg = 100% Saturation. This is a practical unit to use. The sensor readout is then a linear function of % Saturation. Organic cell walls and the Dissolved Oxygen sensor behave in the same way, so % Saturation units are a more meaningful measure of the Dissolved Oxygen requirement of biological organisms (eg fish).

% Saturation is the best unit for industrial control and not ppM, contrary to popular beliefs. The partial pressure (and consequently the pressure defined % Saturation) varies only slightly with temperature. (Recall at this stage that the permeability of the membrane has a temperature coefficient, but the electronics has scaled this out by the operation of the

Automatic Membrane Temperature Compensator Thermistor incorporated in the D.O. sensor).

If mass units are used for measurement of Dissolved Oxygen, the temperature problem of relating the linear partial pressure reading of the sensor to the mass (ppM or mg/L) at different temperatures becomes more involved. As well, there is the mass variation due to dissolved salts (salinity correction). Therefore, the fully corrected instrument would need 3 correction systems.

(a) Membrane correction for temperature permeability effects ;

(b) Solubility correction of Dissolved Oxygen with temperature and ;

(c) Salinity correction of Dissolved Oxygen by weight (Salinity has no effect on pressure units readout).

In the **Aqua-DP** instrument,

(a) Membrane correction is achieved AUTOMATICALLY ;

(b) To provide the mass units (ppM) readout (so popular due to the Winkler process used in the past), the **Aqua-DP** Meter has Solubility Correction via an additional temperature sensor in the sensor ;

(c) Salinity correction is performed automatically once the Salinity value of the solution is entered (section 7).

12.1.5 Equilibrium Conditions

Whilst Saline Water has a lower ppM than does Fresh Water, it does not mean it necessarily has less biologically available oxygen. Both have 100% Saturation (presuming no Chemical Oxygen Demand (C.O.D.), Biological Oxygen Demand (B.O.D.), etc.) because both are in partial pressure equilibrium with air. Any usage of oxygen is immediately replenished by the dissolving of more from air to meet partial pressure equilibrium requirements. This is so for both saline and fresh water. The reporting of oxygen at a lower level (in ppM units) in Salt Water is therefore QUITE MISLEADING !

In closed systems, such as tanks, pipes and deep waters, equilibrium is not so readily available and the Salinity Effect gains importance in the reporting of Dissolved Oxygen. It is suggested, unless such closed (or deep, low diffusion) systems are encountered, that Oxygen should be reported in % Saturation or ppM of equivalent Fresh Water.

12.1.6 Velocity Past the Membrane

Research has shown that the relationship between the diffusion current (oxygen current) and the external velocity of the liquid is exponential. Some workers using thicker membranes have shown even less dependence of the diffusion current on liquid velocity. Because of the exponential nature of the relationship, considerable changes in velocity have to be made before noticing any change in the diffusing current once the flow is sufficiently high. Tests with this sensor have shown that flow rates above 0.2 litres/minute past the membrane give results indistinguishable from those with appreciably higher flow rates (5 litres/minute). Fluctuations in readings due to air bubbles passing through the membrane are a different matter, however.

With the type of sensor to be used with this instrument, very little change in diffusion current is caused by altering the pH of the external environment. Pressure changes over a moderate range exerted on the membrane also cause no change. The YSI Dissolved Oxygen sensor has a unique pressure compensation system which is effective to 100psi or 230 feet/70.10 metres.

12.2 pH Sensor Fundamentals

A combination pH sensor is two sensors in one. The sensing membrane is the round or spear shaped bulb at the tip of the sensor. This produces a voltage that changes with the pH of the Solution. This voltage is measured with respect to the second part of the sensor, the reference section. The reference section makes contact with the sample solution using a salt bridge, which is referred to as the reference junction. A saturated solution of KCl is used to make contact with the sample. It is vital that the KCl solution has an adequate flow rate in order to obtain stable, accurate pH measurements.

12.2.1 Asymmetry of a pH Sensor

An “ideal” pH sensor produces 0 mV output at 7.00 pH. In practice, pH sensors generally produce 0 mV output at slightly above or below 7.00 pH. The amount of variance from 7.00 pH is called the asymmetry. Figure 12 - illustrates how asymmetry is expressed.

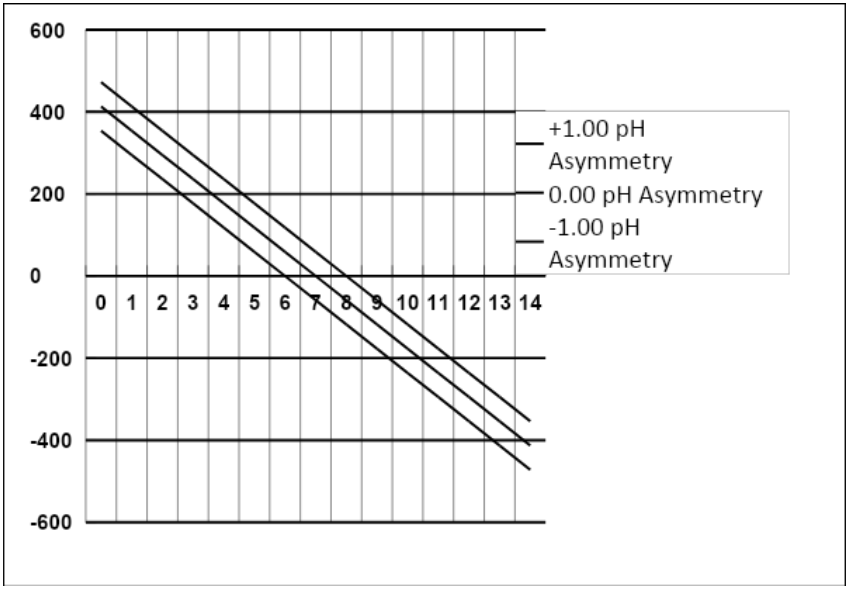


Figure 12-1

12.2.2 The Slope of a pH Sensor

As mentioned above, a pH sensor produces 0 mV output at around 7.00 pH. As the pH goes up, an “ideal” pH sensor produces -59mV/pH unit at 25 ^{O}C As the pH goes down, an ideal pH sensor produces +59mV/pH unit. In practice, pH sensors usually produce slightly less than this. The output of a pH sensor is expressed as a percentage of an ideal sensor. For example, an ideal sensor that produces 59mV/pH unit has “100% Slope”. An sensor that produces 50.15mV/pH unit has “85% Slope” (see Figure 12 -).

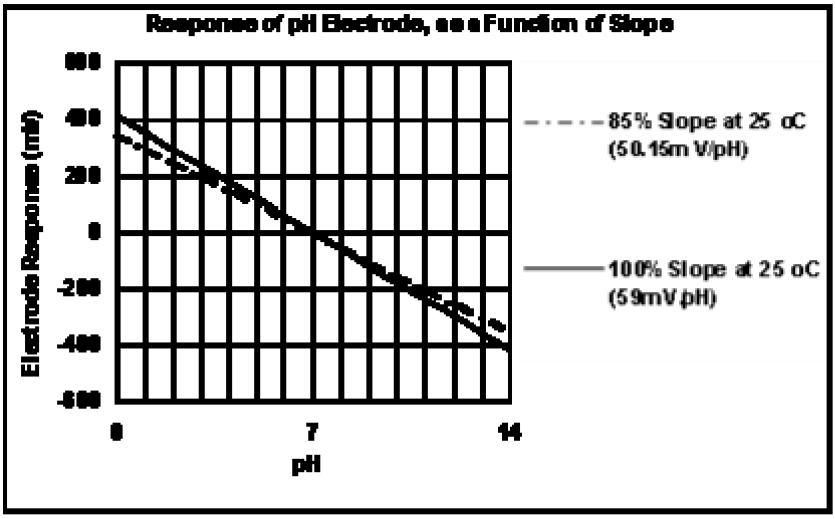


Figure 12-2

12.2.3 Temperature Compensation

The slope of a pH sensor (section 12.2.2) is affected by temperature. This effect is compensated for either by using an Automatic Temperature Compensation (ATC) sensor or by entering the sample temperature manually. Figure 12 - shows the slope of a pH sensor at various temperatures.

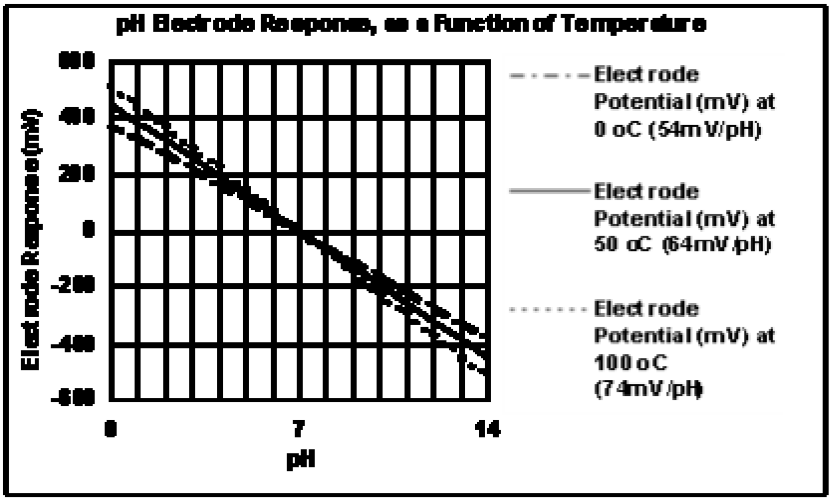


Figure 12-3

12.3 Instrument software version number.

If you need to phone or fax TPS for any further technical assistance, the version number of your **Aqua-DP** firmware may of benefit to us. Please obtain the version number before phoning or faxing.

The version number is displayed on the bottom left of the display when the **Aqua-DP** is switched on. For example…

```
TPS AQUA-DP
V1.3  S1234
```

"**V1.3**" in this example is the firmware version number.

"**S1234**" in this example is the instrument's serial number.

13. Warranty

TPS Pty Ltd guarantees all instruments and sensors to be free from defects in material and workmanship when subjected to normal use and service. This guarantee is expressly limited to the servicing and/or adjustment of an instrument returned to the TPS Pty Ltd Factory Service Centre, freight prepaid, within twelve (12) months from the date of delivery, and to the repairing, replacing, or adjusting of parts which upon inspection are found to be defective. Warranty period on sensors is twelve (12) months.

Freight costs to and from the factory are the responsibility of the purchaser. Shipping damage is not covered by this warranty.

TPS Pty Ltd accepts no liability for any incidental or consequential damages caused by or resulting from the use or misuse of this equipment either due to failure of the equipment, incorrect calibration, incorrect operation, or from interpretation of information derived from the equipment. Specifications are subject to change without notice. This warranty becomes invalid if modifications or repairs are carried out on this unit by unauthorised persons. There are no express or implied warranties which extend beyond the face hereof.

Procedure for Service

Please read service details on our **'Service and Repair'** page at **www.tps.com.au**.

TPS Pty Ltd has a reputation for prompt and efficient service. If you feel that this equipment is in need of repair, please re-read the manual. Sometimes, instruments are received for "repair" in perfect working order. This can occur where batteries simply require replacement or re-charging, or where the sensor simply requires cleaning or replacement.

Return the instrument AND ALL SENSORS to TPS Pty Ltd freight pre-paid. It is your responsibility as the sender to ensure that TPS Pty Ltd receives the unit, so consider using a traceable freight service.

Please check that the following is enclosed with your equipment:

A TPS ‘Service / Return Goods Form’ – from our website.

Your full name

Your company name

Your email address

Your return street address

A description of the fault. (Please be specific - "Please Repair" does not describe a fault.)

Your equipment will be repaired and returned to you by express air freight where possible.

For instruments beyond warranty period, a repair cost will be calculated from parts and labour costs and emailed to you. If you decline to have the equipment repaired, the complete instrument will be returned to you freight paid, not serviced.