Congratulations !

The **smart*CHEM*-D** is an advanced, high quality Dissolved Oxygen, Conductivity, TDS and Temperature meter.

Despite its impressive list of features, the **smart*CHEM*-D** is a breeze to operate. This manual has been designed to help you get started, and also 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:

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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.

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

3. **Main Section**
   The main section of the handbook provides complete details of the **smart*CHEM*-D**, including operating modes, calibration, troubleshooting, specifications, and warranty terms.

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

smart*CHEM*-D
Dissolved Oxygen, Conductivity, TDS, Temperature Meter
Date : 20-Aug-2002
Author : KE
Version : 1.0

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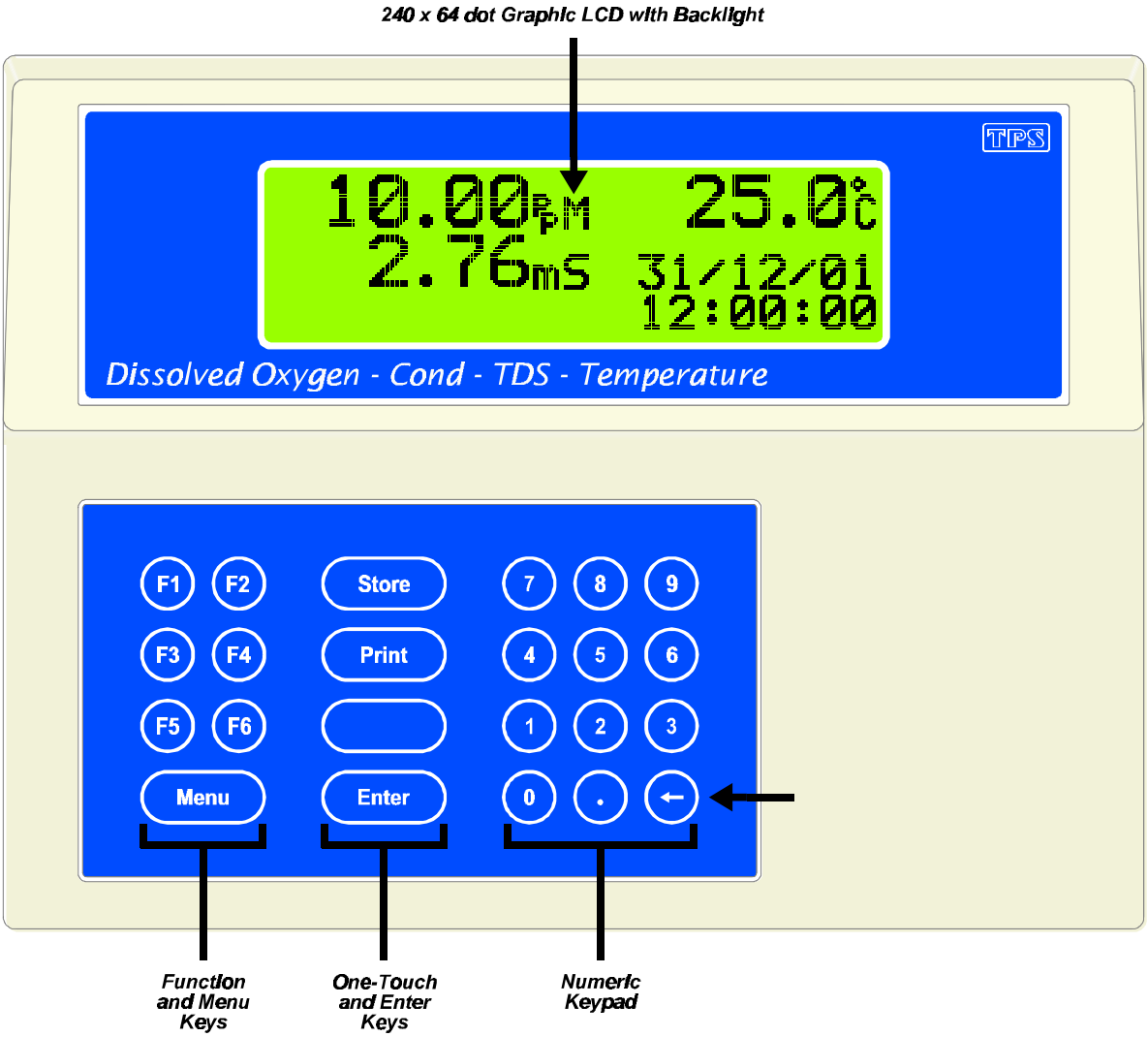
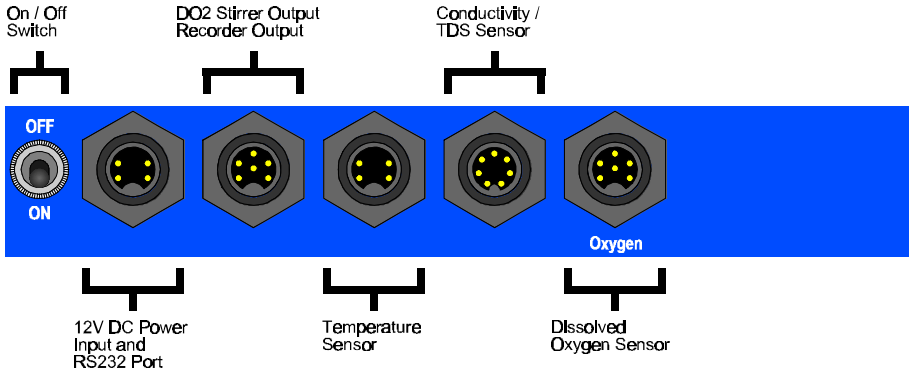
Contents

1. Introduction

1.1 smart*CHEM*-D Display and Controls



1.2 smart*CHEM*-D Rear Panel Connectors



Turn the retaining nut clockwise until it clicks into place when plugging in plastic connectors. This is essential to produce a waterproof seal.

Always replace the waterproof cap when a connector is not in use to maintain waterproof integrity.

1.3 Function and Menu Keys

Press Menu to enter the user-friendly menu system. Menu is also used to step backwards through the menu one level at a time, and as an “escape” key to quit functions such as calibration, data entry etc.

Press the F1 to F5 function keys to select desired options within the menu system.

Additionally, these keys perform the following function directly in normal measurement mode…

F2 : Press to start and stop the optional Dissolved Oxygen stirrer. See section 3.2.2.

F5 : Press to start and stop the Automatic Stability Function. See section 7.

1.4 One-touch Keys

Store : Press to manually record readings into the Logger. See section 11.1.

Print : Press to transmit current reading plus date and time to the RS232 port. See section 12.2.

AutoLog : Press to start and stop Automatic Datalogging. See section 11.2.

Enter : Press Enter to accept default values or those entered on the Numeric Keypad.

1.5 Numeric Keypad

Used to enter values during set-up and calibration. A decimal point is provided.

1.6 Delete Key

Press ⇦ to make corrections to values entered on the Numeric Keypad.

1.7 240 x 64 Dot Graphic Display

Graphic display with large, clear digits and letters. Features a user-friendly menu and context-sensitive help system. Shows Dissolved Oxygen, Conductivity/TDS, Temperature, Date and Time simultaneously.

Backlight can be set to On, Off or Energy Saver modes. See section 8.

1.8 Unpacking Information

Before using your new **smart*CHEM*-D**, please check that the following accessories have been included:

Part No

Standard Kit…

1. **smart*CHEM*-D** Dissolved Oxygen, Conductivity, TDS, Temperature Meter 123104
2. k=1/ATC/Temp Conductivity/TDS Sensor 122230
3. Temperature/ATC Sensor 121248
4. 2.76 mS/cm Conductivity Standard, 200mL 122306
5. 2.0 ppK TDS Standard, 200mL 122307
6. Plug-Pack Power Supply 130037
7. **smart*CHEM*-D** Handbook 130050

Optional sensors that may have been ordered with your smartCHEM-D…

1. ED1 Dissolved Oxygen sensor 123400
2. 1m Cable for ED1 DO_2 sensor 123228
3. YSI Non-stirring DO_2 sensor for BOD bottles 123214
4. YSI Self-stirring DO_2 sensor for BOD bottles 123213
5. YSI Field type DO_2 sensor 123204
6. 1m Cable for YSI Field DO_2 sensor 123212
7. k=0.1/ATC/Temp Conductivity/TDS Sensor 122232
8. k=10/ATC/Temp Conductivity/TDS Sensor 122234

Instrument Options…

1. Flexible arm type electrode holder 130088
2. RS232 Serial Interface Cable 130041
3. Recorder Output Option (includes cable) 130028
4. ...Serial to USB adaptor (must also have 130041 Serial Cable) 130087
5. WinTPS RS232 Communication software for Windows 95, 98 and ME 130086
6. Adaptor for 4.5V DC output for Oxygen Stirrers 123311

A complete range of Conductivity/TDS sensors is available from TPS.

1.9 Specifications

1.9.1 Dissolved Oxygen

Ranges	Resolution	Accuracy
ED1 Sensor		
0 to 20.00 ppM 20.0 to 40.0 ppM	0.01 ppM 0.1 ppM	±0.2% of full scale of selected range
0 to 250.0 % Saturation 250 to 450 % Saturation	0.1 % Saturation 1 % Saturation	±0.3 % Saturation
0 to 50.0 % Gaseous 50 to 100 % Gaseous	0.1 % Gaseous 1 % Gaseous	±0.1 % Gaseous
YSI Sensors		
0 to 25.00 ppM 25.0 to 40.0 ppM	0.01 ppM 0.1 ppM	±0.2% of full scale of selected range
0 to 300.0 % Saturation 300 to 450 % Saturation	0.1 % Saturation 1 % Saturation	±0.3 % Saturation
0 to 60.0 % Gaseous 60 to 100 % Gaseous	0.1 % Gaseous 1 % Gaseous	±0.1 % Gaseous
Note : Ranges are automatically selected. Exact auto-ranging points and full scales are subject to sensor performance.		

Sensor Type ..... Clark type polarographic sensor, with in-built ATC.

Salinity Correction ..... 0 to 50.0 ppK, automatic using conductivity/TDS reading.

Temperature Compensation ..... Automatic for membrane permeability.
Automatic for Dissolved Oxygen solubility in ppM mode.

Calibration ..... Automatic zero and span calibration.

Sensor Span Range ..... 65 to 200 %

1.9.2 Conductivity

Ranges	Resolution	Accuracy
	k=0.1 Sensor	
0 to 2.000 µS/cm 0 to 20.00 µS/cm 0 to 200.0 µS/cm 0 to 2000 µS/cm	0.001 µS/cm 0.01 µS/cm 0.1 µS/cm 1 µS/cm	±0.5% of full scale of selected range at 25 ^{O}C
	k=1.0 Sensor	
0 to 20.00 µS/cm 0 to 200.0 µS/cm 0 to 2000 µS/cm 0 to 20.00 mS/cm	0.01 µS/cm 0.1 µS/cm 1 µS/cm 0.01 mS/cm	±0.5% of full scale of selected range at 25 ^{O}C
	k=10 Sensor	
0 to 200.0 µS/cm 0 to 2000 µS/cm 0 to 20.00 mS/cm 0 to 200.0 mS/cm	0.1 µS/cm 1 µS/cm 0.01 mS/cm 0.1 mS/cm	±0.5% of full scale of selected range at 25 ^{O}C
Note : Ranges are automatically selected. Exact auto-ranging points and full scales are subject to sensor performance.		

Sensor Type..... Glass body with two platinised platinum plates. In-built ATC.

Temperature Compensation..... Automatic, 0 to 100 ^{O}C

Calibration ..... Automatic zero and span calibration.

Sensor Span Range..... k=0.1 : k=0.075 to k=0.133
k=1.0 : k=0.75 to k=1.33
k=10 : k=7.5 to k=13.3

1.9.3 TDS

Ranges	Resolution	Accuracy
k=0.1 Sensor		
0 to 1.000 ppM 0 to 10.00 ppM 0 to 100.0 ppM 0 to 1000 ppM	0.001 ppM 0.01 ppM 0.1 ppM 1 ppM	±0.5% of full scale of selected range at 25 ^{O}C
k=1.0 Sensor		
0 to 10.00 ppM 0 to 100.0 ppM 0 to 1000 ppM 0 to 10.00 ppK	0.01 ppM 0.1 ppM 1 ppM 0.01 ppK	±0.5% of full scale of selected range at 25 ^{O}C
k=10 Sensor		
0 to 100.0 ppM 0 to 1000 ppM 0 to 10.00 ppK 0 to 100.0 ppK	0.1 ppM 1 ppM 0.01 ppK 0.1 ppK	±0.5% of full scale of selected range at 25 ^{O}C
Note : Ranges are automatically selected. Exact auto-ranging points and full scales are subject to sensor performance.		

Sensor Type ..... Glass body with two platinised platinum plates. In-built ATC.

Temperature Compensation ..... Automatic, 0 to 100 ^{O}C

Calibration ..... Automatic zero and span calibration.

Sensor Span Range ..... k=0.1 : k=0.075 to k=0.133
k=1.0 : k=0.75 to k=1.33
k=10 : k=7.5 to k=13.3

1.9.4 Temperature

Range	Resolution	Accuracy
-10.0 to 120.0 ^{O}C	0.1 ^{O}C	±0.2 ^{O}C

Sensor Type ..... Silicon transistor

Calibration ..... Automatic offset calibration

Sensor Offset Range ..... -10.0 to 10.0 ^{O}C

1.9.5 General Specifications

Memory ..... 1489 readings including date and time

Automatic Logging ..... User-set for one reading every 2 to 90 seconds, minutes or hours.

RS232 Port ..... 1200, 9600, 19200 & 38400 baud.
8 bits, no parity, 1 stop bit, XON/XOFF Protocol.

Clock ..... Calendar clock displays date, month, year, hours, minutes & seconds.

Good Laboratory Practices ..... Date, time and results of last calibration for all parameters are stored. This information can be recalled or sent to the RS232 port at any time.

Power ..... 12V DC, 90 mA (backlight off) / 130 mA (backlight on). AC/DC adaptor to suit country of destination is included in standard kit.

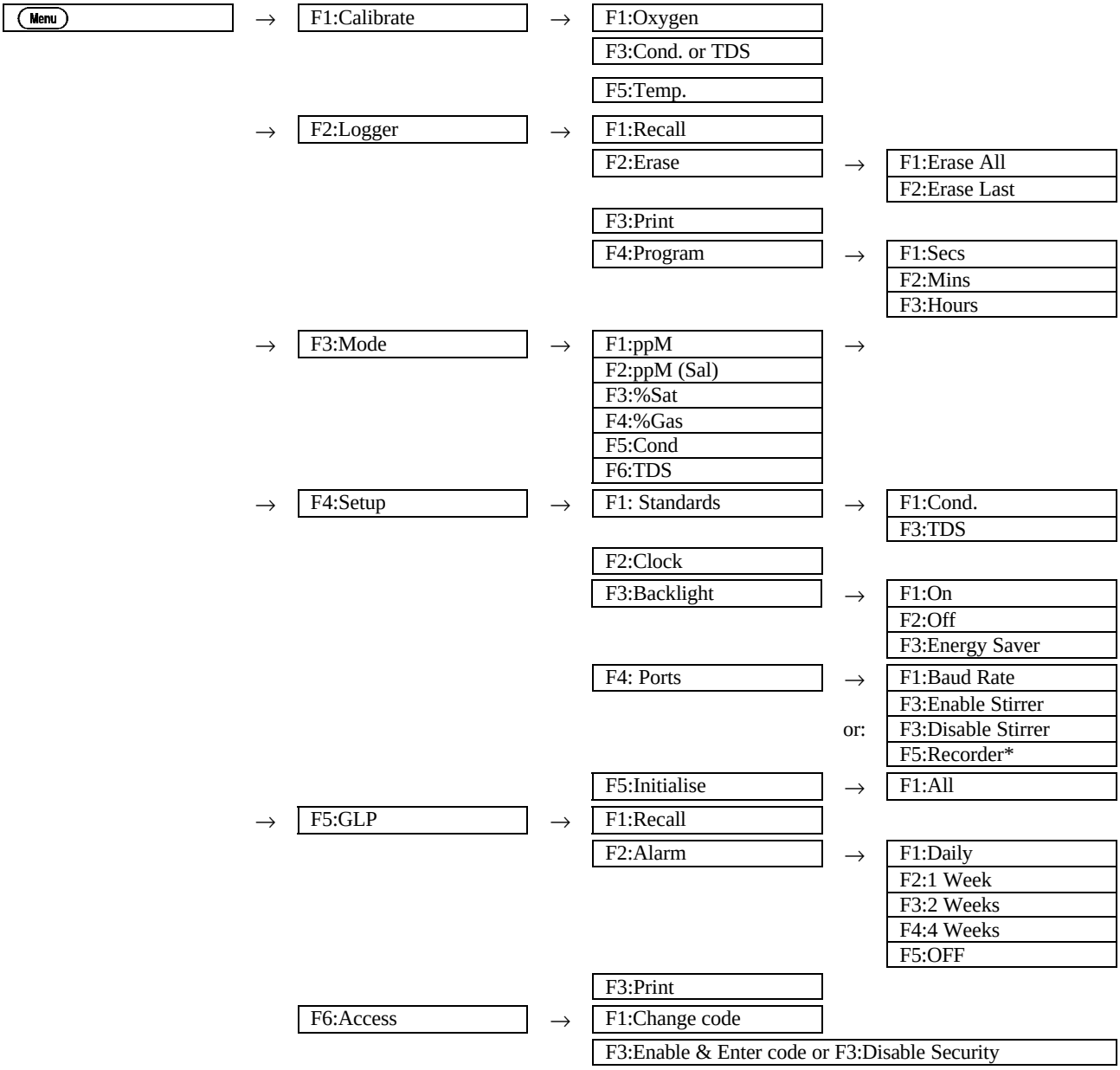
Dimensions ..... 240 x 180 x 105 mm

Mass ..... Instrument only : Approx. 1.0 kg
Full Kit : Approx. 3.0 kg

Environment ..... Temperature : 0 to 45 ^{O}C
Humidity : 0 to 90 % R.H.

2. smart*CHEM*-D Menu Structure

A detailed breakdown of the menu system of the **smart*CHEM*-D** is shown below. This diagram provides a quick reference for the menu functions available for the **smart*CHEM*-D**.



* This function only available when Recorder Port option is fitted.

3. Dissolved Oxygen Mode

3.1 Selecting Dissolved Oxygen Mode

1. Select Mode (Menu → **F3:Mode**).
2. The Mode readout units selection screen is now displayed…

```
 MODE
>F1:ppM   F2:ppM (Sal)
 F3:%Sat  F4:%Gas
>F5:Cond. F6:TDS
```

The arrow indicates the current selection.

Press F1 to select Dissolved Oxygen readout in ppM units. This selection will not apply Salinity correction to the displayed readings.

Press F2 to select Dissolved Oxygen readout in Salinity-corrected ppm units. This selection will use the Conductivity or TDS reading for automatic Salinity correction.

Press F3 to select Dissolved Oxygen readout in % Saturation units.

Press F4 to select Dissolved Oxygen readout in % Gaseous units.

Press Menu to quit without changing the current setting.

3.2 Dissolved Oxygen Stirrer

The **smart*CHEM*-D** is equipped with a 4.5V DC output to power a stirrer for the Dissolved Oxygen sensor. This power output is suitable for the YSI self-stirring BOD sensor (part number 123213), or the TPS submersible DO_2 stirrer (part number 123305).

The 4.5V output is available at the **Accessories** connector on the rear of the **smart*CHEM*-D**. When using the YSI self-stirring BOD sensor (part number 123213), please use the optional adaptor cable (part number 123311).

The Control output is capable of supplying 150 mA, which is ample for the two stirrers detailed above.

3.2.1 Enabling and Disabling the Dissolved Oxygen Stirrer Output

1. Select the Ports menu (Menu → **F4:Setup** → **F4:Ports**).
2. Select **F3:Enable Stirrer** or **F3:Disable Stirrer** from the menu as required.

3.2.2 Starting and Stopping the Dissolved Oxygen Stirrer

1. Ensure that the Dissolved Oxygen stirrer output has been enabled, as per section 3.2.1.
2. Press F2 once in normal display mode to start the stirrer. The stirrer will stay on for 40 seconds and then stop. A countdown is provided on the screen. The unit will beep every second for the last five seconds.
3. Press F2 a second time any time during the 40 second period to set the Dissolved Oxygen stirrer to operate continuously. The stirrer icon plus the word "**ON**" is shown on the display.
4. Press F2 a third time to stop the Dissolved Oxygen stirrer.

The operator has the choice whether or not to operate the Dissolved Oxygen stirrer during automatic datalogging. See section 11.2.

3.3 Dissolved Oxygen Calibration

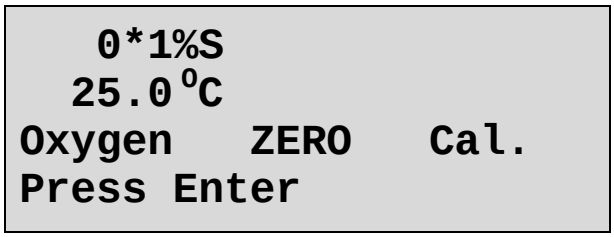
1. Plug the Dissolved Oxygen sensor into the **Oxygen** socket.
2. Switch the meter on.
3. Select the Dissolved Oxygen readout mode to be used, as detailed in section 3.1.
4. Ensure that the Temperature readout has been calibrated. When a separate Temperature sensor is connected, the **smart*CHEM*-D** will use it for Automatic Temperature Compensation in the ppM Dissolved Oxygen modes. When the Temperature sensor is not connected, the **smart*CHEM*-D** will use the Temperature sensor built into the tip of the Dissolved Oxygen sensor for Automatic Temperature Compensation in the ppM Dissolved Oxygen modes.

   It is vital that the correct Temperature sensor is calibrated. See section 6.1 for a detailed explanation.
5. Rinse the Dissolved Oxygen sensor (and Temperature sensor, if applicable) in distilled water and blot dry.

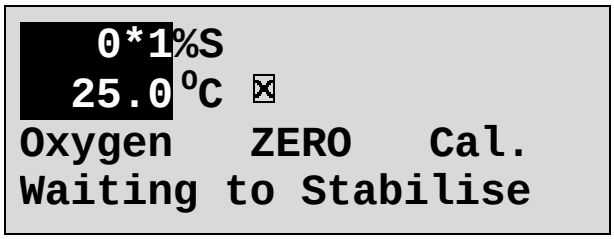
3.3.1 Zero Calibration

1. Place the sensor(s) 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 (part number 123302) is supplied with a new Dissolved Oxygen sensor for this purpose.
2. Allow the reading to stabilise at or near zero. This may take 2-3 minutes.
3. Select Oxygen Calibration. (Menu → **F1:Calibrate** → **F1:Oxygen**)

   When the reading is below approximately 25 % Saturation, 2 ppM or 5% Gaseous, the **smart*CHEM*-D** will display the ZERO calibration screen…



4. Press Enter to calibrate. The Automatic Stability Function will now show a ☒ and highlight any unstable readings…



   When the Dissolved Oxygen and Temperature readings have both stabilised, the unit will calibrate itself.

   To calibrate immediately without waiting for complete stability, press F5 to disable the Automatic Stability Function.

   A "*" will not be removed from the display after a Zero Calibration.
5. Remove the sensor(s) from the Zero solution, rinse well in distilled water and blot dry.

   The **smart*CHEM*-D** will now prompt you to perform an AIR calibration.

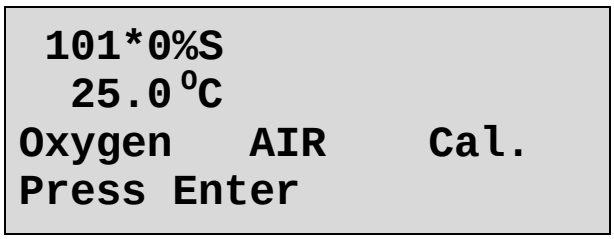
3.3.2 Span Calibration in Air (all Oxygen modes)

1. Hang the Dissolved Oxygen sensor (and Temperature sensor, if applicable) in air. The tip of the Dissolved Oxygen sensor should be pointing downwards.

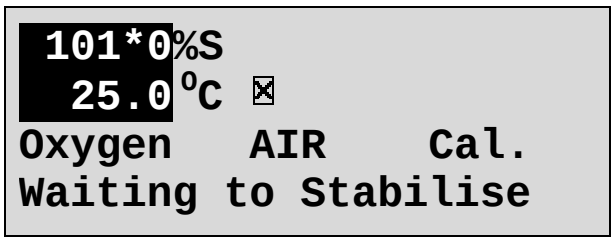
   Allow the reading to stabilise. After a zero calibration, this may take up to 5 minutes.

2. Select Oxygen Calibration. (Menu → **F1:Calibrate** → **F1:Oxygen**)

   When the reading is above approximately 25% Saturation, 2 ppM or 5% Gaseous, the **smart*CHEM*-D** will display the AIR calibration screen…



3. Press Enter to calibrate. The Automatic Stability Function will now show a ☒ and highlight any unstable readings…



   When the Dissolved Oxygen and Temperature readings have both stabilised, the unit will calibrate itself.

   To calibrate immediately without waiting for complete stability, press F5 to disable the Automatic Stability Function.

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

4. The **smart*CHEM*-D** is now calibrated and is ready for Dissolved Oxygen measurement. Rinse the Dissolved Oxygen sensor in distilled water and blot dry before placing into unknown samples.

3.3.3 Span Calibration in Solution (Salinity-corrected ppM Mode only)

This span calibration provides an alternative to calibrating the Dissolved Oxygen sensor in air. It is only available when the **smart*CHEM*-D** is in Salinity-corrected ppM mode. Please note that the normal AIR calibration (section 3.3.2) is still available for Salinity-corrected ppM mode.

1. Measure the Dissolved Oxygen content of the solution to be used for calibration. This is generally done with a Winkler titration. The **smart*CHEM*-D** span calibration should be performed immediately the Dissolved Oxygen content of the solution is known, as the value may not be stable.

2. Place the Dissolved Oxygen and Conductivity/TDS sensors (and Temperature sensor, if applicable) into the calibration solution. Ensure that the Conductivity/TDS sensor is immersed at least to the top of the vent hole in the side of the sensor.

   The solution must be stirred at a moderate rate.

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

3. Select Oxygen Calibration. (Menu → **F1:Calibrate** → **F1:Oxygen**)

   When the reading is above approximately 2 ppM, the **smart*CHEM*-D** will display the AIR/SPAN calibration screen. Note the cursor underlining the "**A**" in "**AIR**".

   ```
     9*00ppMs
     25.0°C
   Oxygen AIR/SPAN Cal.
   Press Enter
   ```

   Use the numeric keypad to enter the Dissolved Oxygen value of the solution. The words "AIR/SPAN" are deleted and the value being entered is displayed. The Conductivity or TDS reading also appears as soon as the first numeric key is pressed.

   Press the ⊖ to correct any errors.

4. Press Enter to calibrate. The Automatic Stability Function will now show a ☒ and highlight any unstable readings…

   ```
     6.70ppMs    33.0ppK
     25.0°C ☒
   Oxygen  Cal.
   Waiting to Stabilise
   ```

   When the Dissolved Oxygen and Temperature readings have both stabilised, the unit will calibrate itself.

   To calibrate immediately without waiting for complete stability, press F5 to disable the Automatic Stability Function.

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

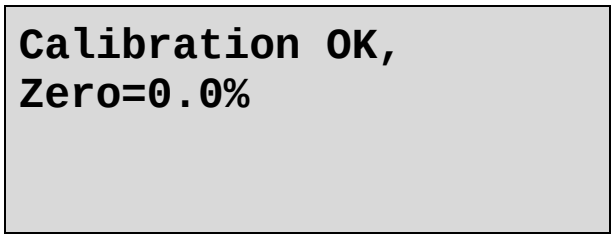
5. The **smart*CHEM*-D** is now calibrated and is ready for Dissolved Oxygen measurement. Rinse the Dissolved Oxygen sensor in distilled water and blot dry before placing into unknown samples.

3.4 Dissolved Oxygen Calibration Notes

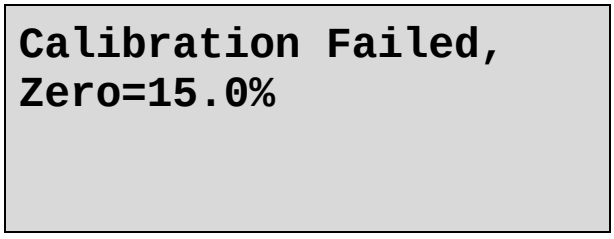
1. The relationship of % Saturation and ppM depends on a number of variables, so ***always calibrate in the mode required***. Do not try to infer Oxygen content from one mode to another.
2. The **smart*CHEM*-D** automatically detects if a TPS ED1 or a YSI sensor is connected. When the unit has been calibrated for one type, and the other type is then connected, the message "**Probe**" appears in the Dissolved Oxygen display. It is necessary to re-calibrate for the new sensor to obtain accurate readings.
3. 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.
4. An air calibration should be performed at least weekly. Of course, more frequent calibration will result in greater confidence in results.
5. All calibration information is retained in memory when the **smart*CHEM*-D** is switched off. This information can be recalled or printed later using the GLP function (see section 9).

3.5 Dissolved Oxygen Calibration Messages

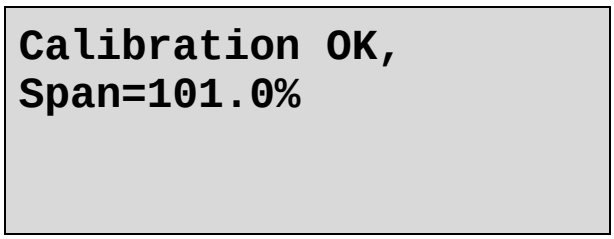
1. If a Zero calibration has been successfully performed, the **smart*CHEM*-D** will display the following message and the Zero value of the sensor…



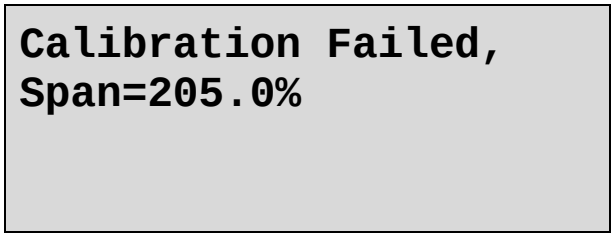
2. If a Zero calibration has failed, the **smart*CHEM*-D** will display the following message and the failed Zero value of the sensor. The unit will return to normal display mode with a " * " in place of the decimal point in the Dissolved Oxygen reading.



3. If an Air/Span calibration has been successfully performed, the **smart*CHEM*-D** will display the following message and the Span value of the sensor…



4. If an Air/Span calibration has failed, the **smart*CHEM*-D** will display the following message and the failed Span value of the sensor. The decimal point will be replaced by a " ∗ " when the unit returns to normal display mode.



5. The **smart*CHEM*-D** will display the following message if the calibration point is too high. The unit must be calibrated in the lower of the two ranges that are provided for each Oxygen mode.

6. The allowable Span range for a Dissolved Oxygen sensor is 65.0 to 200.0 %. If calibration fails due to the Span value being outside these limits, then please consult the Troubleshooting guide (section 17.2) for possible remedies.

4. Conductivity Mode

4.1 Selecting Conductivity Mode

1. Select Mode (Menu → **F3:Mode** → **F5:Conductivity**).
2. The **smart*CHEM*-D** now proceeds to Conductivity measurement mode. Note that a " * " is shown in place of the decimal point until a successful calibration has been performed (see section 4.4).

4.2 Setting the Conductivity calibration standard

The factory default for this item is 2.76mS/cm. If this is satisfactory, go directly to section 4.3.

1. Select the Conductivity Standard entry

   (Menu → **F4:Setup** → **F1:Standards** → **F1:Conductivity.**).

   The following screen is now displayed…

   ```
   Conductivity
   Standard:2760.uS
   Range
   20uS/cm to 2000mS/cm
   ```

2. Type in the value of the Conductivity standard that is to be used for calibration, including the decimal point. Use the ⇦ key to make any corrections.
3. Press Enter to save the value of the standard solution.

   Alternatively, press Menu to quit without changing the current setting.
4. The **smart*CHEM*-D** will now ask you to enter the units for the Conductivity standard…

   ```
   Conductivity
   Standard:2760
   Select Units
   F1:uS/cm   F2:mS/cm
   ```

   Press F1 to set the Conductivity Standard as µS/cm.

   Press F2 to set the Conductivity Standard as mS/cm.
5. The Conductivity standard is now programmed for use at calibration.

4.3 Conductivity sensor k factor

The **smart*CHEM*-D** automatically recognises whether a k=0.1, k=1.0 or k=10 Conductivity sensor is being used via links in the connector.

Calibration settings for the various k factors are NOT stored separately. The **smart*CHEM*-D** requires re-calibration when a new k factor sensor is connected.

If the **smart*CHEM*-D** has been calibrated on one k factor sensor and a different k factor sensor is subsequently connected, the word "**Probe**" appears instead of the Conductivity reading. In this case, it is necessary to re-calibrate the Conductivity reading before proceeding.

4.4 Conductivity Calibration

Before attempting a Conductivity calibration, ensure that the **smart*CHEM*-D** has been set up correctly according to sections 4.1 to 4.3.

Automatic Temperature Compensation is done via a temperature sensor inside the Conductivity sensor. It is therefore not necessary to calibrate the Temperature readout of the **smart*CHEM*-D** before taking Conductivity measurements.

1. Plug the Conductivity sensor into the **Cond / TDS** socket.
2. Rinse the Conductivity sensor in distilled water. Shake off as much water as possible. Blot the outside of the sensor dry. DO NOT BLOT THE ELECTRODE PLATES.

Zero Calibration

3. Let the sensor dry in air.
4. Select Conductivity Calibration (Menu → **F1:Calibrate** → **F3:Cond.**).
5. The **smart*CHEM*-D** will recognise the low conductivity signal and attempt a Zero calibration. For example…

```
Cond.        0*01uS
ZERO     Calibration

Press Enter
```

6. Press Enter to calibrate. The Automatic Stability Function will now show a ☒ and highlight the reading while it is unstable…

```
Cond.    ☒   0*01uS
ZERO     Calibration

Waiting to Stabilise
```

When the Conductivity reading has stabilised, the unit will calibrate itself.

To calibrate immediately without waiting for complete stability, press F5 to disable the Automatic Stability Function.

The " ∗ " will not be removed after a zero calibration.

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Standard Calibration

7. Place the Conductivity sensor into a sample of Conductivity standard. Ensure that it is immersed correctly at least to the top of the vent hole in the side of the sensor.

   DO NOT place the sensor directly into the bottle of standard. Discard the used sample of standard after use.

   Select Conductivity Calibration (Menu → **F1:Calibrate** → **F3:Cond.**). The calibration screen will be displayed with the Conductivity standard to be used. For example…

```
Cond.        2*86mS
2760.uS  Calibration

Press Enter
```

8. Press Enter to calibrate. The Automatic Stability Function will now show a ☒ and highlight the reading while it is unstable…

```
Cond.     ☒  2*86mS
2760.uS  Calibration

Waiting to Stabilise
```

   When the Conductivity reading has stabilised, the unit will calibrate itself.

   To calibrate immediately without waiting for complete stability, press F5 to disable the Automatic Stability Function.

   The " ∗ " will now be replaced by a decimal point if calibration was successful.

9. The **smart*CHEM*-D** is now calibrated for Conductivity and is ready for use in this mode.

4.5 Conductivity Calibration Notes

1. A Zero calibration should be performed at least monthly. In low conductivity applications (where a zero error is particularly significant), a zero calibration may have to be done weekly.
2. A Standard calibration should be performed at least weekly. Of course, more frequent calibration will result in greater confidence in results.
3. Conductivity and TDS calibration data is stored separately in memory. Ensure that the **smart*CHEM*-D** has been correctly calibrated for the mode in which it will be used. The **smart*CHEM*-D** does not require re-calibration when alternating between Conductivity and TDS modes, providing the instrument has been correctly calibrated for each mode on the k factor sensor to be used.
4. All calibration information is retained in memory when the **smart*CHEM*-D** is switched off. This information can be recalled or printed later using the GLP function (see section 9).
5. The **smart*CHEM*-D** displays the value of the standard to which it will attempt to calibrate. Ensure that the standard value displayed corresponds to the standard that you are using. Alter the Standards set-up if necessary (see section 4.2).
6. Calibration settings for k=0.1, k=1.0 and k=10 sensors are NOT stored separately.

   The **smart*CHEM*-D** requires re-calibration when a new k factor sensor is connected.

4.6 Conductivity Calibration Messages

1. If a Zero Calibration has been successfully performed, the **smart*CHEM*-D** will display the following message…

   ```
   Calibration OK,
   Zero=0.01uS
   ```

2. If a Standard Calibration has been successfully performed, the **smart*CHEM*-D** will display the following message and the calculated k factor of the sensor. For example…

   ```
   Calibration OK,
   k=0.99
   ```

3. If a Standard Calibration has failed, the **smart*CHEM*-D** will display the following message and the calculated k factor of the sensor. For example…

   ```
   Calibrate Failure,
   Check STD=2760.uS
   k=3.64,Exceeds Limit
   ```

Notes

1. The allowable k factor range is +/-25% of nominal. This range is ample to allow for correctly functioning Conductivity sensors. If calibration fails due to the k factor being outside these limits, then please consult the Troubleshooting guide (section 17.3) for possible remedies.

5. TDS Mode

5.1 Selecting TDS Mode

1. Select Mode (Menu → **F3:Mode** → **F6:TDS**).
2. The **smart*CHEM*-D** now proceeds to TDS measurement mode. Note that a " * " is shown in place of the decimal point until a successful calibration has been performed (see section 5.4).

5.2 Setting the TDS calibration standard

The factory default for this item is 2.00ppK. If this is satisfactory, go directly to section 5.3.

1. Select the TDS Standard entry

   (Menu → **F4:Setup** → **F1:Standards** → **F3:TDS**).

   The following screen is now displayed…

   ```
   TDS
   Standard:2000.ppM
   Range
   20ppM to 500ppK
   ```

2. Type in the value of the TDS standard that is to be used for calibration, including the decimal point. Use the ⇦ key to make any corrections.
3. Press Enter to save the value of the standard solution.

   Alternatively, press Menu to quit without changing the current setting.
4. The **smart*CHEM*-D** will now ask you to enter the units for the TDS standard…

   ```
   TDS
   Standard:2000
   Select Units
   F1:ppM     F2:ppK
   ```

   Press F1 to set the TDS Standard as ppM.

   Press F2 to set the TDS Standard as ppK.
5. The TDS standard is now programmed for use at calibration.

5.3 TDS sensor k factor

The **smart*CHEM*-D** automatically recognises whether a k=0.1, k=1.0 or k=10 TDS sensor is being used, via links in the connector.

Calibration settings for the various k factors are NOT stored separately. The **smart*CHEM*-D** requires re-calibration when a new k factor sensor is connected.

If the **smart*CHEM*-D** has been calibrated on one k factor sensor and a different k factor sensor is subsequently connected, the word "**Probe**" appears instead of the TDS reading. In this case, it is necessary to re-calibrate the TDS reading before proceeding.

5.4 TDS Calibration

Before attempting a TDS calibration, ensure that the **smart*CHEM*-D** has been set up correctly according to sections 5.1 to 5.3.

Automatic Temperature Compensation is done via a temperature sensor inside the TDS sensor. It is therefore not necessary to calibrate the Temperature readout of the **smart*CHEM*-D** before taking TDS measurements.

1. Plug the TDS sensor into the **Cond / TDS** socket.
2. Rinse the TDS sensor in distilled water. Shake off as much water as possible. Blot the outside of the sensor dry. DO NOT BLOT THE ELECTRODE PLATES.

Zero Calibration

3. Let the sensor dry in air.
4. Select TDS Calibration (Menu → **F1:Calibrate** → **F3:TDS**).
5. The **smart*CHEM*-D** will recognise the low TDS signal and attempt a Zero calibration. For example…

```
TDS          0*01ppM
ZERO     Calibration

Press Enter
```

6. Press Enter to calibrate. The Automatic Stability Function will now show a ☒ and highlight the reading while it is unstable…

```
TDS       ☒   0*01ppM
ZERO     Calibration

Waiting to Stabilise
```

When the TDS reading has stabilised, the unit will calibrate itself.

To calibrate immediately without waiting for complete stability, press F5 to disable the Automatic Stability Function.

The " ∗ " will not be removed after a zero calibration.

Continued over the page…

Standard Calibration

7. Place the TDS sensor into a sample of TDS standard. Ensure that it is immersed correctly at least to the top of the vent hole in the side of the sensor.

   DO NOT place the sensor directly into the bottle of standard. Discard the used sample of standard after use.

   Select TDS Calibration (Menu → **F1:Calibrate** → **F3:TDS**). The calibration screen will be displayed with the TDS standard to be used. For example…

   ```
   TDS            2*10ppK
   2000.ppM Calibration
   Press Enter
   ```

8. Press Enter to calibrate. The Automatic Stability Function will now show a ☒ and highlight the reading while it is unstable…

   ```
   TDS        ☒    2*10ppK
   2000.ppM Calibration

   Waiting to Stabilise
   ```

   When the TDS reading has stabilised, the unit will calibrate itself.

   To calibrate immediately without waiting for complete stability, press F5 to disable the Automatic Stability Function.

   The " ∗ " will now be replaced by a decimal point if calibration was successful.

9. The **smart*CHEM*-D** is now calibrated for TDS and is ready for use in this mode.

5.5 TDS Calibration Notes

1. A Zero calibration should be performed at least monthly. In low conductivity applications (where a zero error is particularly significant), a zero calibration may have to be done weekly.
2. A Standard calibration should be performed at least weekly. Of course, more frequent calibration will result in greater confidence in results.
3. Conductivity and TDS calibration data is stored separately in memory. Ensure that the **smart*CHEM*-D** has been correctly calibrated for the mode in which it will be used. The **smart*CHEM*-D** does not require re-calibration when alternating between Conductivity and TDS modes, providing the instrument has been correctly calibrated for each mode on the k factor sensor to be used.
4. All calibration information is retained in memory when the **smart*CHEM*-D** is switched off. This information can be recalled or printed later using the GLP function (see section 9).
5. The **smart*CHEM*-D** displays the value of the standard to which it will attempt to calibrate. Ensure that the standard value displayed corresponds to the standard that you are using. Alter the Standards set-up if necessary (see section 5.2).
6. Calibration settings for k=0.1, k=1.0 and k=10 sensors are NOT stored separately.

   The **smart*CHEM*-D** requires re-calibration when a new k factor sensor is connected.

5.6 TDS Calibration Messages

1. If a Zero Calibration has been successfully performed, the **smart*CHEM*-D** will display the following message…

   ```
   Calibration OK,
   Zero=0.01ppM
   ```

2. If a Standard Calibration has been successfully performed, the **smart*CHEM*-D** will display the following message and the calculated k factor of the sensor. For example…

   ```
   Calibration OK,
   k=0.99
   ```

3. If a Standard Calibration has failed, the **smart*CHEM*-D** will display the following message and the calculated k factor of the sensor. For example…

   ```
   Calibrate Failure,
   Check STD=2000.ppM
   k=3.64,Exceeds Limit
   ```

Notes

1. The allowable k factor range is +/-25% of nominal. This range is ample to allow for correctly functioning TDS sensors. If calibration fails due to the k factor being outside these limits, then please consult the Troubleshooting guide (section 17.3) for possible remedies.

6. Temperature Mode

The temperature readout must be calibrated before attempting ppM Dissolved Oxygen calibration.

The decimal point is replaced by a " * " if the reading is not calibrated.

The **smart*CHEM*-D** is able to take Temperature readings from the Temperature sensor, ED1 Dissolved Oxygen sensor or YSI Dissolved Oxygen sensor. If both the Temperature sensor and a Dissolved Oxygen sensor are connected at the same time, the Temperature reading is taken from the Temperature sensor.

If the **smart*CHEM*-D**'s Temperature readout was calibrated on an ED1 sensor and then a YSI sensor is connected, the unit displays "**Probe**" instead of the Temperature data. The same occurs when an ED1 sensor is connected after the unit was calibrated on a YSI sensor. This warning is only displayed when the separate Temperature sensor is not connected. The Temperature readout must be re-calibrated if Temperature measurements from the new Dissolved Oxygen are required.

6.1 Temperature Calibration

1. To calibrate the separate Temperature sensor, plug the temperature sensor into the **Temperature** socket.

   To calibrate the Temperature readout from a Dissolved Oxygen sensor, plug the Dissolved Oxygen sensor into the **Oxygen** socket and ensure that the separate Temperature is not connected.

2. Switch the meter on.

3. Place the Temperature or Dissolved Oxygen sensor into a beaker of room temperature water, alongside a good quality mercury thermometer. Stir the probe and the thermometer gently to ensure an even temperature throughout the beaker.

4. Select Temperature Calibration (Menu → **F1:Calibrate** → **F5:Temperature**).

   The Temperature Calibration screen is now displayed. The bottom line provides confirmation of which sensor is being calibrated. The following example shows the Temperature sensor being calibrated.

   ```
   Enter Actual
   Temperature:_
    24*0°C
   Using Temp. Probe.
   ```

   The current reading from the Temperature or Dissolved Oxygen sensor is displayed.

5. Type in the temperature as measured by the mercury thermometer using the Numeric Keypad and press Enter. The Automatic Stability Function will now show a ☒ and highlight the Temperature reading while it is unstable…

   ```
   Enter Actual
   Temperature: 25.0
    24*0°C ☒
   Waiting to Stabilise
   ```

   When the Temperature reading has stabilised, the unit will calibrate itself.

   To calibrate immediately without waiting for complete stability, press F5 to disable the Automatic Stability Function.

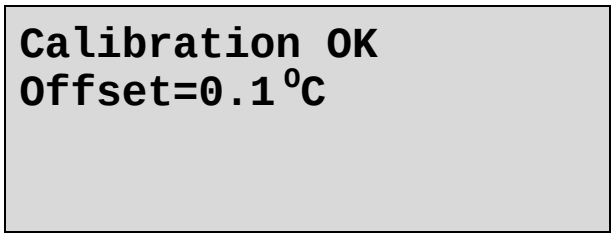
6. The **smart*CHEM*-D** is now calibrated for Temperature and is ready for use in this mode.

6.2 Temperature Calibration Notes

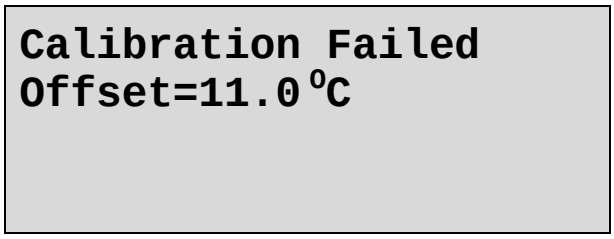
1. Temperature calibration information is retained in memory when the **smart*CHEM*-D** is switched off, even when the power supply is removed. This information can be recalled later using the GLP function (see section 9).
2. Temperature does not need to be re-calibrated unless the Temperature or Dissolved Oxygen sensor is replaced or the meter is initialised.
3. The **smart*CHEM*-D** keeps the Temperature calibration data for the Temperature sensor and one type of Dissolved Oxygen sensor separately so these can be swapped as required.

6.3 Calibration Messages

1. If a temperature calibration has been successfully performed, the **smart*CHEM*-D** will display the following message and the offset of the sensor.

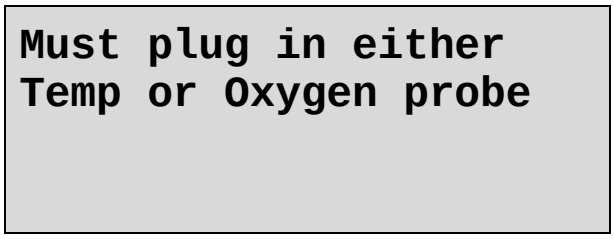


2. If a temperature calibration has failed, the **smart*CHEM*-D** will display the following message and the failed offset value of the sensor.



3. The **smart*CHEM*-D** has an allowable Offset range of -10.0 to +10.0 °C. If calibration fails due to the Offset being outside these limits, then please consult the Troubleshooting guide (section 17.4) for possible remedies.

4. If neither a Temperature sensor nor a Dissolved Oxygen sensor is connected to the **smart*CHEM*-D**, and a temperature calibration is attempted, then the following message will be displayed.



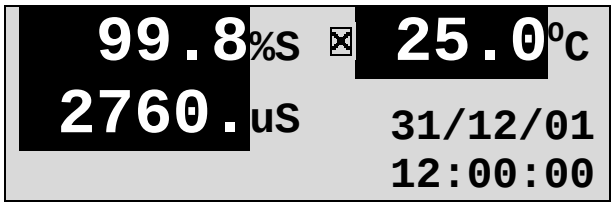
7. Auto Stability Function (ASF)

ASF adds an extra level of versatility to the **smart*CHEM*-D**. When ASF is activated, the **smart*CHEM*-D** monitors all parameters that are currently in use. When **ALL** parameters become stable, the readings are frozen on the display.

ASF can be used in the following ways…

7.1 ASF During Normal Measurement

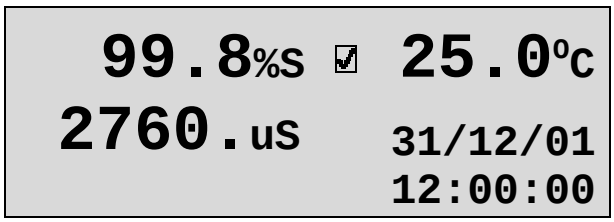
1. Press F5 in normal measurement mode. All active parameters are highlighted and the ☒ symbol appears in the display. For example…



   As each parameter becomes stable, the highlighting is removed. If any parameter subsequently becomes unstable, the highlighting is applied again.

   The highlighting is provided to give the operator a visual indication of exactly which parameters have not stabilised in case user intervention is required.

2. When ALL parameters have stabilised, all highlighting will be removed and the ☒ will change to a ☑. All readings are now frozen. For example…



3. The operator can now make a note of the reading as required.
4. Press F5 again to re-start the ASF sampling process.
5. Press F5 a second time, while the ☒ symbol is being displayed, to turn ASF off.

7.2 ASF During Calibration

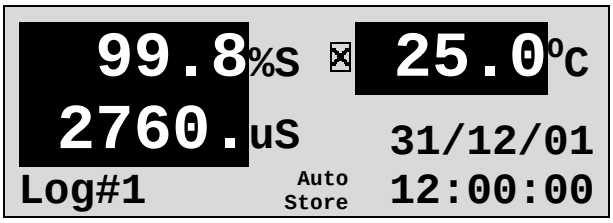
The Automatic Stability Function is automatically invoked during calibration. The stability parameters programmed into the **smart*CHEM*-D** have a finer tolerance during calibration than during normal measurement. This is done to ensure the most accurate possible calibration results.

Press F5 while the ☒ symbol is being displayed during calibration to turn ASF off and calibrate immediately, before the reading has stabilised.

See the calibration sections of this manual for further details on the ASF function during calibration.

7.3 ASF with Manual Datalogging

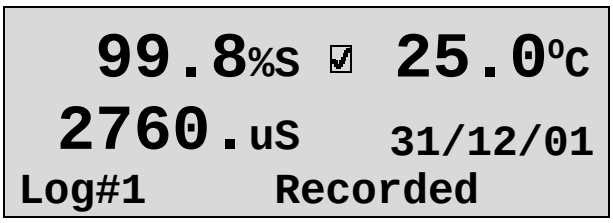
1. Press F5 then Store in normal measurement mode. All active parameters are highlighted and the ☒ symbol appears in the display, along with the message “Auto Store”. For example…



   As each parameter becomes stable, the highlighting is removed. If any parameter subsequently becomes unstable, the highlighting is applied again.

   The highlighting is provided to give the operator a visual indication of exactly which parameters have not stabilised in case user intervention is required.

2. When ALL parameters have stabilised, all highlighting will be removed and the ☒ will change to a ☑. All readings are now frozen and will be recorded into memory. For example…



3. Press F5 and Store again to re-start the ASF Auto-Store process.

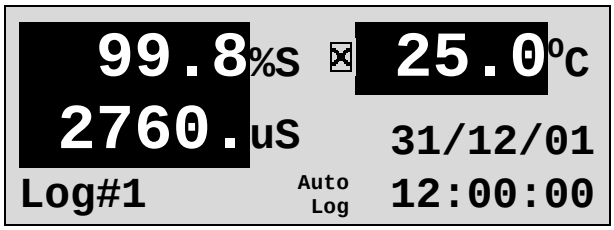
4. Press F5 a second time, while the ☒ symbol is being displayed, to turn ASF off.

7.4 ASF with Automatic Datalogging

Using ASF with Automatic Datalogging allows continuous logging until all readings are stable. This is useful in titrations etc, where logging is no longer required once an end point is reached.

See section 11.2 for details on programming the Automatic Datalogging function.

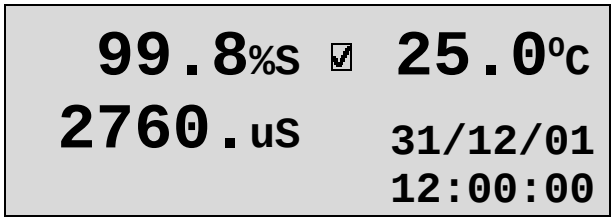
1. Press F5 then AutoLog in normal measurement mode. All active parameters are highlighted and the ☒ symbol appears in the display, along with the message "Auto Log". For example…



   As each parameter becomes stable, the highlighting is removed. If any parameter subsequently becomes unstable, the highlighting is applied again.

   The highlighting is provided to give the operator a visual indication of exactly which parameters are not yet stable in case user intervention is required.

2. When ALL parameters have become stable, all highlighting will be removed and the ☒ will change to a ☑. All readings are now frozen and automatic datalogging has stopped. For example…



3. **To unfreeze the display in order to take the next reading, press F5 and AutoLog again to re-start the ASF automatic datalogging process.**

4. Press F5 a second time, while the ☒ symbol is being displayed, to turn ASF off.

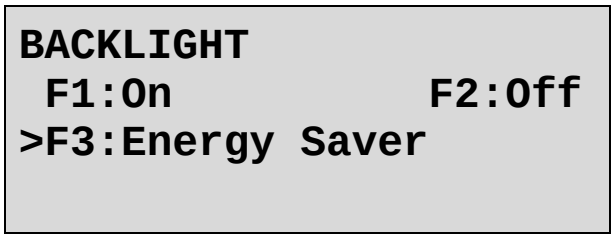
8. Display Backlight

The **smart*CHEM*-D** is fitted with an Electro-Luminescence ("EL") backlight. This can be set up according to your preferences as follows…

1. Switch the meter on.

2. Select the Backlight menu (Menu → **F4:Setup** → **F3:Backlight**).

3. The Backlight menu is now displayed…



   The arrow indicates the current selection.

   Press F1 to set the Backlight to be on continuously.

   Press F2 to set the Backlight to be off continuously.

   Press F3 to set the Backlight to turn on automatically whenever a key is pressed. It will turn off automatically if no key has been pressed for 5 minutes.

9. Good Laboratory Practices (GLP)

The **smart*CHEM*-D** keeps a record of the date and time of the last calibrations for all parameters as part of GLP guidelines.

9.1 To recall GLP information on the display

1. Switch the meter on.
2. Select the GLP menu (Menu → **F5:GLP**).
3. Select **F1:Recall** from the menu.
4. The instrument model, firmware version number, and instrument serial number are displayed, along with a prompt describing how to scroll through the GLP information. For example…

```
smartCHEM-D V1.0 S1234  31/12/01 15:00

Oxygen Zero=0.1%          31/12/01 12:00
Oxygen Span=100.0%        31/12/01 12:10
Oxygen Calibrated


                                F4:Next
```

5. Press F4 to sequentially scroll through the GLP information for all parameters. Press F2 to scroll back to previous data. The sequence of information displayed is shown below. Press Menu to abort at any time.

GLP Display sequence…

```
smartCHEM-D V1.0 S1234  31/12/01 15:00

Oxygen Zero=0.1%          31/12/01 12:00
Oxygen Span=100.0%        31/12/01 12:10
Oxygen Calibrated


                                F4:Next
```

↑F2 ↓F4

```
Cond Zero=0.01uS          31/12/01 12:20
Cond k=1.01               31/12/01 12:30
Cond Calibrated

TDS  Zero=0.01ppM         31/12/01 12:40
TDS  k=1.01               31/12/01 12:50
TDS Calibrated
                         F2:Back F4:Next
```

↑F2 ↓F4

```
Temp Probe Offset=1.0°c   31/12/01 14:40
Temp Probe Calibrated

ED1 Temp Offset=1.0°c     31/12/01 14:50
Oxygen Temp Calibrated


                         F2:Back F4:Ends
```

9.2 Failed Calibration

If calibration has failed, the GLP function will reset the date and time for the failed parameter to zero. The **smart*CHEM*-D** still shows the results for the last successful calibration, as shown in the following example where the last Conductivity calibration has failed…

```
Cond Zero=0.01uS          00/00/00 00:00
Cond k=1.01               00/00/00 00:00
Cond UnCalibrated

TDS  Zero=0.01ppM         31/12/01 12:40
TDS  k=1.01               31/12/01 12:50
TDS Calibrated
                         F2:Back F4:Next
```

9.3 Printing GLP Information to the RS232 Port

The GLP information stored in the instrument's memory can be sent to a printer or PC via the RS232 port.

1. Switch the meter on.
2. Connect one end of the RS232 cable to the **Power/RS232** socket of the **smart*CHEM*-D**.
3. Connect the other end of the RS232 cable to an RS232 Printer, or to a Serial port on a PC.
4. Send the GLP information to the RS232 port:

   Menu → **F5:GLP** → **F3:Print**

   The message "**Printing GLP Data**" is displayed while sending the data to the RS232 port.

5. The GLP information is sent to the RS232 port in formatted ASCII text. For example…

```
smartCHEM-D V1.0 S1234 @ 31/12/2001 15:00
Oxygen       Zero=       0.1%     @ 31/12/2001 12:00
Oxygen       Span=     100.0%     @ 31/12/2001 12:10
Conductivity Zero=      0.01uS    @ 31/12/2001 12:20
Conductivity k=         1.01      @ 31/12/2001 12:30
TDS          Zero=      0.01ppM   @ 31/12/2001 12:40
TDS          k=         1.01      @ 31/12/2001 12:50
Temp. Probe  Offset=     1.0oC    @ 31/12/2001 14:40
Temp. ED1    Offset=     1.0oC    @ 31/12/2001 14:50
Ends
```

9.4 GLP Calibration Alarm

A new feature of the **smart*CHEM*-D** is the GLP calibration alarm. The operator can select how often they wish to be reminded that the instrument requires calibration, and for which parameters they wish to be reminded.

9.4.1 To set the GLP Calibration Alarm…

1. Select the GLP Calibration Alarm menu (Menu → **F5:GLP** → **F2:Alarm**).
2. The calibration alarm period can now be selected…

```
 GLP ALARM
 F1:Daily   F2:1 Week
 F3:2 Weeks F4:4 Weeks
>F5:OFF
```

   The arrow indicates the current selection.

   Press F1 to be reminded that calibration is due every day.

   Press F2 to be reminded that calibration is due every week.

   Press F3 to be reminded that calibration is due every 2 weeks.

   Press F4 to be reminded that calibration is due every 4 weeks.

   Press F5 to switch the GLP Calibration Alarm system off.

   Press Menu to quit and retain the current setting.

3. If F1, F2, F3 or F4 was pressed above, the **smart*CHEM*-D** will now allow the operator to select which parameters will be flagged with a calibration alarm…

```
Select Channels
 F1:Oxygen
 F3:Conductivity/TDS
 F5:Temperature
```

   Press the relevant F1 to F5 function key to select which parameter or parameters you would like to be flagged with a calibration alarm whenever calibration is due. Note the " * " which appears next to the relevant parameter(s).

   Pressing the function key repeatedly adds and removes the " * ".

4. Press Menu to exit and save the selection.

9.4.2 How the GLP Alarm Operates

On the day that calibration is due, the following message will be displayed the first time the **smart*CHEM*-D** is switched on…

```
GLP Alarm, Calibrate
Oxygen
Conductivity/TDS
Temperature
```

Only those parameters that were selected (see section 9.4.1) will be displayed.

This message will not be displayed again until the next time calibration is due.

In addition to the message shown above, the **smart*CHEM*-D** also flashes the decimal point of each parameter that requires calibration, and flashes the message "**`Cal Now`**" on the display.

9.4.3 Notes on the GLP Calibration Alarm function

1. To remove the "**`Cal Now`**" message and flashing decimal points, each selected parameter must be correctly calibrated.
2. Switching the GLP Calibration Alarm function off will not clear "**`Cal Now`**" message and flashing decimal points. The relevant parameters must be calibrated.
3. When Weekly, 2 Weekly or 4 Weekly periods have been selected, the GLP Calibration Alarm will always be activated on the same day of the week as when the function was first activated, even if the unit is not calibrated on that day. For example, if the GLP Calibration Alarm is triggered weekly on a Monday and the meter is finally calibrated the following Wednesday, the next GLP Calibration Alarm will still be on the following Monday.

9.5 Instrument Serial Number

In case the serial number that is fitted to the rear of the **smart*CHEM*-D** is removed or becomes illegible, it is also available on the **smart*CHEM*-D** display.

1. The serial number is displayed at turn-on, for example…

   ```
   smartCHEM-D V1.0mr
   S1234 © 2002 TPS P/L
   Oxygen, Conductivity
   /TDS, Temperature
   ```

   The "`m`" after **V1.0** is shown when the Dissolved Oxygen Stirrer output is enabled (section 3.2).

   The "**`r`**" after **V1.0** is shown when the Recorder Port option is fitted.

2. The serial number is displayed when recalling the GLP information (section 9.1).
3. The serial number is included on the print-out of GLP information (section 9.3).
4. The GLP information can be downloaded to a PC using the optional Windows® software (part number 130086).

9.6 Additional GLP Features

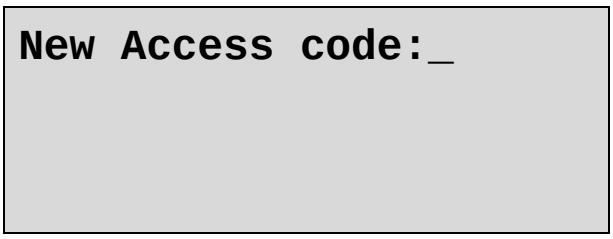
Another GLP requirement is to record the date and time of every reading. The **smart*CHEM*-D** does this for you whenever readings are recorded either with the Manual Datalogging function (section 11.1) or the Automatic Logging function (section 11.2).

10. Access Code

The Access Code is system is provided for those users who need to ensure the integrity of recorded data, calibration settings and so forth. The Access Code function will prevent anyone who does not know the code from entering the menu system. Keys that are available during normal measurement, (Store, Print, AutoLog and F1 to F5) are still available without the Access Code. This means that others are still able to carry out day-to-day work.

10.1 Enabling the Access Code System

1. Select the Access Code menu (Menu → **F6:Access**).
2. Select **F3:Enable & Enter Code** from the menu.
3. The **smart*CHEM*-D** now prompts you to enter a new access code…

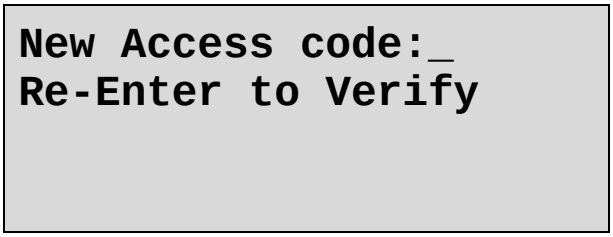
   

   Enter a new code of up to 4 digits using the numeric keypad.

   If less than 4 digits are entered, press Enter to save the new code.

   If 4 digits are entered, it is not necessary to press Enter.

   Press Menu to quit without enabling the Access Code system.
4. The **smart*CHEM*-D** now prompts you to re-enter the access code for verification…

   Re-enter the access code as per the previous step.

   Press Menu to quit without enabling the Access Code system.
5. The **smart*CHEM*-D** now confirms that the Access Code system is enabled before returning to the Access Code menu.

10.2 Using the Access Code System

When the Access Code system is enabled (as per section 10.1), the **smart*CHEM*-D** prompts the operator to enter the access code whenever Menu is pressed in normal display mode. No further access code entry is required to access any of the menu functions. It is therefore imperative never to remain in any of the menus when leaving the unit. Always press Menu until the **smart*CHEM*-D** is in normal display mode before leaving the unit.

For access codes with less than 4 digits, you must press Enter after entering the code.

For access codes with 4 digits it is not necessary to press Enter.

Notes

1. Do not store your Access Code on or near the unit.
2. If you forget the Access Code, please contact TPS. Once we have established your ownership of the unit, we will be able to give you an access code. We will need the serial number of the unit to provide this code.

10.3 Changing the Access Code

1. Select the Access Code menu (Menu → **F6:Access**).
   (Of course, you will need to enter the current access code after pressing Menu.)
2. Select **F1:Change Code** from the menu.
3. The **smart*CHEM*-D** now prompts you to enter a new access code…

   ```
   New Access code:_
   ```

   Enter a new code of up to 4 digits using the numeric keypad.

   If less than 4 digits are entered, press Enter to save the new code.

   If 4 digits are entered, it is not necessary to press Enter.

   Press Menu to quit without changing the Access Code.
4. The **smart*CHEM*-D** now prompts you to re-enter the access code for verification…

   ```
   New Access code:_
   Re-Enter to Verify
   ```

   Re-enter the access code as per the previous step.

   Press Menu to quit without changing the Access Code.
5. The **smart*CHEM*-D** now confirms that the Access Code system is enabled before returning to the Access Code menu.

10.4 Disabling the Access Code System

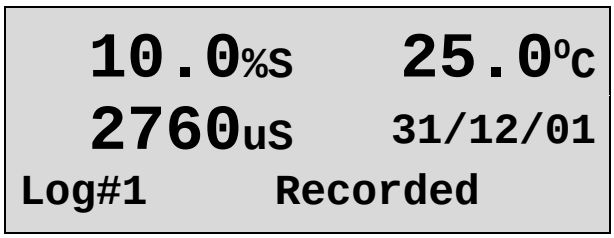
1. Select the Access Code menu (Menu → **F6:Access**).
   (Of course, you will need to enter the current access code after pressing Menu.)
2. Select **F3:Disable Security** from the menu.
3. The **smart*CHEM*-D** now confirms that Access Code system has been disabled before returning to the Access Code menu.

11. Datalogging

11.1 Manual Datalogging

To manually record readings into the Logger memory…

1. Press (Store) in normal display mode to record all parameters plus Date and Time into the Logger. This will be labelled as reading number 1. For example…



2. Repeat as often as required. The maximum number of readings that can be stored in the Logger is 1489.

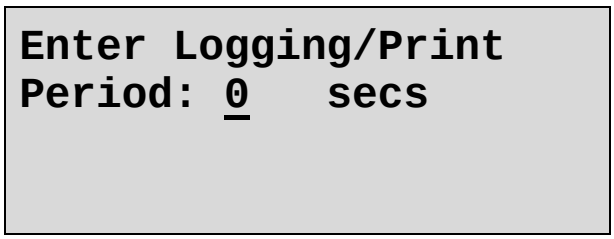
Hint : Press (F5) before (Store) to make the **smart*CHEM*-D** store the reading only when all the readings have stabilised. See section 7 for more details on the Auto Stability Function.

11.2 Automatic Datalogging

The **smart*CHEM*-D** can automatically record records into the Logger. First the logging period must be programmed, then automatic logging can be started and stopped as required.

1. Select the Logger menu ((Menu) → **F2:Logger**)
2. Select **F4:Program** from the menu.

   The display should now look similar to that shown below. The current Logging/Printing Period is displayed.

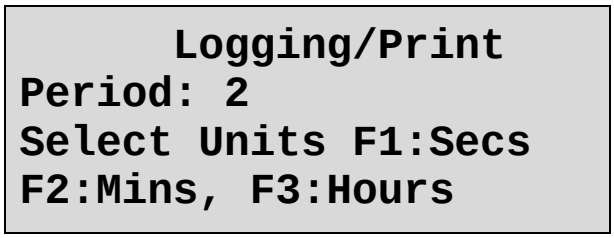


3. Use the Numeric Keypad to set the period at which the **smart*CHEM*-D** will automatically log records into memory or to the RS232 port.

   Press (Enter) to save the Logging/Printing Period.

   Press (Menu) to quit without changing the current setting.

4. After pressing (Enter), the **smart*CHEM*-D** will ask you to enter the units. The Logging/ Printing Period you have set is also displayed. For example…

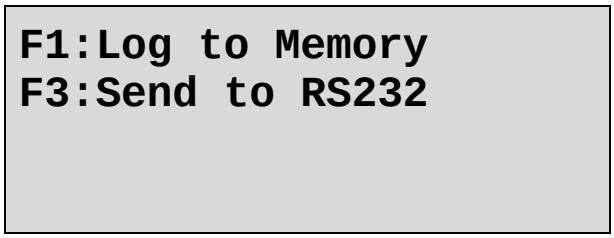


   Press (F1) to save the Logging/Printing Period as seconds.

   Press (F2) to save the Logging/Printing Period as minutes.

   Press (F3) to save the Logging/Printing Period as hours.

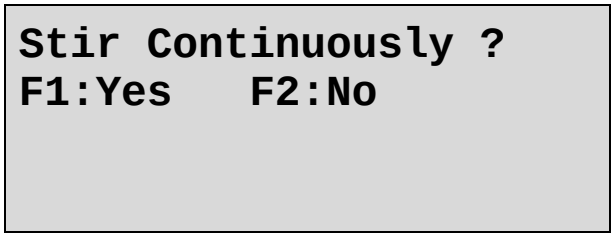
5. The **smart*CHEM*-D** will ask if the records are to be logged into the instrument's memory, or sent directly to the RS232 port. The display will look like this…



Press (F1) to log records into the Logger (maximum of 1489 readings).

Press (F2) to send records directly to the RS232 port.

6. If the Dissolved Oxygen stirrer output is enabled (section 3.2.1), the **smart*CHEM*-D** will stir continuously if the logging period is ≤ 50 seconds, or ask if the stirrer is to be ON continuously while logging if the logging period is > 50 seconds.



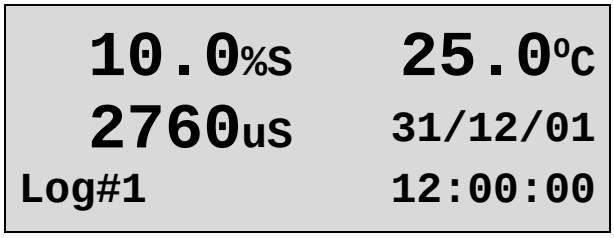
Press (F1) to activate the Dissolved Oxygen stirrer continuously during automatic datalogging.

Press (F2) to ***not*** activate the Dissolved Oxygen stirrer during automatic datalogging. The stirrer output can still be activated manually during automatic datalogging.

7. The automatic logging function is now programmed, and can be started and stopped as required.

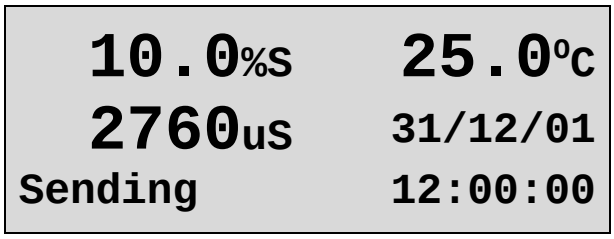
8. To start automatic logging, press (AutoLog) in normal display mode.

When the **smart*CHEM*-D** is logging into its own memory, the display will look like this…



The log number will increment and the **smart*CHEM*-D** will beep each time a reading is recorded.

If the **smart*CHEM*-D** is sending records directly to the RS232 port, the display will look like this…



The **smart*CHEM*-D** will beep each time a record is sent to the RS232 port.

9. Press (AutoLog) to stop automatic logging.

Hint : Press (F5) before starting automatic logging to make the **smart*CHEM*-D** stop logging as soon as all the readings have become stable. See section 7 for more details on the Auto Stability Function.

Notes on Automatic Datalogging

1. The clock must be set before the **smart*CHEM*-D** will allow automatic datalogging to start. The message "**`Clock Not Set`**" is displayed if the clock is not set. See section 14 for details on setting the clock.
2. Pressing (Menu) during automatic datalogging halts logging. Press (AutoLog) after returning to normal display mode to re-start automatic datalogging.

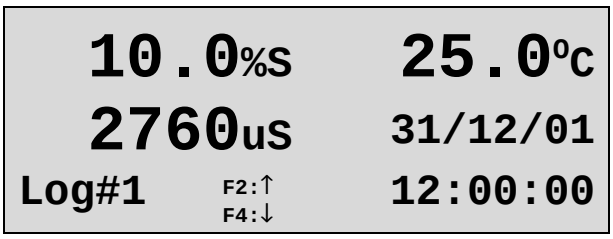
11.3 Recalling Readings from the Logger

To recall records from the Logger onto the **smart*CHEM*-D** display…

1. Select the Logger menu ((Menu) → **`F2:Logger`**)
2. Select **`F1:Recall`** from the menu.

   Record number 1 is now displayed.

   For example…



3. Press (F2) and (F4) to move forwards and backwards through the records.

   Press and hold (F2) or (F4) to scroll continuously through the readings. The rate is slow enough to allow the operator to see trends in the data as it is scrolling.

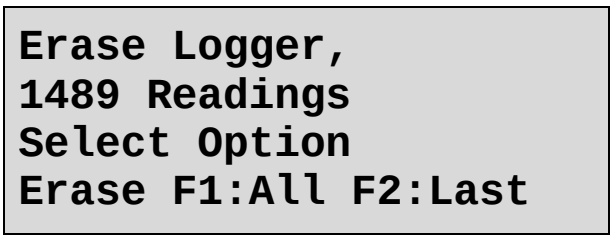
   To display a specific record, type in the desired record number using the Numeric Keypad and press (Enter).

   Press (F3) to send the displayed record to the RS232 port.

11.4 Erasing Records from the Logger

To erase records from the Logger…

1. Select the Erase Logger menu ((Menu) → **`F2:Logger`** → **`F2:Erase`**)
2. The **smart*CHEM*-D** now displays the Erase menu, for example…



   The number of readings stored in the Logger is displayed. See the "**`1489`**" in the example above.

3. Press (F1) to erase all of the readings stored in the Logger.

   Press (F2) to erase the last recorded reading only.

   Press (Menu) to quit without erasing any records.

11.5 Printing Records from the Logger to the RS232 Port

1. Connect one end of the RS232 cable to the **Power/RS232** socket of the **smart*CHEM*-D**.
2. Connect the other end of the RS232 cable to an RS232 Printer, or to a Serial port of a PC.
3. Ensure that the baud rate for the printer or PC and the **smart*CHEM*-D** are the same. If necessary, alter the baud rate of the **smart*CHEM*-D** (see section 12.1).

   The **smart*CHEM*-D** uses XON/XOFF protocol. Ensure that the printer is set accordingly.
4. Select the Logger menu. (Menu → **`F2:Logger`**).
5. Select **`F3:Print`** from the menu.
6. Printing starts as soon as F3 is pressed. The display shows the word "**`Printing`**" until printing is completed.

12. RS232 Port

12.1 Setting the Baud Rate

1. Select the Ports Set-up menu (Menu → **F4:Setup** → **F4:Ports**)
2. Select **F1:Baud Rate** from the menu. The available baud rates are listed, along with the RS232 port configuration…

```
 Baud Rate
 F1:1200  F2:9600
>F3:19200 F4:38400
8 bits, No Parity, 1 Stop bit, XON/XOFF
```

   The arrow indicates the current selection.

3. Press F1 to select 1200 baud.
   Press F2 to select 9600 baud.
   Press F3 to select 19200 baud.
   Press F4 to select 38400 baud.
   Press Menu to quit and retain the current setting.

12.2 Sending Readings to the RS232 Port

Press Print to instantly send readings to the RS232 port whenever the **smart*CHEM*-D** is in normal display mode.

Records can be sent directly to the RS232 port rather than stored in memory during automatic datalogging. See section 11.2 for details.

Press Print while recalling data on the display (see section 11.3) to send that record to the RS232 port.

12.3 RS232 Configuration

The **smart*CHEM*-D** RS232 configuration is 8 Bits, No Parity, 1 Stop Bit, XON/XOFF Protocol.

This information is displayed when setting the baud rate (see section 12.1)

12.4 Communication and Statistical Software

Communication between the **smart*CHEM*-D** and a PC can be handled with any RS232 communication software. A TPS communication software package for Windows® is optionally available (part number 130086).

Once the data is saved to disk, the next problem is how to use it. The data sent by the **smart*CHEM*-D** is formatted in fixed-width columns that can be imported by programs such as Microsoft® Excel® and Lotus 123®.

Help on importing the data into Microsoft® Excel® is provided in section 12.8 and the “excel.txt” file in the folder where you installed the WinTPS program.

12.5 Commands

The following commands can be sent from a PC to the **smart*CHEM*-D**. Note that <cr> denotes carriage return and <lf> denotes a line feed.

Action	Command	Notes
Request current data	?D<cr>	Returns the current data of all parameters plus date and time from the **smart*CHEM*-D**. The log number returned is set to Zero.
Request logged data	?R<cr>	Returns all logged records from the **smart*CHEM*-D** memory. The data ends with the message **ENDS**<cr>
Erase logged data	?E<cr>	Erases all logged records from the **smart*CHEM*-D** memory. Returns the message **ERASED**<cr> to confirm that the records have been erased.
Request status information	?S<cr>	Returns the model name, firmware version number, instrument serial number and number of logged readings in memory, for example… **smartCHEM-D•V1.0•S1234•1489•m%<cr>,** where • are spaces. Note that the number of logged readings is right-justified. The "**m**" is present when the Dissolved Oxygen stirrer is enabled (section 3.2.1) and the "**%**" is used internally by the WinTPS software.
Request GLP information	?G<cr>	Returns all calibration GLP information, plus the instrument model, serial number and current date (see section 12.7 for data format and hand-shaking).
Positions of Data Fields	?P<cr>	Returns the number of data fields, along with their position and length as follows… **6,1,10,12,8,21,4,26,6,36,7,47,5** This denotes 6 fields, the first of which is at column 1 and is 10 characters long. The second field is at column 12 and is 8 characters long and so on.
Data Column Header	?H<cr>	Returns a text string which can be used to provide headers for each data field. Spaces are included to ensure that the headers are correctly aligned with the data.

12.6 Data Format

Data is returned to the RS232 Port by the **smart*CHEM*-D** in the following format.

Please note that a " • " shown anywhere in this section denotes one space.

dd/mm/yyyy•hh:mm:ss•LLLL•DDDDDDuuu•CCCCCCCuuu•TTTTTuuu

where….

dd/mm/yyyy is the date, month and year data.

hh:mm:ss is the hours, minutes and seconds data.

LLLL is the Log Number, 4 characters, right justified. The **smart*CHEM*-D** sends a Zero for instant readings (see section 12.2).

DDDDDD is the Dissolved Oxygen data, 6 characters, right justified.

uuu is the Dissolved Oxygen units description, which can be any of the following…

ppm	for parts per Million readout without Salinity correction. Note the lower case "**m**".
ppM	for parts per Million readout with Salinity correction applied. Note the upper case "**M**".
%S•	for % Saturation readout.
%G•	for % Gaseous readout.

CCCCCCC is the Conductivity or TDS data, 7 characters, right justified.

uuu is the Conductivity/TDS units description, which can be any of the following…

uS•	for µS/cm Conductivity readout.
mS•	for mS/cm Conductivity readout.
ppM	for parts per Million TDS readout.
ppK	for parts per Thousand TDS readout.

TTTTT is Temperature data, 5 characters, right justified.

uuu is the Temperature unit description, which is the following…

oC•	for real Temperature data.

When requested by a PC with the ?D or ?R commands (section 12.5), the data is terminated with a carriage return.

When the data is sent by the **smart*CHEM*-D** using the Print function (section 11.5) or the Instant Send function (section 12.2), the data ends with a carriage return and a line feed.

12.7 GLP Data Format

GLP information is returned as 18 lines terminated by a carriage return. When using the “?G” command (section 12.5), the computer must respond with a character after receiving each line.

For example…

```
smartCHEM-D V1.0 S1234 @ 31/12/2001 15:00
Oxygen       Zero=       0.1%     @ 31/12/2001 12:00
Oxygen       Span=     100.0%     @ 31/12/2001 12:10
Conductivity Zero=      0.01uS    @ 31/12/2001 12:20
Conductivity k=         1.01      @ 31/12/2001 12:30
TDS          Zero=      0.01ppM   @ 31/12/2001 12:40
TDS          k=         1.01      @ 31/12/2001 12:50
Temp. Probe  Offset=     1.0oC    @ 31/12/2001 14:40
Temp. ED1    Offset=     1.0oC    @ 31/12/2001 14:50
Ends
```

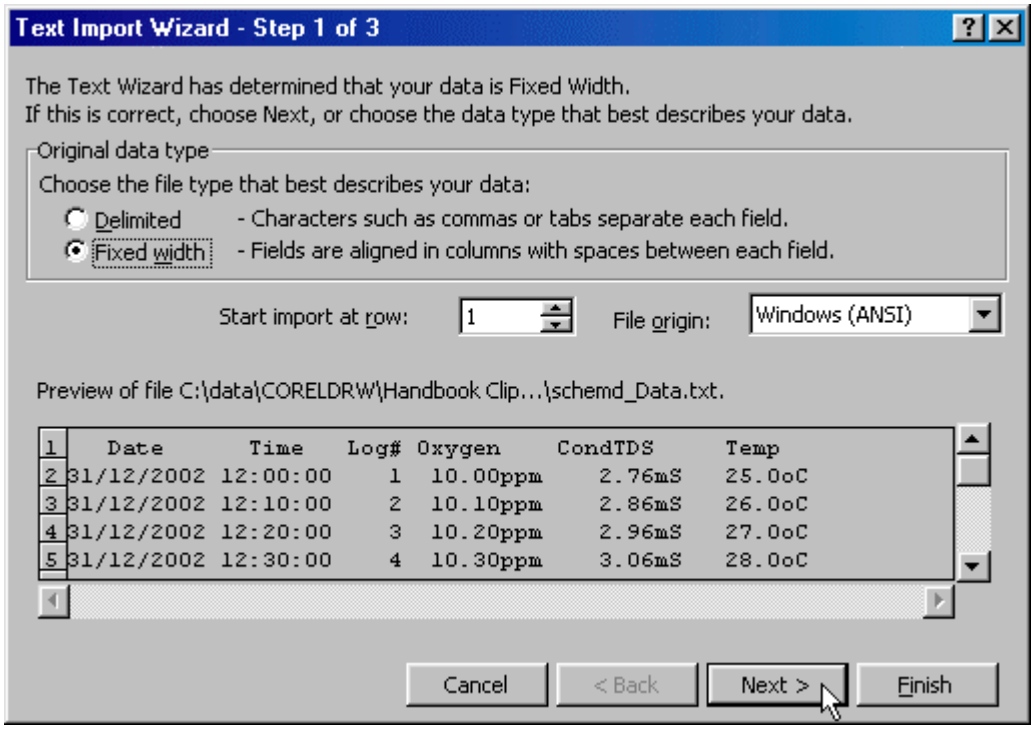
12.8 Importing Data into Microsoft Excel

The following procedure details the method for importing a **smart*CHEM*-D** text data file into Microsoft® Excel®.

1. Start Microsoft® Excel® and select File → Open
2. In the "Files of type:" pull-down box, choose "Text Files (*prn; *.txt; *.csv)".
3. Navigate to the folder where your data file is stored and double-click it to start the Text Import Wizard.

   Note : The default data folder for the WinTPS software is "C:\My Documents\WinTPS".
4. In step 1 of the Text Import Wizard select "Fixed width", as per the sample screen below, then press "Next >".

   Note that the data column headers in row 1 appear only when the data is downloaded using the WinTPS software.

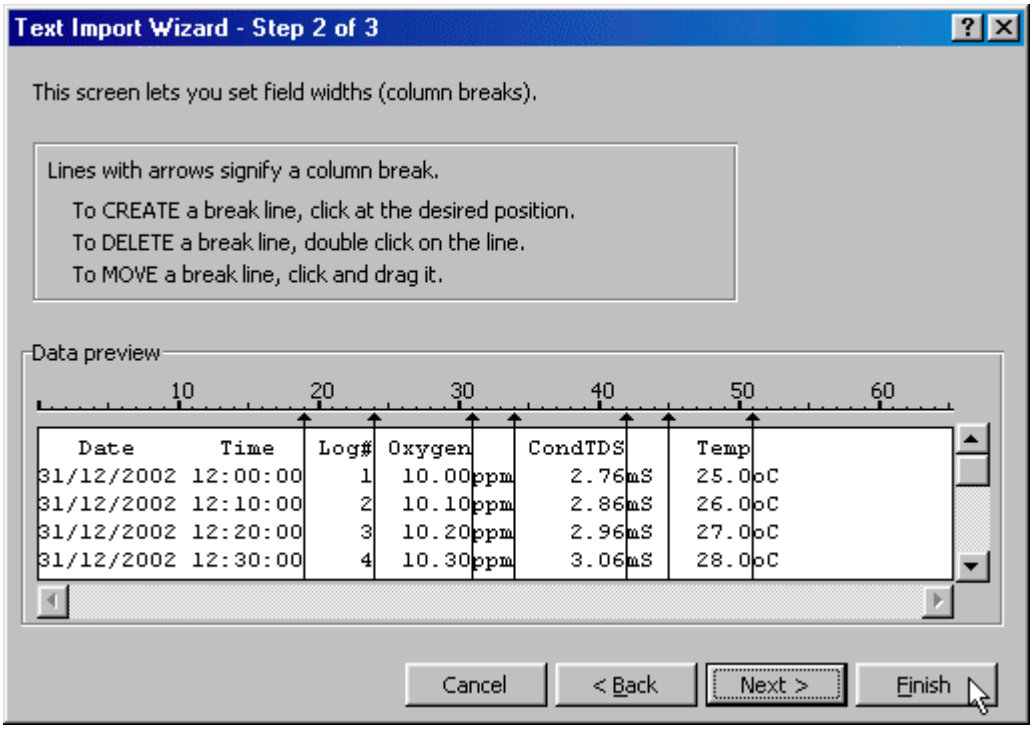


Continued over the page…

5. Step 2 of the Text Import Wizard allows you to select the points at which each data field will break into a new column. The sample screens below show where TPS recommends the breaks be inserted.

   The date and time have been incorporated into a single column to ensure that the X-axis is correctly formatted if the data is to be charted later.

   Press “Next >” after all the column breaks have been inserted.



6. Simply press “Finish” at step 3 of the Text Import Wizard. TPS recommends that the data format for each column be set once the data is in spreadsheet format.

   For help on formatting the data columns, charting, graphing or other operations please consult the Microsoft® Excel® help file. Alternatively please contact TPS and we will try to provide further assistance.

13. Recorder Port

This section is applicable if the optional Recorder port is fitted.

The optional Recorder Port can be used to send the data from any one parameter to a chart recorder or other analogue logging device.

13.1 Recorder Port Configuration

1. Select the Recorder set-up menu

   (Menu → **F4:Setup** → **F4:Ports** → **F5:Recorder**).

   The **smart*CHEM*-D** will now display the Recorder Port configuration screen…

   ```
   RECORDER
   >F1:Oxygen
    F3:Conductivity
    F5:Temperature
   ```

   The arrow indicates the current selection.

2. Press F1 to set the Recorder output to Dissolved Oxygen data.

   Press F3 to set the Recorder output to Conductivity or TDS data

   Press F5 to set the Recorder output to Temperature data.

   Press Menu to quit and retain the current setting.

13.2 Recorder Port Specifications

Mode	Range	Output Range	Examples (Reading = mV Out)
Dissolved Oxygen	0.00 to 40.0 ppM 0.0 to 500 %Sat'n 0.0 to 100 %Gas	0 to 2000 mV	0.00 ppM = 0 mV 100.0 %Sat'n = 400 mV
Conductivity	0 to 3.000 µS/cm 0 to 30.00 µS/cm 0 to 300.0 µS/cm 0 to 3000 µS/cm 0 to 30.00 mS/cm 0 to 300.0 mS/cm	0 to 2000 mV for full scale of selected range.	0.000 µS/cm = 0 mV 2760 mS/cm = 1840 mV
TDS	0 to 2.000 ppM 0 to 20.00 ppM 0 to 200.0 ppM 0 to 2000 ppM 0 to 20.00 ppK 0 to 200.0 ppK	0 to 2000 mV for full scale of selected range.	0.00 ppM = 0 mV 1000 ppM = 1000 mV 36.0 ppK = 360 mV

Note : The ranges shown above exceed the range specifications detailed in section 1.9 to allow for variations due to sensor performance.

Output Impedance : Approximately 1000 Ohms

Resolution : Approximately 2 mV

14. Setting the Clock

1. Select the Clock Set-up menu (Menu → **F4:Setup** → **F2:Clock**)
2. The display now shows the current time, for example…

```
Time is now 12:00
Enter Time  12:00
```

3. Use the Numeric Keypad to enter the current time, then press Enter.

   Alternatively, press menu to quit and retain the current setting.

4. If you pressed Enter above, the display will now show the current date, for example…

```
Date is now 04/09/01
Enter Date  04/09/01
            dd/mm/yy
```

5. Use the Numeric Keypad to enter the current date, then press Enter.

   Alternatively, press menu to quit and retain the current setting.

Notes

1. The **smart*CHEM*-D** tests that a valid day of the month is entered. If an invalid date is entered (eg. 31/02/2001), the **smart*CHEM*-D** beeps and displays the message "**Invalid Date**". The meter then returns to the clock setting screen so that the correct date can be entered.
2. The **smart*CHEM*-D** also tests for leap years.

15. Initialising the smart*CHEM*-D

If the calibration settings of the **smart*CHEM*-D** exceed the allowable limits, the unit may need to be initialised to factory default values. This action may be required if a sensor is replaced.

Initialising the unit will reset all user setups to their factory default values and erase all readings logged in memory. ***Ensure that any valuable data has been noted or downloaded and saved before proceeding.***

To initialise the **smart*CHEM*-D**…

1. Select Initialise from the Setup menu (Menu → **F4:Setup** → **F5:Initialise**)
2. The **smart*CHEM*-D** now asks if you are sure that you wish to initialise ALL parameters…

   Press F1 to initialise ALL parameters, reset all factory default settings and clear the memory.
3. When returning the meter to normal display mode, note that the decimal points have been replaced with a " ∗ ", to indicate that each parameter requires re-calibration.

16. Instrument firmware version number

If you need to contact TPS for any further technical assistance, the version number of your **smart*CHEM*-D** firmware may of benefit to us. The version number is displayed by the **smart*CHEM*-D** at turn-on.

17. Troubleshooting

17.1 General Errors

Error Message	Possible Causes	Remedy
Factory Cal. Failure **Need Factory Service**	The EEPROM chip which contains the factory calibration information has failed.	The unit must be returned to TPS for service.
EEPROM Write Failure **Need Factory Service**	User calibration settings have been lost or corrupted.	Switch the meter OFF for 5 seconds and switch back ON. If the problem persists, return the unit to TPS for service.
Data Pointer Error **Logged Data Lost**	Data stored in memory has been lost or corrupted.	Switch the meter OFF for 5 seconds and switch back ON. If the problem persists, return the unit to TPS for service.

17.2 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 15.
• Zero calibration fails (Zero is greater than 7.0%) • Air calibration fails (Span is less than 70% or greater than 135%). • Unstable or inaccurate readings.	1. Membrane is leaking or broken.	Replace membrane and refill electrode.
	2. Gap between membrane and gold cathode is dry.	ED1 Undo the barrel 3 turns, then re-tighten to re-flush the filling solution. YSI Gently pump the pressure compensation diaphragm several times.
	3. Incorrectly fitted membrane.	Membrane should be smooth and convex with no wrinkles. Re-fit membrane if necessary.
	4. Electrode is empty.	Replace membrane and re-fill electrode.
	5. Electrode is faulty.	Return electrode to factory for repair or replacement
Blackened Silver anode.	Electrode has been exposed to sulphides or other chemical poisoning.	ED1 Remove barrel and soak in 5% Ammonia solution for 10 minutes. If anode is still blackened, sand silver tube with #800 Wet & Dry sandpaper. YSI Remove pressure compensation diaphragm and membrane, then soak in 5% Ammonia solution for 10 minutes. If cleaning is unsuccessful, return the sensor to the TPS factory for cleaning and service.
Tarnished or scratched Gold cathode.	Electrode has been chemically poisoned or physically damaged.	Return to the TPS factory for cleaning and service.
Meters displays "**Probe**" instead of Dissolved Oxygen data.	Meter has been calibrated on ED1 and then a YSI sensor is connected, or vice versa.	Re-calibrate the Dissolved Oxygen reading on the new sensor. Meter only keeps calibration data for one Dissolved Oxygen sensor.
Meter displays **OVR ppM** or **OVR%** instead of Dissolved Oxygen data.	1. Electrode has not yet polarised. 2. Electrode is faulty	Wait for 2-3 minutes for the electrode to polarise after the **smart*CHEM*-D** is switched on. Return electrode to factory for repair or replacement.
Reading does not change in any sample being measured	Auto Stability Function has frozen display (notice the ☑).	Turn Auto Stability Function OFF or re-start sampling (see section 7).

17.3 Conductivity / TDS Troubleshooting

Symptom	Possible Causes	Remedy
Unit fails to calibrate, even with new probe.	Calibration settings outside of allowable limits due to previous failed calibration.	Initialise the unit. See section 15.
Unit attempts Span calibration instead of Zero calibration.	Sensor has Zero error.	Thoroughly rinse sensor in distilled water and allow to completely dry in air before attempting zero calibration. Clean the glass around the platinum plate area. DO NOT rub the black platinised surfaces.
Standard calibration fails, and k factor is greater than 25% ***above*** the nominal value.	1. Sensor is not immersed correctly. 2. Sensor may have a build-up of dirt or oily material on electrode plates. 3. Platinum-black coating has worn off. 4. Standard solution is inaccurate. 5. Sensor is faulty. 6. Faulty instrument.	Immerse sensor at least to the vent hole in the side of the sensor. Clean sensor as per the instructions detailed in section 18.2.1. Sensor requires replatinisation as per section 18.2.1. Alternatively, return to the factory for replatinisation. Replace standard solution. Return sensor to factory for repair or replacement. Return to factory for repair.
Standard calibration fails, and k factor is greater than 25% ***below*** the nominal value.	1. Standard solution is inaccurate. 2. Sensor may have a build-up of conductive material, such as salt. 3. Sensor is faulty. 4. Faulty instrument.	Replace standard solution. Clean sensor as per the instructions detailed in section 18.2.1. Return sensor to factory for repair or replacement. Return to factory for repair.
Inaccurate readings, even when calibration is successful.	1. Sensor may have a build-up of dirt or oily material on electrode plates. 2. Platinum-black coating has worn off.	Clean sensor as per the instructions detailed in section 18.2.1. Sensor requires replatinisation as per section 18.2.1. Alternatively, return to the factory for replatinisation.
Readings drift.	Sensor may have a build-up of dirt or oily material on electrode plates.	Clean sensor as per the instructions detailed in section 18.2.1.
Readings are low or near zero.	1. Sensor may have a build-up of dirt or oily material on electrode plates. 2. Sensor is not immersed correctly. 3. Sensor is faulty. 4. Faulty instrument.	Clean sensor as per the instructions detailed in section 18.2.1. Immerse sensor at least to the vent hole in the side of the sensor. Return sensor to factory for repair or replacement. Return to factory for repair.
Reading does not change in any sample being measured	Auto Stability Function has frozen display (notice the ☑).	Turn Auto Stability Function OFF or re-start sampling (see section 7).

17.4 Temperature Troubleshooting

Symptom	Possible Causes	Remedy
Temperature inaccurate and cannot be calibrated.	1. Faulty connector.	Check the connector and replace if necessary.
	2. Faulty Dissolved Oxygen or Temperature sensor, whichever is being calibrated.	Return Dissolved Oxygen or Temperature sensor for repair, or replace sensor.
	3. Faulty Dissolved Oxygen cable if Dissolved Oxygen sensor is being used for Temperature readout.	Return Dissolved Oxygen cable for repair or replace cable.
Meters displays "**Probe**" instead of Temperature data.	Meter has been Temperature-calibrated on ED1 and then a YSI sensor is connected, or vice versa.	Re-calibrate the Temperature reading on the new sensor. Meter only keeps Temperature calibration data for one Dissolved Oxygen sensor.
Displays flashing "**M**" when Temperature and/or Dissolved Oxygen sensor plugged in.	1. Faulty instrument socket.	Return the instrument to the TPS factory for service.
	2. Faulty Dissolved Oxygen or Temperature sensor, whichever is being calibrated.	Return Dissolved Oxygen or Temperature sensor for repair, or replace sensor.
	3. Faulty Dissolved Oxygen cable if Dissolved Oxygen sensor is being used for Temperature readout.	Return Dissolved Oxygen cable for repair or replace cable.
Reading does not change in any sample being measured	Auto Stability Function has frozen display (notice the ☑).	Turn Auto Stability Function OFF or re-start sampling (see section 7).

18. Appendices

18.1 Dissolved Oxygen

18.1.1 Dissolved Oxygen Sensor Fundamentals

The electrode used is the amperometric type of Clark Electrode and is suitable for the measurement of oxygen pressures in the range 0 to 100 cm of mercury. While the probe 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 probe 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.

18.1.2 Operating Principle

The Clark oxygen electrode 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 electrode. A load resistor (actually a thermistor in this case) situated in the electrode itself, converts this current into a voltage proportional to the oxygen partial pressure. The thermistor provided within the body of the electrode 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 probe achieves this.

18.1.3 Probe Storage

The Oxygen probe 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 probe can be stored with the tip in water or in a humid environment.

For long term storage of several weeks or more, remove the membrane and empty out the electrolyte. Replace the membrane without electrolyte to avoid contamination of the gold and silver surfaces. When the electrode is stored in this way, the membrane should be replaced and the electrode refilled before use.

18.1.4 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. To replace the membrane, please see the separate instruction leaflet supplied with your sensor.

18.1.5 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^{o}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 Electrode 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 probe linear readout is then a linear function of % Saturation. Organic cell walls behave like the probe and pressure units are valuable.

% 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. probe).

If mass units are used for measurement of Dissolved Oxygen, the temperature problem of relating the linear partial pressure reading of the probe 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 **smart*CHEM*-D** 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 **smart*CHEM*-D** Meter has Solubility Correction via an additional temperature sensor in the electrode ;

(c) Salinity correction is performed automatically via the Conductivity/TDS sensor.

18.1.6 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 the 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 the 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.

18.1.7 Velocity Past The Membrane

Workers have shown that the relationship between the diffusion current (oxygen current) and the external velocity of the liquid is expotential. Some workers using thicker membranes have shown even less dependence of the diffusion current on liquid velocity. Because of the expotential 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 electrode 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 electrode 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 ED1 Dissolved Oxygen sensor is sealed by glands for total immersion to a depth of 3 metres. The EDYSI has a pressure compensation diaphragm to allow submersion to 60 metres.

18.2 Conductivity/TDS

18.2.1 Care, Cleaning and Maintenance of Conductivity Sensors

Care of Conductivity sensors

The conductivity section of the sensor supplied with your **smart*CHEM*-D** consists of two platinum plates that are plated with a layer of "platinum-black". This is quite a soft layer and is required for stable, accurate measurements. In time, the platinum-black layer may wear off in some applications, at which time the sensor will require replatinising (see detail later in this section). You can help to maintain the platinum-black layer by following these simple rules:

1. **NEVER** touch or rub the electrode plates with your fingers, cloth etc.
2. Avoid using the sensor in solutions that contain a high concentration of suspended solids, such as sand or soil, which can abrade the electrode plates. Filter these types of solutions first if possible.
3. Avoid concentrated acids. If you must measure acids, remove the sensor immediately after taking the measurement and rinse well with distilled water.

Conductivity sensors can be stored dry. Ensure that the sensor is stored in a covered container, to avoid dust and dirt build-up.

Cleaning Conductivity of Sensors.

Platinised platinum Conductivity sensors can only be cleaned by rinsing in a suitable solvent.

DO NOT wipe the electrode plates, as this will remove the platinum-black layer.

1. Rinsing in distilled water will remove most build-ups of material on the electrode plates.
2. Films of oils or fats on the electrode plates can usually be removed by rinsing the sensor in methylated spirits.
3. Stubborn contamination can be removed by soaking the sensor in a solution of 1 part Concentrated HCl and 10 parts distilled water. The sensor should not be soaked for more than approximately 5 minutes, otherwise the platinum-black layer may start to dissolve.
4. If all of these methods fail, then the last resort is to physically scrub the electrode plates, which will remove the contaminant and the layer of platinum-black. Use only a cloth or nylon scouring pad. DO NOT USE STEEL WOOL. The sensor will then need to be cleaned in HCl, as per step 3 and replatinised (see detail later in this section).

Replatinising Conductivity Sensors

There are several ways to replatinise Conductivity electrodes.

1. The simplest way is to return the electrode to the TPS factory. We can fully clean the electrode, replatinise it and test all aspects of its performance.

2. An automatic replatiniser is available from TPS, along with replatinising solution. This will plate the electrodes for the right amount of time at the correct current. Ordering details are as follows…

Automatic Conductivity Electrode Replatiniser	Part No 122160
20mL Platinising Solution (suitable for approx 30 uses)	Part No 122300

3. Conductivity electrodes can be manually replatinised, according to the following procedure…

   (a) Soak the electrode in a solution of 1 part Concentrated HCl and 10 parts distilled water for approximately 5 minutes.

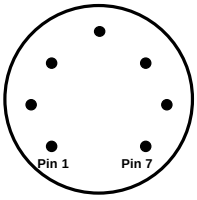
   (b) Rinse the electrode well in distilled water.

   (c) Immerse the electrode in platinising solution at least to the vent hole in the glass body. Platinising solution is available from TPS (part no 122300). Alternatively, platinising solution can be prepared by dissolving 1g of Hydrogen Chloroplatinate (H_2PtCl_{16}) in 30mL of distilled water, and including about 0.01g of Lead Acetate ($(CH_3COO)_2Pb$) and a drop or two of concentrated HCl. **Caution : This is a dangerous solution and should be handled with the utmost care.**

   (d) Apply a direct current of 10mA between pins 1 and 7 of the electrode plug, as per the diagram below. Reverse the polarity every 30 seconds. After approximately 8 minutes (4 minutes per electrode plate), they should have an even “sooty” appearance. Avoid excess current as this will cause incorrect platinising.

   (e) After platinising, rinse the electrode well in distilled water.

   (f) If you have any doubts about any of these steps, then you should consider returning the electrode to the factory. The cost of replatinising is quite low, and you will be guaranteed of the best possible result.



Sensor Connector

19. Warranty

TPS Pty. Ltd. guarantees all instruments and electrodes 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 Factory, or Authorised 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 electrodes is three (3) months.

There are no express or implied warranties which extend beyond the face hereof, and TPS Pty. Ltd. is not liable for any incidental or consequential damages arising from the use or misuse of this equipment, or from interpretation of information derived from the equipment.

Shipping damage is not covered by this warranty.

PLEASE NOTE:

A guarantee card is packed with the instrument or electrode. This card must be completed at the time of purchase and the registration section returned to TPS Pty. Ltd. within 7 days. No claims will be recognised without the original guarantee card or other proof of purchase. This warranty becomes invalid if modifications or repairs are attempted by unauthorised persons, or the serial number is missing.

PROCEDURE FOR 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 electrode simply requires cleaning or replacement.

TPS Pty. Ltd. has a fine reputation for prompt and efficient service. In just a few days, our factory service engineers and technicians will examine and repair your equipment to your full satisfaction.

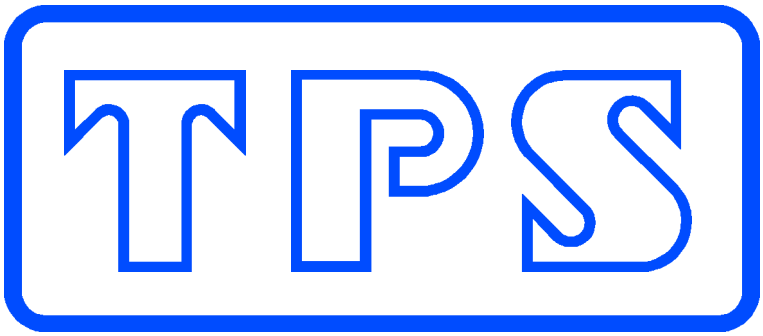
Return the instrument **AND ALL SENSORS** to TPS freight pre-paid and insured in its original packing or suitable equivalent. INSIST on a proof of delivery receipt from the carrier for your protection in the case of shipping claims for transit loss or damage. It is your responsibility as the sender to ensure that TPS receives the unit.

Please check that the following is enclosed with your equipment:

- **Your Name and daytime phone number.**
- **Your company name, ORDER number, and return street address.**
- **A description of the fault. (Please be SPECIFIC.)**
  (Note: "Please Repair" does NOT describe a fault.)

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

For out-of-warranty units, a repair cost will be calculated from parts and labour costs. If payment is not received for the additional charges within 30 days, or if you decline to have the equipment repaired, the complete unit will be returned to you freight paid, not repaired. For full-account customers, the repair charges will be debited to your account.


TPS