Congratulations !

The **smart*CHEM*-Titro** is an advanced, high quality pH, mV & Temperature instrument. It features the ability to directly connect to a Schott Universal burette for Automatic Titration applications.

Despite its impressive list of features, the **smart*CHEM*-Titro** 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:

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*-Titro**. 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*-Titro**, including operating modes, calibration, troubleshooting, specifications, and warranty terms.
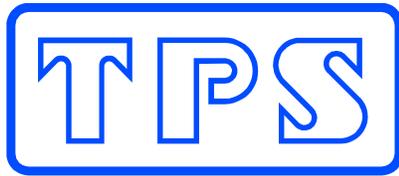
4. **Appendices**
   Appendices containing background information and application notes are provided at the back of this manual.

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smart*CHEM*-Titro

pH, mV, Temperature Meter with Automatic Titrator function

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Version : 1.2

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Contents

1. Introduction

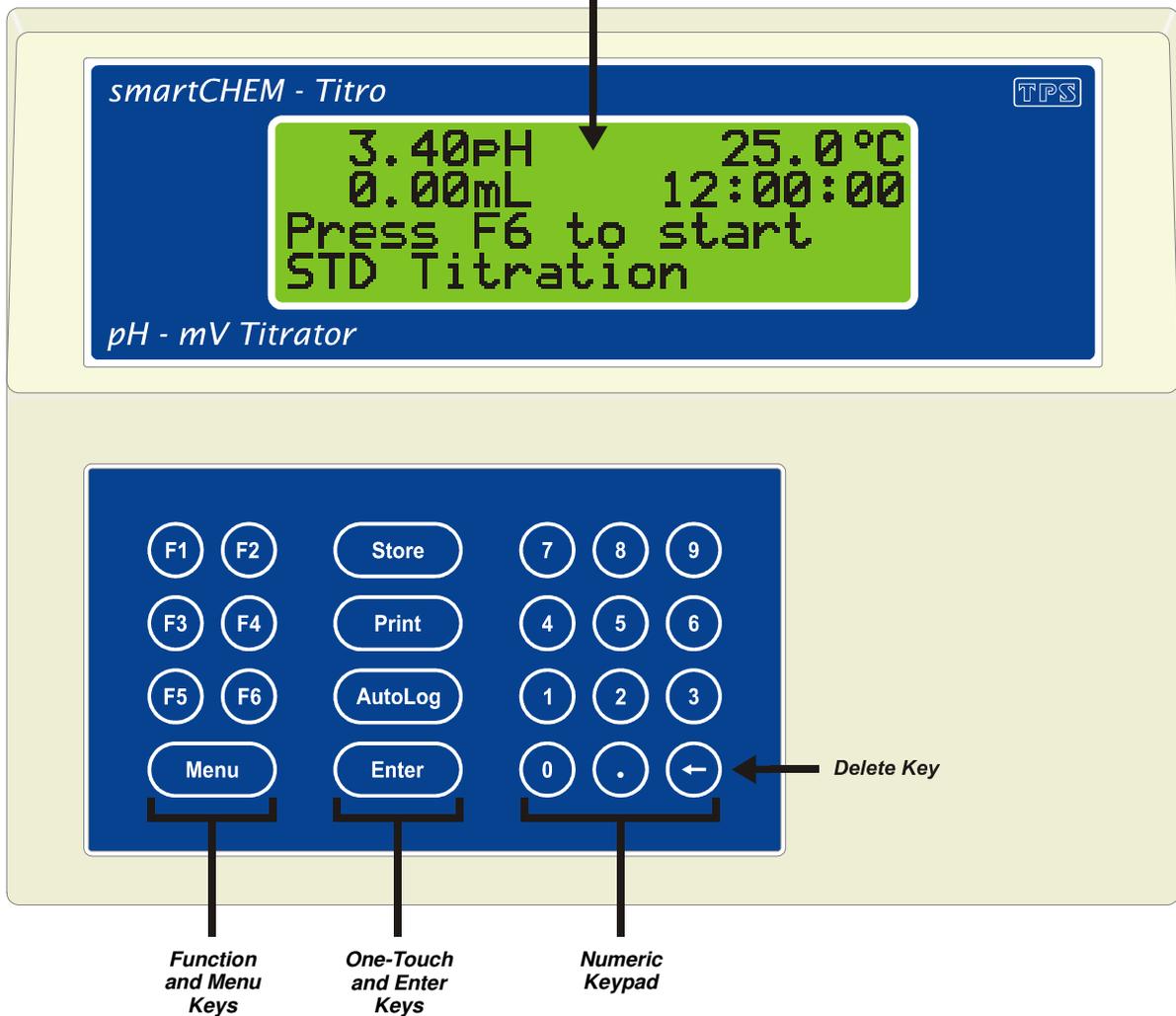## 1.1 smart*CHEM*-Titro Display and Controls

240 x 64 dot Graphic LCD with Backlight

```
smartCHEM - Titro                        TPS

        3.40pH          25.0°C
        0.00mL        12:00:00
    Press F6 to start
    STD Titration

pH - mV Titrator
```

F1 F2   Store   7 8 9

F3 F4   Print   4 5 6

F5 F6   AutoLog   1 2 3

Menu   Enter   0 . ←   *Delete Key*

Function and Menu Keys   *One-Touch and Enter Keys*   *Numeric Keypad*

1.2 smart*CHEM*-Titro Rear Panel Connectors

On / Off Switch   *Karl Fischer Polarisation*   *Titration Burette*   *Reference Sensor*

OFF

ON

Power / RS232   Accessories   Temperature   Burette   Ref   pH / mV / Ion

12V DC Power Input and RS232 Port   *Temperature Sensor*   *pH/mV/Ion Sensor*
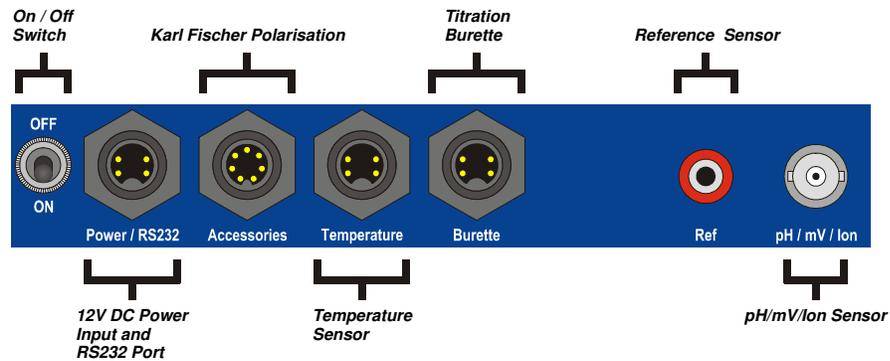
Turn the retaining nut clockwise until it clicks into place when plugging in plastic connectors. This is essential to produce a waterproof seal.

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…

(F6)   : Press to start the Automatic Titration (section 3.4).

(F5)   : Press to start and stop the Automatic Stability Function. See section 8.

1.4 One-Touch Keys

(Store) : Press to manually record readings into the Logger. See section 12.1.

(Print) : Press to transmit current reading plus date and time to the RS232 port. See section 13.2.

(AutoLog) : Press to start and stop Automatic Datalogging. See section 12.2.

(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. pH/mV/Relative mV, Temperature, Dosed mL and Time simultaneously.

Backlight can be set to On, Off or Energy Saver modes. See section 9.

1.8 Unpacking Information

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

Part No

Standard Kit…
1. **smart*CHEM*-Titro** pH / mV Automatic Titrator.. 121106
2. Cable to connect Schott Burette to **smart*CHEM*-Titro** 130122
3. pH Sensor, Double Junction Porous Teflon design, 1m.. 121207
4. Temperature/ATC Sensor 121248
5. pH6.88 Buffer, 200mL.. 121306
6. pH4.00 Buffer, 200mL.. 121381
7. Plug-Pack Power Supply... 130048
8. **smart*CHEM*-Titro** Handbook 130050

Options that may have been ordered with your smartCHEM-Titro…
1. Schott Universal Digital Piston Burette.. 130350
2. Flexible arm type electrode holder 130088
3. Double Platinum Karl Fischer Sensor 122209
4. Silver Billet Sensor with IJ Reference for Silver Nitrate titration method for Chloride.... 121298
5. RS232 Serial Interface Cable 130041
6. Serial to USB adaptor (must also have 130041 Serial Cable) 130087
7. WinTPS RS232 Communication software for Windows 95 and later 130086

1.9 Specifications

1.9.1 pH

Ranges	Resolution	Accuracy
0 to 14.000 pH 0 to 14.00 pH	0.001 pH 0.01 pH	±0.002 pH ±0.01 pH

Sensor Type ....Glass bulb pH sensor, combination or half cell.

Input Impedance...................................$>3 \times 10^{12}$ Ohms

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

Calibration...Automatic asymmetry and slope calibration.

Automatic Buffer Recognition ....pH4.00, pH6.88, pH7.00, pH9.23 & pH10.06.
Any other can be entered during calibration.

Sensor Asymmetry Range ....-1.00 to 1.00 pH

Sensor Slope Range ....85.0 to 105.0 %

1.9.2 Absolute and Relative mV

Ranges	Resolution	Accuracy
0 to ± 400.0 mV 0 to ±1500 mV (auto-ranging)	0.1 mV 1 mV	±0.15 mV ±1 mV

Sensor Type ....Platinum or Gold tip ORP sensor, combination or half cell.
Ion Selective Electrodes can also be used in this mode.

Input Impedance...................................$>3 \times 10^{12}$ Ohms

1.9.3 Temperature

Range	Resolution	Accuracy
−10.0 to 120.0 ºC	0.1 ºC	±0.2 ºC

Sensor Type ....Silicon transistor

Calibration...Automatic offset calibration

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

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1.9.4 General Specifications

Memory...2340 readings including date and time

Automatic Logging...............................User-set for one reading every 1 to 60 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. 4.0 kg

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

2. smart*CHEM*-Titro Menu Structure

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

Menu	→	F1:Calibrate	→	F1:pH or mV	F1 does not appear in the menu when Relative mV mode is selected.
				F3:Temperature	

	→	F2:Logger	→	F1:Recall

			F2:Erase	→	F1:Erase All
					F2:Erase Last

F3:Print

F4:Program	→	F1:Secs
		F2:Mins
		F3:Hours

	→	F3:Mode	→	F1:0.01pH
				F2:0.001pH
				F3:mV
				F4:Rel mV

F5:Titrator	→	F1:Titrator ON
		F3:Titrator OFF

	→	F4:Setup	→	F1:pH Buffer
				F2:Clock

F3:Backlight	→	F1:On
		F2:Off
		F3:Energy Saver

F4: Ports	→	F1:Baud Rate

F5:Initialise	→	F1:All
		F3:pH SlopeB

F6:Titr.	→	F1:Max Rate
		F2:Prop.
		F3:Min rate
		F4:Delay
		F5:STD Parameters

	→	F5:GLP	→	F1:Recall

F2:Alarm	→	F1:Daily
		F2:1 Week
		F3:2 Weeks
		F4:4 Weeks
		F5:Off

F3:Print

		F6:Access	→	F1:Change code
				F3:Enable & Enter code or F3:Disable Security

3. Automatic Titrator Mode

3.1 Selecting Automatic Titrator Mode

1. Select the Mode menu ((Menu) → `F3:Mode`)…

```
Mode
>F1:0.01pH  F2:0.001pH
 F3:mV       F4:Rel mV
>F5:Titrator
```

The arrow indicates the current selection.

2. Select **F5:Titrator** from the menu. The Titrator mode section menu is now displayed…

```
TITRATOR
>F1:Titrator ON

 F5:Titrator OFF
```

The arrow indicates the current selection.

Press Ⓕ to turn the Automatic Titrator function ON.

Press Ⓕ⑤ to turn the Automatic Titrator function OFF.

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

3. In normal display mode, the **smart*CHEM*-Titro** will now prompt you to press Ⓕ⑥ to start the Standard Titration. For example…

```
  7.00pH      25.0°C
  0.00mL    12:00:00
Press F6 to start
STD Titration
```

If the Automatic Datalogging function is programmed (as per section 12.2), an additional prompt informs the user that the titration curve will be logged into memory. For example…

```
  7.00pH      25.0°C
  0.00mL    12:00:00
Press F6 to start
STD Titration & Log
```

See section 3.3 for details on setting up the Standard Titration parameters to your specific requirements.

3.2 Setting up the apparatus for Automatic Titrations

Illustration of connections for **smart*CHEM*-Titro** Standard Titration setup…
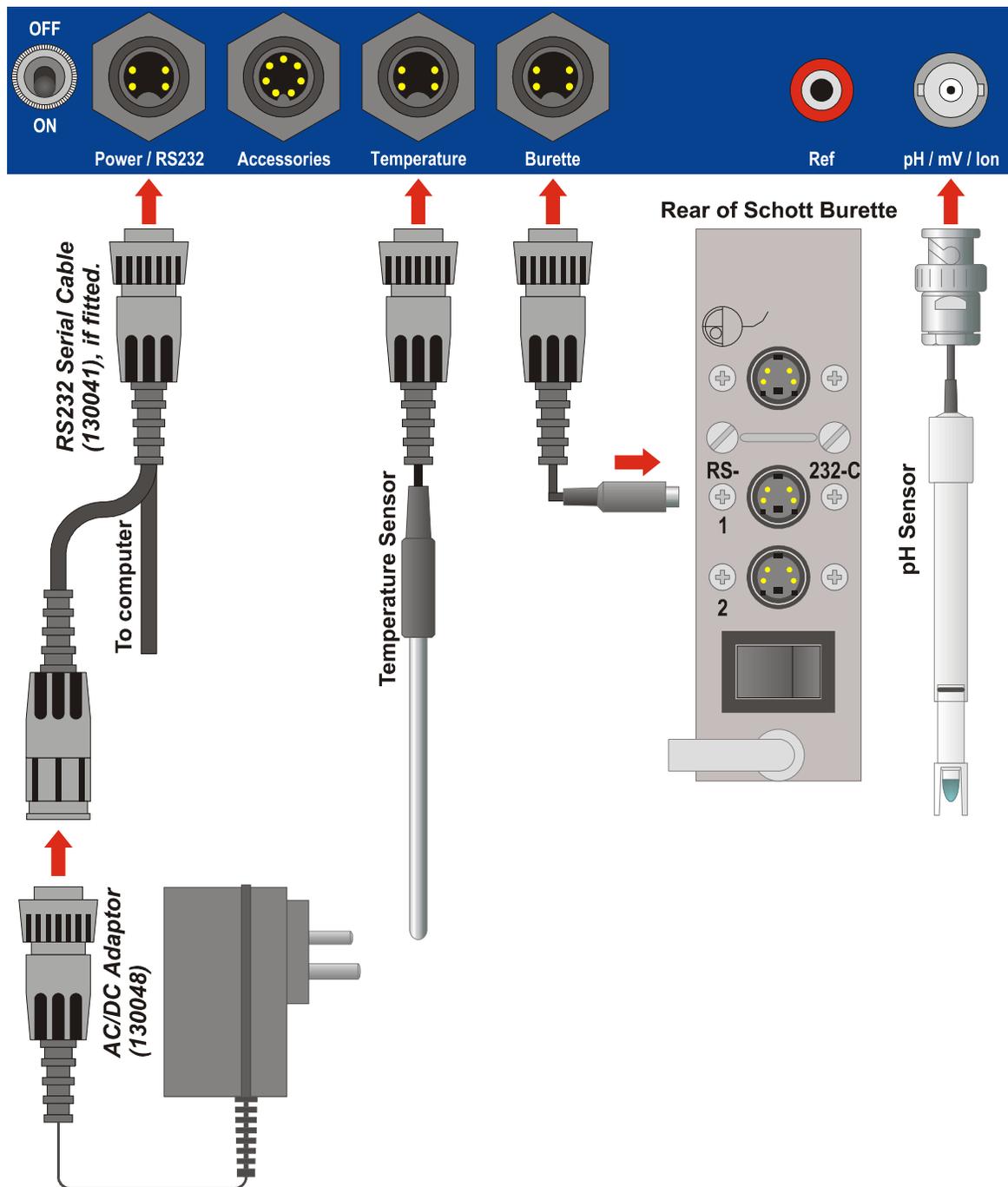
1. Select a flat Benchtop with enough free space to fit the entire Titration apparatus.

2. If computer interfacing is desired, connect the Serial cable (130041) to the **Power / RS232** socket of the **smart*CHEM*-Titro**.

3. Connect the AC/DC Adaptor (130048) to the **Power / RS232** socket of the **smart*CHEM*-Titro**. If the Serial cable is connected, connect the AC/DC Adaptor in the spare in-line socket of the Serial cable.

Continued over the page…

4. Connect the Burette Cable (130122) to the **RS-232** socket on the Schott Burette and the **Burette** socket on the smart*CHEM*-**Titro**. See the Schott Burette handbook for full details on setting up this device. The default factory settings should not need to be changed for use with the TPS smart*CHEM*-**Titro**.

5. Connect the pH sensor to the **pH/mV/Ion** socket and the Temperature sensor to the **Temperature** socket of the smart*CHEM*-**Titro**.

6. Other apparatus that will be required includes…

   • Magnetic stirrer
   • Wash bottle with distilled water

3.3 Titration Parameters

3.3.1 General Titration Parameters

This section is only applicable if the titration parameters need to be changed in case of overshooting the end point, speeding up the procedure etc. The maximum dose rate (mL/min), minimum dose rate (mL/min), proportional band and delay times can all be set by the user.

- The maximum dose rate is the mL/min of titrant addition when the pH or Millivolt reading is outside the proportional band.

- The minimum dose rate is the mL/min of titrant addition when pH is within 0.01 pH of the end point or Millivolts is within 10 mV of the end point.

- The proportional band is the number of pH units or the number of Millivolts away from the end point at which titrant addition is slowed down to avoid overshooting. The addition rate is slowed down from the maximum dose rate to the minimum dose rate gradually over this band.

- The delay time is the number of seconds the **smart*CHEM*-Titro** will wait for when the end point is reached before pronouncing the titration complete.

In the diagram below, the maximum dose rate is 10.0mL/min, the minimum dose rate is 0.2mL/min, the proportional band is 1.00 pH and the end point is pH8.20.
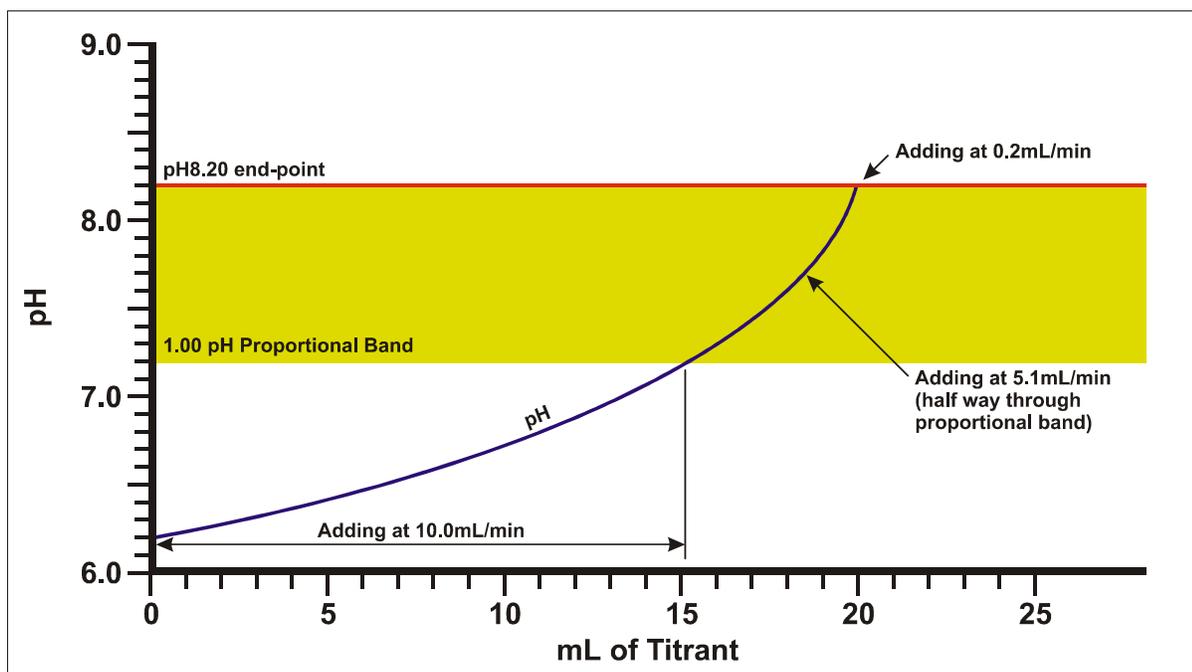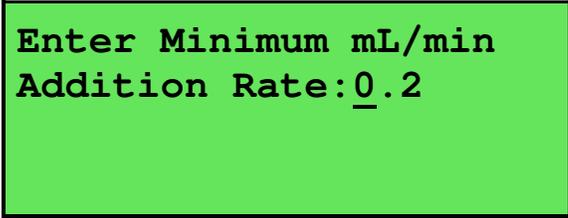

To set the maximum dose rate…

1. Select the Titration menu ((Menu) → **F4:Setup** → **F6:Titr.**).

2. Select **F1:Max Rate** from the menu. The following screen is now displayed…

```
Enter Maximum mL/min
Addition Rate:10.0
```

Enter the maximum dose rate, from 5.0 to 20.0 mL / minute, and press (Enter).

To set the minimum dose rate…

1. Select the Titration menu (Menu → **F4:Setup** → **F6:Titr.**).

2. Select **F3:Min Rate** from the menu. The following screen is now displayed…

```
Enter Minimum mL/min
Addition Rate:0.2
```

Enter the minimum dose rate, from 0.1 to 3.0 mL / minute, and press Enter.

To set the proportional band...

1. Select the Titration menu (Menu → **F4:Setup** → **F6:Titr.**).

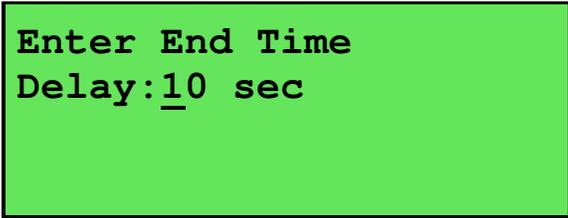2. Select **F2:Prop.** from the menu. The following screen is now displayed…

```
Enter Proportional
Band:1.00pH
```

Enter the proportional band, from 0.1 to 1.00 pH. and press Enter.

To set the delay time...

1. Select the Titration menu (Menu → **F4:Setup** → **F6:Titr.**).

2. Select **F4:Delay** from the menu. The following screen is now displayed…

```
Enter End Time
Delay:10 sec
```

Enter the end point time delay, from 3 to 300 seconds, and press Enter.

3.3.2 Standard Titration Parameters

This section is applicable directly to a Standard Titration procedure. The user is able to set the Titration variables to their requirements…

1.   Select the Titration menu ((Menu) → **F4:Setup** → **F6:Titr.**).

2.   Select **F5:STD Parameters** from the menu. The following screen is displayed…

For pH Titrations…

```
STD Parameters
Endpoint  : 7.00 pH
```

Enter the desired Endpoint, from 0 to 14 pH, and press (Enter).

For mV and Relative mV Titrations…

```
STD Parameters
Endpoint  : 0    mV

 F2:Negative
```

Enter the desired Endpoint, from 0 to 1500 mV, and press (Enter).

Press (F2) to alternately select a Negative or Positive value for the Endpoint

3.   The direction of the titration process can now be selected…

For pH Titrations…

```
STD Parameters
Titration Direction
>F1:Increasing pH
 F3:Decreasing pH
```

Press (F1) when using an alkaline titrant that increases the pH of the sample.

Press (F3) when using an acidic titrant that decreases the pH of the sample.

Press (Menu) to quit and retain the current setting.

For mV and Relative mV Titrations…

```
STD Parameters
Titration Direction
>F1:Increasing mV
 F3:Decreasing mV
```

Press (F1) when using a titrant that increases the Millivolts of the sample.

Press (F3) when using a titrant that decreases the Millivolts of the sample.

Press (Menu) to quit and retain the current setting.

4.   The Titration Parameters are now set. A Standard Titration can now be performed.

3.4 Performing a Standard Titration

For most users, the default settings programmed into the **smart*CHEM*-Titro** will result in fast, reproducible titrations. However, some variables may be altered by the user to speed up the process, avoid overshooting etc. See section 3.3.1 for details on changing the Titration Parameters.

Press (Menu) *at any time during the titration procedure to abort the titration.*

1. When the **smart*CHEM*-Titro** is in Standard Titrator mode, the following display is shown in normal display mode…

```
   4.00pH        25.0°C
   0.00mL     12:00:00
Press F6 to start
STD Titration
```

If the Automatic Datalogging function is programmed (as per section 12.2), an additional prompt informs you that the titration curve will be logged into memory. For example…

```
   3.40pH        25.0°C
   0.00mL     12:00:00
Press F6 to start
STD Titration & Log
```
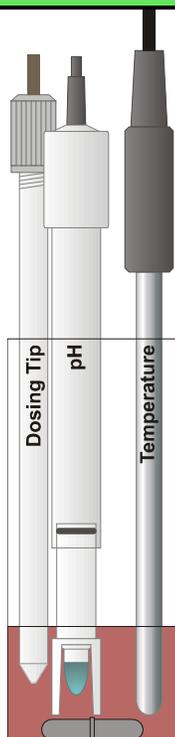
2. Place the pH and Temperature sensors into the sample. The reference junction of the pH sensor must be immersed, as per the diagram.

The burette dosing tip should be immersed to the same level as the green bulb of the pH sensor. It is best to mount this upstream from the pH sensor when the stirrer is running.

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3. Press ⑥ to begin the Standard Titration. The **smart*CHEM*-Titro** will refill the burette and start the titration. For example…

```
  4.00pH        25.0°C
  0.00mL     12:01:00
Titrating to
7.00pH
```

4. The **smart*CHEM*-Titro** will display a prompt when the titration is complete. For example…

```
  7.00pH        25.0°C
 10.00mL      12:05:00
Titration complete.
Press Print or Enter
```

5. Press ⌨Print to send the result to the serial port, which can be connected to a PC or an RS232 compatible printer. Press ⌨Enter to exit and return to the opening screen.

3.5 12V DC Switched Output (Optional)

When the **smart*CHEM*-Titro** is in Standard Titrator mode, the 12V DC output can be activated manually to switch on devices such as a solenoid valve for degassing. This function is available at any time. A 1 Amp AC/DC adaptor is required when using the optional solenoid valve.

Press ② when the unit is in its main display to switch the 12V output ON. A " ***** " is shown in the display to provide visual indication, for example…

```
 11.00pH        25.0°C
  0.00mL*     12:00:00
Press F6 to start
STD Titration
```
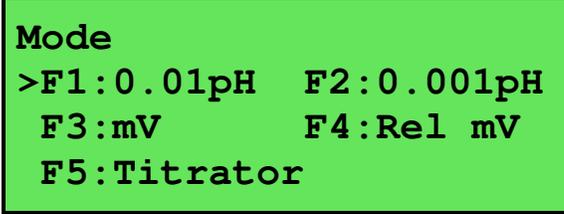
Press ② again to switch the 12V output OFF.

4. Standard pH Mode

4.1 Selecting pH Mode

To select or change the pH Mode…

1. Select the Mode menu (Menu → **F3:Mode**)…

```
Mode
>F1:0.01pH  F2:0.001pH
 F3:mV      F4:Rel mV
 F5:Titrator
```

The arrow indicates the current selection.

Press F1 to select pH mode with 0.01 pH resolution.

Press F2 to select pH mode 0.001 pH resolution.

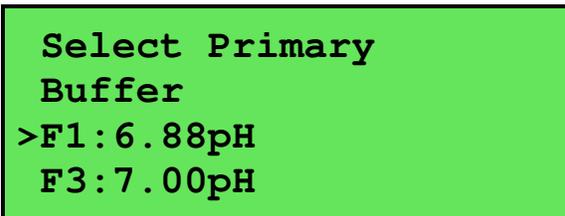Press Menu to quit without changing the current selection.

4.2 Selecting the pH Buffer Set

The **smart*CHEM*-Titro** can be programmed to automatically recognise any of the following buffer sets during pH calibration. All pH values listed below are at 25 ^{O}C.

1. pH4.00, pH6.88, pH9.23
2. pH4.00, pH6.88, pH10.06
3. pH4.00, pH7.00, pH9.23
4. pH4.00, pH7.00, pH10.06.

To select the pH buffer set for automatic recognition…

1. Select the pH Buffer set-up menu.

   (Menu → `F4:Setup` → `F1:pH Buffer`).

2. The primary buffer selection menu is now displayed…

```
 Select Primary
 Buffer
>F1:6.88pH
 F3:7.00pH
```
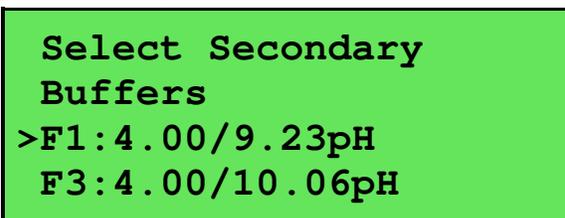
   The arrow indicates the current selection.

   Press F1 to select pH6.88 as the Primary Buffer.

   Press F3 to select pH7.00 as the Primary Buffer.

   Press Menu to quit without changing the current setting.

3. The secondary buffers selection menu is now displayed…

```
 Select Secondary
 Buffers
>F1:4.00/9.23pH
 F3:4.00/10.06pH
```

   The arrow indicates the current selection.

   Press F1 to select pH4.00 and pH9.23 as the Secondary Buffers.

   Press F3 to select pH4.00 and pH10.06 as the Secondary Buffers.

   Press Menu to quit without changing the current setting.

Notes

1. The selected buffer set is kept in memory when the meter is switched off.

2. The buffers are re-set to pH4.00, pH6.88 and pH9.23 during initialisation.

3. pH6.88 buffer is a DIN 19266 and NBS Primary-standard pH solution. Its use as the primary buffer is highly recommended for the most accurate possible results. If pH7.00 buffer is used, ensure that it is manufactured to at least 0.01pH accuracy. pH7.00 buffer has a buffer capacity less than half that of pH6.88 buffer and is therefore much less stable.

4. pH9.23 and pH10.01 buffers are highly unstable. Avoid using these buffers if possible. Discard immediately after use.

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5.   If you wish to use a pH buffer other than one of those listed above, its value can be keyed in during calibration. Make sure that pH versus Temperature data for the buffer is known.

4.3 Calibration Buffer Sequence

Before proceeding to pH Calibration (section 4.4), please consider the sequence in which the buffers should be used. This will vary depending on whether a 1, 2 or 3 point pH calibration is required.

4.3.1 1 Point Calibration

A 1 point pH calibration can be performed in any buffer and will only adjust for the asymmetry of the pH sensor. See section 18.1.1 for a detailed explanation of asymmetry. A 1 point calibration will not remove the " * ", which is shown in place of the decimal point when pH is un-calibrated or has failed calibration.

4.3.2 2 Point Calibration

A 2 point calibration is performed automatically after a successful 1 point calibration, when the pH sensor is calibrated in a buffer that is at least 1.50pH higher or lower than the buffer that was used for the first point.

A 2 point calibration can be performed in any two pH buffers, and in any order, as long as they are at least 1.50pH apart.

4.3.3 3 Point Calibration

A 3 point calibration must be performed in the correct order.

For the pre-programmed buffers (see section 4.2), this order can be any one of the following…

First Point	Second Point	Third Point
pH6.88 or pH7.00	pH4.00	pH9.23 or pH10.06
pH4.00	pH6.88 or pH7.00	pH9.23 or pH10.06

When using buffers other than the pre-programmed buffers, please use the following guidelines to determine the correct order in which to perform a 3 point calibration…

1. *Definitions*
   a) A neutral buffer must be between pH6.50 and pH7.50, inclusive.

   b) An acidic buffer must be 1.50pH or more lower than the neutral buffer that is being used.

   c) A basic buffer must be 8.50pH or higher.

2. *Buffer Order*
   a) Neutral $\rightarrow$ Acid $\rightarrow$ Base
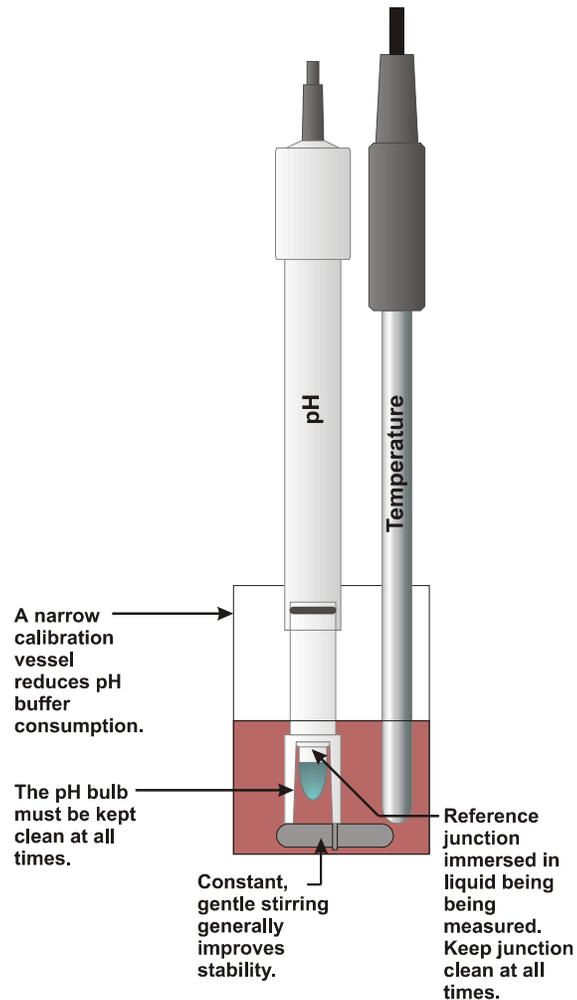
   b) Acid $\rightarrow$ Neutral $\rightarrow$ Base

3. *Notes*
   a) When using buffers other than the pre-programmed buffers, ensure that the pH versus Temperature characteristics are known. The buffer value corresponding to the calibration temperature must be keyed in correctly.

   b) pH sensors offer an extremely linear response over a wide range. A 2 point calibration would normally be sufficient for most measurements between pH2.00 and pH10.00.

   c) When a 3 point calibration has been successfully performed, an extra line appears in the GLP Recall (section 10.1) and the GLP print-out (section 10.3) labelled "**SlopeB**".

4.4 pH Calibration

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

1. Plug the pH sensor into the **pH/mV/Ion** BNC socket and the temperature sensor into the **Temperature** socket. Switch the meter on.

2. Select the desired pH resolution (see section 4.1).

3. Ensure that temperature has already been calibrated, or manually set (see sections 7.1 and 7.4). NOTE: For real temperature readings, the decimal point is shown by a " $*$ ", when the temperature readout is not calibrated.

4. Remove the wetting cap from the pH sensor. Rinse the pH and Temperature sensors in distilled water and blot them dry.

5. Ensure that the primary and secondary buffers to be used have been correctly selected for automatic buffer recognition. See section 4.2.

6. Place both sensors into a small sample of buffer so that the bulb and reference junction are both covered as per the diagram below. Choose the buffer to be used according to the details in section 4.3.

A narrow calibration vessel reduces pH buffer consumption.

The pH bulb must be kept clean at all times.

Constant, gentle stirring generally improves stability.

Reference junction immersed in liquid being being measured. Keep junction clean at all times.

DO NOT place the electrodes directly into the buffer bottle.

7. Select pH Calibration (Menu → **F1:Calibrate** → **F1:pH**).

    The display should now look something like this…
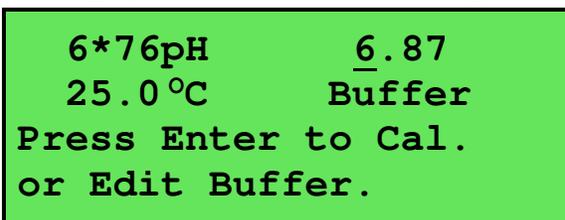
    ```
       6*76pH          6.87
       25.0 OC        Buffer
    Press Enter to Cal.
    or Edit Buffer.
    ```

    The current pH reading is shown on the left. A " * " in place of the decimal point indicates that pH is currently not calibrated.

    The buffer that the **smart*CHEM*-Titro** has attempted to recognise is also displayed with the correct value at the current temperature.

8. Press Enter to calibrate to the displayed buffer. Otherwise, enter an alternative buffer using the Numeric Keypad, and then press Enter . The Automatic Stability Function will now show a ⊠ and highlight any unstable readings…
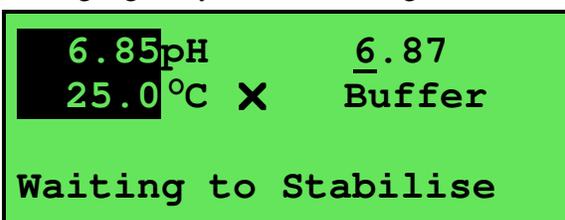
    ```
       6.85pH          6.87
       25.0 OC  ✗     Buffer

    Waiting to Stabilise
    ```

    When the pH and Temperature readings have stabilised, the unit will calibrate itself.

    To calibrate immediately without waiting for complete stability, press ⑤ to disable the Automatic Stability Function.

9. The meter is now 1 point calibrated. Note that a " * " will not be removed until a 2 point calibration has been performed. Rinse the pH and Temperature sensors in distilled water and blot them dry.

10. Repeat steps 6 to 8 in a second buffer to perform a 2 point calibration. See section 4.3.2 for details on the correct sequence of buffers to ensure the instrument is correctly calibrated at the 2 points. If a " * " was shown in place of the decimal point, this will be removed after a successful 2 point calibration.

11. Repeat steps 6 to 8 in a third buffer to perform a 3 point calibration, if required. See section 4.3.3 for details on the correct sequence of buffers to ensure the instrument is correctly calibrated at the 3 points.

12. The **smart*CHEM*-Titro** is now calibrated for pH and is ready for use in this mode. Discard the used samples of buffer.

    Rinse the pH and Temperature sensors in distilled water and blot them dry before placing them into unknown samples.

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4.5 pH Calibration Notes

1. **DO NOT** place the electrodes directly into buffer bottles. Decant a small quantity and discard after use.

2. **pH9.23 and pH10.01 buffers are highly unstable. Avoid using these buffers if possible. Discard immediately after use**.

3. A 1 point calibration should be performed at least weekly. In applications where the electrode junction can become blocked such as dairy products, mining slurries etc, a 1 point calibration may have to be done daily.

4. A full 2 point calibration should be performed at least monthly. Of course, more frequent calibration will result in greater confidence in results.

5. All calibration information is retained in memory when the **smart*CHEM*-Titro** is switched off, even when the power supply is removed. This information can be recalled or printed later using the GLP function (see section 10).

6. When a 3 point calibration has been successfully performed, an extra line appears in the GLP Recall (section 10.1) and the GLP print-out (section 10.3) labelled "`SlopeB`".

7. To clear the Slope B from a 3 point calibration without losing all other calibration data, please refer to the section regarding Initialisation (section 15).

4.6 pH Calibration Messages

1. If a 1-point calibration has been successfully performed, the **smart*CHEM*-Titro** will display the following message and the asymmetry of the electrode.

```
Asymmetry
Calibration OK
+0.10pH Asym
```

2. If a 1-point calibration has failed, the **smart*CHEM*-Titro** will display the following message and the failed asymmetry value of the electrode.

```
Calibration Failed,
Repeat Cal. or
Initialise
1.1 pH Asymmetry
```

3. If a 2-point calibration has been successfully performed, the **smart*CHEM*-Titro** will display the following message and the asymmetry and slope of the electrode.

```
Slope & Asymmetry
Calibration OK
+0.10pH Asym
99.0% Slope
```

4. If a 2-point calibration has failed, the **smart*CHEM*-Titro** will display the following message and the failed slope value of the electrode.

```
Calibration Failed,
Repeat Cal. or
Initialise
80.0% Slope
```

5. If a 3-point calibration has been successfully performed, the **smart*CHEM*-Titro** will display the following message and the asymmetry and second slope of the electrode.

```
3 Point
Calibration OK
99.0% SlopeB
```

6.   If a 3-point calibration has failed, the **smart*CHEM*-Titro** will display the following message and the failed slope value of the electrode.

```
Calibration Failed,
Repeat Cal. or
Initialise
80.0% SlopeB
```

7.   If the **smart*CHEM*-Titro** has been 3-point calibrated and the incorrect buffer sequence is subsequently used, the following message will be displayed…

```
Cal. sequence wrong.
Cannot 3 Point Cal.
Change to 2 point ?
F1:Yes    F2:No
```

Press Ⓕⁱ to proceed with a 2 point calibration. The second slope currently in memory from the previous 3 point calibration will be deleted.

Press Ⓕ² to cancel, without re-calibrating.

See section 4.3.3 for details on the correct 3 point calibration buffer sequence.

8.   The **smart*CHEM*-Titro** has an allowable Asymmetry range of –1.00 to +1.00 pH. The allowable Slope range is 85.0 to 105.0 %. If calibration fails due to either the Asymmetry or the Slope being outside these limits, then please consult the Troubleshooting guide (section 17.2) for possible remedies.

5. Absolute Millivolt Mode

5.1 Selecting Absolute Millivolt Mode

To select Absolute Millivolt Mode…

1. Select the Mode menu (Menu → `F3:Mode`)…

```
Mode
>F1:0.01pH  F2:0.001pH
 F3:mV      F4:Rel mV
 F5:Titrator
```

The arrow indicates the current selection.
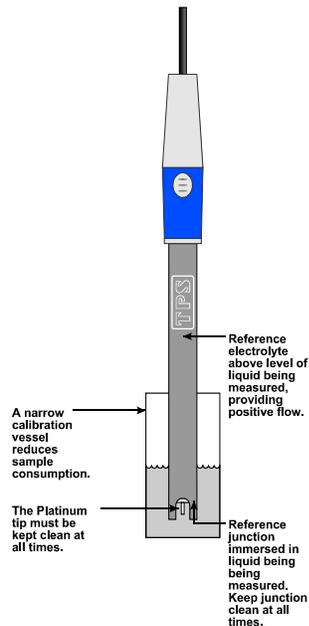
Press F3 to select Absolute Millivolt mode.

Press Menu to quit without changing the current selection.

2. The **smart*CHEM*-Titro** will display the actual millivolts produced by the sensor in this mode.
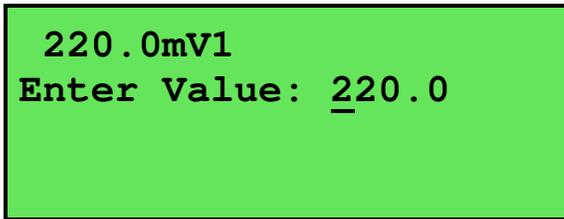
5.2 Absolute Millivolt Calibration

This calibration procedure uses a Redox/ORP sensor and ZoBell calibration as examples. For other types of sensors (eg. ISE's) and solutions, please substitute them when carrying out this procedure.

1. Plug the Redox sensor into the **pH/mV/Ion** BNC socket. Temperature compensation is not applicable for Millivolt mode, so it is not necessary to connect a Temperature sensor. Switch the meter on.

2. Select Millivolt mode (see section 5.1).

3. Remove the wetting cap from the sensor, if fitted. Rinse the sensor in distilled water and blot dry.

4. Place the sensor into a small sample of known millivolt solution so that the platinum tip and reference junction are both covered as per the diagram below. ZoBell Redox standard can be made with a 1:1 mixture of Part A and Part B. This solution produces +231mV of Redox potential. **Caution: ZoBell solution is poisonous and should be handled with care.**

Reference electrolyte above level of liquid being measured, providing positive flow.

A narrow calibration vessel reduces sample consumption.

The Platinum tip must be kept clean at all times.

Reference junction immersed in liquid being being measured. Keep junction clean at all times.

5.   Select mV Calibration ((Menu) → **F1:Calibrate** → **F1:mV**).

The display should now look something like this…

```
 220.0mV1
Enter Value: 220.0
```

The current mV reading is shown on the top line.

The **smart*CHEM*-Titro** displays the same value on the second line, on the assumption that the reading will be close to the expected calibration point.

6.   Enter the value of the calibration solution using the Numeric Keypad, and then press (Enter). The Automatic Stability Function will now show a ⊠ and highlight any unstable readings…
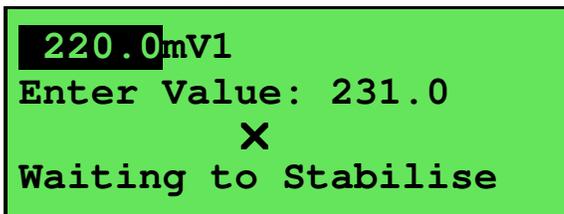
```
 220.0mV1
Enter Value: 231.0
        ✕
Waiting to Stabilise
```

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

To calibrate immediately without waiting for complete stability, press Ⓕ⑤ to disable the Automatic Stability Function.

7.   The **smart*CHEM*-Titro** is now calibrated for mV and is ready for use in this mode. Discard the used samples of standard.

Rinse the Redox sensor in distilled water and blot dry before placing into unknown samples.

5.3 mV Calibration Notes

1.   **DO NOT** place the sensor directly into stock bottles of standard. Decant a small quantity and discard after use.

2.   **Redox standards are highly unstable. Discard immediately after use**.

3.   A mV calibration should be performed at least weekly. In applications where the electrode junction can become blocked such as dairy products, mining slurries etc, a 1 point calibration may have to be done daily.

4.   All calibration information is retained in memory when the **smart*CHEM*-Titro** is switched off, even when the power supply is removed. This information can be recalled or printed later using the GLP function (see section 10).
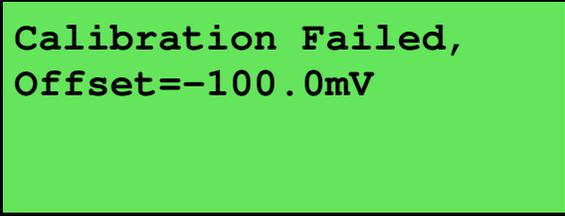
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5.4 mV Calibration Messages

1. If a mV calibration has been successfully performed, the **smart*CHEM*-Titro** will display the following message and the offset of the sensor.
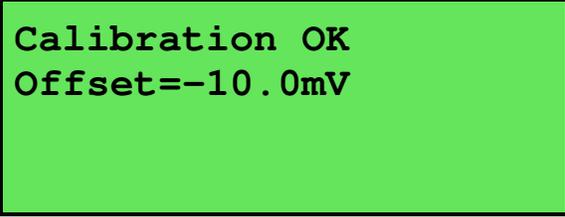
```
Calibration OK
Offset=-10.0mV


```

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

```
Calibration Failed,
Offset=-100.0mV


```

3. The **smart*CHEM*-Titro** has an allowable Offset range of –60 to +60 mV. If calibration fails due to the Offset being outside these limits, then please consult the Troubleshooting guide (section 17.2) for possible remedies.

6. Relative Millivolt Mode

6.1 Selecting Relative Millivolt Mode

To select Relative Millivolt Mode…

3. Select the Mode menu ((Menu) → **F3:Mode**)…

```
Mode
>F1:0.01pH  F2:0.001pH
 F3:mV       F4:Rel mV
 F5:Titrator
```

The arrow indicates the current selection.

Press F4 to select Relative Millivolt mode.

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

4. The **smart*CHEM*-Titro** will display the millivolt data relative to a known, user-selectable zero point.

6.2 Relative Millivolt Calibration

Calibration of the Relative mV mode is simply a matter of zeroing the reading when the sensor is in the known standard.
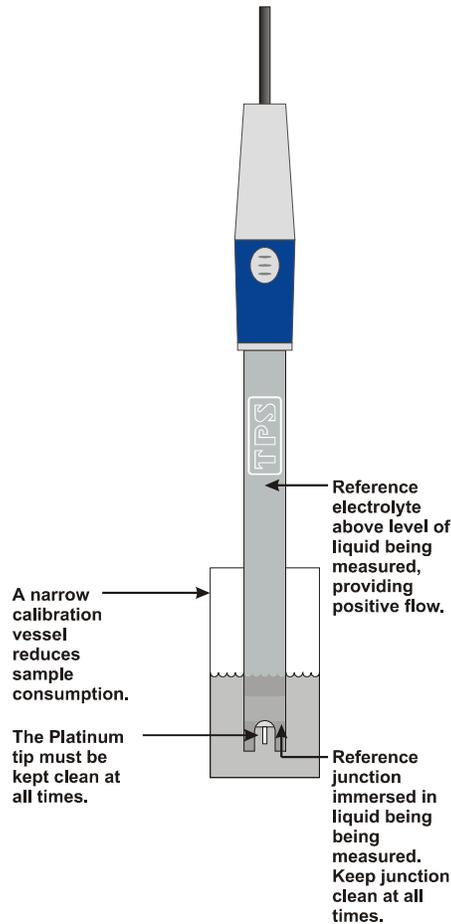
Relative mV cannot be Zeroed when the smartCHEM-Titro is in Automatic Titration mode, as the F6 is used to start the titration process.

1. Plug the Redox sensor into the **pH/mV/Ion** BNC socket. Temperature compensation is not applied in Relative mV mode, so the temperature sensor does not need to be connected. Switch the meter on.

2. Select Relative mV Mode (see section 6.1).

3. The display now shows the millivolt data with the units "**mVR**" The "**R**" indicates Relative mV…

```
400.0mVR  25.0°C

          31/12/04
          12:00:00
```

4. Remove the wetting cap from the Redox sensor.

5. Rinse the sensor in distilled water and blot dry.

6. Place the Redox sensor into a sample of the known standard. Ensure that the platinum tip and reference junction are both covered as per the diagram over the page.

Reference
electrolyte
above level of
liquid being
measured,
providing
positive flow.

A narrow
calibration
vessel
reduces
sample
consumption.

The Platinum
tip must be
kept clean at
all times.

Reference
junction
immersed in
liquid being
being
measured.
Keep junction
clean at all
times.

7. Press F6 to zero the Relative mV reading. The Automatic Stability Function will now show a ⌧ and highlight the Relative mV reading while it is unstable. For example…
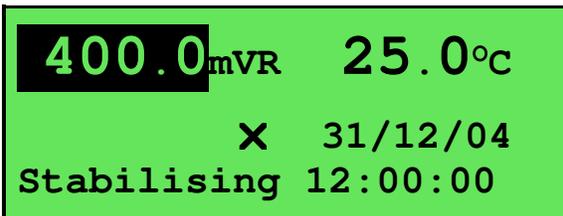
The Relative mV reading will automatically be zeroed once the reading becomes stable.

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

8. The **smart*CHEM*-Titro** Relative mV mode is now zeroed and is ready for use. The readout can be re-zeroed by pressing F6 whenever required.

6.3 Relative Millivolt Calibration Notes

1. Temperature compensation does not apply in Relative mV mode,

2. The Relative mV offset is retained in memory when the **smart*CHEM*-Titro** is switched off.

3. The Relative mV zero offset is reset when entering or leaving Relative mV mode.
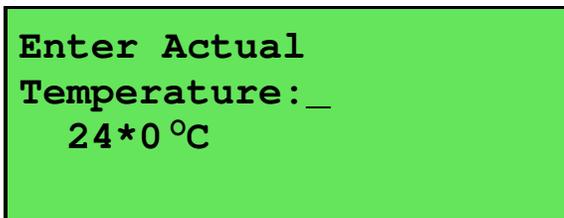
7. Temperature Mode

The temperature readout must be calibrated or manually set before attempting pH calibration.

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

7.1 Temperature Calibration
1. Plug the temperature sensor into the **Temperature** socket.

2. Switch the meter on.

3. Place the Temperature 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` → `F3:Temperature`).

   The Temperature Calibration screen is now displayed, for example…

```
Enter Actual
Temperature:_
  24*0 ºC
```

   The current reading from the Temperature 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…
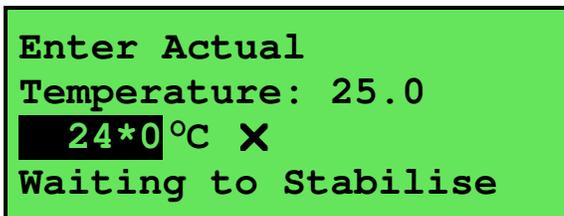
```
Enter Actual
Temperature: 25.0
 24*0 ºC ✗
Waiting to Stabilise
```

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

   To calibrate immediately without waiting for complete stability, press Ⓕ⑤ to disable the Automatic Stability Function.

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

7.2 Temperature Calibration Notes

1. Temperature calibration information is retained in memory when the **smart*CHEM*-Titro** is switched off, even when the power supply is removed. This information can be recalled later using the GLP function (see section 8).

2. Temperature does not need to be re-calibrated unless the Temperature sensor is replaced or the meter is initialised.
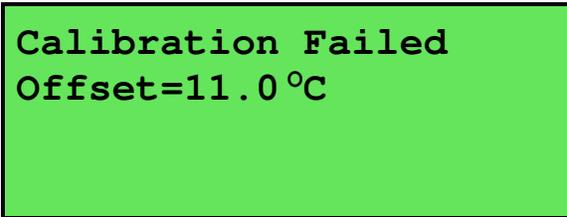
7.3 Calibration Messages

1. If a temperature calibration has been successfully performed, the **smart*CHEM*-Titro** will display the following message and the offset of the sensor.
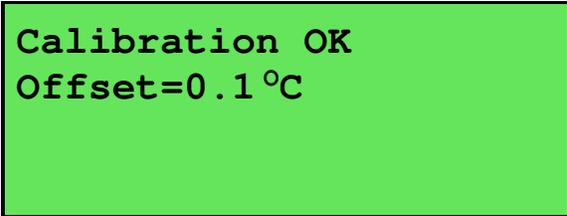
```
Calibration OK
Offset=0.1 ᵒC
```

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

```
Calibration Failed
Offset=11.0 ᵒC
```

3. The **smart*CHEM*-Titro** has an allowable Offset range of -10.0 to +10.0 ᵒC. If calibration fails due to the Offset being outside these limits, then please consult the Troubleshooting guide (section 17.3) for possible remedies.

7.4 Manual Temperature Setting

If the Temperature sensor is not connected, the temperature of the sample solution must be set manually for accurate pH measurements. A separate thermometer will be required for this.

1. Switch the meter on.

2. Measure the temperature of the sample.

3. Select Temperature Calibration ((Menu) → **F1:Calibrate** → **F3:Temp.**).

4. The current temperature setting is now displayed. For example…
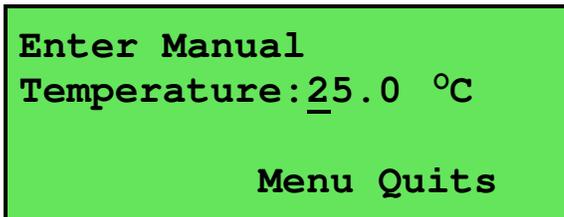
```
Enter Manual
Temperature:25.0 °C


          Menu Quits
```

5. Enter the temperature of the sample using the Numeric Keypad.
    Press (Enter) to save the new value.
    Alternatively, press (Menu) to quit and retain the current setting.

6. When returning the **smart***CHEM***-Titro** to normal measurement mode, note the "**C**" in the temperature readout alternating with an "**M**" indicating that Manual Temperature Compensation is in use. For example…
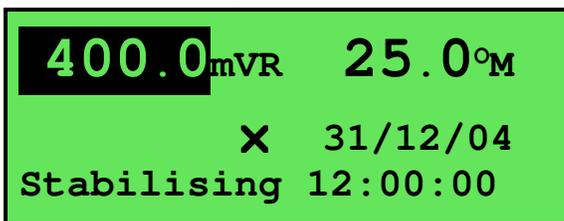
```
 400.0mVR   25.0°M

          ✗  31/12/04
Stabilising 12:00:00
```
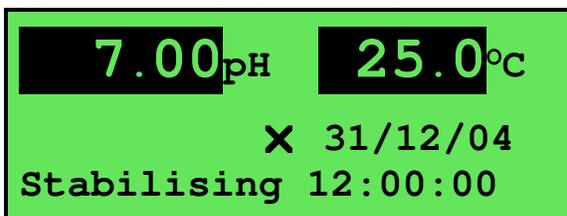
8. Auto Stability Function (ASF)

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

ASF is automatically activated during a Titration procedure, so there is no need to press any keys to start it.

ASF can be used in the following ways…

8.1 ASF During Normal Measurement

1. Press ⑤ in normal measurement mode. All active parameters are highlighted and the ☒ symbol appears in the display. For example…

```
┌─────────────────────────────┐
│  7.00pH    25.0°C           │
│                             │
│        ✗ 31/12/04           │
│ Stabilising 12:00:00        │
└─────────────────────────────┘
```

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…

```
┌─────────────────────────────┐
│  7.00pH    25.0°C           │
│                             │
│        ✔ 31/12/04           │
│          12:00:00           │
└─────────────────────────────┘
```

3. The operator can now make a note of the reading as required.

4. **To unfreeze the display in order to take the next reading, press ⑤ again to re-start the ASF sampling process.**

5. Press ⑤ a second time, while the ☒ symbol is being displayed, to turn ASF off.

8.2 ASF During Calibration

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

Press ⑤ 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.

8.3 ASF with Manual Datalogging

1. Press Ⓕ⁵ 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…
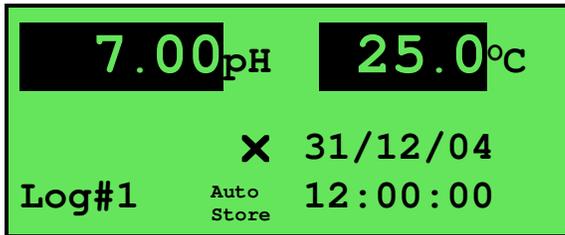
```
  7.00pH    25.0°C


        ✗  31/12/04
Log#1    Auto  12:00:00
         Store
```

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…

```
  7.00pH    25.0°C


        ✔  31/12/04
Log#1     Recorded
```

3. **To unfreeze the display in order to take the next reading, press Ⓕ⁵ and ⊂Store⊃ again to re-start the ASF Auto-Store process.**

4. Press Ⓕ⁵ a second time, while the ☒ symbol is being displayed, to turn ASF off.
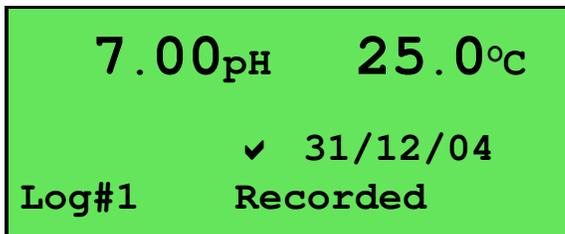
8.4 ASF with Automatic Datalogging

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.

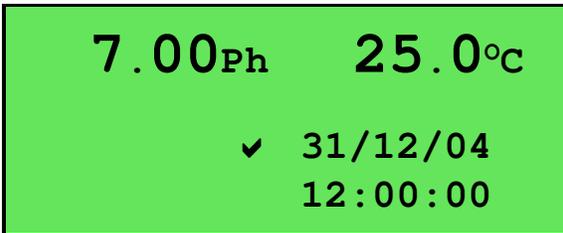See section 12.2 for details on programming the Automatic Datalogging function.

1. Press ⑤ 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…

```
 ┌──────────────────────────────┐
 │  ▐7.00▌pH    ▐25.0▌°C         │
 │                               │
 │           ✖ 31/12/04          │
 │  Log#1    Auto  12:00:00      │
 │           Log                 │
 └──────────────────────────────┘
```

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…

```
 ┌──────────────────────────────┐
 │  7.00pH     25.0°C            │
 │                               │
 │         ✔ 31/12/04            │
 │           12:00:00            │
 └──────────────────────────────┘
```

3. **To unfreeze the display in order to take the next reading, press ⑤ and (AutoLog) again to re-start the ASF automatic datalogging process.**

4. Press ⑤ a second time, while the ⊠ symbol is being displayed, to turn ASF off.

9. Display Backlight

The **smart*CHEM*-Titro** 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…

```
BACKLIGHT
 F1:On            F2:Off
>F3:Energy Saver

```
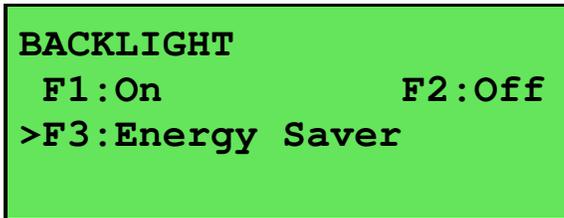
The arrow indicates the current selection.

Press Ⓕ⁰ to set the Backlight to be on continuously.

Press Ⓕ² to set the Backlight to be off continuously.

Press Ⓕ³ 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.

10. Good Laboratory Practices (GLP)

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

10.1 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 along with current calibration information. For example…

```
smartCHEM-T  V1.0 T1234    31/12/04 13:00
mV Offset=10mV             31/12/04 12:00
pH Asymmetry=0.10pH        31/12/04 12:10
pH SlopeA= 99.0%           31/12/04 12:20
pH SlopeB= 99.0%           31/12/04 12:30
pH Calibrated
Temp Probe Offset=1.0ºc   31/12/04 12:40
Temp Probe Calibrated           F4:Ends
```

5. Press F4 to quit.

10.2 Failed Calibration

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

```
smartCHEM-T  V1.0 T1234    31/12/04 13:00
mV Offset=10mV             31/12/04 12:00
pH Asymmetry=0.10pH        00/00/00 00:00
pH SlopeA= 99.0%           00/00/00 00:00

pH Un-Calibrated
Temp Probe Offset=1.0ºc   31/12/04 12:40
Temp Probe Calibrated           F4:Ends
```

10.3 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*-Titro**.

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-T  V1.0 T1234            @ 31/12/2004 13:00
mV            Offset=    10.0mV    @ 01/04/2004 12:00
pH            Asy=       0.10pH    @ 01/04/2004 12:10
pH            SlopeA=    99.0%     @ 01/04/2004 12:20
pH            SlopeB=    99.0%     @ 01/04/2004 12:30
Temp. Probe   Offset=     1.0oC    @ 01/04/2004 12:40
ENDS
```

TPS

10.4 GLP Calibration Alarm

A new feature of the **smart*CHEM*-Titro** 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.

10.4.1 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*-Titro** will now allow the operator to select which parameters will be flagged with a calibration alarm…

```
Select Channels
 F1:pH
 F3:Temperature

```

Press the relevant (F1) or (F3) 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.

10.4.2 How the GLP Alarm Operates

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

```
GLP Alarm, Calibrate
pH, Temperature
```

Only those parameters that were selected (see section 10.4.1) 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*-Titro** also flashes the decimal point of each parameter that requires calibration, and flashes the message "`Cal Now`" on the display.

10.4.3 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.

10.5 Instrument Serial Number

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

1. The serial number is displayed at turn-on, for example…
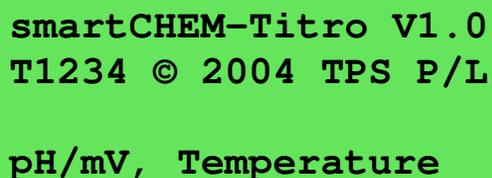
```
smartCHEM-Titro V1.0
T1234 © 2004 TPS P/L

pH/mV, Temperature
```

2. The serial number is displayed when recalling the GLP information (section 10.1).

3. The serial number is included on the print-out of GLP information (section 10.3).

4. The GLP information can be downloaded to a PC using the optional Windows® software (part number 130086).

10.6 Additional GLP Features

Another GLP requirement is to record the date and time of every reading. The **smart*CHEM*-Titro** does this for you whenever readings are recorded either with the Manual Datalogging function (section 12.1) or the Automatic Logging function (section 12.2).

11. 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.

11.1 Enabling the Access Code System

1.   Select the Access Code menu (⌐Menu⌐ → **F6:Access**).

2.   Select **F3:Enable & Enter Code** from the menu.
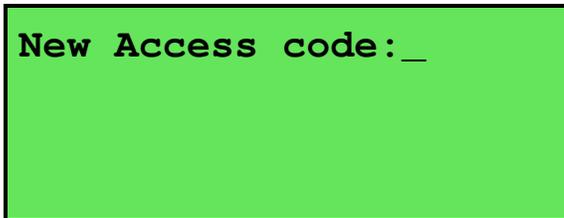
3.   The **smart*CHEM*-Titro** now prompts you to enter a new access code…

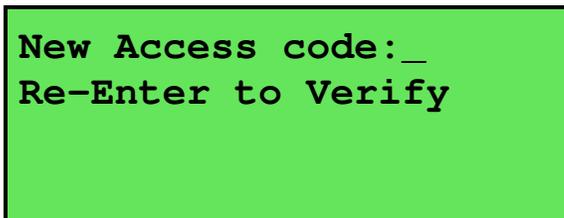```
New Access code:_


```

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 enabling the Access Code system.

4.   The **smart*CHEM*-Titro** 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 enabling the Access Code system.

5.   The **smart*CHEM*-Titro** now confirms that the Access Code system is enabled before returning to the Access Code menu.

### 11.2  Using the Access Code System

When the Access Code system is enabled (as per section 11.1), the **smart*CHEM*-Titro** 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*-Titro** 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.

**11.3  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*-Titro** now prompts you to enter a new access code…
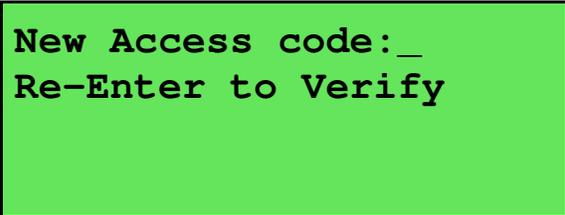
> **New Access code:_**

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*-Titro** 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*-Titro** now confirms that the Access Code system is enabled before returning to the Access Code menu.

**11.4  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*-Titro** now confirms that Access Code system has been disabled before returning to the Access Code menu.

## 12. Datalogging

### 12.1 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…

```
   7.00pH   25.0ºC

            31/12/04
Log#1   Recorded
```

2.  Repeat as often as required. The maximum number of readings that can be stored in the Logger is 2340.

**Hint** : Press (F5) before (Store) to make the **smart*CHEM*-Titro** store the reading only when all the readings have stabilised. See section 8 for more details on the Auto Stability Function.

### 12.2 Automatic Datalogging

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

*When any period greater than Zero is programmed, Datalogging starts and stops automatically during a titration procedure.*

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.

```
Enter Logging/Print
Period: 0   secs


```

3.  Use the Numeric Keypad to set the period at which the **smart*CHEM*-Titro** 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*-Titro** will ask you to enter the units. The Logging/ Printing Period you have set is also displayed. For example…

```
      Logging/Print
Period: 2
Select Units F1:Secs
F2:Mins, F3:Hours
```

   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*-Titro** 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…

```
F1:Log to Memory
F2:Send to RS232
```

Press Ⓕ① to log records into the Logger (maximum of 2340 readings).

Press Ⓕ② to send records directly to the RS232 port.

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

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

    When any period greater than Zero is programmed, Datalogging starts and stops automatically during a titration procedure.
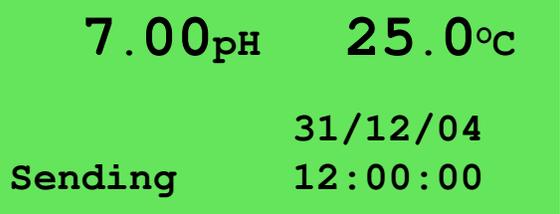
    When the **smart*CHEM*-Titro** is logging into its own memory, the display will look like this…
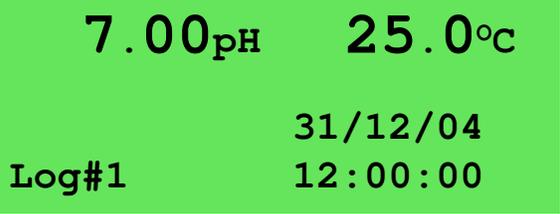
```
  7.00pH    25.0°C


           31/12/04
Log#1      12:00:00
```

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

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

```
  7.00pH    25.0°C


           31/12/04
Sending    12:00:00
```

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

8. Press (AutoLog) to stop automatic logging.

Hint : Press Ⓕ⑤ before starting automatic logging to make the **smart*CHEM*-Titro** stop logging as soon as all the readings have become stable. See section 8 for more details on the Auto Stability Function.

Notes on Automatic Datalogging

1. The clock must be set before the **smart*CHEM*-Titro** 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.

12.3 Recalling Readings from the Logger

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

1. Select the Logger menu ((Menu) → **F2:Logger**)

2. Select **F1:Recall** from the menu.

    Record number 1 is now displayed.

    For example…

```
   7.00pH    25.0°C
  20.00mL  31/12/04
 Log#1    F2:↑  12:00:00
          F4:↓
```

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.

12.4 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*-Titro** now displays the Erase menu, for example…

```
Erase Logger,
2340 Readings
Select Option
Erase F1:All F2:Last
```
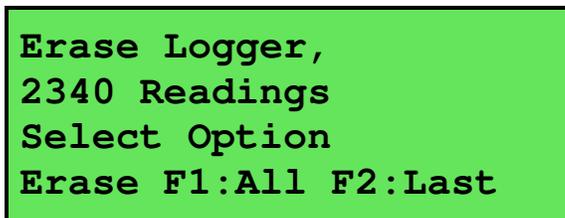
    The number of readings stored in the Logger is displayed. See the "**2340**" in the example above.

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.

12.5 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*-Titro**.

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*-Titro** are the same. If necessary, alter the baud rate of the **smart*CHEM*-Titro** (see section 13.1).

    The **smart*CHEM*-Titro** 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.

TPS

13. RS232 Port

13.1 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.

13.2 Sending Readings to the RS232 Port

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

Records can be sent directly to the RS232 port rather than stored in memory during automatic datalogging. See section 12.2 for details.

Press (Print) while recalling data on the display (see section 12.3) to send that record to the RS232 port.

13.3 RS232 Configuration

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

This information is displayed when setting the baud rate (see section 13.1)

13.4 Communication and Statistical Software

Communication between the **smart*CHEM*-Titro** 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*-Titro** 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 13.8 and the "excel.txt" file in the folder where you installed the WinTPS program.

13.5 Commands

The following commands can be sent from a PC to the **smart*CHEM*-Titro**. 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*-Titro**. The log number returned is set to Zero.
Request logged data	?R<cr>	Returns all logged records from the **smart*CHEM*-Titro** memory. The data ends with the message **ENDS**<cr>
Erase logged data	?E<cr>	Erases all logged records from the **smart*CHEM*-Titro** 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-T •V1.0•T1234•2340•%<cr>,` where "•" are spaces. Note that the number of logged readings is right-justified. 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 13.7 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… `6,1,10,12,8,21,4,26,8,38,5,47,6` 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.

13.6 Data Format

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

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

`dd/mm/yyyy•hh:mm:ss•LLLL•PPPPPPPPuuu•TTTTTuuu•VVVVVVmL`

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*-Titro** sends a Zero for instant readings (see section 13.2).

`PPPPPPPP` is pH, mV or Relative mV data. 8 characters, right justified.

`uuu` is the pH/mV unit description, which can be any one of the following…

`pH•`	for pH readout.
`mV•`	for Absolute Millivolts readout.
`mVR`	for Relative Millivolts readout.

`TTTTT` is Temperature data, 5 characters, right justified.

`uuu` is the Temperature unit description, which can be either of the following…

`oC•`	for real Temperature data.
`oCm`	for manual Temperature compensation values.

`VVVVVV` is dosed Volume data, 6 characters, right justified. Only present when data was logged with the Automatic Titrator mode ON.

`mL` is the Volume unit description, always sent as "**`mL`**".

When requested by a PC with the ?D or ?R commands (section 13.5), the data is terminated with a carriage return.

When the data is sent by the **smart*CHEM*-Titro** using the Print function (section 12.5) or the Instant Send function (section 13.2), the data ends with a carriage return and a line feed.

13.7 GLP Data Format

GLP information is returned as 18 lines terminated by a carriage return. When using the "?G" command (section 13.5), the computer must respond with a character after receiving each line.

For example…

```
smartCHEM-T  V1.0 T1234 @ 31/12/2004 13:00
mV            Offset=    10.0mV    @ 01/04/2004 12:00
pH            Asy=       0.10pH    @ 01/04/2004 12:10
pH            SlopeA=    99.0%     @ 01/04/2004 12:20
pH            SlopeB=    99.0%     @ 01/04/2004 12:30
Temp. Probe   Offset=     1.0oC    @ 01/04/2004 12:40
ENDS
```

### 13.8 Importing Data into Microsoft Excel

The following procedure details the method for importing a **smart*CHEM*-Titro** 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.
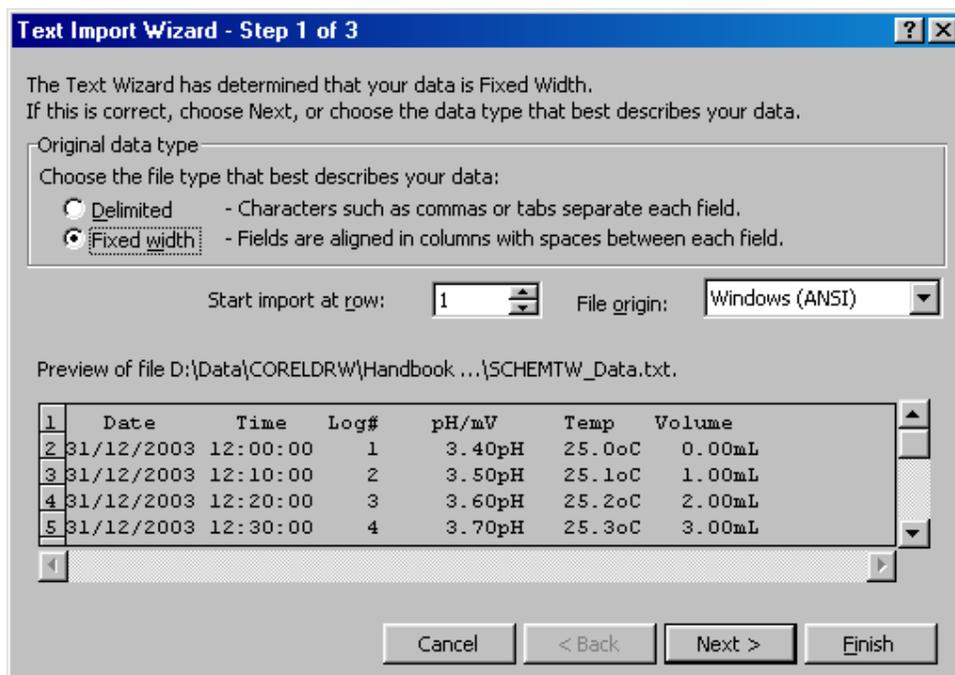

Continued over the page…

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. There are two screens, as the width of the data requires the window to be scrolled over.

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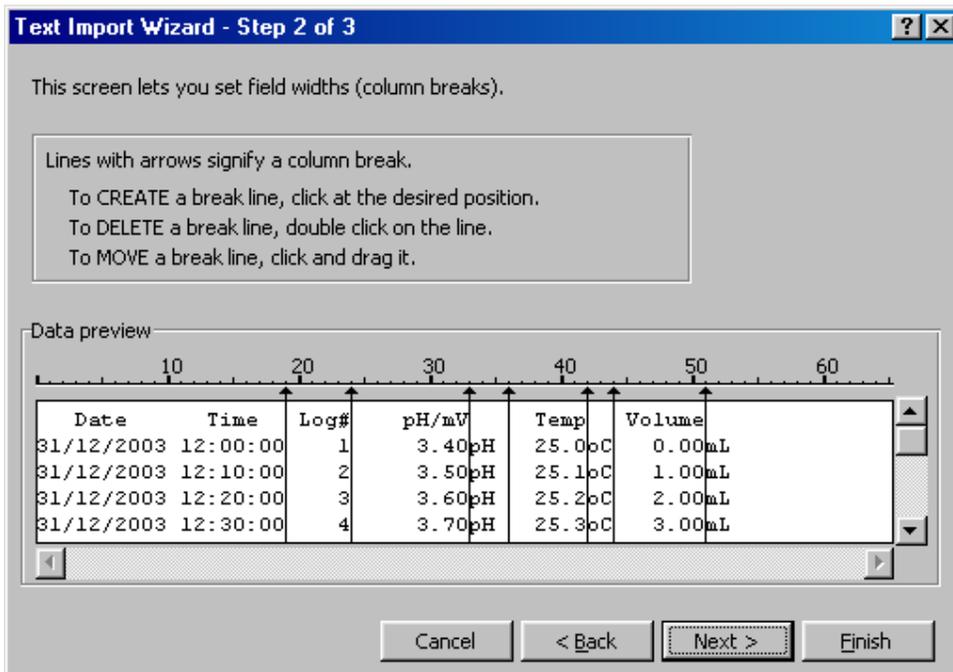
6. Simply press "Finish" at step 3 of the Text Import Wizard. TPS recommends that the data format for each column be set once the data is in spreadsheet format.

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.

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 31/12/04
Enter Date  31/31/04
            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*-Titro** tests that a valid day of the month is entered. If an invalid date is entered (eg. 31/04/2004), the **smart*CHEM*-Titro** 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*-Titro** also tests for leap years.

15. Initialising the smart*CHEM*-Titro

If the calibration settings of the **smart*CHEM*-Titro** 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*-Titro**…

1. Select Initialise from the Setup menu (Menu → **F4:Setup** → **F5:Initialise**)

2. The **smart*CHEM*-Titro** now asks if you are sure that you wish to initialise ALL parameters, or just the Slope B from a 3 point pH calibration. The latter is only offered when a 3 point pH calibration has actually been performed…
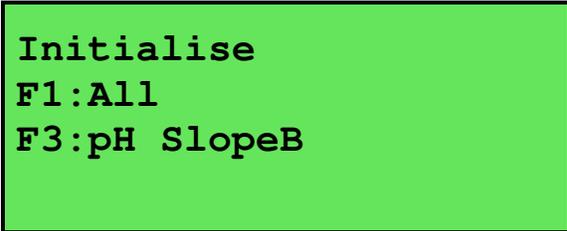
```
Initialise
F1:All
F3:pH SlopeB
```

Press F1 to initialise ALL parameters, reset all factory default settings and clear the memory.

Press F3 to clear just the Slope B from a 3 point pH calibration.

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*-Titro** firmware may of benefit to us. The version number is displayed by the **smart*CHEM*-Titro** 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.
Waiting for Burette **Press Menu to exit**	The **smart*CHEM*-Titro** could not detect the Schott Burette due to 1. The burette is not connected. 2. The burette is not switched on.	 Connect the burette, as per the details in section 3.2. Switch the burette on. The On/Off switch is located on the rear of the unit.
Burette Not Detected **Cannot Titrate**	This message appears when communication with the burette is lost some time after the meter was turned on.	Connect the burette, as per the details in section 3.2. Switch the burette on. The On/Off switch is located on the rear of the unit.

17.2 pH and mV 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.
1 Point calibration fails. (pH asymmetry is greater than ±1.00 pH, or mV offset is greater than ±60mV).	1. Reference junction blocked. 2. Reference electrolyte contaminated.	Clean reference junction as per instructions supplied with the pH or reference electrode. Flush with distilled water and replace electrolyte.
2 Point calibration fails. (pH slope is less than 85.0%.) 3 Point pH calibration fails. (pH SlopeB is less than 85.0%).	1. pH Buffers not correctly set. 2. pH glass bulb not clean. 3. Electrode is aged. 4. Connector is damp. 5. pH Buffers are inaccurate.	For automatic pH buffer recognition, ensure that you are using buffers that match the selected buffer set (see section 4.2). Otherwise, ensure that the buffer value is entered correctly at pH calibration. Clean pH glass bulb as per instructions supplied with the electrode. Attempt rejuvenation as per instructions supplied with the electrode. If unsuccessful, replace electrode. Dry in a warm place. Replace standards or buffers.
Unstable readings.	1. Reference Electrolyte chamber needs to be refilled. 2. Reference junction blocked. 3. pH glass bulb not clean. 4. Bubble in pH glass bulb. 5. Faulty connection to meter. 6. Reference junction not immersed. 7. KCl crystals around reference junction inside the electrolyte chamber.	Refill with saturated KCl filling solution. Clean reference junction as per instructions supplied with the electrode. Clean glass bulb as per instructions supplied with the electrode. Flick the electrode to remove bubble. Check connectors. Replace if necessary. Ensure that the reference junction is fully immersed. See diagrams in sections 4.4, 5.2, & 6.2. Rinse electrolyte chamber with warm distilled water until dissolved. Replace electrolyte.
Inaccurate readings, even when calibration is successful.	Reference junction blocked.	Clean reference junction as per instructions supplied with the electrode.
Displays constant reading around pH7.00 or 0mV for all solutions.	Electrical short in connector.	1. Check connector. Replace if necessary. 2. Replace electrode.
Displays 4-5 pH for all solutions.	pH electrode glass bulb or internal stem cracked.	Replace pH electrode.
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 8).

17.3 Temperature Troubleshooting

Symptom	Possible Causes	Remedy
Temperature inaccurate and cannot be calibrated.	1. Faulty connector. 2. Faulty Temperature sensor.	Check the connector and replace if necessary. Return Temperature sensor for repair, or replace sensor.
Displays flashing "**M**" when Temperature sensor plugged in.	1. Faulty instrument socket. 2. Faulty Temperature sensor.	Return the instrument to the TPS factory for service. Return Temperature sensor for repair, or replace sensor.
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 8).

18. Appendices

18.1 pH Electrode Fundamentals

pH electrodes are generally combination electrodes, where the pH sensing membrane and the reference system are contained in a single body. The sensing membrane is the round or spear shaped bulb at the tip of the electrode. This produces a voltage that changes with the pH of the solution. This voltage is measured with respect to the reference section. The reference section makes contact with the sample solution using a salt bridge, which is referred to as the reference junction. A saturated solution of KCl is used to make contact with the sample. It is vital that the KCl solution has an adequate flow rate in order to obtain stable, accurate pH measurements.

18.1.1 Asymmetry of a pH Electrode

An "ideal" pH electrode produces 0 mV output at 7.00 pH. In practice, pH electrodes generally produce 0 mV output at slightly above or below 7.00 pH. The amount of variance from 7.00 pH is called the asymmetry.

Figure 18-1 illustrates how asymmetry is expressed for a pH electrode.
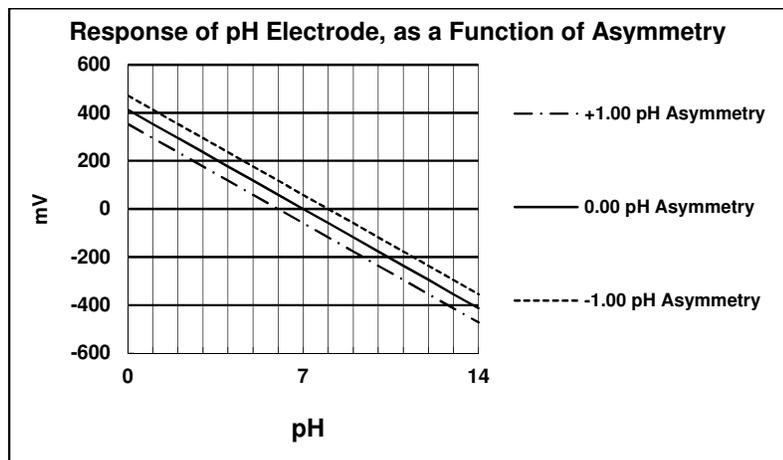

Figure 18-1

18.1.2 Slope of a pH or Specific Ion Electrode

As mentioned above, a pH electrode produces 0 mV output at around 7.00 pH. As the pH goes up, an "ideal" pH electrode produces –59.16mV/pH unit at 25 ^{O}C As the pH goes down, an ideal pH electrode produces +59.16mV/pH unit. In practice, pH electrodes usually produce slightly less than this. The output of a pH electrode is expressed as a percentage of an ideal electrode. For example, an ideal electrode that produces 59.16mV/pH unit has "100% Slope". An electrode that produces 50.15mV/pH unit has "85% Slope".

Figure 18-2 illustrates the principle of electrode slope, using a pH sensor as an example.

Response of pH Electrode, as a Function of Slope

— · — · 85% Slope at 25 oC (50.15mV/pH)
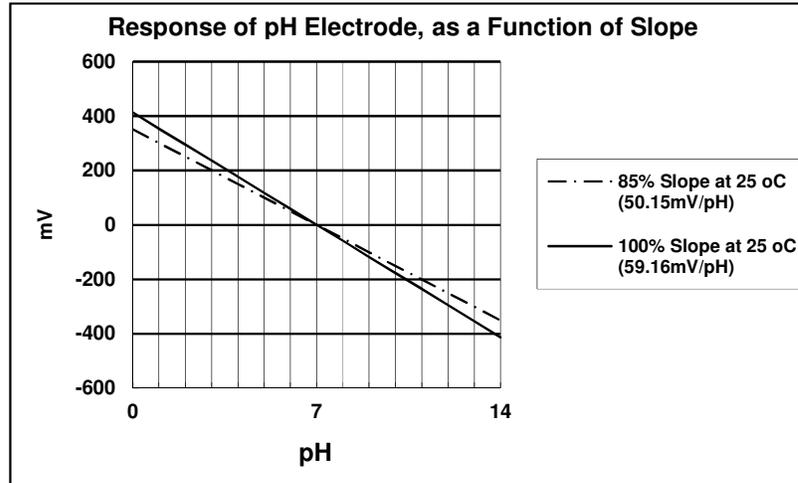
———— 100% Slope at 25 oC (59.16mV/pH)

Figure 18-2

18.1.3 Temperature Compensation

The slope of a pH electrodes is affected by temperature. This effect is compensated for either by using an Automatic Temperature Compensation (ATC) probe or by entering the sample temperature manually. Figure 18-3 shows the slope of a pH electrode at various temperatures.
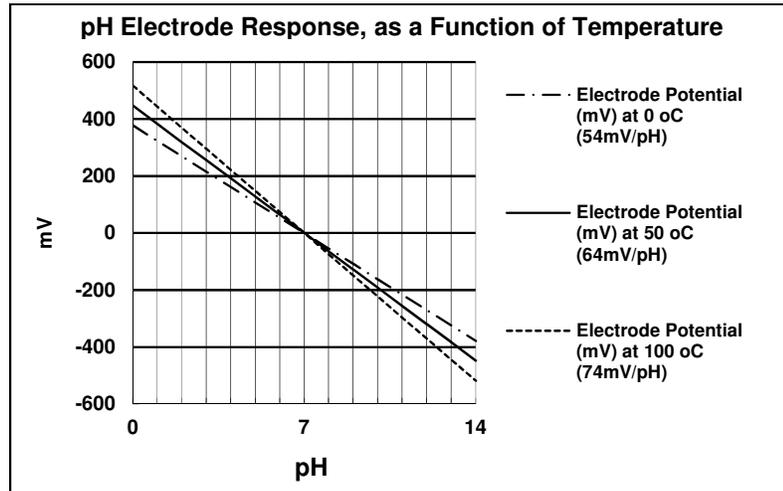

Figure 18-3

18.1.4 Polarisation Output

The **Accessories** connector on the rear panel of the **smart***CHEM***-Titro** contains a polarisation output for Karl Fischer titrations. This titration is a method for determining minute quantities of water in non-aqueous liquids.

The TPS Double Platinum electrode (part no 122237) has two connectors. The bayonet type BNC connector fits to the **pH/mV/Ion** BNC socket and the black plastic connector fits to the **Accessories** socket.

When performing Karl Fischer titrations, ensure that the **smart***CHEM***-Titro** is in mV.

18.1.5 Checking the reference junction of a pH electrode

If pH readings are inaccurate or unstable, the reference junction of the electrode may be blocked. The following test can be performed to determine if the reference junction of a pH electrode is making adequate contact with the sample solution.

1. Calibrate the **smart*CHEM*-Titro**, as per section 4.4.

2. Dilute 1 part of pH6.88 buffer with 9 parts of distilled water.

3. Measure the pH of the diluted buffer. The result should be 7.06 +/-0.05 pH.

4. If the value obtained is outside of these limits, then clean the reference junction as per the instructions supplied with the pH electrode.

5. Re-calibrate the **smart*CHEM*-Titro** and repeat the test.

6. If the value obtained is still outside 7.06 +/-0.05 pH, then the electrode should be replaced.

18.1.6 Determining if an instrument or electrode is faulty

The following test can be performed to help determine if the **smart*CHEM*-Titro** or the pH or Redox electrode is faulty.

1. Initialise the **smart*CHEM*-Titro** (see section 15).

2. Disconnect the pH or Redox electrode from the main **pH/mV/Ion** BNC connector.

3. Connect the centre pin of the main **pH/mV/Ion** BNC connector with the outside frame of the connector, using a short piece of wire or a paper clip etc.

4. The meter should display approximately pH7.00, depending on the current calibration settings.

5. If the **smart*CHEM*-Titro** is operating correctly, the reading should be totally stable with the wire firmly in place. If not, the meter requires servicing.

6. Now carefully disconnect the wire from the centre pin only (make sure the other end of the wire remains connected to the outside frame of the connector).

7. The reading should steadily drift away from 7.00 (either up or down) at a rate of approximately 1 pH or less every 3 seconds. If the drift rate is faster than this, then input circuitry of the **smart*CHEM*-Titro** is faulty and requires servicing.

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.