1312 Photoacoustic Multi-gas Monitor

May 1997

Safety Considerations

The 1312 Photoacoustic Multi-gas Monitor complies with IEC 348; Safety Requirements for Electronic Measuring Apparatus and IEC 1010 – 1; Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, and is supplied in a safe condition. To ensure safe operation and retain the 1312 in a safe condition, note the following:

EXPLOSION HAZARD!

TO AVOID THE POSSIBILITY OF AN EXPLOSION, MONITORING OF FLAMMABLE GASES IN EXPLOSIVE CONCENTRATIONS MUST NEVER BE ATTEMPTED.

Never operate the 1312 Photoacoustic Multi-gas Monitor in potentially explosive environments.

When monitoring potentially flammable or toxic gases it is essential that:

- The instrument itself is placed in a well-ventilated area outside the potentially hazardous zone.
- A sufficiently long tube is connected to the air-outlet on the back panel so that the sampled gas is carried away to the open air or to an extraction and/or filtration unit.

WARNINGS!

- Avoid water condensation in the instrument.
- Switch off all equipment before connecting or disconnecting their digital interface. Failure to do so could damage the equipment.
- Whenever it is likely that the correct function or operating safety of the apparatus has been impaired, the apparatus must be made inoperative and be secured against unintended operation.
- Any adjustment, maintenance and repair of the open apparatus under voltage must be avoided as far as possible and, if unavoidable, must be carried out only by trained service personnel.
- If a fault is reported by the monitor that indicates correct function of the instrument may be impaired, consult your local Innova AirTech representative. Under no circumstances should repair be attempted by persons not qualified in the service of electronic instrumentation.

Safety Considerations

APPLYING POWER

Before using the 1312, check that it is set to match the available mains voltage and that the correct fuses are installed.

SAFETY SYMBOLS

⚠ The apparatus will be marked with this symbol when it is important that the user refers to the associated warning statements given in the User Guide.

Frame or Chassis — Protective earth — Dangerous voltage

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Chapter 1

Using this Manual

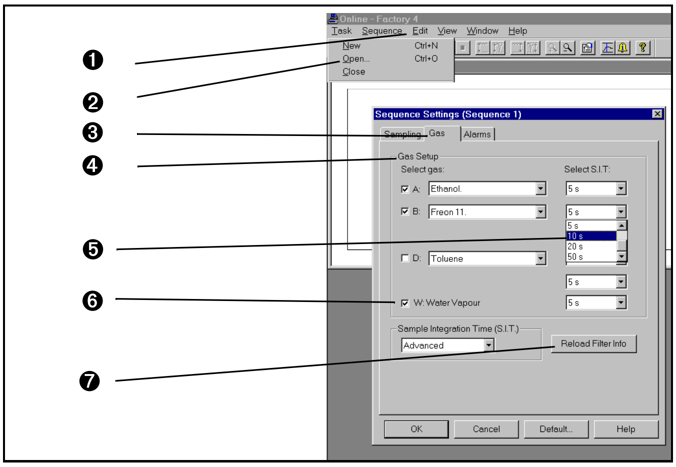
1.1 Introduction

This manual can be used in several ways. The first time users can work their way through the examples in order to get to know this monitoring system. The more experienced users can jump directly to the relevant chapters in order to gain assistance, and experts can use this manual as a reference book by using the index.

When Offline operation is required, the normal instructions should be followed. If there is a deviation from these instructions, this will be indicated in the relevant sections.

1.2 Displaying Information

The information displayed on screen is presented in this manual as shown below:



❶ Menu-bar option e.g. **Edit**

❷ Pull-down menu option e.g. **Open**

❸ Index-card e.g. ”Gas”

❹ Group e.g. Gas Setup

❺ Select Field e.g. *Select S.I.T:*

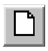
❻ Check box: used to select several options

❼ Soft-key e.g. **Reload Filter Info.**

Radio push-buttons: these are not illustrated above, but are commonly used in the software. They act as a toggle function when several options are available, but only one can be selected at a time.

1.3 Tool-bar Icons in 1312PC Software

The instructions in this manual use the pull-down menu paths to describe how operations are possible. However, in many cases, the icons in the tool-bar can be used to speed things up. The text below provides the key to the icons.

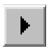
 Create a new measurement task

 Open an existing measurement task

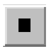
 Copy active window to clipboard

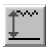
 Print active screen

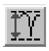
 Change sequence settings

 *Online only* – Start a measurement sequence

 *Online only* – Pause a measurement sequence

 *Online only* – Stop a measurement sequence

 Auto-scale axis from 0 to maximum value (only available when the Autoscale OFF is selected in the windows properties dialogue)

 Auto-scale axis from minimum to maximum values (only available when the Autoscale OFF is selected in the windows properties dialogue)

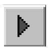
 Zoom in (only available when two cursors are selected)

 Zoom out (only available when zoom is enabled)

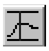
 Display the active window's properties

 *Presentation only* – Go to the start of the measurement task

 *Presentation only* – Scroll backwards through the measurement task

 *Presentation only* – Scroll forwards through the measurement task

 *Presentation only* – Go to the end of the measurement task

 Open the Cursor values dialogue

 *Online only* – Open the Alarm status dialogue

Chapter 2

Preliminary Tasks

When taking delivery of the 1312 Photoacoustic Multi-gas Monitor, five very important and necessary preliminary tasks must be completed before starting to operate it:

- Install the 1312PC Software
- Connect the Monitor to a PC.
- Adjustment of the "Mains Voltage" selector.
- Check/Change the fuses in the monitor.
- Set the Communication Parameters.

2.1 Installing the 1312PC Software

Before installing the software, the PC must meet the following requirements:

Hardware:	A 486 (50MHz) co-processor or better Min. 16Mbytes of RAM Min. 40Mbytes of space available on the hard disk VGA monitor or better One RS–232 port Mouse
Software:	Windows®95

The 1312PC software comes complete with an installation program. Insert the disk labelled "1312PC Software Disk 1" and use the standard Windows®95 procedure to run `SETUP.EXE`.

If you are unsure how to install programs, refer to your Windows®95 Help.

After the installation is successfully completed, five icons appear in the 1312PC program menu. These are labelled:

- `ONLINE`
- `PRESENTATION`
- `CALIBRATE`
- `OFFLINE`
- `DATABASE ADMINISTRATION`

These icons can be placed on your desktop for easy access to the programs.

2.2 Connecting the Monitor to the PC

The monitor comes complete with a 9-pin to 25-pin null modem RS – 232 interface cable. If your PC has a 25-pin serial port, an adaptor can be fitted to enable the supplied cable to be used.

2.2.1 Fitting the RS–232 Cable

1. Ensure that both the 1312 and the PC are switched off at the mains. Failure to do so may result in your equipment being damaged.
2. Locate the serial port at the back of the PC, refer to your PC manual if in doubt.
3. Push the connector on the RS–232 cable on to the serial port socket, and secure it firmly using the securing screws.
4. Locate the output labelled “RS–232” at the back of the 1312.
5. Push the connector at the other end of the RS–232 cable on to this socket, and secure it firmly using the securing screws.

If the mains voltage selector has been set, the instruments can be turned at the mains now.

2.3 Adjusting the “Mains Voltage” Selector

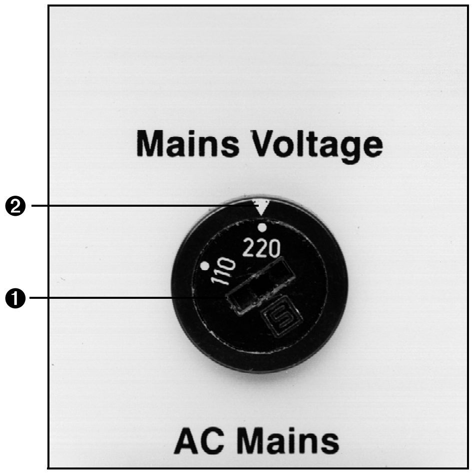
The 1312 is able to operate in two different AC voltage ranges:

- 100 V – 127 V, and
- 200 – 240 V.

Before the 1312 is operated, the mains voltage selector (labelled “Mains Voltage”) on the back panel of the 1312 (see Fig 2.1) must be adjusted to match the voltage of the AC mains power supply being used.

To set the voltage selector:

Fig. 2.1 The "Mains Voltage" selector



Insert a small screwdriver into the groove ❶ on the "Mains Voltage" selector and turn it so that the white arrowhead ❷ points towards either:

- **110** if the voltage of the AC mains voltage supply to be used lies between 100 and 127 V;

or

- **220** if the voltage of the AC mains voltage supply to be used lies between 200 and 240 V.

2.4 Checking/changing the Fuses in the 1312

The voltage-rating of the mains power supply determines the rating of the fuses that need to be installed in the 1312 before it is used. This is done as follows:

Fig. 2.2 The "AC Mains" socket

1. Insert a small screwdriver under the top edge of the plate covering the "AC Mains" socket and use it to lever the plate downwards (see Fig 2.2).

2. Take out the fuse-holders (they each have a small white arrow on them) and fuses. Check that the installed fuses have the correct rating. The fuses used must be:

Supply Voltage	Fuse Ratings
100 - 127 V	Slow-blow (T) fuses with a rating of 1.25 A
200 - 240 V	Slow-blow (T) fuses with a rating of 0.63 A

If the installed fuses do not have the correct rating, remove them from the fuse-holders and install fuses which have the correct rating.

3. Turn the fuse-holders so that the arrows on them are pointing in the same direction as the arrows on the inside surface of the plate covering the fuses in the "AC Mains" socket, and slide the fuse-holders (with fuses) into position in the 1312 (see Fig 2.3).

Fig. 2.3 Taking out and putting back the fuse-holders

4. Flip the top plate back and "click" it into position by pressing it gently against the back panel of the 1312.

2.5 Setting the Communication Parameters

The 1312PC software and the monitor communicate using the RS – 232 interface. In order for the communication to be successful, it is essential that the communication parameters in the two instruments are set correctly. This is a two stage process: the PC communication port is selected via the 1312PC software while the baud rate, parity, data bits and stop bits are defined via the monitor.

The communication parameters necessary for the monitor to communicate with the 1312PC software are shown below:

Baud rate	9600
Stop bits	1
Data bits	7
Parity	Even
Hardwire mode	Leased line
Handshake Type	Hardwire

These values are set as the default values in the monitor.

To prevent communication errors, the text line terminator, print data log and print error log must be set as shown below.

Text line Terminator	CR–LF
Print Data Log	NO
Print Error Log	NO

2.5.1 Selecting the PC Communication Port

It is just a simple case of selecting the correct port on the PC. The software offers four to choose from: COM1, COM2, COM3 and COM4. If you are not sure which port the cable is connected to on your computer, refer to you PC manual.

Start any one of the 1312PC software options: Online, Offline, or Calibrate.

1. Pull down the **Task** menu. Click on **Communication**. The Communication dialogue is displayed.
2. Click on the radio push-button next to the correct port name.
3. Click on **OK** to store the selection and exit this dialogue.

2.5.2 Checking/Changing the Communication Parameters

The communication parameters for the serial interface must be set using the push-buttons on the front of the monitor. With the PC and the monitor already connected, as described in section 2.2:

1. Press **SET-UP** **S3** **S1** **S3** **S1**. The screen display now shows the following text.

SELECT BAUD RATE 9600
PRESS ENTER TO CHANGE VALUE

2. If the baud rate displayed is incorrect, press ↵ and use △ and ▽ to display the correct value. Press ↵ again to store your selection.

   If the baud rate displayed is correct, then press ▽ to continue on to the next parameter.
3. Press **S1** to select 1 STOP BIT.
4. Press **S1** to select 7 DATA BITS.
5. Press **S2** to select an EVEN PARITY.
6. Press **S3** to select LEASED-LINE.
7. Press **S3** to select HARD-WIRED HANDSHAKE.

8. Press **SET-UP** to exit the set-up mode.
9. Press **RESET** and **S1** in order that the new settings are enabled.

The monitor and 1312PC software are now able to communicate together.

2.5.3 Checking/Changing the Text line Terminator

With the PC and the monitor already connected, as described in section 2.2:

Press **SET-UP** **S2** ▽ ▽ **S3**.

2.5.4 Checking/Changing the Data Log and Error Log Options

With the PC and the monitor already connected, as described in section 2.2:

Press **SET-UP** **S3** **S1** **S1** **S3** ▽ **S1** **S1**.

Chapter 3

Philosophy of Operation

3.1 Online

A monitoring system, where you use the PC environment to set-up the monitor prior to measuring, display measurement data on the PC screen while monitoring and store the measurement results directly on the PC's hard disk. These results can be used by other programs that use Open Database Connectivity (ODBC). The instructions for this mode of operation are covered in this manual under the PC Use headings.

Using the online mode provides you with a variety of Alarm options. Not only are the alarm trigger levels definable, but the action resulting from an alarm being triggered can also be defined here. This enables you to connect external warning systems to the monitoring system.

The philosophy behind the 1312PC software is common to almost all Windows®95 programs. Access to the various levels of the program is gained by use of the MENU BAR, PULL-DOWN MENUS, NEW WINDOW options and INDEX-CARD separators. These familiar procedures, together with the simple software structure, make the instructions in the Online sections of this manual understandable and easy to implement.

If you are unsure of any of the commands used in the Online instructions, please refer to section 1.2 of this manual or your Windows®95 manual.

3.2 Offline

This method of operation enables you to set-up the monitor using the PC, down load the setup to the monitor, and then disconnect the PC. The monitor is ready for use as a stand-alone instrument. While monitoring, the monitor stores all the measurement results in its internal memory. On completion of the monitoring task, the PC and the monitor can then be connected again and the results uploaded to the PC. These results can then be displayed on the PC screen, analysed and, if necessary, are available to other software programs.

When Offline operation is required, the Online instructions in this manual should be followed. If there is a deviation from these instructions, this will be indicated in the relevant sections.

Chapter 4

Introduction to and Familiarization with the 1312

The 1312 is an extremely versatile measuring instrument, which can be used to perform almost any kind of monitoring task. Its versatility may appear overwhelming at first, but to avoid such a reaction, we suggest that you read this chapter thoroughly, and follow the practical exercises which are included. These exercises give you a “guided tour” through a number of different practical procedures — setting-up various parameters: environmental and measurement units; setting up a monitoring task; performance of a monitoring task; scrolling through data collected during a monitoring task, and finally, scrolling through data after completion of a monitoring task. By following these different procedures the 1312’s operating philosophy will become apparent and you will be able to quickly familiarize yourself with its operation and control.

4.1 Special Terminology

Certain terms are used to describe the operation of the 1312 and it is necessary to fully understand what these terms mean before you start any practical exercise with the 1312.

4.1.1 Measurement Cycle

A description of a measurement cycle is given on page 2 of Product Data Sheet (see boxed-in text and schematic diagram of the measurement system of the 1312). “Measurement cycle” is the term used to describe everything that takes place in the 1312 from the time the pump starts to flush out the “old” gas sample in its analysis cell, until the signal in the measurement chamber has been measured using the last relevant optical filter.

The time taken to complete a measurement cycle is dependent upon the following factors:

- How many gases/vapours are being measured — this affects the number of optical filters which need to be used.
- The sample integration time selected — longer measurement times provide greater accuracy.
- The Flushing times selected for the measurement chamber and the tube as well as the length of the sampling tube attached to the 1312’s air-inlet — the longer the tube, the more time is needed to flush it out between measurement cycles.
- The cleanliness of the two air-filters which filter the air drawn into the cell (this affects the pumping time required to draw a fresh air sample into the analysis cell).
- The degree of fluctuation in the concentration of the various gases measured in consecutive measurement cycles (this affects the time required to adjust the gain of the amplifier attached to the microphones).

Table 4.1 gives some indication to the measurement times depending on the number of gases measured and the measurement times selected. However, these times may vary from one measurement cycle to another due to the cleanliness of the filters and the degree of fluctuation in the concentration of the various gases.

Table 4.1 Approximate measurement times

Monitor Setup	Volume of Air	Response Times
S.I.T.: "Normal" (5s) Flushing: Auto, (tube 1m)	140 cm^3/sample	One gas: ~25 s 5 gases + water: ~75 s
S.I.T.: "Fast" (1s) Flushing: Chamber 4s, Tube "OFF"	20 cm^3/sample	One gas: ~15 s 5 gases + water: ~45 s

4.1.2 Monitoring Task

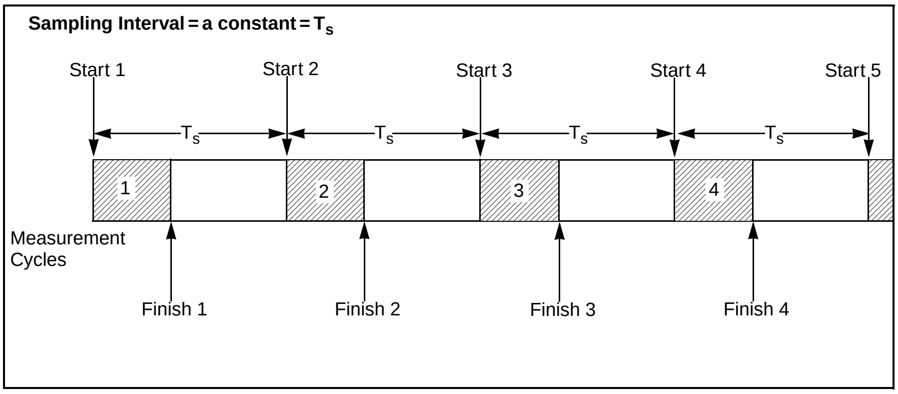
A monitoring task consists of a series of similar measurement cycles. These cycles can either be repeated at regular intervals or be continuous:

Sampling Interval

The sampling interval is a measure of the time between the start of one measurement cycle and the start of the following measurement cycle.

When the 1312 is **not** sampling continuously the sampling interval has to be defined by the user and is a fixed period of time (see Fig. 4.1).

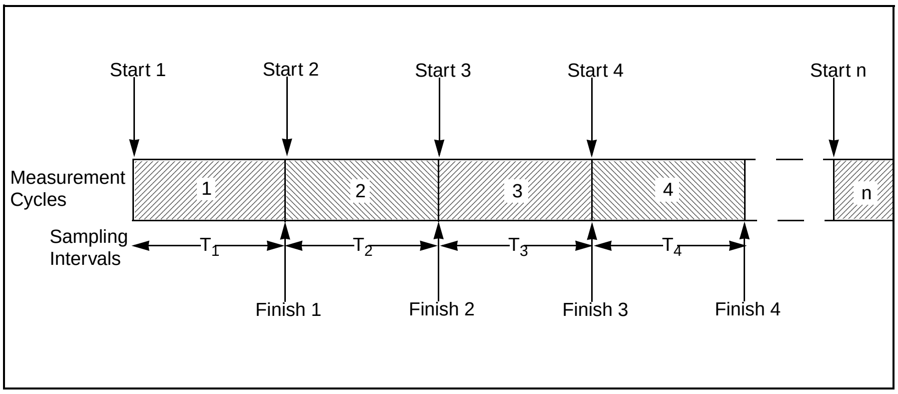
Fig. 4.1 An illustration of the fixed sampling intervals of the 1312 when it is not sampling continuously



Continuous Sampling

The 1312 is said to be sampling continuously when each measurement cycle is followed immediately by another similar measurement cycle (see Fig.4.2).

Fig.4.2 An illustration of continuous sampling



Monitoring Period

The monitoring period is the time between the **start** of the first measurement cycle in a monitoring task and the **finish** of the final measurement cycle in a monitoring task.

The monitoring period can either be pre-set by the user — in which case the 1312 automatically stops monitoring after the monitoring period is over — or, **not** pre-set — in which case the 1312 will continue to monitor until the user stops the monitoring task manually (see section 4.3.6).

4.2 Attaching the Sampling Tube and External Filter

1. Cut a short section of sampling tube from the roll of polytetrafluoroethylene (Teflon) tubing which is provided as an accessory, a 1m tube should be sufficient.
2. Using Fig.4.3 and the instructions below, attach one end of this tube to the air-inlet stub on the back-panel of the 1312.

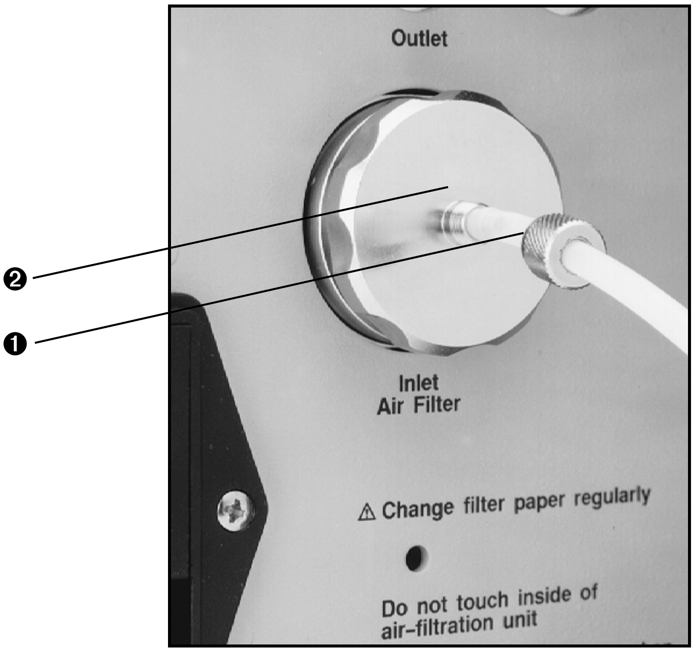
   a. Push one end of the Teflon tubing through the non-threaded end of the nut ❶.

   b. Hold the end of the tubing between the fingers and gently push the tubing over the end of the 1312's air-inlet stub ❷ as far as it will go.

   Note: if the tubing is bent/broken during this procedure, remove the tubing from the stub and repeat this step using an undamaged length of tubing.

   c. Screw the threaded-nut ❶ firmly onto the end of the air-inlet stub.

Fig.4.3 Attaching tubing to the air-inlet stub and the external filter



3. Attach the other end of the sampling tube to the external air-filter which is also provided as an accessory.

4.3 Familiarization with the 1312 using 1312PC Software

Warning! Before you start to use the 1312 Photoacoustic Multi-gas Monitor it is very important that:

- the "**Mains Voltage Selector**" on the back panel of the 1312 is adjusted correctly, and
- the fuses have been checked and, if necessary changed to suit the mains voltage.

Details of these operations are described in Chapter 2 of this manual.

4.3.1 Setting the Internal Clock

The internal clock is set automatically when the monitor is connected to a PC and the 1312PC software is started. The internal clock in the monitor is synchronized with the time and date from the PC clock. If either of these entries are incorrect, then they must be corrected via the PC using standard Windows procedures.

4.3.2 Setting Units

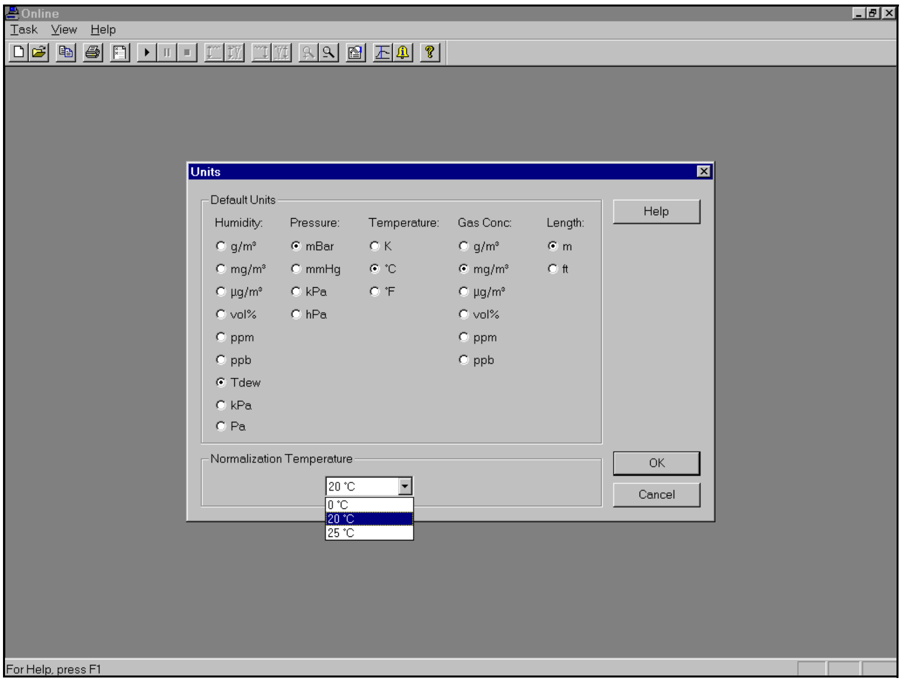
All data in the 1312 is stored as raw data. The different units, which you can select here, enable you to enter gas concentrations, temperatures, lengths and pressures in units that you are comfortable with. These units are also used to present measurement data in a form that is most convenient for you.

The 1312 can display gas concentrations either in absolute units of mg/m^3 — unit that is dependent on a particular temperature, termed the **normalization** temperature, or in units of parts per million (by volume) — which is independent of the temperature of the gas. You can inform the 1312 about the units you intend to use — for example: the length of the sampling tube attached to the 1312's inlet (in metres or feet); the normalization temperature (°C or °F or K); the units of atmospheric pressure (kPa or mBar or mmHg) and unit for humidity (ppm or T_{dew} or kPa or mg/m^3).

With the monitor and the PC connected properly, as described in section 2.2 and section 2.5, and the 1312PC software already running:

1. Click on **Online** to start this option.
2. Pull down the **Task** menu. Click on **Units,** and the Units dialogue is displayed, see Fig.4.4

Fig.4.4 The Units dialogue



3. Click on the desired units for: humidity, pressure, temperature, gas concentration and length of tubing.

4. Click in the *Normalization Temp.* field, and select one of the three temperatures: 0, 20, or 25°C (Note these temperature values change depending on the temperature units selected, i.e. °C, °F and K).

Unit	Normalization Temp. Values
°C	0°C, 20°C and 25°C
°F	32°F, 68°F and 77°F
K	273K, 293K and 298K

5. Click **OK**.

4.3.3 Setting-up a Monitoring Task

The optical filters in the 1312 have to be calibrated before they can be used to measure gas concentrations. The user can only set-up a monitoring task using those optical filters which have been installed. In this example, we have chosen to measure gas A (that is, to measure gas A's concentration using the optical filter installed in position "A" of the filter carousel) and water vapour. If your 1312 has only been calibrated to measure with another filter (for example, the filter in position "B") then choose gas B to replace gas A in the following instructions. The parameters which describe the monitoring task we shall set-up are listed below:

Online Settings

Sampling index card

Monitoring Task name = **Area 1**

Sampling Mode = **Continuous**

Flushing = **Auto**, Tube Length = **1m**

Gas Monitor Display = **Instantaneous** (i.e. no tick in check box**)**

Current Air Pressure = **1000** mbar

Gas index card

Gas Setup: Active = **A**: **Ethanol & water**

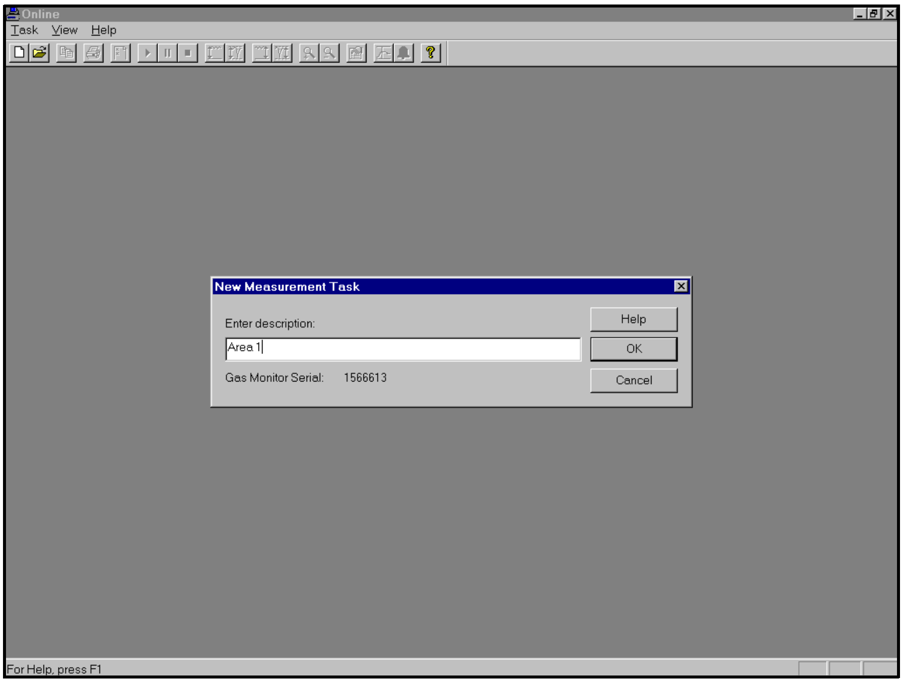
Sample Integration Time = **Normal** (5s)

Alarm index card
None active (i.e. none displayed in the *Alarms* field)

With the monitor and the PC connected properly, as described in section 2.2 and section 2.5, and the 1312PC software already running:

1. Click on **Online** to start this option.
2. Pull down the **Task** menu. Click on **New,** and the New Measurement Task dialogue is displayed, see Fig.4.5.

Fig.4.5 The New Measurement Task dialogue



3. Type in the desired name for the monitoring task, i.e. **Area 1**.
4. Press **OK**. The name you have just typed in appears at the top of the window. An extended menu bar and a graphic window appear.
5. Pull down the **Sequence** menu. Click on **Settings** and the Sequence Settings dialogue appears, see Fig.4.6.

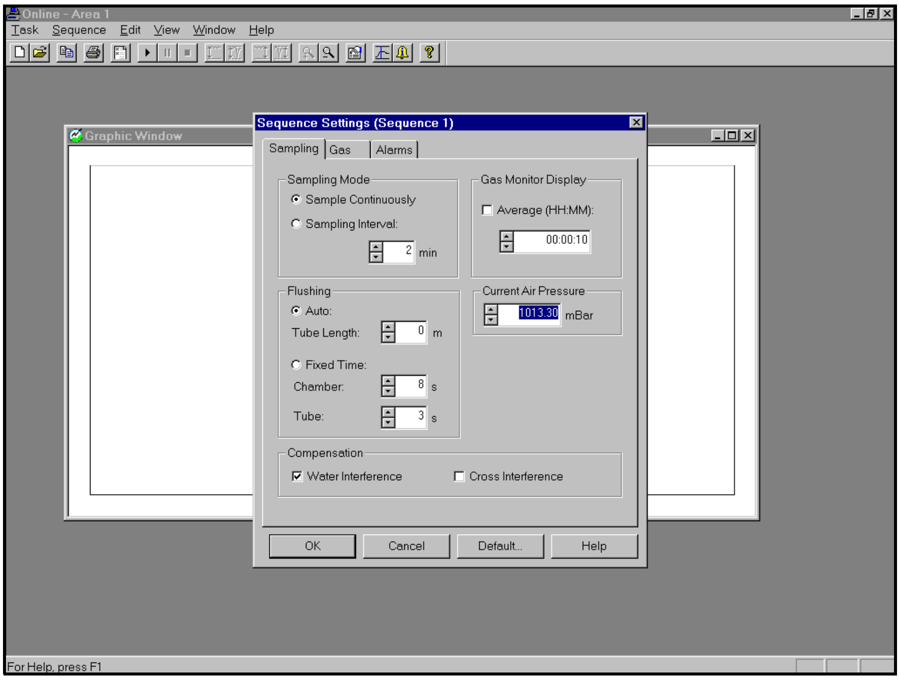
Interval index card

6. Select the settings defined at the start of this section, by clicking on the radio push-buttons.

Gas index card

7. Select the "Gas" index card and select Filter A and the Water Filter by clicking in the check boxes.
8. Click in the *Sample Integration Time* field, and select Fast.

Fig.4.6 The Sequence Settings dialogue



Alarm index card

9. Select the “Alarm” index card. Ensure that no alarms are selected in the Alarm box. If any alarms are selected, click on the name and then click on **Remove**.
10. When all the settings are correct, click on **OK**.

The monitoring task is now set-up. This information is not transferred to the monitor until you start monitoring.

4.3.4 Starting a Monitoring Task

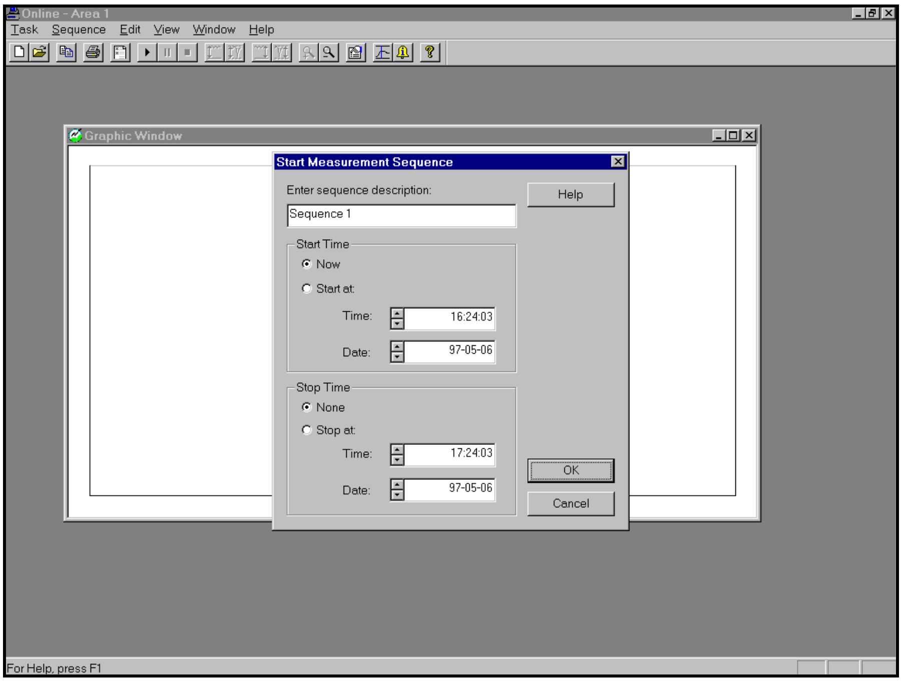
Note: before a monitoring task can be started, the Monitoring Task Settings must be defined, see section 4.3.3.

This section will explain how to perform a monitoring task — for example, monitoring task number 1 which was set-up in section 4.3.3.

If you have just set up the monitoring task using the Online option, and the monitoring task is still open, proceed from step 1. If the monitoring task is not open, you must open one before continuing.

1. Pull down the **Sequence** menu. Click on **Start** and the Start Measurement Sequence dialogue is displayed, see Fig.4.7.

Fig.4.7 The Start Measurement Sequence dialogue



2. Click in the *Enter sequence description* field and type in the desired name. This name enables you to have many measurement sequences stored under the same monitoring task name.
3. In order for the measurement to start immediately, select Now in the *Start Time* field and None in the *Stop Time* field by clicking on the radio push-buttons.
4. Click on **OK** to start a monitoring task.

4.3.5 Displaying Measurement Results while a Monitoring Task is in Progress

Measurement data is displayed on screen as soon as it is available from the monitor. The data can be displayed in both a graphic window and a numeric window, simultaneously.

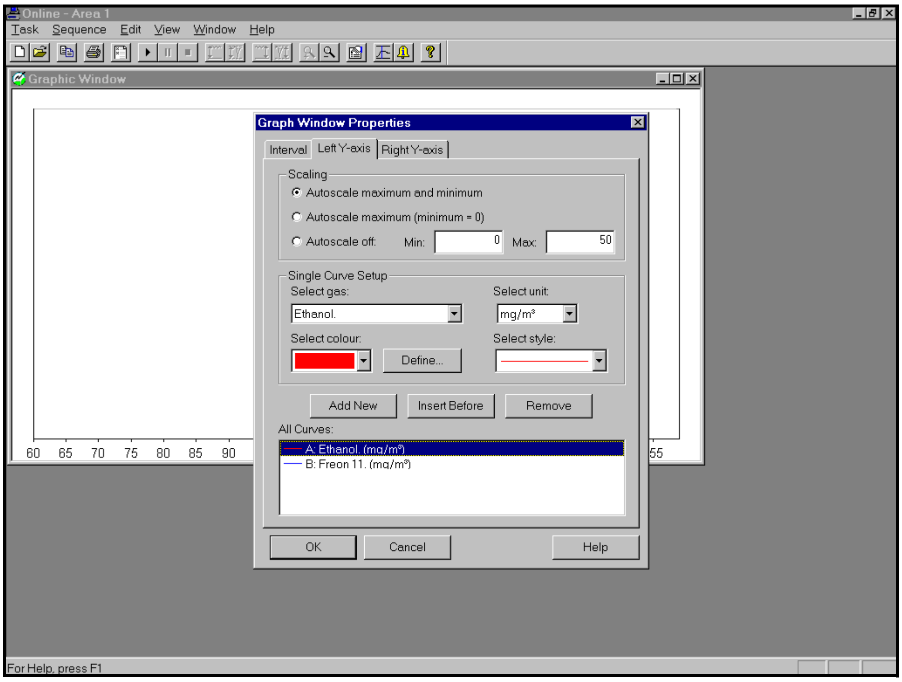
The graphic window: can display all the measured gas concentrations as graphs, simultaneously. The concentration curves can be allocated to either of the two axes. The scale and concentration units of these axes can be set individually to suit the concentration of the gas(es) displayed on them. The number of concentration curves displayed, their colour and their style are defined by you. Measurement data can be displayed as instantaneous concentration curves or as average concentration curves, where you define the averaging interval.

The numeric window: can display all the measured gases, simultaneously. The measurement data is displayed in columns, one for each gas, and the number of gases displayed is defined by you. Measurement data can be displayed as instantaneous sample concentration values or as average concentration values, where you define the averaging interval.

With the Online option selected and a monitoring task started:

1. To open an extra window, pull down the **Window** menu and click on **New Graphic Window** or **New Numeric Window**. The measured gases are automatically displayed in this window.
2. Click in the window you want to set up, and pull down the **Edit** menu. Click on **Window Properties**, see Fig.4.8.

Fig.4.8 The Window Properties dialogue for a graphic window



Interval index card

3. Click on the Time radio push-button and define the interval length to 1 min.
4. Ensure that the Average check box is not ticked in the Sample Type group. This enables single sample values to be displayed.

If you have opened a numeric window, go to step 5. If you have opened a graphic window go to step 11.

Column index card

5. Click on the “Column” index card

6. In the Single Gas Setup group, click in the *Select Gas* field and select the gas name for Filter A.
7. Click in the *Select unit* field and select the desired units.
8. When all your selections are correct, click on **Add**. The selected gas is now displayed in the *All Columns* field. This means it will be displayed in the numeric window.
9. Repeat steps 6. to 8. selecting the Water filter.
10. Press **OK** to save selections and exit the dialogue box.

The measurement sequence is started and the results are displayed on screen as soon as they are available.

Left Y-axis index card

11. Click on the “Left Y-axis” index card
12. In the Scaling group, click on the radio push-button next to Autoscale maximum and minimum.
13. In the Single Curve Setup, click in the *Select Gas* field and select the gas name for Filter A.
14. Select the desired colour, style and units.
15. When all your selections are correct, click on **Add**. The selected gas is now displayed in the *All curves* field. This means it will be displayed on the graph, with its concentration scale on the left axis.

Right Y-axis index card

16. Click on the “Right Y-axis” index card
17. In the Scaling group, click on the radio push-button next to Autoscale maximum and minimum.
18. In the Single Curve Setup, click in the *Select Gas* field and select the Water Filter.
19. Select the desired colour, style and units.
20. When all your selections are correct, click on **Add**. The selected gas is now displayed in the *All curves* field. This means it will be displayed on the graph, with its concentration scale displayed on the right axis.
21. Press **OK** to save the selections and exit the dialogue box. The measured data will now be displayed on screen.

4.3.6 Stopping a Monitoring Task

Pull down the **Sequence** window and click on **Stop**.

4.3.7 Scrolling through Measurement Results on Completion of a Monitoring Task

Open the Presentation option of the 1312PC software:

1. Pull down the **Task** menu. Click on **Open** and the Open Measurement Task dialogue is displayed.
2. In the Select Task box, select the desired name.
3. Click on **OK** and a graphic window and the Window Properties dialogue are displayed.
4. If you want a numeric window, pull down the **Window** menu and click on **New Numeric Window**. A numeric window and the Window Properties dialogue are displayed.

Interval index card

5. Click in the *Measurement Sequence* field and select the desired sequence name.
6. Click on the Time radio push-button. The time period for the measurement sequence is displayed in the *From:* and *To:* fields.
7. Ensure that the Average check box in the Sample Type group is not ticked.

If you have opened a numeric window, go to step 8. If you have opened a graphic window go step 14.

Column index card

8. Click on the “Column” index card
9. In the Single Column Setup group, click in the *Select Gas* field and select the gas name for Filter A.
10. Click in the *Select unit* field and select the desired units.
11. When all your selections are correct, click on **Add**. The selected gas is now displayed in the *All Columns* field. This means it will be displayed in the numeric window.
12. Repeat steps 5 to 7, selecting the Water filter.
13. Press **OK** to save selections and exit the dialogue box.

To display the Event markers, go to step 24.

Left Y-axis index card

14. Click on the “Left Y-axis” index card
15. In the Scaling group, click on the Autoscale maximum and minimum radio push-button.

16. In the Single Curve Setup, click in the *Select Gas* field and select the gas name for Filter A.
17. Select the desired colour, style and units.
18. When all your selections are correct, click on **Add**. The selected gas is now displayed in the *All curves* field. This means it will be displayed on the graph, with its concentration scale on the left axis.

Right Y-axis index card

19. Click on the “Right Y-axis” index card
20. In the Scaling group, click on the Autoscale maximum and minimum radio push-button.
21. In the Single Curve Setup, click in the *Select Gas* field and select the Water Filter.
22. Select the desired colour, style and units.
23. When all your selections are correct, click on **Add**. The selected gas is now displayed in the *All curves* field. This means it will be displayed on the graph, with its concentration scale displayed on the right axis.

Events index card

24. Click on the “Events” index card.
25. Click in all event check boxes to enable all the event markers, if there are any, to be displayed. The event markers appear as vertical lines with a letter at the end of them. See section 8.5 for full details.
26. Press **OK** to save the selections and exit the dialogue box. The measured data will now be displayed on screen.

4.3.8 Changing Units after a Monitoring Task

The 1312 has all the measurement data as SI units. So, to change any of the displayed parameters’ units, it is simply a case of repeating the instructions in section 4.3.2.

For example, change the selected concentration units to ppm and see how they are displayed on screen.

Chapter 5

The 1312 Monitor

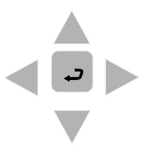
5.1 Front Panel

The front panel of the monitor is dominated by a 2 × 40 character fluorescent display screen, 3 **Select** push-buttons located beneath it and 5 direction push-buttons (see Fig. 5.1). The rest of the push-buttons, situated in a line along the bottom, are function push-buttons.

Fig. 5.1 The front panel of the 1312

Small light-emitting diodes (LEDs) are mounted above some of the front-panel push-buttons. Their function is to inform you of the operating state of the monitor. For example, if the LED above the **MEASURE** push-button is lit, it indicates that the 1312 is either busy performing measurements or has been set-up to start measurements at a pre-defined time.

5.1.1 Direction Push-buttons



This group of 5 push-buttons is referred to in this manual as the direction push-buttons.

△ & ▽ have two uses: to increase & decrease numbers, respectively, or to go to the Previous & Next Displays, respectively.

The number increase and decrease functions are used whenever values, which can be changed manually, are displayed on screen, for example, changing a parameter such as the length of sampling tube.

The “Previous Display” and “Next Display” functions are used when you want to view the previous or next screen texts. This can be useful when setting up the monitor. By using these push-buttons, you can scroll quickly through a branch of the set-up "tree".

◁ & ▷ enable you to move across number fields or go to the Previous & Next gases, respectively.

When you are entering values or names in the monitor, for example when setting up the monitor, you can use these push-buttons to move the cursor across the entry fields.

"Previous Gas" & "Next Gas" functions are used primarily when viewing measurement data.

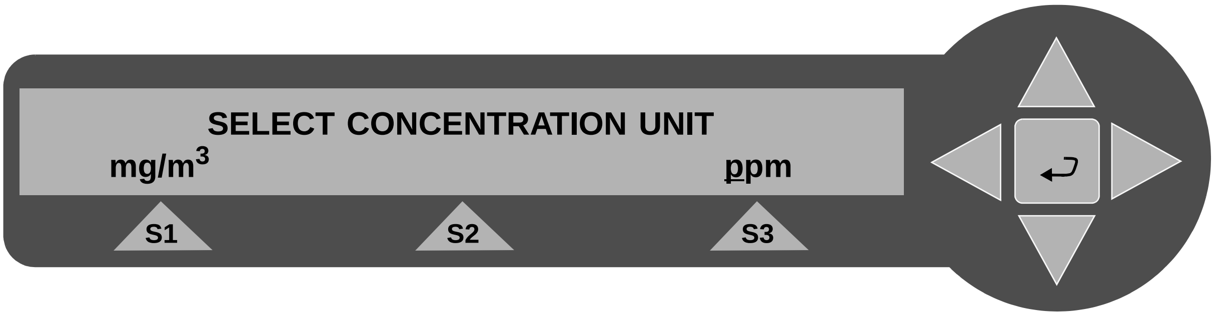
↵ Depending on the situation, this push-button acts as an "Enter" function

The "Enter" function is used whenever measurement units are selected or any text, for example, filter names or gas names are being entered. The 1312 display will typically display a text similar to **PRESS ENTER TO CHANGE VALUE**.

5.1.2 The Select Push-buttons

Located below the text display screen, these three push-buttons, allow you to select from the pre-defined options appearing on the display screen. The following example illustrates the use of the select push-buttons:

If the text on the screen appeared as follows:



a. By pressing **S1** the gas concentrations which appear in the measurement results will be quoted in mg/m^3.

b. By pressing **S3** the gas concentrations which appear in the measurement results will be quoted in ppm.

5.1.3 Function Push-buttons

The order of these push-buttons is the same as they are seen on the front of the monitor when looking left to right.

RESET By pressing this push-button you can choose the type of reset the 1312 should perform. For further details see section 5.2.

MEASURE In this mode you are able to choose the type of measurement the 1312 should perform, and decide when the measurement should start.

AVERAGE This push-button allows you to average measurement data. The lamp in this push-button is lit when measurement data is being averaged. You define the averaging times using the set-up **mode**.

EVENT If an unusual or interesting event occurs during a measurement period, you can mark the time such an event took place by pressing this push-button. Each event marker is given a serial number which can be used as a reference. Events are marked on print-outs of measurement data.

INFO This push-button has two functions. It allows you to perform the following two functions:

- Acknowledge any message which may appear on the display screen during operation of the 1312.
- Obtain more detailed information about the condition of the 1312 at any particular moment of time, if such information exists.

MEMORY In this mode you are able to store measurement data in the *Background memory* of the monitor, as well as recall or delete data from the *Background memory*.

PRINT By pressing this push-button measurement results in the *Display memory* of the 1302 can be printed out. The lamp above this push-button is lit while measurements are being printed and the display will show **PRINTING MEASUREMENT DATA** until all data has been printed out.

SET-UP In this mode you are able to enter the set-up “tree” of the 1312. In set-up **mode** the user is able to program the 1312 to perform almost any kind of measurement and, amongst other things; enter data about the optical filter(s) which are installed in the 1312; select different measurement parameters; choose how measurement results should be formatted in print-outs; choose the interface and communication codes which are necessary to print data; set the internal clock of the 1312 and choose the self-tests the 1312 should perform.

When the **Talk/Listen** LED is lit, this means that there is activity on one of the interfaces.

5.2 Starting-up or Restarting the Monitor

5.2.1 Introduction

When the monitor is started up in the normal way, that is, by switching on the AC Mains power-switch on the back panel, the monitor responds by performing a **partial reset**. A **partial reset** is also performed if during operation the monitor is switched off and is re-started in any of the following ways:

- If the 1312 stops operating due to an AC mains power failure and then re-starts itself (automatically) when power is restored to it;
- If the user stops operating the 1312 by switching it off using the AC mains power switch on the back panel, and then re-starts it by using the same switch;

Users can also "partially reset" the 1312 by using the **RESET** push-button on the front panel (see section 5.1.3).

5.2.2 A Partial Reset of the Monitor

When the 1312 performs a **partial reset** a number of self-tests are automatically performed. The types of tests performed depend **only** upon the time which has elapsed since the 1312 was last switched on.

- If **more** than 10 mins. have elapsed since the 1312 was switched on it will perform the **software**, **data-integrity**, and **hardware** tests when switched on again.
- If **less** than 10 mins. have elapsed since the 1312 was switched on it will perform **only** the **data-integrity** tests when switched on again.

There are essentially 3 types of self-tests which can be performed during a "partial reset" — a **software** test, a **data-integrity** test and a **hardware** test. It takes the 1312 only a few seconds to perform the **data-integrity** tests; and about 3 minutes to perform both the **software** and **hardware** test. The different tests are explained below.

Software test
This test checks the information in the 1312's software (ROM — **R**ead **O**nly **M**emory.

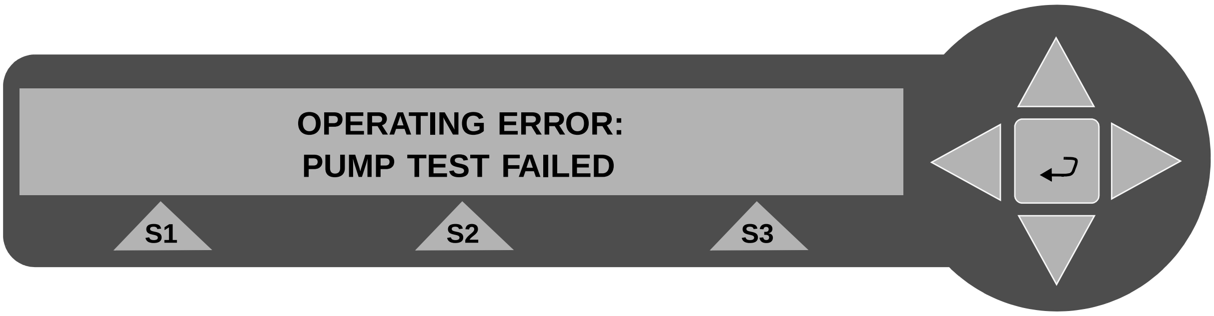
Data-integrity test
This test checks the integrity of the data stored in the 1312's ***Source Memory*** (i.e. its EEPROM — **E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory) and the integrity of the data stored in the 1312's ***Working Memory*** (RAM).

Hardware test
This test checks that the electrical, mechanical and electronic parts of the 1312 are functioning properly.

The following parts of the 1312 are checked: the pump; the valves in the pneumatic system; the infra-red light source; the power supply; the filter carousel; the motor which drives the chopper wheel; the external vibration level (to make sure that it does not contribute to the signal measured in the analysis cell); the analogue circuitry and the microphones (to check that they are functioning properly).

If you do not wish the 1312 to perform the **hardware** test during a partial reset, you can disable it (see section 5.3.2). This also disables the regular self-tests.

If any part of the 1312 is found to be functioning incorrectly a message will appear in the display to inform the user of the problem. For example:



The user must acknowledge receipt of such a message by pressing **INFO**. Operating errors and warning messages are listed in table-form in Appendix 2 at the end of this manual.

If a fault is found in any of the blocks of data stored in the ***Working Memory***, the 1312 will automatically set the parameters in the relevant compartment(s) to their default values, and the 1312 will send the following message on its display screen:

WARNING: MEMORY SET TO DEFAULT
ERROR DETECTED IN XXXXX MEMORY

Where XXXXX denotes the part of the memory that has been affected. When such a message is received users must check the contents of the relevant memory to find out which data has been affected before continuing to operate the 1312.

5.2.3 Response of the 1312 after a Partial Reset

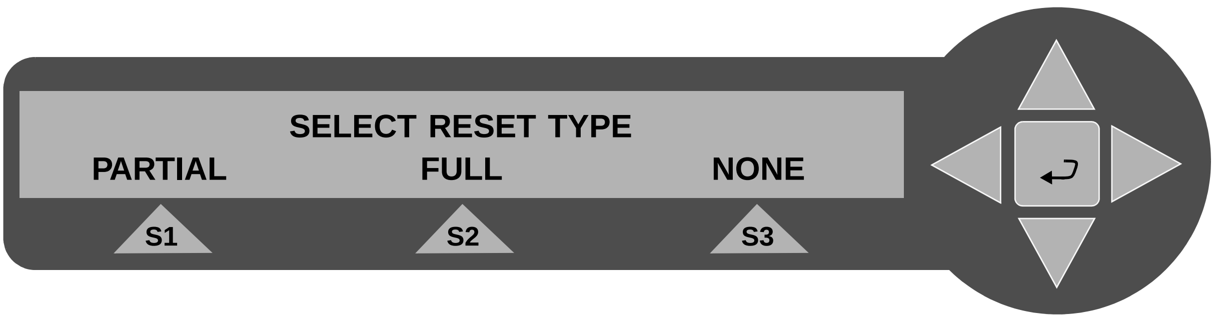
The way in which the 1312 responds after a **partial reset** is dependent upon the way it was being operated at the time of the partial reset (see Table 5.1). For example, if the 1312 was busy taking a measurement when it was “partially reset” it will complete the interrupted measurement after the partial reset, continue its monitoring task and make a special “mark” alongside the first complete measurement cycle it performs after the reset. These “marks” are described in section 9.2.2 and section 9.2.3.

Table 5.1 Dependence of 1312's response, after a partial reset, to its operating condition at the time of the partial reset

1312 last used while in....	Task being performed	Task started after a PARTIAL RESET
Measurement **mode**	A gas measurement	Completes the monitoring task
“Display”	Looking at measurement results on the display screen	Measurement results are shown on the display from the beginning again
Set-up **mode**	Changing set-up parameters which control the operation of the 1312	Measurement results are shown in the display from the beginning
Memory **mode**	Handling measurement results which are stored in Display Memory and Background Memory	Completes any interrupted task and then measurement results are shown in the display from the beginning
“Interface”	Obtaining hard-copies (that is, print-outs of, for example, measurement data)	Print-out is stopped and measurement results are shown in the display from the beginning

5.2.4 Full Reset and/or Partial Reset of the 1312 via its Front Panel

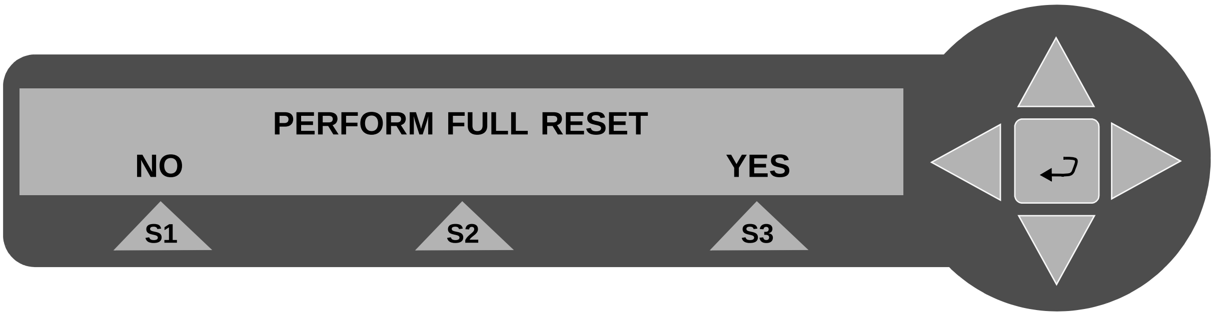
There are two well-defined levels of reset. By pressing **RESET** the following text appears on the display screen:



If **S3** is pressed, you can come out of reset **mode** without performing any kind of reset. The 1312 just goes back to operating the same way it was operating before the **RESET** push-button was pressed.

S1 **PARTIAL** Reset: If this level of reset is chosen the 1312 stops operating, performs a **partial reset** as described in the previous section (section 5.2.2) and then resumes operating in the fashion described in Table 5.1.

S2 FULL Reset: If this level of reset is chosen the 1312 responds by changing the text on the display so that you have a chance to **confirm** that you wish the 1312 to perform a FULL reset:



S1 By pressing this push-button the user can come out of reset **mode** without performing any kind of reset. The 1312 just goes back to operating the same way it was operating before RESET was pressed.

S3 By pressing this push-button the user confirms that a FULL reset is required. During a FULL reset the 1312 performs the following two tasks:

- "Clearing" (emptying) all data from its ***Working Memory***. This means all data in *Display Memory* and *Background Memory* will be lost.
- Copying data from its ***Source Memory*** into its ***Working Memory***. This means that set-up parameters in block 3 of ***Working Memory*** "Other Set-up Parameters" will be given their **default** values, and the values of the optical filter set-up parameters in ***Working Memory*** will be the same as those found in ***Source Memory***.

5.3 Configuring the Monitor

5.3.1 Adjusting the Sound Level

During certain operations or, for example, when an incorrect push-button is pressed, the monitor emits a "beep". You choose the volume of the 1312's "beep". The volume of the "beep" is expressed on a scale from 0 (no "beep") to 3 (loudest "beep"). Table 5.2. provides details of the available choices and the default value of this parameter.

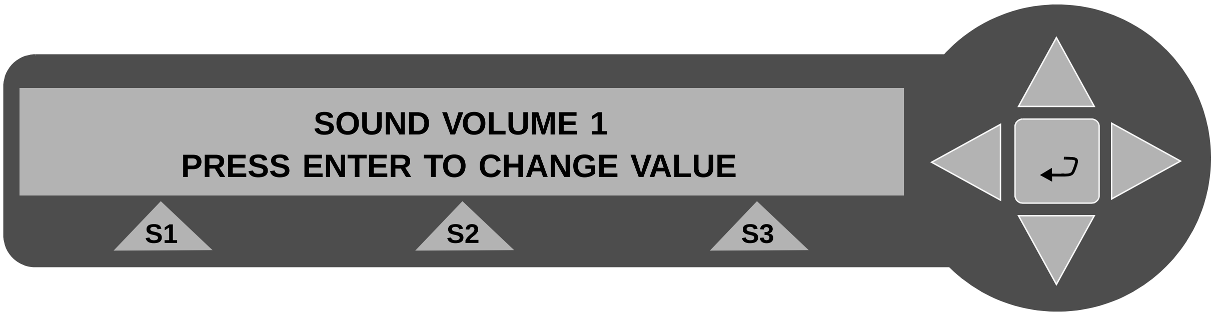
Table 5.2 The available choices and the default value of the 1312's "beep"

Display Text	Available Choices	Default Value
ENTER SOUND VOLUME 0	0, 1, 2, 3	1

To set the volume:

1. Press SET-UP.
2. Press S3 S1 S1 S2.

   The following screen picture appears:

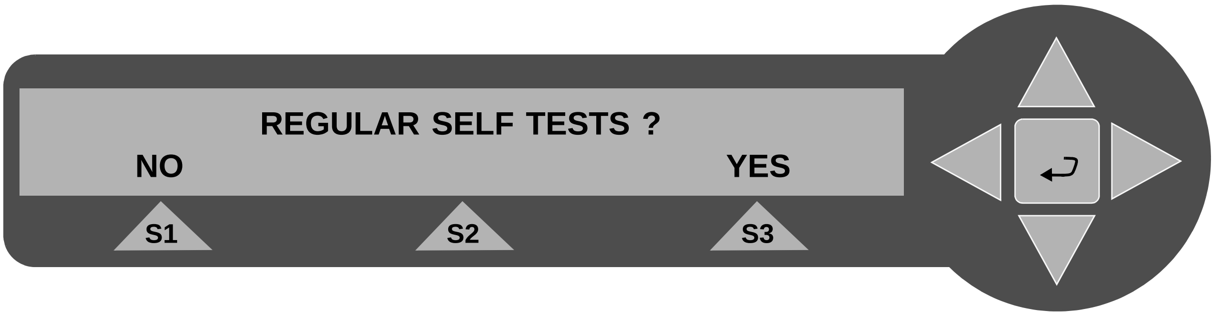


3. To change the volume, press ⏎.
4. Use the direction push-buttons to enter the correct volume. If you make a mistake, press S1 to revert back to the original volume.
5. Press ⏎ to accept volume.
6. Press SET-UP to exit the set-up function.

5.3.2 Enabling/Disabling Self Tests

If you do not wish the 1312 to perform regular self tests, including the **hardware** test on power-up (see section 5.1.3 for a full explanation), you can disable it.

1. Press SET-UP S3 S1 S1 S3



2. Press S1, the 1312 no longer performs the **hardware** test as part of its self-testing procedure during any kind of reset.

3. Press **SET-UP** to exit the set-up function.

5.4 Alarm Relay

Two alarm relays are built into the **alarm relay** socket on the back panel of the monitor. The function of the pins in this female connector are shown in Fig. 5.2. The two alarm relays can be connected to a variety of either audio (for example, a siren) and/or visual (for example a flashing light) alarm systems and they are activated whenever a pre-defined concentration (alarm level) of one (or more) of the gases being measured is exceeded. Alarm signals are given by opening and closing the relay contacts. Both relays are closed when the 1312 is switched off and when the 1312 is switched on. This means that there is a direct electrical connection between pins 1 & 2 and pins 4 & 5 at all times except when the 1312 measures a gas concentration which is greater than the alarm limit for the gas. When this concentration is measured, the 1312 breaks the connection between pins 1 & 2 and 4 & 5. This activates the attached alarm system.

The two alarm relays work in slightly different ways:

Alarm Relay 1:

Whenever one or more gases exceed their alarm level(s), the 1312 breaks the electrical connection between pins 1 & 2 and this activates the attached alarm system. The user can switch off this alarm either (1) by pressing **INFO** on the front of the 1312 (this produces a direct electrical connection between pins 1 & 2); or (2) by stopping the monitoring task. **Note:** once this alarm is activated it does not automatically switch itself off when all gas concentrations fall below their alarm levels.

Alarm Relay 2:

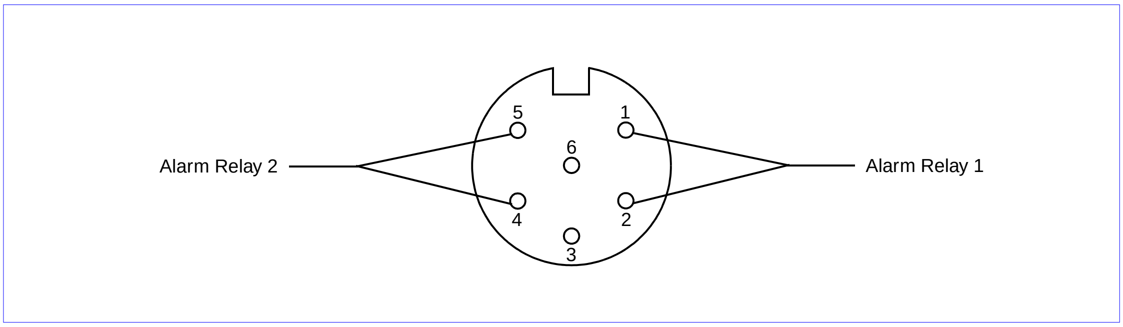
Whenever the alarm level of one or more gases is exceeded, the 1312 breaks the electrical connection between pin 4 and pin 5 and this activates the attached alarm system. This alarm relay differs from alarm relay 1 because it **will** automatically switch itself off when all gas concentrations fall below their alarm levels. The alarm will continue until either (1) **all** measured gas concentrations fall below their user-defined alarm level(s); or (2) the monitoring task is stopped — this automatically closes the alarm relay.

INNOVA supplies a 6-pin DIN plug (male) with a locking collar JP 0600 for connecting external alarm devices to the alarm relay.

Caution:
The DC voltage across the relay contacts must not exceed 25 V. The potential on the relay contacts must not be more than 25V DC above chassis potential, as this will

cause an excessive leakage current. The current through the contacts must not exceed 100 mA. AC voltages must not be connected to the Alarm Relay socket.

Fig. 5.2 Configuration of the pins in the alarm relay socket



Chapter 6

Keying-in Parameters

6.1 Types of Parameters

There are four types of parameters:

- Numerical: you are free to enter the desired values. However, there may in many instances be a range in which your values must lie. These ranges can be found in the relevant sections of his manual.
- Text: you are able to type user-defined text, for example, the names of the gases you are measuring and when using the 1312PC the names of your databases.

  The characters available to you when using the monitor on its own are shown in the table below:

Table 6.1 The characters which are available for gas names

<table>
<tr><th>Characters available for Gas Names</th></tr>
<tr><td>△ →

A a B b C c D d E e F f G g H h I i J K k L l M m N n O o P p Q q R r S s

T t U V v X x Y y Z z _ ’ ” . , : ; & ! ? @ | ^ # $ \ % * / + – = ( ) { } [ ] 〈 〉 Ø

1 2 3 4 5 6 7 8 9 A a B b C etc.

← ▽</td></tr>
</table>

- Pre-defined: you are able to select a parameter using the “select” push-buttons when there are three or less options, or by scrolling through a pre-defined list using the direction push-keys. The parameters in the lists are given in more detail in the relevant sections of this manual.
- Current Time: in the monitor is synchronized to match the time and date of the internal clock in the PC when the two are connected together.

6.2 Choosing Parameters

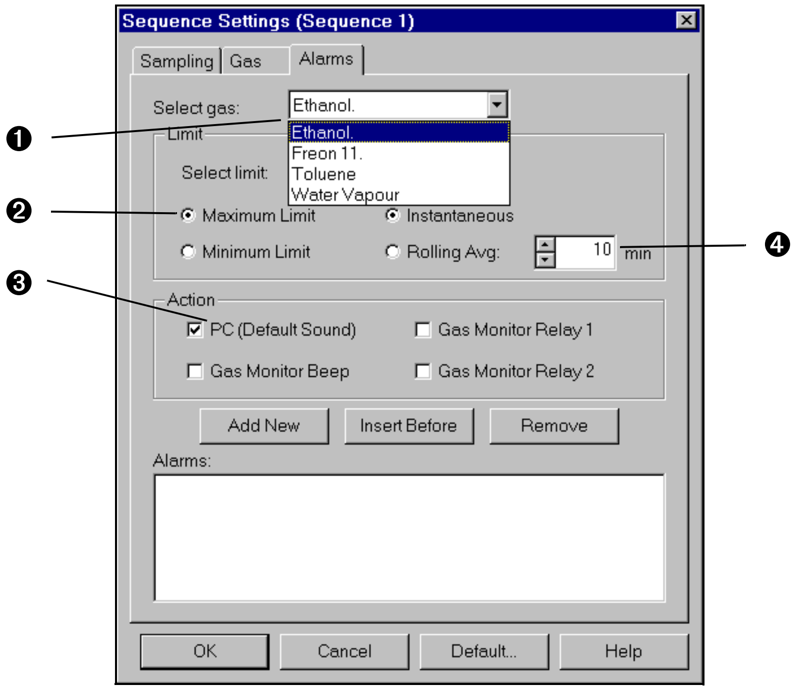
Parameters can be set in three ways: Using the numbers illustrated in Fig.6.1.

❶ Parameters in a Select Field. By clicking in the field, a list of pre-defined options appear. By scrolling through this list, the desired parameter can be selected.

❷ Parameters selected using radio push-buttons. These are often parameters that are similar to each other. But only one of these parameters can be selected at any one time.

❸ Check Boxes. These are commonly used for functions where more than one can be selected, simultaneously. When the tick is displayed, the function is selected.

Fig. 6.1 Illustration of the different parameters



❹ Definable values. Some parameters require a value defined. This value must lie within the permitted range. If you enter a value outside the range, a warning appears on screen telling you to enter a value which is within the range.

Chapter 7

Setting-up and Starting a Monitoring Task

Before a measurement task can commence, there are a variety of parameters that *must* be defined first. This is called "Setting up the 1312".

This chapter instructs you on how to set up the 1312 monitoring system before starting to measure.

Before leaving the factory, each of the parameters found in the set-up "tree" (see the Quick Setup Guide) are given factory values (**default values**).

Warning! Failure to define any parameter may result in the default parameters being used. This can result in the monitor measuring incorrectly or being unable to start the measurement task.

7.1 The Parameters' Units

The 1312 works internally with measurement parameters in SI units. These units can be converted and displayed as a variety of other measurement units. Defining the units here has two uses. It enables you to set-up the measurement parameters using familiar units and display the measurement results with the desired concentration units.

These parameters are listed below.

Table 7.1 The possible parameter units and the default settings

Parameters	Units	Default Unit
Humidity	mg/m^3, ppm, Tdew, kPa	mg/m^3
Pressure	mbar, mmHg, kPa	kPa
Temperature	°C, °F, K	°C
Gas Concentrations	mg/m^3, ppm	mg/m^3
Length	m, ft	m

The units for existing measurement results can also be changed using these instructions.

Normalization Temperature

If you have chosen to measure gas concentrations in the unit mg/m^3, you must "enter" the temperature at which the 1312 should calculate gas concentrations. If, for example, you "enter" a normalization temperature of 25°C, the measured gas concentrations which appear on the display during a monitoring task will be calculated in mg/m^3 units **at 25°C**. The acceptable values and the default values of the normalization temperature are given in Table 7.2 in the different temperature units.

Table 7.2 The acceptable values and the default values of the normalization temperature

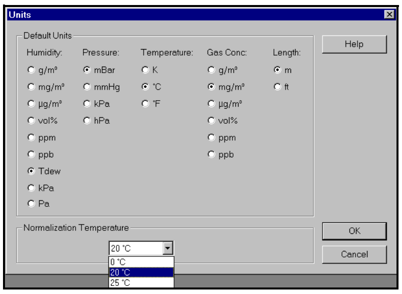
Display Text	Acceptable Values	Default Value
NORMALIZATION TEMPERATURE	0°C, 20°C and 25°C	20°C
NORMALIZATION TEMPERATURE	32°F, 68°F and 77°F	68°F
NORMALIZATION TEMPERATURE	273K, 293K and 298K	293K

7.1.1 Online Unit Set-up

With the Online program running, follow the instructions below.

1. Pull down the **Task** menu. Click on **Units** and the unit dialogue appears, see Fig. 7.1.

Fig. 7.1 The Units dialogue



2. Click on the radio push-buttons to select the desired units.
3. If you have selected the mg/m^3 unit for the gas concentration, click in the *Normalization Temperature* field.

   Note these temperature values change depending on the temperature units selected, i.e. °C, °F and K.
4. Select the desired value and click on **OK**.

All the parameters' units are now set.

7.1.2 Offline Unit Set-up

With the Offline program running:

1. Click on the **Units** softkey at the bottom of the dialogue box. The Units dialogue appears, see Fig. 7.1.

2. Click on the radio push-buttons to select the desired units.
3. If you have selected the mg/m^3 unit for the gas concentration, click in the *Normalization Temperature* field.

   Note these temperature values change depending on the temperature units selected, i.e. °C, °F and K.
4. Select the desired value and click on **OK**.

All the parameters' units are now set.

7.2 The Measurement Parameters

The list of parameters to be defined is long. To help show where these parameters appear in the 1312PC software, the parameters are grouped under their index card name.

Sampling index card

Sampling mode: the manner in which the gases are sampled. There are two possibilities here:

Continuous sampling: once the monitor is finished measuring it starts again making the next measurement, for a full explanation see section 4.1.2.

Fixed interval sampling: this is the time from the start of one measurement cycle to the start of the next one, for a full explanation see section 4.1.2.

Table 7.3 The range of acceptable values and the default value for the Fixed interval sampling

Acceptable Values hours:minutes	Interval hours:minutes	Default Value hours:minutes
00:01 to 00:59	00:01	00:02

Flushing: the length of time the monitor flushes the measurement chamber and the sample tubing between measurements. There are two options here:

Auto: the monitoring system controls the flushing by selecting the optimum flushing time. This time can vary as this option takes in to account the cleanliness of the external air-filters and the length of the sampling tube Therefore, the sample tube length must be defined.

Fixed Time: there are two selections here: Chamber, which is always selected with this option and Tube. See Table 7.5 for the acceptable values.

Air Pressure: the actual air pressure read from your barometer, see Table 7.6.

Water Interference: the 1312 is capable of measuring water's contribution to the signal measured in its analysis cell. The user can decide whether or not the

Table 7.4 The acceptable values and the default values of the length of the sampling tube

1312 Display Text	Acceptable Values	Default Value
LENGTH OF SAMPLING TUBE	0 - 99 metres	0.00
LENGTH OF SAMPLING TUBE	0 - 324.90 feet	0.00

Table 7.5 The range of acceptable values and the default value for the chamber and sample tube flushing times

Acceptable Values	Interval	Default Value
Chamber: 2 to 60 s Tube: 0 (=off), 3 to 120 s	1 s 1 s	8 s 3 s

Table 7.6 The acceptable values and the default values of the actual air pressure

1312 Display Text	Acceptable Values	Default Value
ACTUAL AIR PRESSURE kPa	50 - 150kPa	101.33kPa
ACTUAL AIR PRESSURE mBar	500 - 1500mBar	1013.2mBar
ACTUAL AIR PRESSURE mmHg	375 - 1125mmHg	760mmHg

signal should be compensated for water’s contribution. It is suggested that water should be compensated for in all measuring situations except where extremely dry gases are being measured.

Cross Interference: if any “interferent” other than water vapour is present in the ambient air-sample, the 1312 can cross compensate for the interference caused by its presence provided that a selective optical filter is installed in the monitor to measure the concentration of interferent gas present.

Gas Monitor Display: this enables you to decide if instantaneous values or averaged values are displayed on the gas monitors screen.

If average values are desired, then the example below illustrates how the values are calculated and displayed.

Let us suppose that the 1312 has been taking measurements every 2.5 mins., over a period of 30 mins., of gas A (acetone), and the following results (un-shaded area) were obtained and recorded.

A: ACETONE

				Averaged Values
0	11:42:30	1	66.72 mg/m^3	66.72 mg/m^3
0	11:45:00	2	154.90 mg/m^3	110.8 mg/m^3
0	11:47:30	3	271.30 mg/m^3	164.3 mg/m^3

0	11:50:00	4	415.90	mg/m^3	227.2	mg/m^3
0	11:52:30	5	588.70	mg/m^3	299.5	mg/m^3
0	11:55:00	6	789.70	mg/m^3	444.1	mg/m^3
0	11:57:30	7	1.019	g/m^3	616.9	mg/m^3
0	12:00:00	8	1.276	g/m^3	817.9	mg/m^3
0	12:02:30	9	1.562	g/m^3	1.047	g/m^3
0	12:05:00	10	1.876	g/m^3	1.304	g/m^3
0	12:07:30	11	2.218	g/m^3	1.159	g/m^3
0	12:10:00	12	2.589	g/m^3	1.904	g/m^3

Let us suppose that the averaging period was set to 10 mins. When the above measurement results are displayed on the screen and the averaging function is activated then each measurement will be averaged over the previous 10 mins. and the averaged measurement results will replace the individual measurement results (averaged results are shown in the shaded area in the list above). For example: measurement number 7 would be 616.9 mg/m^3. This is the average of the 5 measurements taken in the 10 min. period ending at 11:57:30. Measurement number 12 would be 1.904 g/m^3 which is the average of the 5 measurements taken in the 10 min. period ending at 12:12:00.

The range of acceptable values and the default value of the averaging period are shown in Table 7.7.

Table 7.7 The range of acceptable values and the default value of the averaging period

Display Text	Acceptable Values	Default Value
ENTER AVERAGING PERIOD 00:10	**hours:minutes** 00:10 to 12:00	**hours:minutes** 00:10

Gas index card

Gas Setup: there are up to six selections here: A, B, C, D, E and W. These represent the filters installed in the monitor's filter carousel. When setting up a new monitoring task, you can choose freely between the gases available for each filter (names entered when calibrating the filters, see sections 12.3 and 12.5). Once a gas has been selected for a filter and the measurement task started, you can no longer change the gas for this filter in this measurement task. However, you can still select gases for filters which have not previously been used in the measurement task.

Note: only one gas per filter can be selected at a time for measuring. The W position always represents the water filter installed in the monitor.

Sample Integration Time: this enables you to make a choice between speed and accuracy. Generally, the longer the integration time the more accurate the results. There are several selection possibilities here:

Integration Type	Integration Time
Fast	1 s
Normal	5 s
Low Noise	20 s
Advanced	0.5 s, 1 s, 2 s, 5 s, 10 s, 20 s, 50 s

Alarms index card

Select Gas: this option enables you to select any of the gases (one per filter position) already defined in the setup.

Limit: enables you to define the gas concentration that will trigger the alarm. The acceptable values are shown in Table 7.8.

Table 7.8 The range of acceptable values and default value of the alarm limit for the gases

Display Text	Acceptable Values	Default Value
ENTER ALARM LIMIT FOR GAS n* ____PPM	0 – 1000000 ppm	Blank
ENTER ALARM LIMIT FOR GAS n* ____mg/m^3	Depends on the molecular weight of the gas	Blank

*n = A to E

Select limit: this defines the concentration level when the alarm is triggered. This parameter must be defined.

Maximum Limit/Minimum Limit: (*Online only*) these are toggle functions, only one of these can be selected. Select between a high alarm or a low alarm.

Instantaneous/Rolling Average: (*Online only*) these are toggle functions, only one of these can be selected. The Rolling Average option enables you to prevent the alarm being triggered by sudden, small fluctuations in the gas concentrations by using values which are averaged over a defined period of time. The averaging time is defined in minutes. The acceptable values are: 1 to 999 mins, and the default value is 10 mins.

Action: this provides you with 4 ways to trigger the alarm. One or more of the options can be selected simultaneously.

PC Beep: (*Online only*) when an alarm is triggered the PC makes a beeping noise.

1312 Beep: when an alarm is triggered the monitor makes a beeping noise.

1312 Relay 1 & 1312 Relay 2: selecting these options enable you to connect the alarms to a variety of either audio (for example, a siren) and/or visual (for example a flashing light) alarm systems.

Active Alarms: only the gases which you have selected and activated are shown in this field.

7.2.1 Measurement Set-up

If you are using the Online program, follow the instructions below. If you are using the Offline program go directly to step 5.

1. Pull down the **Task** menu. Click on **New** if you want to create a new database, or click on **Open** to use an existing database.
2. In the database window:

   For new databases: click in *Enter name for* field and type in the desired name.

   For existing databases, click on the desired database name.
3. Click **OK**.

   A graphic window and an extended menu bar appear.
4. Pull down the **Sequence** menu. Click on **Settings** and the Setup window appears

In the new window there are several labelled “index card” separators. Each index card contains several parameters.

Sampling index card

5. Click on the radio-button for the desired sampling mode. If Sample Interval is selected, set the time to the correct value.
6. Click on the radio-button for the desired flushing mode.
   a. If Auto is selected, set the correct tube length
   b. If Fixed Time is selected, set the desired chamber flushing time and the tube flushing time.
7. If water vapour and cross interference are required, click in the appropriate check boxes.
8. If average values are to be displayed on the gas monitors screen, click in the Average check box, and set the interval to correct value.
9. Click in the *Air Pressure* field and type in the value read from your barometer.

Gas index card

10. Click on the “Gas” index card.
11. Click in the check box to the left of the desired filter.

12. Click in the field to the right of the selected filter and select the correct gas.
13. Repeat steps 11. & 12. until all the filters which are required for the measurements are selected and the correct names are displayed.
14. Click in the *Sample Integration Time* field and select the desired option.
15. (Advanced settings only). Note that a new field has appeared to the right of the gas names. Click in the field and define the times for the selected filters.

Alarms index card

16. Click on the “Alarms” index card
17. Click in the *Select gas* field to display the list of gas names.
18. Click on the desired gas name.
19. Click in the *Select Limit* field, and type in the desired concentration.
20. *Online Only* – Click on the Maximum Limit or Minimum Limit radio push-button.
21. *Online Only* – Click on the Instantaneous or Rolling Average radio push-button. If you select Rolling Average, click in the field to the right and define the averaging interval for the alarm.
22. *Online Only* – Click in the desired *Action* check boxes.
23. Click on **Add New** or **Insert Before** if you want to insert the new entry at the top of the list.
24. Repeat steps 17. to 23. until all the required alarms are set.

Note: if you wish to remove an alarm, select the gas in the *Alarms:* field and click on **Remove**.

If you are using the Offline program, go to step 25.

If you are using the Online program, and you have completed all the steps, click on **OK**, the system is now ready to start measuring, see section 7.3.1.

Up/Download index card – Offline Only

25. Click on the Up/Download index card
26. Click on the **Download Settings** softkey. This will download the settings in the Sequence Settings dialogue to the monitor.
27. When the transfer is complete, Click on the **Close** softkey to exit the Offline program.

You are now ready to start measuring, see section 7.3.2.

7.3 Starting and a Monitoring Task

Monitoring tasks can be started in two ways. They can be started immediately, or set to start at a pre-set time. The duration of the monitoring sequence can also be determined. A monitoring task can continue until it is stopped manually, or at a pre-set time.

When using the 1312PC and the Online option, there are no limits to the duration of a monitoring task. However, if the measurement results are being stored in the monitor's memory, the duration of the monitoring task should be considered as there is only a finite amount of memory in the monitor. See section 9.3 for full details about the storage capacity of the monitor.

7.3.1 Online Program

Using the 1312PC, a monitoring task can be paused or stopped and then re-started at your convenience. This means a monitoring task can comprise of one or more monitoring sequences, where each sequence has a distinct name. When sequences are measured consecutively, using the same name, a number appears after the name (starting at 1). This shows the order in which they were measured.

Before a monitoring task is started, the set-up, as described in section 7.2, must be completed.

1. Pull down the **Sequence** menu and click on **Start**. The New Measurement Sequence window opens.
2. In the *Enter sequence description*: field, type in the name of the monitoring sequence. If you do not enter a name, the default name is used: *Sequence 1*.
3. In the Start Time group:

   To start the measurement immediately, click on the Now radio-button.

   or

   To delay the start, click on the Start at: radio-button and define the start time.
4. In the Stop Time group:

   If no stop time is required, click on the None radio-button. This means the measurement must be stopped manually.

   or

   To determine the duration of the monitoring sequence, click on the Stop at: radio-button and define the stop time.
5. Press **OK** to start the monitoring task.

Stopping the Monitoring Task

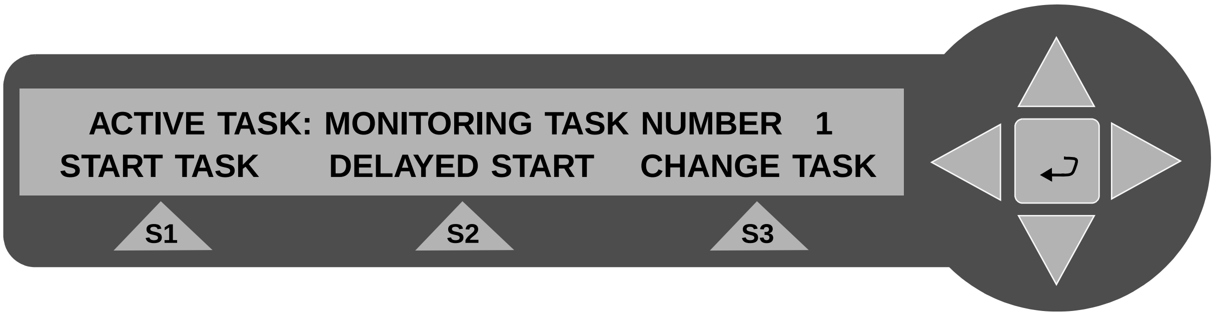
If no pre-set monitoring period is defined, then to stop the monitoring task, pull down the **Sequence** menu and click on **Stop**.

7.3.2 Offline Program

Before a monitoring task is started, the monitor should be warmed up and the set-up, as described in section 7.2, must be completed and downloaded to the monitor.

1. Press **MEASURE**.

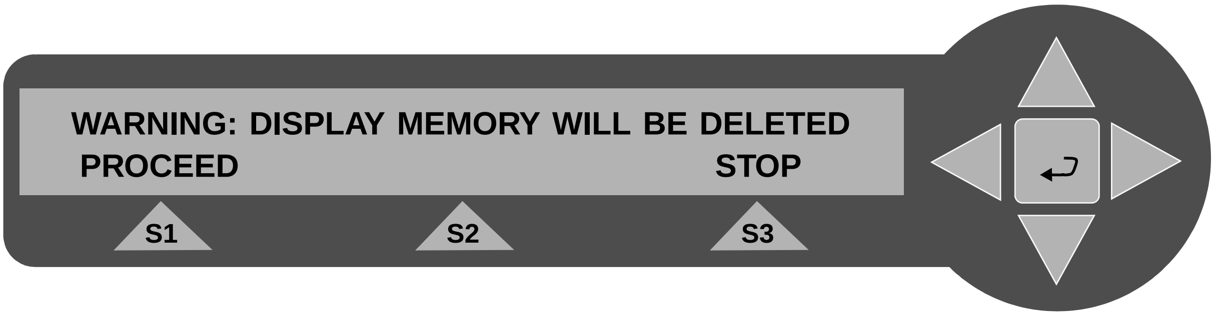
   The following text appears on the screen:



Please note: if you do not use one of the “select” keys within a short time after the above text appears, the 1312 will automatically stop operating in **Measure** mode (the light-emitting diode in the **MEASURE** key switches off). If this happens just press **MEASURE** again.

2. To start the measurement immediately, press **S1**.
   To delay the start, press **S2**.

   The following warning then appears on the display:



Display Memory is where the 1312 stores the results of all measurements while it is performing a monitoring task. If the monitoring task is stopped and then started again all the data already collected will be deleted from *Display Memory*. However, the data in *Display Memory* can be copied into and stored in the

1312's *Background Memory*. This operation is described in section 10.2.

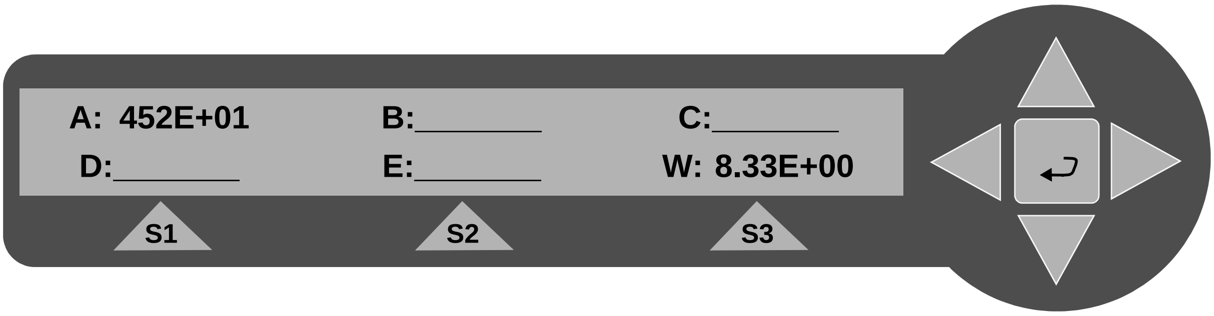
3. Press **S1**.

Immediate Start

If you selected an immediate start, the following text appears on the screen:

MEASUREMENT IN PROGRESS
RESULTS NOT YET AVAILABLE

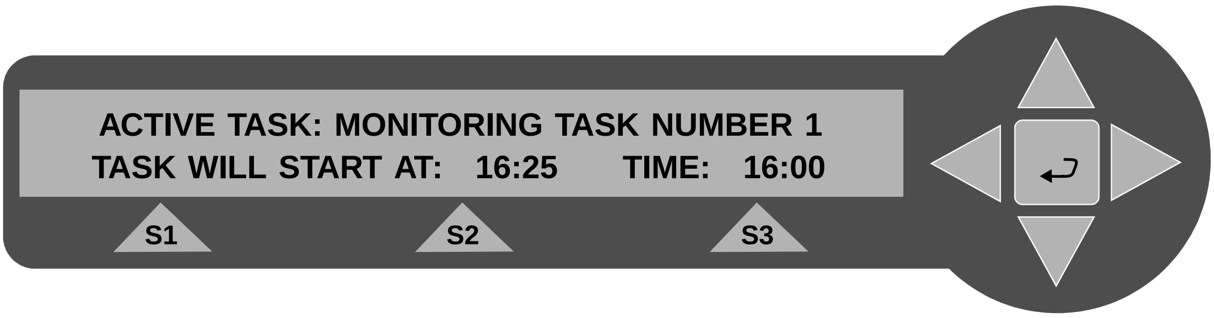
4. When the first measurement cycle is complete the 1312 will automatically display the results and update them every time a new measurement cycle is completed. An example is shown below:



This display gives the overview of the gas/vapour concentrations last measured — in this case the concentration of gas A and humidity of the water vapour are in the units that were selected — that is mg/m^3 for gas A and Tdew for water vapour (see section 4.3.2).

Delayed Start

If you selected a delayed start, the following text is displayed:



The time shown in the TIME: field is the current time. When the monitoring task starts, the monitor's screen will change and display the same messages as those displayed when a monitoring task starts immediately.

Stopping the Monitoring Task

If no pre-set monitoring period is defined, then to stop the monitoring task, press **MEASURE** and **S3**.

Chapter 8

Viewing Measurement Data — using a PC

8.1 Measurement Data

In order for the measurement data to be viewed using the PC software, the data must be stored in the PC. For Offline and Stand-alone use, where the measurement data is stored in the monitor, then the data must be Uploaded to the PC.

All measurement data from the 1312 monitor, regardless of what is being displayed on screen during the measurement, is transferred to the PC and stored in a MS-Access® format. This measurement data can be viewed on screen, analyzed and used in other software programs that utilize ODBC.

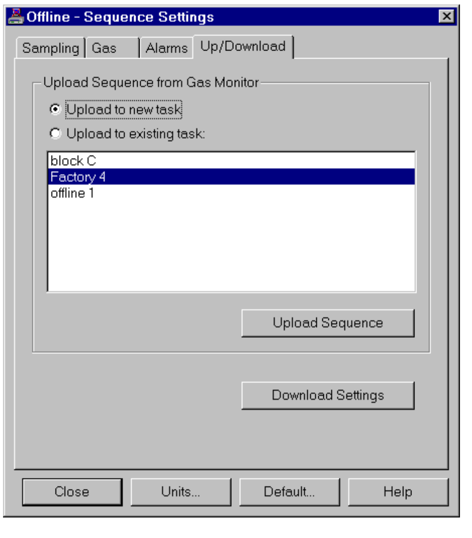
8.1.1 Uploading Measurement Data from the Monitor

Any measurement data that is stored in the monitor's display memory can be uploaded to a PC. Measurement data can be uploaded either as a new measurement task, which is given a unique name, or it can be uploaded so that it becomes a sequence in an existing measurement task. If **EVENT** was pressed or something happened while monitoring, the uploaded data retains these marks, which can be displayed using the Presentation program.

With the monitor and the PC connected as described in section 2.2 and the Offline program running:

1. Click on Up/Download index card, see Fig.8.1.

Fig.8.1 The Up/Download dialogue



2. Click on the radio-button to either Upload to a new task or Upload to an existing task.

   If you are adding data to an Existing Task, select the monitoring task from the list displayed.

3. Click on the **Upload Sequence** softkey.

   If you are uploading measurement to a New Task, a New Measurement Task dialogue opens, type in the desired monitoring task name now, and click on **OK**.

The measurement data is uploaded to the PC, where it can be viewed using the Presentation program.

8.2 Graphic Window

This window can display all the measured gases, simultaneously. The concentration curves can be allocated to either of the two axes. The scale and concentration units of these axes can be set individually to suit the concentration of the gas(es) displayed on them. The number of concentration curves displayed, their colour and their style are defined by you. Measurement data can be displayed as instantaneous concentration curves or as average concentration curves, where you define the averaging interval. This window also displays several “MARKS”. These appear if something happens during the measurement, or an alarm is triggered. If any events have been added during the monitoring task, these are also displayed here. These marks and events are always displayed with the Online program, but can be hidden with the Presentation program. See “Events” index card in section 8.2.1 and section 8.3.1.

When using the Online program, the latest measurement results are always displayed at the right-hand end of the axis. Previous measurement results roll across the x-axis, disappearing from view at the left Y-axis when the interval defined for the x-axis is full. These measurement results are not lost, just not displayed.

8.2.1 Graphic Window Properties Dialogue Box

This dialogue box enables you to define exactly what is displayed in the graphic window. The separate sections are divided up by index cards. To simplify matters, the following explanations are given under the index card name headings.

Interval index card

This index card is divided in to several groups:

Measurement Sequence: this option is only available when the **Presentation** software option is used. You can select any one of the sequences recorded under the currently selected monitoring task. When using the **Online** program, only a specified interval from the latest measurement can be displayed.

Time: this is a toggle option. You can select either this option or the measurement number option. This option enables you to define the X-axis as a period of time.

Note there are slight variations here between the Online program and the Presentation program.

Online: defining a time period here determines the time period for the length of the x-axis. This acts like a rolling window, where the period for the x-axis is always the same and the latest measurement result will always be displayed at the right-hand end of the x-axis.

Presentation: defining the times and dates here, enable you to select a time period which can stretch over several measurement sequences. In fact, the complete monitoring task can be displayed by defining the times and dates here.

Measurement Number: this is a toggle option. You can select either this option or the Time option. Like the time option, by defining a value here, you define the length of the x-axis, defined as a number of measurements. For the Online program, the x-axis works like a rolling window, where the latest measurement is always displayed at the right-hand end of the axis. For the presentation option, several measurement sequences, under the same monitoring task name, can be displayed at the same time.

Rolling Average: this enables you to define what sample values are displayed. If the check box in this field is *not* ticked (default setting), then individual sample concentration values are displayed. However, if the check box is ticked an averaging interval must be entered:

Rolling Average: the individual sample values are averaged and displayed on the graph. By defining the averaging time, you can display defined Time-weighted Average (TWA) values. This can be of use if you need to know 8 hour National Occupational Exposure Limits or Short Term Exposure Limits (STEL) averaged over 15 minutes. The formulae used to calculate the average values are described in detail in section 8.4. The units of the value defined here change depending on which radio-button was selected, time or measurement number.

Left Y-axis index card

It is here you define the scale of the left Y-axis, which curves (gases) are allocated to this axis, and their appearance.

Scaling: this enables you to set the scale of this axis. There are three possibilities:

Autoscale maximum and minimum: by selecting this option, the gas concentrations will always be displayed. The scale will start just below the minimum concentration value and end just above the maximum value. With the Online option, the scale will widen as the concentrations vary, both upwards and downwards.

Autoscale maximum (minimum = 0): by selecting this option, the axis will always start at zero. The top value depends on the maximum value. With the Online option, the scale will increase when the concentrations exceed the displayed value.

Autoscale OFF: this option enables you to define the minimum and maximum values on the axis. This can be of use if you are interested in a particular concentration range. Note that with this option, the curve(s) may not appear on the screen. When you select this option, the scaling icons ( ) in the tool bar become active. These icons enable you to change the scaling: 0 to maximum or minimum to maximum, respectively.

Single Curve Setup: it is here you define which gas curves are allocated to this axis. You define their colour, the style of line, you can even change their units here if necessary.

Select gas: by clicking in this field, the names of all the gases measured during this monitoring task are displayed. Clicking on a gas name enables you to set up the gases individually.

Select color: there are seven standard colours to choose from. If necessary, a user-defined colour can be selected. By clicking on **Define**, the Windows® mixing palette is displayed. The standard Windows procedure should be followed.

Select style: there are several styles to choose from. These are displayed by clicking in the style field.

Select unit: this enables you to display the gas with the desired units. When you click in the select unit field, the units available for this gas are displayed.

All Curves: if a gas is to be displayed in the graphic window, then it must appear here. Gases are entered in this field by first displaying their name in the *Select gas* field, setting up the display parameters for the curve and then pressing the **Add New** soft-key. Note that if a gas already appears here, but you want to edit one or more of the display parameters, then you must click on the name here first before you can change its appearance.

Soft-keys: these three keys are used to edit the names in the All curves list.

Add New: if this is pressed after the appearance of a gas has been defined, then the gas is added to the end of the list of gases already displayed.

Insert Before: this puts the selected gas at the top of the list.

Remove: this enables you to remove a gas curve name, resulting in this gas not being displayed.

Note: the fastest way to set the Y-axis in the graphic window is: when the sequence settings are defined, open a new graphic window. All the selected gases are displayed. If you want to change any of the display parameters, then do this using the Windows Properties dialogue.

Right Y-axis index card

It is here you define the scale of the right Y-axis, which curves (gases) are allocated to this axis, and their appearance.

All the values in this index card are set up in exactly the same way as those in the Left Y-axis index card.

Events index card (presentation only)

There are five check boxes that can be selected here. If a tick appears in the check box, then this “event” is displayed in the graphic window.

Communication Errors: are marked by a line with a “C” at the end of it. These indicate when a communication error has occurred between the monitor and the PC.

Alarms: are marked by a line with a small red triangle at the end. These indicate when the alarm was triggered, and which gas triggered the alarm.

New Air Pressure Entered: are marked by a line with an “N” at the end of it. These indicate if a new air pressure is entered during a measurement.

User Events: are marked with by a cursor with a “U” at the top of it.

Gas Monitor Warnings/Errors:

Event Marks	Description
Common Marks: apply to all filters	
“P”	The 1312 stopped measuring due to a power failure, but automatically re-started monitoring again after regaining power. The 1312 was “reset” because a fault was detected.
“U”	The measurement was marked by the user when the Event button was pressed.
“W”	A operational error was detected, or a warning was given during the measurement. The accuracy of the measurement cannot be guaranteed.
Gas Marks: apply to individual filters	
“B”	The 1312 was incapable of calculating this gas concentration.
“F”	After this measurement the filter carousel was found to be out of alignment. If the misalignment is only slight, then accuracy of the measurement has not been affected, but the accuracy of such a measurement can not be guaranteed.
“A”	The gas concentration measured during this measurement cycle exceeded the user-defined alarm limit, resulting in an alarm being triggered.
To see which gas the Common Mark adheres to, open a numeric window.	

8.3 Numeric Window

This window can display all the measurement data, simultaneously. Measurement data can be displayed as instantaneous concentration values or as average concentration values. This window also displays several “MARKS”. These appear if something happens during the measurement, or an alarm is triggered. If any events have been added during the monitoring task, these are also displayed here. These marks and events are always displayed with the Online program, but can be hidden with the Presentation program. See “Events” index card in section 8.2.1 and section 8.3.1.

When using the Online program, the latest measurement results are always displayed at the bottom of the column. Previous measurement results roll upwards, disappearing from view at the top of the column when the defined interval is full. These measurement results are not lost, just not displayed.

8.3.1 Numeric Window Properties Dialogue Box

Interval index card

This index card is divided in to several groups:

Measurement Sequence: this option is only available when the **Presentation** software option is used. You can select any one of the sequences recorded under the currently selected monitoring task. When using the **Online** program, a specified interval from the latest measurement can be displayed.

Time: this is a toggle option. You can select either this option or the measurement number option. This option enables you to define the column length as a period of time. Note there are slight variations here between the Online program and the Presentation program.

Online: defining a time period here determines the time period for the length of the column. This acts like a rolling window, where the period for the column is always the same and the latest result will always be displayed at the bottom of the column.

Presentation: defining the times and dates here enable you to select a time period, which can stretch over several measurement sequences. In fact, the complete monitoring task can be displayed by defining the times and dates here.

Measurement Number: this is a toggle option. You can select either this option or the Time option. Like the time option, by defining a value here, you define the length of the column, defined as a number of measurements. For the Online option, the x-axis works like a rolling window, where the latest measurement is always displayed at the bottom of the column. For the presentation option, several measurement sequences, under the same monitoring task name, can be displayed at the same time.

Rolling Average: this enables you to define what sample values are displayed. If the check box in this field is *not* ticked (default setting), then individual sample concentration values are displayed. However, if the check box is ticked an averaging interval must be entered:

Rolling Average: the individual sample values are averaged and displayed in the columns. By defining the averaging time, you can display defined Time-weighted Average (TWA) values. This can be of use if you need to know 8 hour National Occupational Exposure Limits or Short Term Exposure Limits (STEL) averaged over 15 minutes. The formulae used to calculate the average values are described in detail in section 8.4. The units of the value defined here change depending on which radio-button was selected, time or measurement number.

Columns index card

It is here you define which gases are displayed in the numeric window.

Single Column Setup: you define which gases are displayed and their units.

Select gas: by clicking in this field, the names of all the gases measured during this monitoring task are displayed. The gases are selected individually.

Select unit: this enables you to display the desired units for each gas. When you click in the select unit field, the available units for this gas are displayed.

All Columns: if a gas is to be displayed in the numeric window, then it must appear here. Gases are entered in this field by first selecting their name and units and then pressing the **Add New** soft-key. Note that if a gas already appears here, but you want to edit the units, then you must click on the name here first before re-selecting its units.

Soft-keys: these three keys are used to edit the names in the All Columns list.

Add New: if this is pressed after the appearance of a gas has been defined, then the gas is added to the end of the list of gases already displayed.

Insert Before: this puts the selected gas at the top of the list.

Remove: this enables you to remove a gas curve name, resulting in this gas not being displayed.

Note: the fastest way to set the properties in the numeric window is: when the sequence settings are defined, open a new numeric window. All the selected gases are displayed. If you want to change any of the display parameters, then do this using the Windows Properties dialogue.

Events index card (presentation only)

There are five check boxes which can be selected here. If a tick appears in the check box, then this "event" is displayed in the numeric window.

Communication Errors: are marked by a line with a "C" at the end of it. These indicate if there has been communication problems between the 1312 monitor and the PC.

Alarms: are marked by a small red triangle. These indicate when the alarm was triggered, and are situated on the value for the gas which triggered the alarm.

New Air Pressure Entered: are marked with a line with an "N" at the end of it. These indicate that a new air pressure value has been entered during a measurement.

User Events: are marked by a line with a "U" at the end of it (see section 8.5).

Gas Monitor Warnings/Errors:

Event Marks	Description
Common Marks: apply to all filters	
"P"	The 1312 stopped measuring due to a power failure, but automatically re-started monitoring again after regaining power. The 1312 was "reset" because a fault was detected.
"U"	The measurement was marked by the user when the Event button was pressed.
"W"	A operational error was detected, or a warning was given during the measurement. The accuracy of the measurement cannot be guaranteed.
Gas Marks: apply to individual filters	
"B"	The 1312 was incapable of calculating this gas concentration.
"F"	After this measurement the filter carousel was found to be out of alignment. If the misalignment is only slight, then accuracy of the measurement has not been affected, but the accuracy of such a measurement can not be guaranteed.
"A"	The gas concentration measured during this measurement cycle exceeded the user-defined alarm limit, resulting in an alarm being triggered.

8.4 Using the Cursors

Cursors can be used in both the numeric and graphic windows. The way they are used and the information they provide is the same in both situations. Before the cursors can be displayed, the Cursor Values window must be opened and the window in which you wish to position the cursor(s) must be selected. Once the Cursor Values window is open, you click on the curve (in the graphic window) or on the value (in the numeric window) that you are interested in.

The cursor function is divided into two parts: when a single cursor is displayed and when two cursors are displayed.

8.4.1 “Single” Cursor

When you click in the window, a single cursor appears in the graphic window while two cursors appear either side of a single value in the numeric window. The Cursor Values dialogue gives several pieces of information:

Cursor Position: this can be given as either a time and date or a measurement number, depending on what was defined in the Window Properties dialogue.

The displayed gases (and their display units) are listed on the left-hand side of the dialogue. Opposite each gas, under the heading Cursor Value, there is a value displayed. This is the measured value for the gas where the cursor has been positioned.

There is a soft-key, **View Settings**, which enables you to see the measurement’s settings (see section 7.2) for the measurement sequence.

Note: the View Settings soft-key is only available when this “single” cursor is displayed.

8.4.2 Two Cursors

If you are interested in the measurement data in a particular range, or need to zoom in, then two cursors can be used. The second cursor is displayed when you click on the initial cursor (either of the cursors in the numeric window), hold the left mouse button down and drag the cursor to the desired position and then release the mouse button. The two cursors are quite easy to see now. The information in the Cursor Values dialogue changes.

When using the Online program, the cursors can be used to look at any of the data more closely. But, note that as soon as a new measurement is available from the monitor, this will be displayed, disturbing your zoomed in view. In this case, it is more convenient to use the Presentation program simultaneously.

Left Cursor Position: this can be given either as a time and date or a measurement number, depending on what was defined in the Window Properties dialogue.

Right Cursor Position: this can be given as either a time and date or a measurement number, depending on what was defined in the Window Properties dialogue.

The displayed gases (and their display units) are listed on the left-hand side of the dialogue. Opposite each gas are several values under the headings:

Minimum: this shows the minimum value for each gas between the cursors.

Average: this gives the linear average value for all the values for each gas between the cursors. The calculation of "the mean value" can be expressed mathematically as follows:

$$\text{The average value} = \frac{\sum_{n=1}^{n=N} (C_n)}{N}$$

Where: N = measurement cycles performed during the monitoring period (T) between the cursors

c_n = gas concentrations (where n = 1 to N)

Maximum: this shows the maximum value for each gas between the cursors.

Standard Deviation: this is the standard deviation of a particular gas's measurements from the average value of this gas.

$$\text{The Standard Deviation} = \sigma = \sqrt{\frac{\sum_{n=1}^{n=N} (C_n - \mu)^2}{N - 1}}$$

Where: μ = the mean value

C_n = individual gas concentrations

N = total number of measurements

Note: the **View Settings** soft-key is not displayed when two cursors are displayed.

Zoom Function

When two cursors are displayed, the zoom function can be used. By pulling down the **View** menu and clicking on **Zoom in**. All the measurement data outside the cursors is removed from the screen. By setting new cursors, the zoom can be repeated.

Note: the Cursor Values dialogue updates each time the new cursors are displayed.

There are two ways to zoom out again.

You can pull down the **View** menu and click on **Zoom out**.

or

You can redefine the time “window” or the number of measurements displayed in the Window Properties dialogue.

8.5 User Event Markers

If something happens or you change something during a monitoring task, or you just want to indicate a measurement for some reason, this is possible using the Insert User Event option. The measurement results are marked by a vertical line with a “U” at the top in the graphic window and a horizontal line with a “U” at the end of it in the numeric window.

User events can be inserted:

Previous measurement: (*Online only*) this is the measurement prior to the one currently being measured.

Next measurement: (*Online only*) this is one currently being measured. The event marker first appears when the measurement is displayed.

At the cursor: this is only possible when the cursor is displayed. The marker appears at the cursor, but remains there after the cursor is moved. This is the only way to insert User Events when using the Presentation program.

When the presentation option is used to view measurement data, the user event markers can be displayed or hidden, depending on the settings in the Window Properties dialogue (see section 8.2.1and section 8.3.1).

8.5.1 Inserting a User Event Marker

1. If you want to insert a User Event marker at the cursor, position the “single” cursor.
2. Pull down the **Edit** menu. Click on **Insert User Event** and a new dialogue box opens.
3. *Online only* – click on the radio-button for the desired position.
4. Type in any comments you may have in the Events Text field.
5. Click on **OK**.

The user event marker will appear at the designated point.

8.6 Status Windows

There are two status windows: Alarms status and Measurement status. These can be displayed when the Online program is being used.

8.6.1 Alarms Status

If an alarm has been defined in the Sequence Settings dialogue (see section 7.2), and that alarm has been triggered, then by opening this window, you can see which gas triggered it. When an alarm is triggered, a red triangle flashes until the alarm has been confirmed, using the **Confirm** soft-key. Alarms can only be confirmed when they are no longer active.

8.6.2 Measurement Status

This informs you if the measurement is active or idle, when the last measurement was made and the latest measurement values for all the measured gases, even if they are not displayed in the graphic or numeric windows.

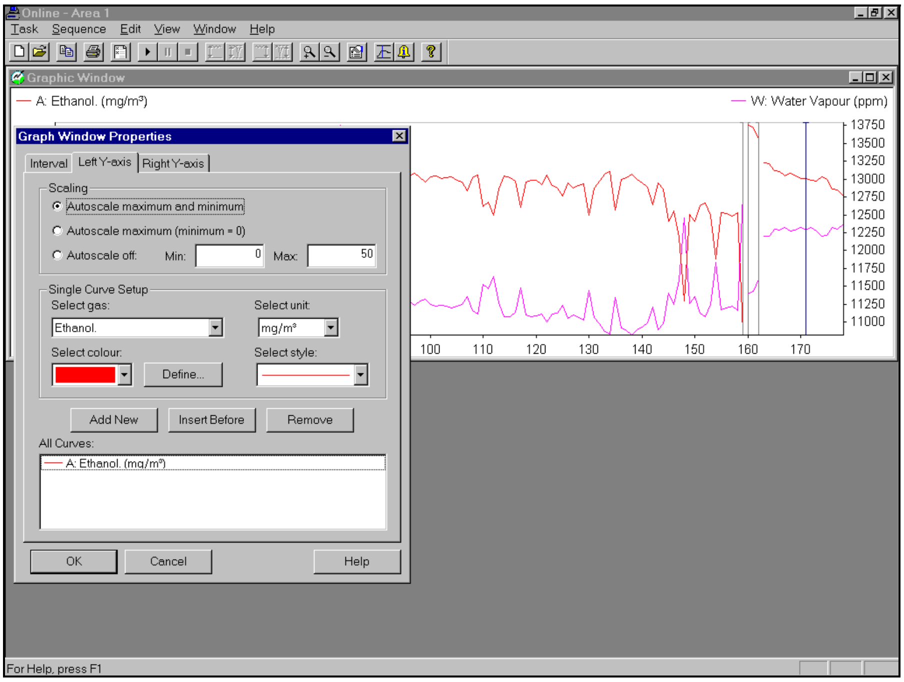
8.7 Displaying Measurement Results while Monitoring

Using the Online program, measurement data is displayed on screen as soon as it is available from the monitor. The data can be displayed in both a graphic window and a numeric window, simultaneously. The latest measurement results are always displayed.

With the Online program running and a monitoring task started:

1. If you want to open another window, pull down the **Window** menu and click on **New Graphic Window** or **New Numeric Window**.
2. Click in the window you want to set up, and pull down the **Edit** menu. Click on **Window Properties**, see Fig.8.2.

Fig.8.2 The Window Properties dialogue for a graphic window



Interval index card

3. Select the interval units for the x-axis. Click on either the Time or Measurement Number radio-buttons and define the interval length.

4. Select the displayed measurement values.

   If you want to display single measurement values, ensure that the check box in the Rolling Average group is not ticked.

   If you want to display rolling average values, click in the Rolling average check box and define the averaging interval.

If you have opened a numeric window, go to step 5. If you have opened a graphic window go step 11.

Column index card

5. Click on the Column index card.

6. If the gases and their units displayed in the *All Columns* field are not correct, click on the gas you want to change.

   If the gas you want to display is not present in the *All Columns* field, click on **Add New** or **Insert Before**.

7. In the Single Gas Setup group, click in the *Select Gas* field and select the desired gas name.

8. Click in the *Select unit* field and select the desired units.
9. Repeat steps 6. to 8., selecting the other gases you want to display.
10. Press **OK** to save selections and exit the dialogue box.

The selected gases will now be displayed in the numeric window as they become available.

Left Y-axis index card

11. Click on the Left Y-axis index card
12. In the Scaling group, select the desired scaling mode by clicking on the correct radio-button.
13. If the gases and their units displayed in the *All Curves* field are not correct, click on the gas you want to change.

    If the gas you want to display is not present in the *All Curves* field, click on **Add New** or **Insert Before**.
14. In the Single Curve Setup, click in the *Select Gas* field and select the desired gas name.
15. Select the desired colour, style and units.
16. Repeat steps 13. to 15. until all the gases you want displayed on the left y-axis are in the *All Curves* list.

Right Y-axis index card

17. Click on the Right Y-axis index card
18. In the Scaling group, select the desired scaling mode by clicking on the correct radio-button.
19. If the gases and their units displayed in the *All Curves* field are not correct, click on the gas you want to change.

    If the gas you want to display is not present in the *All Curves* field, click on **Add New** or **Insert Before**.
20. In the Single Curve Setup, click in the *Select Gas* field and select the desired gas name.
21. Select the desired colour, style and units.
22. When all your selections are correct, click on **Add New**. The selected gas is now displayed in the *All curves* field. This means it will be displayed on the graph, with its concentration scale displayed on the right axis.
23. Repeat steps 19. to 23. until all the gases you want displayed on the right y-axis are in the *All Curves* list.
24. Press **OK** to save the selections and exit the dialogue box. The measured data will now be displayed on screen.

Note: you can display the same gas several times, simultaneously, with different units if desired.

8.8 Displaying Measurement Results After Monitoring

Using the Presentation program, measurement data from monitoring tasks stored in the computers memory is displayed on screen. The data can be displayed in both a graphic window and a numeric window, simultaneously.

With the presentation program running:

1. Pull down the **Task** menu. Click on **Open** to view an existing database.
2. In the database window, click on the desired database name.
3. Click on **OK**.

   A graphic window opens showing all the measurement values for the complete monitoring task. The Window Properties dialogue also opens.

Interval index card

4. Click in the *Measurement Sequence* field and a list of all the sequences in the monitoring task is displayed.
5. Select the desired sequence or all sequences.

   If you select all, then you can zoom in on the individual areas using the cursor function (see section 8.4.2).
6. Select the interval units for the x-axis. Click on either Time or Measurement Number radio-buttons and define the values in the *From:* and *To:* fields.
7. Select the displayed measurement values.

   If you want to display instantaneous values, ensure that the check box in the Rolling Average group is *not* ticked.

   If you want to display rolling average values, click in the Rolling average check box and define the averaging interval.

If you have opened a numeric window, go to step 8. If you have opened a graphic window go step 13.

Column index card

8. Click on the Column index card.
9. If the gases and their units displayed in the *All Columns* field are not correct, click on the gas you want to change.

   If the gas you want to display is not present in the *All Columns* field, click on **Add New** or **Insert Before**.

10. In the Single Gas Setup group, click in the *Select Gas* field and select the desired gas name.
11. Click in the *Select unit* field and select the desired units.
12. Repeat steps 9. to 11., selecting the other gases you want to display.

Go to step 25. to define the event markers that you want displayed in the numeric window.

Left Y-axis index card

13. Click on the Left Y-axis index card
14. In the Scaling group, select the desired scaling mode by clicking on the correct radio-button.
15. If the gases and their units displayed in the *All Curves* field are not correct, click on the gas you want to change.

    If the gas you want to display is not present in the *All Curves* field, click on **Add New** or **Insert Before**.
16. In the Single Curve Setup, click in the *Select Gas* field and select the desired gas name.
17. Select the desired colour, style and units.
18. Repeat steps 15. to 17. until all the gases you want displayed on the left y-axis are in the *All Curves* list.

Right Y-axis index card

19. Click on the Right Y-axis index card
20. In the Scaling group, select the desired scaling mode by clicking on the correct radio-button.
21. If the gases and their units displayed in the *All Curves* field are not correct, click on the gas you want to change.

    If the gas you want to display is not present in the *All Curves* field, click on **Add New** or **Insert Before**.
22. In the Single Curve Setup, click in the *Select Gas* field and select the desired gas name.
23. Select the desired colour, style and units.
24. Repeat steps 21. to 23. until all the gases you want displayed on the right y-axis are in the *All Curves* list.

Events index card

25. Click on the Events index card.

26. Click in the desired check boxes to display the different event markers.
27. Press **OK** to save selections and exit the dialogue box.

Although the measurement data may be displayed on screen, you can change any of the parameters, including the averaging value, in the Window Properties dialogue when ever you please without losing any data in the process.

Chapter 9

Database Administration for PC Use

9.1 Introduction

The Database Administration program enables you to backup, restore and delete the databases you have stored on your hard disk. This chapter also explains how to export data, this is achieved using the Presentation program.

Note: database files **cannot** be copied or moved using Windows®95 Explorer. In order to copy and move files that will continue to work with the 1312PC Software, follow the instructions below.

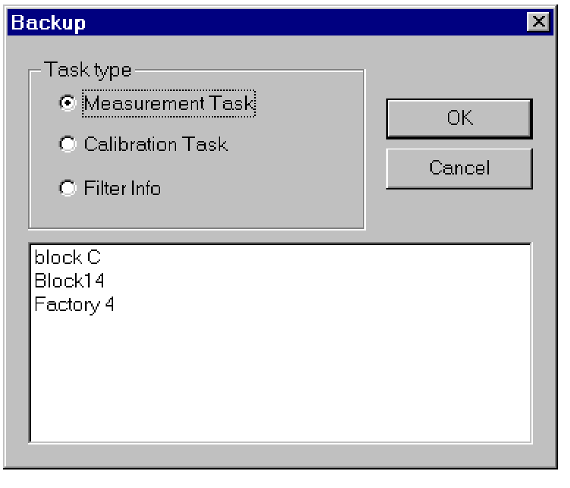
9.2 Backup Databases

This option enables you to make a backup copy of your existing databases. There are three types of files that can backed up here: Measurement Tasks; Calibration Tasks; and Filter Information.

With the Database Administration program running:

1. Click on **Backup** and the dialogue shown in Fig.9.1 is displayed.

Fig.9.1 The Backup dialogue



2. Click on the radio-button to select the type of data to be backed up.
3. Select the correct name from the list displayed and click on **OK**.
4. Now define the destination where the backup should stored and click on **OK**.

A copy of the selected database is now made. If you want to use this database again, use the Restore option.

9.3 Restore Databases

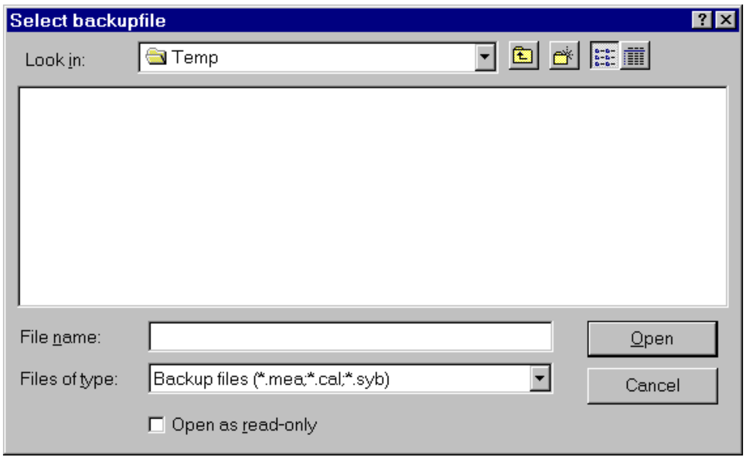
This option enables you to restore backup copies of databases, so that they may be used again in the 1312PC Software. All backup files, made using the Backup option, can be restored.

Restored databases can be restored as “read-only” files. This prevents you from adding additional measurement data to the database, or corrupting the existing data. This is of particular use when restoring Calibration databases that must not be changed.

With the Database Administration program running:

1. Click on **Restore** and the dialogue shown in Fig.9.2 is displayed.

Fig.9.2 The Select Backup File dialogue



2. Use the standard Windows®95 browser procedures to select the databases to be restored.
3. If you want to restore the database(s) as a read-only file(s), click in the Open as read-only check box.
4. Click on **Open**. The selected files are restored to the 1312PC Software working directory.

Click on **Cancel** to exit the Restore dialogue when all the desired databases have been restored.

9.4 Delete Databases

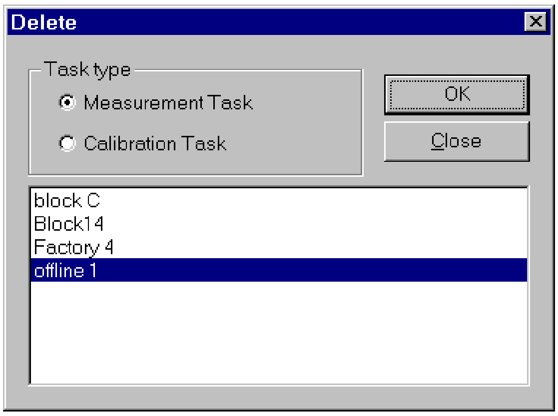
This option enables you delete measurement and calibration databases from the 1312PC Software working directory without disturbing the filter information.

Note: using Explorer to delete files may result in information in remaining databases being damaged or deleted by mistake.

With the Database Administration program running:

1. Click on **Delete** and the dialogue shown in Fig.9.3 is displayed.

Fig.9.3 The Delete dialogue



2. Click on the radio-button to select the type of data to be backed up.
3. Select the correct name from the list displayed and click on **OK**. A warning appears, to confirm that you do want to delete the selected database.
4. Confirm the deletion by clicking on **Yes**.

Click on Close to exit the Delete dialogue.

9.5 Export Databases

This option enables you to export existing databases as semicolon delimited ASCII files. The export function works from within the Presentation program. The database to be exported must be open.

Note: only the data displayed, either in a numeric or graphic window is exported.

With the desired data displayed, as described in section 8.8:

1. Pull down the **Task** menu and click on **Export**.
2. Use the standard Windows®95 browser, which appears on screen, to define thee destination for the exported data.
3. Type in the desired file name. All files have a .TXT extension.
4. Click on **Export**.

Chapter 10

Storage of Data in the 1312's Memory

In order to fully understand the functioning of the 1312 it is necessary to know something about the different types of memory the 1312 uses, the kind of data stored in each type of memory, and how this data is affected by the various operations performed by the 1312.

Offline users may find the information in this chapter of interest as their measurement data is stored in the 1312's memory before being uploaded to the PC. However, any mention of selecting or setting up **active** filters or filter banks in this chapter is not applicable as these are set-up or selected in the Offline Sequence Settings dialogue.

10.1 Types of Memory in the 1312

The 1312 has three types of memory:

1. A **R**ead **O**nly **M**emory (**ROM**);
2. An **E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory (**EEPROM**), which we have named the ***Source Memory***;
3. A **R**andom **A**ccess **M**emory (**RAM**) which we have named the ***Working Memory***.

10.1.1 Read Only Memory (ROM)

Data stored in this memory cannot be changed by the user. The **Optical Filter Factors**, which describe each of the optical filters which are available for installation in the 1312, are stored in this memory. These factors are listed in a print-out of the "Calibration Data Block" (see section 12.7).

When optical filters are installed in the carousel wheel, the 1312 must be informed about:

- **Which** filters have been installed in its carousel (UA numbers of the filters); and
- **Where** they have been installed (position "A"–"E" of the carousel — see section 12.3.3).

This information allows the 1312 to read the correct optical filter factors from its **ROM** memory when the filter is installed. As these factors are used in the calculation of calibration factors, it is **vitally important** that this information is correctly entered **before** calibration is performed.

10.1.2 Source Memory (EEPROM)

The data stored in ***Source Memory*** is not lost if A.C. mains power is removed from the 1312. There are three blocks of data in the ***Source Memory*** (see Fig 10.1):

Block 1 — contains calibration factors and 3 optical-filter parameters

Block 2 — contains 3 of the 6 set-up parameters found under the **Filters** branch of the set-up "tree"

Block 3 — contains all other parameters in the set-up "tree"

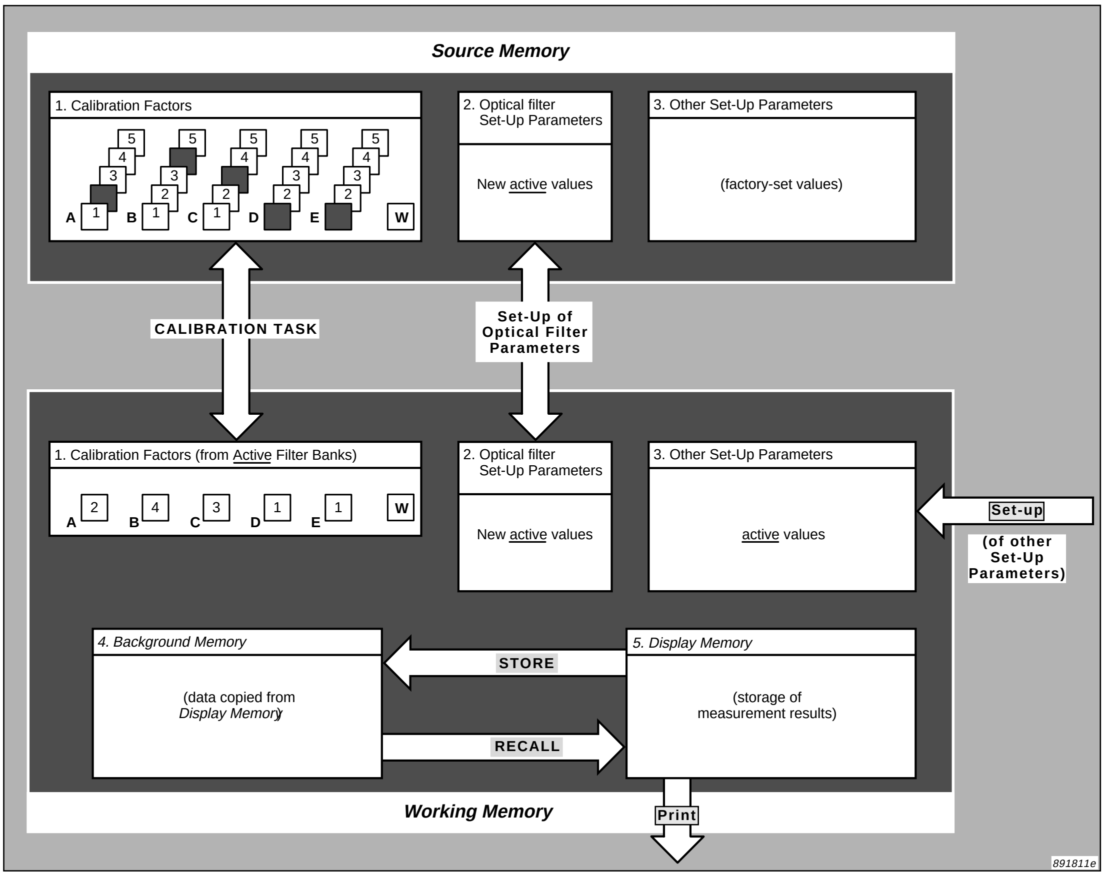
Block 1 — Calibration Factors and 3 Optical-filter Parameters:

There are six different "data files" in this block. Each data file is denoted by a letter which indicates the position a particular optical filter occupies in the 1312's carousel. Each file "A" to "E" is divided into **five** sections called **Filter Banks**, which are numbered from 1 to 5. The water-vapour filter is only capable of measuring water-vapour and therefore its data file ("W") is not divided into different filter banks.

Each **Filter Bank** contains the following data:

1. The name of the gas used during span calibration of the filter.
2. The molecular weight of the gas used during span calibration.
3. The alarm limit for the gas.
4. A **Concentration offset factor**: obtained during zero-point calibration of the filter.
5. A **Humidity gain factor**: obtained during an humidity-interference calibration of the filter.
6. A **Conversion factor**: obtained during the span calibration of the filter with the gas named in point 1 above.
7. **Cross-interference calibration factors** — obtained during cross-interference calibration.

Fig.10.1 Schematic diagram showing the structure of the 1312's memory



Before calibrating a particular filter, one of the filter's banks is made **active** (by operating the 1312 in **Set-Up mode** and "entering" the chosen filter-bank number for the filter being calibrated). The filter bank no. which is made **active** before the filter is calibrated, is the filter bank where the 1312 will store calibration factors calculated during calibration. This means that the user is able to calibrate any particular optical filter to measure up to **five** different gases.

If a particular filter is to measure more than **one** gas, it is therefore necessary to **span** calibrate it with each of the gases it is to measure. For example, if you refer to the "**Gas Detection Limits**" wall chart you will see that the filter UA 0976 can be used to measure the following three gases:

1. Sulphur hexafluoride
2. Acetic acid
3. Vinyl chloride

Suppose that filter UA 0976 is installed in position "A" of the filter carousel to measure each of the above gases. Before this filter is calibrated, the 1312 has to be told where to store the calibration factors which are calculated during the calibration procedure. This is done by selecting a FILTER BANK NO. — in the **active** set-up for Filter A each time the filter is calibrated. For example, Filter Bank No."1" for storage of the calibration factors for sulphur hexafluoride, Filter Bank No."2" for acetic acid and Filter Bank No."3" for vinyl chloride.

After calibration of the filter UA 0976 the 1312 is able to accurately monitor any of the three gases mentioned — but only **one** of these gases during any particular monitoring task. By selecting the correct FILTER BANK NO. in the set-up of the 1312 before a monitoring task is started, the user determines which calibration factors will be used during the task and therefore the kind of gas monitored by filter A. For example, when Filter Bank No."3" is entered in the **active** set-up for filter UA 0976 in position "A", the 1312 reads the calibration factors from file "A3" into its ***Working Memory*** so that the concentration of vinyl chloride can be calculated during the monitoring task.

Block 2 — Optical Filter Set-up Parameters:

This block contains 3 of the 6 the parameters which describe the optical filter installed in each position of the filter carousel:

UA number of the filter;

Filter bank number;

S.I.T. information;

If any of the above-listed parameters are changed in the **active** set-up they are also automatically changed in the ***Source Memory***.

Block 3 — Other Set-Up Parameters:

This block of data contains all set-up parameters except the optical filter parameters. Before leaving the factory the parameters in this block are given factory-set values. These are the values obtained for a parameter when the **Default** button is pressed.

10.1.3 Working Memory (RAM:

The ***Working Memory*** is a "volatile" memory, that is, data will be lost from it if electric power is removed from the 1312. When the 1312 is not connected to a mains power supply a lithium battery in the 1312 provides a back-up power supply to protect the data in this memory. When this battery is no longer providing enough power a warning BACK-UP BATTERY TOO LOW will appear on the 1312's display to indicate that the battery needs to be replaced by a new one.

There are four different blocks of data in the ***Working Memory*** (see Fig. 11.1):

Block 1 — contains only calibration factors and 3 optical-filter parameters from each of the **active** "Filter Banks"

Block 2 — contains 2 of the 5 optical filter parameters with values which are the same as those found in Block 2 of the ***Source Memory***.

Block 3 — contains all other set-up parameters (i.e. excluding the optical filter parameters) with **active** set-up values.

Block 4 — this block contains measurement data which was copied into it from the *Display Memory*. This block is called *Background Memory* because the data stored in it cannot be **accidentally** deleted.

Block 5 — contains data collected during the performance of a monitoring task. This data block is named the *Display Memory* because this data is displayed on the 1312's screen while a monitoring task is being performed.

Block 1 — Calibration Factors and 3 Optical-filter Parameters from Each Active Filter Bank:

If, for example, 5 optical filters are installed in the 1312 and their UA numbers have been entered in the **active** set-up and Filter Bank No. 2 has been selected for filter "A"; no. 4 for filter "B"; no. 3 for filter "C"; no. 1 for filter "D" and no. 1 for filter "E", then only calibration factors from filter banks A 2, B 4, C 3, D 1, E 1 and W will be stored in this block of data (see Fig. 11.1). The name, molecular weight and alarm limit of each gas will also be stored in this block.

Block 2 — Optical Filter Set-up Parameters:

Whenever either an optical filter's UA number or its **active** Filter Bank Number is changed, the same values are automatically read into Block 2 of the ***Source Memory***.

Block 3 — Other Set-up Parameters:

The **active** set-up values are those values which are underlined by a cursor on the display screen of the 1312 when it is operated in **Set-Up** mode.

Block 5 — Measurement Data:

Whenever the 1312 performs any operation which results in data occupying the *Display Memory*, the data already stored there will be deleted. To reduce the risk of accidental losing data from *Display Memory*, a warning **"WARNING: DISPLAY MEMORY WILL BE DELETED"** is displayed whenever a user attempts to perform an operation with the 1312 which will result in the deletion of data from *Display Memory*.

Data in *Display Memory* can be copied into the 1312's *Background Memory* (see Block 4 below) to protect it against accidental deletion. Alternatively, the data in *Display Memory* can be printed out by connecting a printer to the 1312 and transmitting data via either the IEEE 488 or the RS 232 interface port of the 1312 (see Chapter 12).

The storage space in *Display Memory* is finite. Once this memory has been filled by data from a monitoring task any additional data collected will start to overwrite some of the data already stored there.

Block 4 — Stored Measurement Data

By selecting to **STORE** data when the 1312 is operating in **Memory** mode the user can copy data from *Display Memory* into *Background Memory* to "protect" data against accidental deletion from the *Display Memory* (see section 10.3.1 for further details).

The storage space in *Background Memory* is finite and is exactly the same size as the storage space available in *Display Memory* (see section 9.3 for further details).

Data which has been stored in *Background Memory* can be recalled to the *Display Memory*. This is done by operating the 1312 in **Memory** mode and selecting to

RECALL data (see Section 11.3.2). When data is "recalled" to *Display Memory* it is not **transferred** from *Background Memory* to *Display Memory*, it is only **copied** into *Display Memory* so there is no risk of losing it. In *Display Memory* the user can scroll through the data.

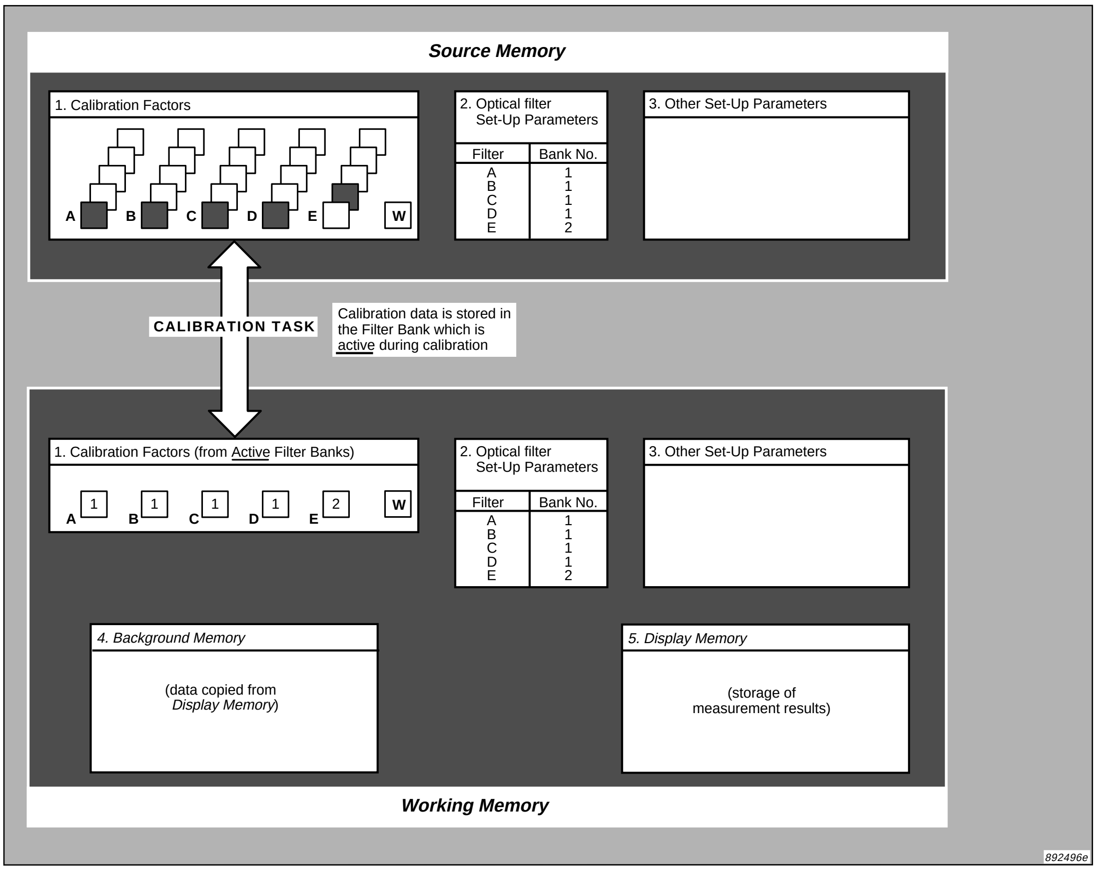
Data stored in *Background Memory* can be deleted by operating the 1312 in Memory **mode** and selecting to **DELETE** data (see section 10.3.3).

10.1.4 Effect of a Calibration Task on the 1312's Memory

Before calibration of the optical filters in the 1312 the UA numbers of each of the installed filters is "entered" into the **active** set-up of the 1312. This enables the 1312 to find a set of numerical parameters which describe each numbered optical filter (this information is found in the **R**ead **O**nly **M**emory of the 1312). These numerical parameters are called Optical Filter Factors.

During a **CALIBRATION TASK** the 1312 uses these Optical Filter Factors to calculate the calibration factors for each installed optical filter. As explained in section 10.1.2, by "entering" a Filter Bank No. in the **active** set-up before calibration of any particular filter with any particular gas, each filter can be calibrated to measure up to five different gases and the filter bank number tells the 1312 exactly where (in the ***Source Memory***) to store the calibration factors calculated during the calibration task.

Fig.10.2 The state of the Source Memory after completion of a **CALIBRATION TASK**



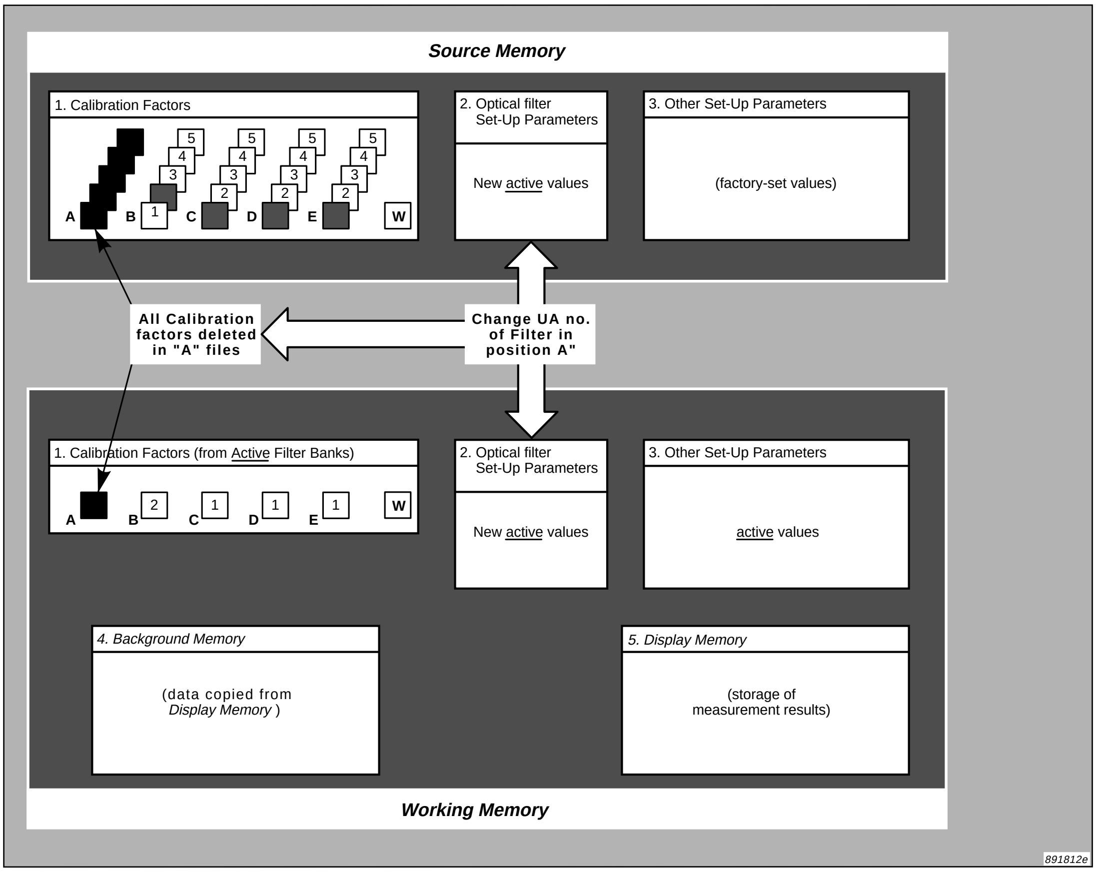
After completion of a calibration task the calibration factors which are found in the ***Working Memory*** are entirely dependent upon the Filter Bank No. which is **active** for each optical filter. If Filter Bank No. 1 is **active** for filters in positions "A" to "D" and Filter Bank No. 2 is **active** for the filter in position "E" then calibration factors from files A 1, B 1, C 1, D 1, E 2 and W will be found in ***Working Memory*** (see Fig 10.2).

10.1.5 Effect of Changing the UA number in the "Active" Set-up

WARNING!: *Changing the UA number of a filter in the 1312's active set-up will destroy all calibration data for the filter.*

As explained in section 10.1.1, the UA no. determines the set of Optical Filter Factors used during the calculation of calibration factors and therefore, if the UA number of any filter is changed in the **active** set-up of the 1312, all calibration data related to the optical filter whose number has been removed from the set-up is **automatically** deleted from both the ***Source Memory*** and the ***Working Memory*** as it is no longer valid.

*Fig.10.3 Effect of changing a UA number in the **"active" set-up***



For example, if the UA number of the filter installed in position "A" of the filter carousel is changed in the **active** set-up then calibration factors are deleted from the **active** file "A" in the ***Working Memory*** and from files A 1, A 2, A 3, A 4 and A 5 in the ***Source Memory*** of the 1312 (see Fig.10.3). The 1312 will not be able to measure any gas with filter "A" until it has been fully calibrated, see Chapter 12 for details.

10.1.6 Effect of a Full Reset on the 1312's Memory

A **FULL RESET** of the 1312 changes the data stored in its ***Working Memory*** as follows:

1. All data stored in *Display Memory* and *Background Memory* is deleted.
2. Values of the Optical Filter Set-up Parameters in Block 2 of the ***Source Memo-***

ry are copied into Block 2 of the ***Working Memory***.

3. The **active** values of the Other set-up parameters in Block 3 of the ***Working Memory*** are replaced by the factory-set values defined in Block 3 of the ***Source Memory***.

4. The **active** values of the Optical Filter Parameters in Block 2 of the ***Working Memory*** are replaced by the values of the optical filter parameters in Block 2 of the ***Source Memory***. Note that under normal circumstances the data in these blocks is the same. However, to ensure that the data in these blocks **is** the same, data is read from ***Source Memory*** into the ***Working Memory*** during a FULL RESET of the 1312.

5. Those Filter Bank Nos. which have been made **active** determine the calibration factors which will be found in Block 1 of ***Working Memory*** after a FULL RESET of the 1312. If, for example the **active** Filter Bank No. chosen for all the filters "A" to "E" is no. 1, then only the calibration data in files A 1; B 1; C 1; D 1; E 1 and W will be found in the 1312's ***Working Memory*** after a FULL RESET. This example is illustrated in Fig 10.4.

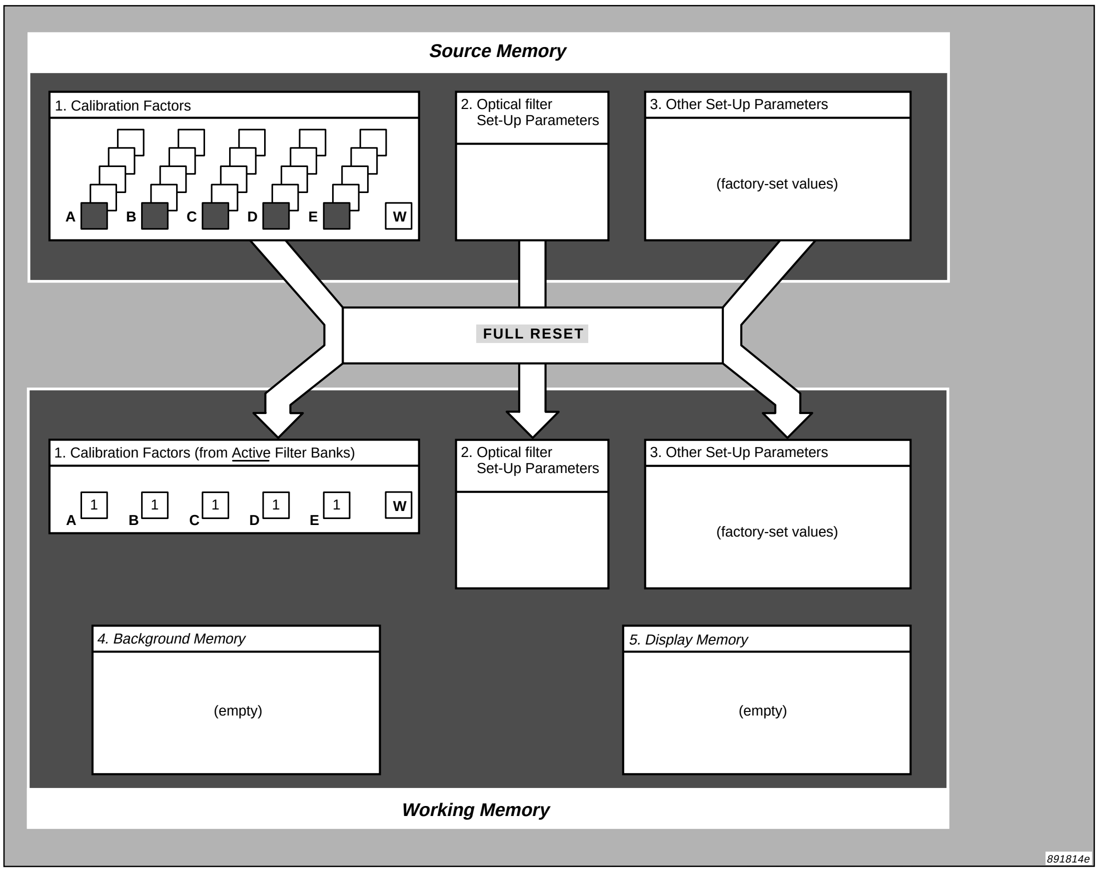


Fig.10.4 The state of the Working Memory after a FULL RESET

10.2 Storage of Measurement Results

While a monitoring task is being performed measurement data is stored in the 1312's *Display Memory*. When the monitoring task is complete the data in *Display Memory* is normally copied into the 1312's *Background Memory* to prevent it from being overwritten (and therefore lost) by measurement data stored during the next monitoring task. The same amount of data can be stored in both the *Background Memory* and the *Display Memory*.

Structure of the Background Memory

The data from a maximum of 10 monitoring tasks can be stored in the *Background Memory* provided the total amount of data from the 10 tasks does not exceed the total capacity of the *Background Memory*. Each monitoring task stored in the *Background Memory* is given a "location number" (from no. 1 to no. 10). The size of each location is flexible and is equal to the space required to store all the data collected during a monitoring task.

If data from a single monitoring task totally occupies the *Display Memory*, then this data can be stored in *Background Memory* provided that no data is already stored there. The data will occupy only one location of *Background Memory* and fill all available storage space. Therefore, it will not be possible to store any data from any new monitoring task in *Background Memory* unless the data already stored there is first deleted (see section 10.3.3).

To illustrate the variable size of each location let us suppose that the following monitoring tasks are performed:

Task No. 1: The data collected in *Display Memory* occupies 20% of the total capacity of the *Display Memory*. The data can be stored in *Background Memory* provided that the data already stored there occupies less than 80% of the total capacity of the *Background Memory*. However, let us suppose that the *Background Memory* is empty and that we **STORE** the data from this monitoring task in location 1 of *Background Memory*. This means that *Background Memory* is now 20% full (see Fig 10.5).

Task No. 2: The collected data occupies 30% of the total capacity of the *Display Memory*. Let us suppose that we **STORE** the data in location 2 of *Background Memory*. This means that *Background Memory* is now 50% full (see Fig 10.5).

Task No. 3: The data occupies 40% of the total capacity of the *Display Memory*. Let us suppose that we **STORE** the data from this task in location 3 of *Background Memory*. *Background Memory* is now 90% full (see Fig 10.5).

Task No. 4: The data occupies 10% of the total capacity of the *Display Memory*. Let us suppose that we **STORE** the data from this task in the

Background Memory — let us say it is stored in location 4. *Background Memory* is now 100% full (see Fig 10.5).

The *Background Memory* has now been filled-up by the data from the four monitoring tasks described above, even though location nos. 5 - 10 (inclusive) have not been used. The user will not be able to **STORE** any more data in *Background Memory* because there is no space available for it. Data in *Background Memory* can, however, be deleted to make space for the storage of new measurement results (see section 10.3.3).

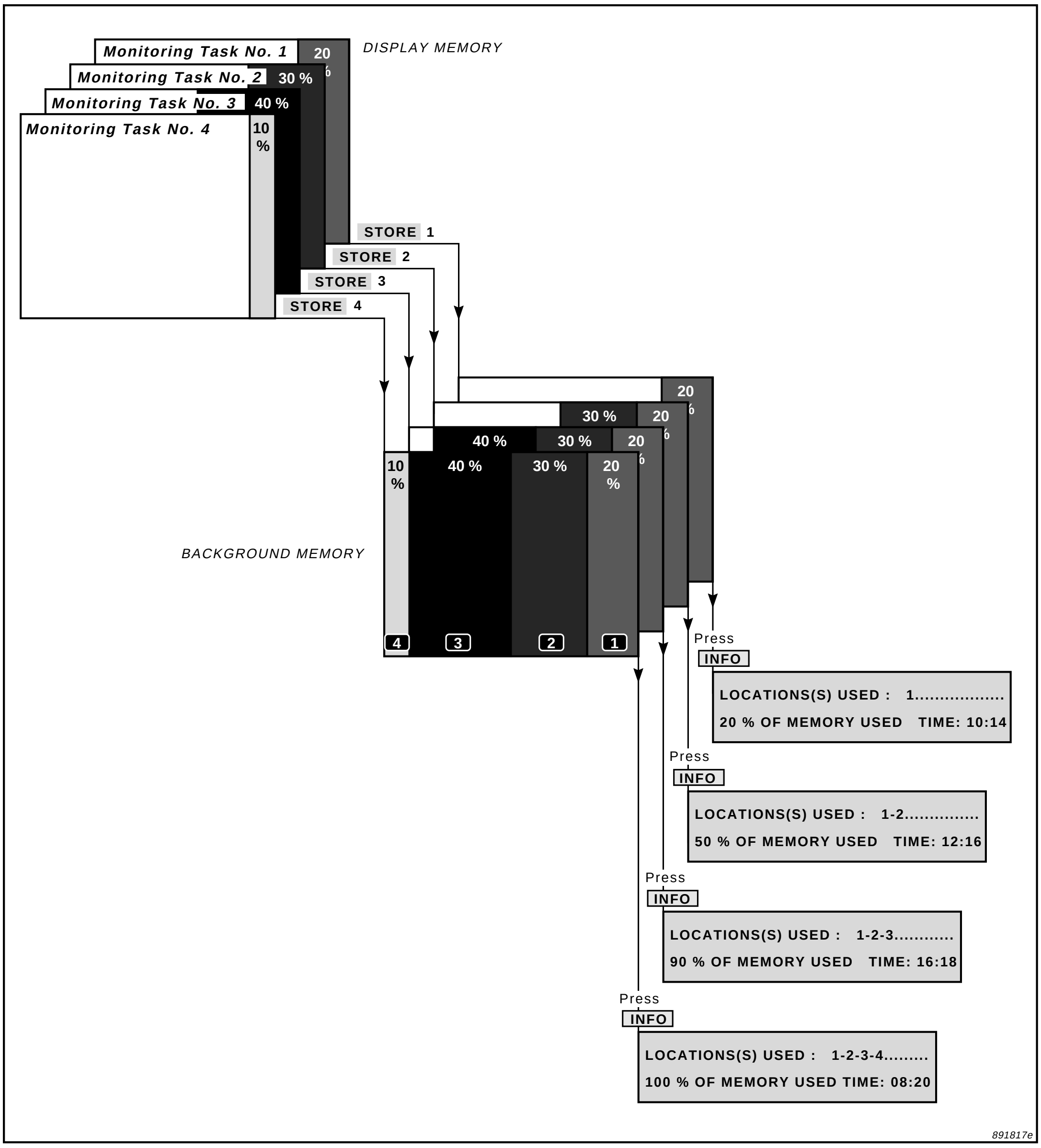


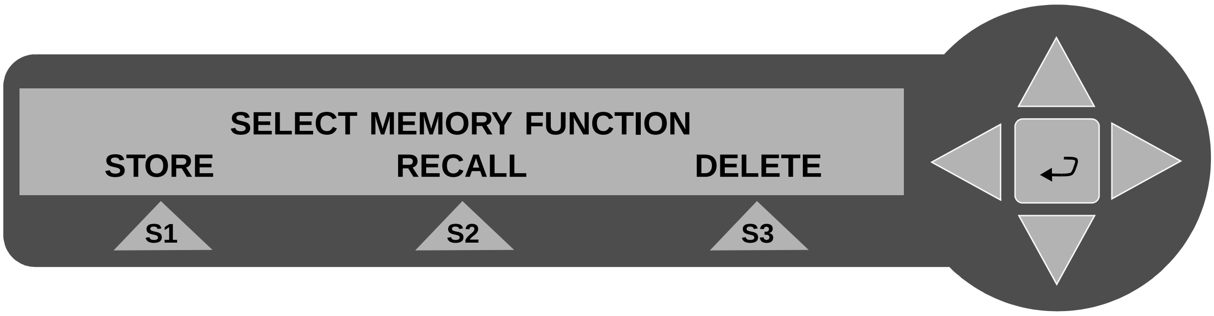
Fig.10.5 Storing data from 4 different consecutive measurement tasks in the Background Memory

Whenever the 1312 is operating in Memory **mode** the user can, by pressing the

INFO push-button, find out what percentage of the *Background Memory* is occupied and which location numbers have been used to store data. Fig 10.5 illustrates the status information one can obtain from the 1312 during various stages of the four monitoring tasks described above. Further information about the INFO push-button can be found in section 10.3.4.

10.3 Management of Data in Background Memory

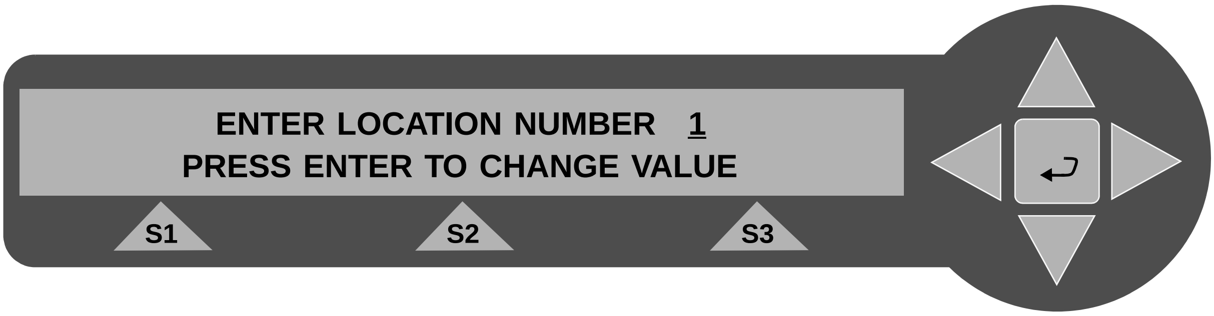
The 1312 has to be operated in Memory **mode** by pressing the MEMORY push-button. The following text appears on the screen:



10.3.1 Storing Data in Background Memory

When data is to be copied from *Display Memory* into *Background Memory*:

Press S1

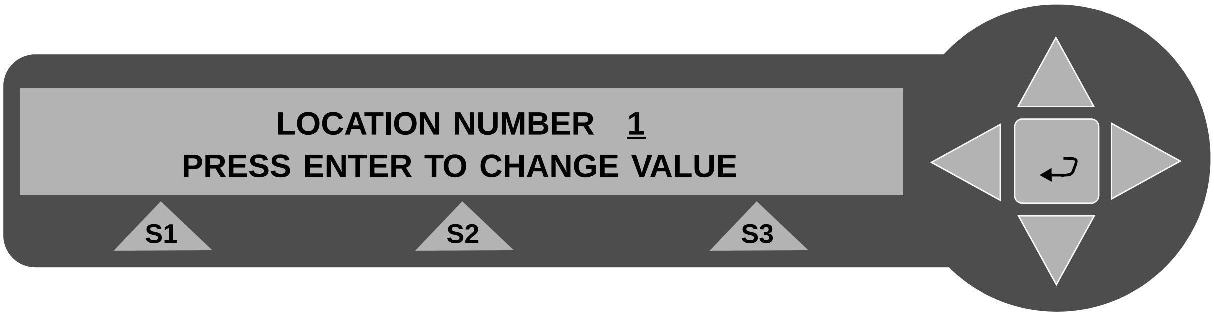


If some data has already been stored in the *Background Memory* and you cannot remember which locations have been occupied (used), press the INFO push-button to find out which locations are occupied and what percentage of the *Background Memory* has been used (see section 10.3.4). Use the direction to select the desired location number. When the chosen location number is on the screen, press **S2** to accept the position.

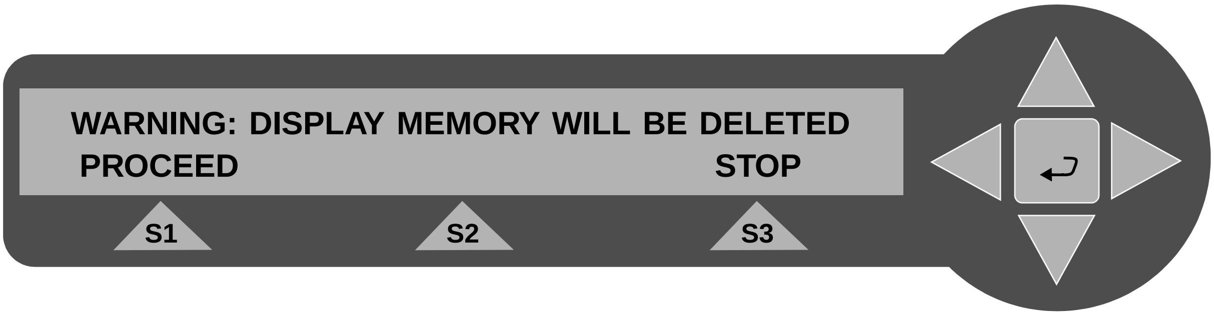
10.3.2 Recalling Data from Background Memory

To recall data stored in *Background Memory* to *Display Memory*:

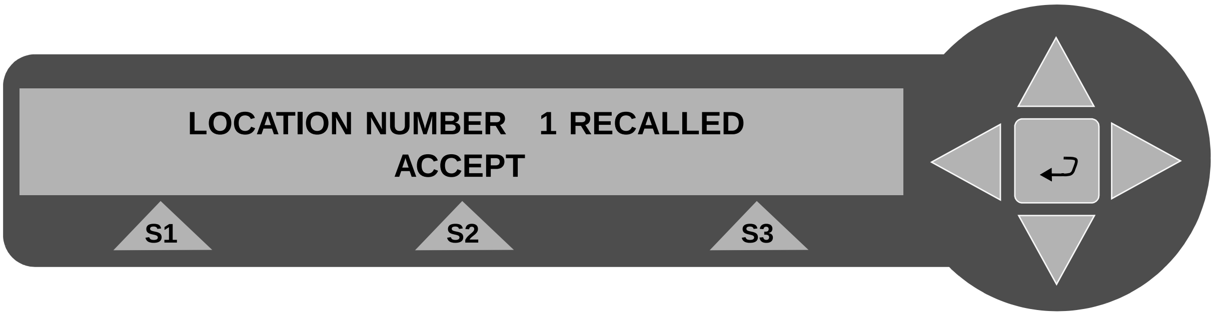
1. Press **Memory** **S2**



2. Use the direction keys to select the correct location number. The following text is displayed



3. If you want to continue, press **S1**, and the following text is displayed.



   If you want to Stop, press **S3**, this returns you to the original display showing **SELECT MEMORY FUNCTION** so that you can **STORE** any data which is stored in *Display Memory* as explained in section 10.3.1.

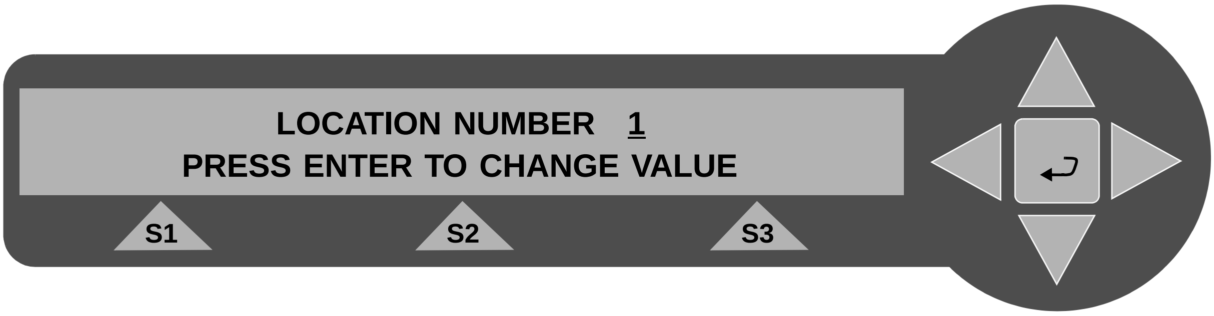
4. Press **S2**. If data has not been stored in the chosen location, a message will appear on the 1312's display to inform the user. Otherwise, the data from the

chosen location in *Background Memory* will be copied into *Display Memory*.

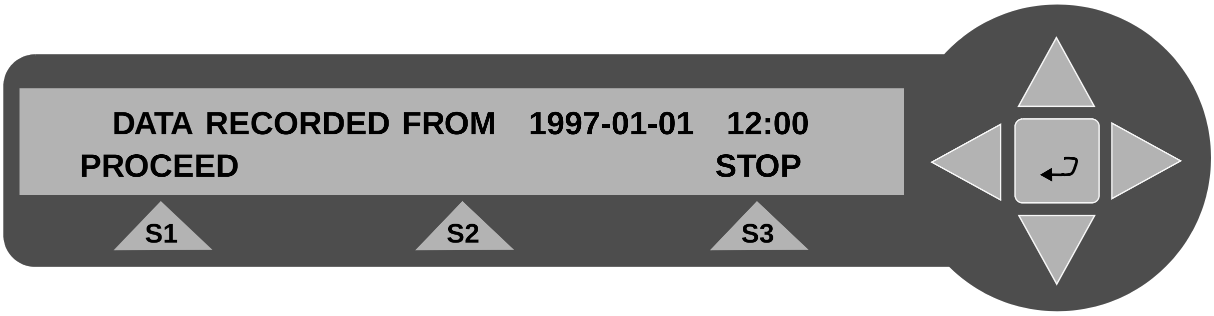
10.3.3 Deleting Data from Background Memory

To delete data which has been stored in *Background Memory*:

Press MEMORY S3



Use the direction keys to select the location number. After selecting the chosen location number the display will show the starting-time of the oldest data stored in the *Background Memory*:

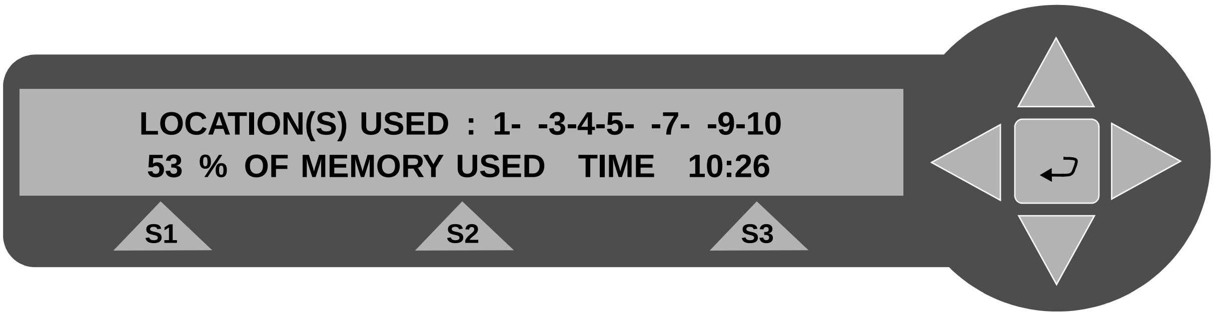


If the starting-time of the oldest stored data to be deleted corresponds with the starting-time shown on the display screen then press S1 and then S2 to accept that the data will be deleted from *Background Memory*.

10.3.4 Obtaining Information in Memory Mode

It is not necessary for the user to remember the numbers of the locations in *Background Memory* which have been used to store data. When the 1312 is operated in Memory **mode**, users can at any time find out which locations are used, and what percentage of the *Background Memory's* total data capacity has been used by:

Pressing the INFO push-button:



The numbers appearing on the above display are those which contain stored data. The 1312 will show the above "Information text" display for a short period of time and then automatically change back to the text which was showing on the display before the INFO push-button was pressed.

Chapter 11

Maintenance of the 1312

The only regular maintenance required for the 1312 is:

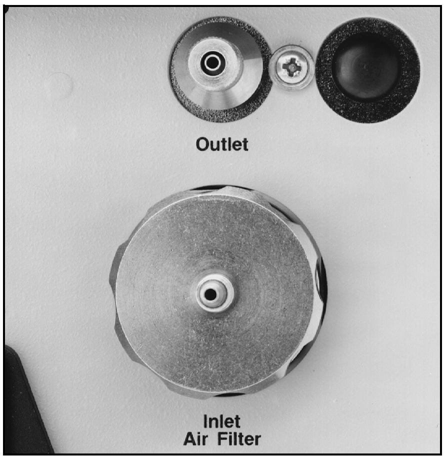
- Calibration — approximately every 3 months (see Chapter 12)
- Changing the fine air-filter paper in the internal and external air-filtration units (see section 11.1)
- Cleaning of the filter in the ventilation unit (see section 11.2).

11.1 Changing the Fine Air-filters

The monitor is equipped with both an ***internal*** and an ***external*** air-filtration unit.

The ***internal*** unit is mounted on the air-inlet, on the back panel. This is shown in Fig 11.1.

Fig.11.1 The internal air-filtration unit mounted on the back panel of the monitor



The internal air-filtration unit can be removed simply by unscrewing the unit by hand. The unit is shown in Fig 11.2.

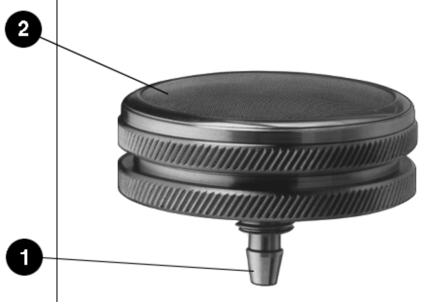
Fig.11.2 The internal air-filtration unit

Inside the unit, a fine (10µm) filter-paper removes fine dust particles and other suspended matter from air samples before they reach the measurement chamber of the monitor.

Whenever the monitor needs to be calibrated, we recommend that the fine filter-paper in the internal air-filtration unit is changed **before** you calibrate. The fine filter-paper in the internal air-filtration unit must be changed at least twice a year; and more frequently if the environment in which the monitor is working contains large quantities of particulate material suspended in the air.

When the monitor is making measurements, we recommend that a length of Teflon® tubing (of up to 50 metres in length) is always attached to the stub of the air-inlet (see Fig 11.1) and that the special *external* air-filtration unit UD 5023, shown in Fig 11.3, is always attached to the free-end of the sampling tube, by means of the small stub ❶. An external coarse metal air-filter ❷ prevents large particles, insects etc. being drawn into the unit, while inside the unit is a fine (10µm) filter-paper, which prevents any finer particles from entering the Teflon® sampling tube. The fine filter-paper in this unit must **also** be changed regularly — at least as frequently as the fine filter-paper in the internal fine air-filter.

Fig. 11.3 The external air-filtration unit UD 5023 used with the analyzer



Changing the fine filter-paper in both the internal and external air-filtration units is explained step by step in the following two sub-sections.

11.1.1 Changing the Filter-paper in the Internal Air-filtration Unit

While you do this, we recommend that you wear clean, rubber gloves.

Tools and equipment required:

- Acetone (analytically pure)
- Spare fine filter-paper DS 0759
- Teflon®-coated tweezers QA 0164
- Cotton buds
- Clean rubber gloves

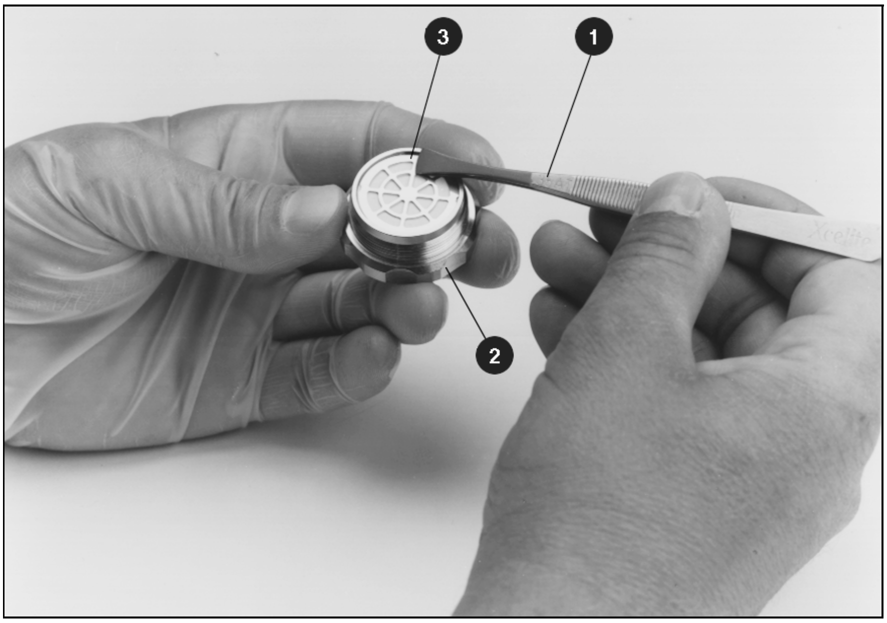
To change the filter-paper:

1. Switch the power to the monitor “Off” by using the AC mains power switch on its back panel (press O), and then pull out the plug connecting the monitor to the AC mains power supply.
2. Put a rubber glove on the hand which is to hold the parts of the unit.
3. Unscrew the internal air-filtration unit from its mounting on the air-inlet, see Fig 11.1. To do this, turn the unit anti-clockwise with your fingers until the unit is free of the slot.

   The unit is removed from the monitor. It is shown in Fig 11.2.
4. Use the Teflon®-coated tweezers ❶ to lift off the retaining disc ❸ and used

filter-paper, while holding the handle of the unit ❷ between your thumb and fingers. Refer to Fig 11.4. The retaining disc has two tabs which “lock” it to the filtration unit.

Fig.11.4 Removing the retaining disc and old filter-paper

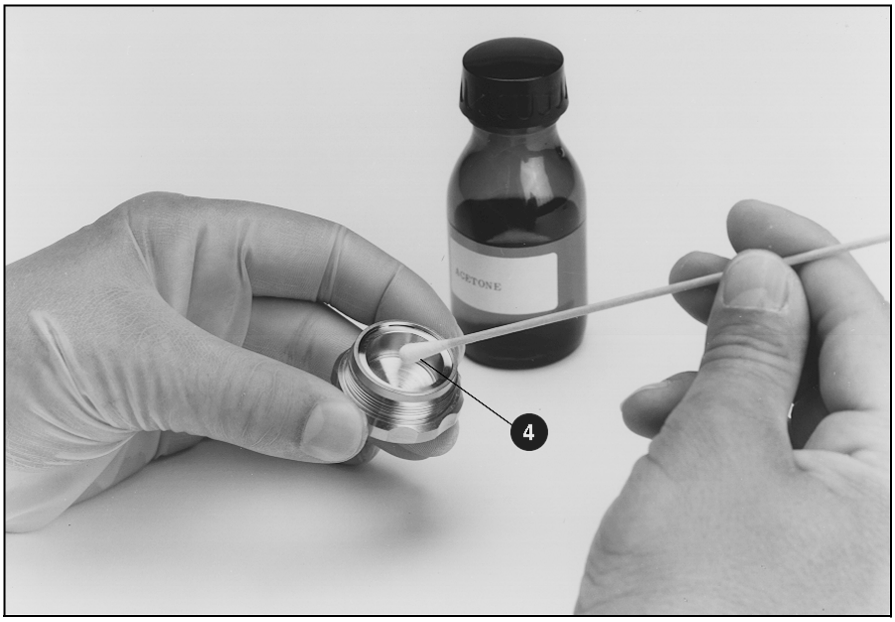


5. Use the tweezers to remove the used filter-paper from the retaining disc.
6. Holding the disc with the tweezers, moisten a cotton bud with pure acetone and use it to clean the surfaces of the disc. Place the disc on a clean, dry surface

   ***Caution*:** Make sure that no cotton fibres remain on the mesh of the retaining disc otherwise they could be sucked up into, and block, the measurement system when the analyzer is operated.

7. Hold the handle-end of the unit between your thumb and fingers. Moisten a cotton bud with pure acetone and use it to clean the surfaces of the unit ❹. Refer to Fig 11.5. Place the unit, with its handle-end downwards, on a clean, dry surface.

Fig.11.5 Cleaning the surfaces of the internal air-filtration unit

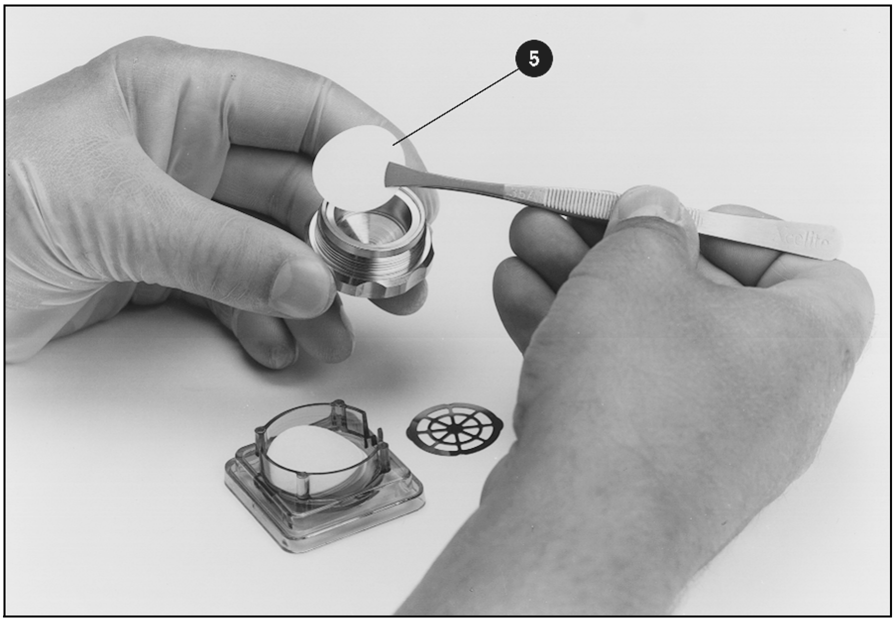


Notes:

- Only proceed to the next step when the acetone has completely evaporated from the air-filter retaining disc and filtration unit.
- Each of the fine filter-papers DS0759 are packed between two pieces of packing paper. The fine filter-paper is always white in colour.

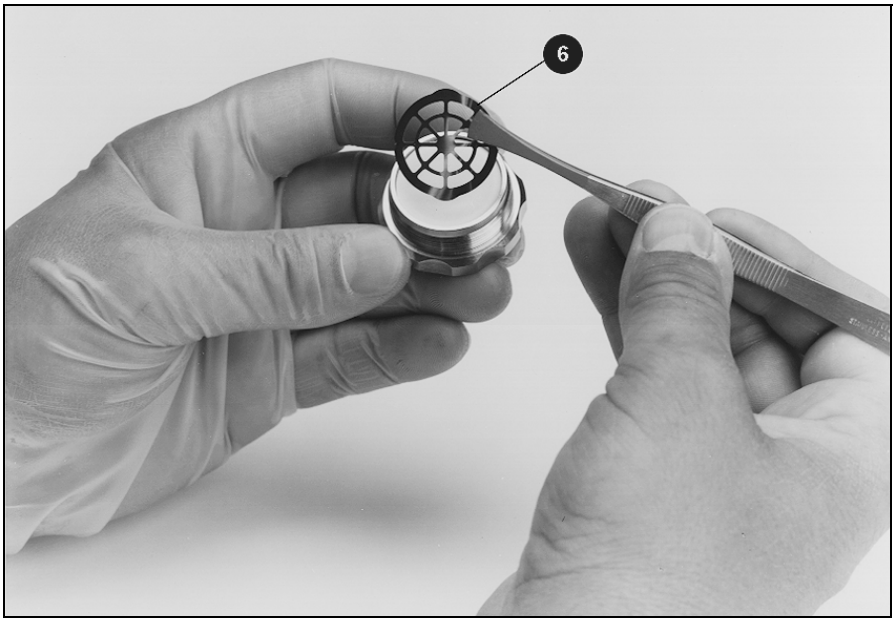
8. Remove a new fine filter-paper from its packaging using the tweezers. Hold it by its edge ❺. Refer to Fig 11.6. Lift the filter up and place it inside the unit.

Fig.11.6 Placing a new filter-paper in the unit



9. Holding the handle-end of the unit between your thumb and fingers, pick up the (dry) retaining disc ❻ and place it over the new filter-paper. Refer to Fig 11.7. Gently press the disc down over the filter-paper, making sure that the disc's locking tabs fit properly into the groove in the unit and that the filter-paper stays in position and is not damaged in any way.
10. Holding the handle-end of the re-assembled unit between your thumb and fingers, place it back into position in the air-inlet of the analyzer. Screw it back into its mounting. To do this, turn the unit clockwise with your fingers to tighten until it is firmly in position.

Fig. 11.7 Refitting the retaining disc



11.1.2 Changing the Filter-paper in the External Air-filtration Unit

While you do this, we recommend that you wear clean, rubber gloves.

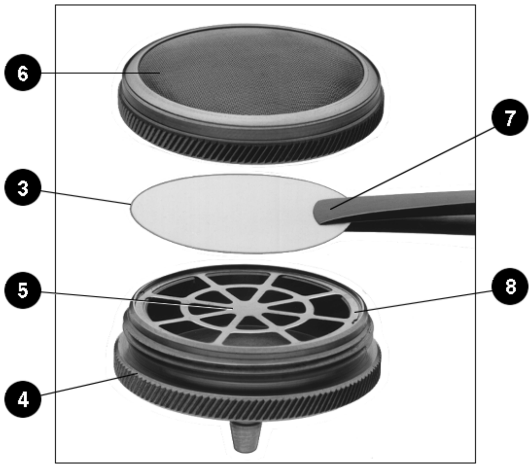
Tools and Equipment Required:

- Acetone (analytically pure)
- Spare fine filter-paper DS 0759
- Teflon-coated tweezers QA 0164
- Cotton buds
- Clean, rubber gloves

To change the filter-paper:

1. Switch off the monitor.
2. Put a rubber glove on the hand which is to hold the parts of the unit.
3. Pull the external fine air-filtration unit off the end of the Teflon® sampling tube. Hold the stub-end ❶ of the external air-filter unit between your thumb and fingers, and unscrew the coarse air filter ❷ from the end of the unit. Refer to Fig 11.3.
4. Remove the used (old) filter-paper ❸ and the retaining disc ❺ from the unit using the tweezers. Refer to Fig 11.8.

Fig. 11.8 The parts of the external air-filtration unit UD 5023



5. Moisten a cotton bud with pure acetone and use it to clean the surfaces of the unit ❹, the retaining disc ❺ and the coarse air-filter ❻. Refer to Fig 11.8. Place the stub-end of the unit downwards, on a clean, dry surface; the coarse air-filter, with its screw-end downwards on a clean, dry surface and rest the retaining disc against it.

   Caution: Make sure that no cotton fibres remain on the mesh of the retaining disc otherwise they could be sucked up into, and block, the measurement system when the analyzer is operated.

   Notes:

   - Only proceed to the next step when the acetone has completely evaporated from the cleaned surfaces.
   - Each of the fine filter-papers DS 0759 are packed between two pieces of packing paper. The fine filter-paper is always white in colour.

6. Hold the stub-end of the unit between your thumb and fingers. Lift the retaining disc ❺ with the tweezers and place it back into position in the unit. Refer to Fig 11.8.

7. Remove a new fine filter-paper from its packaging using the tweezers. Hold it by its edge ❼. Carefully place the filter-paper over the top of the retaining disc so that it is held in position by the small "lip" ❽ on the rim of the unit.
8. Screw the coarse air-filter over the end of the external air-filtration unit. Make sure that the fine filter-paper remains in its correct position directly over the retaining disc.

11.2 Cleaning the Filter in the Ventilation Unit

A small ventilation unit is mounted on the back panel of the 1312 (see ❶ in Fig 11.9). The ventilating fan in this unit circulates air through the 1312 to keep it cool. To ensure that the air being drawn into the 1312 is free of particles a filter pad is placed between the fan and grid which covers it. This filter needs to be periodically taken out and cleaned. We recommend that this task is done at least as often as calibration, and more frequently if the 1312 is working in a very dusty atmosphere or an atmosphere containing high concentrations of other particulate matter.

1. Use a "pozidrive" screwdriver to unscrew the two screws on the grid cover.
2. Remove the filter pad from inside the grid cover. Wash the filter pad in warm water containing some liquid soap. Rinse all the soap out of the filter, by running clean water through it, and let it dry **thoroughly**.
3. Place the clean, thoroughly dry, filter pad inside the grid cover. Screw the grid cover firmly back in place over the ventilation unit.

Fig.11.9 Back panel of the 1312 showing the ventilation unit

Chapter 12

Calibration of the Optical Filters

12.1 About the Installed Optical Filters

In collaboration with *INNOVA* Sales Engineers, you have chosen the optical filters that are best suited to your measuring task. Each of these optical filters has been installed in one of the positions marked “A”, “B”,“C”, “D”, or “E” of the filter carousel wheel in your 1312. A special optical filter, which is only selective to water vapour, is always installed in position “W”. Before leaving the factory, the optical filters are either partially or fully calibrated and then a **span check** is performed on each of the installed optical filters to check that the 1312 is functioning properly. The gas used during this **span check** is not named, it is given the name “Gas UA 09xx” where 09xx is the number of the UA filter being checked.

Note: a **span check** is not the same as a **span calibration**. Each optical filter has to be **span calibrated** with the gas it is to measure. If this **span calibration** is not performed the 1312 is unable to measure accurately.

Each filter in the carousel has to be **fully** calibrated before the 1312 can perform accurate gas measurements. The practical calibration procedure is fairly simple, it involves performing measurements with the 1312 while various gas supplies are attached to its air-inlet.

A **full** calibration of the water-vapour filter SB 0257 involves:

- **Zero-point calibration** (using a zero-gas*)
- **Span calibration** (using a known concentration of water vapour)

A **full** calibration of the optical filters in positions “A” to “E” involves:

- **Zero-point calibration** (using a zero-gas*)
- **Humidity-interference calibration** (using water-vapour)
- **Span calibration** (using a known concentration of the gas this filter is to measure)
- **Cross-interference calibration** (when this is necessary). If the gas to be measured by filter “A” actually absorbs light from any of the other installed optical filters it will interfere with the signal measured when the other optical filters are used. If this is the case, it is necessary to perform a cross-compensation calibration of this filter. This involves taking measurements with all the other installed optical filters while the span calibration is performed.

The following sections explain what a calibration is and why it is necessary. Some of the expressions used in this chapter are also explained, to help you understand the process.

* A zero-gas is a gas which does not absorb infra-red light, e.g. pure nitrogen

12.2 What is Calibration and Why is it Necessary?

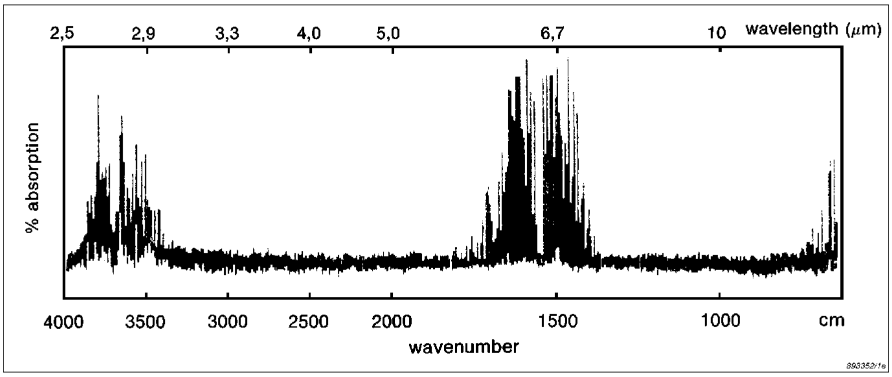
In order to understand calibration, it is necessary to look at what happens inside the analysis cell during a gas concentration measurement. A sample of air is drawn into the cell. The cell is then sealed off and light is sent from the infra-red source via a chopper (to pulsate it) through an optical filter. The optical filter only transmits light in a defined wavelength range and this light enters the cell.

If there is a gas in the cell which absorbs light of this wavelength, a pressure wave is created and this is measured by the microphones mounted within the cell. The greater the concentration of the absorbing gas in the cell the greater the pressure (sound) wave it creates.

How do we measure the relationship between the measured sound signal and the concentration of the absorbing gas in the cell? We calibrate the optical filter.

Our description of what happens in the cell is, however, a little too simplified. In reality, we have to take three other factors into consideration: namely: (1) cell noise; (2) the presence of water vapour in the sample (humidity interference); and (3) the possible presence of other interferent gases.

Fig.12.1 High resolution absorption spectrum of water vapour



Cell Noise

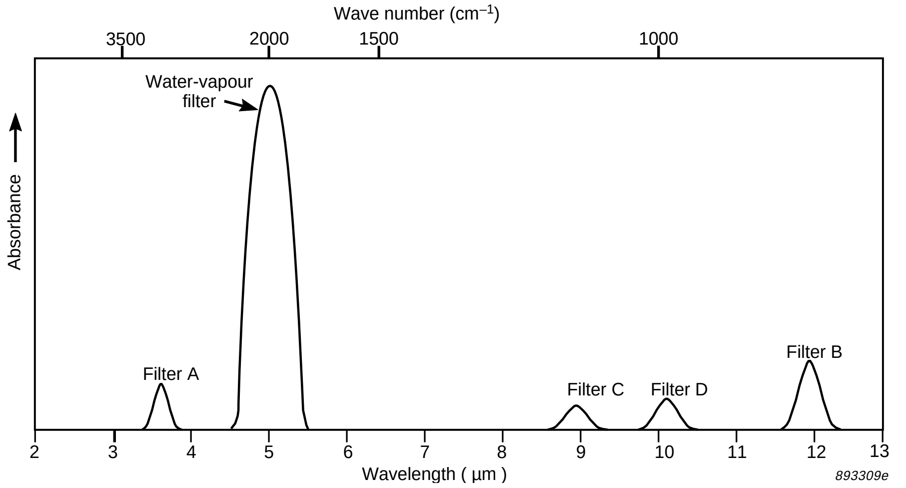
When there is zero-gas in the cell (that is, a gas which does not absorb any infra-red light) a signal is measured in the cell. This signal is due to what is termed **cell noise**. Cell noise is created by the imperfect reflection of infra-red light from the cell walls. It is dependent upon the properties of the cell itself (for example, its dimensions and the reflectivity of its walls) as well as the wavelength (and thus energy) of the infra-red light which is incident on its walls. As it is the optical filter which determines the wavelength of light, cell noise will depend upon the optical filter being used.

This cell-noise signal is measured during the **Zero-point Calibration** of each filter. A supply of dry, zero gas is attached to the air-inlet of the 1312 and the signal in the cell is measured with each installed optical filter (“A” to “E”). This signal is called the **concentration offset factor** for the filter. Whenever the filter is used, this signal is subtracted from the total measured signal as it is not related to the concentration of any gas.

Presence of Water Vapour

Water vapour is nearly always present in ambient air and it absorbs infra-red light, to a greater or lesser extent, at nearly all wavelengths (see Fig. 12.1). This means that no matter which optical filter is transmitting light into the cell the water vapour in the cell will absorb some of this light and create a signal. This signal is said to “interfere” with the signal produced by the gas we wish to measure with this filter.

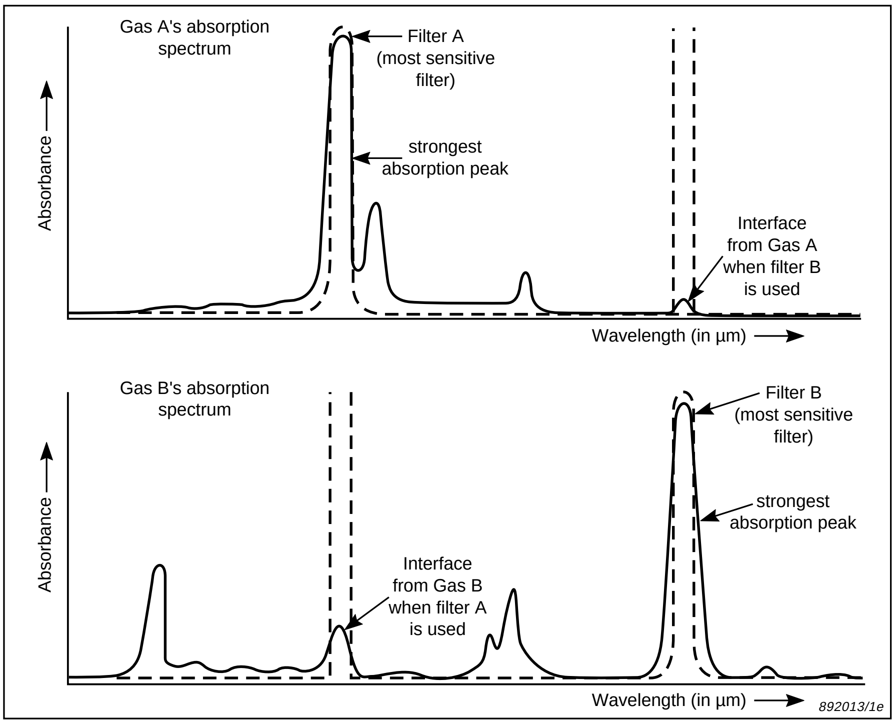
Fig. 12.2 Schematic diagram showing the relative absorption of water vapour by different optical filters



How is this interference measured? A water-vapour optical filter, which transmits light with a wavelength which is absorbed by very few gases, except water vapour, is always installed in position “W” of the filter carousel. Using this filter, water-vapour’s interference is measured during the **Humidity Interference Calibration** of each installed filter. A supply of zero gas containing a constant concentration of water vapour is attached to the air-inlet of the 1312. The signal in the cell is measured with the water vapour filter and with **all** the other installed optical filters.

The water vapour in the cell absorbs light from the water-vapour filter and from the other installed filters, producing signals which are related to water-vapour’s relative absorption of the light at the wavelengths transmitted by the different optical filters (see Fig. 12.2). We know, however, that the ratio of the signal measured with any one filter (e.g. "A") and the signal measured with the water-vapour filter is a constant. This ratio is related to the **Humidity Gain Factor** calculated during the humidity-interference calibration of filter "A". For example, if the signal produced by water vapour when using the water-vapour filter is 160 μV and using Filter "A" is 16 μV, then, if the signal measured with the water-vapour filter is found to be 80 μV, we know that this concentration of water vapour will produce a signal of 8 μV when Filter "A" is used. Measurements made during humidity-interference calibration of the installed filters therefore enable the 1312 to compensate any measured signal for water-vapour's interference.

Fig. 12.3 Schematic diagram showing the absorption spectrum of gas A and gas B. The dashed lines represent the half-power bandwidths of the filters used to measure each gas



Presence of Other Interferents

In many measurement situations water vapour is not likely to be the only interferent present. Suppose that you have installed an optical filter "A" to measure a gas (A), but another gas (B) is normally found in the ambient air you are monitoring. If gas B absorbs some light from filter "A", it will "interfere" with the signal produced by gas A's absorption of this light. This is illustrated by the lower absorption spectrum in Fig. 12.3 ("Interference from Gas B when filter A is used"). This interference is termed **cross interference**.

How is this interference measured? An optical filter "B" is chosen, which transmits light with a wavelength which is most strongly absorbed by gas B, and less strongly by gas A, this is illustrated by the lower absorption spectrum shown in Fig. 12.3. During **cross interference calibration** two sets of measurements are performed:

1. The signal in the cell is measured using filter "A" and then filter "B" when a known concentration of gas A is in the analysis cell. The ratio of these two signals is directly related to gas A's relative absorption of light at these two wavelengths (upper spectrum in Fig. 12.3). This ratio is a constant and is a measure of **Gas A's Interference on filter "B"**.
2. The signal in the cell is measured using filter "A" and filter "B" when a known concentration of gas B is in the cell. The ratio of these two signals is directly related to gas B's relative absorption of light at these two wavelengths (lower spectrum in Fig. 12.3). This ratio is a constant and is a measure of **Gas B's Interference on filter "A"**.

By measuring the ratios described above, the 1312 is able to compensate any measurement made with filter "A" for any interference signal produced by the presence of gas B in the cell, and vice versa. This procedure is known as **cross compensation**.

12.3 Tasks Before Starting Any Calibration

Before starting any kind of calibration task there are several operations which need to be performed:

12.3.1 Obtaining a Print-out of Calibration Data in the Monitor

Whether the 1312 is to be used online or as a stand-alone instrument, the 1312PC software can be used to check the 1312's existing calibration. All the calibration factors can be printed out directly from the 1312PC software using the "Print all Banks from Gas Monitor" option. Alternatively, you can "Upload" the calibration data for all the filters, or the data for just one of the filters, to the PC. The data can be viewed on screen in an numeric window and then printed out.

With the PC connected to the monitor and the calibration program running:

1. Pull down the **Task** menu. Click on **New** and the New Calibration Task dialogue appears.
2. Type in the desired calibration task name, and click on **OK**. An extended menubar and a graphic window appear.
3. Pull down the **Bank** menu and click on **Print all Banks from Gas Monitor**.

All the data is now printed out on the printer connected to your PC.

12.3.2 Checking the Calibration of Each Installed Optical Filter

A print-out of the calibration data in the 1312's memory is useful to have for reference. It also enables you to find out how "old" calibration factors compare with the "new" calibration factors calculated during re-calibration tasks, see section 12.3.1.

Fig. 12.4 illustrates only part of a typical calibration data print-out. To simplify our discussion, we will confine our discussion to the calibration data for a single optical filter installed in position "A". Note that there are **five** different filter banks which contain calibration data. These banks are numbered from 1 to 5. This enables each filter to be calibrated to measure up to 5 different gases. Before the filter is calibrated to measure any one particular gas, you have to inform the 1312 about where you wish to store the calibration data for this gas. The number of the filter bank chosen when operating in **Set-Up mode** is called the **active** filter bank.

When checking the optical filters using the front panel push-buttons, Chapter 12 provides details of how to obtain a print-out of calibration data using a printer with an RS 232 interface or an IEEE 488 interface.

Note that calibration data in the **active** filter bank is always printed out directly after the optical filter factors data and this data is also shown under the heading **CALIBRATION DATA IN FILTER BANK : X**, where X is the number of the active filter bank.

Note: all calibration factors are expressed as exponential numbers. For example: 104.05E–3, this is the same as the number $104.05 \times 10^{-3} = 0.10405$.

1. Refer to your calibration data print-out and check the following information:
   a. Under the heading **GENERAL CALIBRATION INFORMATION FOR FILTER A**: check that the UA number of the installed optical filter is the same as the UA number appearing on the "Calibration Chart" for the optical filter in position "A".
   b. Under the headings **CALIBRATION DATA IN FILTER BANK:1**; **CALIBRATION DATA IN FILTER BANK:2**; **CALIBRATION DATA IN FILTER BANK:3**; **CALIBRATION DATA IN FILTER BANK:4**; and **CALIBRATION DATA IN FILTER BANK:5** check the following information:

      Zero-point calibration performed : if a date appears here **(year-month-day)** this is the last time the zero-point calibration data in this filter bank was updated.

      Concentration offset factor : if a number appears here this means that this filter bank contains calibration data obtained during a zero-point calibration of filter "A".

      Hum. Interference Calibration performed : if a date appears here **(year-month-day)** this is the last time the humidity-interference calibration data in this filter bank was updated.

c. **Humidity gain factor :** if a number appears here this means that this filter bank contains calibration data obtained during the humidity-interference calibration of filter “A”.

d. **Cross Interference Calibration performed :** if a date appears here **(year-month-day)** this is the last time cross interference calibration data in this filter bank was updated.

e. **“Gas name” interference on Filter B, C, D, E :** if a number appears after these headings this means that this filter bank contains calibration data collected during cross-interference calibration for this named gas.

f. If the following three conditions are found in any filter bank:

- **Gas name :** if the name which appears here is the same as the name of the gas you intend to measure with filter “A”;
- **Span Calibration performed :** if a date appears here; and
- **Conversion factor :** a number appears here;

then this filter has been properly span calibrated with the named gas. The **filter bank** containing this calibration data is the filter bank which has to be made **active** when filter “A” is to measure this named gas.

g. However, if the **Gas name :** is given as “Gas UA number” then the filter has only been checked to see that it is functioning correctly, it has **not** been **span calibrated** to measure the gas you wish to measure.

2. Under the heading **GENERAL INFORMATION FOR WATER FILTER — ACTIVE CALIBRATION DATA :** check the following information:

a. **Zero-point Calibration performed :** if a date appears here this is the last time the water-vapour filter was zero-point calibrated.

b. **Concentration offset factor :** if a number appears here this means that the water-vapour filter has been zero-point calibrated.

c. **Span Calibration performed :** if a date (year-month-day) appears here this is the last time span calibration of the water-vapour filter was performed.

d. **Conversion Factor :** if a number appears here this means that the water-vapour filter has been span calibrated.

When the water-vapour filter has been zero-point calibrated **and** span calibrated it is able to measure the absolute concentration of water vapour in any gas sample in the analysis cell of the 1312, and it requires **no** further calibration.

When all installed optical filters (in positions “A” to “E”) have been zero-point, humidity-interference, span and cross-interference calibrated (if necessary) then the 1312 is able to perform accurate measurements.

Fig. 12.4 Part of a calibration data print-out

```
GENERAL CALIBRATION INFORMATION FOR FILTER A.
------------------------------------------------------------

Installed Optical Filter            :     UA0983
Active Filter Bank Number           :          1

OPTICAL FILTER FACTORS
------------------------------------------------------------
Back. temp. factor                  :   -1.400E-03
Conc. temp. factor                  :   5.5000E-03
Hum. temp. 1 factor                 :   -10.60E-03
Hum. temp. 2 factor                 :   -13.60E-03
Hum. temp. 3 factor                 :   0.0000E+00
Hum. sqr. factor                    :   -1.243E+03
Hum. cub. factor                    :   0.0000E+00

ACTIVE CALIBRATION DATA
------------------------------------------------------------
Gas name : Carbon dioxide
Molecular weight                    :   44.010E+00
Alarm Limit                         :   _______ mg/m3

Span Calibration performed          :   1997-03-21
Type of Span Calibration            :   Single Point
Conversion factor                   :   21.884E+06
Concentration                       :   ____ mg/m3

Zero-Point Calibration performed    :   1997-03-21
Concentration offset factor         :   1.1011E-06

Hum. Interference Calibration performed :   1997-03-21
Humidity gain factor                :   27.987E-03

Cross Interference Calibration performed :   1997-03-21
Carbon dioxide interference on :
Filter B                            :   37.889E+09
Filter C                            :   105.21E+09
Filter D                            :   3.8121E+09
Filter E                            :   __________
```

12.3.3 Checking and Changing Optical Filter Parameters

Before starting calibration it is always wise to check that information about the installed optical filters has been "entered" **correctly** in the **active** set-up of the 1312. If the **incorrect** UA number is "entered" for the optical filter in a particular position, the incorrect optical filter factors will be used in the calculation of the calibration factors, and calibration will therefore be useless.

The UA number can only be changed using the push-buttons on the front panel of the monitor.

1. Press **SET-UP** **S3** **S3**.

   The following text appears on the screen display:

CHECK AND /OR CHANGE SET-UP FOR FILTER A
NO YES

2. Press **S3** and the following text appears on the screen display:

SELECT UA NUMBER FOR FILTER A 0988
PRESS ENTER TO CHANGE VALUE

The UA number of the filter installed in position “A” should have already been checked (see section 12.3.2).

WARNING! If this number **is** changed all calibration data for this filter — in all 5 filter banks — will be deleted (i.e. lost) and the filter will have to be fully calibrated again before it can be used.

If the incorrect filter is selected, press ⏎ and use △ and ▽ to scroll through the UA numbers, until the correct UA number is displayed.

3. Only the Filter UA numbers need to be checked/changed using the monitor’s push-buttons. All the other parameters are set when setting up the calibration using the Calibration program.

   Press ⏎ and use ▽ until the following text is displayed.

CHECK AND /OR CHANGE SET-UP FOR FILTER B	
NO	YES

Repeat steps 2 and 3 until the correct UA numbers have been entered for the fitted optical filters. Then exit the Calibration Set-up by pressing **SET-UP**.

12.3.4 Warming Up the 1312

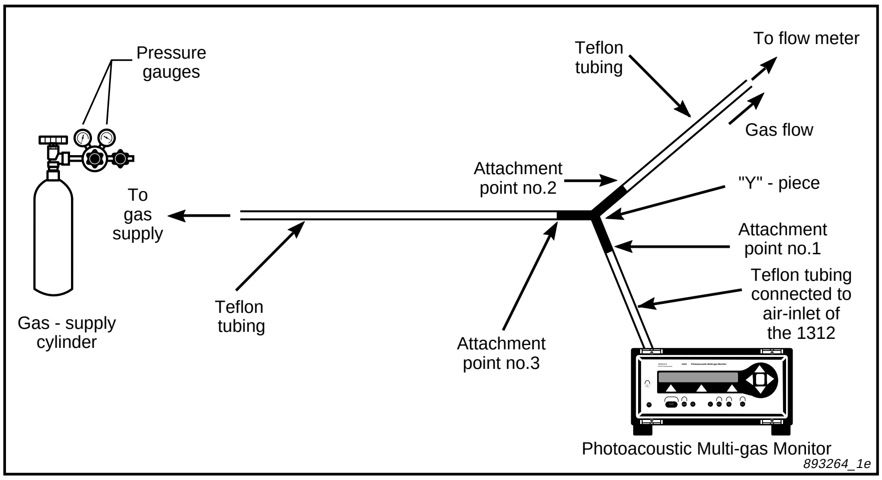
The infra-red light source is very hot and the temperature in the analysis cell thus increases as calibration measurements proceed. Conditions within the cell tend to stabilise more quickly once the temperature inside the analysis cell is 15°C above the ambient room temperature. We therefore suggest that you set-up the 1312 to sample water vapour continuously, for a period of 30 – 40 min. to warm up the analysis cell before a calibration task is started. This will reduce the time required for calibration.

To warm-up the 1312 you need to set-up a monitoring task and make the 1312 perform the task for a period of time. If you are unsure about setting up and starting a monitoring task, full instructions are provided together with an example in section 4.3.

12.4 The Basic Calibration Set-up

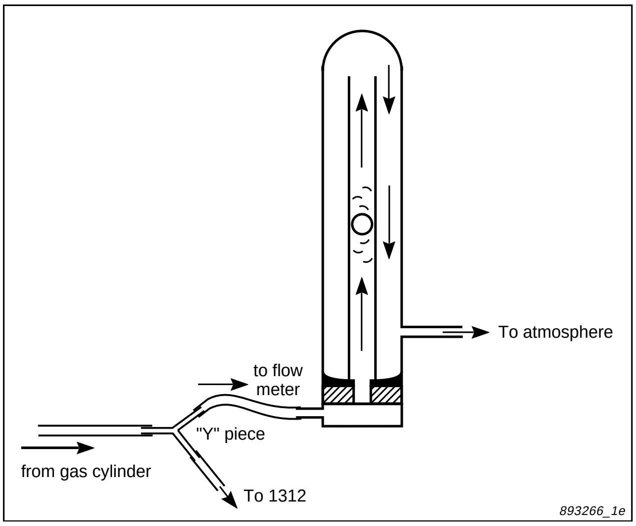
The general equipment required to perform the calibration is shown in Fig. 12.5. Three different lengths of teflon tubing are connected to a “Y”-piece. The tube attached to point 1 is connected to the air-inlet of the 1312; the tube attached to point 2 is attached to a gas flow meter or similar apparatus; and the tube attached to point 3 is attached to the cylinder of gas which is to be used during calibration.

Fig. 12.5 General equipment required for a calibration task



Attaching a gas flow meter serves two vital functions (see Fig. 12.6):

Fig. 12.6 Schematic diagram of a flow meter



- It allows you to have a visually check that there is a net flow of gas **out** of the teflon tube attached to it during the whole calibration procedure. The “flow ball” can be seen to be bouncing on the upward flow of air out of the meter.

  If the pressure of the gas from the cylinder is too low at any time then the “flow ball” will just remain seated at the bottom of its tube. This condition must be avoided because atmospheric air will be drawn into the teflon tube system via the flow meter and cause dilution of the calibration gas. This will affect the accuracy of your calibration.

- It functions as an **escape valve**. When the pressure of the gas in the tubing becomes greater than atmospheric pressure, gas flows out to the atmosphere via the flow meter. This ensures that the gas entering the analysis cell is as close to atmospheric pressure as possible, and this prevents damage to the very sensitive microphones in the analysis cell.

WARNING!: The analysis cell of the monitor is equipped with sensitive microphones, and therefore NO direct connection between the 1312's air-inlet and the pressure-valve on a gas cylinder is allowed. Under NO circumstances should the pressure of the air in the analysis cell be allowed to exceed 0.1 bar above the ambient pressure.

1. Attach the teflon tubing to the Air Inlet Filter at the back of the monitor. This is described in detail in section 4.2.
2.
   a. Connect the free-end of the length of tubing attached to the air-inlet to one of the branches of the "Y"-piece (see attachment point no. 1 in Fig. 12.5).
   b. Cut off another 1 m length of teflon tubing and connect one of its ends to attachment point no. 2 of the "Y"-piece (see Fig. 12.5) and its other end to a flow-meter.
3. Connect a 1 m length of tubing to attachment point no. 3 of the "Y"-piece (see Fig. 12.5).

12.4.1 Producing a Supply of Clean, Wet Air

When humidity-interference calibrations are performed, clean, wet air is required. This can be produced in the following manner.

We suggest that you bubble zero-gas (e.g. pure nitrogen) through a thermostatically-controlled water-bath to produce a supply of clean, wet air to the 1312 during humidity-interference calibration of the filters (see Fig. 12.7). Notice that the thermostatically-controlled water bath is linked up to an extra "empty" flask. This is to prevent a situation where the level of water in the controlled water-bath rises and covers the outlet tube "A" and draws water, via the "Y"-piece, directly into the 1312's analysis cell. Water will seriously damage the cell. To avoid such a situation, we suggest that the wet air from the water-bath outlet tube is fed into an extra empty flask before being fed to the air-inlet of the 1312. Note the length of the respective tubes in the flasks. It is **vitally important** that any water which collects in the extra flask does not cover the short outlet tube "B".

It is very important that the concentration of water vapour used is below the **saturated** water-vapour pressure of the air in the room where calibration is being performed, otherwise water vapour will condense out in the analysis cell. In practical terms this means that:

- The 1312 must have time to reach the ambient temperature of the room before a calibration task is performed.
- The temperature of the water bath you use should be at least 2°C **below** the

ambient temperature of the room where calibration is to be performed. So, if your ambient temperature is 20°C, make sure that the temperature of the water-bath you use is set at a maximum of 18°C.

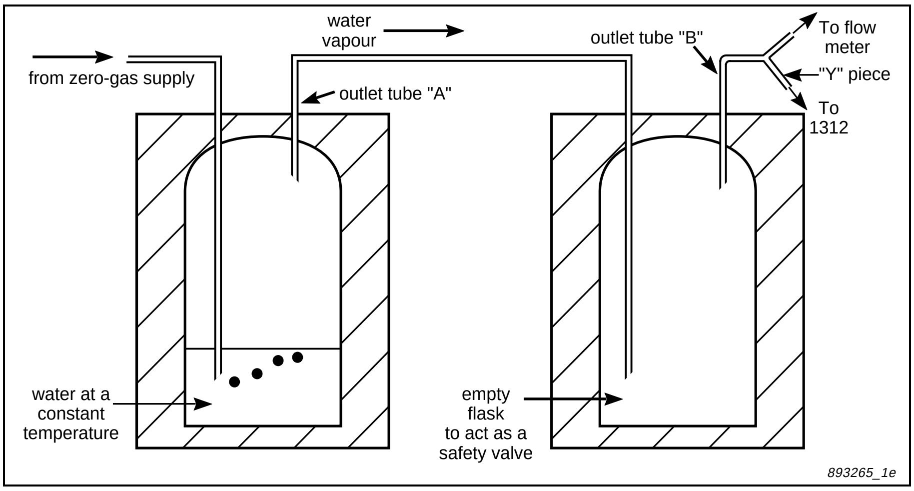


Fig.12.7 Schematic diagram of the equipment necessary to produce a supply of clean, wet air

12.5 General Settings for a Calibration

The procedures in the following sections assume that all the preliminary tasks described in section 12.3 and section 12.4 have been completed.

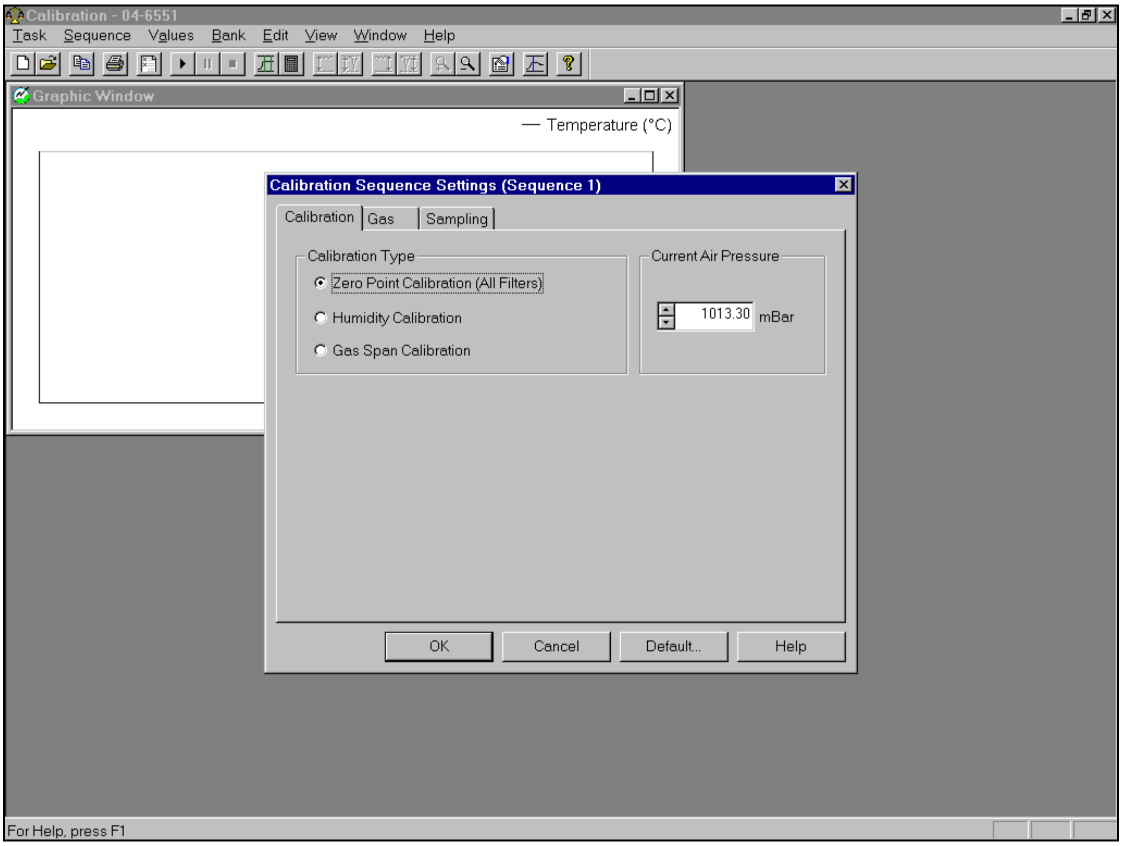
Although there are four types of calibration, many of the procedures for these calibrations are similar. These similarities are described here. Things that are particular to the individual calibrations are described in more detail in the relevant sections. The basic calibration can be divided in to 3 stages:

- Measuring Raw Data
- Calculating Calibration Values
- Downloading the Calibration Values to the Filter Banks

12.5.1 Measuring Raw Data

With the Calibration program already running and the correct tubing attached:

Fig.12.8 Calibration Sequence Settings dialogue



1. Pull down the **Task** menu and click on **New.** If you want to use an existing task then click on **Open**. The Calibration Task dialogue is displayed.
2. Type in the desired task name, or highlight the desired name if opening an existing task, and click on **OK**. A graphic window and an extended menu-bar now appear.
3. Pull down the **Task** menu again and click on **Units**. The Units dialogue appears.
4. Select the units you want to use in the calibration setup windows and when entering the concentration values. The monitor measures raw data, so these units do not affect the display data. Click on **OK**.
5. Pull down the **Sequence** menu. Click on **Settings**. The Calibration Sequence Settings dialogue is displayed, Fig.12.8.

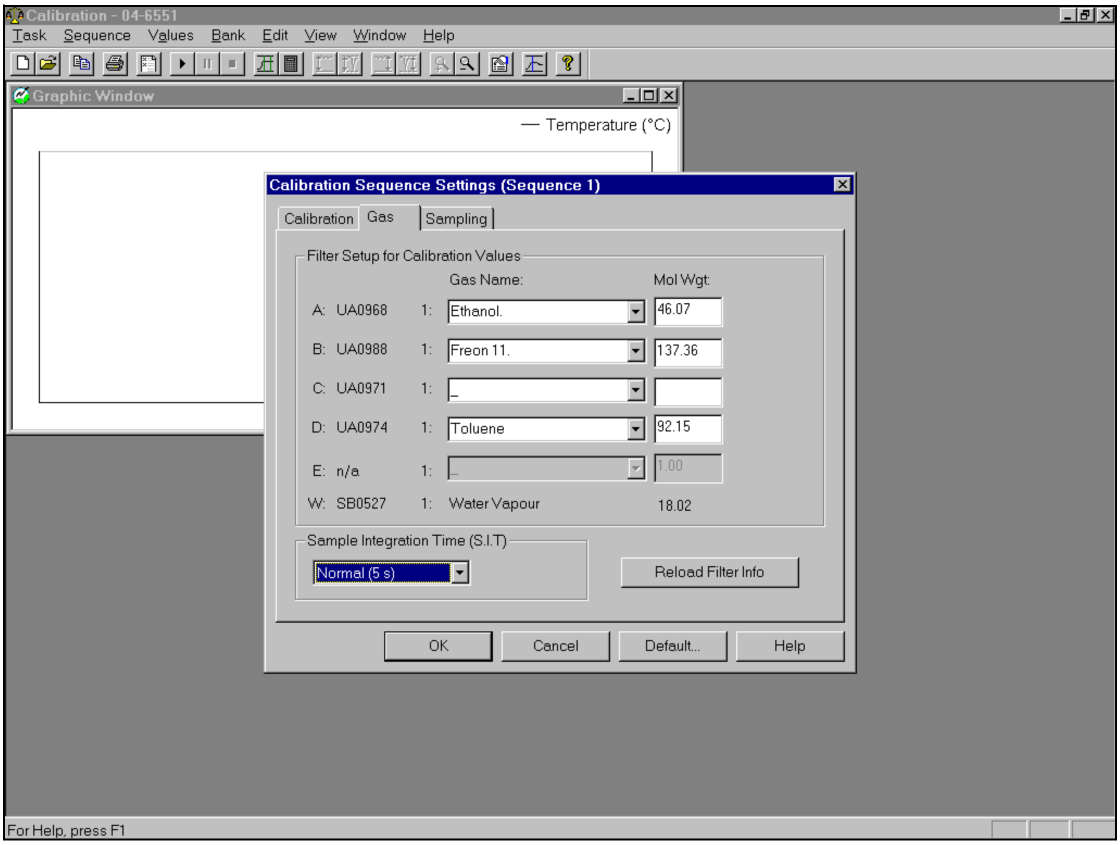
Calibration index card

6. Click on the Calibration index-card, if it is not already at the front.
7. Click on the radio-button to select the desired calibration type. The individual sections named below provide full details.
   - Zero point — see section 12.6
   - Humidity — see section 12.7
   - Gas span — see section 12.9

Gas index card

8. Click on the Gas index-card, see Fig.12.9.

Fig.12.9 Gas Settings dialogue



9. If you have not uploaded the calibration, filter, gas names and molecular weight information already, then do it now. Click on the **Reload Filter Info.** soft-key. This takes several minutes, so wait until it has finished before continuing.

   If you are performing a span calibration, follow the steps given in section 12.9.1.

   For zero-point and humidity calibrations follow the steps here.

10. Click in the *Sample Integration Time* field, and select the desired time.

    Note: the S.I.T. value should be set to the same as those used for monitoring.

Sampling index card

11. Click on the Sampling index card.
12. Select the desired Flushing Type. The procedure to do this is the same as that used when monitoring, see section 7.2.

    Note: the Flushing type and values should be set to the same as those used when monitoring.
13. When all the settings are correct, click in **OK**.

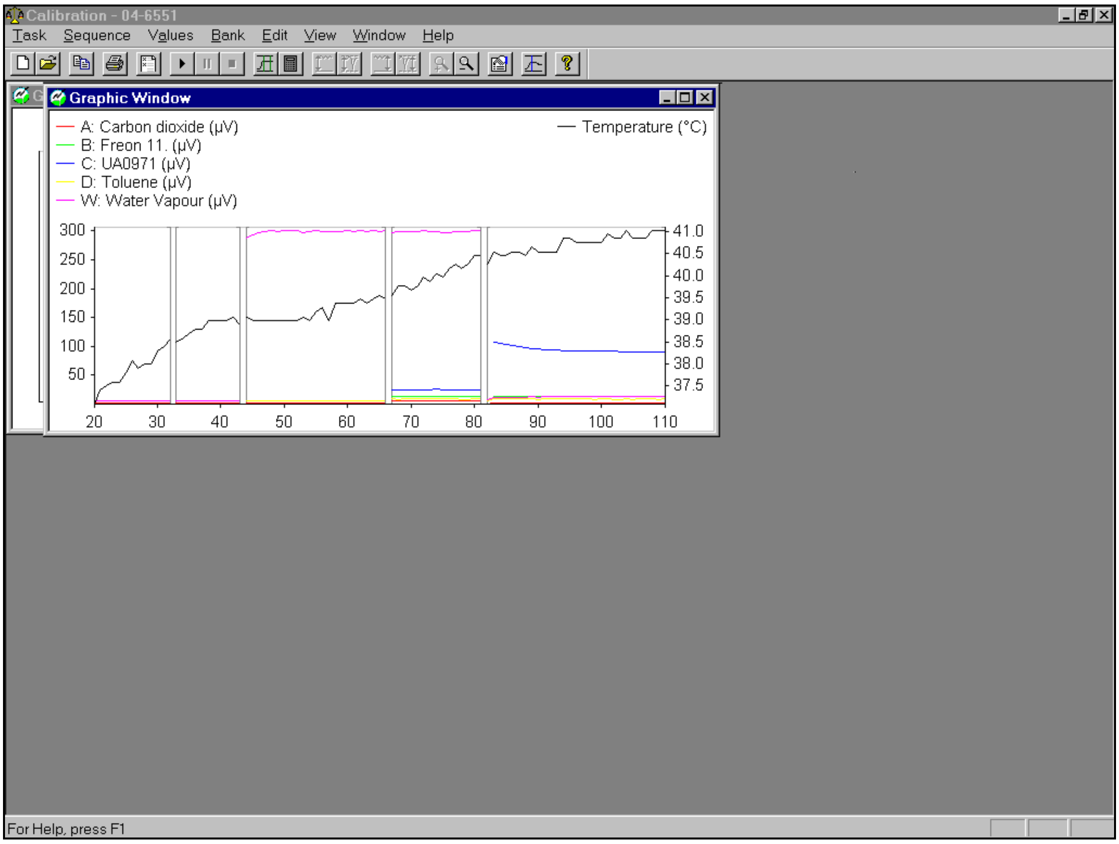
Starting a Calibration

1.
    a. Connect the free-end of the teflon tubing mentioned in section 12.4 to the pressure valve on a cylinder of calibration gas.

    b. Gently open the pressure-valve on the gas cylinder.
2. Pull down the **Sequence** menu and click on **Start**.

The monitor will now begin to measure the raw data. All the gases have the same units — µV or mV. Fig. 12.10 illustrates how measurement data is displayed.

Fig. 12.10 Raw calibration data displayed on screen



Stop the calibration when you have enough raw measurement data.

Note: if you are performing a two-point span calibration, or, you want more than one calibration type, then you can at this point stop the calibration, change the Calibration Sequence Settings and calibration gas, restart the measurement and collect the new raw data for the next calibration type. This enables you to gather all the measurement data and then calculate all the calibration factors in a single operation.

Stopping a Calibration Task

Pull down the **Sequence** menu and click on **Stop**.

12.5.2 Calculating Calibration Factors

Once you have measured enough raw data, you are able to calculate the calibration factors. With the raw measurement data displayed on screen:

1. Open the Cursor Values dialogue. Use of the cursors is described in section 8.4.
2. Use two cursors and the statistical data displayed in the Cursor Values dialogue to located a suitable range of data.
3. When you have the desired region between the cursors, pull down the **Sequence** menu and click on **Mark Interval**.

   Note: the marked interval must be the same type in the whole interval.

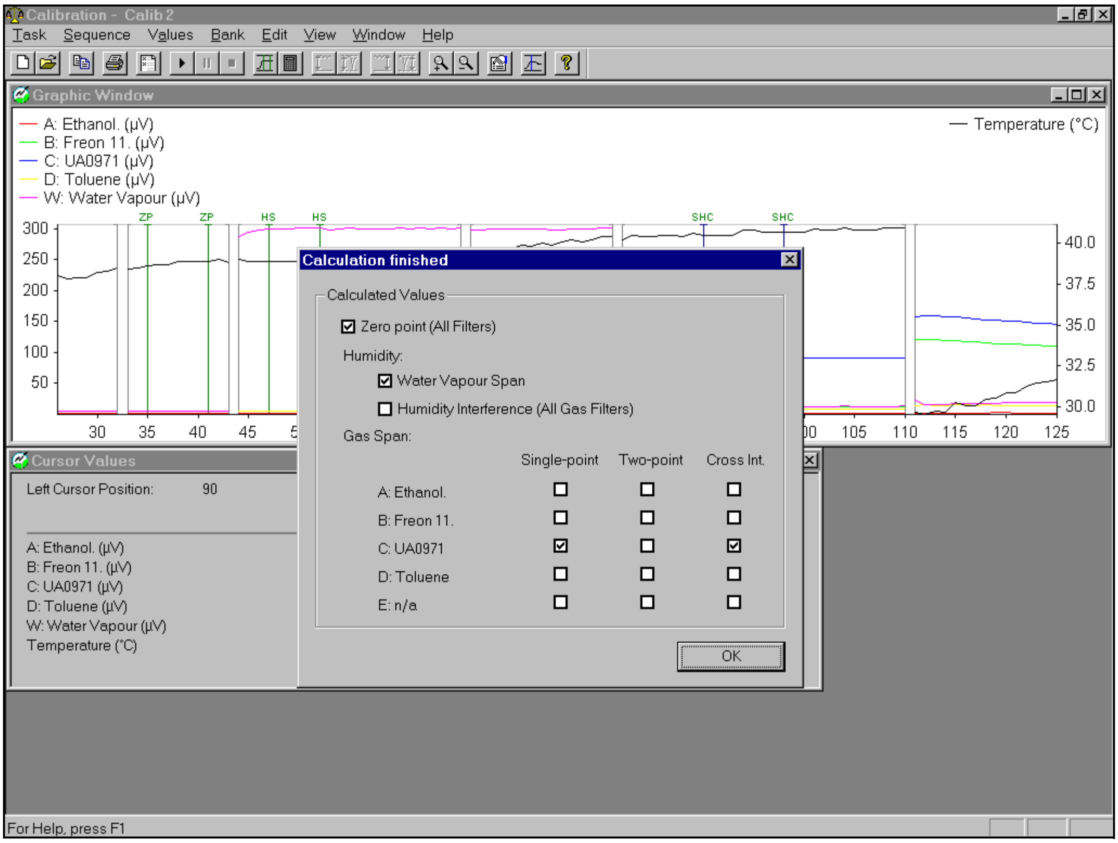
   The two cursors are replaced by a pair of green lines. These lines have markings at the end of them, which show the type of calibration data lying between the lines. The markings are:

ZP:	shows a zero point calibration
HS:	shows a humidity span calibration
HI	shows a humidity interference calibration
HIS	shows a humidity interference and a humidity span calibration
SHA	shows a Single point or Two point (High conc.) span calibration (filter A)
SLA:	shows a Two point (Low conc.) calibration (filter A)

4. When the calculation(s) is complete a Calculation Finished dialogue is displayed.

See Fig.12.11.

Fig.12.11 Calculation Finished dialogue



This dialogue informs you which calibration factors have been calculated by placing a tick in the check box. The number of check boxes ticked depends on the number of curves marked, and not the number of gases measured,

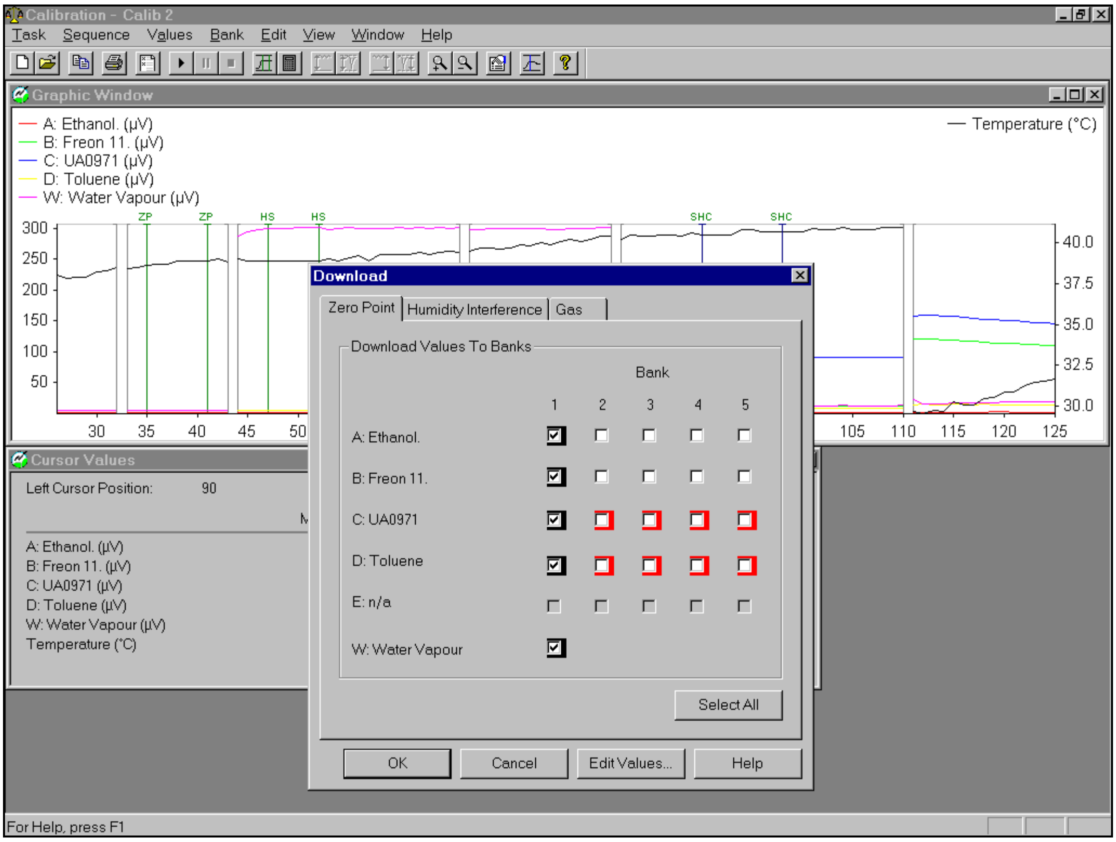
12.5.3 Downloading the Calculated Values

When you are finished measuring the raw data and have calculated the calibration factors, then you are ready to download the calculated values to the monitor.

NOTE: calibration factors calculated for a specific filter can *not* be downloaded to filter banks of another filter.

The Download dialogue, see Fig. 12.12, is divided by index cards in to three calibra-

Fig. 12.12 Download dialogue



tion types; Zero point, Humidity interference and Gas (span calibration). The names of the calibrated gases for the different filters are listed, and opposite each filter position are 5 check boxes. These boxes represent the 5 filter banks for each optical filter. The check boxes provide 4 types of information:

- The white boxes represent filter banks containing no calibration factors – you can freely enter calibration factors here without losing any existing information.
- The white boxes with a red shadow already contain calibration factors – you can download the new factors to these filter banks, but the existing information will be lost.
- The ticked check boxes with a black shadow are the computers suggestion as to where the new calibration factors should be downloaded – it is normally these positions you would select when performing a recalibration of the monitor. However, you are free to remove the tick from the check box and place it elsewhere, or place more than one tick for a filter. Several ticks enables calibration factors to be downloaded to several banks for the same filter.
- The grey boxes – these filter banks are not available – therefore no calibra-

tion factors can be downloaded here.

When a check box is ticked, then a calibration factor will be downloaded to the corresponding filter bank.

The **Select All** soft-key enables you to tick all the check boxes on the displayed index card. This is useful for zero point and humidity interference calibrations, where calibration factors are commonly required for all the filters.

To download the calculated values:

1. Pull down the **Values** menu. Click on **Download** and the Download dialogue is displayed, see Fig. 12.12.
2. Depending on the calibrations performed, select the correct index card.
3. Set ticks in the preferred check boxes.
4. Repeat steps 2 and 3 until all the desired check boxes are ticked.

Special Function – Edit Values

Warning! This option should only be used by experienced users. Editing the calibration values here can result in the monitor providing incorrect results.

a. If you want to edit the calibration values manually, click on the **Edit Values** soft-key.

b. When you are sure that the results are correct and the correct values and filters have been selected, click on **OK**. This returns you to the Download dialogue.

5. When you are sure you have selected the correct filter bank numbers, click on **OK**. The calibration factors are now downloaded to the monitor.

12.5.4 Downloading Existing Calibration Factors

If you have made a back-up of the calibration factors present in the monitor, using the Upload Banks from Gas Monitor option, it is possible to reload them again without performing the calibrations described above. This is possible using the “Download Banks to Gas Monitor” option. You can download the values for all the filters, or you can select single filter values to be downloaded. This is done as follows:

1. Pull down the **Bank** menu, Click on **Download Banks to Gas Monitor** and the Download Banks to 1312 dialogue appears.
2. Click on the desired radio-button: All Banks or Single.

   If you select Single, highlight the correct filter and filter bank.
3. Type in a unique name in the *Description* field.

4. Click on **OK**.

12.6 Zero-point Calibration

To calculate the **concentration offset factor** for a filter (during a zero-point calibration) it is necessary to have a **humidity gain factor** for the filter, and vice versa. If a **humidity gain factor** is not stored in each of the filter banks which are **active** during a **zero-point** calibration, then it is necessary to perform a **combined** zero-point and humidity-interference calibration task.

As mentioned in the previous sections, the zero-point calibration task is not selective. This means that you cannot choose zero-point calibration of a **single** filter in the carousel (for example, when a new optical filter has been installed). When you perform a zero-point calibration then **all** the installed filters will be zero-point calibrated.

If it is only a newly-installed optical filter which needs to be calibrated, then the same procedure used for an individual filter must be used. In this way you can protect your original **concentration offset factors**.

12.6.1 Setting a Zero-point Calibration

Note: the gas supply required during a zero-point calibration is a pure gas that does not absorb infra-red light, e.g. pure nitrogen.

Note: if you want to be able to use this zero-point calibration in connection with a span calibration of the water filter, then is **vitally** important that the gas is perfectly dry.

The general equipment necessary to perform a calibration task is described in section 12.4. Follow the procedure from step 1 to step 3 inclusive and then continue as follows:

Use the instructions in section 12.5.1. Click on the radio-button next to Zero Point Calibration on the "Calibration" index card and enter the correct value in the *Current Air Pressure* field. Now continue from step 8. in section 12.5.1.

12.7 Humidity Calibrations

The water-vapour filter has two different functions. Its most important function is to enable any measured signal to be compensated for water-vapour interference. Its other function is to measure the absolute concentration of water-vapour in air samples. If you only wish to use the water-vapour filter to compensate for water-vapour interference, then it only has to be **zero-point calibrated**. If you wish to use it to measure the absolute concentration of water vapour in air samples then it has to be **zero-point calibrated** and **span calibrated**.

When the Humidity Calibration radio-button is selected two check boxes appear in the *Calibration Parameters* field:

Perform Water Vapour Span Calibration: this is a span calibration performed specifically on the water vapour filter installed in the filter carousel, (position W). When you tick this check box, a clean, wet gas with a known water concentration must be used. This concentration must be entered in the *Water Concentration* field.

Humidity Interference: this calibration is performed on all the filters. However, like the zero point calibration, you are able to select which filters receive the **humidity gain factors** when you download them. Like the span calibration of the water filter, a constant concentration of wet gas is required here. However, you do not need to know the concentration of the water vapour in this case.

These calibrations can be performed individually or both together, which ever suits your needs.

Setting-up and performing a Humidity Calibration

Note: the gas supply required during a humidity calibration is a clean, wet air supply, as described section 12.4.1.

The general equipment necessary to perform a calibration task is described in section 12.4. Follow the procedure from step 1 to step 3 inclusive and then continue as follows:

1. Follow the instructions in section 12.5.1 up to step 7.
2. Click on the radio-button next to Humidity Calibration on the “Calibration” index card. Select one or both of the calibration tasks.

   If you select a Water Vapour Span Calibration, remember to enter the correct water concentration value.
3. Enter the correct value in the *Current Air Pressure* field.

Now continue from step 8. in section 12.5.1.

12.8 Cross–interference Calibration

If any gas measured by the installed optical filters absorbs light from more than one of the installed optical filters, then it is advisable to calibrate for **cross-interference** (see section 12.1). Cross-interference calibration cannot be performed alone! It **has to be** performed together with the span calibration of each of the installed optical filters. **Cross-interference** calibration is **not** selective, that is, if you select to perform a cross-interference calibration, then each time a gas is supplied to the 1312 during a span calibration, the signal in the cell is measured using each installed optical filter. You cannot choose which filters should be calibrated for cross-interference from a particular gas.

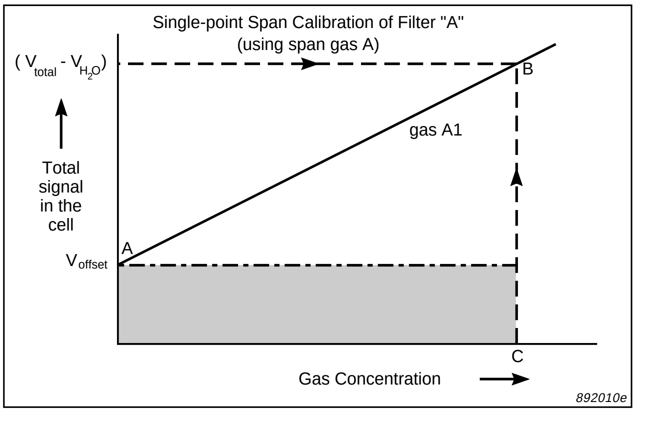
Section 12.9 includes information about how to set up a combined cross-interference and span calibration task.

12.9 Span Calibration

Before calculating the **conversion factor** for a filter (during span calibration) a **concentration offset factor** and a **humidity gain factor** must be in the filter bank which is selected for the filter during span calibration. Span calibration of a filter can therefore only be done after the filter has already been zero-point and humidity-interference calibrated.

During span calibration a supply of a particular gas (e.g. gas A1) of known concentration is attached to the air-inlet of the 1312 and the total signal in the cell is measured using the water-vapour filter and the filter which is being span calibrated (for example "A"). As filter "A" has already been calibrated for humidity interference, the total signal (V_{total}) measured with filter "A" can be compensated for any signal produced by water-vapour's absorption of light from filter "A" (V_{H_2O}) during the span calibration task. This means that your span gas does not have to be perfectly dry. As the filter has already been zero-point calibrated, the cell noise V_{offset} (when filter "A" is used) is known, and therefore the span calibration curve can be drawn (see Fig. 12.13).

Fig. 12.13 Curve showing a linear span-calibration curve



Choosing a filter bank

If a filter (e.g. "A") has already been calibrated to measure a gas (e.g. A1) and you wish to calibrate with gas A1 again, then select the filter bank containing the **gas**

conversion factor for gas A1. Online users can do this when downloading the calibration factors. Stand-alone users should do this before setting-up and performing the span calibration task. The **gas conversion factor** calculated during the span calibration will then just overwrite the **gas conversion factor** calculated during the previous span calibration of the filter with this gas.

If you wish to span calibrate a filter to measure more than one gas, then select a new filter bank each time you span calibrate with a different gas. In this way the **conversion factor** for each gas is stored in separate filter banks.

The **gas conversion factor** stored in the selected filter bank during a span calibration task will be overwritten by the new **gas conversion factor** calculated during the span calibration of the filter.

Gas to be Used During Span Calibration

The gas you need to use during span calibration must be the gas you wish to measure with the filter.

Type of Span Calibration – Single-point or Two-point?

Fig. 12.14a Graph showing a non-linear span-calibration curve which can be plotted using the signals measured during a two-point span calibration task

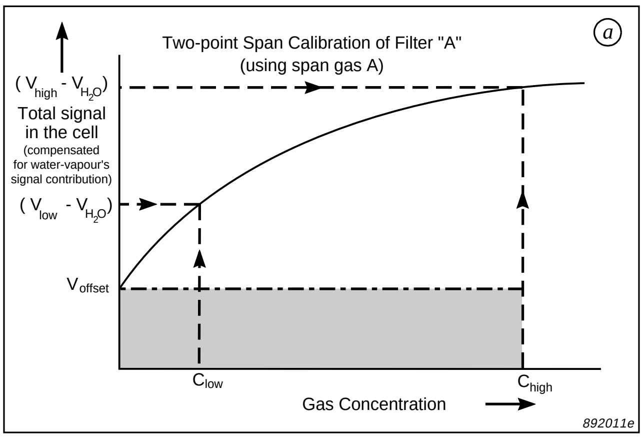
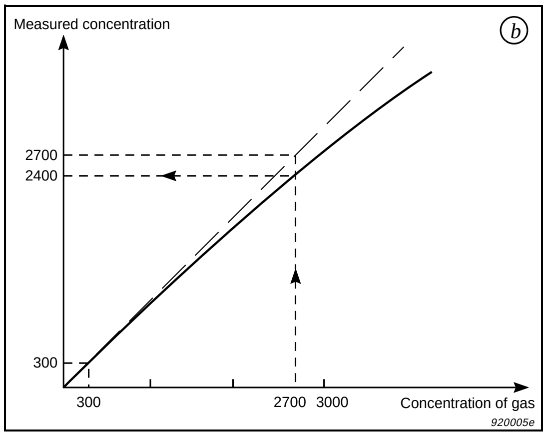


Fig. 12.14b Graph showing a non-linear measurement curve



The question about whether to perform a single- or a two-point span calibration is difficult to answer, as it is dependent on how linear the relationship is between a gas's concentration and the signal it produces in the cell (see Fig. 12.13, Fig. 12.14a and Fig. 12.14b). However, we can give you some guidelines on whether you have to perform a single- or a two-point span-calibration.

- Single-point calibration should be used when you wish to measure in the linear range. We define the linear range as the dynamic concentration range in which you can measure with a error of 5% of the real concentration (this is illustrated in Fig. 12.14b). For the most common gases, the linear range is from its detection limit and up to 10 000 times its detection limit.
- Two-point calibration is recommended to be used when you wish to measure in the non-linear range and when you wish to measure over a dynamic range of 100 000.

Gas Concentrations – Single-point Calibration

If a single-point span-calibration is performed then the span gas should have a concentration which is at least 100 times its detection limit and preferably not more than the highest concentration you expect to measure.

For certain gases it can be inexpedient to use a concentration of at least 100 times its detection limit, e.g. if you wish to measure a poisonous gas with a high detection limit, it would be natural to use a lower concentration. However, this means that the noise and vibration will have a larger influence on the calibration. This must, therefore, be taken into account when considering using a lower concentration.

Gas Concentrations – Two-point Calibration

During a two-point span calibration, the total signal in the cell (V_{low}) is measured first with a low concentration (C_{low}) of span gas, and then the total signal in the cell (V_{high}) is measured with a high concentration (C_{high}) of span gas. This enables the 1312 to compensate for any unlinearity in the relationship between the signal measured in the cell and the concentration of the gas in the cell (this is illustrated, for a gas A1, in Fig. 12.14a).

Here are some guidelines about the concentration of gas you should use during a two-point span calibration:

- The **Low Concentration** should be 10 to 30% of the highest concentration you expect to measure.

  If the desired measurement range is mainly within the linear range then the low concentration should be between 1000 and 10 000 times the detection limit.

  If the desired measurement range is mainly above the linear range then the low concentration should be more than 10 000 times the detection limit.
- The **High Concentration** should be 75% to 100% of the highest concentration you expect to measure, but no higher than this.

Simple Test to Determine the Linearity

Let us assume that you wish to measure a gas over a dynamic range from 100 ppm and 3000 ppm of a gas that has a detection limit of 0.3 ppm.

In this case, the range in which you want to measure is from 333 times to 10 000 times the detection limit. With our general guidelines, you're not able to decide whether you have to perform a single- or two-point calibration. Therefore, we advise you to perform the following test:

1. Perform a single-point calibration with a low concentration of the gas. Use 10% of the highest expected concentration level. In this case, use 300 ppm (1000 times the detection limit).
2. Perform a measurement with a high concentration of the gas. Use, for example, 90% of the highest expected concentration level. In this case, use 2700 ppm.

If the measured gas concentration differs by more than 5% from the real concentration, then a two-point calibration with 2 gas concentrations is recommended.

In the example in Fig. 12.14b, we have measured 2400 ppm with 2700 ppm gas. This gives an error of 1% and an even greater error at the highest concentration level.

12.9.1 Setting-up an Span Calibration

If the span gas used during a span calibration task absorbs any of the light from the other installed optical filters, then it is advisable to perform a **cross-interference calibration**. This means that during span calibration the signal in the cell is not only measured with the water-vapour filter and the filter being span calibrated, but is also measured with all the other installed optical filters. Note that cross-interference calibration cannot be performed alone, it has to be performed together with span calibration.

The general equipment necessary to perform a calibration task is described in section 12.4. Follow the procedure from step 1 to step 3 inclusive and then follow the instructions in section 12.5.1 up to step 7.

Calibration index card

1. Click in the Gas Span Calibration radio-button. The Calibration Parameters group is displayed as shown, see Fig. 12.15
2. Select the filter position you want to calibrate.

   If you are recalibrating the monitor, using the same filter positions and filter banks, then the gas name displayed here is likely to be correct. If not go to step 10.

   If you are calibrating for a new gas, or an existing gas in a new filter bank, then

Fig.12.15 Span Calibration dialogue

the gas name and molecular weight need to be typed in. This is done via the "Gas" index card. Go to step 10.

3. If you require a Single-point calibration, go to step 4.

   If you require a Two-point calibration, go to step 5.

4. Ensure that the Perform Two-point Calibration check box is empty.

   a. Type in the concentration of the calibration gas to be measured.

   b. If a cross-interference calibration is necessary, tick the check box.

If you have not already set the S.I.T. values, click on the "Gas" index card and go to step 13. If you have set all the parameters on the "Gas" index card, return to the basic set-up instructions section 12.5.1, and continue from step 11.

5. Click in the Perform Two-point Calibration check box.
6. Click on either the High Gas Conc. or Low Gas Conc. radio-button.
7. Type in the correct gas concentration.
8. If you require a cross-interference calibration, click in this check box when the High Gas Conc. radio-button is selected.
9. Repeat steps 6. to 8. selecting the other gas concentration.

If you have not already set the S.I.T. values, click on the “Gas” index card and go to step 13. If you have set all the parameters on the “Gas” index card, return to the basic set-up instructions section 12.5.1, and continue from step 11.

Gas index card

10. Click on the “Gas” index card.
11. If you want to recalibrate using gas names already stored in the monitor’s filter banks, click in the *Gas Name* fields and select the desired gas names. Repeat this for all the loaded filter positions.

    If you want to calibrate with a new gas, select the correct filter, pull down the *Gas Name* field to show all the filter banks. Click in the desired filter bank position and type in the gas name. Type in the correct molecular weight in the field next to the gas name.
12. Repeat step 11. until you have the correct gas names and molecular weights displayed for all the filters.
13. Click in the *Sample Integration Time* field and select the correct time.

    Note: if you select Advanced, then you need to define the S.I.T. for the individual filter positions, including the water filter. These values should be the same as those used when monitoring.

If you are still setting up the calibration, click on the “Calibration” index card and go to step 3.

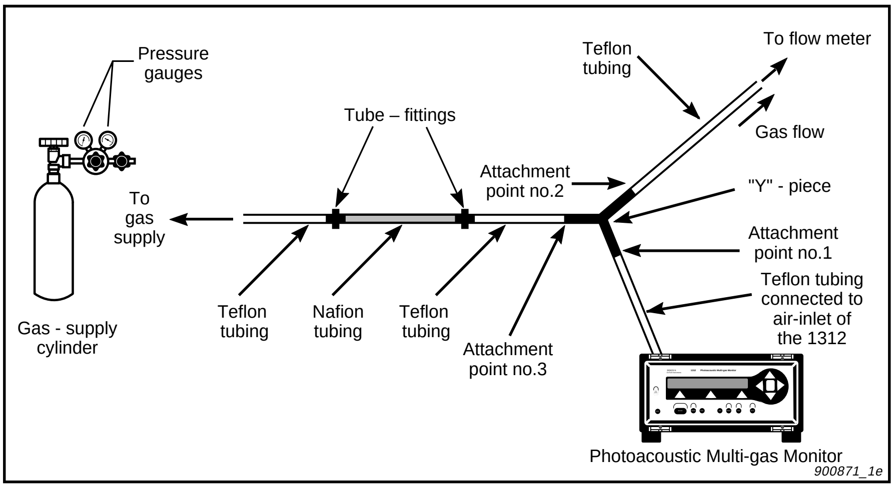
If you have already completed the “Calibration” index card, return to the basic set-up instructions, section 12.5.1, and continue from step 11.

Note: you need to span calibrate each filter individually. Therefore, these instructions need to be repeated to collect raw measurement data for each gas you want to span calibrate.

12.9.2 Use of Nafion Tubing during Span Calibration of CO_2, CO and N_2O

A length of Nafion tubing is supplied as an accessory with the 1312. It is required during the span calibration of carbon dioxide (CO_2), carbon monoxide (CO) and dinitrogen oxide (N_2O). The Teflon tubing connected to attachment point no. 3 of the “Y”-piece should be cut in half and a short length (~0,5m) of Nafion tubing should be connected between the two cut-ends of the teflon tubing using the tube fittings supplied for the purpose (Fig. 12.16).

Fig.12.16 Diagram showing how to use Nafion tubing when span calibrating a filter with one of the following gases: CO_2, CO or N_2O



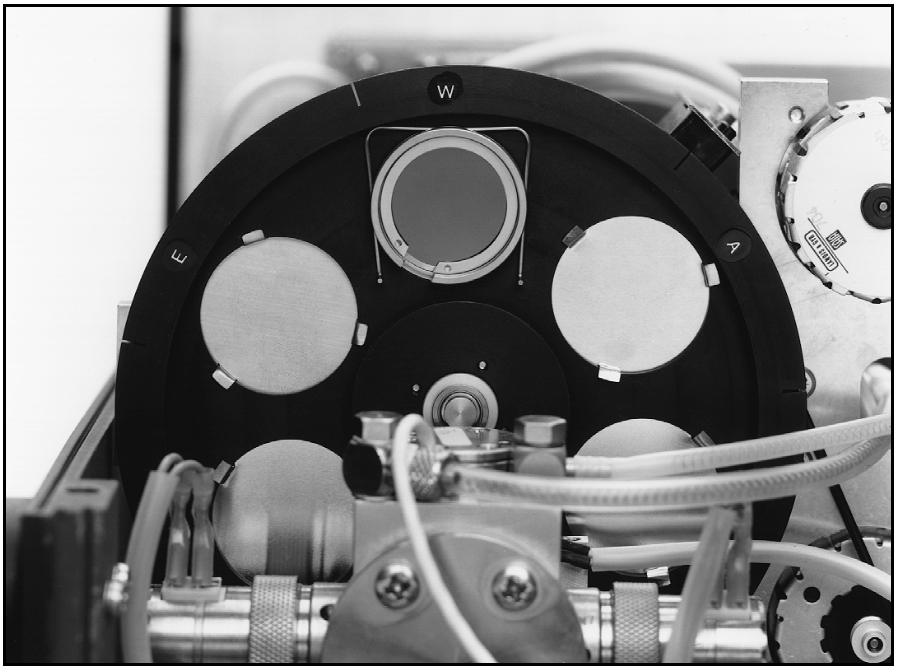
Chapter 13

Installing the Optical Filters

13.1 Introduction

Each of the optical filters available for use with the 1312 have a “UA” number printed on them. The “UA” numbers run from UA 0968 – UA 0988 and UA 0936. The 1312 has a carousel wheel on which relevant optical filters are mounted. There are six mounting holes in the carousel. Each mounting hole is labelled with one of the following letters: “A”, “B”, “C”, “D”, “E” and “W” (see Fig. 13.1). Before leaving the factory a special “water” filter ❶ is mounted in the position marked “W” and user-chosen optical filters are mounted in the other positions of the carousel. If less than 6 optical filters are installed in the carousel, blank plates ❷ are mounted in the those positions of the carousel where no optical filter has been installed.

Fig. 13.1 The filter carousel in the 1312



Blank plates may only be removed from the carousel **if** they are replaced by a chosen optical filter. Each blank plate is held in position on the wheel by three lugs ❸ (see Fig. 13.1). The blank plate can be taken out of the mounting hole by bending the metal lugs towards the centre of the plate using your fingernail. The chosen optical filter is installed in the open mounting hole and “locked” into position on the carousel with a “locking” spring ❹.

13.1.1 Installing an Optical Filter

Materials and Equipment Required: (Accessories supplied with the 1312 are numbered)

- Optical filter to be installed
- Special tool QA 0170
- “Locking” spring DL 3322
- Pozidrive screwdriver No 0
- Pozidrive screwdriver No. 1

The procedure to install an optical filter is:

1. Unplug the 1312 from the mains power supply and pull out the plug in the **AC Mains** socket of the 1312.
2. Turn the 1312 so that it stands on its back panel and remove the rubber “shoes” mounted on the four “feet” of its base-plate. Using Pozidrive screwdriver No. 1, undo and completely remove the screws located under the rubber “shoes” which have just been removed.

   Note: these screws hold the upper and lower covers of the 1312 together. If the screws are not completely undone you will not be able to remove the upper cover as explained in step 6.
3. Turn the 1312 so that it is resting on its “feet”. Undo the catch holding the lid over the front-panel of the 1312 and remove the lid by pushing it gently upwards to release it from its hinges.
4. Undo the uppermost four screws holding the frame over the back-panel of the 1312 using Pozidrive screwdriver No. 0.
5. Using the Pozidrive screwdriver No. 0 undo the upper four screws which hold the frame over the front-panel of the 1312.
6. Gently lift off the upper cover of the 1312 by pulling it firmly upward.

   Note: if the four screws mentioned in step 2. have not been completely unscrewed, you will not be able to remove the upper cover.
7. Using the Pozidrive screwdriver No. 0 undo the lower four screws on the frame holding the front panel. Hold the front panel in its present position with your hand and carefully remove the frame from around it.
8. Still holding the front panel in position with your hand, lower the carrying handle of the 1312 so that it rests on the work-bench surface in front of the 1312 (see Fig. 13.2a).

Fig.13.2a The 1312 showing the position of the carrying handle

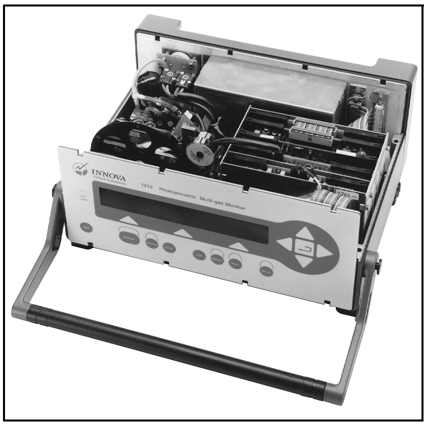


Fig.13.2b The 1312 showing the correct resting-position of the front panel

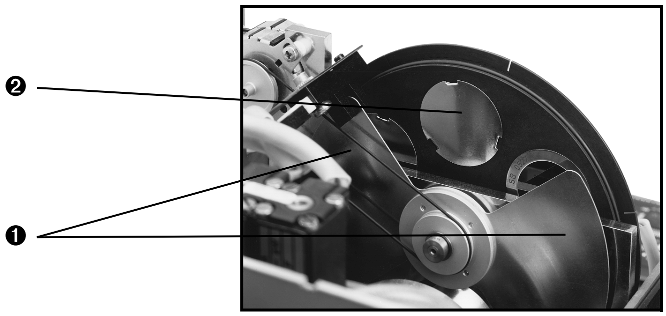
9. Hold the front panel firmly and gently pull it forwards. Rest its lower edge on the surface of the clean work-bench up against the handle of the 1312, and rest its upper edge against the front of the 1312 (see Fig.13.2b).

   Note: take care that the cable connecting the front panel to the rest of the 1312 is not pulled out of its plug.

10. Hold the edge of the carousel wheel between two fingers and gently turn it until the blank plate which is to be removed is at the top of the carousel wheel.

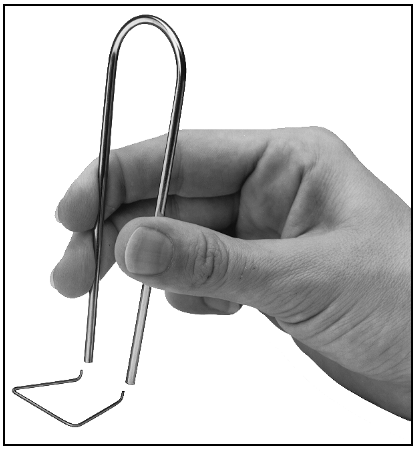
11. Hold the edge of the chopper wheel between two fingers and gently turn it so that the “blades” ❶ of the chopper do not cover the blank plate ❷ which is to be removed (see Fig.13.3).

Fig.13.3 Correct position of the chopper wheel



12. Working from the front-end of the 1312, use your fingers to bend the metal lugs of the blank plate towards the centre of the plate. Remove the blank plate by pushing it gently in a direction towards the back-panel of the 1312.

Fig. 13.4 Attaching the special tool to the "locking" spring



13.Push the "legs" of the special tool ❶ together slightly before inserting the ends ❷ of a "locking" spring into the holes at the end of the "legs" of the special tool (see Fig. 13.4).

Caution: the surfaces of the optical filter must not be touched by the fingers because perspiration can damage them. If the fingers do by accident touch the surfaces, the surfaces must be cleaned immediately using a cotton bud which has been moistened with analytically pure ethyl alcohol.

Fig. 13.5 The optical filter

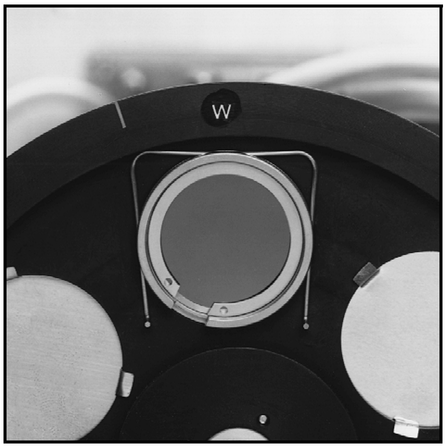
14.Using clean plastic gloves lift the chosen optical filter out of its box by holding its edges between the thumb and forefinger (see Fig. 13.5). Turn it so that the surface with the UA number faces towards the back-panel of the 1312. Insert it through the mounting hole from behind the carousel wheel (that is, it must be inserted in a direction toward the front-panel of the 1312). Hold it in this position until step 15. is completed.

15.Take the special tool QA 0170 holding the "locking" spring and position it so that its "legs" are parallel with the surface of the carousel wheel. Position the top edge of the "locking" spring along the groove of the optical filter being installed (see Fig. 13.6a).

Carefully lower the special tool so that the "locking" spring fits around the groove of the optical filter and then remove the special tool (see Fig. 13.6b).

Fig. 13.6a Fitting the "locking" spring

Fig. 13.6b Position of the "locking" spring



16. Install any other chosen optical filters in the place of the blank plates already installed in the filter carousel, by following the same procedure described above (Steps 10 – 15).

17. Note the UA number of each optical filter and its position in the filter carousel (for example, UA 0987 in position "B", UA 0988 in position "D" and so on).

Fig. 13.7 The inside of the top cover

18. Fig. 13.7 shows the inside of the top cover of the 1312. Note that the front side of the cover has square flanges ❶. Place the top cover back in its correct position on top of the 1312. Lightly screw-in (do not tighten) the four screws on the frame holding the back panel in position.

19. Lift the front panel of the 1312 and place it gently into its position in the 1312. Re-position the front frame over the front panel and screw it in place by tightening the eight screws.

20. Tighten the four screws on the frame holding the back panel in position.

21. Turn the 1312 so that its back panel is resting on the work-bench surface. Screw the four long screws, which were removed in step 2, into position on the base-plate of the 1312, and tighten them properly. Push the four rubber "shoes" into position on the 1312's "feet".

22. Enter the correct UA number of the optical filter installed in each position ("A" to "E") of the filter carousel — section 12.3.3 provides details. This is a **very important** step as it determines the set of Optical Filter Factors which will be used during the calibration of each optical

filter. If the UA number is not correctly entered then the filter cannot be calibrated to measure any gas accurately.

Chapter 14

Messages Related to Calibration

All the possible error messages connected with calibration results are discussed in this appendix. Messages fall into three calibration categories: (1) successful; (2) uncertain and (3) invalid. An explanation is given of each message and its significance so that the user can ascertain what action to take if such messages are displayed after calibration.

14.1 “Successful” Calibration Messages

The messages listed below indicate (1) that the calibration task you have just performed has been successful, and (2) that the calibration factor calculated during the calibration task has been stored in the filter bank which was **selected/active** during the calibration task.

ZERO–POINT CALIBRATION SUCCESSFUL

HUM. INTERFERENCE CALIBRATION SUCCESSFUL

ZERO–POINT/HUM. INTERF. CALIB. SUCCESSFUL

GAS X* SINGLE–POINT CALIBRATION SUCCESSFUL

GAS X* TWO–POINT CALIBRATION SUCCESSFUL

Where Gas X is the gas used during the span calibration of the filter installed in position “X” of the filter carousel (Where: X = “A” to “E” or “W”)

14.2 “Successful ∗” Calibration Messages

The messages listed below indicate (1) that the calibration task you have just performed is perhaps not as good as can be expected; (2) that the calibration factor which has just been calculated **has** been stored in the filter bank which was **active** during the calibration task; and (3) that you will have to judge the validity of the calibration. If you judge it to be invalid then the task will have to be repeated so that the calibration factor stored in the filter bank can be overwritten by a new and valid factor.

You can find out why there is uncertainty about the validity of the calibration factor by pressing **INFO**.

The messages displayed when **INFO** is used are discussed in section 14.4.

ZERO–POINT CALIBRATION SUCCESSFUL∗

HUM. INTERFERENCE CALIBRATION SUCCESSFUL∗

ZERO–POINT/HUM. INTERF. CALIB. SUCCESSFUL∗

GAS X* SINGLE–POINT CALIB. SUCCESSFUL∗

GAS X* TWO–POINT CALIBRATION SUCCESSFUL∗

14.3 “Invalid” Calibration Messages

The messages listed below indicate: (1) that the calibration factor calculated during the calibration task you have just performed is not valid and therefore has not been stored in any filter bank; and (2) that the calibration task must therefore be repeated.

ZERO–POINT CALIBRATION INVALID ∗

HUM. INTERFERENCE CALIBRATION INVALID ∗

ZERO–POINT/HUM. INTERF. CALIB. INVALID ∗

GAS X* SINGLE–POINT CALIBRATION INVALID ∗

GAS X* TWO–POINT CALIBRATION INVALID ∗

14.4 Error Messages Displayed when the INFO button is used

All “successful*” or “invalid” calibration messages are marked with an asterisk (∗) which tells you that more detailed information about the calibration can be obtained by pressing **INFO**. The messages displayed when **INFO** is pressed are listed and explained below.

14.4.1 “**Invalid**” **Error Messages**

MISSING MEASUREMENT DATA

This message indicates that the 1312 does not have the necessary data to calculate absolutely valid calibration factors. This situation could, for example, be caused by too much noise in the analysis chamber. The calibration task will have to be repeated.

WATER VAPOUR MEASUREMENT < OFFSET

This message is associated with either (1) a span calibration of the water-vapour filter, or (2) a humidity-interference calibration.

This message indicates that the signal measured with a particular filter, when water-vapour of known concentration is in the analysis cell, is less than the signal measured in the cell when zero-gas is in the cell. This could indicate either:

- That the gas used during the zero-point calibration of the filter was not dry;

  or

- That the water vapour used during either the span calibration of the water-vapour filter; or the humidity-interference calibration, was not wet enough.

WET MEAS. < DRY MEAS. FOR WATER FILTER and

HUMIDITY INTERFERENCE FACTOR < 0

Both these messages are associated with a combined zero-point and humidity-interference calibration task.

WET MEAS. < DRY MEAS. FOR WATER FILTER

During the zero-point calibration task the signal is measured when dry, zero gas is in the cell. During the humidity-interference calibration task the signal is measured when wet, zero gas is in the cell. If the difference between these two signals is less than 10µV this message will be given. It most likely indicates that your zero gas was not dry, or alternatively the concentration of water-vapour used was too low.

HUMIDITY INTERFERENCE FACTOR < 0

During the zero-point calibration task the signal is measured when dry, zero gas is in the cell — this is a measure of the noise in the cell when a particular optical filter is used. This measurement allows the **concentration offset factor** for the particular filter to be calculated. During the humidity-interference calibration task the signal in the cell when a particular optical filter is used is measured when wet, zero gas is in the cell — this signal is compared with the signal measured with the water-vapour filter to give the **humidity gain factor**. The above message is given if the **humidity gain factor** is found to be less than zero. This could indicate that the zero-gas you used during the zero-point calibration was not dry, or alternatively that the concentration of water-vapour you used during the humidity-interference calibration was too low.

GAS X: CALIBRATION FACTOR LESS THAN 0

This message is associated with a single-point span calibration task.

The **gas conversion factor** calculated during the single-point span calibration task is found to be less than zero. This could indicate that the concentration of gas used during the calibration was too low.

GAS X: LOW MEAS. > HIGH MEAS.

GAS X: MEAS. INDICATES LINEAR COHERENCE

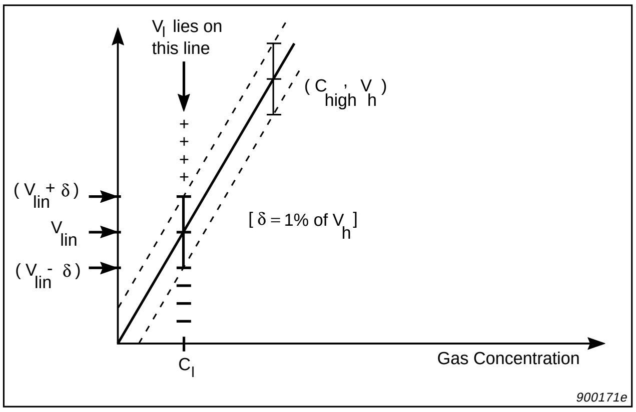
GAS X: MEAS. DOES NOT FIT NON-LINEAR CURVE

GAS X: CALIBRATION IMPOSSIBLE: MAX ITER.

All these messages are associated with a two-point span calibration task.

During a two-point span calibration the signal (V_{high}) is measured when the gas concentration C_{high} is in the cell, and the signal (V_{low}) is measured when the gas concentration C_{low} is in the cell (see section 12.9).

Fig. 14.1 Curve illustrating the two points measured during a two-point span calibration task



GAS X: LOW MEAS. > HIGH MEAS.

This message indicates that the signal measured in the cell when the gas concentration was low is found to be greater than the signal when the gas concentration was high.

The above message could indicate that the span gas concentrations were incorrectly "entered" when the task was set-up (that is, the "entered" low gas concentration was actually greater than the "entered" high gas concentration). Alternatively, it could indicate that the concentration of the gas supplied to the 1312 during the measurement of V_{low} was actually the high concentration (C_{high}) and vice versa.

The signals V_{high} and V_{low} have to be corrected for water-vapour interference and cell noise, that is:

$$V_{high} - V_{offset} - V_{H_2O} = V_h;$$

and:

$$V_{low} - V_{offset} - V_{H_2O} = V_l$$

These two points (V_h,C_h) and (V_l,C_l) can than be plotted on a graph (see Fig. 14.1).

When the two signals have been measured, the 1312 then finds the value $\delta = 1\%$ of V_h and finds out the relationship between the measured values:

If there is a perfectly linear relationship between the points C_{low},V_{low} and C_{high},V_{high} then:

$$V_{lin} = \frac{C_l}{C_h} \cdot V_h$$

GAS X: MEAS. INDICATES LINEAR COHERENCE

This message will be given in the status display if V_l lies between the values $V_{lin} - \delta$ and $V_{lin} + \delta$. This indicates that the two gas concentrations you have chosen lie in the linear region of the calibration curve. If the high concentration of gas you used (C_{high}) is equal to or greater than the highest concentration you expect to measure, then it is not necessary to use a two-point span calibration, a single-point span calibration using C_{high} as the concentration of span gas used will be sufficient to give you a good calibration result. However, if the high concentration of gas you used is less than the highest gas concentration you expect to measure, the two-point span calibration task should be repeated using a high concentration which is equal to or greater than the highest concentration you expect to measure. There will therefore be a better chance to find a point in the non-linear region of the span calibration curve so that any non-linearity can be plotted.

GAS X: MEAS. DOES NOT FIT NON-LINEAR CURVE

This message will be given in the status display if V_l is less than $V_{lin} - \delta$. This message indicates that a two-point span calibration cannot be performed.

If V_l is found to be greater than $V_{lin} + \delta$ then the 1312 will try to fit the two measured points onto a curve, whose shape has been pre-determined by *INNOVA*, by an iterative process. The iterative process involves scaling on the concentration and signal axes until the two points fit the curve within certain tolerances.

GAS X: CALIBRATION IMPOSSIBLE: MAX ITER.

If after 255 iterative processes, the two points cannot be fitted onto the curve within tolerance limits, this message is displayed.

This could indicate that the wrong concentration has been “entered” in the set-up of the span calibration task (which does not relate to the measured signal). Alternatively, it could indicate that there is a linear relationship between the gas signal in the cell and the concentration of the gas (in which case only a single-point span calibration is required).

SPAN CALIBRATION IMPOSSIBLE

This message is associated with the span calibration of the water-vapour filter.

The above message indicates that the 1312 cannot calculate the **gas conversion factor**. This could indicate that the concentration of water-vapour used during the calibration was too low — this could either be due to an incorrectly “entered” water-vapour concentration in the set-up of the span calibration or that the concentration of water-vapour used was not the same as that which was “entered” in the set-up.

14.4.2 “**Successful ✱**” Error Messages

WATER VAP. MEAS. < OFFSET MEAS

This message is associated with one, or more, of the following calibration tasks: (1) the one- or two-point span calibration of an optical filter; (2) the cross-interference calibration of the installed optical filters (“A” to “E”); (3) the zero-point calibration of all the installed optical filters (“A” to “E”).

During all the above-listed calibration tasks, the signal in the cell is measured using the water-vapour filter: this enables the 1312 to compensate for any interference signal produced by the presence of any water-vapour in the span gas/zero-gas being used. If the signal in the cell using the water-vapour filter is found to be less than the **concentration offset factor** for the water-vapour filter, the above message is sent.

This could indicate that the zero gas you used, during the zero-point calibration of the water-vapour filter, was **not** perfectly dry.

ZERO-POINT MEASUREMENT TOO HIGH

This message is associated with the zero-point calibration of either the filters (“A” to “E”) or the water-vapour filter.

If the above message is received after the zero-point calibration of the filters (“A” to “E”) it indicates that the signal measured in the cell during calibration is greater than 10 μV. This means that the zero gas used is not dry enough.

If the above message is received after the zero-point calibration of the water-vapour filter it indicates that the signal measured in the cell during calibration is greater than 20 μV. This means that the zero-gas used is not absolutely dry.

SPAN MEASUREMENT TOO LOW

This message is associated with the span calibration of one (or more) of the filters.

The above message indicates that the signal measured in the cell during span calibration is less than 3 μV and therefore cannot be used to obtain a good calibration. This means that the concentration of your span gas is too low.

SIGNIFICANT CHANGE IN CALIB. FACTORS

This message is associated with the span calibration of one (or more) of the filters.

The above message indicates that **Conversion factor** calculated during span calibration of a particular filter deviates more than 15% from the **Conversion factor** calculated during the last span calibration of this filter. If you are absolutely sure that the previous span calibration of this filter was correctly performed then this message could indicate:

1. That you have "entered" the wrong concentration for the span-gas in the span calibration set-up.
2. That the concentration of your span gas is not correctly quoted on its "Analysis Certificate".
3. That there is a leak in the tubing/fittings in your calibration equipment which alters the concentration of the span gas reaching the cell.

NO CROSS INTERFERENCE FOUND

This message is associated with a combined cross-interference and span calibration task.

The above message indicates that the signal measured with a particular filter (for example "A") when a certain gas (for example "B") was in the cell is less than 1.5 nV. This indicates that there is effectively no signal contribution from gas "B" when filter "A" is used, i.e. gas "B" does not interfere with measurements made with filter "A". In this case the factor **"Gas B's" Interference on Filter "A"** listed in the calibration data bank (see section 12.3.2) will be seen to be zero.

HIGH CONC. SPAN MEASUREMENT TOO LOW

This message is associated with a two-point span calibration task.

The above message indicates that the signal measured during span calibration, when the high concentration of span gas is in the cell, is less than 15 µV. This means that the "high" concentration of span gas is too low.

LOW CONC. SPAN MEASUREMENT TOO LOW

This message is associated with a two-point span calibration task.

The above message indicates that the signal measured during span calibration, when the low concentration of span gas is in the cell, is less than 3 µV. This means that the "low" concentration of span gas is too low.

Chapter 15

Warning and Error Messages

When the 1312 is switched on, and while it is being operated, the 1312 regularly performs a series of self-tests which check that the various mechanical, electrical and electronic components of the 1312 are functioning correctly. These self-tests are described in more detail in Chapter 5. You can select to disable the **regular self-tests** if desired (see section 5.3.2). If any component is found to be functioning outside of its specifications either a “Warning” or a “Operating-error” message will appear on the gas monitor’s screen.

Please note: A “Warning” and/or “Operating-error” message will only be displayed **once**. If the fault is still found to be present during the next regular self-test the message will **not** be displayed again. Messages are only displayed when a fault is first detected. If the fault corrects itself and then is later found to be faulty the message will be displayed again. It is therefore important to note the message before pressing the **INFO** button which will cause the error message to be removed from the display.

Although the message is removed from the screen, any gas measurements performed while the fault is still present will be marked with an asterisk (*). By pressing **INFO** when such a measurement is displayed, the **Common mark “O” and/or “W”**, and in some cases, the **Gas Mark “F”** and **Gas Mark “A”** will be shown on the display.

On the following pages, all possible “Warning” messages are listed; all possible “Operating-errors” messages are listed; and all possible “Interface-error” messages are listed. There is a description of each fault as well as the possible cause(s) of each fault. The user must evaluate the significance of each message. As long as the fault is detected, all measurements will be marked by an asterisk. Some “faults” are easily corrected, for example, the error:

INTERNAL TEMPERATURE OUT OF RANGE

If you switch the 1312 off and let its internal temperature fall to the ambient temperature, the error will not be detected when the 1312 is switched on and operated again.

Warning Messages		
Displayed Text	**Description of Fault**	**Possible Cause(s)**
AIRFLOW TOO LOW	The air pressure difference created by the pump in the pneumatic (airway) system (tubes and/or analysis cell) is too low. This means that the tubing and/or analysis cell cannot be properly flushed out and the sample in the analysis cell is therefore not necessarily “new”.	1. The length of the sampling tube attached to the 1312’s air inlet has been incorrectly entered. 2. Either the external or internal pneumatic system is not air-tight. 3. The pump is defective
AIRWAY SYSTEM BLOCKED	The air pressure difference created by the pump in the pneumatic (airway) system (tubes and/or analysis cell) is too high.	1. The length of the sampling tube attached to the 1312’s air inlet has been incorrectly entered. 2. Either the external or internal pneumatic system is not air-tight.
ALARM LIMIT EXCEEDED	The 1312 has measured a concentration of gas greater than the alarm limit concentration entered.	
BACK-UP BATTERY TOO LOW	The potential difference measured across the terminals of the battery providing the back-up power supply to the 1312, to run the internal clock and protect the Working Memory, is too low.	1. The back-up battery is either defective or flat (no longer providing sufficient power. 2. The 1312’s back-up battery has been disconnected. Under no circumstances must the battery be removed or replaced as there is a danger of explosion. See Explosion Hazard under Safety Considerations at the front of this manual.
INTERNAL PROGRAM ERROR FOUND	There is a fault in the software.	
NO INDEX MARK FROM FILTER CAROUSEL	The 1312 cannot determine the position of its filter carousel.	1. The motor that drives the filter carousel is not working. 2. The belt that drives the carousel motor is defective. 3. The optical detector that checks the movement of the carousel is not working.
POWER SUPPLY VOLTAGE OUT OF RANGE	The DC voltage supplied internally to the 1312 is either too high or too low (it lies outside the specified operating range).	1. The 1312 power supply (AC/DC converter) is defective 2. The AC mains supply is operating outside the specified range.

Warning Messages		
Displayed Text	**Description of Fault**	**Possible Cause(s)**
CLOCK SET TO DEFAULT ERROR DETECTED IN CLOCK SETTINGS	The 1312's internal clock was found to be incorrectly set so these values have been set to their default values.	A new battery has been installed.
FACTORS SET TO DEFAULT ERROR DETECTED IN CALIBRATION FACTORS	An error has been found in the data stored in the Calibration Factors part of the 1312's memory, so these factors have been set to their default values	1. A defective back-up battery. 2. A defective Working Memory (RAM) or Source Memory (EEPROM). 3. A software fault.
MEMORY SET TO DEFAULT ERROR DETECTED IN BACKGROUND MEMORY	An error has been detected in the 1312's Background Memory, so the 1312 automatically deletes all data stored in this memory.	1. A defective back-up battery. 2. A defective Working Memory (RAM). 3. A software fault.
MEMORY SET TO DEFAULT ERROR DETECTED IN DISPLAY MEMORY	An error has been detected in the 1312's Display Memory, so the 1312 automatically deletes all data stored in this memory.	1. A defective back-up battery. 2. A defective Working Memory (RAM). 3. A software fault.
MEMORY SET TO DEFAULT ERROR DETECTED IN INTERNAL MEMORY	An error has been found in the data stored in the 1312's internal memory. Data stored in this memory cannot be read or altered by the user, so the 1312 automatically corrects any errors found in this memory.	1. A defective back-up battery. 2. A defective Working Memory (RAM). 3. A software fault.
MEMORY SET TO DEFAULT ERROR DETECTED IN SOURCE MEMORY	An error has been found in the data stored in the 1312's source memory, so the 1312 automatically gives the stored parameters default values.	1. A defective back-up battery. 2. A defective Source Memory (EEPROM). 3. A software fault.

Warning Messages		
Displayed Text	**Description of Fault**	**Possible Cause(s)**
PARAMETERS SET TO DEFAULT ERROR DETECTED IN CONFIG./FORMAT PARAM.	An error has been found in the value parameters stored in the Configuration and/or Format branches of the 1312's set-up tree, and therefore, the 1312 has automatically given these parameters default values.	1. A defective back-up battery. 2. A defective Working Memory (RAM). 3. A software fault.
PARAMETERS SET TO DEFAULT ERROR DETECTED IN TASK SET-UP PARAM.	An error has been found in the value parameters stored in the Monitoring Task branch of the 1312's set-up tree, and therefore, the 1312 has automatically given these parameters default values.	1. A defective back-up battery. 2. A defective Working Memory (RAM). 3. A software fault.

General Operating Error Messages		
Displayed Text	**Description of Fault**	**Possible Cause(s)**
`A/D INTERRUPT FAILED`	A/D converter was not able to collect the necessary number of signal measurements to ensure an accurate concentration measurement.	The analogue card is defective.
`AIR SHUNT BLOCKED. SAMPLE ABORTED`	The pressure of air in the analysis cell is too high. The microphones risk being damaged by being exposed to such high pressures.	The air-shunt valve is either defective or blocked
`CHOPPER FAILED`	The A/D converter was not able to collect the necessary number of measurements to ensure an accurate concentration measurement.	1. The chopper motor is not working. 2. The belt which drives the chopper is defective. 3. The optical sensor which checks the chopper's movement is not working.
`INTERNAL TEMPERATURE OUT OF RANGE`	The temperature in the analysis cell is either too high or too low. As the 1312 is operating outside its temperature specifications, accurate measurements can not be guaranteed.	1. The ventilating fan is defective. 2. The ambient air temperature is either too high or too low. 3. The temperature sensor is defective
`IR-SOURCE TEMPERATURE OUT OF RANGE`	The temperature of the infra-red light source is either too high or too low. As the IR-source is operating outside its temperature specifications, accurate measurements cannot be guaranteed.	The infra-red light source is defective
`MICROPHONE TEST FAILED`	The signal received from the microphone during the self-testing procedures is out of range.	1. The analogue card is defective. 2. A microphone(s) is defective.

General Operating Error Messages		
Displayed Text	**Description of Fault**	**Possible Cause(s)**
PUMP TEST FAILED	The pump cannot build up the necessary pressure during the self-testing procedure.	1. The pump is defective 2. The internal pneumatic system is not air-tight.
VIBRATION LEVEL TOO HIGH	The signal measured in the analysis cell when the IR-source and the chopper are both switched off is too high. The 1312 is likely to interpret the signal as being due to the presence of gas and therefore gas concentrations measured by the 1312 will be higher than they are in reality	1. A microphone(s) is defective. 2. The analogue card is defective. 3. The 1312 is being exposed to external vibrations (around 20 Hz).

Warnings connected with Printing, Data-logging and Error-logging		
Displayed Text	**Description of Fault**	**Possible Cause(s)**
IEEE CONTROL TIMEOUT	The 1312 wishes to send data to a printer via the IEEE interface, but the 1312 is not the system controller.	There are no other “controllers” on the IEEE bus, so the 1312 should be made the system controller.
WARNING: CTS HANDSHAKE CONFLICT	The 1312 receives the handshake signal from the RS 232 CTS (clear to send) line, but it has not been set-up to use this CTS line.	The 1312 and the RS 232 device (printer) do not agree about which handshake signal they should use. Perhaps the wrong interface cable has been used.
WARNING: DSR HANDSHAKE CONFLICT	The 1312 receives the handshake signal on the RS 232 DSR (data send ready) line, but has not been set-up to use this signal.	The 1312 and the RS 232 device (printer) do not agree about which handshake signal they should use. For example, if the device uses DSR line and you have selected either “switched-line” or “leased line” as a hard-wire mode and not selected “hard-wired” as the handshake type.
WARNING: X-ON/X-OFF HANDSHAKE CONFLICT	The 1312 receives the X-On/ X-Off handshake signal via the RS 232 interface, but it has not been set-up to use this signal.	The 1312 receives the handshake signal on the RS 232 interface, but it has not been set-up to use this signal
WARNING: TIMEOUT. DEVICE NOT CONNECTED	1312 wishes to send data (print, data-log or error-log) via the IEEE interface, but there is no response from the device with the address entered in the 1312 set-up.	1. No device is connected to the 1312. 2. The device address has been entered incorrectly in the 1312’s set-up.
WARNING: TIMEOUT. DEVICE NOT READY	1312 wishes to send data (print, data-log or error-log), but after the start of data transmission, the device stops receiving data.	1. The device is “off-line” (it can not receive data). 2. The device is not able to receive data fast enough. 3. The device is no longer connected to the 1312.