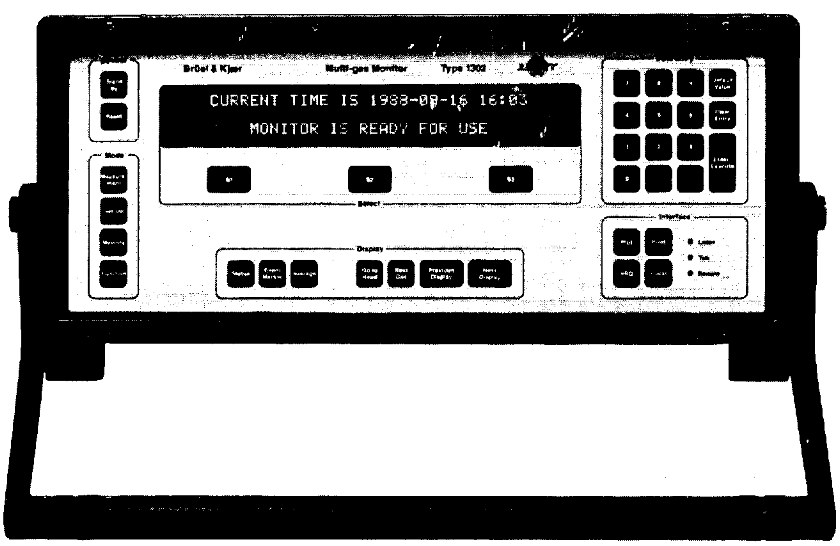
1302

Instruction Manual
Vol. 1

Operation & Maintenance

Multi-gas Monitor Type 1302



This volume provides users with detailed information about how to operate and maintain the Multi-gas Monitor Type 1302.

Brüel & Kjær

SAFETY CONSIDERATIONS

PLEASE READ THESE SAFETY CONSIDERATIONS CAREFULLY AND MAKE SURE YOU UNDERSTAND THEM PROPERLY BEFORE YOU START OPERATING THE MULTI-GAS MONITOR TYPE 1302

EXPLOSION HAZARD

⚠ **THE MULTI–GAS MONITOR TYPE 1302 IS NOT DESIGNED FOR USE IN POTENTIALLY EXPLOSIVE ENVIRONMENTS.**

This means that the instrument must **not** be placed and operated in an area with a potentially explosive atmosphere.

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

1) the instrument itself is placed in a well-ventilated area **outside** the potentially hazardous zone; and
2) that a sufficiently long tube is connected to the Monitor's "Air Outlet" so that the measured gas is carried **away** to the open air or to an extraction and/or filtration unit.

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

⚠ **AVOID WATER CONDENSATION IN THE ANALYSIS CELL.**

Liquids must be prevented from entering the analysis cell. It is therefore important that warm humid gases are not drawn into a cold analysis cell because condensation will take place. If such a situation is likely to occur you should ensure that the gases are drawn through a water-trap filter before they enter the air-inlet of the 1302. This will condense out water vapour in the gases and thus prevent condensation within the analysis cell. The water-trap filter should be used in the immediate environment of the Monitor so it maintains either the same temperature, or a lower temperature, than the Monitor.

Note: that some gases may be absorbed by the water trapped in the filter. This will reduce the gases' concentration.

MULTI–GAS MONITOR
TYPE 1302

From serial number 1487212

May 1990

SAFETY CONSIDERATIONS

The Multi-gas Monitor Type 1302 has been designed and tested in accordance with IEC Publication 348, *Safety Requirements for Class 1 Electronic Measuring Apparatus*, and has been supplied in safe condition. This Instruction Manual contains information and warnings which must be followed by the user to ensure safe operation and to retain the Multi-gas Monitor in safe condition. Special note should be made of the following:

APPLICATION OF POWER

Before using the Multi-gas Monitor check that its Mains Voltage matches the available mains voltage supply and that the correct fuse is installed (details are provided in Chapter 2).

SAFETY SYMBOLS

⚠ The apparatus is marked with this symbol when it is important that the user refers to the associated warning statements given in the Instruction Manual.

⊥ Chassis terminal ⏚ Safety earth terminal ⚡ Hazardous voltage.

EXPLOSION HAZARD

The Multi-gas Monitor is not designed to be used in potentially explosive environments. It should not be operated in the presence of flammable liquids or gases.

The Monitor contains a lithium battery. Under no circumstances should this battery be removed or replaced by the user as there is a danger of explosion. The lithium battery should only be removed by a Brüel & Kjær representative.

WARNINGS

Switch off all power to instruments before either connecting or disconnecting interface cables.

Whenever it is likely that the correct function or operating safety of the Multi-gas Monitor has been impaired, it must be made inoperative and be secured against unintended operation.

Any adjustment, maintenence and repair of the open Multi-gas Monitor Type 1302 while it is still connected to an AC mains voltage supply must be avoided as far as possible, and, if inevitable, must only be performed by a qualified person who is aware of the hazard involved.

CONTENTS

Multi-gas Monitor — Type 1302

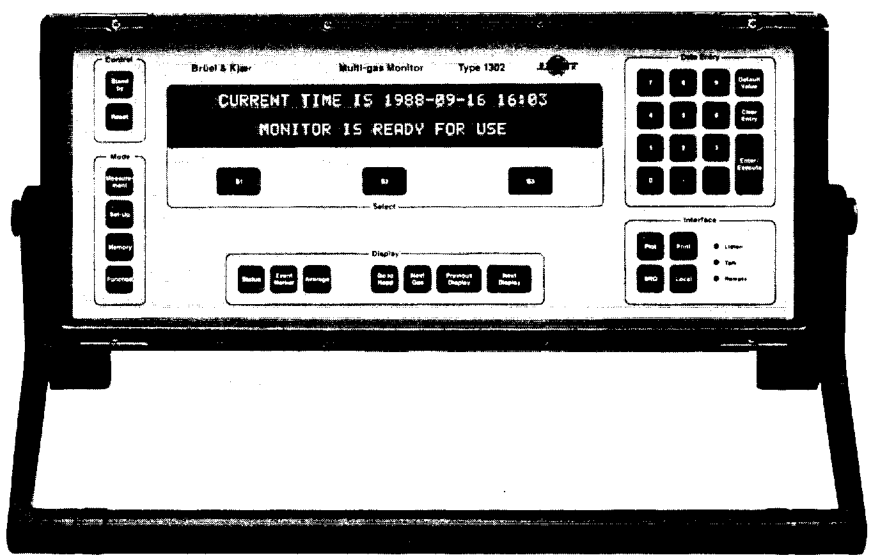
USES:

- ○ Quantitative analysis of up to 5 components and water vapour in gas mixtures
- ○ Occupational health and safety measurements
- ○ Indoor air-quality and ventilation measurements
- ○ Detection of accidental releases of gases/vapours

FEATURES:

- ○ Selectively detects a wide range of gases/vapours
- ○ Linear response over a wide dynamic range
- ○ Extremely reliable due to self-testing procedures
- ○ High stability (low drift) makes calibration only necessary about four times a year
- ○ User-friendly — easily operated by non-technical personnel
- ○ Accurate — compensates for temperature fluctuations, water-vapour interference and interference from other known gases
- ○ Extensive data-storage capacity
- ○ Equipped with RS 232C serial and IEEE 488 parallel interfaces for data transfer/remote control
- ○ Portable
- ○ Operates immediately — no warm-up time necessary
- ○ Immediate display of measurement results
- ○ Collects samples from points up to 50m away
- ○ Used with one/two Multipoint Doser and Sampler Units Type 1303 it can monitor air samples collected from 6/12 different locations

Introduction



The Brüel & Kjær Multi-gas Monitor Type 1302 is a highly accurate, reliable and stable quantitative gas analyzer which is microprocessor controlled. Its measurement principle is based on the photoacoustic infra-red detection method. In effect this means that the 1302 can be used to measure almost any gas which absorbs infra-red light. Appropriate optical filters (up to 5) are installed in the 1302's filter carousel so that it can selectively measure the concentration of up to 5 component gases and water vapour in any air sample. The 1302's detection threshold is gas-dependent but typically in the 10^{-3}ppm region.

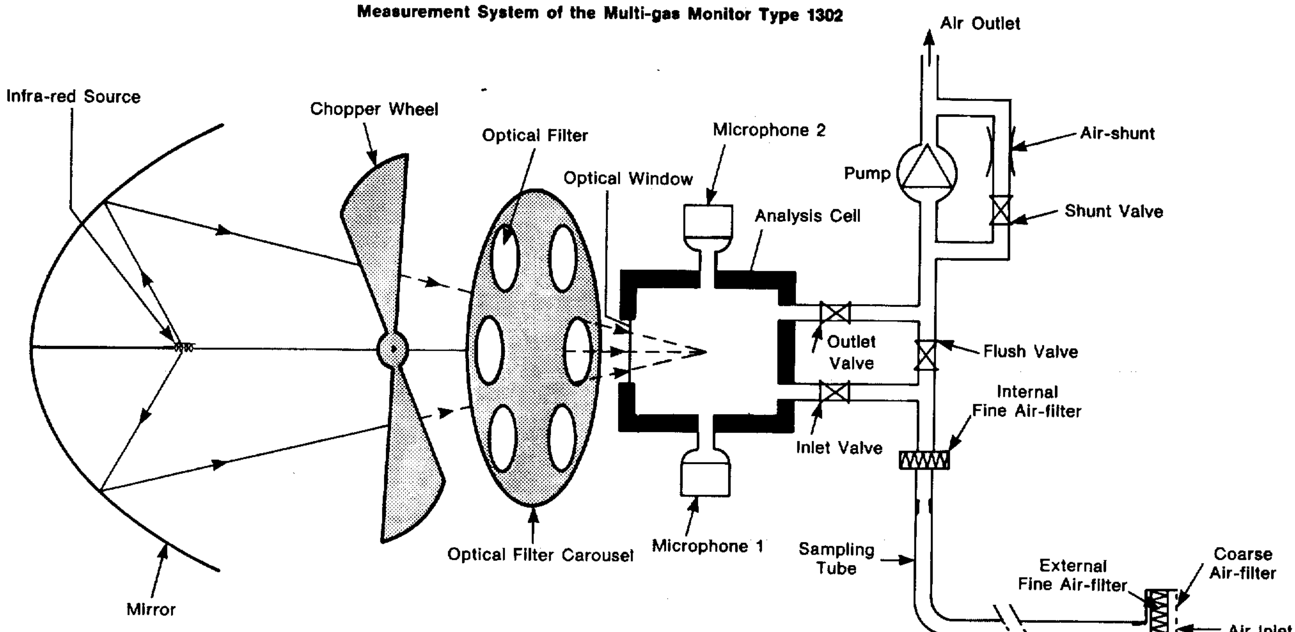
Reliability of measurement results is ensured by the regular self-tests which the 1302 performs to check that it is functioning correctly. Accuracy is ensured by the 1302's ability to compensate any measurement for temperature fluctuations, water-vapour interference and interference from other gases which are known to be present.

The Multi-gas Monitor is easily operated via its front-panel push-buttons. Each time a push-button is pressed a short self-explanatory text appears on the 1302's display screen which guides the user through each operating procedure. Directions are so logical and uncomplicated that no special training is required to learn to operate the 1302.

Users can "set-up" the 1302 to perform almost any type of monitoring task. Measurement results are displayed on the 2 × 40 character display screen as soon as they are available (30s for one gas and 105s for 5 gases and water vapour). These results are automatically stored in the 1302's extensive memory and can be printed or plotted out at a later stage.

The measurement system and the electronics necessary for signal processing and data storage are enclosed in the dust-proof case of the 1302. Be-

Measurement System of the Multi-gas Monitor Type 1302



Measurement Cycle

1. The pump draws air from the sampling point through two air-filters to flush out the "old" air in the measurement system and replace it with a "new" sample of air.
2. The "new" air sample is hermetically sealed in the analysis cell by closing the inlet and outlet valves.
3. Light from an infra-red light source is reflected off a mirror, passed through a mechanical chopper, which pulsates it, and then through one of the optical filters in the filter carousel.
4. The light transmitted by the optical filter is selectively absorbed by the gas being monitored, causing the temperature of the gas to increase. The temperature of the gas increases and decreases because the light is pulsating, and this causes an equivalent increase and decrease of the pressure of the gas (an acoustic signal) in the closed cell.
5. Two microphones mounted in the cell wall measure this pressure wave, which is directly proportional to the concentration of the monitored gas present in the cell.
6. The filter carousel turns so that light is transmitted through the next optical filter, and the new signal is measured. The number of times this step is repeated is dependent on the number of gases being measured.

If only one gas or water vapour is measured, and gas samples are drawn from the ambient air around the 1302 itself, the measurement time is about 30 s, and about 105 s if 5 gases and water vapour are measured. Increasing the length of the sampling tube increases the time taken to pump in a new sample of air and therefore increases the measurement time.

ing portable and requiring no warm-up time or re-calibration after moving, the 1302 is ideal for short-term monitoring of air samples drawn from its immediate environment. For long-term monitoring the 1302 is placed indoors and collects air samples for analysis, via polytetrafluoroethylene tubing, from points up to 50 m away.

Selectivity

The selectivity of the Multi-gas Monitor is determined by the optical filters installed in the 1302's filter carousel. A wide range of narrow-band optical filters is available from Brüel & Kjær. By studying the absorption spectra of the gases to be monitored, as well as the absorption spectra of any other gases which are likely to be found in the ambient air in the same area, the most appropriate optical filters can be chosen. Please refer to the Product Data Sheet for the Optical Filters for details.

Water vapour, which is nearly always present in ambient air, absorbs infra-red light at nearly all wavelengths so that, irrespective of which optical filter is being used during the measurement sequence of the 1302, water vapour will contribute to the total acoustic signal in the analysis cell. The higher the concentration of water vapour in the cell the more it contributes to the measured signal. However, a special optical filter is permanently installed in the filter carousel of the 1302 which allows water-vapour's contribution to be measured separately during each measurement cycle. The 1302 is thus able to compensate for water-vapour's interference.

Any other interferent gas, which is known to be present in the ambient air, can be compensated for in a similar fashion. By installing an optical filter to selectively measure the concentration of the interferent gas, the user can "set-up" the 1302 to compensate for the interferent gas's contribution.

Calibration

After installation of relevant optical filters, the Multi-gas Monitor is zero-point calibrated (using clean, dry air), humidity-interference calibrated (using clean, wet air) and then span-calibrated (using a known concentration of each of the gases it is to monitor). Calibration is very easy — the user is guided through the procedure simply by following the directions which are displayed on the 1302's screen. Due to the 1302's high stability (low drift) calibration is seldom necessary more than four times a year.

Operation

The 1302 is operated by using the push-buttons on its front panel. Short self-explanatory text appears on the 1302's display screen to guide the operator in the use of these push-buttons. There are four different operation modes: "Set-Up"; "Measurement"; "Memory"; and "Function".

User-defined Monitoring Task
Monitor gas A? / B? / C? / D? / E?
Monitor water vapour (Yes/No)?
Continuous Sampling (Yes/No)?
Sampling Interval?
Total Monitoring Period?
Compensate for Water Vapour?
Cross-compensate for Interference?

T02004GB0

Table 1. Monitoring-task "set-up" parameters which are user-definable

Set-Up Mode

When the 1302 is operated in "set-up" mode the user is able to select the parameters which define a particular monitoring task (see Table. 1). Details of up to 10 different monitoring tasks can be stored in the 1302's memory. Each monitoring task "set-up" is given a number from 1 - 10.

When operating in "set-up" mode users are also able to select the parameters which determine, for example, the units of measurement (e.g. ppm or mg/m^3 for gas concentrations); the interface and communication codes which enable measurement data to be printed and/or plotted out; the time over which measurements can be averaged (e.g. 15 min. if Short Term Exposure Levels (STEL) are required).

Measurement Mode

Operating in this mode the user selects the monitoring task he wishes the 1302 to perform, and the start-time of the task. The 1302's internal clock will automatically start the task at the pre-determined time. If a fixed monitoring period is chosen the 1302 will automatically stop the task at the end of the monitoring period; if the monitoring period is not fixed the 1302 will only stop monitoring when it is switched off manually.

Memory Mode

During a monitoring task all results are stored in a memory called *Display Memory*. While operating in "memory" mode data in this memory can be copied into (stored in) the 1302's other memory (called *Background Memory*) to prevent it being lost by being overwritten by results from the following new monitoring task.

Data stored in *Background Memory* can be recalled to *Display Memory* where the user can scroll through the measurement results on the 1302's display screen using the "Display" push-buttons. Data can also be deleted from *Background Memory* to enable new measurement data to be stored in it.

Function Mode

In this mode the user can "set-up" the 1302 to automatically perform almost any sequence of operations over any period of time. Using the front-panel push-buttons the user "keys-in" the sequence of operations he wishes the 1302 to perform. This "key sequence" is stored in the 1302's memory and the operation sequence automatically performed on request.

A "key sequence" could for example be used to "set-up" the 1302 to perform three different monitoring tasks during three consecutive work-shifts in a factory manufacturing 24 hours a day.

Measurement Results

Gas measurement results are displayed on the 1302's display screen as soon as they are available and are constantly updated. During a task the 1302 performs a running statistical analysis of measured gas concentrations. The Mean Value; the Standard Deviation; the Maximum and Minimum measured concentrations of each monitored gas are calculated. The Mean Value is the same as the Time-Weighted Average (TWA) value during the total monitoring period.

By pressing the **Average** push-button the individual gas-measurement results stored in *Display Memory* are automatically averaged and presented on the display. When the **Average** push-button is pressed again the original measurement results will again be shown on the display screen.

Measurement data stored in the 1302's *Display Memory* can be printed out in list form on the Brüel & Kjær Graphics Recorder Type 2313, or any standard text-printer, via either the IEEE 488 parallel interface or the RS 232 C serial interface port of the 1302. Data can also be represented graphically and plotted-out using the Brüel & Kjær Graphics Plotter Type 2319.

If any interesting or unusual event occurs during a monitoring task, the measurement being performed at this time can be marked by pressing the **Event Marker** push-button. This enables the user to assess the "event's" affect on the monitoring task.

Remote Control

The Multi-gas Monitor Type 1302 can be remotely controlled by computer via either the RS 232 C or the IEEE 488 interface. Brüel & Kjær Application Software Type 7620 enables an IBM AT or PS/2-50 (or larger) computer to remotely control either a Multi-gas Monitor Type 1302 alone, or, alternatively, the 1302 together with one or two Multipoint Doser and Sampler Units Type 1303 (see Fig. 1). A single 1303 extends the monitoring capabilities of the 1302 substantially by enabling it to analyze air-samples from up to 6 different locations. The Application Software controls the whole system.

If the 1303 is only used as a "Sampler" the 1302 is able to sequentially monitor air-samples collected from up to 6 different locations; if the 1303 is used as a "Doser" and "Sampler" the 1303 can "dose" up to 6 different locations with a tracer gas and then draw air-samples from each of these locations for analysis by the 1302. The software analyzes the resultant measurements to calculate the air-change or ventilation efficiency of each location.

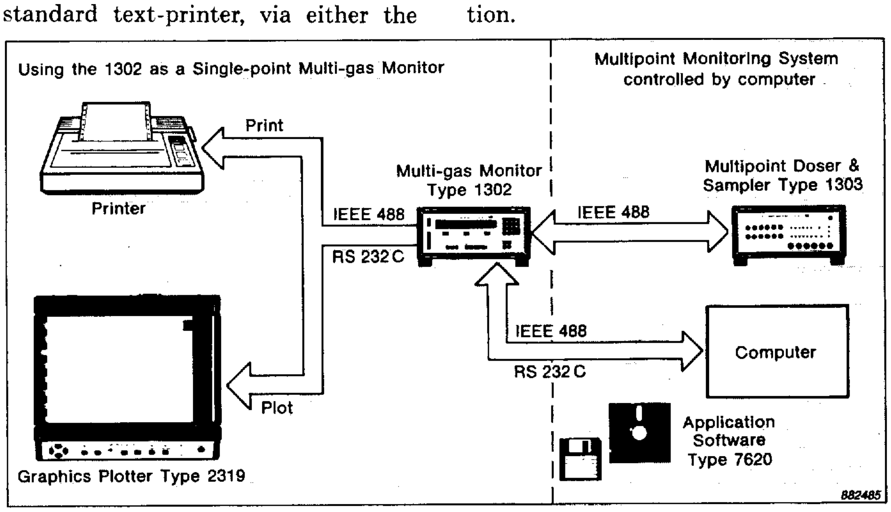


Fig. 1. Using the Multi-gas Monitor Type 1302 either alone, as a single-point multi-gas monitor, or together with a 1303 in a multipoint multi-gas monitoring system controlled by computer using available software

Reliability

Performance reliability is ensured by the series of self-tests which the 1302 performs. The self-tests include: checking software; data integrity and the electrical, mechanical and electronic parts of the 1302 to ensure that it is functioning properly. If any fault is found, it is reported in the measurement results so that users can see what, if anything, has affected the accuracy of the measurement. If there is an AC mains power-supply failure the 1302 will automatically start-up again when power is restored.

Maintenance

The only maintenance tasks necessary are calibration and changing the fine filter-paper in the internal and external air-filtration units of the 1302. Both tasks are easily performed and should typically be necessary only four times a year.

Specifications 1302

All terms relating to gas analysis are in accordance with the definitions set out in the ISO Draft International Standard 8158

Your local Brüel & Kjær representative will assist in the selection of suitable optical filters. Details are provided in the "Optical Filters" Product Data Sheet.

If the optical filters necessary for the user's monitoring task are ordered together with the 1302 they are installed by B & K. The 1302 is then zero-point and humidity-interference calibrated. Span-calibration with a specific gas is optional. A "calibration chart" provided with the 1302 details the optical filters installed and the type of calibration performed with the 1302.

Optical filters can be bought at a later stage when new applications are found. Details of the installation of the filters and calibration of the 1302 are found in the 1302's Instruction Manual.

MEASUREMENT TECHNIQUE:
Photoacoustic Infra-red spectroscopy

RESPONSE TIME: (this includes the purging of the cell) is dependent on the number of gases being measured and the length of the sampling tube used. If the tube is less than 1 m then the response time is ~30 s if one gas or water vapour is measured, and ~105 s if 5 gases and water vapour are measured. Use of a 50 m tube will increase the response time.

MEASUREMENT RANGE:●
Detection Threshold: is gas-dependent but typically ranges from 10^{-3} parts/million (ppm) to 1 ppm (see Product Data for the Optical Filters for examples of the detection threshold of some pure gases/vapours).
Dynamic Range: five orders of magnitude (that is, the upper detection limit = 100 000 times the lower detection limit). If the 1302 is required to measure over this wide dynamic range span-calibration has to be performed with two different gas concentrations. Users should be aware that certain gases in high concentration in the presence of water vapour could damage the 1302. Ask your local B & K specialist for further information.

MEASUREMENT UNITS:
In mg/m^3 and parts/million (ppm) normalized to the temperature entered by the user.

ACCURACY:
Zero Drift:
Typically = Detection Threshold per 3 months●
Influence of temperature■: ± 10% of detection threshold/°C
Influence of pressure▲: ± 0,5% of detection threshold/mbar
Repeatability: 1% of measured value●
Range Drift:
± 2,5% of measured value per 3 months●
Influence of temperature■: ± 0,3% of measured value/°C
Influence of pressure▲: − 0,01% of measured value/mbar

REFERENCE CONDITIONS:
- ● Measured at 20°C, 1013 mbar, and relative humidity (RH): 60%.
- ■ Measured at 1013 mbar, and RH: 60%.
- ▲ Measured at 20°C and RH: 60%.

CALIBRATION:
Calibration is a three/four-stage operation performed by consecutively attaching supplies of (1) dry air; (2) wet air; and (3) one or two different known concentrations of the gas-to-be-monitored to the 1302's air-inlet. Calibration is typically necessary only four times a year.

INTERFERENCE:
The 1302 automatically compensates for interference caused by temperature fluctuations in its analysis cell, and it can compensate for the presence of water vapour in the air sample. If an optical filter is installed to measure a known interferent the 1302 can cross-compensate for the interferant.

DATA STORAGE CAPACITY:
Can store measurement results from a 12-day monitoring task involving the monitoring of water vapour and 5 gases every 10 min.

GENERAL:
Cabinet: complies with IEC 529 Standards.
Dimensions:
Height: 175 mm (6,9 in)
Width: 395 mm (15,6 in)
Depth: 300 mm (11,8 in)
Weight: 9 kg (19,8 lbs)
Operating Temperature: +5°C to +40°C
Relative Humidity: Up to 90% relative humidity at 30°C (non-condensing)
Maximum Pumping Rate: 30 cm^3/s (when purging the sampling tube) and 5 cm^3/s (when purging the analysis cell)
Volume of Air required per sample: (using a 1 m sampling tube) 140 cm^3/sample
Power Requirement: 100 − 127 V and 200 −240 V (50 - 400 Hz) ± 10% AC. Complies with IEC 348 Class 1 Safety Standards
Power Consumption: ~100 VA.
Alarm Relay Socket: for connection to one or two alarm relays (visual/audio). Alarm levels for each gas are user-defined.
Acoustic Sensitivity: Not influenced by external sound
Electromagnetic Compatibility: Complies with U.S. FCC requirements for class B computing devices.

COMMUNICATION:
The 1302 has an IEEE 488 parallel interface and an RS 232 C serial interface. Data can be both sent to and received from other equipment and the 1302 can also be remotely controlled via these interfaces. The RS 232 C baud-rate is from 300–9600. The 1302 is able to convert data received via its RS 232 C serial interface (e.g. from a computer) into data which can be sent on its IEEE 488 parallel interface to the 1303.
Back-up Battery: a 3 V lithium battery, which has a life-time of 5 years, protects the data stored in the 1302's *Display and Background memory* and enables the internal clock to run.

ACCESSORIES INCLUDED:
Optical filter "locking" springs (8) .... DL 3322
Spanner (wrench) for internal air-filtration unit .... QA 0181
Fine filter-papers (10) for internal air-filtration unit .... DS 0714
External Air-filtration unit .... UD 5023
Fine filter-papers (25) for external air-filtration unit .... DS 0759
Tweezers .... QA 0164
Tool for "locking" spring .... QA 0170

Calibration Kit consisting of:
"Y"-piece .... UD 5001
Threaded Nuts (2) .... YM 0652
Polytetrafluorethylene tubing .... AT 2177
Nafion (copolymer of tetrafluoro-ethylene & fluorosuphonyl monomer) tubing .... UD 5037
Fittings for tubing .... UD 5046

Lid to cover front panel .... FE 0023
"User's Guide to the Set-up Tree" .... QH 0029
Shoulder strap .... DH 0541
Mains cable with 3-pole female CEE plug .... AN 0010
Spare fuses:
110 V, 1,25 A slow-blow (2) .... VF 0027
220 V, 0,63 A slow-blow (2) .... VF 0032

ACCESSORIES AVAILABLE:
Optical Filters (22) .... UA 0968-UA 0988 .... and UA 0936
Span Calibration .... UA 1098
IEEE 488–IEEE 488 Interface cable .... AO 0265
IEEE 488–IEC 625 Interface cable .... AO 0264
RS 232 C Interface cable (25 pin–25 pin) nul-modem included .... WL 0947
6-pin DIN plug (male) with locking collar for alarm relay .... JP 0600
Polytetrafluorethylene tubing .... AF 0614
Graphics Recorder .... Type 2313
Graphics Plotter .... Type 2319
Multipoint Sampler & Doser Unit .... Type 1303
Application Software .... Type 7620

2. PRELIMINARY TASKS

When taking delivery of the Multi-gas Monitor Type 1302, three very important and necessary preliminary tasks must be completed before starting to operate it:

1. Adjustment of the "Mains Voltage" selector (see Section 2.1).
2. Check/Change of the fuse in the 1302 (see Section 2.2).
3. Calibration of the installed optical filters (see Section 2.3, 2.4 & 2.5).

2.1. ADJUSTMENT OF THE "MAINS VOLTAGE" SELECTOR

The 1302 is able to operate in two different AC voltage ranges:

1. From 100 V - 127 V, and
2. From 200 V - 240 V.

Before the 1302 is operated, the mains voltage selector (labelled "Mains Voltage") on the back panel of the 1302 (see Fig. 2.1) must be adjusted to match the voltage of the AC mains power supply being used.

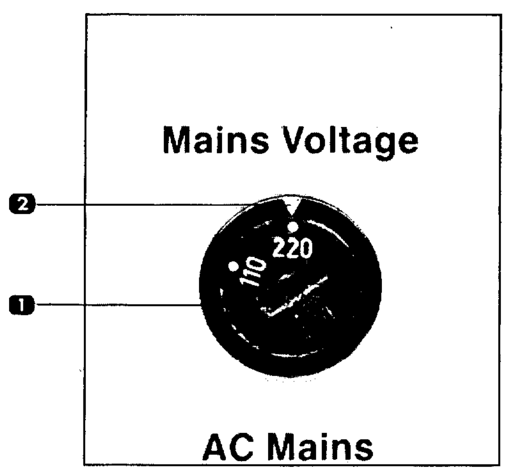


Fig. 2.1. The "Mains Voltage" selector

Step 1.
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:

- the number **110** if the voltage of the AC mains voltage supply to be used lies between 100 and 127 V; or
- the number **220** if the voltage of the AC mains voltage supply to be used lies between 200 and 240 V.

2.2. CHECK/CHANGE OF THE FUSE IN THE 1302

The voltage-rating of the mains power supply being used also determines the rating of the fuse which needs to be installed in the 1302 before it is used.

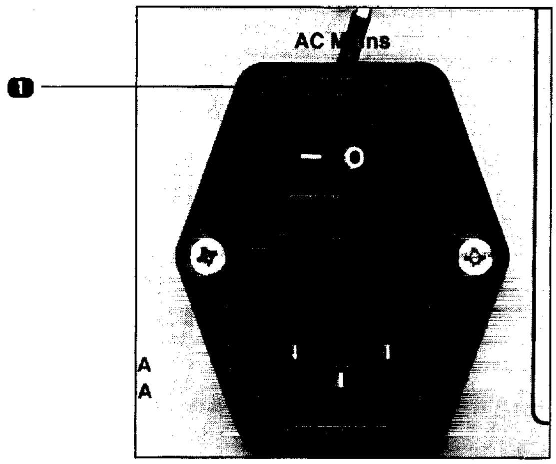


Fig. 2.2. The "AC mains" socket

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

Step 2.
Take out the fuse-holders ❶ (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 either:

- Slow-blow (T) fuses with a rating of 1,25 A if the AC mains voltage to be used lies between 100 - 127 V; or
- Slow-blow (T) fuses with a rating of 0,63 A if the AC mains voltage to be used lies between 200 - 240 V.

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

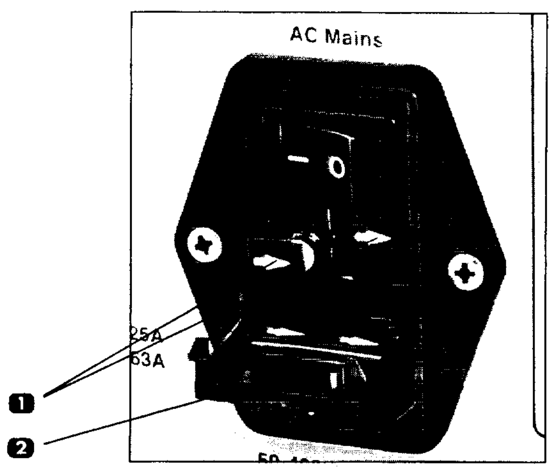


Fig. 2.3. Taking out the fuse-holders

Step 3.
Turn the fuse-holders so that the arrows ❶ on them are pointing in the same direction as the arrows on the inside surface of the plate ❷ covering the fuses in the "AC Mains" socket, and slide the fuse-holders (with fuses) into position in the 1302 (see Fig. 2.3).

Step 4.
Flip the top plate back and "click" it into position by pressing it gently against the back panel of the 1302.

2.3. CALIBRATION OF THE INSTALLED OPTICAL FILTERS

In collaboration with Brüel & Kjær Sales Engineers you have chosen the optical filters which 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 1302. A special optical filter, which is only selective to water vapour, is always installed in position "W" of the filter carousel. 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 1302 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. 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 1302 is unable to measure accurately.

Each filter in the carousel has to be **fully** calibrated before the 1302 can perform accurate gas measurements. The practical calibration procedure is fairly simple, it involves performing measurements with the 1302 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.

2.3.1. Checking the Calibration of Each Installed Optical Filter

The best way of checking the calibration of each optical filter is to obtain a print-out of the calibration data stored in the 1302's memory. This data print-out is useful to have for reference and it also enables you to find out how "old" calibration factors compare with the "new" calibration factors calculated during re-calibration tasks. Section 12.2.1 provides details of how to obtain a print-out of calibration data using a printer with an RS 232 C interface; and Section 12.2.2 provides details of how to obtain a print-out of calibration data using a printer with an IEEE 488 interface.

---

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

```
- 1302 Calibration Data ------------ 1081011 - 1990-03-13 08:21 - Page  1 -
GENERAL CALIBRATION INFORMATION FOR FILTER A.
---------------------------------------------------------------------------

Installed Optical Filter                     :          UA0976
Active Filter Bank Number                    :               1
OPTICAL FILTER FACTORS
---------------------------------------------------------------------------
Back. temp. factor                           :      -4.252E-03
Conc. temp. factor                           :      6.9600E-03
Hum. temp. 1 factor                          :      -11.50E-03
Hum. temp. 2 factor                          :      -100.0E-06
Hum. temp. 3 factor                          :      -5.000E-03
Hum. sqr. factor                             :      884.00E+00
Hum. cub. factor                             :      1.6530E+06
ACTIVE CALIBRATION DATA
---------------------------------------------------------------------------
Gas name : Gas UA0976
Molecular weight                             :      146.05E+00
Alarm Limit                                  :        _______ ppm

Span Calibration performed                   :      1990-03-13
Type of Span Calibration                     :    Single Point
Conversion factor                            :      133.81E+03
Concentration                                :            14.3 ppm
Microphone Signal                            :             546 uV

Zero-Point Calibration performed             :      1990-03-13
Concentration offset factor                  :      10.842E-06
Microphone Signal                            :            2.77 uV

Hum. Interference Calibration performed      :      1990-03-13
Humidity gain factor                         :      20.441E-03
Microphone Signal                            :            5.34 uV

Cross Interference Calibration performed     :      __________
Formaldehyd interference on :
Filter B                                     :      __________
Filter C                                     :      __________
Filter D                                     :      __________
Filter E                                     :      __________
CALIBRATION DATA IN FILTER BANK NUMBER       :               1
---------------------------------------------------------------------------
Gas name : Gas UA0976
Molecular weight                             :      146.05E+00
Alarm Limit                                  :        _______ ppm

Span Calibration performed                   :      1990-03-13
Type of Span Calibration                     :    Single Point
Conversion factor                            :      133.81E+03
Concentration                                :            14.3 ppm
Microphone Signal                            :             546 uV

Zero-Point Calibration performed             :      1990-03-13
Concentration offset factor                  :      10.842E-06
Microphone Signal                            :            2.77 uV

Hum. Interference Calibration performed      :      1990-03-13
Humidity gain factor                         :      20.441E-03
Microphone Signal                            :            5.34 uV

Cross Interference Calibration performed     :      __________
Formaldehyd interference on :
Filter B                                     :      __________
Filter C                                     :      __________
Filter D                                     :      __________
Filter E                                     :      __________
GENERAL CALIBRATION INFORMATION FOR WATER FILTER.
---------------------------------------------------------------------------

WATER FILTER FACTORS
---------------------------------------------------------------------------
Back. temp. factor                           :      4.0000E-03
Conc. temp. factor                           :      2.1500E-03
Hum. sqr. factor                             :      2.4070E-06


ACTIVE CALIBRATION DATA
---------------------------------------------------------------------------
Span Calibration performed                   :      1990-03-13
Conversion factor                            :      16.703E-09
Microphone Signal                            :             241 V

Zero-Point Calibration performed             :      1990-03-13
Concentration offset factor                  :      4.9598E-06
Microphone Signal                            :            5.26 V
                                                                    900538
```

Fig. 2.4. Part of a calibration data print-out

Fig. 2.4 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 1302 about where you wish to store the calibration data for this gas. This is done by operating the 1302 in **Set-Up mode** and choosing the number of the filter bank in which to store the calibration factors for this particular gas. The number of the filter bank chosen when operating in **Set-Up mode** is called the **active** filter bank.

Step 1.
Connect your 1302 to a printer and obtain a print-out of calibration data.

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.

All calibration factors are expressed as exponential numbers. For example: 104,05E–3, this is the same as the number $104{,}05 \times 10^{-3} = 0{,}10405$.

Step 2.
Refer to your calibration data print-out and check the following information:

1. 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".

2. 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:

   (*a*) **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.

   (*b*) **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".

   (*c*) **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.

   (*d*) **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".

   (*e*) **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.

   (*f*) **"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.

(*g*) 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.

(*h*) 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.

3. 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 1302, 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 1302 is able to perform accurate measurements.

In most cases users will find that only span calibration of the filters "A" to "E" will be required and this calibration is described in the following section. If any other type of calibration is necessary refer to Chapter 15.

2.4. SPAN CALIBRATION OF THE OPTICAL FILTER IN POSITION "A"

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

1. Checking optical filter parameters (see Section 2.4.1).
2. Connecting the 1302 to a printer and setting it up to print a data log (see Section 2.4.2).
3. Warming up the 1302 (see Section 2.4.3).
4. Setting-up a span calibration task (see Section 2.4.4).

Step-by-step instructions are provided in this section about how to perform the above-mentioned tasks, but little explanation is given. It will therefore be possible for even first-time users to complete these tasks without first familiarizing themselves with the operating philosophy of the 1302. Explanations of these tasks can, however, be found in other chapters of this manual.

1. **Checking the 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 1302. 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.

2. **Connecting the 1302 to a printer:** During calibration a particular gas is drawn into the cell and the microphones measure the signal produced by the gas's absorption of light from the infra-red light source. As soon as a measurement is made it is displayed on the 1302's screen. Measurement results are constantly updated on the display but only **one** set of measurement results are displayed at any time, and no scrolling facility is available to look at previously-displayed results. We therefore suggest that you link your 1302 to a printer and set the 1302 up to print a "**Data log**". This will enable the 1302 to automatically send measurement results to the printer which will save you the time and effort required to manually copy results from the screen during calibration.

3. **Warming-up the 1302:** 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 1302 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.

4. **Setting up a span calibration task:** Before the practical calibration task can be started, the 1302 has to be informed about the kind of calibration task you wish it to perform.

2.4.1. Checking Optical Filter Parameters

Before starting any calibration of the optical filters it **is very** important to check that the correct information about the installed optical filters has been "entered" into the 1302's memory.

Step 1.
Press the **Set-Up** **S3** **S3** **S3** buttons

The following text appears on the screen display:

```
SELECT UA NUMBER FOR FILTER A 0988
DOWN          ACCEPT          UP
```

Step 2.
The UA number of the filter installed in position "A" was checked on the calibration data print-out (see Step 2 of Section 2.3.1).

Note: Be aware that 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.

Step 3.
Press the **S2** button.

The following text appears on the screen:

ENTER FILTER BANK NUMBER 1		
DOWN	ACCEPT	UP

Step 4.
"Enter" the number of the filter bank (1–5) where you wish the 1302 to store the **conversion factor** calculated during span calibration of this filter using this particular gas. Use either the **S1** or **S3** button to obtain the chosen number.

Step 5.
Press the **S2** button.

The following text appears on the screen:

GAS A IS "_ "		
CHANGE CHAR.	ACCEPT NAME	NEXT CHAR.

Step 6.
"Enter" the name of the gas which the filter in position "A" is to measure — see Section 7.2.3. This is the gas which will be used during the span calibration of this filter.

Step 7.
Press the **S2** button to "Accept" the name you have "entered" on the display screen:

ENTER MOLECULAR WEIGHT OF GAS A 1.0000		
DOWN	ACCEPT	UP

Step 8.
Use the **Data Entry** buttons to "enter" the molecular weight of the gas to be measured by filter A as described in Section 7.2.4.

Step 9.
Press the **Set-Up** button.

2.4.2. Connecting the 1302 to a Printer

Section 12.2.1 provides details of how to connect the 1302 to a printer with an RS 232C interface; and Section 12.2.2 provides details of how to connect the 1302 to a printer with an IEEE 488 interface.

Setting-up the 1302 to Print a Data Log

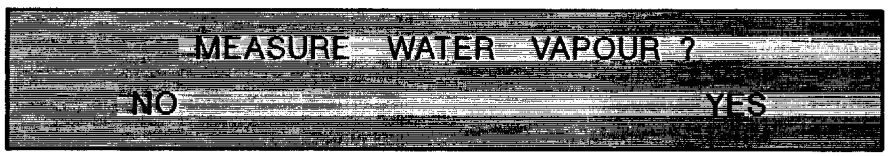
Press the [Set-Up] [S3] [S1] [S1] [S3] [Next Display] [S3] and [Set-Up] buttons.

2.4.3. Warming up the 1302

To warm-up the 1302 you need to set-up a monitoring task and make the 1302 perform the task for a period of time.

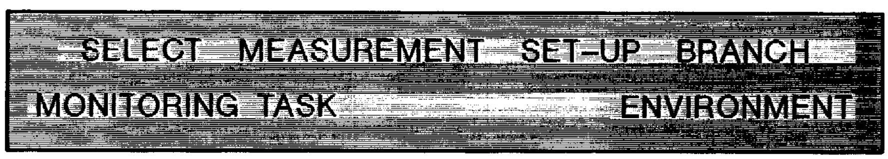
Setting-up a Monitoring Task

Step 1.
Press the [Set-Up] [S1] [S1] [S2] [S3] [S1] [S1] [S1] buttons and then press the [S1] button until the following text is shown on the display:



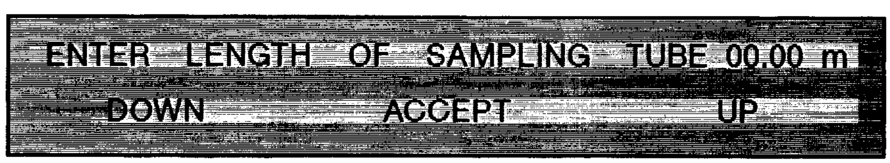
Step 2.
Press the [S3] button.

The following text appears on the screen:



Step 3.
Press [S3].

The following text appears:



Step 4.
Use the **Data Entry** keys to enter the length of the sampling tube attached to the air inlet of the 1302. If you make a mistake just press the [Clear Entry] button and enter the correct value. When the correct value is shown on the display, press the [Enter] button.

Note: the actual length of the sampling tube is not taken into consideration during a calibration task, however, during a monitoring task, the length is used to calculate how long the pump should run in order to flush out the sampling tubes between each measurement cycle.

The following text appears:

ENTER ACTUAL AIR PRESSURE 101,33 kPa		
DOWN	ACCEPT	UP

Step 5.
Use the **Data Entry** buttons to enter the barometric pressure in your environment and then press the **S2** button to "accept" the value.

Step 6.
Press the **Set-Up** button.

Starting the Monitoring Task

Step 7.
Press the **Measurement** **S1** **S1** buttons.

The 1302 will now monitor water vapour continuously. Let it monitor for 30–40 min.

Stopping the Monitoring Task

Step 8.
Press the **Measurement** and **S3** buttons.

This will stop the monitoring task.

2.4.4. Setting-up a Span-calibration Task

During span calibration of a filter a known concentration of span gas is attached to the air inlet of the 1302 and measurements are performed using the filter installed to measure the gas. However, before these practical measurements are performed, the 1302 has to be informed about what kind of calibration task you wish it it perform. It is possible to select to span calibrate a single filter. In this section we will illustrate how to set-up the span calibration of the optical filter in position "A", with or without cross-compensation calibration.

What is a Span Gas, and what Concentration do you Need to Use?

Which gas is used to span calibrate filter "A"? It is the same as the gas you wish the 1302 to measure using filter A.

What concentration should it have? It must have a concentration of at least 25 times its detection limit and not more than the highest concentration of gas A which you expect to be measuring.

The wall chart "Gas Detection Limits" (literature number BG 0552) will give you some indication of the gas's detection limit using the filter you have chosen.

To illustrate, suppose filter UA 0986 is installed in position A to measure acetaldehyde gas:

The detection limit for acetaldehyde using this filter is = 0,1 ppm, thus a concentration of 0,1 × 25 = 2,5 ppm is the minimum concentration which could be used during the span calibration of this filter with acetaldehyde. Suppose that the upper limit of acetaldehyde concentrations you expect to be measuring = 100 ppm, this concentration is the maximum concentration which should be used for a single-point span calibration of filter "A" using acetaldehyde. Any acetaldehyde provided in a gas cylinder with a concentration between 2,5 and 100 ppm can be used.

The span gas you use for calibration should be provided with an "Analysis Certificate" which states the accurate concentration of gas in the cylinder. This is the concentration which you will have to "enter" when setting-up the span calibration task. Normally the concentration is given in units of ppm. If this is so, then we suggest that you change the 1302's default concentration unit (mg/m^3) to ppm. This is described in Section 7.3.

Setting-up a Span-calibration Task

Step 1.
Press [Measurement] [S3] [S3] [S1] [S1] [S1]

PERFORM CROSS INTERFERENCE CALIBRATION ?
NO YES

Step 2. (There are 2 possible choices)

1. If you wish to measure the cross-interference of gas "A" on the other installed optical filters, press [S3].
2. If you do **not** wish to measure the cross-interference of gas "A" on the other installed optical filters, press [S1].

Step 3.
Press [S3].

The following display appears:

CALIBRATE A WITH: (name entered in Section 2.4.1 will appear here)
NO SINGLE TWO-POINT

Step 4.
Press [S2]

The following text appears on the display:

ENTER GAS CONC. ——— ppm*
DOWN ACCEPT UP

*this unit will depend on the unit chosen in the 1302's set-up

The "Gas Concentration" referred to is that which is to be used during the span calibration of filter "A". This is the concentration which must be entered on the above display.

If the gas concentration on the "Analysis Certificate" is given in ppm then the following formula can be used to convert from parts per million units (ppm) to mg/m^3:

For a gas at 25°C and at 1 atmosphere pressure:

$$\text{Concentration (in mg/m}^3\text{)} = \frac{\text{Concentration (in ppm)} \times \text{Molecular Weight (in g)}}{24{,}45}$$

CHAPT24

Step 5.
Use the **Data Entry** buttons to "enter" the concentration of gas to be used.

Step 6.
Press the **S2** button and then the **S1** button until the following text is displayed:

PERFORM PRACTICAL CALIBRATION TASK ?
NO YES

Step 7.
Press the **S3** button.

The following text appears on the screen:

CONNECT (the name of the gas appears here) ——— ppm
AND PRESS <ENTER> WHEN READY

2.5. PRACTICAL SPAN CALIBRATION OF FILTER "A"

The practical span calibration task is performed immediately after the span calibration task has been set up.

The general equipment required to perform the calibration is shown in Fig. 2.5. 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 1302; 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.

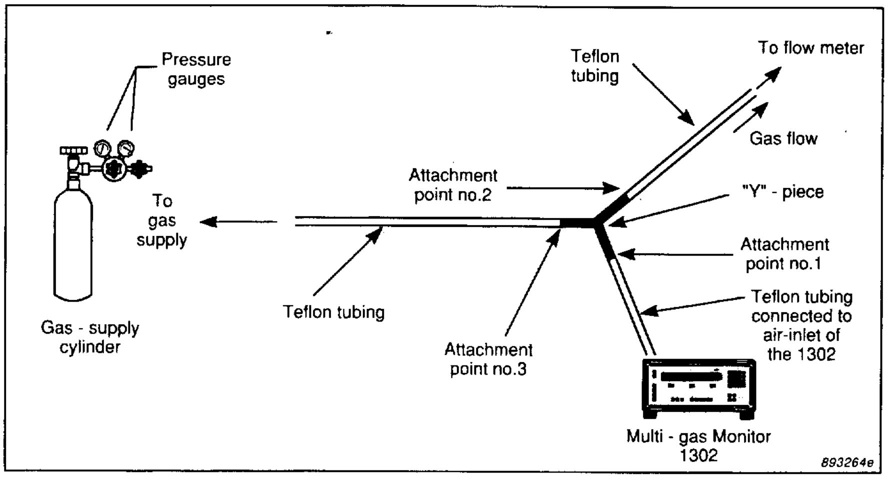


Fig. 2.5. General equipment required for a calibration task

Attaching a gas flow meter serves two vital functions (see Fig. 2.6):

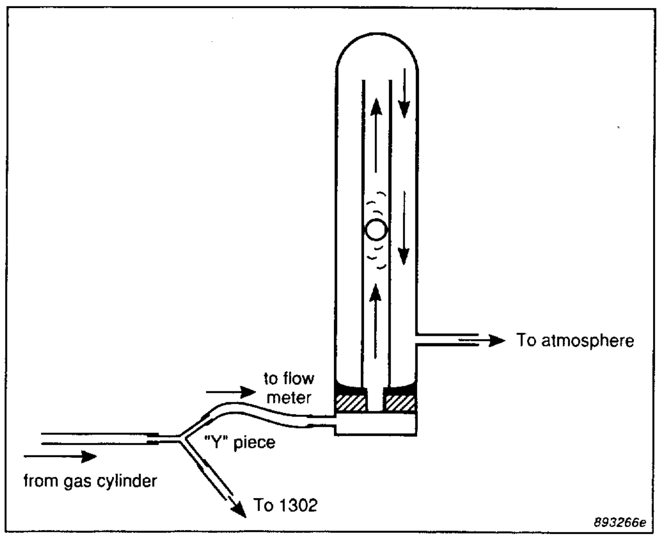


Fig. 2.6. Schematic diagram of a flow meter

1. It allows you to 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.

2. 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 pressure of the gas in the analysis cell should **NEVER** be greater than 1.1 bars, that is, 0,1 bars above atmospheric pressure otherwise the microphones are likely to be damaged.

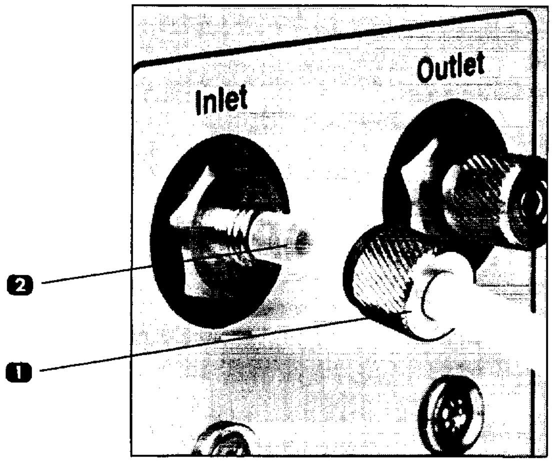


Fig. 2.7. Attaching tubing to the air-inlet stub

Step 1. (see Fig. 2.7)

(a) Push one end of 1 m length of Teflon (polytetrafluoroethylene) tubing through the non-threaded end of the nut **1**.

(b) Hold the end of the tubing between the fingers and gently push the tubing over the end of the 1302's air-inlet stub **2** 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 **1** firmly onto the end of the air-inlet stub.

Step 2.

(a) Connect the free-end of the length of tubing attached to the air-inlet of the 1302 to one of the branches of the "Y"-piece (see attachment point no. 1 in Fig. 2.5).

(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. 2.5) and its other end to a flow-meter.

Step 3.

Connect a 1 m length of tubing to attachment point no. 3 of the "Y"-piece (see Fig. 2.5).

⚠ **WARNING:** The analysis cell of the Multi-gas Monitor is equipped with highly sensitive microphones, and therefore NO direct connection between the 1302'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.

Step 4.

(a) Connect the free-end of the teflon tubing mentioned in Step 3 to the pressure valve on a cylinder of gas A of known concentration (the display tells you the concentration).

(b) Press the **Enter** button.

(c) Gently open the pressure-valve on the gas cylinder and regulate the flow of gas so that when the 1302's pump is running there is a positive flow of gas **out** of the flow meter. This will ensure that the calibration gas is not diluted by atmospheric air.

The following text appears on the screen:

RESULTS NOT YET AVAILABLE
PLEASE WAIT

Once the first measurement result is available the screen text illustrated above is replaced by a screen displaying the measurement results — for example the following:

```
W:   μ 3.0μV      σ ——— V      1      35.0°C
PRESS <ENTER> WHEN RESULTS ARE STABLE
```

As soon as measurement results are available they not only appear on the display (see Fig. 2.8) but are automatically printed out on the printer (see Fig. 2.9).

Each time a sample of gas is drawn into the analysis cell the signal is measured using both optical filter "A" and the water-vapour filter ("W") but, due to lack of space on the **display**, the 1302 only displays the signal measured using the water-vapour filter. The data-log print-out, however, shows the signal measured using both the water-vapour filter and filter "A". If **cross-compensation calibration** was also selected in the calibration set-up (see Section 2.4.4., Step 2 no. 1), then the signal is measured in the cell using all the installed filters.

A maximum of 6 measurements are stored in the 1302 during any calibration. The number (n) indicates how many measurements are stored. When 7 measurements have been performed the number (n) will show the number 6 because the very first measurement is overwritten by the 7th measurement so that ony 6 measurements are still stored. When 8 measurements have been completed the number (n) will also show 6 because the results of the first and second measurements have been overwritten by the 7th and 8th measurement results ... and so on.

Step 5.
Let the 1302 continue measuring the span gas A until the temperature in the cell is approximately 15° above the ambient temperature in the room where calibration is being performed. Look at the print-out of the average and standard deviation measurements for (1) the water-vapour and (2) the filter "A". When these values have stabilised for both filters, span calibration measurements do not need to continue. Continue to the next Step.

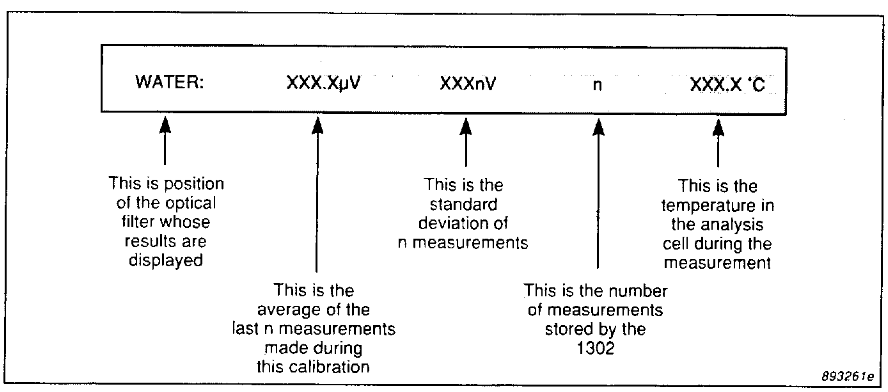


Fig. 2.8. Example of data displayed during span calibration of Filter "A" (the text below the display describes the displayed data)

```
---- Data Logger: Span Calibration ( High ) Started

1 12:46:59   545E-06    . . .    . . .    . . .    . . .   28.4E-06 V Mean
      38.45    . . .    . . .    . . .    . . .    . . .      . . . V Dev.

1 12:48:45   547E-06    . . .    . . .    . . .    . . .   21.9E-06 V Mean
      38.45 1.97E-06    . . .    . . .    . . .    . . .   6.51E-06 V Dev.

1 12:50:26   547E-06    . . .    . . .    . . .    . . .   18.3E-06 V Mean
      38.45 1.76E-06    . . .    . . .    . . .    . . .   7.28E-06 V Dev.

1 12:52:07   548E-06    . . .    . . .    . . .    . . .   16.2E-06 V Mean
      38.45 1.57E-06    . . .    . . .    . . .    . . .   7.36E-06 V Dev.

1 12:53:48   548E-06    . . .    . . .    . . .    . . .   14.6E-06 V Mean
      38.55 1.40E-06    . . .    . . .    . . .    . . .   7.29E-06 V Dev.

1 12:55:28   548E-06    . . .    . . .    . . .    . . .   13.4E-06 V Mean
      38.55 1.30E-06    . . .    . . .    . . .    . . .   7.16E-06 V Dev.

1 12:57:09   548E-06    . . .    . . .    . . .    . . .   9.88E-06 V Mean
      38.65  642E-09    . . .    . . .    . . .    . . .   2.80E-06 V Dev.

1 12:58:49   548E-06    . . .    . . .    . . .    . . .   8.44E-06 V Mean
      38.75  489E-09    . . .    . . .    . . .    . . .   1.58E-06 V Dev.

1 13:00:30   547E-06    . . .    . . .    . . .    . . .   7.65E-06 V Mean
      38.95  417E-09    . . .    . . .    . . .    . . .   1.03E-06 V Dev.

1 13:02:11   547E-06    . . .    . . .    . . .    . . .   7.10E-06 V Mean
      38.95  375E-09    . . .    . . .    . . .    . . .    677E-09 V Dev.

1 13:03:52   547E-06    . . .    . . .    . . .    . . .   6.72E-06 V Mean
      38.85  368E-09    . . .    . . .    . . .    . . .    514E-09 V Dev.

1 13:05:32   547E-06    . . .    . . .    . . .    . . .   6.45E-06 V Mean
      38.95  434E-09    . . .    . . .    . . .    . . .    470E-09 V Dev.

1 13:07:12   547E-06    . . .    . . .    . . .    . . .   6.21E-06 V Mean
      38.95  385E-09    . . .    . . .    . . .    . . .    341E-09 V Dev.

1 13:08:45   547E-06    . . .    . . .    . . .    . . .   6.05E-06 V Mean
      39.05  215E-09    . . .    . . .    . . .    . . .    287E-09 V Dev.

1 13:10:37   547E-06    . . .    . . .    . . .    . . .   5.87E-06 V Mean
      39.15  193E-09    . . .    . . .    . . .    . . .    242E-09 V Dev.

1 13:12:18   547E-06    . . .    . . .    . . .    . . .   5.75E-06 V Mean
      39.25  224E-09    . . .    . . .    . . .    . . .    179E-09 V Dev.

1 13:13:58   546E-06    . . .    . . .    . . .    . . .   5.70E-06 V Mean
      39.25  246E-09    . . .    . . .    . . .    . . .    138E-09 V Dev.

1 13:15:39   546E-06    . . .    . . .    . . .    . . .   5.61E-06 V Mean
      39.35  282E-09    . . .    . . .    . . .    . . .    190E-09 V Dev.

1 13:17:19   546E-06    . . .    . . .    . . .    . . .   5.71E-06 V Mean
      39.35 1.00E-06    . . .    . . .    . . .    . . .    364E-09 V Dev.

---- Data Logger: Value for Filter A Accepted
                                                                     900540
```

Fig. 2.9. Example of data printed out during span calibration of Filter "A"

Step 6.
Press the **Enter** button.

This causes the following text to appear on the screen:

```
A:    μ 123.8μV      σ 617nV      6      35.1°C
PRESS <ENTER> WHEN RESULTS ARE STABLE
```

These results have been shown on the data-log print-out. If they have stabilised continue to the next Step.

Step 7.
Press **Enter**.

The text CALCULATING CALIBRATION FACTORS—PLEASE WAIT appears on the screen.

The 1302 only uses the last six measurement results when calculating any calibration factor. The **conversion factor** (in mg/m^3 per volt), which is calculated during a **span calibration**, is the factor which allows the 1302 to relate the signal produced by the gas to the concentration of gas in the cell. The **cross interference factors**, which are calculated during **cross-compensation calibration** are those factors which allow the 1302 to compensate for any interference gas A has on the other installed optical filters.

If any calibration data is doubtful or unacceptable an error message (marked by an asterisk) will appear on the screen after the calibration factors have been calculated. Whenever an asterisk is shown on the screen further information about the condition of the 1302 can be obtained by pressing the **Status** button.

Appendix 1 lists all the error messages connected with doubtful calibration results and gives an explanation of their significance so that the user can ascertain what action to take if such messages are displayed after calibration.

2.6. ATTACHMENT OF THE EXTERNAL AIR-FILTRATION UNIT

An external air-filtration unit is supplied as an accessory with the 1302. This unit is shown in Fig. 15.8 in Chapter 15. A fine air-filter paper is installed in this unit on delivery. By attaching this unit to the end of the teflon sampling tube connected to the 1302's air-inlet stub contamination of the sampling tube can be avoided. We strongly recommend that you always use it when the 1302 is performing a monitoring task.

The fine air-filter paper in the unit must be changed periodically (see Section 15.1.2).

2.7. ALARM RELAYS

Two alarm relays are built into the **alarm relay** socket on the back panel of the Multi-gas Monitor Type 1302. The function of the pins in this female connector are shown in Fig. 2.10. 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 1302 is switched off and when the 1302 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 1302 measures a gas concentration which is greater than the alarm limit for the gas. When this concentration is measured, the 1302 breaks the connection between pins 1 & 2 and 4 & 5. This activates the attached alarm system.

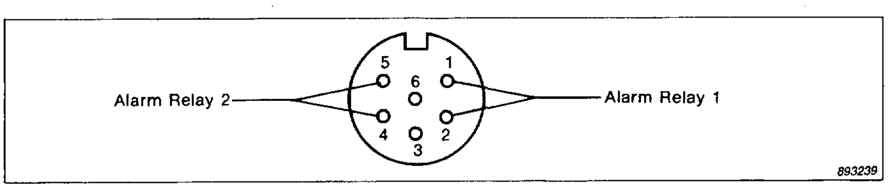


Fig. 2.10. Configuration of the pins in the alarm relay socket

The two alarm relays work in slightly different ways:

Alarm Relay 1: Whenever one or more gases exceed their alarm level(s), the 1302 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 the **Status** push-button on the front panel of the 1302 (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 1302 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.

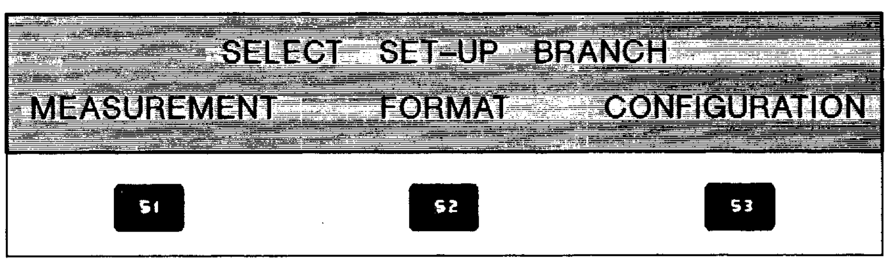
Brüel & Kjær supplies a 6-pin DIN plug (male) with a locking collar JP 0600 for connecting external alarm devices to the alarm relay.

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.

3. PHILOSOPHY OF OPERATION

The Multi-gas Monitor Type 1302 has several essential operational features which enable users to operate it without undue reference to this Instruction Manual. The main features of the 1302 which ensure its simple and easy operation are listed below:

- The short, self-explanatory texts which appear in the 1302's display when the 1302 is being used, give operational guidance to the user.
- The small light-emitting diodes in some of the push-buttons allow the user to identify how the 1302 is operating at any particular time.
- If any push-buttons are used in the wrong way the 1302 informs the user by giving an audible *"beep"*.
- When any push-button is used correctly the 1302 informs the user by giving an audible "*click*" and responds by performing the chosen operation.
- The front panel of the 1302 is divided up into groups of push-buttons which are related to one another. For example all the push-buttons grouped under **"Mode"** affect the **mode** of operation of the 1302.
- The three **select** push-buttons labelled **S1** **S2** **S3** have the same function — they allow the user to select from options appearing on the display screen. For example if the 1302 is operated in set-up **mode** by pressing the **Set-Up** push-button the following text appears on the screen:



By pressing the **S1** push-button the **MEASUREMENT** branch of the set-up "tree" can be followed on the display; by pressing the **S2** push-button the **FORMAT** branch of the set-up "tree" can be followed; and by pressing the **S3** push-button the **CONFIGURATION** branch of the set-up "tree" can be followed.

In the large majority of cases the above-listed features will enable users to operate the 1302 without reference to this Instruction Manual. However, when it is necessary to refer to this manual, the text is made easier to understand by using a special text-code:

- Push-buttons are always represented with the name of the push-button enclosed in a box which is shaded-in. For example **Memory** represents the memory push-button.

- When referring to any text which appears on the display screen the text is shown shaded-in and with a special typeface which resembles that on the display screen. For example SELECT SET-UP TYPE

- When referring to any part of the set-up "tree" (which is represented in Fig. 7.1 which folds out at the back of this manual) the text is shown with the same typeface as that used in Fig. 7.1 and it is also shaded-in. For example **CONFIGURATION**, **System**, ***General*** and *Clock*.

- When referring to any group of push-buttons, the name of the push-button group is written in bold typeface. For example Set-Up **mode**, Memory **mode**.

4. INTRODUCTION TO AND FAMILIARIZATION WITH THE 1302

The Multi-gas Monitor Type 1302 is an extremely versatile measuring instrument which can be used to perform almost any kind of monitoring task. Its very versatility may appear overwhelming at first — how does one learn to operate and control such an instrument? 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 the internal clock; 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 1302'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 1302 and it is necessary to fully understand what these terms mean before you start any practical exercise with the 1302.

4.1.1. Measurement Cycle

A description of a measurement cycle is given on page 2 of Chapter 1 (see boxed-in text and schematic diagram of the measurement system of the 1302). "Measurement cycle" is the term used to describe everything that takes place in the 1302 from the time the pump starts to flush out the "old" gas sample in its analysis cell, until the signal in the cell has been measured using the last relevant optical filter.

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

1. How many gases/vapours are being measured — this affects the number of optical filters which need to be used.
2. The length of the sampling tube attached to the 1302's air-inlet — the longer the tube, the more time is needed to flush it out between measurement cycles.
3. 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).
4. 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).

Under ideal conditions the time taken to measure one gas only is 30 seconds but because factors 3 and 4 above may vary from one measurement cycle to another this time can vary by a number of seconds.

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 1302 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).

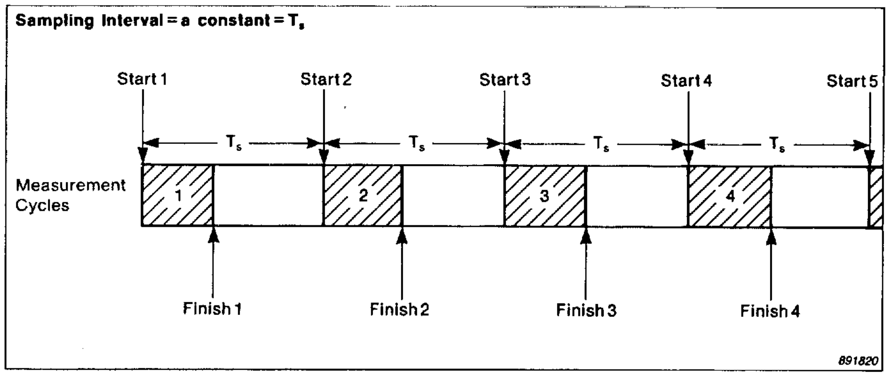


Fig. 4.1. An illustration of the fixed sampling intervals of the 1302 when it is not sampling continuously

- **Continuous Sampling**

  The 1302 is said to be sampling continuously when each measurement cycle is followed immediately by another similar measurement cycle (see Fig. 4.2).

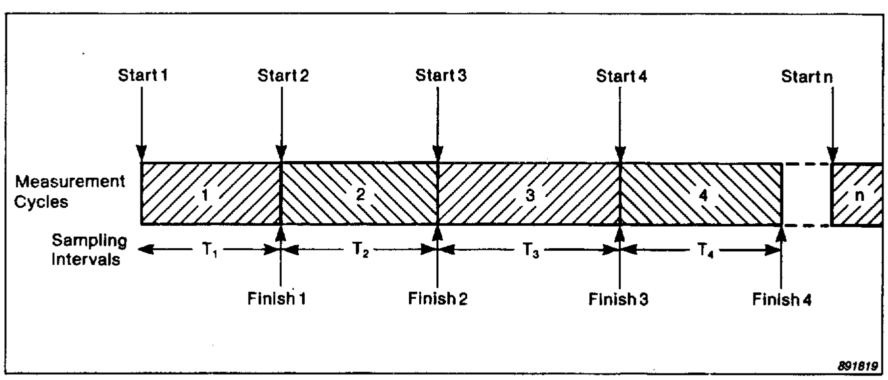


Fig. 4.2. An illustration of continuous sampling

- **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 1302 automatically stops monitoring after the monitoring period is over — or, **not** pre-set — in which case the 1302 will continue to monitor until the user stops the monitoring task manually (see Section 4.2.8).

4.2. FAMILIARIZATION WITH THE 1302

Before you start to use the Multi-gas Monitor Type 1302 it is very important to (1) adjust the "**Mains Voltage Selector**" on the back panel of the 1302 and (2) check and/or change the fuse in the 1302. Details of these operations are described in Chapter 2, Section 2.1 and 2.2 of this manual.

4.2.1. Attaching the External Air-filtration Unit

Step 1.
Cut a short section of sampling tube from the roll of polytetrafluoroethylene (Teflon) tubing which is provided as an accessory, a 0,5m tube should be sufficient.

a) Attach one end of this tube to the air-inlet stub on the back-panel of the 1302 (details are given in Section 2.5).

b) Attach the other end of the sampling tube to the external air-filter which is also provided as an accessory (Section 2.6 provides details).

4.2.2. Setting the Internal Clock

Before dispatch from the factory the internal clock of the 1302 is set to the correct local (Danish) time. The clock may therefore need to be adjusted to your local time.

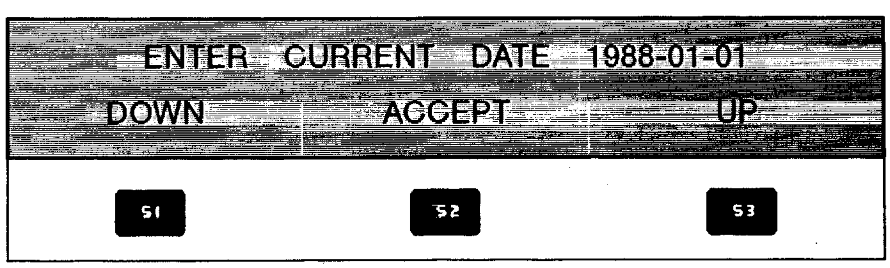
Step 1.
Switch on the AC Mains power switch on the back-panel of the 1302.

Step 2.
Operate in **Set-Up** mode by pressing the **Set-Up** button.

Refer to the copy of the Set-Up "tree" diagram which is mounted on the inside of the front cover of the 1302 so that you can follow your movement through the various branches of this "tree" in the following sequence of button pressing:

Step 3.
Press **S3** **S1** **S1** **S1**.

The following screen picture appears:



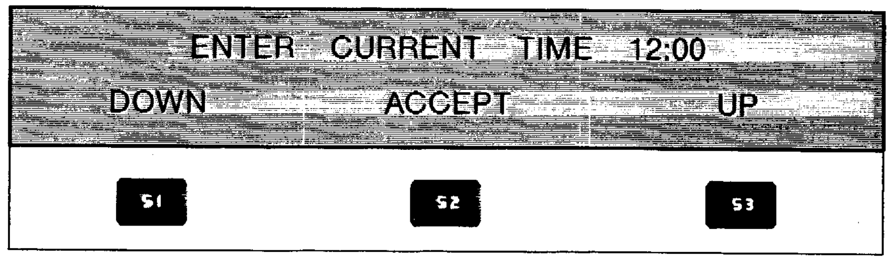
Dates are entered as the Year-Month-Day, for example the 19th April, 1989 has to be entered as 1989-04-19.

Step 4.
Use the push-buttons in the **Data Entry** group of buttons to enter the day's date. If you make an error in entering the correct date just press the Clear Entry push-button and enter the correct date.

When the correct date has been "typed-in", you can "enter" it into the 1302's **active** set-up in one of two ways:

1. Press the Enter button; or
2. Press the S2 button to "accept" the date.

This causes the text on the display screen to change to the following:



The current time is entered as the time as read on a 24-hour digital clock. For example, 13:45 is 15 minutes to 2 o'clock in the afternoon. The current time can be entered in one of two ways:

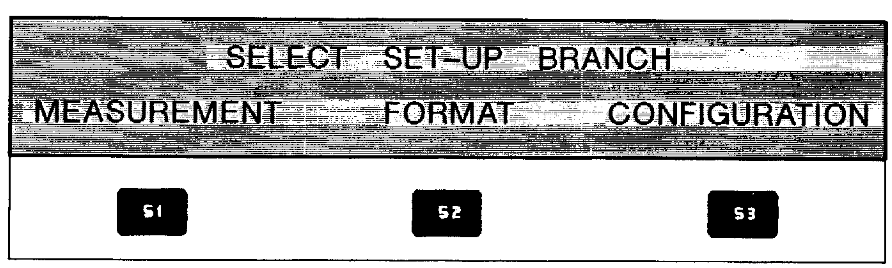
Step 5a.
Use the **Data Entry** push-buttons as explained in Step 4 or, alternatively:

Step 5b.
Use the select button S3 to increase the time on the screen **or** the S1 button to decrease the time until it reaches 13:45 and then press the S2 button to "accept" the time shown on the screen.

When Step 5 has been performed the display then moves to the **previous** head of the set-up "tree".

Step 6.
Press the Go to Head button three times and follow the path you take *en route* through the set-up "tree".

When Step 6 has been performed the screen display shows the following text:

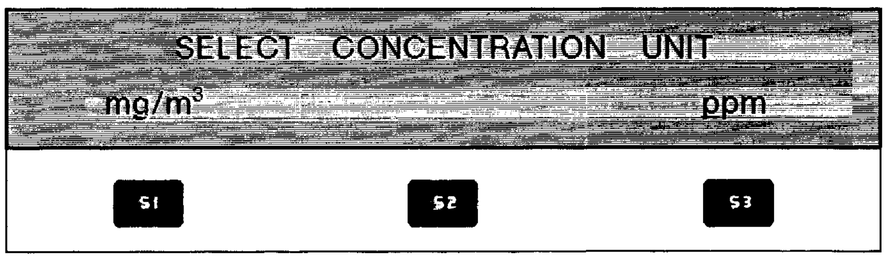


4.2.3. Setting-up Units of Measurement

The 1302 can display gas concentrations either in absolute units of mg/m^3 or in units of parts per million (by volume) at a particular temperature termed the **normalization** temperature. By operating the 1302 in Set-up **mode** you can inform the 1302 about the units you intend to use — for example: the length of the sampling tube attached to the 1302'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).

Step 1.
Press the **S3** and then the **S2** buttons.

The following text appears on the screen display:

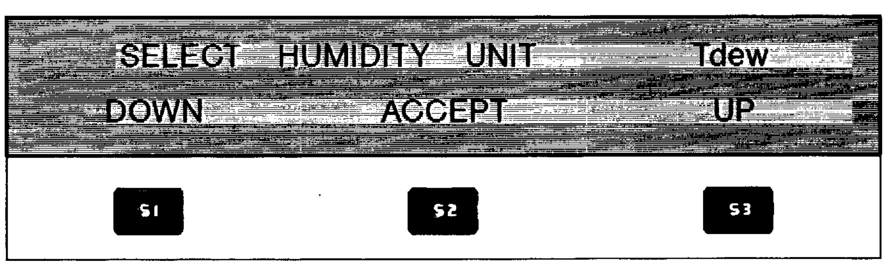


The cursor appears under the unit which is presently in the **active** set-up — here it is ppm (parts/million) unit. By pressing the **S3** button you can select to display gas concentrations in ppm, by pressing the **S1** button you can select to display gas concentrations in mg/m^3.

Step 2.
Select the unit mg/m^3 by pressing the **S1** button.

Step 3.
Select metres as the unit of length, °C as the temperature unit, and kPa as the pressure unit by using a procedure similar to that described in the previous step (2).

After the pressure unit has been selected the following text appears on the display:



There are more than three humidity units to choose from and therefore the means by which a unit is selected differs — one uses the select buttons **S1** **S3** to scroll through the possible units. When the required unit appears on the display it is "accepted" by pressing the **S2** button.

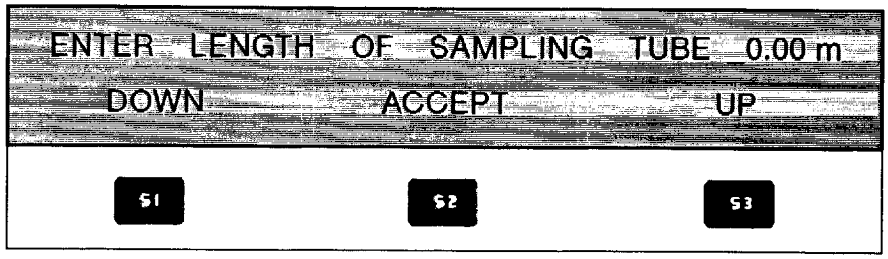
Step 4.
Select Tdew as the humidity unit.

4.2.4. Setting-up Environment Parameters

Environmental parameters describe the factors which influence the measurement situation — the length of the sampling tube attached to the 1302, the pressure of the air in the environment and the normalization temperature. These parameters are discussed more fully later on in this section.

Step 1.
Press the **Go to Head** **S1** button and then the **S3** button.

This brings you into the **Environment** branch of the set-up "tree" where the following text is displayed:

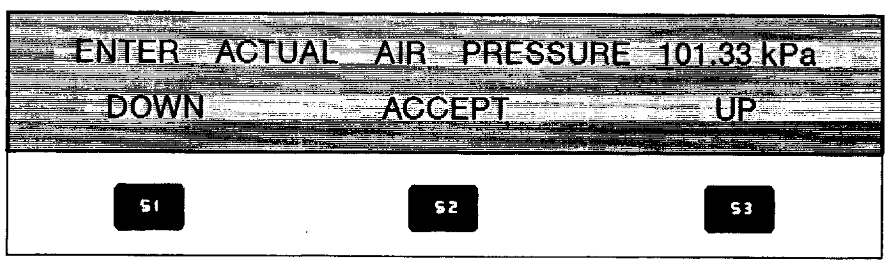


Step 2.
a) Use the select buttons **S1** and/or **S3** to change the length of the sampling tube shown on the screen to the length of the tube you attached to the 1302 in Step 1 described in Section 4.2.1.

Note: The range of acceptable values for the sampling tube range from 00,00m to 99,00m. When the sampling tube length displayed reaches 99,00m and the **S3** button is pushed, the displayed value changes to 00,00m and will be increased by 0,01m with each subsequent button-press.

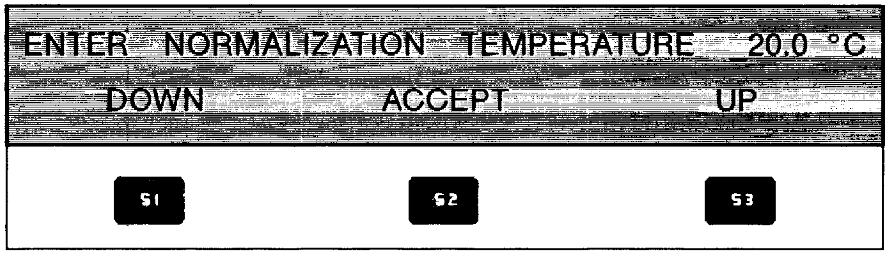
b) Press the **S2** button to "accept" the value on the screen.

The screen display then shows the following text:



Step 3.
Use the numerical **Data Entry** buttons to enter the air pressure read on your barometer. When the correct value is shown on the display press the **S2** button to "accept" the value.

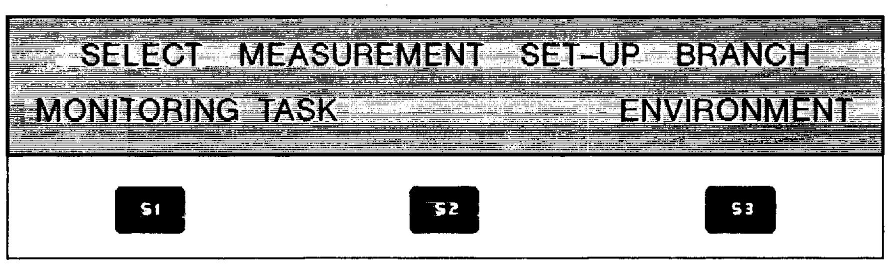
The following text then appears on the screen:



The 1302 measures gas concentrations in the absolute unit of mg/m^3 — a unit which is independent of temperature. It is, however, possible for the 1302 to convert mg/m^3 to the unit of parts per million (ppm), by volume, at a pre-defined temperature. This pre-defined temperature is termed the NORMALIZATION TEMPERATURE.

Step 4.
Enter the temperature you wish the 1302 to use when calculating gas concentrations in ppm.

The display screen then jumps to the "head" of the **MEASUREMENT** branch of the set-up "tree" and the following text is shown:



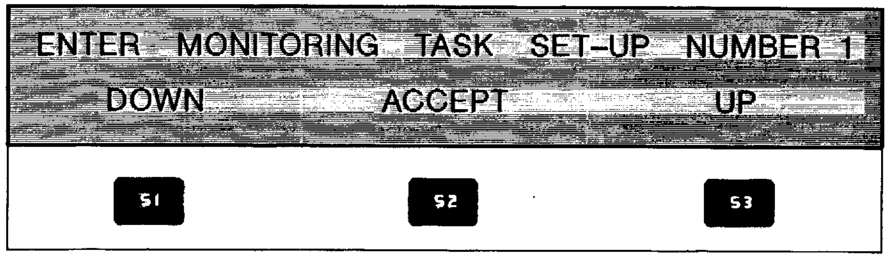
4.2.5. Setting-up a Monitoring Task

The optical filters in the 1302 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 1302 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:

- Monitoring Task Set-up Number = **1**
- Sampling = **Continuous**
- Monitoring Period = **not pre-set**
- Measurements compensated for water vapour interference = **yes**
- Measurements compensated for cross interference = **no**
- Gases/vapours measured = **gas A and water vapour**

Step 1.
Press S1

The following text appears on the screen:



Up to 10 different monitoring tasks can be set-up while operating the 1302 in **Set-up** mode. The parameters describing these tasks are automatically stored in the memory of the 1302.

Step 2.
If the number on the display is already "1" then press **S2** to "accept" the value. If the number is not "1" change its value to "1" by using either the **Data Entry** buttons or by using the select buttons **S1** and/or **S3** and then the **S2** to "accept" the value.

The text which appears on the display during the next step is really self-explanatory and it is therefore possible for you to follow why the button-pushes listed in the next step will set-up the monitoring task which is described at the beginning of Section 4.2.5.

Step 3.
Press **S3** **S1** **S3** **S1** **S3** buttons, then press the **S1** button until the text MEASURE WATER VAPOUR appears on the display.

Step 4.
Press the **S3** button to answer "YES" to measuring water vapour.

Once Step 4 is complete, monitoring task number 1 has been set-up and the display moves to the previous head of the set-up tree.

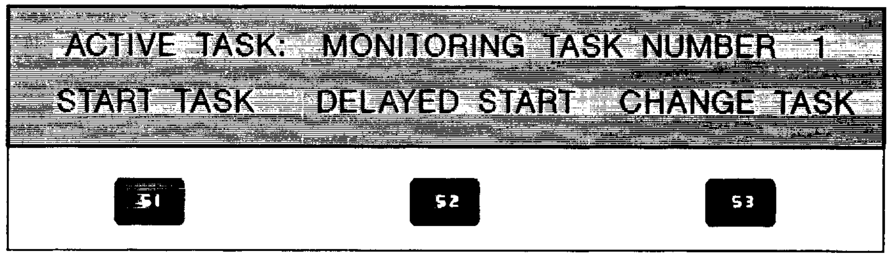
Step 5.
Press the **Set-Up** button to stop operating in **Set-Up** mode.

4.2.6. Starting a Monitoring Task

This section will explain how to perform a monitoring task — for example, monitoring task number 1 which was set-up in Section 4.2.5.

Step 1.
Press the **Measurement** mode button.

The following text appears on the screen:



Please note: If the user does not use one of the **Select** buttons within a short time after the above text appears, the 1302 will automatically stop operating in **Measurement** mode (the light-emitting diode in the **Measurement** button switches off). If this happens just press the **Measurement** button again.

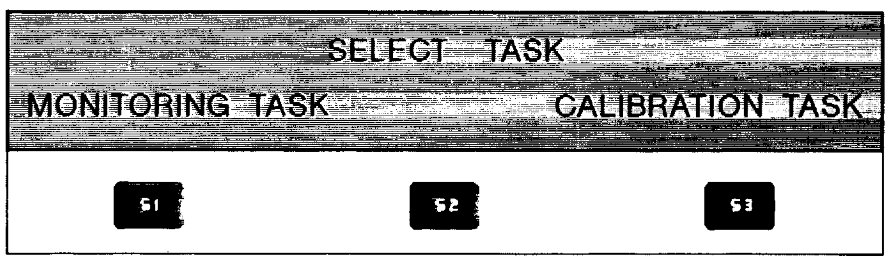
The **active** monitoring task number is the number of the monitoring task you wish the 1302 to perform.

Step 2.

a) If the number on the display **is** number 1 then go to Step 5 below.

b) If the number on the display is **not** number 1 then press the **S3** button to change the task number to number 1.

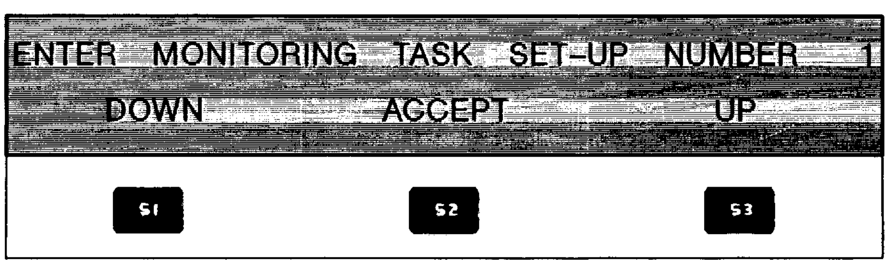
This changes the display text to the following:



Step 3.

Press the **S1** button.

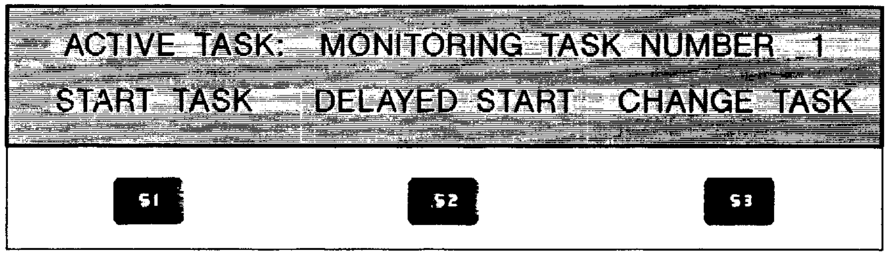
This causes the following text to appear on the display:



The number appearing on the screen will be a number from 1 to 10.

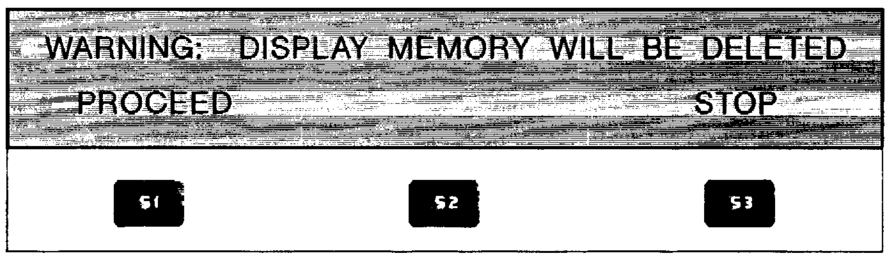
Step 4.
If the monitoring task number is not number 1, use the select buttons **S1** or **S3** to change the number to 1 and then "accept" it by pressing the **S2** button.

The following text appears on the display screen:



Step 5.
Press the **S1** button to start the monitoring task.

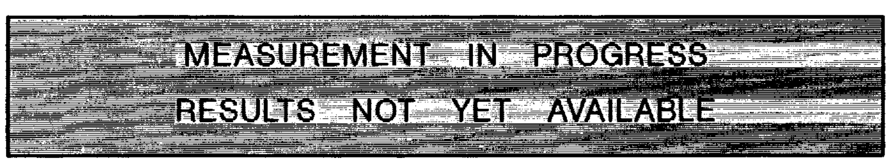
The following warning then appears on the display:



Display Memory is where the 1302 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 1302's *Background Memory.* This operation is described in Section 11.2.

Step 6.
Press the **S1** button.

The following text then appears on the screen:



Step 7.
When the first measurement cycle is complete the 1302 will automatically display the results and update them every time a new measurement cycle is completed. An example is shown below:

A: 4.52E+01 B: ——— C: ———
D: ——— E: ——— W: 6.67E+00

S1 S2 S3

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 which were selected — that is mg/m^3 for gas A and Tdew for water vapour (see Step 2 and 4 of Section 4.2.3).

4.2.7. Scrolling through Measurement Results while a Monitoring Task is in Progress

All measurement data collected during a monitoring task is stored in *Display Memory* — together with the parameters which describe the task (see Section 4.2.5). Using the push-buttons grouped under the title **Display**, the user can scroll through this data.

Step 1.
After the monitoring task has been running for 10–15 minutes, press the **Next Display** button.

An example of the text which appears on the screen is shown below:

DATA IN DISPLAY MEMORY RECORDED FROM
1989-05-16 09:50 TO 1989-05-16 10:04

This screen text allows you to find out how long the monitoring task has been running — here from 9:50 to 10:04 on the same day. The date on the right-hand-side of the display indicates the time at which the last measurement cycle was completed — while a monitoring task is in progress this date is, of course, constantly updated.

Step 2.
Press the **Next Display** button and **Next Gas** until the following text appears on the display:

FILTER A USED TO MEASURE
(the name of the gas will appear here)

The number in square brackets alongside the gas name on the display indicates the number of the filter banks which is **active** for this filter during this monitoring task.

The displays which follow indicate the type of text which appears each time the **Next Display** button is pressed:

```
GAS A:                 MAX 84.5E+00   μ 8.03E+00
  ALARM  ———          MIN 7.42E+00   σ 2.36E−00
```

While a monitoring task is being performed a running statistical analysis of the monitored gases/vapours is made and the results are displayed as shown above, where:

MAX = maximum concentration of gas A measured during the period of time the monitoring task has been performed

MIN = minimum concentration of gas A measured during the period of time the monitoring task has been performed

ALARM = the user-defined concentration of gas A which, if measured by the 1302, will trigger a switch in the 1302 and activate an external alarm relay connected to it.

μ = linear average, or mean value, of all the gas A concentrations measured during the period of time the monitoring task has been performed

σ = standard deviation of gas A's concentrations from the mean value (μ) described above (see Section 9.1 for further details).

All numbers are written in the exponential form, for example:

$$84{,}5E{+}00 = 84{,}5 \times 10^{+0} = 84{,}5$$

The concentration unit in this case is mg/m^3 as this was chosen in the **active** set-up (see Step 2 of Section 4.2.3).

Step 3.
Press **Next Display**

```
A: (the name of the gas being measured by Filter A will appear here)
  1989-05-16   09:50:32    ———      7.42 mg/m³
```

```
A: (the name of the gas being measured by Filter A will appear here)
  1989-05-16   09:51:33    ———      7.43 mg/m³
```

As you can see the display provides the date and time at which the measurement was made, and the concentration of gas A is given in the units mg/m^3 because this was the unit chosen for gas concentration in the **active** set-up. The dashed lines which appear after the time will be replaced by a number as soon as the monitoring task has been stopped (see Section 4.2.9).

After scrolling through the list of individual measurement results for gas A the following text is displayed:

```
SAMPLING IS CONTINUOUS
```

```
MONITORING PERIOD IS NOT PRE-SET
```

```
COMPENSATED FOR WATER VAP. INTERFERENCE
```

```
MONITORING TASK STARTED 1989-05-16 09:50
```

```
A: 7.42E+00     B: ————     C: ————
D: ————     E: ————     W: 6.67E+00
```

The last display above shows the up-dated overview of the gas concentrations measured during the most recent measurement cycle. This display does not appear after the monitoring task has been stopped.

Data collected during a monitoring task is stored in the *Display Memory* of the 1302 and therefore, before a new monitoring task is started, all data stored in this memory is deleted. *Display Memory* has finite size, and therefore there is a limit to how much data can be stored in it. Once this memory has been filled-up all subsequent data collected during the task will start to overwrite the data already collected during the start of the monitoring task. **Only** in this event will the date displayed after the text **MONITORING TASK STARTED** on the above screen be different from the **earliest** date on the display (shown below) which gives the most up-to-date overview of the monitoring task:

```
DATA IN DISPLAY MEMORY RECORDED FROM
1989-05-16 09:50 TO 1989-05-16 10:04
```

Step 4.
Press the **Next Gas** button.

This causes the following text to appear on the screen:

```
WATER VAPOUR MEASURED
```

Step 5.
Use the **Next Display** button to scroll through the following screen displays:

```
WATER:            MAX 8.55E+00  μ 8.15E+00
                  MIN 7.01E+00  σ 816E-03
```

```
W: WATER VAPOUR:
   1989-05-16  09:50:32  ——  7.39 Tdew
```

```
W: WATER VAPOUR:
   1989-05-16  09:51:33  ——  7.49 Tdew
```

Step 6.
Press the **Next Gas** button.

This causes the display to jump over to the list of measurement results for gas A. The following text appears:

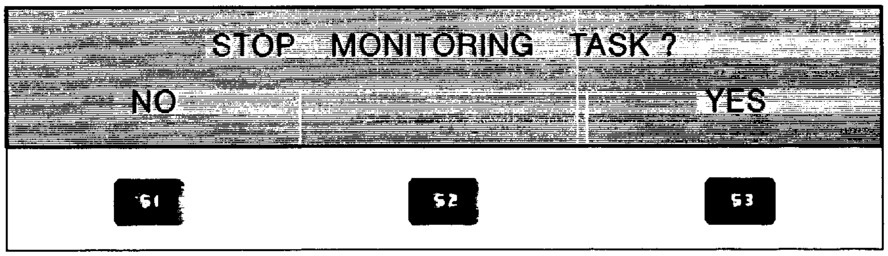
```
A: (the name of the gas being measured by Filter A will appear here)
   1989-05-16  09:51:33  ——  7.43 mg/m³
```

By using the **Next Display** and the **Previous Display** buttons you can now scroll through the list of measurement results for gas A.

4.2.8. Stopping a Monitoring Task

Step 1.
Let the 1302 monitor for a total period of about 30 minutes and then press the **Measurement** button.

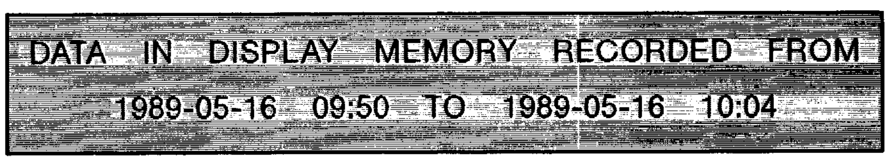
The following text will appear on the screen:



If the **Measurement** button had been pressed accidentally, this screen enables the user to cancel the request to stop the monitoring task in progress — by pressing the **S1** button. Alternatively, if one does wish to stop a monitoring task which is in progress this can be done.

Step 2.
Press the **S3** button to stop the task.

The text which appears briefly on the screen indicates that the 1302 is aborting the monitoring task and a summary of the monitoring task will appear on the display as soon as the 1302 has aborted the task. For example:



4.2.9. Scrolling through Measurement Results after Completion of a Monitoring Task

All measurement data collected during a monitoring task is stored in *Display Memory* — together with the parameters which describe the task (a description of the task is given in Section 4.2.4). Using the push-buttons grouped under the title **Display**, the user can scroll through the set-up parameters as well as the individual gas concentration measurements results as explained in Section 4.2.7. The organisation of data collected during a monitoring task is illustrated in Fig. 4.3. This illustration also shows the function of the various push-buttons grouped under the title **Display**. For example, the **Next Gas** button enables one to page from the measurement results of one gas to the measurement results of another.

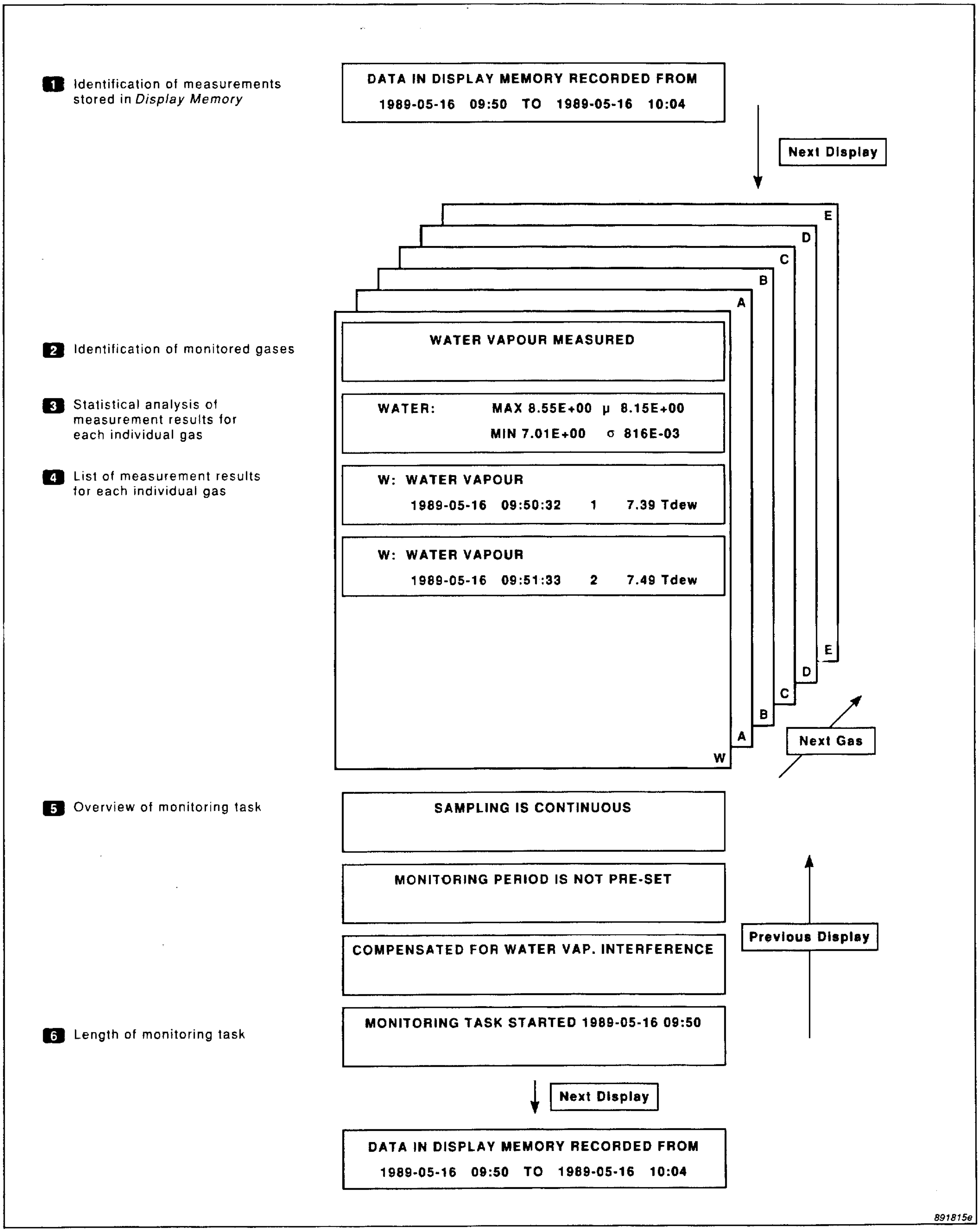


Fig. 4.3. Organisation of the data displayed on the 1302's screen after completion of a monitoring task

Step 1.
Press the **Next Display** and the **Next Gas** buttons.

The following text appears on the display:

WATER VAPOUR MEASURED

The displays which follow indicate the type of text which appears each time the **Next Display** button is pressed:

WATER: MAX 8.55E+00 μ 8.15E+00
MIN 7.01E+00 σ 816E-03

This is the statistical report of the monitored gases/vapours displayed when the monitoring task is complete. In this case where:

MAX	=	maximum concentration of water vapour measured during the **whole** monitoring task
MIN	=	minimum concentration of water measured during the **whole** monitoring task
μ	=	linear average, or mean value, of all the water vapour concentrations measured during the **whole** monitoring task
σ	=	standard deviation of water-vapour's concentrations from the mean value (μ) described above (see Section 9.1 for further details).

The humidity unit in this case is Tdew because this is the unit chosen in the **active** set-up (see Step 4 of Section 4.2.3).

W: WATER VAPOUR:
1989-05-16 09:50:32 1 7.39 Tdew

W: WATER VAPOUR:
1989-05-16 09:51:33 2 7.49 Tdew

As you can see the measurement cycles are numbered sequentially as soon as the monitoring task has been stopped — for example, the above measurement was made at 09:51:33 on the 16th of May and it was the **second** measurement cycle of the monitoring task. The concentration of water vapour is given in the units of Tdew because this was the unit chosen for humidity in the **active** set-up.

After scrolling through the list of individual measurement results for water vapour the following screen displays appear:

SAMPLING IS CONTINUOUS

MONITORING PERIOD IS NOT PRE-SET

COMPENSATED FOR WATER VAP. INTERFERENCE

MONITORING TASK STARTED 1989-05-16 09:50

DATA IN DISPLAY MEMORY RECORDED FROM
1989-05-16 09:50 TO 1989-05-16 10:04

Note that the screen showing the over-view of gas concentrations measured during any particular measurement cycle is no longer shown when the monitoring task has been stopped, as mentioned in Section 4.2.7, Step 3.

Step 2.
Press the **Next Gas** button.

This causes the following text to appear on the screen:

FILTER A USED TO MEASURE
(the name of the gas being measured by Filter A will appear here)

Step 3.
Press the **Next Display** button to scroll through the following data displays:

```
GAS A:              MAX 84.5E+00   μ 8.03E+00
  ALARM  ———        MIN 7.42E+00   σ 2.36E-00
```

```
A: (the name of the gas being measured by Filter A will appear here)
    1989-05-16   09:50:32    1    7.42 mg/m³
```

```
A: (the name of the gas being measured by Filter A will appear here)
    1989-05-16   09:51:33    2    7.43 mg/m³
```

Step 4.
Press the **Next Gas** button so you can scroll through the list showing water-vapour's results.

4.2.10. Changing Gas-concentration Units after a Monitoring Task

The unit mg/m^3 was chosen for gas concentrations in the monitoring task which was set up in Section 4.2.5. As long as mg/m^3 is the **active** concentration unit (that is, the unit selected while operating in **Set-Up** mode), this is the unit which will be used to express gas concentrations on the display screen of the 1302 as well as print- and plot-outs of monitoring task data. However, the user can make the 1302 express the measured gas concentrations in ppm:

Step 1.
Press **Set-Up** **S3** **S2** **S3** and then the **Set-up** buttons.

Step 2.
Use the **Next Display** button to scroll through the results of the monitoring task no. 1 displayed on the screen. Notice that the gas concentration units have been changed to **ppm**.

In a similar way the humidity unit for water vapour can be changed.

4.2.11. Changing the Humidity Unit after a Monitoring Task

Step 1.
Press **Set-Up** **S 3** **S 2** and then use the **Next Display** button to reach the following display:

SELECT HUMIDITY UNIT		Tdew
DOWN	ACCEPT	UP

Step 2.
Press **S 1** and then **S 2** — to accept the unit of **ppm** — and then the **Set-Up** button.

Step 3.
Use the **Next Display** button to scroll through the results of the monitoring task no. 1 displayed on the screen. Notice that the water vapour unit has been changed to **ppm**.

5. CONTROLS

5.1. FRONT PANEL

The front panel of the Multi-gas Monitor Type 1302 is dominated by a 2 × 40 character fluorescent display screen and the 3 **Select** push-buttons **S1** **S2** **S3** beneath it (see Fig. 5.1). The rest of the push-buttons on the front panel are arranged into groups which are named according to the effect they have on the operation of the 1302 (see Table 5.1). For example, all the push-buttons in the group named **Display** will, when used, affect the information displayed on the screen of the 1302.

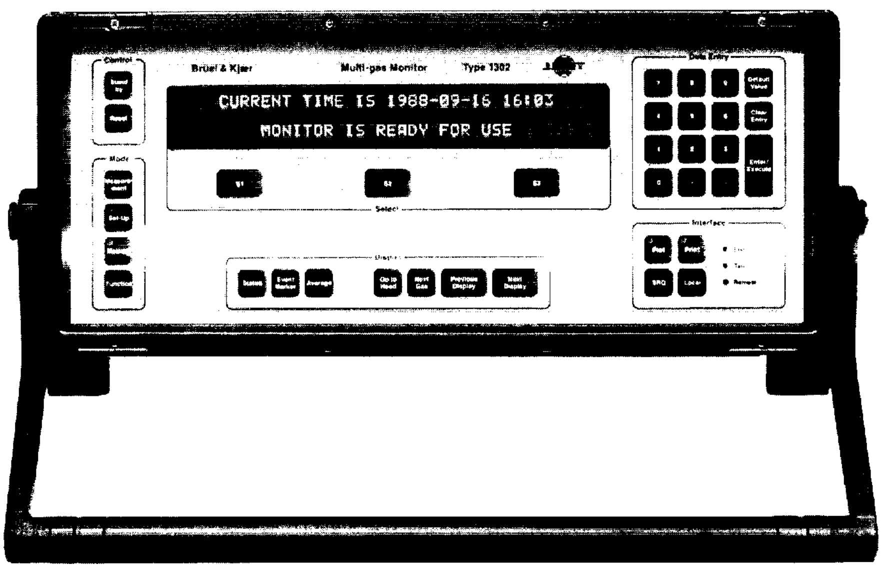


Fig. 5.1. The front panel of the 1302

All push-buttons on the front panel of the 1302 are membrane-type push-buttons and therefore the front panel is waterproof. The push-buttons are operated by exerting pressure on them.

Small light-emitting diodes (LEDs) are mounted at the top left-hand corner of some of the front-panel push-buttons. Their function is to inform users of the operating state of the 1302. For example, if the LED in the **Measurement** push-button is lit, it indicates that the 1302 is either busy performing measurements or has been set-up to start measurements at a pre-defined time.

Functional Group	Purpose of Push-buttons in the Functional Group
Select	Selecting parameters from the display screen
Control	Stand by and reset functions
Mode	Operating 1302 in Measurement, Set-Up, Memory and Function modes
Display	Reading measurement results
Interface	To start print-outs and/or plot-outs of measurement data via either the 1302's RS 232 C or IEEE 488 interface ports
Data Entry	Numerical keyboard to "enter" numerical parameter values

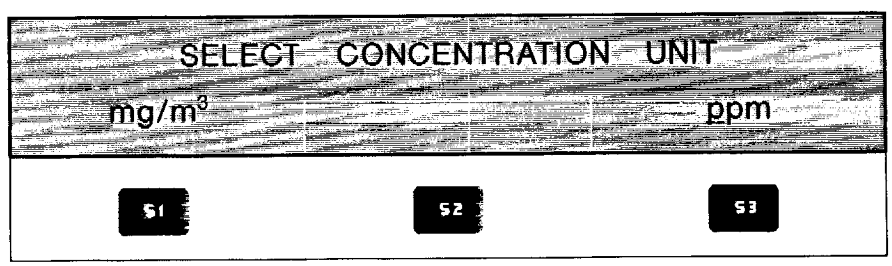
T01928GB0

Table 5.1. The purpose of push-buttons in the various functional groups of the 1302

5.1.1. Select Push-buttons

The **select** push-buttons S1, S2 and S3 are "soft-keys" which allow users to either select pre-defined options from the display screen, or to look through a pre-defined list of parameters and then accept one of the parameters presented on the screen. The following two examples illustrate the use of the select push-buttons:

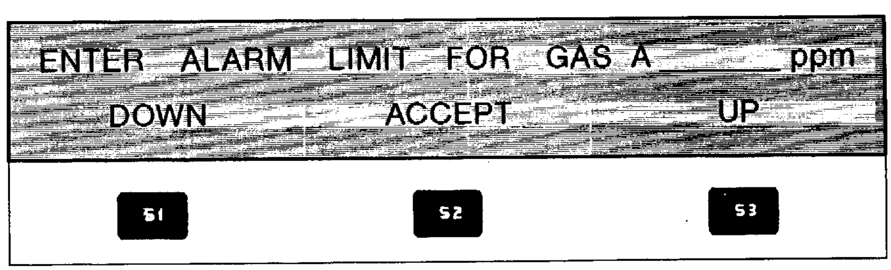
1. If the text on the screen appeared as follows:



(a) By pressing the S1 push-button the gas concentrations which appear in the measurement results will be quoted in mg/m^3.

(b) By pressing the S3 push-button the gas concentrations which appear in the measurement results will be quoted in ppm.

2. If the text on the screen appeared as follows:



(a) Each time the **S1** push-button is pressed the value of the alarm limit for gas A, which appears on the screen, will be decreased.

(b) Each time the **S3** push-button is pressed the value of the alarm limit for gas A which appears on the screen, will be increased.

(c) When the **S2** push-button is pressed the value of the alarm limit for gas A printed on the screen will be accepted.

5.1.2. Control Push-buttons

The control push-buttons allow the user to switch the 1302 on and off, and to reset it.

Stand by This push-button is used to switch the Multi-gas Monitor Type 1302 on and off. When the small light diode in this button is lit it indicates that the 1302 is switched off (that is, it is on "stand by"). When the **Stand by** push-button is pressed, the light diode will switch off and the 1302 will be ready for operation. However, if the 1302 is not operated within 5 minutes of switching it on, it will automatically switch itself off unless the user chooses to cancel this facility (called ACTIVATE AUTOMATIC SWITCH-OFF) when setting-up the 1302. See Section 7.4 for details.

Reset By pressing this push-button the user can choose the type of reset the 1302 should perform. For further details see Section 8.1.3.

5.1.3. Mode Push-buttons

Using the **Mode** push-buttons the user is able to choose the mode in which to operate the 1302.

Measurement In this mode the user is able to choose the type of measurement the 1302 should perform, and decide when the measurement should start.

Set-Up In this mode the user is able to enter the set-up "tree" of the 1302. In set-up **mode** the user is able to program the 1302 to perform almost any kind of measurement and, amongst other things; enter data about the optical filter(s) which are installed in the 1302; select different measurement parameters; choose how measurement results should be formatted in print- or plot-outs; choose the interface and communication codes which are necessary to print/plot data; set the internal clock of the 1302 and choose the self-tests the 1302 should perform.

Memory In this mode the user is able to store measurement data in the *Background memory* of the 1302, and recall or delete data from the *Background memory* of the 1302.

Function In this mode the user is able to program the 1302 to perform any one of a number of special functions. These functions are pre-defined and include functions such as: entering a key sequence; executing a key sequence and displaying a key sequence (see Chapter 10 for details).

5.1.4. Display Push-buttons

The push-buttons in this functional group affect what is displayed on the screen. If the 1302 is performing measurements, results will be displayed on the screen and constantly updated unless one of the other **Mode** push-buttons is being used.

Status This push-button has two functions. It allows users to perform the following two functions:

- Acknowledge any message which may appear on the display screen during operation of the 1302.
- Obtain more detailed information about the condition of the 1302 at any particular moment of time, if such information exists.

Event Marker If an unusual or interesting event occurs during a measurement period, users 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 both print-outs and plot-outs of measurement data.

Average This push-button allows users to average measurement data. The lamp in this push-button is lit when measurement data is being averaged. Users can choose averaging times when in set-up **mode**.

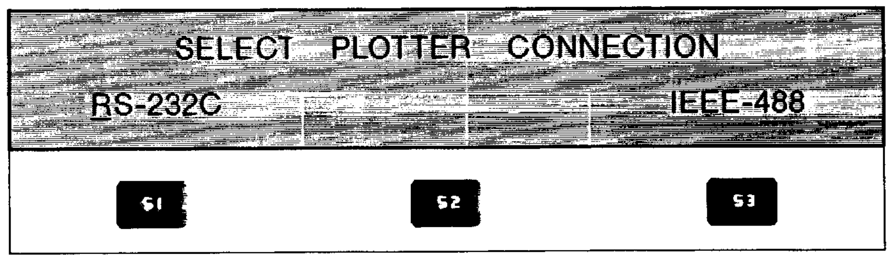
Go to Head The effect of using this push-button is dependent upon how the 1302 is being operated at the time the button is pressed. The following three examples illustrate this push-button's effect:

- If the 1302 is being operated in set-up **mode** when the **Go to Head** push-button is pressed, the 1302's display will move to the junction of the set-up "tree" above the branch which the user is following (see Fig. 7.1 which folds out at the end of this manual). For example, if the user is following the *RS 232C* branch of the set-up "tree", the display will jump up to the *Communication* junction of the set-up "tree" when the **Go to Head** push-button is pressed once, and up to the **System** junction of the "tree" if the **Go to Head** push-button is pressed again, and up to the **CONFIGURATION** junction of the "tree" if the **Go to Head** push-button is pressed once more.
- If the 1302 is in **Display**, for example if a user is looking through a list of measurement data on the screen, when the **Go to Head** push-button is pressed, the display will move to the screen showing the text `DATA IN DISPLAY MEMORY RECORDED FROM..` which gives the period of time data was recorded — see Fig. 4.3 for details.
- If the 1302 is performing measurements when the **Go to Head** push-button is pressed, the 1302 will display the last measured concentrations of all gases.

Next Gas The display screen only displays the measurement data for one gas at a time (out of 5 gases and water vapour). This push-button allows users to look at the measurement data for any one of the 4 other gases and water vapour (see Fig. 4.3 and Section 4.2.9).

Previous Display and **Next Display** These push-buttons allow users to see the previous or next display. For example, if one is looking at gas A's measurement result no. 3 — by pressing **Previous Display** gas A's measurement result no. 2 will be shown on the screen. By pressing **Next Display** gas A's measurement result no. 4 will appear on the display screen.

If the **Next Display** push-button is used while in set-up **mode** it can be used to scroll quickly through a branch of the set-up "tree".For example, if the user is in the *Connections* branch of the set-up "tree" and the following is shown on the display:



When the **Next Display** push-button is pressed the RS 232 C interface, which is the underlined parameter on the screen, is accepted as the plotter connection. The **Next Display** push-button can **only** accept the parameter which has the cursor underneath it, it cannot be used to select the parameter which is not underlined. Only by using a **Select** push-button can one select a parameter which is not underlined.

5.1.5. Interface Push-buttons

The **Interface** group of push-buttons allow the user to control communication between the 1302 and any attached unit whether this unit be a printer, plotter or computer.

Plot By pressing this push-button measurement results in the *display memory* of the 1302 can be plotted out on a connected plotter. The lamp in this push-button is lit while measurements are being plotted out and the display will show **PLOTTING MEASUREMENT DATA** until all data has been plotted out.

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

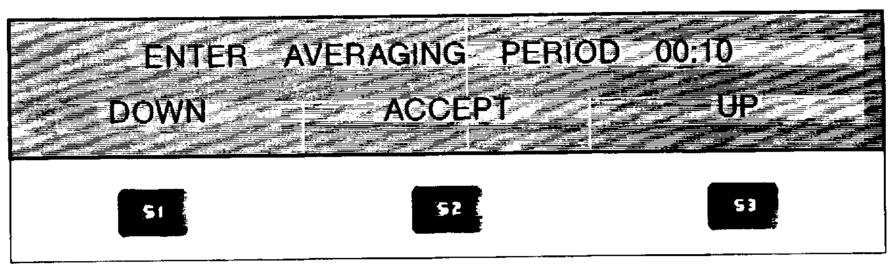
SRQ Every time a special event takes place in the 1302 or if the user presses this button when the 1302 is being remotely controlled by computer for example, when it is used with the Multipoint Doser and Sampler Type 1303, it will send a "Service Request" (SRQ) out on its IEEE 488 interface bus and the LED will light-up while the Service Request signal is active. If the RS 232 C interface is used a "Service Request" is sent via this interface.

Local When the **Remote** LED is lit, this means that the 1302 can no longer be operated via its front panel, it can only be remotely operated via a computer. However, by pressing the **Local** button the user is able to operate the 1302 manually via its front panel, as well as remotely via the computer. This push-button can be made inoperable by giving the 1302 a "local lock-out" via the computer. Further details can be found in Volume 2 of the Interface Manual for the 1302.

5.1.6. Data Entry Push-buttons

This group of push-buttons enable the user to "enter" numerical values of various parameters. In order to describe the function of each of the push-buttons in this group suppose that you wish to set-up the parameters which influence the format of a print-out of measurement data:

Press **Set-Up** **S2** . The following text will appear:



Enter/Execute By pressing this button you "enter" the value of the averaging period displayed on the screen.

Clear Entry If you change the value of the averaging period on the display screen and then decide that the new value is not correct, the original value of the parameter can be brought back to the screen be pressing the **Clear Entry** push-button.

Default Value Most of the parameters in the 1302's set-up "tree" are given factory-defined values called **default values**. These represent the values parameters will have after a **FULL RESET** of the 1302. By pressing this button the parameter on the screen will be given its **default value**.

Some parameters are not given default values so when the **Default Value** push-button is pressed only a cursor will appear instead of a default value. The default value of such a parameter is said to be "blank".

6. KEYING–IN PARAMETERS

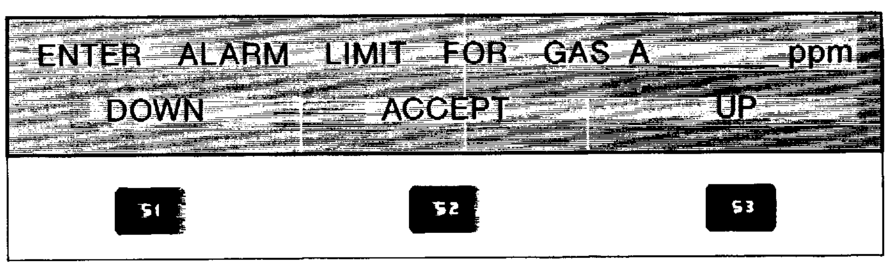
6.1. CHOOSING PARAMETERS

There are several push-buttons on the front-panel of the 1302 which are available for use during the process of choosing parameters and/or "entering" parameter values:

Clear Entry If you change the value of a numerical parameter appearing on the display screen and then decide that the new value is not correct, the original value of the parameter can be brought back to the screen by pressing the **Clear Entry** push-button.

Default Value If you wish the parameter appearing on the display screen to have the same value as the factory-defined value you can press the **Default Value** push-button.

Some parameters do not have pre-defined **default** values so that when the **Default Value** is used a blank line will appear instead of a number. The **default** value of such a parameter is said to be "blank". For example:



If the value of a chosen parameter lies outside the pre-defined minimum and maximum values the value will be corrected and, at the same time, an *"beep"* will sound. Users will then have to either "enter" the corrected value by pressing the **Enter/Execute** push-button, or to press the **S2** select push-button to "accept" the value which appears on the screen. Alternatively users can change the value of the parameter so that it lies within the pre-defined maximum and minimum values and then "enter"/"accept" it.

6.2. TYPES OF PARAMETERS

There are three types of parameter: numerical, pre-defined, and time parameters. These types are explained below:

6.2.1. Numerical Parameters

Users are always requested to "Enter" numerical parameters. This can be done in one of two ways:

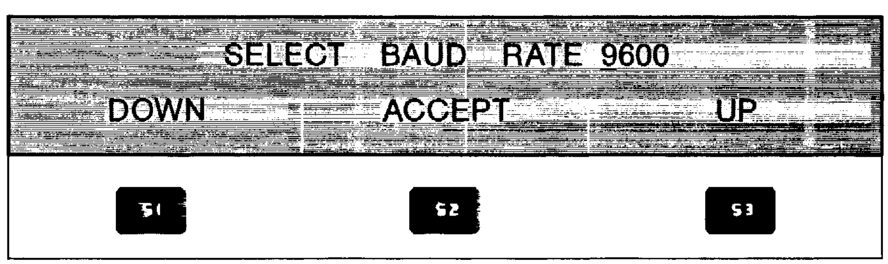
1. Use the **"Data Entry"** push-buttons to type in a value and then either press the **Enter/Execute** push-button or, alternatively, press the **S2** select push-button to "accept" the value which appears on the screen.

2. Using the **S1** and/or **S3** **"Select"** push-buttons to respectively decrease/increase the value of the parameter already displayed on the screen in steps which correspond to one "least significant value". For example if the displayed value was 1,25 then the least significant value will be 0,01 and each time the **S1** and/or **S3** button is used the displayed value will change by this amount. When the parameter has the required value it can be entered by pressing either the **Enter/Execute** push-button or, alternatively, the **S2** select push-button to "accept" the value which appears on the screen.

As explained in Section 6.1., the numerical value of each parameter entered must fall within a pre-defined range of values. If they do not the 1302 automatically changes the value, and an audible *"beep"* informs the user of the change.

6.2.2. Pre-defined Parameters

These parameters have well-defined values and can only be chosen by using the **"Select"** push-buttons. For example when the baud-rate has pre-defined values (300/600/1200/2400/4800/9600). When the baud-rate parameter has to be chosen the following display appears on the screen:



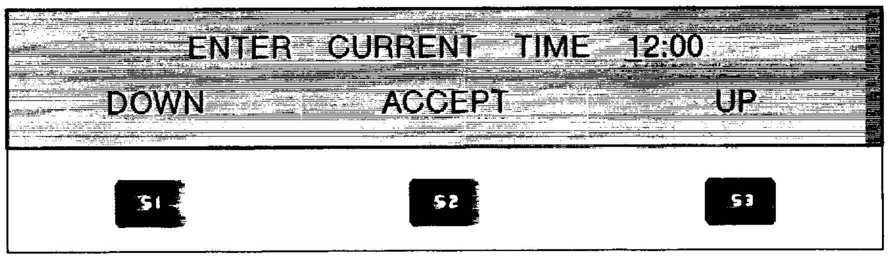
1. By using the **S1** push-button one can scroll through the available values of the baud-rate given above from right to left — the baud-rate appearing on the screen will be changed to 4800.

2. By using the S3 push-button one can scroll through the available values of the baud-rate given above from left to right — the baud-rate appearing on the screen will be changed to 300.

3. When the baud-rate on the screen has the required value users can "accept" the value by pressing the S2 push-button.

6.2.3. Time Parameters

Time parameter values have pre-defined maximum and minimum values which cannot be changed. The value of these parameters can be entered in two different ways. This can be illustrated by the following example:



1. Using the **"Data Entry"** push-buttons the current time can be typed-in and then entered/accepted by pressing either the Enter/Execute push-button to enter the value or the S2 push-button to "accept" the value.

2. Each time the S1 push-button is pressed the time shown on the display will be reduced. Each time the S3 push-button is pressed the time shown on the display will be increased. When the time on the display has the required value users can enter/accept the value by pressing either the Enter/Execute push-button to enter the value or the S2 push-button to "accept" the value.

7. SETTING–UP THE 1302

When the 1302 is operated in Set-up **mode**, the user can select or enter the value of a number of parameters which determine how the 1302 will operate. For example, the parameters found in the **Monitoring Task** branch of the set-up "tree" determine the type of task which will be performed by the 1302 when it is operated in Measurement **mode.**

Before leaving the factory, each of the parameters found in the set-up "tree" (see the fold-out Fig. 7.1 at the back of this Manual) are given factory values (**default values**).

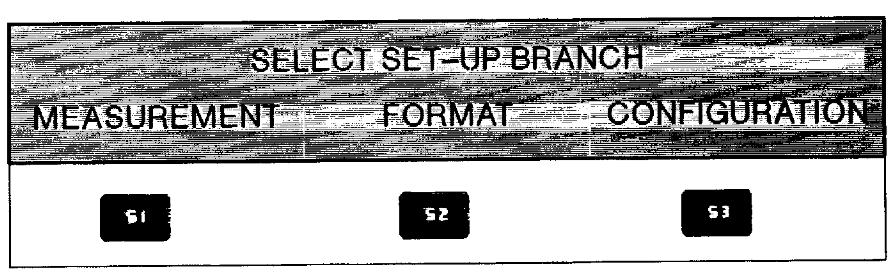
When the 1302 is operated in set-up **mode** those parameter values which appear on the display with a cursor underneath them are called **active values**. It is the **active values** which determine how the 1302 will operate.

7.1. THE ORGANISATION OF PARAMETERS IN THE SET–UP "TREE"

The working parameters of the 1302 are organised into a structure which resembles an inverted "tree" with a main stem splitting into several branches which are split again into smaller branches. This "tree" structure is illustrated in Fig. 7.1. The same illustration, sealed in a plastic cover, is supplied as an accessory with the 1302. It can be mounted on the inside of the front-panel cover of the 1302 so that users can more easily find their way around the set-up "tree" while operating the 1302 in "Set-Up" **mode**.

In this section we will give an overall description and overview of the set-up "tree". In following sections a series of push-button sequences are used to illustrate how a particular branch of the set-up "tree" can be reached, and the set-up parameters in each particular branch are individually described.

When the **Set-Up** push-button is pressed the following text appears on the screen:



The "select" push-buttons allow the user to follow the three main branches of the set-up "tree":

S1 By pressing this push-button the user can follow the **MEASUREMENT** branch of the set-up "tree" and select/enter the parameters which influence the way in which the 1302 performs a monitoring task.

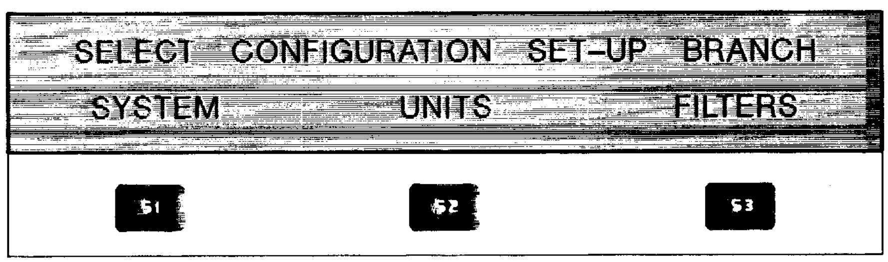
S2 By pressing this push-button the user can follow the **FORMAT** branch of the set-up "tree" and select/enter the parameters which influence the way in which measurement data is printed/plotted out.

S3 By pressing this push-button the user can follow the **CONFIGURATION** branch of the set-up "tree" and select/enter details about: the optical filters which have been installed in the 1302; the parameters which influence the way in which the 1302 communicates with other equipment (for example a printer); measurement units; the current time and date; and choose the self-tests the 1302 should perform, etcetera.

7.1.1. The "Configuration" Branch of the Set-Up "Tree"

To follow the **CONFIGURATION** branch of the set-up "tree" on the display screen:

Press **Set-Up** **S3**

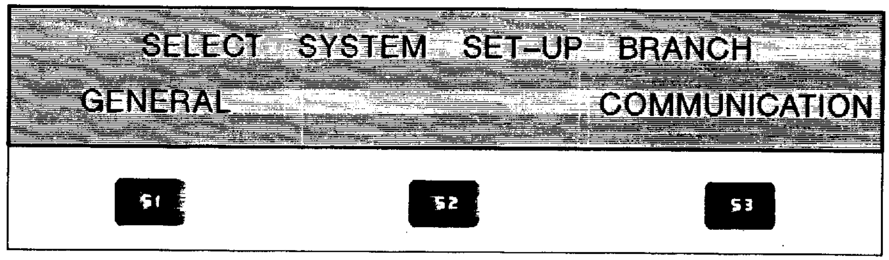


S1 Using this push-button users can follow the **System** branch of the set-up "tree" and select/enter parameters which set-up the 1302 for operation (for example, setting the current date and time), as well as those parameters which influence the way in which the 1302 will communicate with other equipment (for example a printer).

S2 Using this push-button the **Units** branch of the set-up "tree" can be followed. In this branch the user selects the units which the 1302 must use for all measured quantities shown on the display and on measurement results which are printed/plotted out.

S3 Using this push-button users can follow the **Filters** branch of the set-up "tree" and select/enter the UA number of each of the optical filters installed in the 1302 as well as the name of the gas each filter measures and its alarm limit (that is, the concentration of gas which will cause any attached alarm to ring/flash).

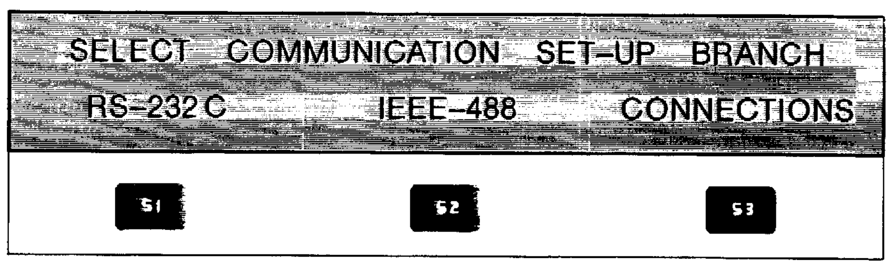
Let us suppose that **System** branch is followed by pressing the **S1** push-button. The following options appear on the screen:



S1 Using this push-button the ***General*** branch of the **System** section of the set-up "tree" can be followed. In this branch the user sets the internal clock of the 1302, the loudness of the 1302's "beeps", and which self-tests should be performed by the 1302.

S3 Using this push-button the ***Communication*** branch of the **System** section of the set-up "tree" can be followed. The user selects/enters the parameters which determine how the 1302 communicates with other equipment (for example, a plotter) via the IEEE 488 or RS 232 C interface ports of the 1302 and which interface is used in communicating with other equipment.

Let us suppose that the ***Communication*** branch is followed by pressing the **S3** push-button. The following options appear on the screen



S1 In this *RS 232 C* branch the user selects/enters parameters which determine how data is transferred (serially) from the 1302 to other equipment via the RS 232 C interface port of the 1302.

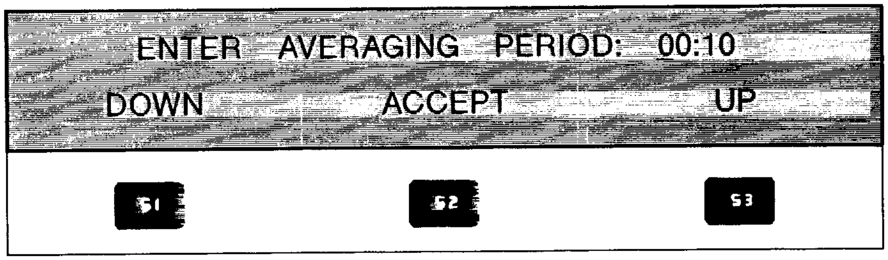
S2 In this *IEEE 488* branch users select/enter parameters which determine how data is transferred (in parallel) from the 1302 to other equipment via the IEEE-488 interface port of the 1302.

S3 In this *Connections* branch users select which of the 1302's interface ports (that is, the IEEE 488 or the RS 232 C) must be used to communicate with the printer and the plotter. If the IEEE 488 interface port is used the printer and/or plotter's address is requested and must be entered.

7.1.2. The "Format" Branch of the Set-Up "Tree"

To follow the **FORMAT** branch of the set-up "tree":

Press **Set-Up** **S2** .

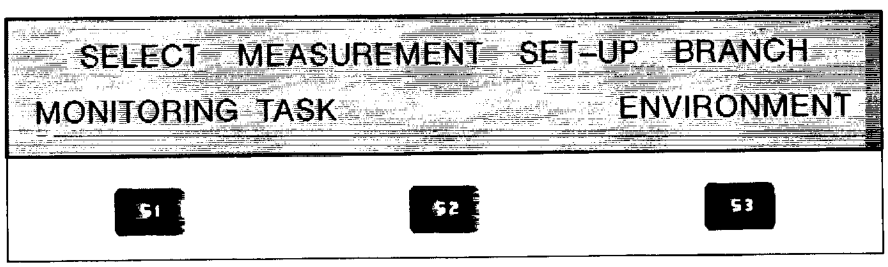


In the **FORMAT** branch of the set-up "tree" the user can select/enter the parameter values which determine how and which gas measurement results should be printed/plotted out.

7.1.3. The "Measurement" Branch of the Set-Up "Tree"

To follow the **MEASUREMENT** branch of the set-up "tree":

Press **Set-Up** **S1** .



S1 In this **Monitoring Task** branch the user selects/enters parameters which determine the way in which a monitoring task is performed. For example, whether measurements should be performed continuously or with a discrete time interval between them; whether gas measurements should be compensated for the presence of water-vapour/interferent gas; the period of time the monitoring task should be performed.

S3 In this **Environment** branch the user selects/enters parameters which describe the 1302's environment. For example, the length of the Teflon sampling tube connected to the 1302; the actual atmospheric pressure.

7.2. SETTING-UP THE OPTICAL FILTER PARAMETERS

Optical Filters of the user's choice are installed in the Multi-gas Monitor Type 1302 before delivery. The UA number of each of the installed filters is then "entered" into the **Filter** set-up. It is **vitally important** that the correct UA number is "entered" into the set-up of each filter because this determines the optical filter factors the 1302 will use to calculate the calibration factors during the calibration of each filter. If the UA number of an installed filter is incorrectly "entered" into the filter's set-up then all calibration factors for this filter will be invalid.

The following parameters are found in the **Filter** branch of the set-up "tree":

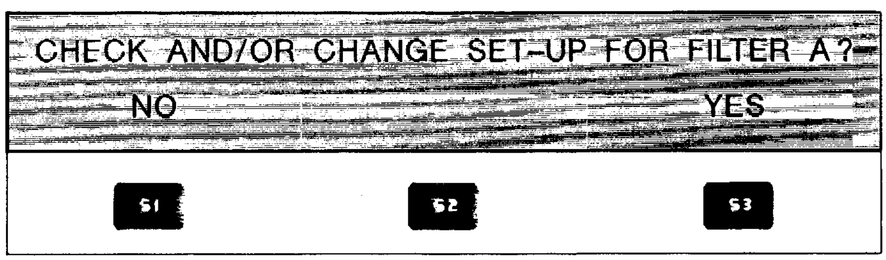
- The UA number of the optical filter installed in each position of the filter carousel. Once an optical filter has been calibrated it is **vital** that the UA number of this optical filter is not changed otherwise **all the calibration data for this filter will be lost (deleted).**
- The Filter Bank Number. There are five filter banks for each filter. Before an installed filter is calibrated, you have to "enter" the number of the filter bank in which you wish the 1302 to store the calibration factor(s) calculated during a calibration task. This is discussed in more detail in Chapter 11.

  The filter bank no. which is made **active** before a monitoring task determines which gas the filter will measure during the task.

- The name of the gas which the optical filter is calibrated to measure when a particular filter bank is made **active**
- The molecular weight of the above gas
- The alarm limit of the above gas

7.2.1. Setting-up the Optical Filter Numbers

Press Set-Up S3 S3

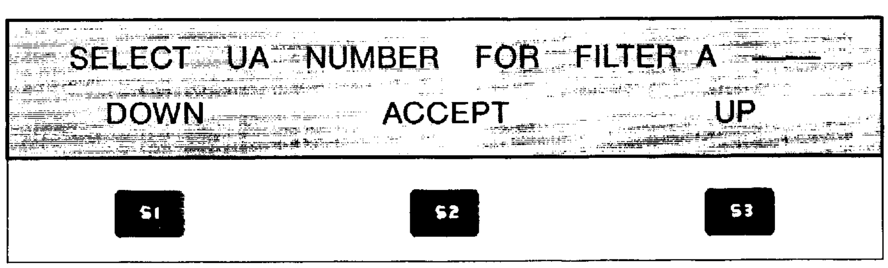


S1

If you do not wish to check and/or change any of the set-up parameters for the optical filter installed in position A of the filter carousel (that is: its UA number; the filter bank number to be used ; the name of the gas to be measured; the molecular weight of the gas to be measured; the alarm limit for the gas) then by pressing the S1 select push-button the 1302 does not enter the set-up for filter "A", and the display text then asks you whether you wish to CHECK AND/OR CHANGE THE SET-UP FOR FILTER B?.

S3

If you wish to check and/or change any of the set-up parameters for the optical filter installed in position A, then by pressing the S3 select push-button the display changes to the following:

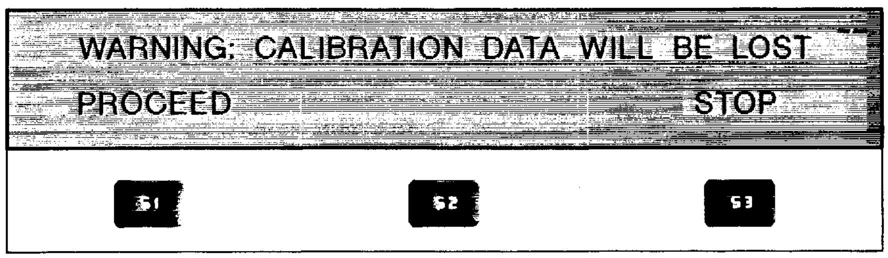


S2 If the S2 push-button is pressed the UA number appearing on the display is accepted as correct.

S1 Each time the S1 push-button is pressed the UA number appearing on the display will be decreased.

S3 Each time the S3 push-button is pressed the UA number appearing on the display will be increased.

If the number of the optical filter in a particular position is changed on the above display and then the S2 button is used to "accept" this number, **all calibration data for the previously installed filter is erased** from the ***Working Memory*** and ***Source Memory*** of the 1302. This means that the filter in this position of the carousel will not be able to measure any gas until it has been fully calibrated. To safeguard accidental deletion of calibration data the following WARNING appears when you "accept" a newly selected UA number by using the S2 button:



S1 If this button is pressed the new optical filter number, selected on the previous screen, will replace the original optical filter number in the set-up and this filter will have to be calibrated before it can be used to measure a gas.

S3 If this button is pressed the display will jump back to the previous display screen and automatically correct the UA number so that the original (unchanged) optical filter number installed in position A appears on the display. The user can then proceed through the rest of the set-up for filter "A" by "accepting" the unchanged optical filter number.

The acceptable values and default value of the UA number of the optical filters are defined in Table 7.1.

Display Text	Acceptable Values	Default Value
ENTER UA NUMBER FOR FILTER n*	0936 / 0968 – 0988	Blank

*n = A to E

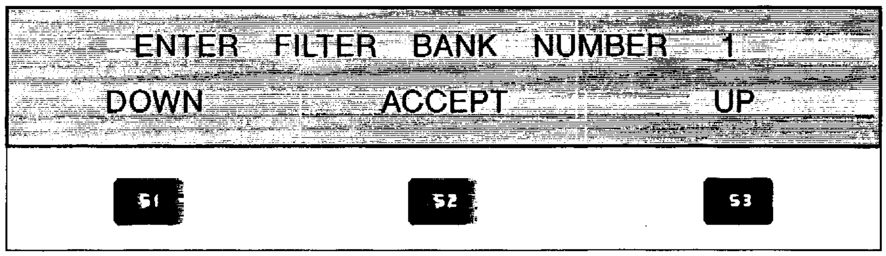
T02634GB0

Table 7.1. The range of acceptable values and default value of the UA number of the optical filters

7.2.2. Choosing a Filter Bank Number

After a new optical filter number has been accepted you are asked to choose which filter bank you wish to use. There are **5** filter banks which are numbered from 1-5 inclusive. Each time a particular optical filter is calibrated with a particular gas the calibration factors determined during the process are stored in a particular **filter bank**. Numbering the filter bank you wish to use during a particular calibration enables you to choose which gas a particular optical filter should measure during a monitoring task (see Chapter 11 for further details).

Press **Set-up** **S3** **S3** **S3** **S2**



The acceptable values and default value of the filter bank numbers are defined in Table 7.2.

Display Text	Acceptable Values	Default Value
ENTER FILTER BANK NUMBER	1 – 5	1

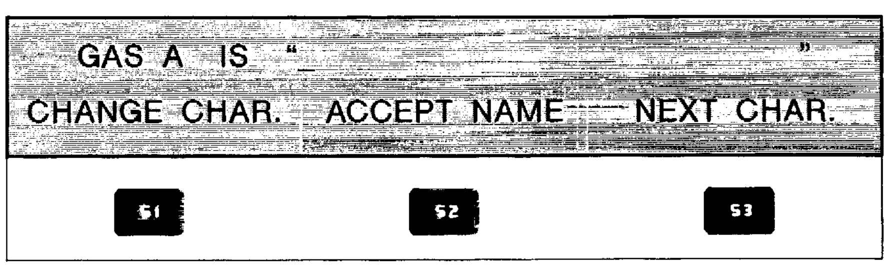
T02635GB

Table 7.2. The range of acceptable values and default value of the filter bank numbers

7.2.3. Assigning Names to the Gases Measured by the 1302

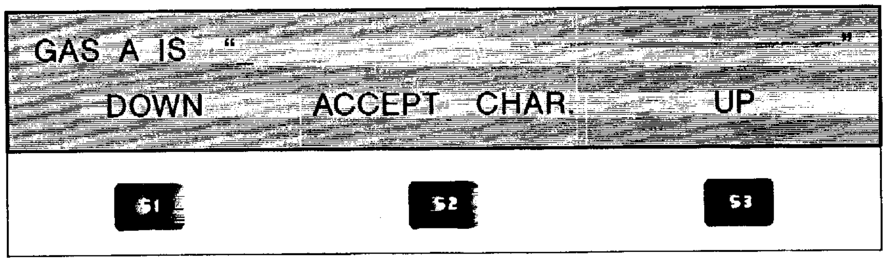
It is possible to assign a name to each gas measured by a particular optical filter. The name can be up to 29 characters in length. Several special characters are available — Table 7.3 lists all available characters.

Press **Set-Up** **S3** **S3** **S3** and accept/enter the correct UA number of the optical filters installed in position A as described in Section 7.2.1. and then enter the filter bank number you wish to use. When these tasks are complete the display will show:

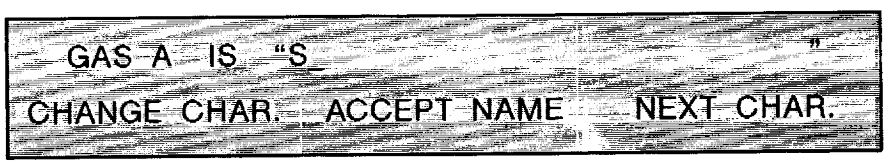


S2 If gas A's name appears correctly on the screen you can accept it by pressing the **S2** push-button. The text on the screen then jumps to the set-up of the molecular weight of gas A (see Section 7.2.4).

S1 By pressing this button you can change the character which is underlined by the cursor. The following display will then appear:



The character which is underlined on the above display can be changed by pressing either the **S1** push-button or the **S3** push-button until the character appearing above the cursor is the correct one. The correct character is then accepted by pressing **S2** which will cause the cursor to move to the next character in the gas name appearing on the previous display. For example if the first chosen character was "S" the display would show:



By using the select buttons as described above all the letters in the gas name can be chosen. When the gas name on the screen is correct it is accepted by pressing **S2** button. These names will appear on both print and plot-outs of data as well as on the display screen showing the set-up data for a monitoring task.

When the name of gas A has been accepted display changes to entering the molecular weight of gas A (see Section 7.2.4).

Characters Available for Gas Names
Scroll UP →
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.
← **Scroll DOWN**

T02636GB0

Table 7.3. The characters which are available for gas names

7.2.4. Entering the Molecular Weight of a Gas

When calculating gas concentrations the 1302 needs to have the molecular weight of the gas it is measuring, that is the weight, in grams, of 1 mole of the gas. This information is entered after the name of the gas has been entered in the filter set-up.

Press **Set-Up** **S3** **S3** **S3** and accept/enter the correct UA number of the optical filters installed in position A as described in Section 7.2.1. and then enter the filter bank number you wish to use and the name of the gas. When these tasks are complete the display will show:

```
ENTER MOLECULAR WEIGHT OF GAS A 1.00000
     DOWN          ACCEPT            UP
```

The range of values and the default value of the molecular weight of the gas to be measured by the filter installed in position "A" of the carousel are defined in Table 7.4.

Display Text	Acceptable Values	Default Value
ENTER MOLECULAR WEIGHT OF GAS n*	1,0000 – 9999,9	1,0000

*n = A to E

T02637GB0

Table 7.4. The range of acceptable values and the default value of the molecular weight of a gas

7.2.5. Setting-up the 1302's Alarm Levels

The alarm limit of a gas is that concentration of gas which should activate any alarm relay connected to the 1302 via its back panel "**Alarm Relay**" socket. There are two different alarm relays which function slightly differently. Details of these relays and the way in which they function is described fully in Section 2.7. The alarm level parameters are found in the **Filters** branch of the set-up "tree".

Press **Set-Up** **S3** **S3** **S3** and enter the UA number of the optical filter, the filter bank number, the name of the gas being measured by the filter, and the molecular weight of the gas. When these tasks have been completed the display will show:

```
ENTER GAS A'S ALARM LIMIT 100000 mg/m3
     DOWN          ACCEPT            UP
```

The alarm-limit parameter can be changed by using either the **"Select"** push-buttons or by using the **"Data Entry"** push-buttons to enter a new alarm limit for the gas. If you do not wish to activate the alarm function for a particular gas, press the **Default Value** push-button. This will "blank out" the alarm level value for the gas and de-activate the alarm for that gas. The range of acceptable values and the default value of the alarm limit for the gases is given in Table 7.5.

S1 When the correct alarm limit for gas A is displayed on the screen it can be accepted by pressing this push-button. This enters the alarm limit of gas A into the active set-up. The display then changes so that parameters for the optical filter in position B can be entered into the active set-up. The same procedure is repeated for all the other filters in the filter carousel.

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

T02638GB0

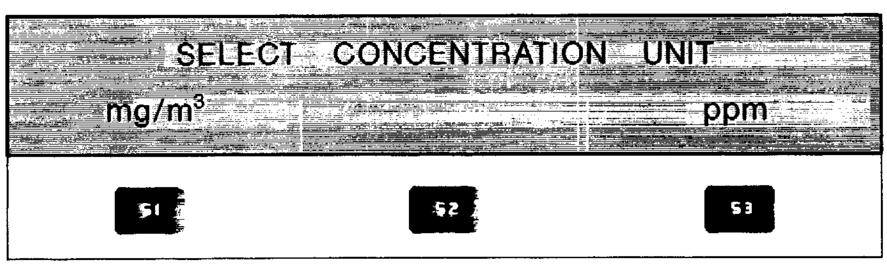
Table 7.5. The range of acceptable values and the default value of the alarm limit for the gases

7.3. SELECTING UNITS OF MEASURE

In the Set-Up "tree" users can select the units in which various parameters should be measured, for example, whether gas concentrations should be calculated in mg/m^3 or parts per million (ppm). The 1302 works internally with measurement parameters in SI units but is able to convert any SI unit into a variety of other measurement units so one is not forced to be consistent in one's choice of units.

The choice of units available in the 1302 as well as the default value of each parameter is shown in Table 7.6.

Press **Set-Up** **S3** **S2**



Once users have chosen a particular unit of measurement then all set-up parameters will have this unit. For example, if "meters" is chosen as the unit of length when configurating the 1302, then when the length of the 1302's sampling tube needs to be "entered" in the **MEASUREMENT** branch of the set-up "tree", the user will be asked to enter its length in meters.

The units chosen for the measurement parameters will be used for measurement results displayed on the screen as well as those which are printed/plotted out.

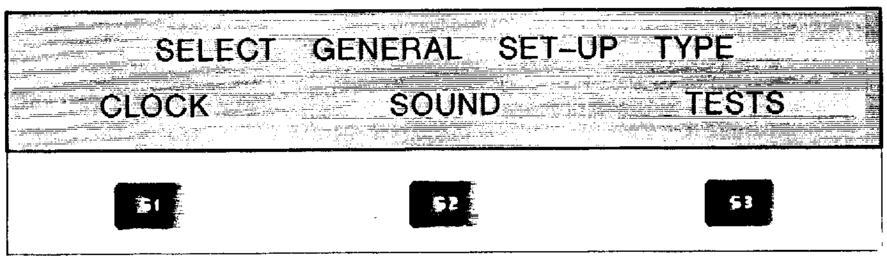
Display Text	Available Units	Default Unit
SELECT CONCENTRATION UNIT	mg/m^3, ppm	mg/m^3
SELECT LENGTH UNIT	m, ft	m
SELECT TEMPERATURE UNIT	°K, °C, °F	°C
SELECT PRESSURE UNIT	kPa, mBar, mmHg	kPa
SELECT HUMIDITY UNIT	mg/m^3, ppm, dew point (Tdew) kPa	mg/m^3

T02639GB0

Table 7.6. The choice of measurement units and the default value of each measurement unit

7.4. SETTING-UP GENERAL PARAMETERS

Press Set-Up S3 S1 S1



S1 By pressing this push-button the user follows the *Clock* branch of the *General* section of the set-up "tree". This enables the user to enter the current date and the current time.

The current date is entered as Year-Month-Day for example, the 23th of July 1989 is entered as 1989-07-23.

The current time is entered as the time on the 24-hour clock, for example, 14:05 is five minutes after two in the afternoon. Table 7.7. details the range of acceptable values and the default value of the date and time.

Display Text	Acceptable Values	Default Value
ENTER CURRENT DATE 0000-01-01	0000-01-01 to 9999-12-31	1988-01-01
ENTER CURRENT TIME 12:47	00:00 to 23:59	12:00

T02640GB0

Table 7.7. The range of acceptable values and the default value of the date and time

S2 Using this push-button the user can follow the *Front Panel* section of the *General* branch of the set-up "tree". The user chooses the volume of the 1302's "beep". The volume of the "beep" is expressed on a scale from 0 (no "beep") to 3 (loudest "beep"). Table 7.8. provides details of the available choices and the default value of this parameter.

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

T02642GB0

Table 7.8. The available choices and the default value of the 1302's "beep"

S3

Pressing this push-button allows the user to follow the *Tests* section of the *General* branch of the set-up "tree". In this section the user selects:

PERFORM ALL SELF-TESTS AFTER POWER-ON ? This allows the user to decide whether the 1302 should perform a full self-test of its various components after it is switched on (see Section 8.1.4).

PRINT DATA LOG ? This allows the 1302 to automatically print-out measurement data while it is performing measurements.

PRINT ERROR LOG If the 1302 is connected to a printer and set-up to print an error-log, then if any messages (warning or operation errors, see Appendix 2) are displayed during a monitoring task, these will be automatically recorded in the printed error-log. This facility is also of benefit during service of the 1302.

ACTIVATE AUTOMATIC SWITCH-OFF ? This allows the user to decide whether the 1302 should automatically switch itself off if it is not operated within five minutes of being switched on. Details of the available choices and the default value of this parameter are provided in Table 7.9.

Display Text	Available Choices	Default Value
PERFORM ALL SELF-TESTS AFTER POWER-ON ?	NO, YES	YES
PRINT DATA LOG ?	NO, YES	NO
PRINT ERROR LOG ?	NO, YES	NO
ACTIVATE AUTOMATIC SWITCH-OFF ?	NO, YES	YES

T02643GB0

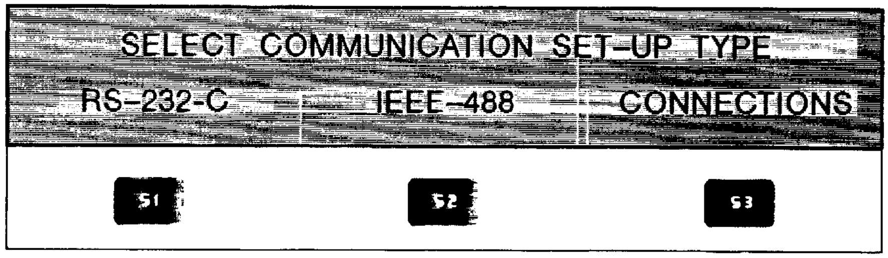
Table 7.9. The acceptable choices and the default value of the parameters in the "Tests" branch of the set-up "tree"

7.5. SETTING-UP COMMUNICATION PARAMETERS

⚠ **WARNING:** You must perform a PARTIAL RESET of the 1302 (press the **Reset** and **S1** buttons) if the **active** value of any parameter in this branch of the set-up "tree" is changed. If the 1302 is not partially reset, then the 1302 will not up-date the communication-parameter data which it used the last time data was transmitted via either of its interfaces. By performing a partial reset you ensure that the 1302 has the parameters necessary to enable it to transmit data to the attached printer/plotter.

In the *Communication* branch of the **System** section of the set-up "tree" the user selects the parameters which determine how the 1302 will communicate with other equipment via either its RS 232C serial interface port or its IEEE 488 interface port.

Press Set-Up S3 S1 S3



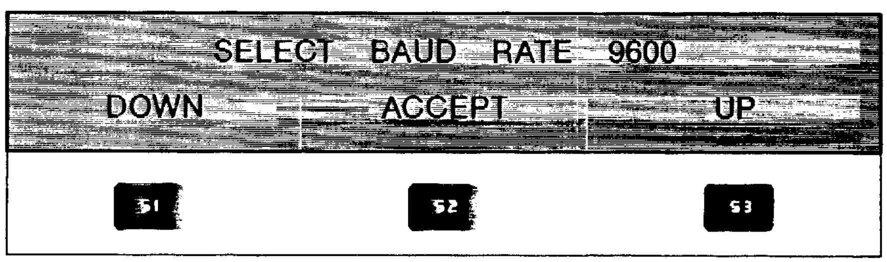
S1 In this *RS-232-C* branch of the ***Communication*** section of the set-up "tree" the user is able to enter/select the parameters which determine how the 1302 should communicate with other equipment (for example a printer or plotter) via its RS 232C serial interface.

S2 In this *IEEE-488* branch of the ***Communication*** section of the set-up "tree" the user is able to enter/select the parameters which determine how the 1302 should communicate with other equipment (for example a printer or plotter) via its IEEE 488 interface.

S3 In this *Connections* section of the ***Communication*** branch of the set-up "tree" the user is able to enter/select the interface to be used when the 1302 is communicating with a printer and/or plotter and, if the IEEE 488 interface is chosen, to enter the address of the printer and plotter.

7.5.1. Selection of Communication Parameters for the RS232C Interface

Press Set-Up S3 S1 S3 S1



SELECT BAUD RATE gives the rate at which data should be transmitted from the 1302 via its RS 232C interface.

The acceptable values and the default value of the baud rate are given in Table 7.10.

Display Text	Acceptable Values	Default Value
SELECT BAUD RATE	300/600/1200 2400/4800/9600	9600

T02644GB0

Table 7.10. The acceptable values and the default value of the baud rate

The other communication parameters which need to be selected in the RS 232 C branch of the set-up "tree" are shown in Table 7.11 together with available choices and default values for each parameter.

Display Text	Acceptable Values	Default Value
SELECT NUMBER OF STOP BITS	1 BIT, 2 BITS	2 BITS
SELECT NUMBER OF DATA BITS	7 BITS, 8 BITS	8 BITS
SELECT PARITY CHECK	NONE, EVEN, ODD	NONE
SELECT HARDWIRE MODE	Three-wire, Switched-line Leased-line	Three-wire
SELECT HANDSHAKE TYPE	None, X–ON/X–OFF Hard-wired	X–ON/ X–OFF

T02645GB0

Table 7.11. The available choices and default values for each RS 232 C communication parameter

SELECT NUMBER OF STOP BITS The user chooses how many stop bits should be used when data is transmitted from the 1302 to other equipment via the RS 232 C interface.

SELECT NUMBER OF DATA BITS The user chooses how many data bits should be used when data is transmitted between the 1302 and other equipment via the RS 232 C interface.

SELECT PARITY CHECK The user chooses whether or not transmitted data should be checked for transmission errors using the parity checking system.

SELECT HARDWIRE MODE The user chooses which communication line (wire) should be used to control data transmission between the 1302 and other equipment.

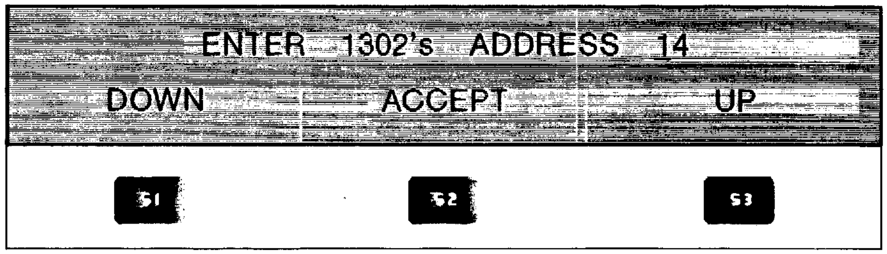
SELECT HANDSHAKE TYPE The user chooses which type of "handshake" should be used for transmission via the RS 232 C interface.

REMEMBER to partially reset your 1302 if any of the above parameters have been changed! See the WARNING at the beginning of Section 7.5.

7.5.2. Selection of Communication Parameters for the IEEE 488 Interface

The parameters in this branch decide how the 1302 communicates via the IEEE 488 interface bus.

Press Set-Up S3 S1 S3 S2



ENTER 1302's ADDRESS 14 This enables the 1302 to be addressed via the IEEE 488 interface. The range of acceptable values and the default value of the 1302's address are shown in Table 7.12.

Display Text	Acceptable Values	Default Value
ENTER 1302 ADDRESS	from 0 to 30	14

T02646GB0

Table 7.12. The range of acceptable values and the default value of the 1302's address

The other IEEE 488 communication parameters which need to be selected in this branch of the set-up "tree" are shown in Table 7.13 together with available choices and default values of each parameter.

Display Text	Available Choices	Default Value
IS 1302 SYSTEM CONTROLLER ?	NO, YES	YES

T02647GB0

Table 7.13. The acceptable values and default value of the IEEE 488 communication parameters

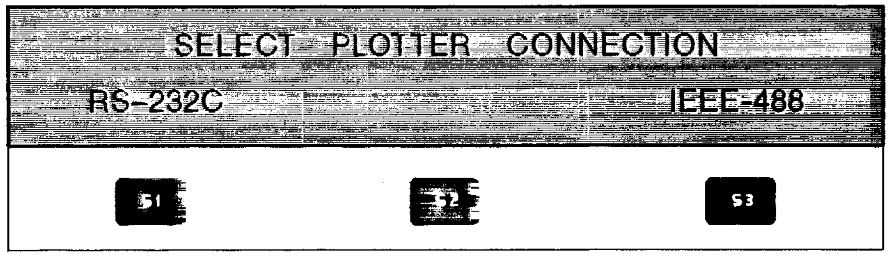
IS 1302 THE SYSTEM CONTROLLER ? The user chooses whether or not the 1302 shall be the system controller on the IEEE 488 interface bus.

REMEMBER to partially reset your 1302 if any of the above parameters have been changed! See the WARNING at the beginning of Section 7.5.

7.5.3. Setting-up the Connections for Communication between the 1302 and other equipment

In the *Connections* section of the ***Communication*** branch of the set-up "tree" the user chooses which of the two interfaces (RS 232C or IEEE 488) should be used when the 1302 is communicating with other equipment (for example a printer). The RS 232C interface cannot be used to communicate with more than one device at a time.

Press **Set-Up** **S3** **S1** **S3** **S3**



SELECT PLOTTER CONNECTION The user chooses the interface to be used when data is transmitted from the 1302 to a plotter. The available choices and the default value of this parameter are shown in Table 7.14.

Display Text	Acceptable Values	Default Value
SELECT PLOTTER CONNECTION	RS-232C, IEEE-488	IEEE-488

T02648GB0

Table 7.14. The interfaces available for connection to a plotter and the default value of this parameter

The other parameters which need to be chosen in this section are listed in Table 7.15. together with the available choices and the default value of the parameters.

Display Text	Available Choices	Default Value
ENTER PLOTTER'S ADDRESS	from 0 to 30	5
SELECT PRINTER CONNECTION	RS-232C, IEEE-488	IEEE-488
ENTER PRINTER'S ADDRESS	from 0 to 30	1

T02649GB0

Table 7.15. Available choices and default values of the interface parameters

ENTER PLOTTER's ADDRESS If the user has chosen the IEEE 488 interface as the plotter's connection then the address of the plotter is entered here.

SELECT PRINTER CONNECTION The user chooses the interface to be used when data is transmitted from the 1302 to a printer.

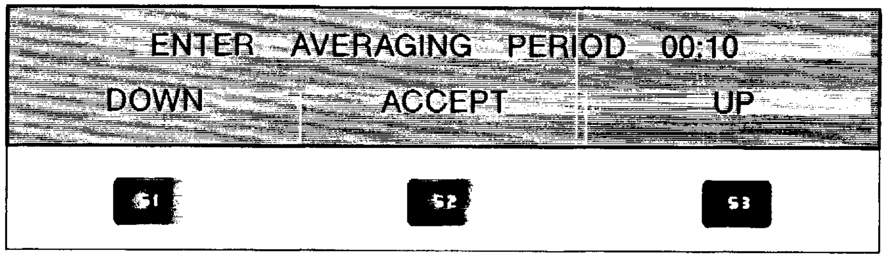
ENTER PRINTER's ADDRESS If the user has chosen the IEEE 488 interface as the printer's connection then the address of the printer is entered here.

REMEMBER to partially reset your 1302 if any of the above parameters have been changed! See the WARNING at the beginning of Section 7.5.

7.6. SELECTION OF FORMAT (OUTPUT) PARAMETERS

In the **FORMAT** branch of the set-up "tree" the user can select/enter the parameters which affect print-outs and/or plot-outs of measurement data from the 1302.

Press **Set-Up** **S2**



ENTER AVERAGING PERIOD refers to the period of time, that is, the length of the "time window", which should be used to average measurement results. To illustrate the function of this averaging "window" let us suppose that the 1302 has been taking measurements every 2,5 mins., over a period of 30 mins., of gas A (acetone), and the following results (unshaded area) were obtained and recorded in the display memory.

A: ACETONE

				Averaged Values
0 11:42:30	1	66,72	mg/m^3	66.72 mg/m^3
0 11:45:00	2	154,9	mg/m^3	110.8 mg/m^3
0 11:47:30	3	271,3	mg/m^3	164.3 mg/m^3
0 11:50:00	4	415,9	mg/m^3	227.2 mg/m^3
0 11:52:30	5	588,7	mg/m^3	299.5 mg/m^3
0 11:55:00	6	789,7	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 in the set-up was set to 10 mins. When the above measurement results are displayed on the screen and the averaging function is activated (by pressing the **Average** push-button) 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.

When the averaging function is active it will not only affect the results displayed on the screen but also the measurement results which are being printed/plotted out from the *Display Memory*. However, when the averaging function is de-activated — by pressing the **Average** button again (the LED will switch off) — the original results (unshaded) will replace the averaged results on the screen.

The range of acceptable values and the default value of the averaging period are shown in Table 7.16.

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

T02650GB0

Table 7.16. The range of acceptable values and the default value of the averaging period

The other output parameters which determine the format of print/plot-outs are shown in Table 7.17. together with available choices and default values.

Display Text	Available Choices	Default Value
PRINT AND/OR PLOT EACH GAS?	No, Yes	Yes
PRINT/PLOT GAS **n***?	No, Yes	No
SELECT CONCENTRATION–AXIS TYPE	Linear, Logarithmic	Linear
ENTER PEN SPEED	1–128	128
SELECT PLOTTER TYPE	Multi-pen Single-pen	Multi-pen
SELECT PLOTTER PAPER FEED	OFF ON ON & CUT	OFF
SELECT TEXT LINE TERMINATOR	CR LF CR–LF	CR–LF

*n = A to E

T02651GB0

Table 7.17. Parameters which determine the format of print/plot-outs

If one chooses to PRINT/PLOT EACH GAS then all gases which have been measured will be printed/plotted out. If one does not choose to PRINT/PLOT EACH GAS then the user is then given the chance to choose which of the gases (A - E) and water (W) should be printed/plotted out — PRINT/PLOT GAS A ? and so on.

When selecting the CONCENTRATION-AXIS TYPE the user determines whether measured concentrations should be represented on a LINEAR or LOGARITHMIC scale on the y-axis of plot-outs. As a rough guide one normally chooses a logarithmic axis if there is a very wide variation in the gas concentrations measured during the monitoring period.

ENTER PEN SPEED The user enters the speed of the plotter pen. This parameter is dependent upon the plotter being used and users should therefore refer to the individual plotter's manual to find out what to enter for the pen speed. If a pen-speed of 128 is chosen the default pen speed of the plotter will be used.

SELECT PLOTTER TYPE The user decides whether the gas measurements to be plotted out should be shown as solid lines using various coloured pens (multi-pen plotter) to distinguish between the various gases, or whether gas measurements should be shown as various kinds of dashed lines using a single colour (single-pen plotter).

SELECT PLOTTER PAPER FEED This parameter informs the 1302 about the kind of plotter you are using. OFF indicates that the plotter uses a single sheet of paper; ON indicates that the plotter feeds itself from a roll (or stack) of plotter paper and, that when a plot is complete, the plotter automatically feeds the plot forward so that it can be detached; ON AND CUT indicates that the plotter feeds itself from a roll (or stack) of plotter paper and, that when a plot is complete, the plotter automatically feeds the plot forward and cuts it off from the roll of paper to which it is attached.

SELECT TEXT LINE TERMINATOR The user chooses which character the 1302 should use as "end of text line" when data is transmitted from the 1302.

7.7. SETTING-UP PARAMETERS FOR MONITORING TASKS

The parameters which determine how a particular monitoring task should be performed are described in detail in Chapter 10. In this section we shall only describe how these parameters are chosen.

Press Set-Up S1

SELECT MEASUREMENT SET-UP BRANCH		
MONITORING TASK		ENVIRONMENT
S1	S2	S3

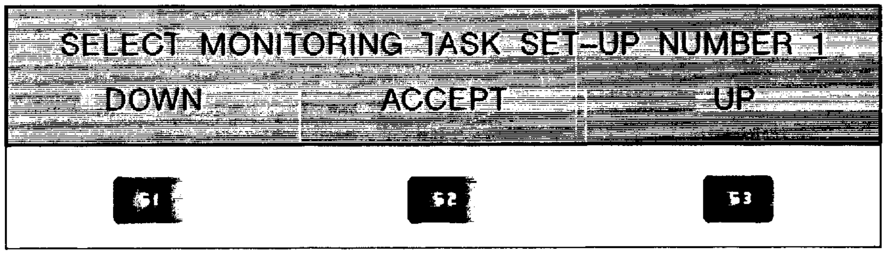
S3 In this Environment branch of the MEASUREMENT section of the set-up "tree" the user either selects or "enters" those environmental parameters which in any way influence the measurement of gas concentration.

S1 In this Monitoring Task branch of the MEASUREMENT section of the set-up "tree" the user can define the parameters which determine how a particular monitoring task should be performed.

7.7.1. Setting-up the 1302 for a Particular Monitoring Task

In the **Monitoring Task** branch of the **MEASUREMENT** section of the set-up "tree" the user can define up to ten different monitoring tasks. Each monitoring task set-up is identified by a number (from one to ten).

Press **Set-Up** **S1** **S1**



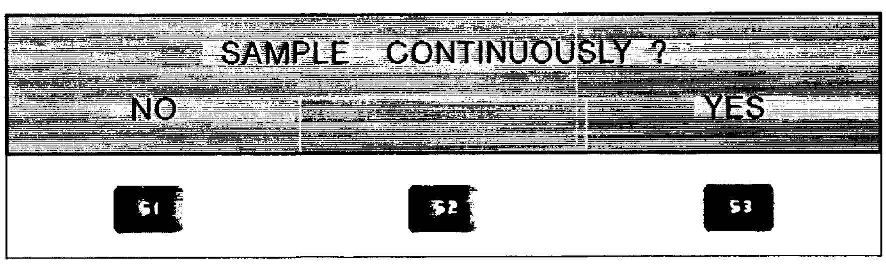
The available choices and default value for the monitoring task set-up numbers are shown in Table 7.18.

Display Text	Available Choices	Default Value
ENTER MONITORING–TASK SET–UP NUMBER	from 1 to 10	1

T02652GB0

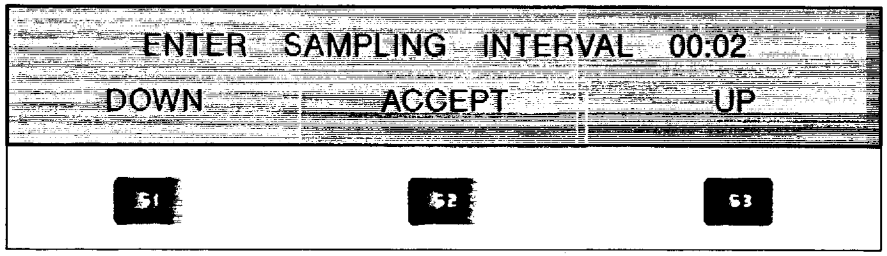
Table 7.18. The available choices and default value for the monitoring task set-up numbers

Once the monitoring task set-up number has been chosen and "entered" the user then defines the parameters which determine how the monitoring task must be performed. The first question asked is:



If the user wants the 1302 to take in a sample of gas, determine the gas concentrations and then immediately afterwards take in a new sample of air for analysis for the duration of a monitoring period, the **S3** push-button must be pressed.

If the user wishes the 1302 to take in and analyse air samples at discrete intervals of time (for example every 10 min.) the **S1** push-button must be pressed. The display then changes and the user is asked to "enter" the sampling interval as follows:



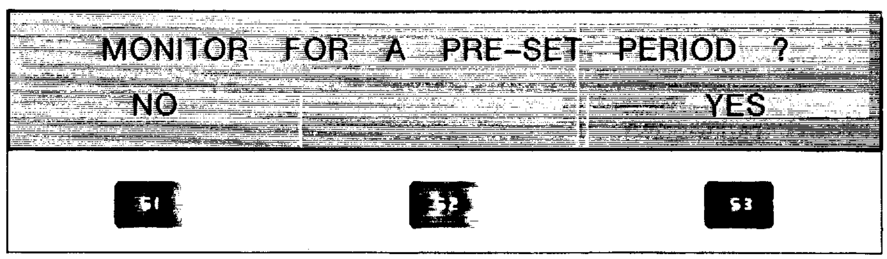
The SAMPLING INTERVAL is entered as hours:minutes. This is the time between the start of one measurement cycle and the start of the following measurement cycle (see Chapter 10). For example, if the user chooses a 10 min. sampling interval the interval has to be changed to read 00:10. The range of acceptable values and the default value of the sampling interval are provided in Table 7.19.

Display Text	Acceptable Values	Default Value
ENTER SAMPLING INTERVAL	**hours:minutes** 00:01 to 01:00	**hours:minutes** 00:02

T02653GB0

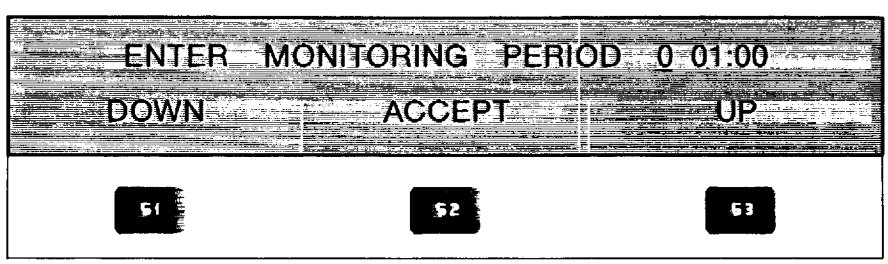
Table 7.19. The range of acceptable values and the default value of the sampling interval

Note: The minimum time required for measuring a given number of gases is shown in Table 9.2 in Section 9.3.



S1 If the user does not wish to define the length of time a monitoring task should be performed, the S1 push-button must be pressed. When this particular monitoring task set-up is used, the 1302 will only stop monitoring if stopped manually by the user.

S3 If the user wishes to limit the monitoring period, that is to pre-define the length of time this particular monitoring task must be performed, then the S3 push-button must be pressed. The next screen allows the user to "enter" the monitoring period of this monitoring task set-up.



The MONITORING PERIOD is entered as Days Hours:Minutes. For example, if this particular measurement cycle needs to be performed during 5 days, 14 hours and 30 minutes the "monitoring period" should be "entered" as 5 14:30. The 1302 will then automatically stop monitoring 5 days, 14 hours and 30 minutes after the measurement cycle with this particular set-up number is started. The range of acceptable values and the default value of the monitoring period is shown in Table 7.20.

Display Text	Acceptable Values	Default Value
ENTER MONITORING PERIOD	**days hours:minutes** 0 00:01 to 7 00:00	**days hours:minutes** 0 01:00

T02654GB0

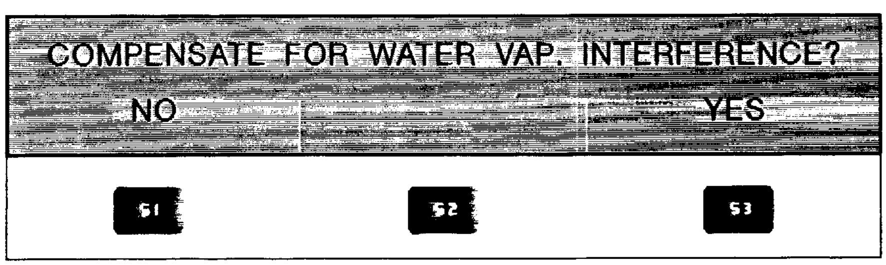
Table 7.20. The range of acceptable values and the default value of the monitoring period

The maximum time you can set a monitoring period to be is 7 days, if you try to enter a greater number of days the 1302 will automatically change the period to 7 days. However, if you do not set a pre-defined monitoring period the 1302 will just store as much data as possible before starting to overwrite the "oldest" stored measurement results.

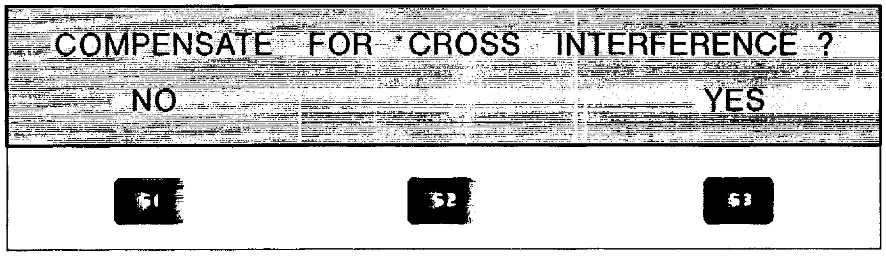
The 1302's *Display Memory* has finite storage capacity. The data storage time available depends upon the number of gases being measured, as well as the frequency with which measurements are performed (that is, the sampling interval). Section 9.3 provides information about how you can roughly calculate the length of time the data from a particular monitoring task can be stored in the *Display Memory.*

It is important to realise that once the *Display Memory* has been filled up by the results of a particular monitoring task, the results of any further measurements in the same monitoring task will start to overwrite the data already stored in the memory.

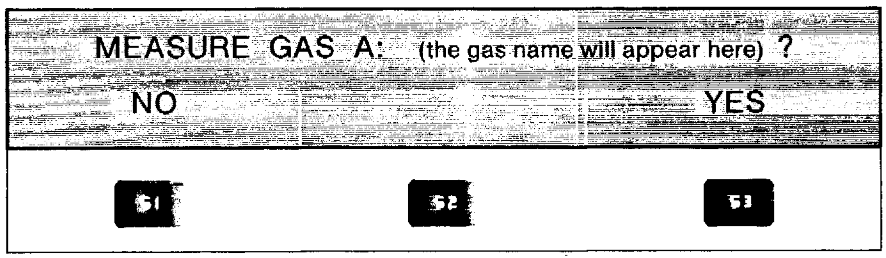
Before any monitoring task is started, all data stored in the 1302's *Display Memory* is removed (cleared). When you start a new monitoring task the following warning is displayed WARNING: DISPLAY MEMORY WILL BE DELETED to remind you to store any data that is presently stored in the *Display Memory.* If a monitoring task is stopped, any data already stored in *Display Memory* will be deleted when any monitoring task is started.



As explained in Chapter 1 the 1302 is capable of measuring water's contribution to the signal measured in its analysis cell. The user can decide whether or not the 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.



If any "interferent" other than water vapour is present in the ambient air-sample, the 1302 can cross compensate for the interference caused by its presence provided that a selective optical filter is installed in the 1302 to measure the concentration of interferent gas present.

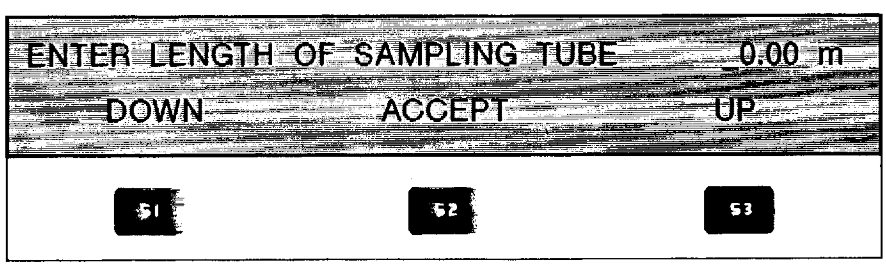


Users choose which gases they wish to monitor. Gas A is the gas which is to be measured by the optical filter installed in position A of the filter carousel. The question on the above display screen is repeated for gas B, C, D, E, and water (W).

7.7.2. Setting-up the 1302's Environmental Parameters

Environmental parameters decribe the factors which influence the measurement situation.

Press **Set-Up** **S1** **S3**

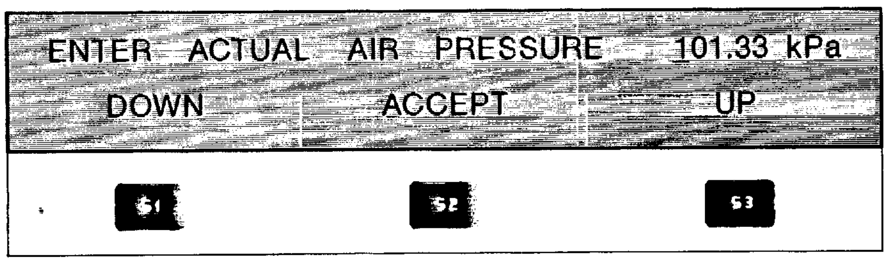


By using the select buttons S1 and S3 the tube length shown on the display can be adjusted to the correct value. The acceptable values and the default values of the length of sampling tube are provided in Table 7.21. The correct value is then "accepted" by pressing the S2 push-button.

Display Text	Acceptable Values	Default Value
ENTER LENGTH OF SAMPLING TUBE	0 - 99 metres	0.00
ENTER LENGTH OF SAMPLING TUBE	0 - 324.80 feet	0.00

T02655GB0

Table 7.21. The acceptable values and the default values of the length of sampling tube



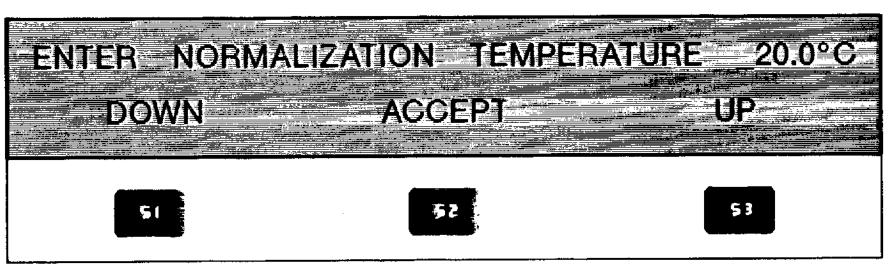
The acceptable values and the default values of the actual air pressure, in the various pressure units, are provided in Table 7.22.

Display Text	Acceptable Values	Default Value
ENTER ACTUAL AIR PRESSURE kPa	50–150kPa	101,33kPa
ENTER ACTUAL AIR PRESSURE mBar	500–1500mBar	1013,2mBar
ENTER ACTUAL AIR PRESSURE mmHg	375–1125mmHg	760mmHg

T02656GB0

Table 7.22. The acceptable values and the default values of the actual air pressure

Once the air pressure has been "entered" the screen text then shows the following:



If the user has chosen to measure gas concentrations in the unit parts per million (ppm) (see Section 7.3) the user must "enter" the temperature at which the 1302 should calculate gas concentrations. For example, if a normalization temperature of 25°C is entered the gas concentration which appears on the display during a monitoring task will be calculated as X ppm **at 25°C**. The acceptable values and the default values of the normalization temperature are given in Table 7.23 in the different temperature units.

Display Text	Acceptable Values	Default Value
ENTER NORMALIZATION TEMPERATURE	–20°C to +50°C	20°C
ENTER NORMALIZATION TEMPERATURE	253,2 K to 323,2 K	293 K
ENTER NORMALIZATION TEMPERATURE	–4°F to +122°F	68°F

T02657GBC

Table 7.23. The acceptable values and the default values of the normalization temperature

8. STARTING-UP AND/OR RE-STARTING THE 1302

8.1. INTRODUCTION

When the Multi-gas Monitor Type 1302 is started up in the normal way, that is, by switching on the AC Mains power-switch on the back panel, the 1302 responds by performing a **partial reset**. The 1302 also responds by performing a **partial reset** if during operation it is switched off and is re-started in any of the following ways:

- If the 1302 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 1302 by switching it off using the AC mains power switch on the back panel, and then re-starts it by using the same switch;
- If the user stops operating the 1302 by switching it off using the **Stand by** control push-button on the front panel, and then re-starts it by using the same switch.

Users can also "partially reset" the 1302 by using the **Reset** push-button on the front panel (see Section 8.1.3).

8.1.1. A Partial Reset of the 1302

When the 1302 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 1302 was last switched on.

- If **more** than 10 mins have elapsed since the 1302 was switched on it will perform the **software**, **data-integrity**, and **hardware** tests when switched on again.
- If **less** than 10 min have elapsed since the 1302 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 1302 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 1302's software (ROM — **R**ead **O**nly **M**emory.

Data-integrity test
This test checks the integrity of the data stored in the 1302'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 1302's ***Working Memory*** (RAM).

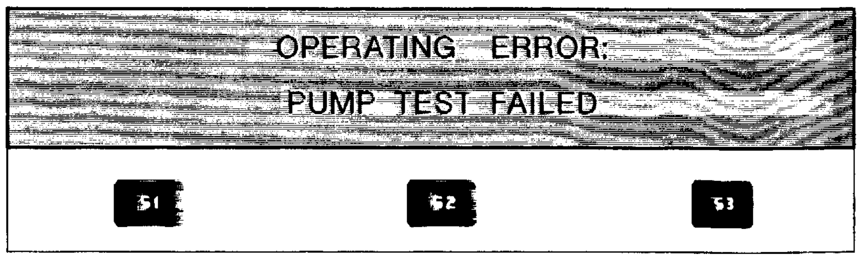
Hardware test

This test checks that the electrical, mechanical and electronic parts of the 1302 are functioning properly.

The following parts of the 1302 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 users do not wish the 1302 to perform the **hardware** test during a partial reset they can disable it (see Section 8.1.4).

If any part of the 1302 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 the **Status** push-button. 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 1302 will automatically set the parameters in the relevant compartment(s) to their default values, and the 1302 will send the following message on its display screen:

WARNING: MEMORY SET TO DEFAULT
ERROR DETECTED IN XXXXX MEMORY

Where XXXX will denote the part of the memory which 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 1302.

8.1.2. Response of the 1302 after a Partial Reset

The way in which the 1302 responds after a **partial reset** is dependent upon the way it was being operated at the time of the partial reset (see Table 8.1). For example, if the 1302 was busy taking a measurement when it was "partially reset" it will complete the interrrupted 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 9.2.3.

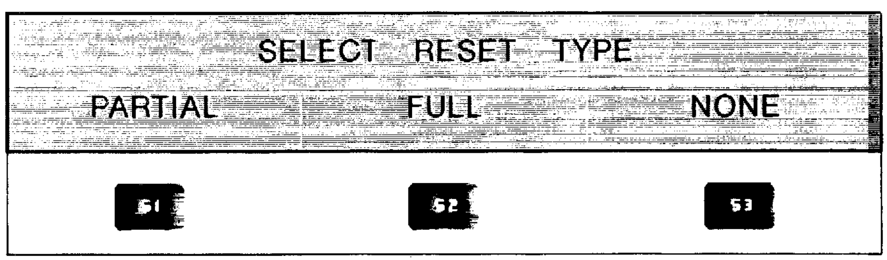
1302 last used while in	Task being performed	Task started after a PARTIAL RESET
Measurement **mode**	A gas measurement	Completes the monitoring task
"Display"	Looking at measurement results on the display screen	Measurement results are shown on the display from the beginning again
Set-Up **mode**	Changing set-up parameters which control the operation of the 1302	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 and/or plot-outs of, for example, measurement data)	Print-out/plot-outs are stopped and measurement results are shown in the display from the beginning

T02658GB0

Table 8.1. Dependence of 1302's response, after a partial reset, to its operating condition at the time of the partial reset

8.1.3. Full Reset and/or Partial Reset of the 1302 via its Front Panel

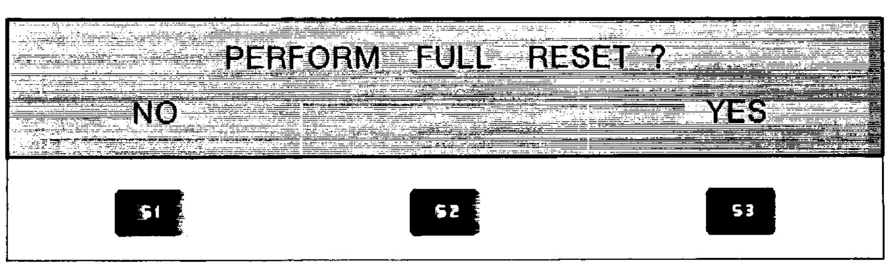
There are two well-defined levels of reset. By pressing the **Reset** push-button the following text appears on the display screen:



S3 If this push-button is pressed the user can come out of reset **mode** without performing any kind of reset. The 1302 just goes back to operating the same way it was operating before its **Reset** push-button was pressed.

S1 PARTIAL Reset: If this level of reset is chosen the 1302 stops operating, performs a **partial reset** as described in the previous section (8.1.2) and then resumes operating in the fashion described in Table 8.1.

S2 FULL Reset: If this level of reset is chosen the 1302 responds by changing the text on the display so that users have a chance to **confirm** that they wish the 1302 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 1302 just goes back to operating the same way it was operating before its **Reset** push-button was pressed.

S3 By pressing this push-button the user confirms that a FULL reset is required — and the 1302 performs a full reset. During a FULL reset the 1302 performs the following two tasks:

1. "Clearing" (emptying) all data from its ***Working Memory***. This means all data in *Display Memory* and *Background Memory* will be lost.
2. 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***.

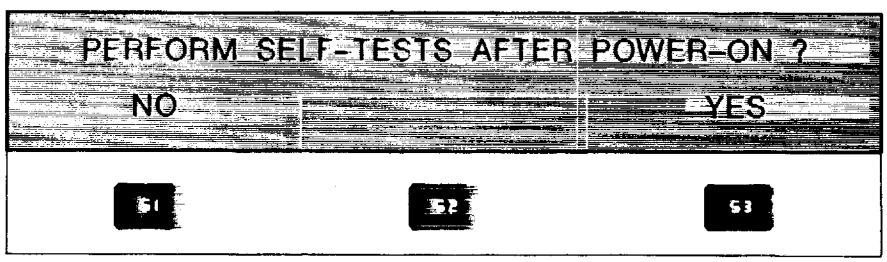
8.1.4. Disabling the 1302's Hardware-tests

If users do not wish the 1302 to perform the **hardware** test on power-up they can disable it (see Section 7.4).

The procedure is as follows:

Operate the 1302 in set-up **mode** and follow the *Tests* branch of the set-up "tree" (see Fig. 7.1 on the fold-out back page of this manual) as follows:

Press **Set-Up** **S3** **S1** **S1** **S3**



S1 By pressing this push-button the user can stop the 1302 from performing the **hardware** test as part of its self-testing procedure during any kind of reset.

9. PRESENTATION OF MONITORING TASK DATA

9.1. DISPLAYED MONITORING TASK DATA

When the 1302 is switched on, but not being operated in any **mode**, the screen display text identifies the data stored in its *Display Memory* by displaying the day and time of the first stored measurement cycle of the monitoring task as well as the day and time of the last measurement cycle of the monitoring task. For example:

```
DATA IN DISPLAY MEMORY RECORDED FROM
  1989-05-16  09:50  TO  1989-05-16  10:04
```

If the 1302 has just been **fully reset** then the display will just show the current time and report that the monitor is ready for use.

The set-up parameters describing a monitoring task and the measurement data collected during the task are stored as a list in the *Display Memory*. The user can scroll through the set-up parameters as well as the data collected during the task by using the **Next Display** button to scroll "vertically" downwards, and the **Previous Display** push-button to scroll "vertically" upwards through the list. Fig. 9.1. illustrates how the data is organised:

1 **Identification of Measurements**
This screen provides the date and time of the first and last measurement results which are stored in *Display Memory*.

2 **Identity of Each Monitored Gas**
This display identifies the gases monitored during the task. By using the **Next Gas** push-button one can find the names of **all** the gases which were monitored during the displayed task.

3 **Statistical Analysis of Measurement Results for Each Gas**
Using the individual measured gas concentrations stored in *Display Memory*, a statistical analysis is performed which provides a summary of the stored measurement results. The MAX (maximum), MIN (minimum) gas concentrations are displayed, and the μ (Mean or Linear Average) and σ (Standard Deviation) values are calculated and displayed. A description of these statistical terms can be found in Section 9.2.1. During the performance of a monitoring task the statistical analysis is updated constantly.

4 **List of Individual Measurement Results**

Each of these displays provide the date and time each measurement cycle was performed and the concentration of the gas whose name appears on the screen. In some cases an asterisk (*) will be shown alongside the gas/vapour concentration. When such an asterisk is shown, press the **Status** button. Text will appear on the screen to indicate why this particular measurement has been marked.

The number which is shown on the display — between time and concentration — is only "filled-in" after completion of a monitoring task. The number indicates the order in which the measurements were made. The "oldest" **stored** measurement is always given the number 1 and the following measurements are numbered sequentially.

5 **Overview of the Monitoring Task**

These displays provide an overview of the monitoring task set-up parameters.

6 **Start of the Monitoring Task**

The *Display Memory* has a finite size and therefore if a monitoring task runs for a long period of time, it will fill up all available memory space and data collected after the memory has been filled-up will start to overwrite the data collected during the start of the monitoring task. Some measurement results will therefore be lost from the memory. In such a situation the date and time appearing after MONITORING TASK STARTED ..... will not be the same as the first date and time displayed on the screen labelled **1** in Fig. 9.1.

Using the push-buttons in the **Display** group, users can scroll through each "page" of stored data and, in addition, average gas concentrations over a pre-defined averaging period. The function of the push-buttons in the **Display** group are described fully in Chapter 5 and can be summarized as follows:

Average When this push-button is pressed the 1302 will average the measurement results which are stored in its *Display Memory* over the period of time Averaging Period specified in the **FORMAT** branch of the Set-Up "tree" (see Section 7.6). When the averaging function is operative (the LED in the push-button is lit) only averaged measurement results are shown on the 1302's display. These averaged measurements may also be printed/plotted out while the averaging function is operative. It is important to realise that when the averaging function is switched off (by pressing the **Average** button again so its LED is no longer lit) the original measurement results will be shown again on the display. An example of averaged measurements is given in Section 7.6.

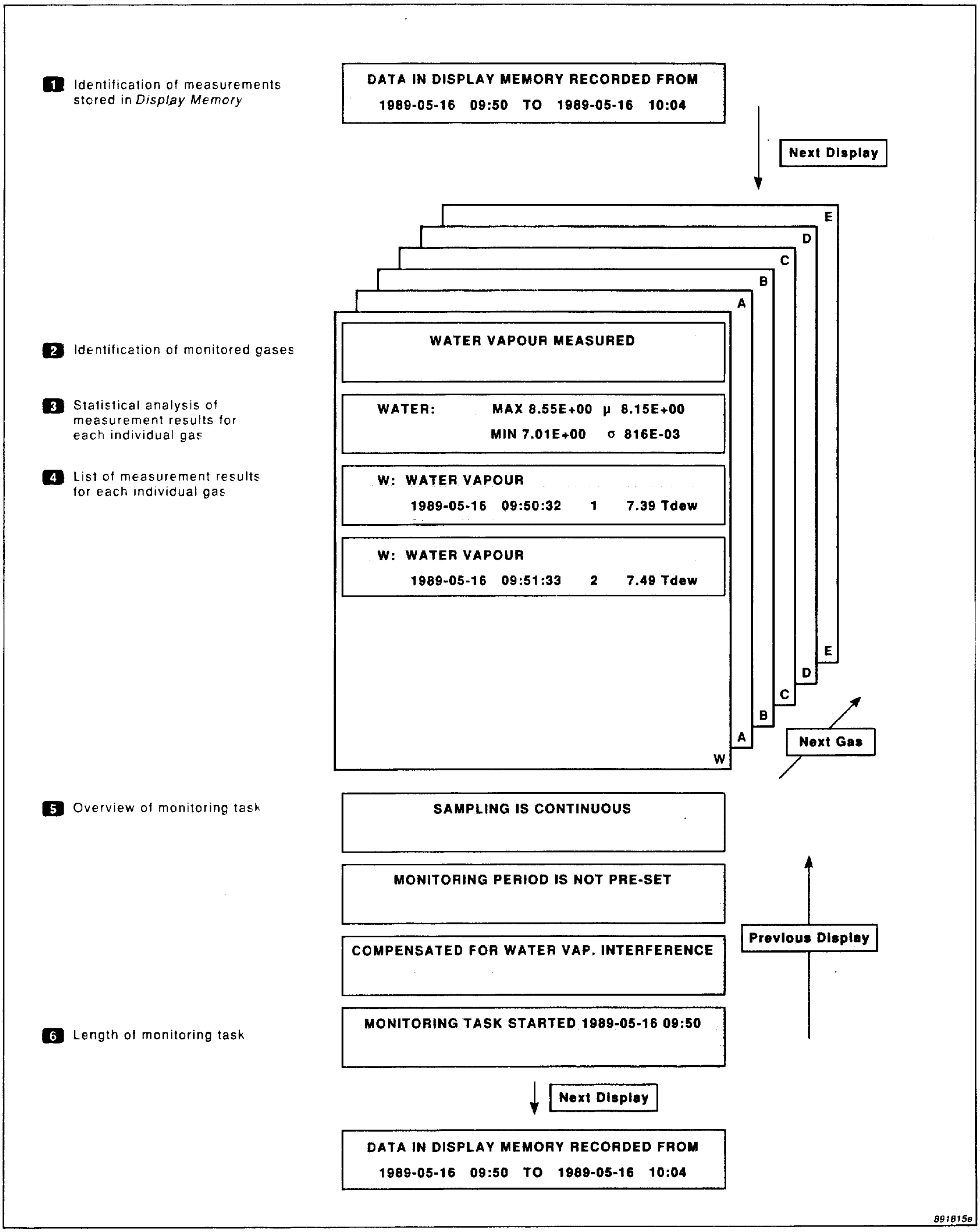


Fig. 9.1. Organisation of monitoring-task data displayed on the 1302's screen

Next Gas

Using this push-button users can scroll "horizontally" through any vertical level of data. For example if the statistical analysis of the measurement results for water-vapour are displayed on the screen then by using the **Next Gas** button one can read the statistical analysis of the measurement results for gas A, B, C etcetera and then go back to the original display (see Fig. 9.1).

Event Marker

This push-button can be used (pressed) to mark the measurement being performed at the time at which a special event occurred during a monitoring task. Any such measurement will appear on the display with an asterisk alongside it. By pressing the **Status** button when such a display is seen you can find out what the asterisk indicates. Section 9.2.2 shows the display which appears when the **Status** button is pressed and explains all the symbols used. Marked events are also shown on print-outs and of monitoring task data (see Section 9.2.3).

Next Display

This push-button allows the user to scroll "vertically" downwards through the list of measurement results (see Fig. 9.1). If the **Next Display** push-button is used when the screen display shows `MONITORING TASK STARTED 1989-05-16 09:50` the display then changes to show the measurement results list from the beginning again that is `DATA IN DISPLAY MEMORY RECORDED FROM ..`. In effect the monitoring task data is like a closed loop.

Previous Display

This push-button allows the user to scroll "vertically" upwards through the list of measurement results. The measurement list is a closed loop and therefore, if this push-button is used when
`DATA IN DISPLAY MEMORY RECORDED FROM ..`
is on the screen (see the top of the list in Fig. 9.1) the screen display will change to `MONITORING TASK STARTED 1989-05-16 09:50` (see the bottom of the list in Fig. 9.1).

The push-buttons **Previous Display** and **Next Display** have a repetitive function which means that if they are pressed continuously they will allow the user to scroll very quickly through a list.

9.1.1. Processing Measurement Data

Gas measurement data stored in *Display Memory* can be processed in the following ways:

1. It can be processed to produce Time-weighted Average (TWA) concentrations of gases over any user-defined period of time.

2. Any spurious gas measurement(s) can be temporarily removed from the list of data stored in the *Display Memory*. When spurious measurements are removed from stored data, the 1302 automatically re-processes the remaining data and a new statistical analysis of the monitoring task is produced. Details about how to "edit" (that is, temporarily remove) individual measurement results are given in Chapter 10.

9.1.2. Obtaining Time-weighted Average (TWA) Values

By using the **Average** button Time-weighted Average concentrations (C_{TWA}) of all the monitored gases can be obtained over any user-defined period of time (T hours). The following steps are involved:

Step 1.
Press the **Set-Up** and **S2** buttons.

Step 2.
"Enter" the period of time required for averaging — this could for example be 8 hours if you are interested in finding out whether the 8 hour Time Weighted Average concentration of gases are in compliance with National Occupational Exposure Limits; or, alternatively, the averaging period could be 15 minute Time-Weighted Average if you are interested in finding out whether the Short Term Exposure Limit (STEL) of the gases complies with National Occupational Exposure Limits.

Step 3.
Press the **Set-Up** button and then the **Average** button.

When steps 1 to 3 are complete scroll through the measurement results displayed on the screen (*Display Memory*). Notice that all measurements have been averaged over the chosen averaging period. A detailed example is given in Section 7.6.

9.1.3. How Time-weighted Averages are Calculated

In order to explain how the 1302 averages gas measurements over a fixed user-defined "averaging period", let us suppose that a particular gas has been monitored continuously and that its measured concentration was C_1 during the first sampling interval T_1 min, C_2 during the second sampling interval T_2 min ..... C_n during the n^{th} sampling interval T_n min (see Fig. 9.2). Suppose that you wished the 1302 to calculate the Time-weighted average (TWA) over a period of time = T min.

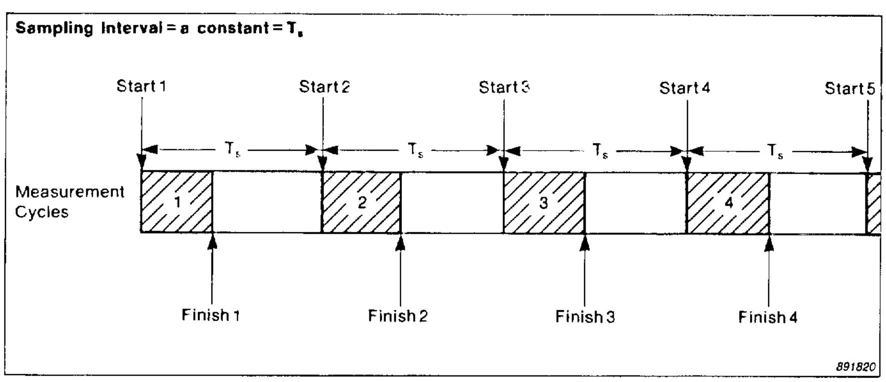


Fig. 9.2. Illustration of a monitoring task

The Time-weighted average of these measurements over the averaging period of T min is calculated using the following mathematical equation:

$$C_{TWA} = \frac{\sum_{n=1}^{n=N} (C_n)}{N}$$

= linear average of all the measurements made during the averaging period.

Where: C_n = constant concentration measured at time T_n;

N = the total number of measurements performed during the averaging period T min.

In the situation where the total monitoring period is the same as the averaging period then the averaged value of the **last** performed measurement will be the same as the Mean Value (μ) shown on the display screen (see **3** in Fig. 9.1).

9.2. PRINTED AND PLOTTED MONITORING TASK DATA

Fig. 9.1 illustrates how data from a monitoring task is displayed on the 1302's screen. When monitoring task data appearing in *Display Memory* is printed out, the same information appears but it is presented in a different format. An example of a monitoring task data print-out is shown in Fig. 9.3 — Section 12.2 describes how this is done. Monitoring task data can also be plotted out — see Section 12.1. A plot-out of the monitoring task data shown in Fig. 9.3 is illustrated in Fig. 9.4.

- 1302 Measurement Data ------------ 1081011 - 1990-03-12 13:30 - Page 1 -

1302 Settings:

Compensate for Water Vap. Interference	:	YES
Compensate for Cross Interference	:	NO
Sample Continuously	:	YES
Pre-set Monitoring Period	:	NO
Measure		
Gas A: SF6	:	YES
Gas B: _	:	NO
Water Vapour	:	YES
Sampling Tube Length	:	0.00 m
Air Pressure	:	101.33 kPa
Normalization Temperature	:	20.0 C

General Information:

Start Time	:	1990-03-12 07:53
Stop Time	:	1990-03-12 10:37
Averaging Period	:	00:15
Number of Event Marks	:	2
Number of Recorded Samples	:	189

	Alarm Limit	Max	Mean	Min	Std.Dev
Gas A:	________	69.6E+00	30.5E+00	154E-03	14.8E+00
Water:		1.87E+03	1.19E+03	57.2E+00	387E+00

Samples Measured From 1990-03-12 07:54

Samp. No.	Time hh:mm:ss	Gas A ppm	Gas B ppm	Gas C ppm	Gas D ppm	Gas E ppm	Water ppm
1	07:54:12	23.1E+00	. . .	. . .	. . .	. . .	121E+00
2	07:55:14	23.0E+00	. . .	. . .	. . .	. . .	94.9E+00
3	07:56:03	23.0E+00	. . .	. . .	. . .	. . .	82.3E+00
	07:56:53	User Event Number 1.					
4	07:56:53	34.6E+00	. . .	. . .	. . .	. . .	108E+00
5	07:57:45	41.6E+00	. . .	. . .	. . .	. . .	127E+00
6	07:58:34	46.3E+00	. . .	. . .	. . .	. . .	140E+00
7	07:59:24	49.6E+00	. . .	. . .	. . .	. . .	150E+00
8	08:00:13	52.1E+00	. . .	. . .	. . .	. . .	157E+00
9	08:01:03	54.0E+00	. . .	. . .	. . .	. . .	165E+00
10	08:01:52	55.5E+00	. . .	. . .	. . .	. . .	171E+00
11	08:02:42	55.1E+00	. . .	. . .	. . .	. . .	258E+00
12	08:03:31	55.7E+00	. . .	. . .	. . .	. . .	266E+00
13	08:04:33	55.9E+00	. . .	. . .	. . .	. . .	278E+00
14	08:05:23	55.9E+00	. . .	. . .	. . .	. . .	293E+00
15	08:06:13	55.8E+00	. . .	. . .	. . .	. . .	308E+00
16	08:07:03	55.7E+00	. . .	. . .	. . .	. . .	322E+00
17	08:07:53	55.6E+00	. . .	. . .	. . .	. . .	334E+00
18	08:08:43	55.4E+00	. . .	. . .	. . .	. . .	347E+00
19	08:09:33	57.0E+00	. . .	. . .	. . .	. . .	371E+00
20	08:10:23	58.7E+00	. . .	. . .	. . .	. . .	399E+00
21	08:11:13	60.3E+00	. . .	. . .	. . .	. . .	429E+00
22	08:12:03	59.2E+00	. . .	. . .	. . .	. . .	453E+00
23	08:12:53	58.2E+00	. . .	. . .	. . .	. . .	476E+00
24	08:14:14	57.1E+00	. . .	. . .	. . .	. . .	500E+00
25	08:15:04	56.0E+00	. . .	. . .	. . .	. . .	525E+00
26	08:15:54	54.8E+00	. . .	. . .	. . .	. . .	551E+00
27	08:16:44	53.7E+00	. . .	. . .	. . .	. . .	577E+00
28	08:17:34	52.5E+00	. . .	. . .	. . .	. . .	603E+00
29	08:18:23	52.2E+00	. . .	. . .	. . .	. . .	579E+00
30	08:19:13	51.3E+00	. . .	. . .	. . .	. . .	598E+00
31	08:20:03	50.6E+00	. . .	. . .	. . .	. . .	613E+00
32	08:20:53	50.1E+00	. . .	. . .	. . .	. . .	629E+00
33	08:21:43	49.7E+00	. . .	. . .	. . .	. . .	644E+00
34	08:22:33	49.2E+00	. . .	. . .	. . .	. . .	659E+00
35	08:23:23	48.7E+00	. . .	. . .	. . .	. . .	674E+00
36	08:24:32	48.3E+00	. . .	. . .	. . .	. . .	689E+00
37	08:25:22	47.9E+00	. . .	. .	. . .	. . .	704E+00
	[illegible]:12	47.4E+00			. . .	. . .	718E+00
						. . .	732E+00
180	10:[illegible]		. . .	. . .			
181	10:30:13	13.1E+00	. . .	. . .	. . .		
182	10:31:03	13.0E+00	. . .	. . .	. . .	. . .	1.56E+03
183	10:31:52	12.9E+00	. . .	. . .	. . .	. . .	1.56E+03
184	10:32:42	12.8E+00	. . .	. . .	. . .	. . .	1.56E+03
185	10:33:31	12.7E+00	. . .	. . .	. . .	. . .	1.57E+03
186	10:34:32	12.6E+00	. . .	. . .	. . .	. . .	1.57E+03
187	10:35:23	12.5E+00	. . .	. . .	. . .	. . .	1.57E+03
188	10:36:13	11.8E+00	. . .	. . .	. . .	. . .	1.59E+03
189	10:37:05	11.0E+00	. . .	. . .	. . .	. . .	1.60E+03

900539

Fig. 9.3. Print-out of monitoring task data

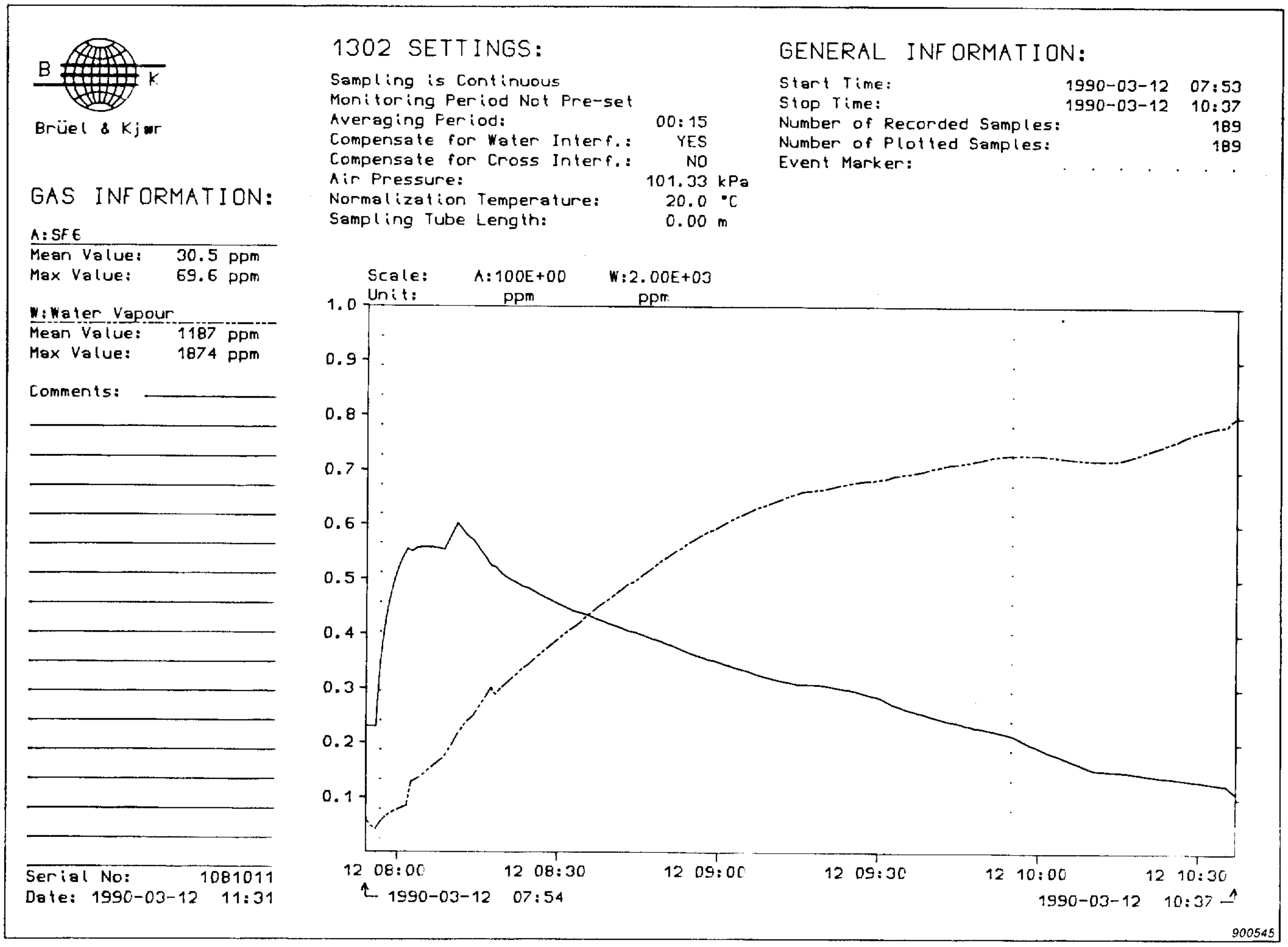


Fig. 9.4. Plot-out of monitoring task data

9.2.1. Statistical Analysis Terms

In the statistical analysis of the measurement results for each gas (see ❸ in Fig. 9.1) the following statistics appear:

The Mean Value (μ) — this is the linear average of all measurements of a gas taken during the total monitoring period. For example, if N measurement cycles were performed during the total monitoring period (T) then "the mean value" of gas A is obtained by adding the N measured gas A concentrations (let us denote them by c_n where n = 1 to N) and dividing the result by N. The calculation of "the mean value" can be expressed mathematically as follows:

$$\text{"The mean value"} = \mu = \frac{\sum_{n=1}^{n=N} C_n}{N}$$

The Standard Deviation (σ) — this is the standard deviation of a particular gas's measurements from the mean value (μ) of this gas. It is calculated by taking the square-root of the following quantity: the sum of the differences between the mean value (μ) and each individual gas measurement C_n which has been divided by the total number of measurements (N). Standard deviation can be expressed mathematically as follows:

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

9.2.2. Symbols used in Displayed Measurement Data

If an asterisk (*) appears on the display alongside any gas concentration, it indicates that something happened during the measurement. You can find out what the asterisk indicates by pressing the **Status** button. The following display appears for a short period of time:

```
GAS X: COMMON MARK: PEOW  GAS MARK: EBFA
EVENT NO: xxxx                TIME: hh:mm
```

"EVENT NO" will appear on the screen only if the Event Mark button was used during the monitoring task. In this case the letter "E" will also appear as a Common Mark. The symbols which can appear after the text **COMMON MARK** and **GAS MARK** are listed below with a short explanation of what they mean:

COMMON MARKS:

"P" (1) The 1302 stopped measuring due to a power failure but has automatically re-started the monitoring task again after regaining power;
(2) the 1302 has been "reset" either because of a detected fault or because the **Reset** button was pressed.

"E" The measurement has been "Event marked" by the user.

"O" This symbol indicates that an operational error was detected during this measurement. The accuracy of such a measurement cannot always be guaranteed.

"W" This symbol indicates that a warning was given during this measurement. The accuracy of such a measurement cannot always be guaranteed.

GAS MARKS:

"E" This measurement has been "edited out" (see Chapter 10)

"B" The 1302 was incapable of calculating this gas concentration

"F" After this measurement the filter carousel was found to be out of alignment. If the carousel was only slightly out of alignment then the accuracy of the measurement has not been affected. The accuracy of such a measurement cannot always be guaranteed.

"A" This gas concentration measured during this measurement cycle was found to exceed the user-defined alarm limit for this gas.

9.2.3. Symbols Used in Print-outs of Measurement Data

Displayed measurements marked with the **COMMON MARKS "O"** and **"W"**, and the **GAS MARKS "A"** and **"F"**, are printed-out with these symbols. However, any displayed measurement marked with the **COMMON MARKS "P"** and/or **"E"**, and the **GAS MARKS "E"** and/or **"B"** are not printed-out with these symbols. These measurements are marked in a different way:

COMMON MARKS:

The symbol **"P"** is replaced by the text **"1302 Restarted"**. This indicates that the 1302 stopped and then started-up again sometime between the previous sample time and the time which appears alongside this message.

The symbol **"E"** is replaced by the text **User Event Number X:** This indicates that the **Event Marker** button was pressed while this measurement cycle was being performed. The number indicates the total number of "events" which have been marked during this monitoring task, at the time this sample was taken.

GAS MARKS:

The symbol **"E"** is replaced by a series of asterisks ***** which indicate that the measurement has been "edited out" (see Section 10.1).

The symbol **"B"** is replaced by a straight line (_____) which indicates that the 1302 was unable to calculate the concentration of the named gas in this sample.

OTHER MARKS USED:

. . . . . . This symbol indicates either: (1) that this gas was not measured; or (2) that this gas was not selected to be printed out (see Section 7.5)

9.3. STORAGE SPACE IN THE DISPLAY MEMORY

Table 9.1 illustrates the space which is required to store individual measurement results. If 5 gases and water vapour are being measured then 35 bytes of space are required to store measurement results from one measurement cycle, whereas only 22 bytes of space are required if 3 gases (for example, gas A, E and water vapour (W) are measured. If only one gas (for example, gas A) is being measured then only 13 bytes of space are required to store measurement results from one measurement cycle.

Data being stored	Bytes	
Measurement times	4	
Event numbers	2	
Common flags	1	
CRC sum	1	
Flags for gas 1 & gas 2	1	
Results for gas 1	4	**13 bytes**
Results for gas 2	4	**17 bytes**
Flags for gas 3 & 4	1	
Results for gas 3	4	**22 bytes**
Results for gas 4	4	**26 bytes**
Flags for gas 5 & 6	1	
Results for gas 5	4	**31 bytes**
Results for gas 6	4	**35 bytes**

The total space available in *Display Memory* to store individual gas measurement results is 64 000 bytes

T02659GBC

Table 9.1. Space occupied by results from one measurement cycle when a different number of gases is monitored

The total space available in *Display Memory* to store data is 64 000 bytes. If only one gas (for example, gas A) and water vapour is measured then data from up to $64\,000/17 = 3\,764$ measurement cycles can be stored in *Display Memory*, whereas if 5 gases and water vapour were measured data from up to only $64\,000/35 = 1\,828$ measurement cycles can be stored in *Display Memory.*

The time required to perform a measurement cycle is dependent upon the number of gases/water vapour being measured. Table 9.2 lists the minimum time required to perform different measurement cycles.

No. of gases measured with water vapour	Minimum time for a measurement cycle
1	45
2	60
3	75
4	90
5	105

T02660GB0

Table 9.2. Minimum time taken to complete various gas measurement cycles

If we take the examples given above we can work out approximately how long the data from a monitoring task can be stored in *Display Memory*:

A measurement cycle in which gas A and water vapour are measured takes at least 45s, and if sampling is continuous this means that 3764 cycles will take 3764 × 45 = 169380s = 47 hours. If, however this measurement cycle is only performed every 10 mins then data can be stored for 3764 × 10 = 37640 mins = 26 days.

A measurement cycle in which 5 gases and water vapour are measured takes at least 105s, and if sampling is continuous this means that 1828 cycles will take 1828 × 105 = 191940s = 53 hours. If, however this measurement cycle is only performed every 10 mins then data can be stored for 1828 × 10 = 18280 mins = 12,6 days.

The maximum time you can set a monitoring period to be is 7 days, if you try to enter a greater number of days the 1302 will automatically change the period to 7 days. However, if you do not set a pre-defined monitoring period the 1302 will just store as much data as possible before starting to overwrite the "oldest" stored measurement results.

10. SPECIAL FUNCTIONS

The Function push-button is located at the end of the row of **Mode** push-buttons. When the 1302 is operated in Function **mode** (by pressing the **Function** button) any one of a number of special functions can be utilized. Table 10.1 lists the functions available and gives a brief description of them.

Special Function	Description of Function
Edit Measurement Data ?	To selectively remove some measurement results from a completed monitoring task
Enter Key Sequence ?	To "program" the 1302 to automatically perform a series of operations
Display Key Sequence ?	To display the series of push-buttons used when the last key sequence was entered
Execute Key Sequence ?	Start the sequence of operations programmed in the last key sequence
Save Set-up in EEPROM ?	To change the value of the set-up parameters stored in the ***Source Memory*** from factory-set values to user-defined values

T02661GB0

*Table 10.1. Description of the the special functions available when operating in Function **mode***

10.1. HOW TO EDIT MONITORING TASK DATA

The edit function only allows users to remove (temporarily) one, or more, measured gas concentrations from monitoring task data. Those measured gas concentrations removed from monitoring-task data are not used in the statistical analysis of the monitoring task. Concentrations which are edited can be replaced by using the edit function once again (see Section 10.1.2).

10.1.1. How to Remove Measured Gas Concentration Values

To illustrate how this function can be used, let us suppose that some measurements performed during a monitoring task, which was recorded from 1989-08-09 08:43 to 1989-08-12 11:13, need to be edited "out". The following steps should be followed:

1. Display the monitoring task that is to be edited on the display screen.
2. Press the **Function** button.

The following text appears on the screen:

```
EDIT MONITORING TASK DATA ?
NO                          YES
```

S1 S2 S3

3. Press the **S3** button:

```
MARK SAMPLE TO EDIT WITH <EVENT MARK>
PRESS <ENTER> WHEN READY
```

4. Press the **Enter** button.

```
EDIT: MEASUREMENT RECORDED FROM
1989-08-09 08:43 TO 1989-08-12 11:13
```

5. Use the **Next Display** button to scroll through the measurements and find the measurement you wish to edit.

Let us suppose the fifth (5^{th}) measured concentration of gas A (which is sulphur hexafluoride) is to be edited out. The sample will appear on the screen in the following format:

```
A: SULPHUR HEXAFLUORIDE
1989-08-09 10:43  5  7.48 ppm
```

6. Press the **Event Marker** button:

You will see that the concentration value for this measurement will be removed and replaced by a number of dashed lines:

```
A: SULPHUR HEXAFLUORIDE
1989-08-09 10:43  5  ——— ppm *
```

7. When all the necessary measured concentration(s) have been edited out, press the **Function** button.

The following text will appear on the display:

RECALCULATING DISPLAY MEMORY STATISTICS
PLEASE WAIT

When the recalculation is complete (it can take up to 2–3 mins depending on the quantity of data in *Display Memory*) the 1302 will stop operating in Function **mode** and data from the **edited** monitoring task will appear on the display.

If you scroll to the concentration values(s) which have been edited "out" you will see that an asterisk appears on the right-hand side of the concentration value, for example measurement no. 5:

A: SULPHUR HEXAFLUORIDE
1989-06-09 10:43 5 —— ppm *

By pressing the **Status** button you can find out what the asterisk indicates — in this case the letter "E" appears, which indicates that the measurement has been edited "out". If data from an **edited** monitoring task is printed out, edited measurements will appear as a row of asterisks (* * * * * *). If data from an **edited** monitoring task is plotted out, the text "Warning: Data has been edited" and "Warning: Missing data has been interpolated" will appear under the heading **GENERAL INFORMATION** on the plot. Interpolation indicates that where a measurement result is missing, a straight line will automatically be drawn to link up the measurement occurring before and after the missing one. It is therefore not always possible to see from a **plot** which measurements have been "edited out".

10.1.2. How to Replace Concentrations which have been Edited-out

Measured concentrations which have been temporarily removed by using the special edit function can be replaced by using the edit function again:

1. Make sure that the **edited** monitoring task is displayed on the display screen.
2. Press the **Function**, **S3** and **Enter** buttons.
3. Scroll through the displayed monitoring task data and, when a "blanked-out" value appears on the display, press the **Event Marker** button.

If the blanked-out value is a value which was edited-out, then the original gas concentration will replace the dashed lines on the screen. If, however, the value was blank because the 1302 was unable to calculate the value (Gas Mark "B" will be shown on the "Status" display — see Section 9.2.2) then the blanked-out value will remain.

4. When all necessary "blanked-out" concentrations have been replaced, press the **Function** button.

The original (un-edited) monitoring task data will be displayed.

5. Scroll to measurement no. 5 which has been "edited-back".

Notice that the original gas concentration has replaced the dashed lines and that no asterisk appears alongside the concentration unit.

10.2. HOW TO ENTER A KEY SEQUENCE

ENTER A KEY SEQUENCE is a special function which allows the user to "program" the 1302 to perform a series of operations sequentially. Once a key (push-button) sequence has been "entered" the 1302 can be instructed to perform the sequence of operations automatically by selecting the special function **EXECUTE KEY SEQUENCE** (see Section 10.4).

After a key sequence has been entered it is possible to scroll through the entered key sequence to check it (see Section 10.3). It is, however, not possible for the 1302 to check the validity of the entered "program". You are therefore strongly advised to check the validity of your key sequence before starting (executing) the sequence. For example, if you intend storing data during a key sequence, make sure that there is enough space in *Background Memory* to store the data (see Section 9.3). If your key sequence is invalid this will only become apparent during **execution** of the key sequence. For example, if the 1302 is instructed ("programmed") to:

1. Monitor 5 gases and water vapour every 10 minutes for 5 days; and then to;
2. Store the collected data in its *Background Memory*; and then;
3. Repeat the sequence 4 times;

The *Background Memory* is able to store approximately 12,6 days' data when 5 gases and water vapour are monitored 24 hours a day at 10 minute intervals (see Section 9.3). If the *Background Memory* is empty before the above key sequence is executed, then the data collected during the first 5-day period and the second 5-day period can be stored but there is not enough space in the memory to store the data collected during the third 5-day period so, when the 1302 tries to store data collected during the third 5-day period, it will stop performance of the Key Sequence as it is unable to perform this part of the sequence.

To illustrate the use of this **ENTER A KEY SEQUENCE** function, let us suppose that a user wished to set-up a key sequence which would enable the 1302 to sequentially perform the following operations:

1. Perform a particular monitoring task during the period 06:30 to 17:00.
2. Store collected data in its *Background Memory*.
3. Plot-out collected data.
4. Print out collected data: and
5. Repeat the above series of operations (1 – 4) over a five day period.

To find the sequence of push-buttons needed for the 1302 to perform the above tasks (1 – 4) it is necessary to go through each task, as though the 1302 was being operated manually, and note down which keys (push-buttons) are used. In the following text each task is described and the push-buttons which need to be pressed in order to make the

1302 perform the tasks are listed in the right-hand side of the main text. This is the sequence of push-buttons which need to be pressed when "Entering a Key Sequence" in the 1302.

Step 1. Setting-up the Monitoring Task

Set up the required monitoring task (let us suppose that monitoring task set-up number 1 is used) as described in Section 7.7.1 and for the PRESET MONITORING PERIOD enter 10 hours 30 minutes (i.e. 10:30) — this covers the period from 06:30 to 17:00.

Step 2. Setting-up a Delayed-start Monitoring Task

a) Press the **Measurement** button. **Measurement**

```
   ACTIVE TASK:  MONITORING TASK NUMBER 1
  START TASK    DELAYED START    CHANGE TASK
```

b) Press the **S2** button.

The following text appears on the display: **S2**

```
WARNING:  DISPLAY  MEMORY  WILL  BE  DELETED
   PROCEED                         STOP
```

c) Press the **S1** button.

The following text appears on the display: **S1**

```
          ENTER  START  TIME  00:00
   DOWN         ACCEPT            UP
```

d) Enter the start time as 06:30 and then press the **S2** button. **0** **6** **3** **0**

The monitoring task will start at 06:30 and monitor for a period of 10,5 hours — stopping at 17:00 hours. The data collected during the monitoring task then has to be stored in the 1302's *Background Memory*. **S2**

Step 3. Storing Monitoring Task Data

a) Press the **Memory** button: **Memory**

```
SELECT  MEMORY  FUNCTION
STORE      RECALL      DELETE
```

b) Press the **S1** button: **S1**

```
ENTER  LOCATION  NUMBER  1
DOWN       ACCEPT       UP
```

The 1302 always displays the lowest un-occupied location number when data is to be stored in its *Background Memory.* If the *Background Memory* is empty before this key sequence is performed then the first day's data will be stored in Location 1, the second day's data in Location 2 and so on.

c) Press the **S2**, button: **S2**

d) Press the **Memory** button to stop operating in Memory **mode.** **Memory**

The monitoring task data then has to be plotted out.

Step 4. Plotting-out Monitoring Task Data

a) Press the **Plot** button: **Plot**

```
ZOOM  ON  PLOT ?
NO                  YES
```

b) Press the **S1** button: **S1**

The monitoring task data then has to be printed out.

Step 5. Printing-out Monitoring Task Data

a) Press the **Print** button: **Print**

SELECT PRINT TYPE
MEASUREMENT SET-UP CALIBRATION

b) Press the **S1** button: **S1**

The only part of the program which remains is to tell the 1302 how many times to repeat the sequence. This is done when you select the special function called **EXECUTE KEY SEQUENCE**.

Step 6. "Entering" a Key Sequence

To illustrate a key sequence let us suppose that we wish to program the 1302 to store the key sequence which will enable it to perform the operations described in the above example:

a) Press the **Function** **S1** and **S3** buttons:

KEY NUMBER 0 READY FOR ENTRY
PRESS <FUNCTION> TO FINISH ENTRY

The "0" indicates that no keys (buttons) have yet been entered in the key sequence. As soon as a button (key) is pressed the number will change to no. 1 and the name of the button will appear in place of the text "READY FOR ENTRY" on the above screen.

b) Press the following buttons:

Measurement
S2
S1
0
6
3
0
S2
Memory
S1
S2
Memory
Plot

S1
Print
S1

c) Press the **Function** button.

The 1302 stores the entered key sequence so that it can automatically perform the various programmed tasks when the special function **EXECUTE KEY SEQUENCE** is selected (see Section 10.4).

10.3. HOW TO DISPLAY A KEY SEQUENCE

The sequence of buttons entered in a key sequence can be checked by selecting the special function DISPLAY KEY SEQUENCE.

Step 1.
Press the **Function** **S1** **S1** buttons and then the **S3** button:

The following text appears on the display:

KEY NUMBER 1 <MEASUREMENT>
PRESS <FUNCTION> TO FINISH DISPLAY

Step 2.
Press the **Next Display** button:

The next push-button in the Key Sequence will be displayed:

KEY NUMBER 2 <S2>
PRESS <FUNCTION> TO FINISH DISPLAY

If you do not wish to display all the keys in a sequence then you can stop the display function by pressing the **Function** button.

Step 3.
Keep pressing the **Next Display** button to scroll through all the keys in the sequence and when all the keys have been displayed the following text appears:

END OF KEY SEQUENCE
ACCEPT

10.4. HOW TO EXECUTE A KEY SEQUENCE

By selecting the special function **EXECUTE KEY SEQUENCE** the user is able to start the sequence of operations programmed in a key sequence, but first it is necessary to inform the 1302 about how often the key sequence should be repeated:

Step 1.
Press the **Function** **S1** **S1** and **S1** buttons:

EXECUTE KEY SEQUENCE ?		
NO		YES

Step 2.
Press the **S3** button:

EXECUTE KEY SEQUENCE _ TIME(S)		
DOWN	ACCEPT	UP

The maximum number of times you can program the 1302 to perform any key sequence is 99 times.

To perform the original key sequence described in Section 10.2:

Step 3.
Press the **5** button and then **S2** button:

ACTIVE TASK: MONITORING TASK NUMBER 1
TASK WILL START AT 06:30 TIME: 16:01

If it is necessary to abort (stop) a Key Sequence which is being executed, press the **Reset** or the **Function** button. If the 1302 is in the process of performing a task when the key sequence is aborted, then the task can be stopped manually in the usual way. For example a monitoring task can be stopped by pressing the **Measurement** and **S3** buttons.

10.5. HOW TO SAVE SET-UP IN EEPROM (*Source Memory*)

A full description of the 1302's memory is given in Chapter 11. It is necessary to understand how a **FULL RESET** affects data in the ***Working Memory*** (RAM) before you will be able to understand how to "save set-up in EEPROM (***Source Memory***)".

A full description of the 1302's memory is given in Chapter 11. It is necessary to understand how a **FULL RESET** affects data in the ***Working Memory*** (RAM) before you will be able to understand how to "save set-up in EEPROM (***Source Memory***)".

When a **full reset** of the 1302 is performed, the factory-set values of the Other Set-up Parameters stored in Block 3 of the ***Source Memory*** will replace the **active** values of set-up parameters stored in Block 3 of the ***Working Memory***. To illustrate, let us take a specific parameter, for example, the concentration unit. The factory-set concentration unit is mg/m^3. Suppose that you have selected "ppm" as your **active** concentration unit and then you had to perform a **FULL RESET** of your 1302. The factory-set unit mg/m^3 will replace "ppm" as your **active** unit (see Section 11.1.7).

When a **partial reset** of the 1302 is performed, data in each data block of its ***Working Memory*** is checked. If an error is found in any block, an error message will be displayed to indicate where the error is (see Table 19.2 and 19.3). The block of data containing the error will be replaced by the equivalent block of data from ***Source Memory***, just as though a **FULL RESET** had been performed. As a **partial reset** is performed frequently, it is very often practical for you to replace the factory-set values of parameters by values of your own choice. This means that when you **fully reset** your 1302, or an error is found in ***Working Memory*** during a **partial reset**, you will not have to check all the data in ***Working Memory***.

To illustrate how to change the factory-set value of a parameter to a user-defined value, let us suppose that we wish to change the factory-set unit for concentration (mg/m^3) to the user-defined unit of "ppm". This is the procedure to follow:

Step 1.
Perform a **full reset** — by pressing the **Reset** and **S2** buttons.

This will make all the factory-set values **active**.

Step 2.
(a) Operate the 1302 in **Set-Up mode** — by pressing **Set-Up**.
(b) Go into the **Units** branch of the set-up "tree" — by pressing **S3** **S2**.
(c) Select "ppm" as your **active** concentration unit — by pressing **S3**.
(d) Stop operating in **Set-Up mode** — by pressing **Set-up**.

Step 3.
(a) Operate the 1302 in **Function mode** — by pressing **Function**.
(b) Scroll through the various available functions by using the **Next Display** button until the following text is displayed:

CHANGE SET-UP IN EEPROM ?	
NO	YES

Step 4.
Press **S3**

This will replace the factory-set value of mg/m^3 by the concentration unit "ppm".

Step 5.
Perform a **full reset** — by pressing the **Reset** and **S2** buttons.

Step 6.
(a) Operate in **Set-Up mode** — by pressing **Set-up**.
(b) Go into the **Units** branch of the set-up "tree" — by pressing **S3** **S2**.

The "blinking" cursor shows which unit is **active**. Notice that **now** the **active** unit is "ppm".

11. STORAGE OF DATA IN THE 1302's MEMORY

In order to fully understand the functioning of the 1302 it is necessary to know something about the different types of memory the 1302 uses, the kind of data stored in each type of memory, and how this data is affected by the various operations performed by the 1302.

11.1. TYPES OF MEMORY IN THE 1302

The 1302 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.***

11.1.1. 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 1302, are stored in this memory. These factors are listed in a print-out of the "Calibration Data Block" (see Section 12.2).

When optical filters are installed in the carousel wheel, the 1302 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 7.2).

This information allows the 1302 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.

11.1.2. *Source Memory* (EEPROM)

The data stored in ***Source Memory*** is not lost if A.C. mains power is removed from the 1302. There are three blocks of data in the ***Source Memory*** (see Fig. 11.1):

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

Block 2 — contains 2 of the 5 set-up parameters found under the **Filters** branch of the set-up "tree" (see fold-out figure on the last page of this manual)

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 1302'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.

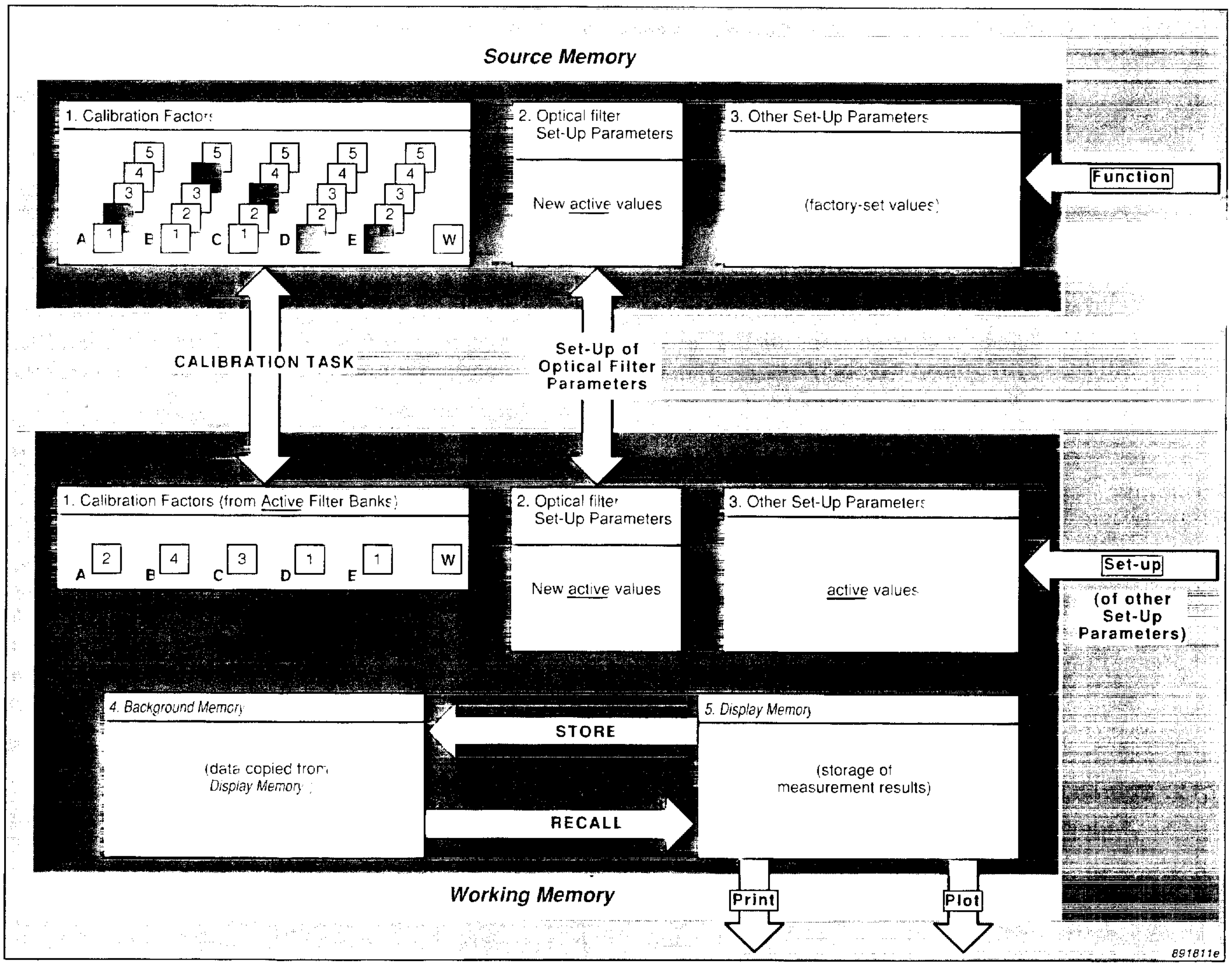


Fig. 11.1. Schematic diagram showing the structure of the 1302's memory

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.

Before calibrating a particular filter, one of the filter's banks is made **active** (by operating the 1302 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 1302 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 (literature no. BG 0552) 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 1302 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 1302 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 1302 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 1302 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 2 of the 5 the parameters which describe the optical filter installed in each position of the filter carousel:

- UA number of the filter;
- Filter bank number;

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.

The factory-set values of the set-up parameters stored in the ***Source Memory*** can be changed by replacing them by user-defined values. This can be done by operating the 1302 in **Function** mode (see Chapter 10, Section 5 for details). Note that changing the value of the set-up parameters in ***Source Memory*** does **not** change the **default** value of any parameter, that is the value a parameter will be given when the **Default** button is pressed.

11.1.3. *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 1302. When the 1302 is not connected to a mains power supply a lithium battery in the 1302 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 1302's display to indicate that the battery needs to be replaced by a new one (see Table 19.1 and Explosion Hazard in the "Safety Considerations").

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 1302'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 1302 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 A2, B4, C3, D1, E1 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 1302 when it is operated in **Set-Up** mode.

Block 5 — Measurement Data:
Whenever the 1302 performs any operation which results in data occupying the *Display Memory*, the data already stored there will be deleted. To reduce the risk of accidently 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 1302 which will result in the deletion of data from *Display Memory*.

Data in *Display Memory* can be copied into the 1302's *Background Memory* (see Block 4 below) to protect it against accidental deletion. Alternatively, the data in *Display Memory* can be printed and/or plotted out by connecting a printer and/or plotter to the 1302 and transmitting data via either the IEEE 488 or the RS 232C interface port of the 1302 (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 (see Section 7.7.1 for details).

Block 4 — Stored Measurement Data
By selecting to STORE data when the 1302 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 11.3.1 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 1302 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 chance of losing it. In *Display Memory* the user can scroll through the data.

Data stored in *Background Memory* can be deleted by operating the 1302 in Memory **mode** and selecting to DELETE data (see Section 11.3.3).

11.1.4. Effect of a Calibration Task on the 1302's Memory

Before calibration of the optical filters in the 1302 the UA numbers of each of the installed filters is "entered" into the **active** set-up of the 1302. This enables the 1302 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 1302). These numerical parameters are called Optical Filter Factors.

During a CALIBRATION TASK the 1302 uses these Optical Filter Factors to calculate the calibration factors for each installed optical filter. As explained in Section 11.1.2, 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 1302 exactly where (in the ***Source Memory***) to store the calibration factors calculated during the calibration task.

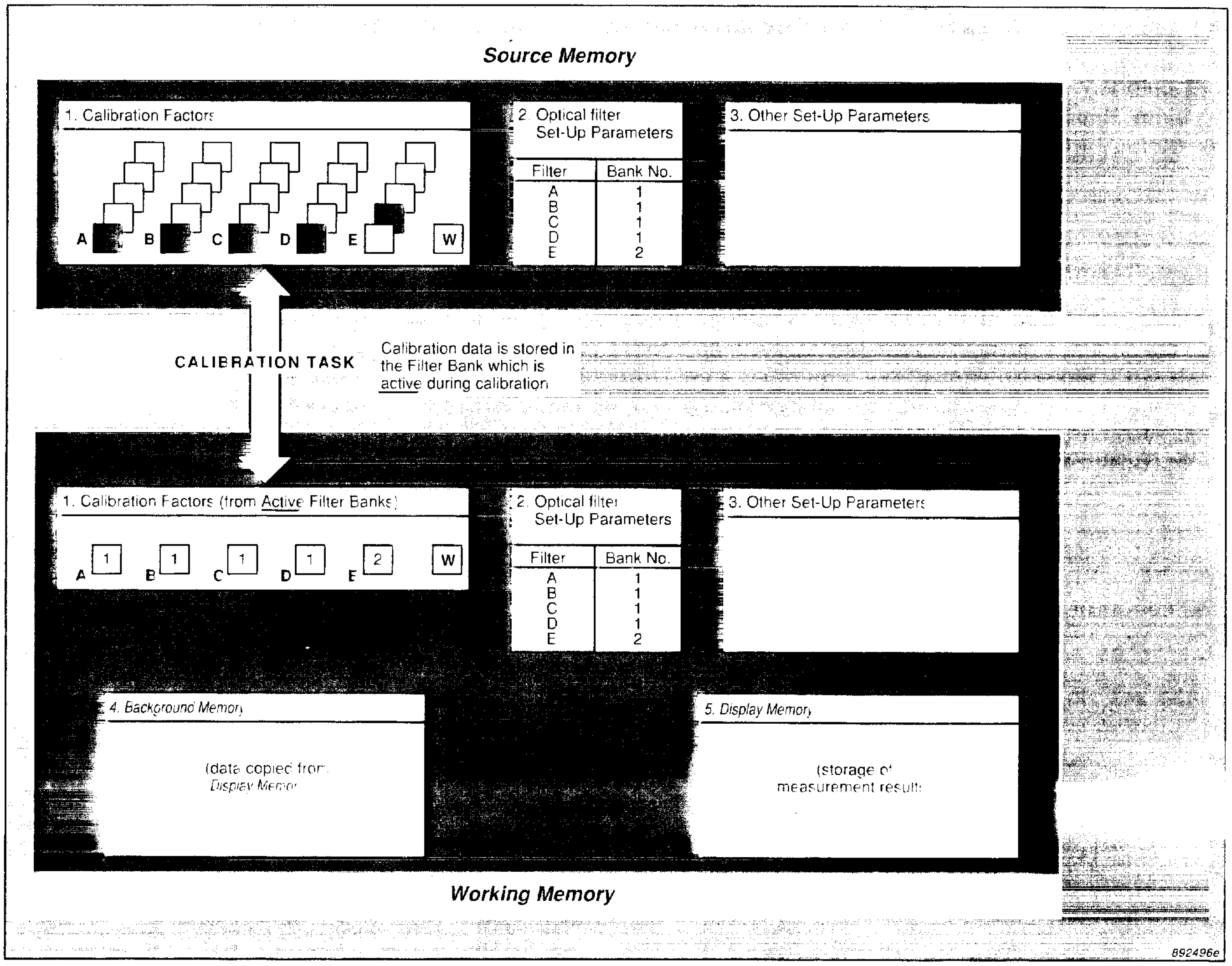


Fig. 11.2. The state of the Source Memory after completion of a **CALIBRATION TASK**

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. 11.2).

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

⚠ **WARNING:** *Changing the UA number of a filter in the 1302's active set-up will destroy all calibration data for the filter.*

As explained in Section 11.1.1, 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 1302, 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.

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 A1, A2, A3, A4 and A5 in the ***Source Memory*** of the 1302 (see Fig. 11.3). The 1302 will not be able to measure any gas with filter "A" until it has been fully calibrated, see Chapter 16 for details.

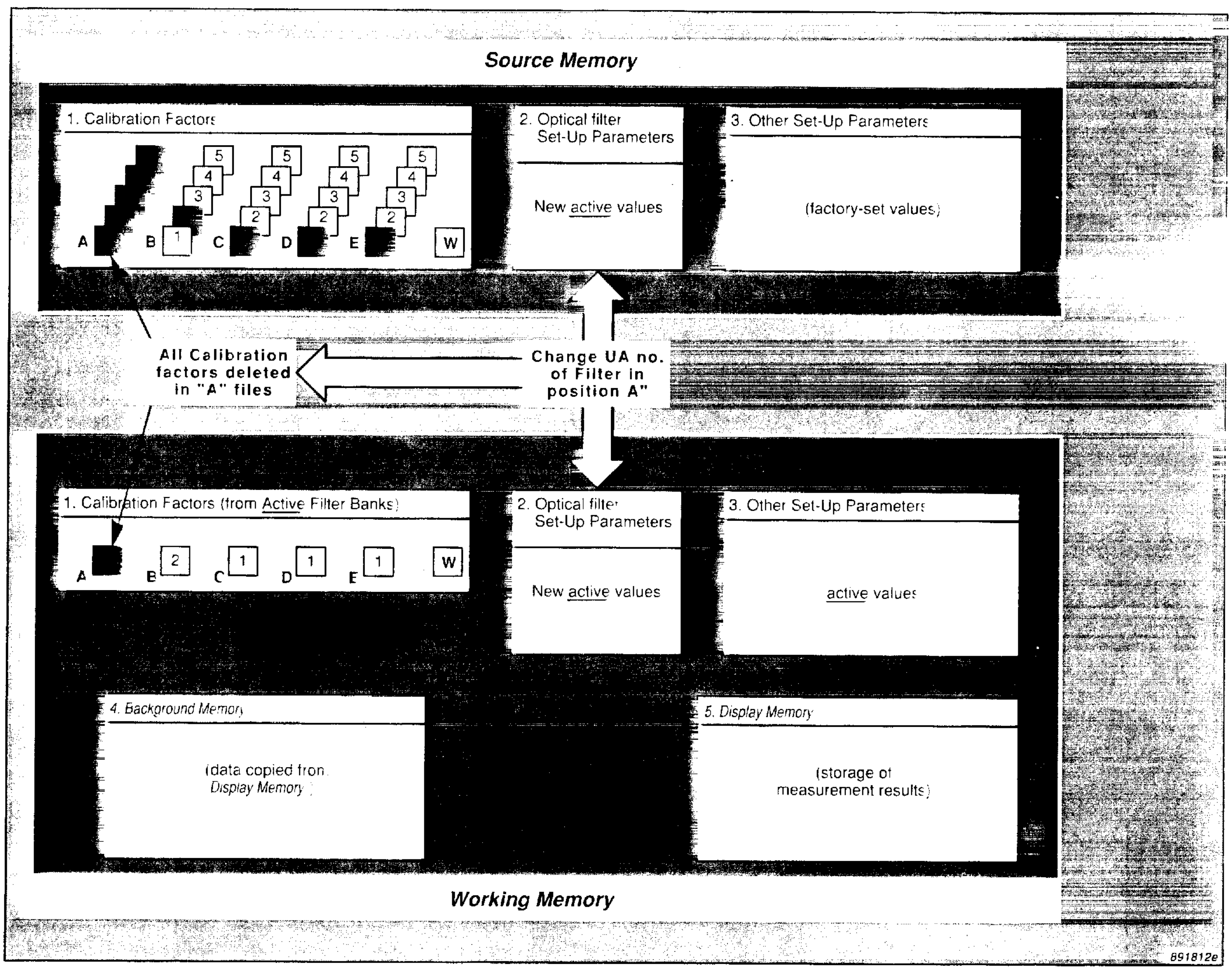


Fig. 11.3. Effect of changing a UA number in the ***"active"*** *set-up*

11.1.6. Effect of a Full Reset on the 1302's Memory

A **FULL RESET** of the 1302 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 Memory*** 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 1302.
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

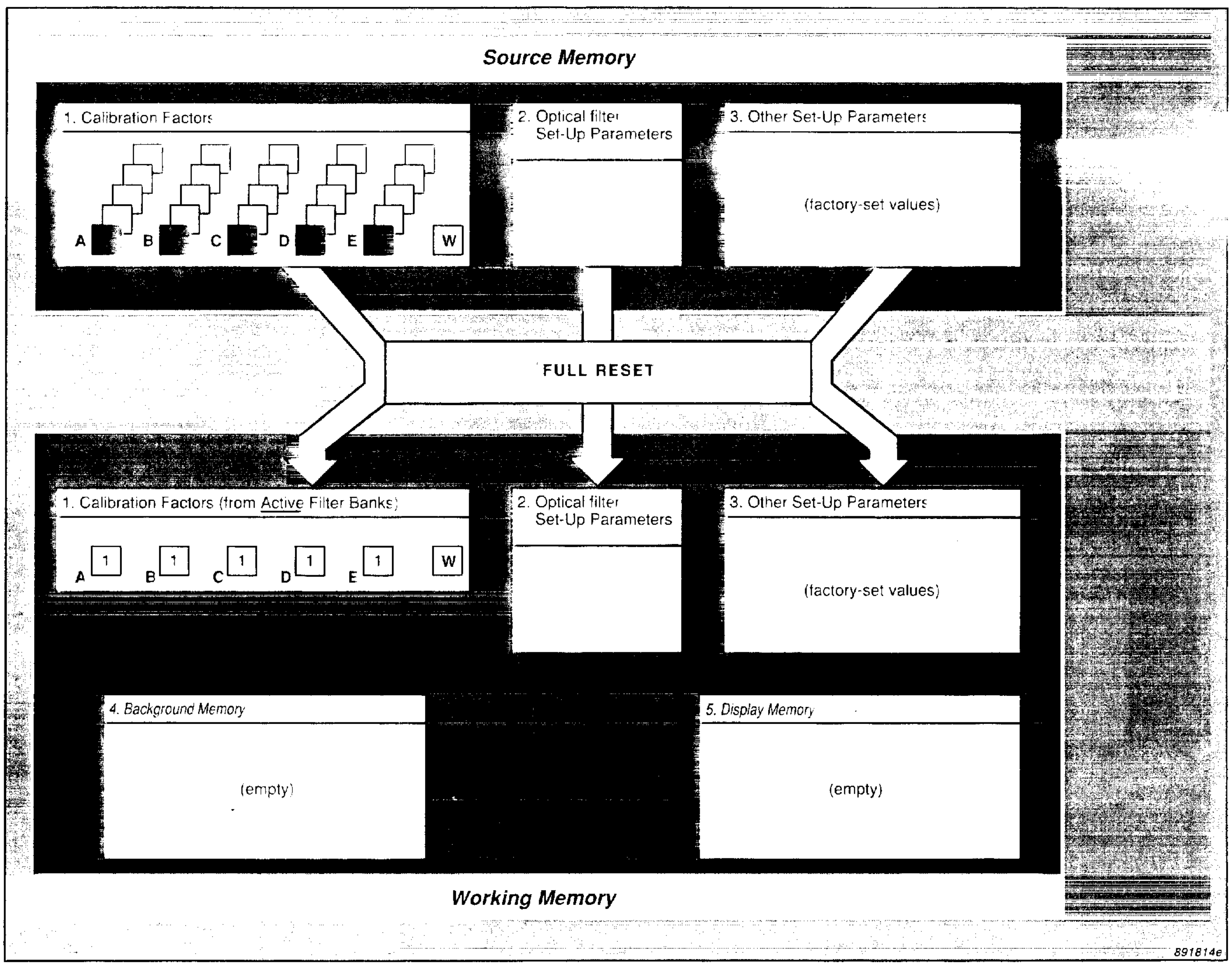


Fig. 11.4. The state of the Working Memory after a **FULL RESET**

the 1302. 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 1302's ***Working Memory*** after a **FULL RESET**. This example is illustrated in Fig. 11.4.

11.1.7. Changing the Factory-set Values of Set-Up Parameters in the *Source Memory*

If the 1302 is operated in Function **mode** users can choose to change the factory set values of the Other Set-Up parameters stored in Block 3 of the 1302's ***Source Memory.*** This procedure is fully described in Chapter 10, Section 5 and illustrated in Fig. 11.5.

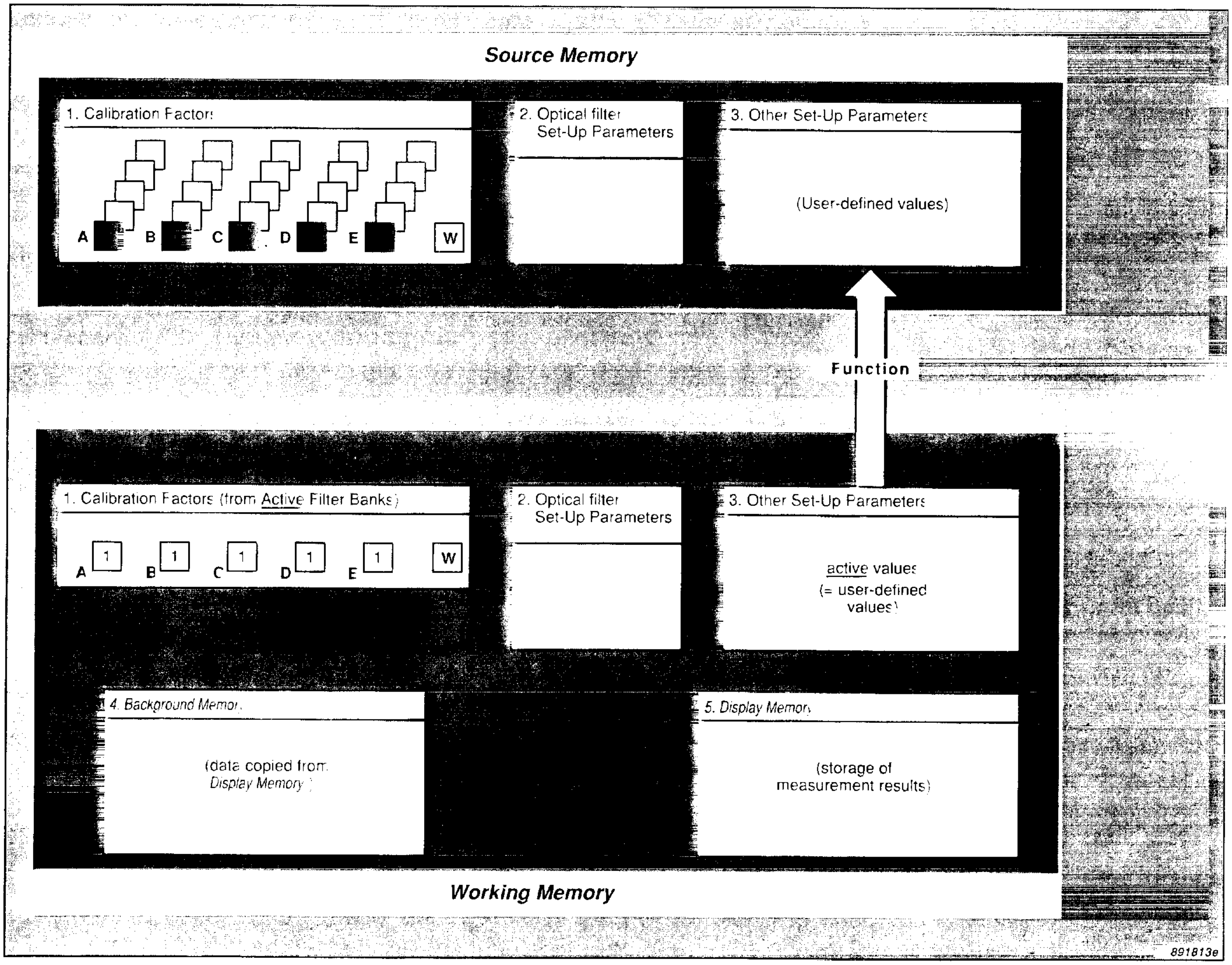


*Fig. 11.5. Changing the value of set-up parameters in **Source Memory***

11.2. STORAGE OF MEASUREMENT RESULTS

While a monitoring task is being performed measurement data is stored in the 1302's *Display Memory.* When the monitoring task is complete the data in *Display Memory* is normally copied into the 1302'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 11.3.3).

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. 11.6).

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. 11.6).

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. 11.6).

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. 11.6).

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 11.3.3).

Whenever the 1302 is operating in Memory **mode** the user can, by pressing the **Status** push-button, find out what percentage of the *Background Memory* is occupied and which location numbers have been used to store data. Fig. 11.6 illustrates the status information one can obtain from the 1302 during various stages of the four monitoring tasks described above. Further information about the **Status** push-button can be found in Section 11.3.4.

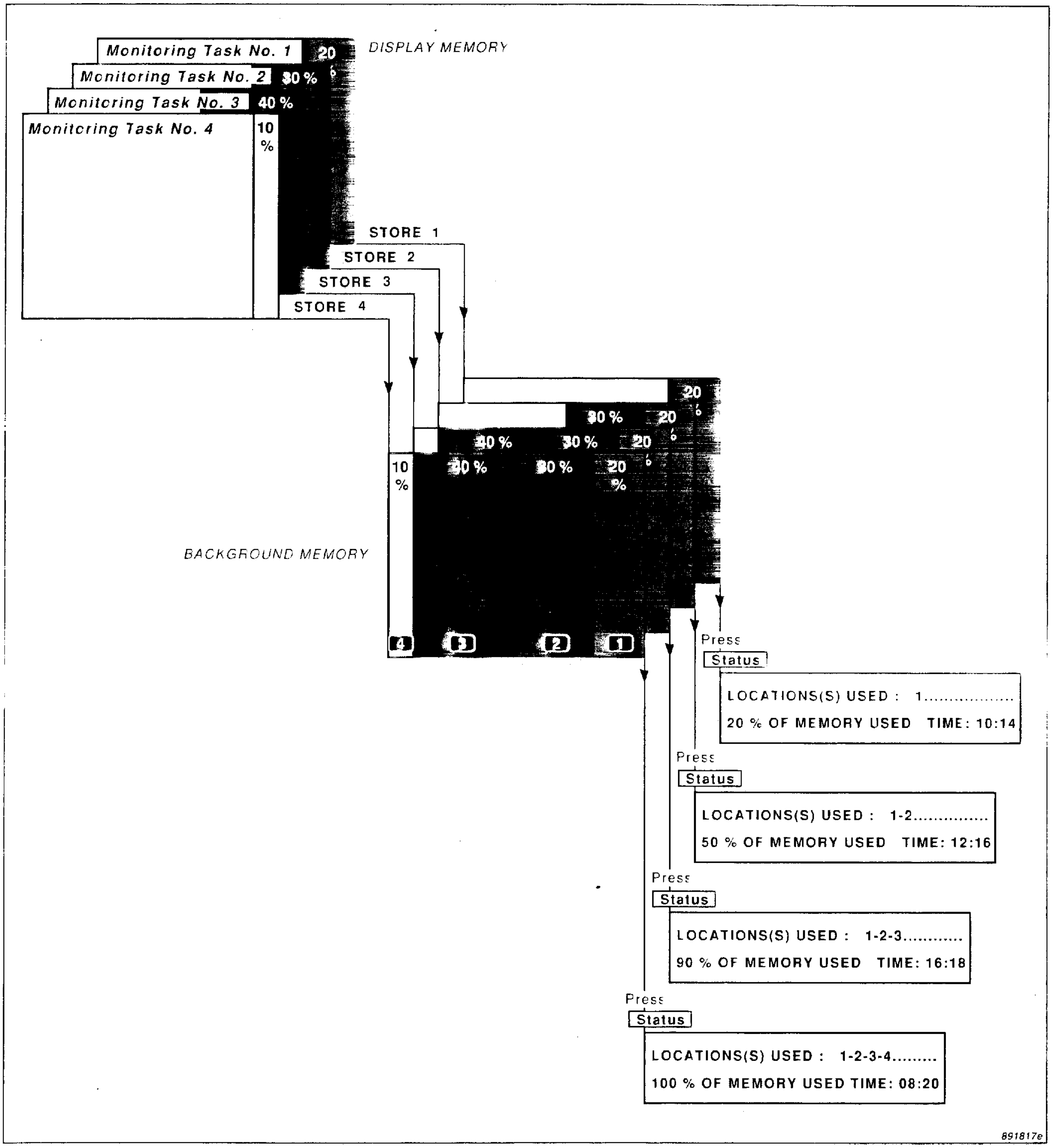
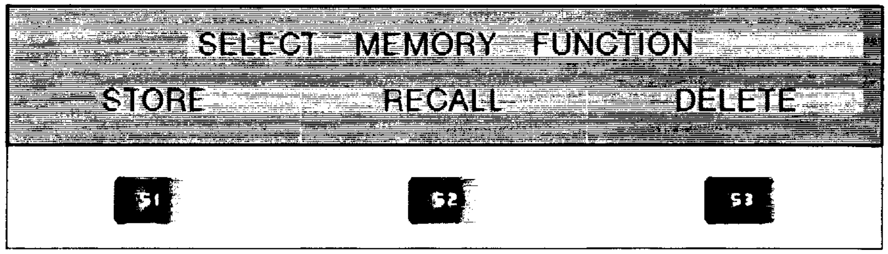


Fig. 11.6. Storing data from 4 different consecutive measuring tasks in the Background Memory

11.3. MANAGEMENT OF DATA IN BACKGROUND MEMORY

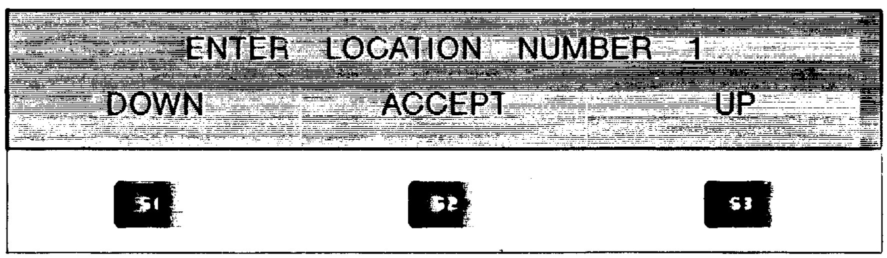
The 1302 has to be operated in Memory **mode** by pressing the **Memory** push-button. The following text appears on the screen:



11.3.1. Storing Data in Background Memory

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

Press **Memory** **S1**

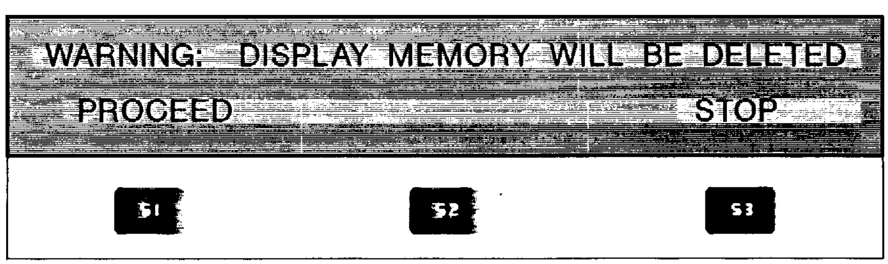


If some data has already been stored in the *Background Memory* and you cannot remember which locations have been occupied (used), press the **Status** push-button to find out which locations are occupied and what percentage of the *Background Memory* has been used (see Section 11.3.4). When the chosen location number is on the screen, press the **S2** push-button to accept the number.

11.3.2. Recalling Data from Background Memory

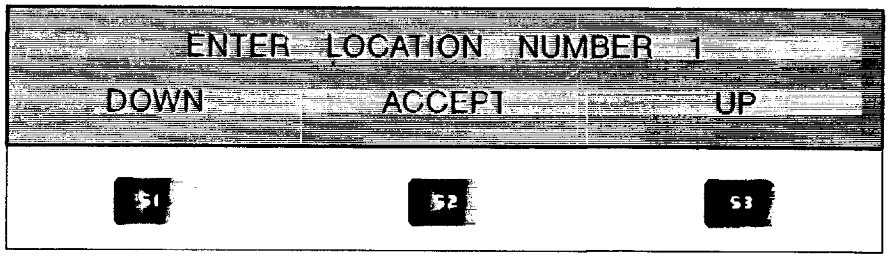
To recall data stored in *Background Memory* to *Display Memory*:

Press **Memory** **S2**



S3 By pressing this, push-button you can return 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 11.3.1.

S1 When this push-button is pressed the display then shows the following text:



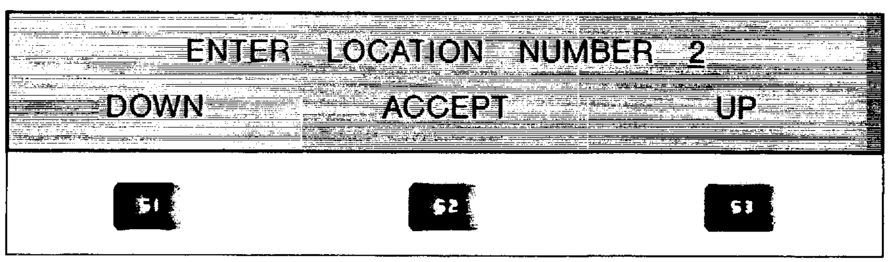
Using the select push-buttons S1 and S3 a location number can be changed to the chosen number and then "accepted" by pressing the S2 push-button. If data has not been stored in the chosen location, a message will appear on the 1302's display to inform the user. Otherwise, the data from the chosen location in *Background Memory* will be copied into *Display Memory* when the S2 push-button is pressed.

S2 By using this push-button the 1302 changes to the first display SELECT MEMORY FUNCTION. By pressing the Memory **mode** push-button again the user can stop operating in memory mode and then the user can scroll through the data which has been recalled to the display screen.

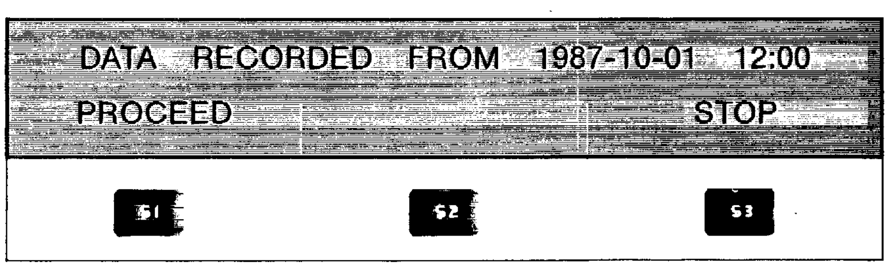
11.3.3. Deleting Data from Background Memory

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

Press Memory S3



After selecting the chosen location number the display will show the starting-time of the oldest data stored in the *Background Memory*.



S1 If the starting-time of the oldest stored data to be deleted corresponds with the starting-time shown on the display screen then by pressing the **S1** push-button the data will be deleted from *Background Memory.*

11.3.4. Obtaining "Status" 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 1302 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 **Status** push-button:

```
LOCATION(S) USED :  1- -3-4-5- -7- -9-10
53 %  OF  MEMORY  USED      TIME :  10:26

   S1            S2            S3
```

The numbers appearing on the above display are those which contain stored data. The 1302 will show the above "status text" display for a short period of time and then automatically change back to the text which was showing on the display before the **Status** push-button was pressed.

12. COMMUNICATING WITH THE 1302

The push-buttons grouped under the heading **Interface** enable the user to obtain hardcopy print-outs and plot-outs of data from the 1302 as well as error-log and data-log print-outs. If any error occurs during any of these operations a warning will be displayed. All possible errors of this kind are listed in a table in Appendix 2 at the end of this manual.

12.1. PLOTTING–OUT DATA FROM THE 1302

Any pen-plotter with either an RS 232 C serial interface or an IEEE 488 parallel interface which uses the Hewlett-Packard Graphics Language (for example, Brüel & Kjær's **Graphics Plotter Type 2319**) can be used to plot out data from the 1302.

12.1.1. Setting-up the Format Parameters of the Plot

Operate the Type 1302 in "**Set-up**" mode and enter the FORMAT branch of the set-up "tree" (see Section 7.6 for details) to select which measurement data you wish to plot-out and the parameters you require for your plot. The choice of PLOTTER TYPE depends upon whether you wish to use different colour pens to plot the various gases' concentrations, or whether a single colour pen is used and the various gases' concentrations are represented by different types of dashed lines — see Section 7.6 for details.

12.1.2. Using a Plotter with an IEEE 488 Interface

Tools and Equipment Required (see Fig. 12.1)

B & K Graphics Plotter Type 2319
Mains cable for plotter AN 0010
IEEE 488–IEEE 488 Interface cable (1302 to plotter) AO 0265
A4 plotting paper QP 4596

Setting-up the Brüel & Kjær Graphics Plotter Type 2319

Step 1.
Set the "Mains Voltage Selector" on the Graphics Plotter Type 2319 to match the local Mains Voltage supply (if the nominal supply voltage is between 100V and 127V the setting of the "Mains Voltage Selector" should be "115"; if the nominal supply voltage is between 200V and 240V the setting of the "Mains Voltage Selector" should be "230".

Step 2.
Check that the fuse in the Type 2319 plotter has the correct rating (for a nominal supply voltage of 100V to 127V the fuse should have a rating of T 0,4 AT/250V, and for a nominal supply voltage of 200V to 240V the fuse should have a rating of T 0,2 AT/250V).

Step 3.
Load the pen(s) which are required for the plot.

Step 4.
Set the address of the plotter to address number "5". This is done by setting the switches labelled "A1" and "A3" to the "up" = 1 position, and setting the switches labelled "A2", "A4" and "A5" to the "down" = 0 position.

Setting-up the 1302's Communication Parameters

Step 5.
Go into the *Communication* branch of the **System** section of the set-up "tree" and select the parameters which determine how the 1302 should communicate with the plotter. In the *Connections* branch: select "IEEE 488" as the PLOTTER CONNECTION; and "enter" "5" as the PLOTTER'S ADDRESS. In the *IEEE 488* branch: answer "YES" to the question IS 1302 SYSTEM CONTROLLER ?.

Step 6.
If you have changed any of the relevant communication parameters since the last time data was transmitted, partially reset the 1302 by pressing the **Reset** and **S1** buttons.

Step 7.
Make sure that the data you wish to plot-out is in *Display Memory* (see Section 11.3.2 for details).

Connecting the Plotter to the 1302

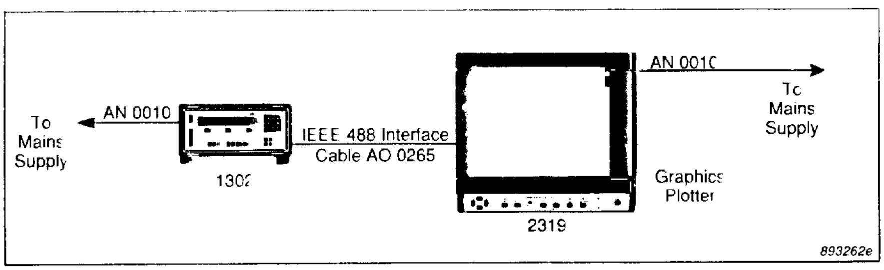


Fig. 12.1. Connecting the Graphics Plotter Type 2319 to Type 1302

Step 8. (see Fig. 12.1)
Connect the IEEE 488 interface port of the 1302 to the IEEE 488 interface port of the Type 2319 plotter using interface cable AO 0265.

Step 9.
Connect the power input socket of the plotter to the mains power supply using the mains power cable AN 0010.

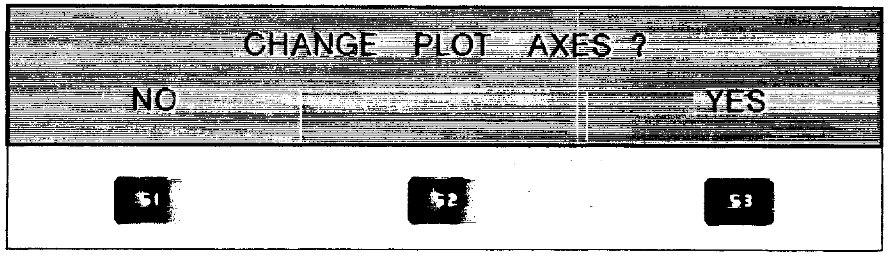
Step 10.
Switch on the mains power supply to the plotter.

Starting a Plot-out

Step 11.
Load the paper onto the printer platen and press "**Chart Hold**" — this will cause the LED above "**Chart Hold**" to be switched on.

Step 12.
Press the **Plot** button.

The following text will appear on the screen:



If you **do not** wish to change either the time axis or the concentration axis, that is, you wish to plot all the data for the gases chosen in the **FORMAT** branch of the set-up "tree", press **S1** and all relevant data from *Display Memory* will be plotted out.

An example of such a plot-out is shown in Fig. 12.2.

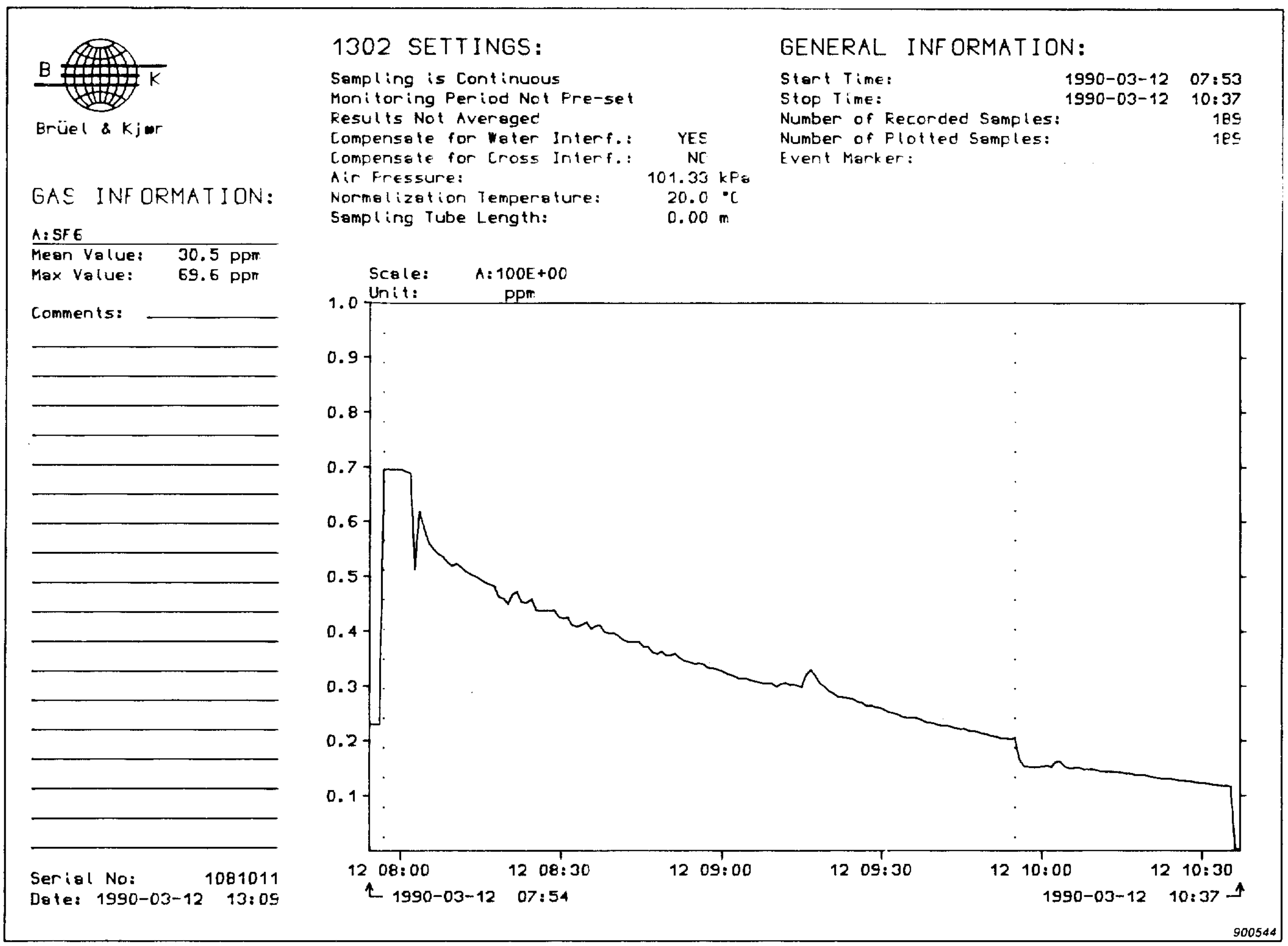


Fig. 12.2. A plot-out of monitoring task data (using all stored data)

If you **do** wish to change the time and/or the concentration axes of a plot, that is, you only wish to plot-out some of the measurements performed during the total monitoring task, then press the **S3** button. This will cause the following text to appear on the display:

ZOOM ON TIME AXIS ?		
NO		YES
S1	S2	S3

If you do not wish to "Zoom on the time axis", that is expand the scale to only show measurements made during a certain period, then press **S1** and the display text CHANGE SCALE ON CONCENTRATION AXIS ? will appear (See Section 12.1.4).

SELECT START & STOP SAMPLES BY		
DATE		SAMPLE NO.
S1	S2	S3

12.1.3. Choosing Zoom Boundaries by Date and Time

If you choose the boundaries of the measurements you wish to zoom-in on by setting the date, press the **S1** button:

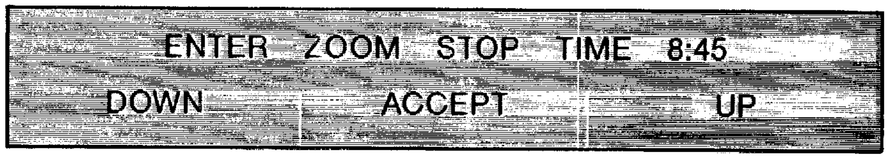
ENTER ZOOM START DATE 1990-03-12		
DOWN	ACCEPT	UP

Once the start date has been chosen the screen text asks the user to enter the start **time** and then the stop **date** of the monitoring period which is to be plotted:

ENTER ZOOM START TIME 07:59		
DOWN	ACCEPT	UP

ENTER ZOOM STOP DATE 1990-03-12		
DOWN	ACCEPT	UP

Once the stop **date** has been entered the user is asked to enter the stop **time**:



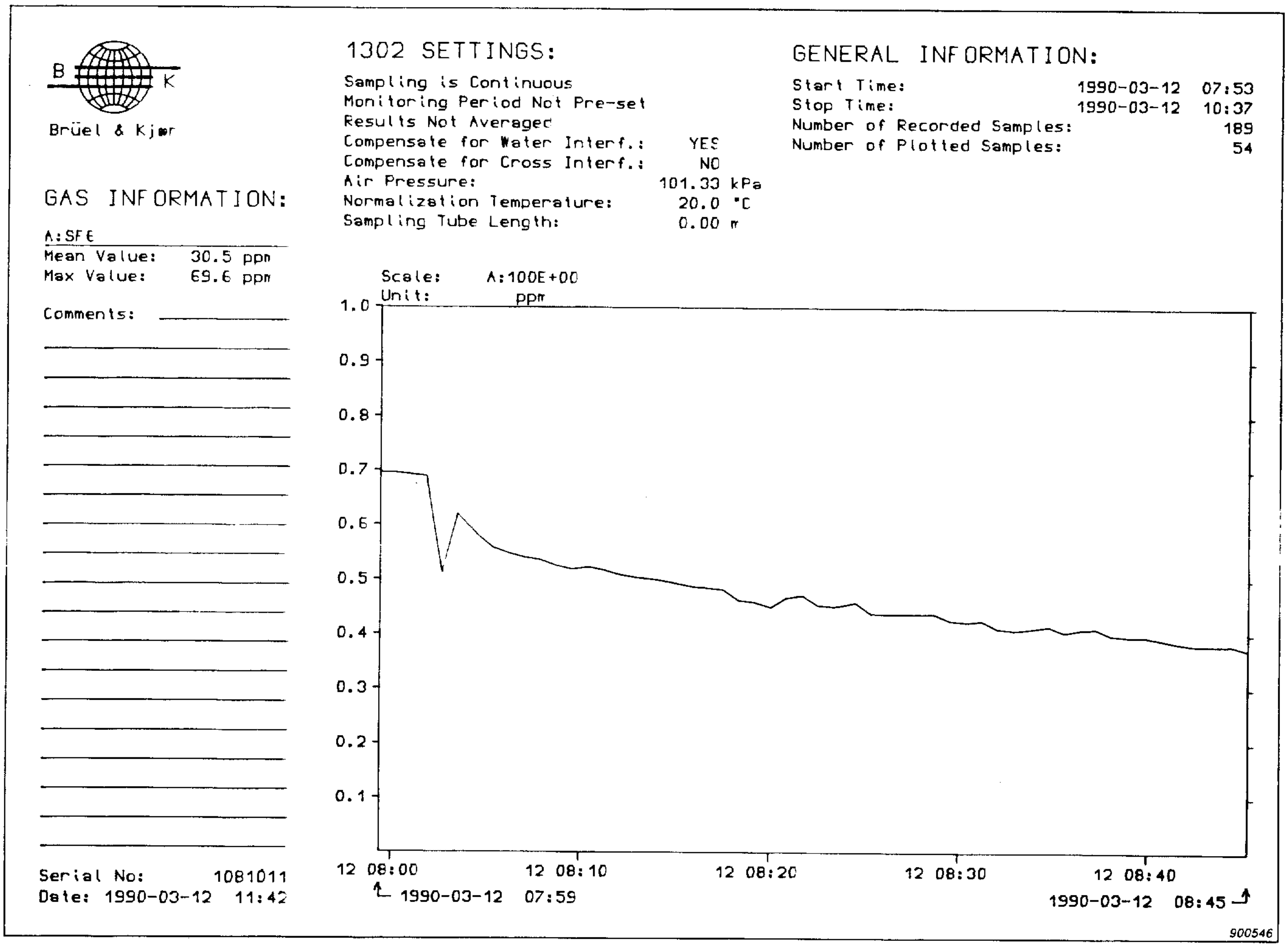


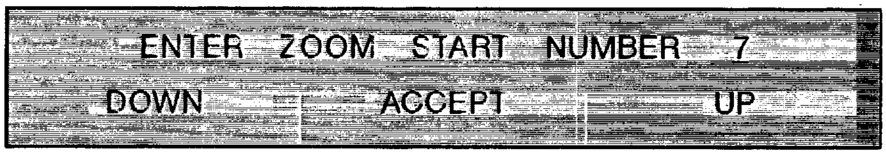
Fig. 12.3. A zoom-in plot of measurements made between two user-defined times

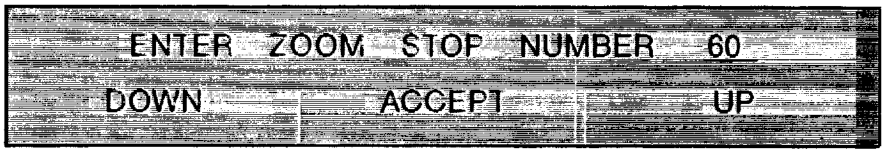
If you chose to zoom-in on the measurements made between 07:59 and 8:45 in the monitoring task represented in Fig. 12.2, the plot which results will be as shown in Fig. 12.3.

12.1.4. Choosing Zoom Boundaries by Sample Number:

If you wish to choose zoom boundaries by using sample numbers:

Press **Plot** **S3** **S3** **S3**





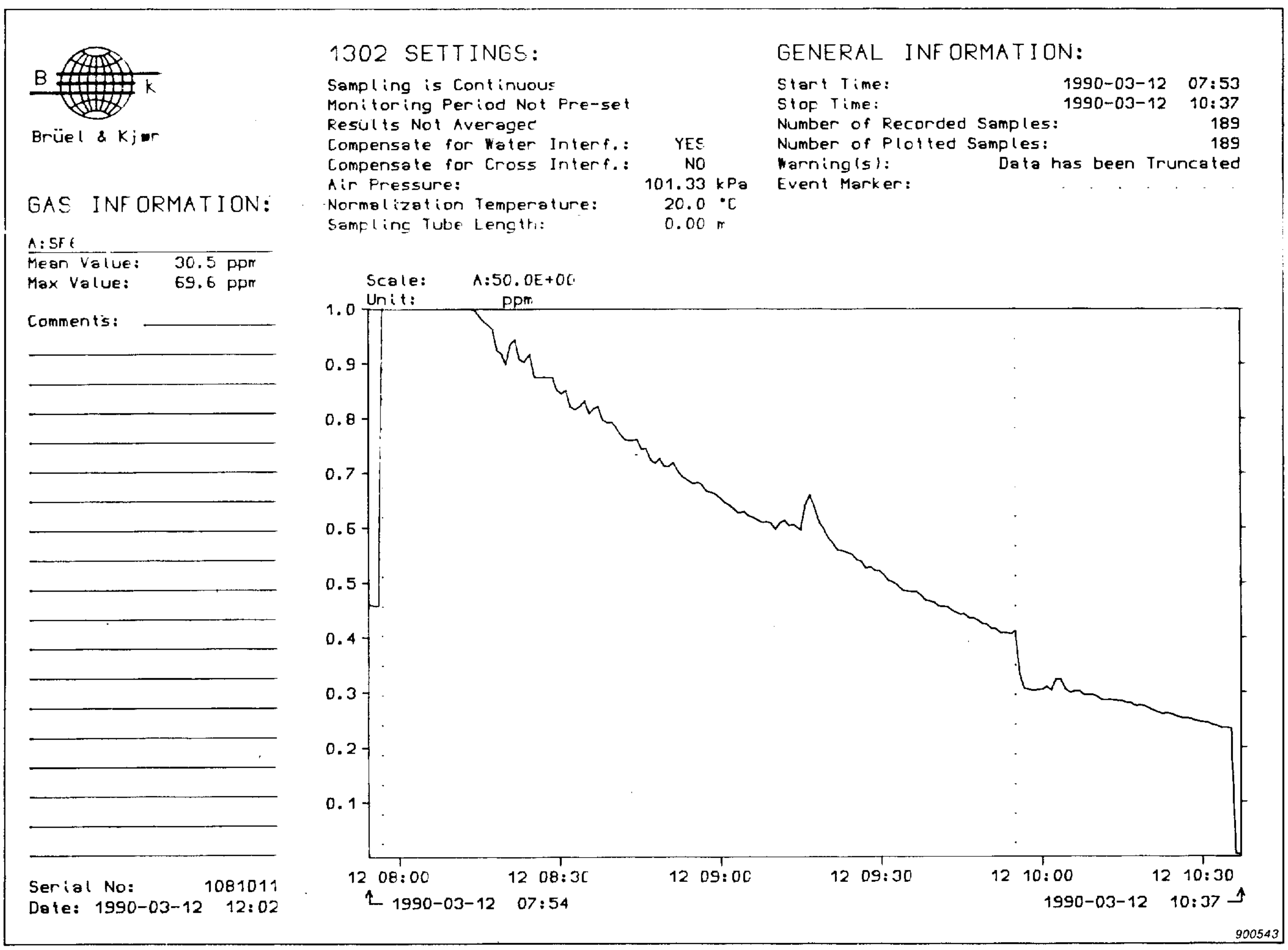


Fig. 12.4. A plot of measurements on a changed concentration axis

As soon as the time axis boundaries have been chosen the user is asked whether to change the scale of the concentration axis.

12.1.5. Changing the Scale of the Concentration Axis

When spurious measurements are seen in the plot-out of a monitoring task you can, in many cases, "edit" them out by changing the scale on the concentration axis.

CHANGE SCALE ON CONCENTRATION AXIS ?	
NO	YES

If you do not wish to change the concentration axis scale press **S1** and data will be plotted out.

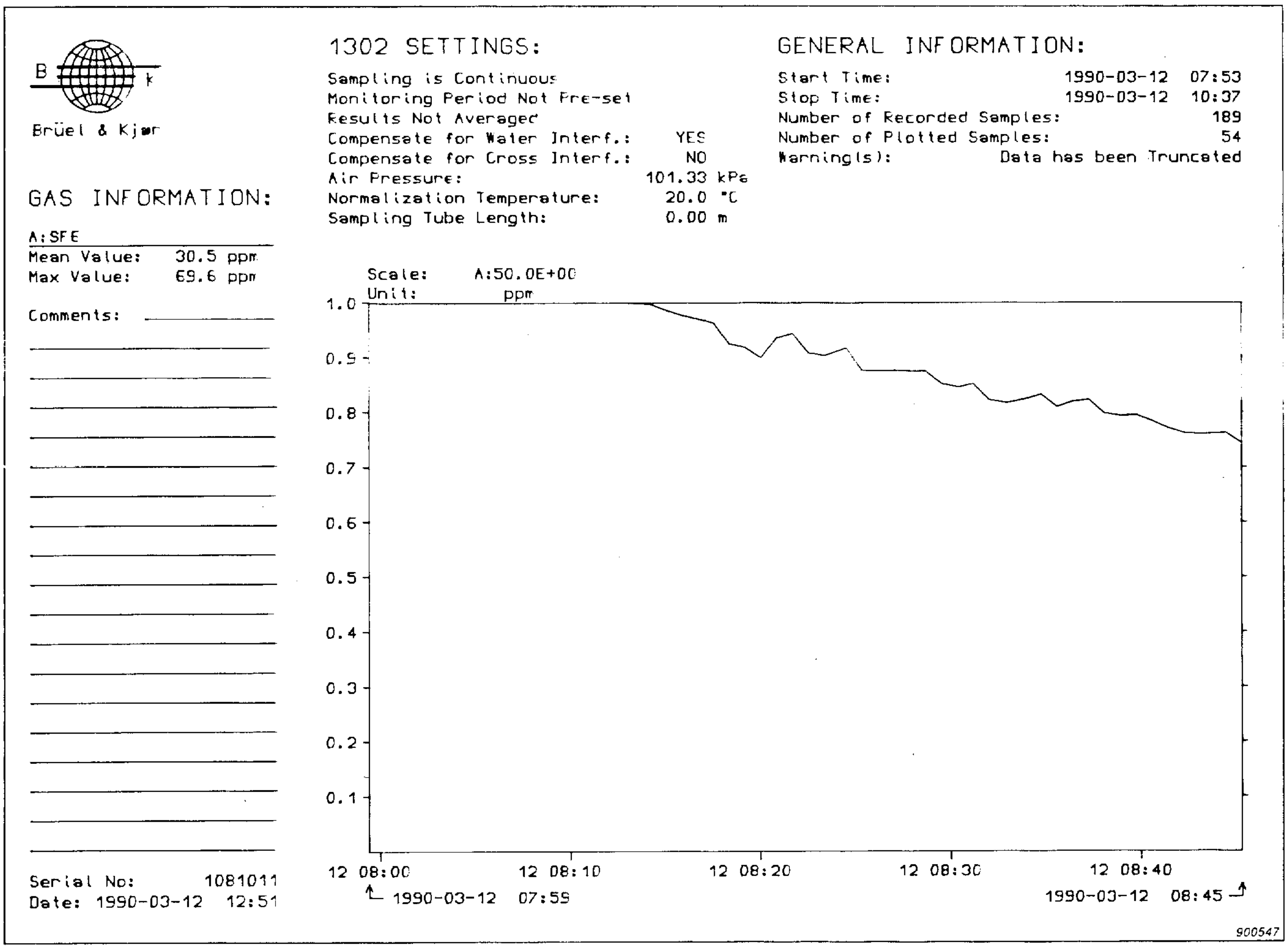


Fig. 12.5. A zoom-in plot of measurements made between two user-defined times on a changed concentration axis

If you do wish to change the concentration axis scale press **S3** and the following screen display will appear:

```
ENTER MAX. FOR GAS A: 69.6 ppm
DOWN        ACCEPT         UP
```

The concentration shown on the above display will be the maximum concentration of gas A measured during the monitoring task displayed on the screen.

The concentration axis scale is always marked from 0.0 to 1.0 and then the various gases are given a scaling unit based on the preferred numbers 2, 5 and 10. Scaling units are expressed as exponential numbers e.g. 100E–03 which is the same as the number $100 \times 10^{-3} = 0{,}1$. This means, for example that if the first unit in the maximum concentration is above the number 5 and below the number 10, the scaling factor will be 1000E+X where X = a positive or negative unit number: if the first unit in the maximum concentration is between the number 2 and the number 5 then the scaling factor will be 500E+X; and if the maximum concentration is between 1,0 and 2,0 then the scaling factor will be 200E+X.

Note: if the maximum concentration shown on the above screen is not changed then the scale on the concentration axis will not change.

The maximum concentration value chosen on the above display will decide the scaling factor used. In the example illustrated in Fig. 12.2, the maximum concentration of gas A is 70ppm — this concentration is plotted as 0,7 on the concentration axis and the scaling factor for it is 100E+00 (= 100) — (0,7 × 100 = 70ppm).

Suppose you only wanted to show concentrations of gas A up to a maximum of 50 ppm, then this concentration must be "entered" on the above display and "accepted". The resultant plot will show the fluctuating concentration of gas A between 0ppm and 50ppm (scaling factor = 10). All concentrations of gas A which are greater than 10ppm will be truncated at the top of the plot (see Fig. 12.4). If you zoom-in on the time axis between 07:59 and 8:45 **and** change the scale for gas A on the concentration axis the resultant plot is shown in Fig. 12.5.

When the relevant data has been plotted out the plotter stops.

12.1.6. Stopping a Plot which is in Progress

If you wish to stop a plot which is in progress, the following steps need to be taken:

Step 1.
Press the **Plot** button on the 1302's front panel.

The plotter will stop plotting data and the following text will appear on the the display:

```
PLOT ABORTING
PLEASE WAIT
```

If you are using the Graphics Plotter Type 2319 then press the "Chart Hold" button. This will reset the plotter pen and move the pen carriage arm off the paper so that it can be removed from the platen.

12.2. PRINTING–OUT DATA FROM THE 1302

The 1302 has two interface ports on its back panel, an IEEE 488 and an RS 232C interface port. This means that any standard text printer with one of these interfaces can be used to print-out data from the 1302. The Brüel & Kjær **Graphics Recorder Type 2313,** which has an IEC 625 interface, may also be used. Data can be printed out while the 1302 is operating — by using the **Data-logging** facility. This means that during a monitoring task or during a calibration task the 1302 will automatically send measurement results to the printer as soon as they are available (see Section 12.2.5). Any operational errors or warnings which occur during a monitoring task can also be automatically printed out by using the **Error-logging** facility. Alternatively, when the 1302 is not being operated in any mode, data can be printed out by using the **Print** button. Data can be printed out in three different blocks:

1. **Measurement:** this block contains the measurement data displayed on the 1302 screen during the printing operation — it also provides the set-up parameters for the displayed monitoring task (see Section 9.2).

2. **Set-Up:** this block contains **active** set-up parameters.

3. **Calibration:** this block contains the optical filter factors, calibration factors and all other information related to the calibration of the optical filters installed in the 1302.

Setting-up the Format Parameters of the 1302

Before asking the 1302 to print out data on a printer it is necessary to select the data you wish it to print out.

The procedure is as follows:

Operate the Type 1302 in "**Set-up**" mode and enter the **FORMAT** branch of the set-up "tree" and select the parameters you require for your print (see Section 7.6 for details). If you require your results to be averaged over a pre-determined period e.g. 15 min to obtain the 15 min STEL (Short Term Exposure Limit) value, remember to enter the correct averaging period and to "activate" the averaging function (by pressing the **Average** button) **before** starting a print-out (see Section 7.6).

12.2.1. Using a Printer with an RS-232C Interface

Step 1.
Use the RS 232C interface cable (Brüel & Kjær Accessory No. WL 0947) to connect the printer to the 1302's RS 232C interface port.

Before the 1302 is capable of sending data to the printer, its communication parameters must be correct.

Setting-up RS 232 C Communication Parameters

Step 2.
Press **Set-Up** **S3** **S1** **S3**

The following text is displayed:

SELECT COMMUNICATION SET-UP BRANCH ?		
RS 232 C	IEEE 488	CONNECTIONS

Step 3.
Press **S1** and then select the correct values for the parameters displayed on the screen:

Baud rate; number of stop bits; number of data bits; parity check; hardwire mode; and handshake type. The Instruction Manual supplied with your printer will tell you what value to give to each of these parameters.

Step 4.
Press the **S3** **S1** **S1** and then **Set-Up** buttons.

Step 5.
Press **Reset** and **S1** to partially reset your 1302.

Starting a Print-out

Step 7.
Switch on the mains power supply to the printer.

Step 8.
Press the **Print** button of the 1302 and then one of its "soft" buttons **S1** **S2** or **S3** depending on which data block you wish to print-out.

12.2.2. Using a Printer with an IEEE 488 Interface:

Step 1.
Use the IEEE 488–IEEE 488 interface cable (Brüel & Kjær Accessory No. AO 0265) to connect the IEEE 488 printer to the 1302's IEEE interface port.

Before the 1302 is capable of sending data to the printer, its communication parameters must be correct.

Setting-up IEEE 488 Communication Parameters

Step 2.
Press **Set-Up** **S3** **S1** **S3** **S2** **S2**

IS 1302 THE SYSTEM CONTROLLER ?		
NO		YES

Step 3.
Press **S3**

Step 4.
Press **S3** **S3** **S2** **S3**

ENTER PRINTER'S ADDRESS 1		
DOWN	ACCEPT	UP

Step 5.
Find the address of your printer (this can be found in the Instruction Manual for your printer) and "enter" this number by using the either the **S1** or the **S3** button to change the number on the screen.

Step 6.
Press **S2** to accept this address.

Step 7.
Press **Reset** and **S1** to partially reset your 1302.

Starting a Print-out

Step 8.
Switch on the mains power supply to the printer.

Step 9.
Press the **Print** button of the 1302 and then one of its "soft" buttons **S1** **S2** or **S3** depending on which data block you wish to print-out.

12.2.3. Using the Brüel & Kjær Graphics Recorder Type 2313

Tools and Equipment Required

B & K Graphics Recorder Type 2313
Application Package BZ 7000
2 × Mains cables (one for recorder, one for 1302) AN 0010
IEEE 488–IEC 625 Interface cable (1302–Graphics Recorder) AO 0264
Roll of recording paper QP 4690

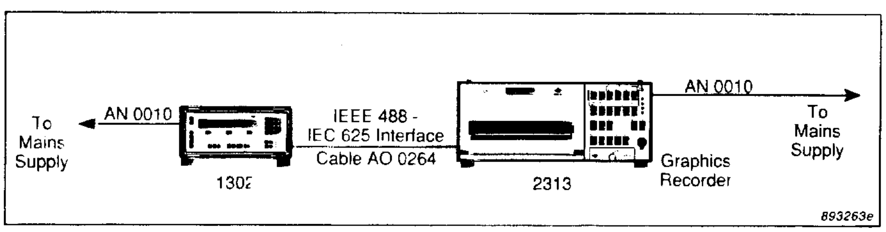


Fig. 12.6. Connecting the Graphics Recorder Type 2313 to the Type 1302

Setting-up the Graphics Recorder

Step 1.
Set the "Mains Voltage Selector" on the Graphics Recorder Type 2313 to match the local Mains Voltage supply.

Step 2.
Check that the fuse in the Type 2313 Graphics Recorder has the correct rating (for a nominal supply voltage of 100V to 240V a 1,6 A slow blow fuse should be used).

Step 3.
Install the Application Package BZ 7000 in the Graphics Recorder and load the paper roll in the Type 2313.

Step 4.
On the back panel of the 2313, set the address-switch number "8" to position 0 ("System Controller not active").

Step 5. (see Fig. 12.6)
Connect the IEEE 488 port of the Multi-gas Monitor to the IEC 625 interface bus port of the Graphics Recorder Type 2313 using interface cable AO 0264.

Step 6.
Set the address of the **Graphics Recorder** to number 1. This is done by pressing down the top part of address switch number 1, and then pressing down the bottom part of address switches numbered "2" to "5" (inclusive).

Setting-up the Communication parameters of the 1302

Step 7.
Go into the *Communication* branch of the **System** section of the set-up "tree" and select the parameters which determine how the 1302 should communicate with the printer (see Section 7.5):

In the "*IEEE 488*" branch:

IS THE 1302 SYSTEM CONTROLLER ? — answer "YES"

In the "*Connnections*" branch:

SELECT PRINTER CONNECTION select "IEEE 488"
ENTER PRINTER'S ADDRESS "enter" and "accept" number 1

Step 8.
Partially reset the 1302.

Step 9.
Make sure that the data you wish to print out from the Type 1302 is in its *Display Memory* (see Section 11.3.2 for details).

Starting a Print-out

Step 10.
Switch on the mains power supply to the printer.

Step 11.
Press the **Print** button on the 1302.

Step 12.
On the front panel of the **Graphics Recorder**, press the **Reset** button and then the **Exec./Ent.** button.

Step 13.
Press the **Print** button of the 1302 and then one of its "soft" buttons **S1** **S2** or **S3** depending on which data block you wish to print out.

12.2.4. Stopping a Print-out which is in Progress

If a print is in progress and you wish to stop it, then the following steps need to be followed:

Step 1.
Press the **Print** button on the 1302's front panel.

The following text will appear on the the display:

PRINT ABORTING
PLEASE WAIT

The printer will stop printing data.

Step 2.
Press the **Paper Feed** button to roll the paper a few centimeters out of the Graphics Recorder before tearing off the pages which have been printed.

12.2.5. Setting-up the 1302 to Print a Data Log

If the 1302 is connected up to a printer, and it is set-up to transmit data to the printer, measurement data will be automatically printed out as soon as it becomes available by setting-up the 1302 to "print a data log".

The procedure is as follows:

Press the following sequence of buttons: **Set-Up** **S3** **S1** **S1** **S3** **Next Display** **S3** and **Set-Up**.

13. A MULTI-CHANNEL GAS-MONITORING SYSTEM

The Multi-gas Monitor Type 1302 can be used together with either one or two Multi-point Doser and Sampler Unit(s) Type 1303. These instruments are controlled by an IBM AT or PS/2 series Computers models 50, 60, 70 and 80 using Brüel & Kjær Application Software Type 7620.

If the Multi-point Doser and Sampler Unit(s) is only used as a "sampling" unit, then the monitoring system can be used to monitor up to 5 gases and water vapour in air samples collected from up to 6 sampling points (or 12 sampling points if 2 Multipoint Doser and Sampler Units are used). If the Multi-point Doser and Sampler Unit is used as a "doser" and a "sampler" unit, it can "dose" one tracer gases to 6 different locations and then sequentially analyze samples of air from these locations. If two Multipoint Doser and Sampler Units are used then one tracer gas can be "dosed" to a maximum of 12 locations, or alternatively, two different tracer gases can each be used to "dose" a maximum of 6 different locations. Using results of these measurements, the Software Type 7620 can automatically calculate a great number of indoor climate parameters, for example, air change and ventilation efficiency.

The operation of this monitoring system is fully described in the Instruction Manual for the Application Software Type 7620.

14. THE RS 232 C AND IEEE 488 INTERFACES

A full description of the IEEE 488 and RS 232 C interfaces is provided in Volume 2 of the Instruction Manual for the Multi-gas Monitor Type 1302.

15. MAINTENANCE OF THE 1302

The only regular maintenance required for the 1302 is:

- Calibration — approximately every 3 months (see Chapter 16)
- Change of the fine air-filter paper in its internal and external air-filtration units (see Section 15.1)
- Cleaning of the filter in the ventilation unit (see Section 15.2).

15.1. CHANGE OF THE FINE AIR-FILTERS

The Multi-gas Monitor Type 1302 is provided with an *internal* air-filtration unit **1** which is mounted on its back panel (see Figs. 15.1 and 15.2). Inside the air-filtration unit a fine (10 μm) filter-paper removes fine dust particles and other suspended matter from air samples before they reach the analysis cell of the 1302.

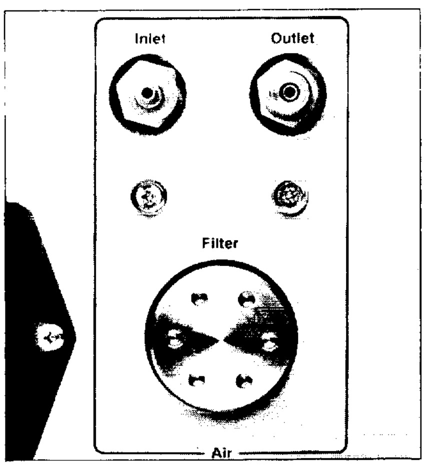


Fig. 15.1. The internal air-filtration unit mounted on the back panel of the 1302

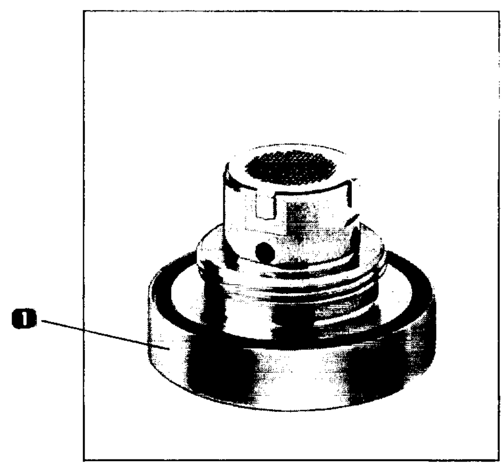


Fig. 15.2. The internal air-filtration unit

Whenever the 1302 needs to be calibrated we recommend that the fine filter-paper in the *internal* air-filtration unit be changed **before** performing the calibration procedure. 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 1302 is working contains large quantities of particulate material in suspension in the air.

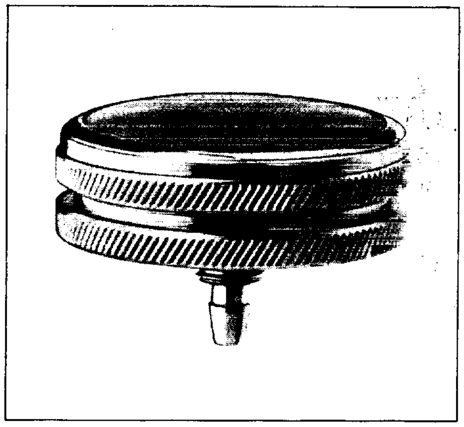


Fig. 15.3. The external air-filtration unit UD5023 used with the 1302

When the 1302 is performing gas measurements we recommend that a length of TEFLON tubing (from 0,20 m to 50 m) is always attached to the stub of the air-inlet (see Fig. 15.1) and that the special *external* air-filtration unit UD5023 (see Fig. 15.3) is always attached to the free-end of the sampling tube at the sampling point by means of the little stub ❶ on its one end. An external coarse metal air-filter ❷ prevents large particles, insects etc. being drawn into the unit, and inside the unit a fine (10 μm) filter-paper prevents any fine 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.

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

15.1.1. Changing the Filter-paper in the Internal Air-filtration Unit

We recommend that clean rubber gloves are worn whilst performing this task.

Tools and Equipment Required: (Accessories supplied with the 1302 are numbered)

- Acetone (analytically pure) ❶
- Spare fine filter-paper DS0714 ❷
- Special Teflon-coated tweezers QA0164 ❸
- Cotton buds ❹
- Special spanner (wrench) QA0181 (to screw/unscrew the *internal* air-filtration unit from the 1302) ❺
- Clean rubber gloves (not shown)

Step 1.
Switch off the 1302 by using the AC Mains power switch on its back panel (press **O**) and then pulling out the plug connecting the 1302 to the AC Mains power supply.

Step 2.
Unscrew the fine *internal* air-filtration unit from its housing in the 1302 using the special spanner QA0181 ❺ (see Fig. 15.4).

Fig. 15.4. Tools and equipment required

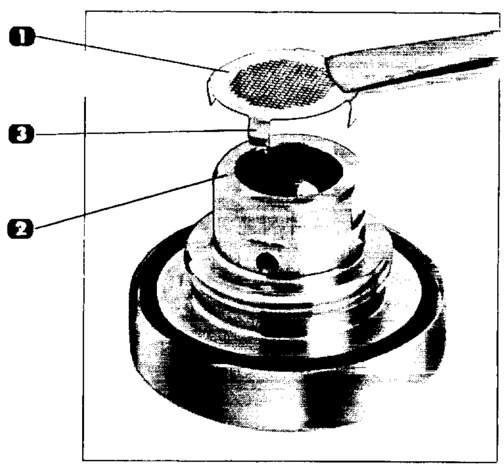


Fig. 15.5. The thumbscrew unit and retaining disc

Step 3.
Use the tweezers to lift the retaining disc ❶ and the old (used) fine filter-paper off the top of the end of the thumbscrew unit ❷ (see Fig. 15.5). Place the disc, with its locating lugs upward ❸ on a clean surface.

Step 4.
Use the tweezers to remove the used fine filter-paper from the retaining disc.

Step 5.
Use the tweezers to hold one of the locating lugs of the retaining disc, and pick the disc up. Moisten a cotton bud with pure acetone, and use it to clean the surfaces of the retaining disc. Place the disc with its locating-lugs **downwards** 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 1302 is operated.*

Step 6.
Hold the thumbscrew-end of the thumbscrew unit between your thumb and forefinger. Moisten a cotton bud with pure acetone and use it to clean the surfaces of the unit. Place the unit, with its thumbscrew-end downwards, on a clean, dry surface.

Note: *Only proceed to the next step when the acetone has completely evaporated from the air-filter retaining disc and thumbscrew unit.*

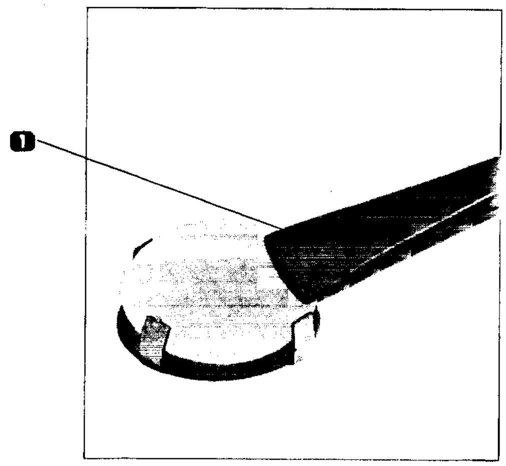


Fig. 15.6. Fitting a new filter-paper

Step 7.
When the retaining disc is completely dry, use the tweezers to pick it up. Place it with its locating lugs facing upward on a clean, dry surface (see Fig. 15.6).

Attention: *Each of the 10 fine filter-papers DS 0714 are packed between two pieces of packing paper. The fine filter-paper is always white in colour.*

Step 8.
Use the tweezers to remove a new fine filter-paper from its packaging by holding it by its edge ❶. Lift the filter up and place it on top of the retaining disc (see Fig. 15.6).

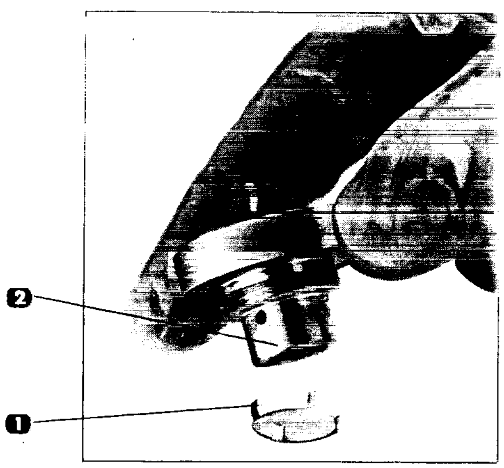


Fig. 15.7. Assembling the internal air-filtration unit

Step 9.
Hold the thumbscrew-end of the *internal* air-filtration unit between your thumb and forefinger and carefully position it above the retaining disc and fine filter-paper so that the locating lugs ❶ are above the notches ❷ (see Fig. 15.7). Gently press the thumbscrew-unit down over the retaining disc and filter-paper making sure that:

(a) the disc's locating lugs fit properly into the notches on the thumbscrew unit, and;

(b) that the new fine filter-paper is not damaged in any way, and that it remains in its correct position — that is, between the retaining disc and the top of the thumbscrew unit.

Step 10.
Hold the thumbscrew-end of the *internal* air-filtration unit between your thumb and forefinger and screw the unit firmly into its position in the 1302.

Step 11.
Use the special spanner to screw the *internal* air-filtration unit very securely into its housing in the 1302 (without damaging it).

15.1.2. Changing the Filter-paper in the External Air-filtration Unit

We recommend that clean rubber gloves are worn whilst performing this task.

Tools and Equipment Required: (Accessories supplied with the 1302 are numbered)

- Spare fine air-filter DS 0759
- Clean rubber gloves (not shown)
- Special Teflon-coated Tweezers QA 0164
- Acetone (analytically pure)
- Cotton buds

Step 1.
Switch off the 1302 by pressing its **Stand by** push-button.

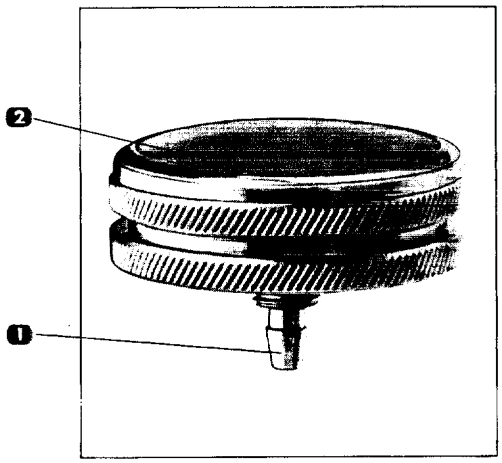


Fig. 15.8. The external air-filtration unit

Step 2.
Pull the *external* fine air-filtration unit off the end of the TEFLON sampling tube. Hold the stub-end 1 of the external air-filter unit between your thumb and forefinger, and unscrew the coarse air filter 2 from the end of the unit (see Fig. 15.8).

Step 3.
Use the special tweezers to remove the used (old) 1 filter-paper from the unit.

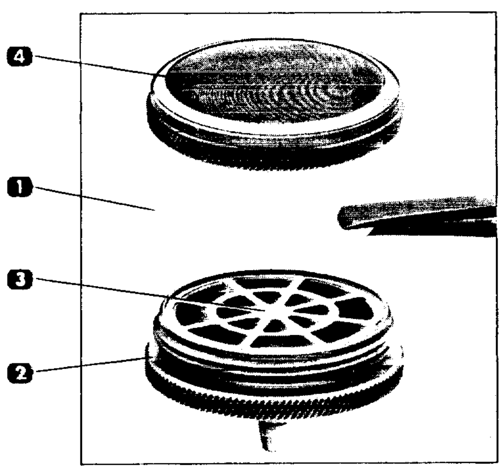


Fig. 15.9. Various parts of the external air-filtration unit

Step 4.
Moisten a cotton bud with pure acetone and use it to clean the surfaces of the unit 2, the retaining disc 3 and the coarse air-filter 4 (see Fig. 15.9). 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 1302 is operated.*

Only proceed to the next step when the acetone has completely evaporated from the cleaned surfaces.

Attention: *Each of the 25 fine filter-papers DS 0759 are packed between two pieces of packing paper. The fine filter-paper is always white in colour.*

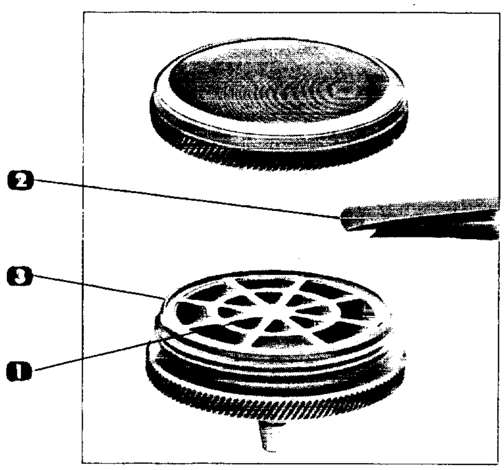


Fig. 15.10. Assembling the external air-filtration unit

Step 5.
Hold the stub-end of the unit between your thumb and forefinger. Lift the retaining disc ❶ with the tweezers and place it in position in the unit (see Fig. 15.10).

Step 6.
Use the special tweezers to remove a new fine filter-paper from its packaging by holding it by its edge ❷. Carefully place the filter-paper over the top of the retaining disc so that it is held in position by the small "lip" ❸ on the rim of the unit.

Step 7.
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.

15.2. CLEANING THE FILTER IN THE VENTILATION UNIT

A small ventilation unit is mounted on the back panel of the 1302 (see ❶ in Fig. 15.11). The ventilating fan in this unit circulates air through the 1302 to keep it cool. To ensure that the air being drawn into the 1302 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 1302 is working in a very dusty atmosphere or an atmosphere containing high concentrations of other particulate matter.

Step 1.
Use a "pozidrive" screwdriver to unscrew the two screws on the grid cover.

Step 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 **throughly**.

Step 3.
Place the clean, thoroughly dry, filter pad inside the grid cover. Screw the grid cover firmly back in place over the ventilation unit.

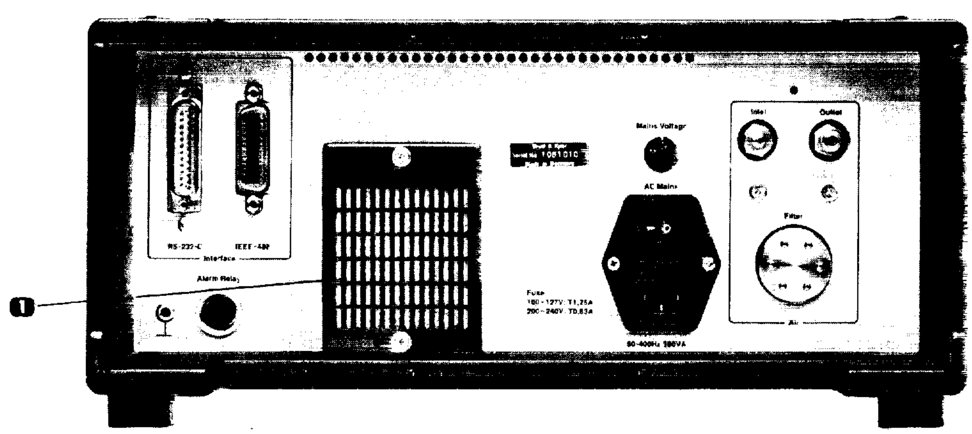


Fig. 15.11. Back panel of the 1302 showing the ventilation unit

16. CALIBRATION OF THE OPTICAL FILTERS

16.1. 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.

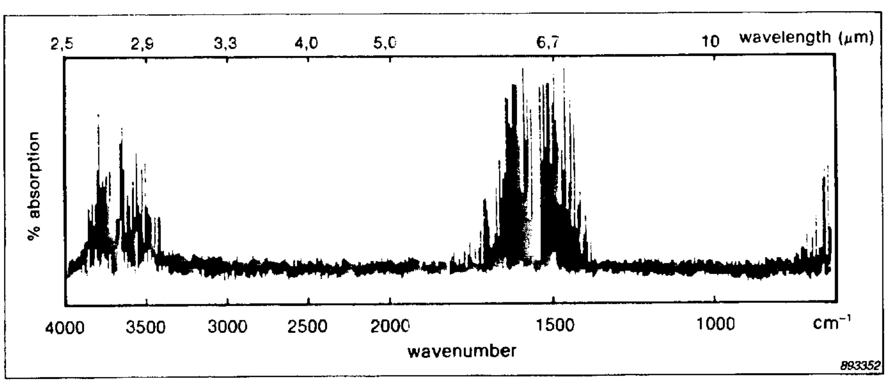


Fig. 16.1. High resolution absorption spectrum of water vapour

(1) 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 1302 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.

(2) 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. 16.1). 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.

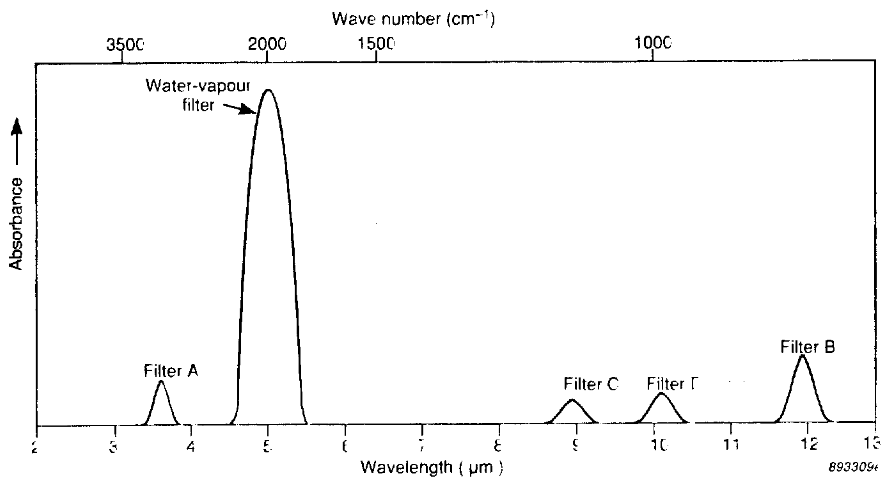


Fig. 16.2. Schematic diagram showing the relative absorption of water vapour by different optical filters

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 1302. 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. 16.2). 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 160μV and using Filter "A" is 16μV, then, if the signal measured with the water-vapour filter is found to be 80μV, we know that this concentration of water vapour will produce a signal of 8μV when Filter "A" is used. Measurements made during humidity-interference calibration of the installed filters therefore enable the 1302 to compensate any measured signal for water-vapour's interference.

(3) The 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. 16.3 ("Interference from Gas B when filter A is used"). This interference is termed **cross interference**.

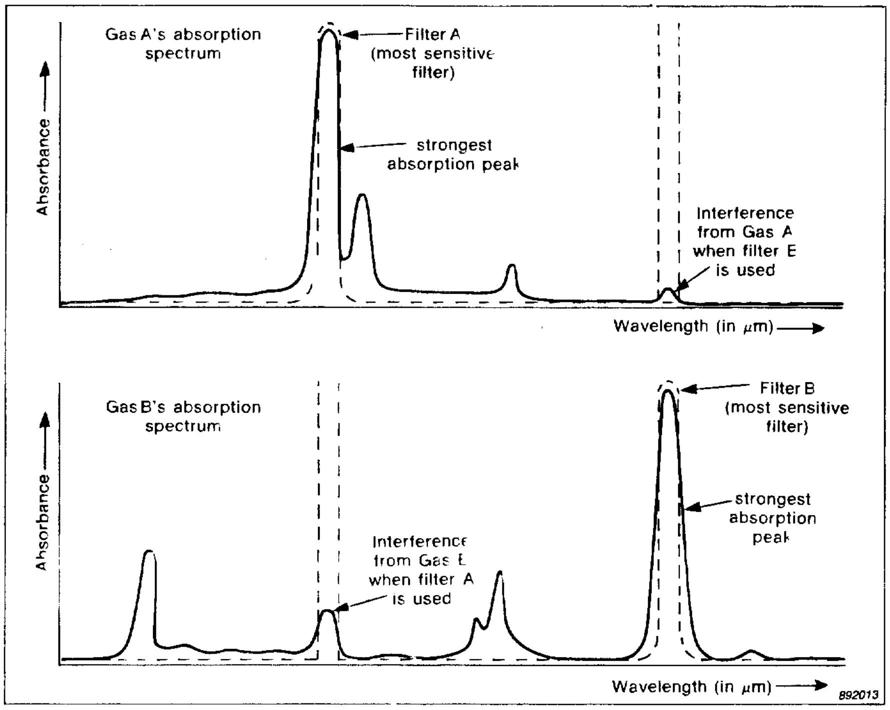


Fig. 16.3. Schematic diagram showing the absorption spectrum of gas A and gas B. The dashed lines represent the half-power bandwidths of the filters used to measure each gas

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. 16.3. 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. 16.2). 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. 16.2). This ratio is a constant and is a measure of **Gas B's Interference on filter "A"**.

By measuring the ratios described above the 1302 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**.

16.2. TASKS BEFORE STARTING ANY CALIBRATION

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

1. Checking optical filter parameters: (see Section 2.4.1).
2. Connecting the 1302 to a printer and setting it up to print a data log. (see Section 2.4.2).
3. Warming up the 1302 (see Section 2.4.3).
4. Checking the Calibration of Each Installed Optical Filter (see Section 2.3.1).
5. Setting-up a calibration task (see Sections 16.3, 16,4, and 2.4.4).

Step-by-step instructions are provided in the above-mentioned sections about how to perform the first three operations listed above, but little explanation is given. It will therefore be possible for even first-time users to complete these tasks without first familiarizing themselves with the operating philosophy of the 1302. Explanations of these tasks can, however, be found in other sections of this manual.

1. **Checking the 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 1302. 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.

2. **Connecting the 1302 to a printer:** During calibration a particular gas is drawn into the cell and the microphones measure the signal produced by the gas's absorption of light from the infra-red light source. As soon as a measurement is made it is displayed on the 1302's screen. Measurement results are constantly updated on the display but only **one** set of measurement results are displayed at any time, and no scrolling facility is available to look at previously-displayed results. We therefore suggest that you link your 1302 to a printer and set the 1302 up to print a "**Data log**". This will enable the 1302 to automatically send measurement results to the printer which will save you the time and effort required to manually copy results from the screen during calibration.

3. **Warming-up the 1302:** 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 1302 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.

4. **Checking the Calibration of Each Installed Optical Filter:** Before setting-up any calibration task it is advisable to obtain a print-out of the calibration data stored in your 1302. Section 12.2.2 describes how to do this, and Section 2.3.1 explains how to find out what calibration data is stored in each of the **five** filter banks for each installed filter. It is important to know which calibration tasks have been performed and which kind of calibration task is still necessary to perform.

5. **Setting up a calibration task:** Before a practical calibration task can be started, the 1302 has to be informed about the kind of calibration task you wish it it perform.

16.3. CALIBRATION TASK SET-UP "TREE"

The calibration tasks are set-up while operating in **Measurement** mode. The **Calibration Task** set-up "tree" is illustrated in Fig. 16.4.

Notice the following:

1. Before starting to set-up a calibration task you must make sure that you choose the correct FILTER BANK NO. to store the calibration factors which will be calculated during calibration (see Section 11.1.2).
2. If you answer "YES" to **PERFORM ZERO-POINT CALIBRATION?**, then **ALL** the installed optical filters ("A" to "E") will be zero-point calibrated, and the **concentration offset factor** for each filter will be stored in the filter bank no. which is **active** for that filter during the practical calibration task.
3. If you answer "YES" to **PERFORM HUM. INTERFERENCE CALIBRATION?**, then **ALL** the installed optical filters ("A" to "E") will be calibrated for humidity interference, and the **humidity gain factor** for each filter will be stored in the filter bank no. which is **active** for that filter during the practical calibration task..
4. If you answer "YES" to **PERFORM CROSS INTERFERENCE CALIBRATION?**, then, during the span calibration of each filter, when each known concentration of span gas is attached to the 1302's air inlet, the signal in the cell is measured using **ALL** of the installed optical filters. The factors which describe each **gas's interference measured on** the other installed filters, are stored in the **active** filter bank of the filter installed to measure this gas.
5. If you answer "YES" to **PERFORM GAS SPAN CALIBRATION?**, then, you can choose (1) which of the installed filters you wish to span calibrate; and (2) whether this calibration should be a single-point or a two-point span calibration. The **concentration conversion factor** calculated during span calibration (for a particular gas using a particular filter), is stored in the filter bank no. which is **active** during the calibration procedure.

16.4. SETTING-UP AND PERFORMING A ZERO-POINT CALIBRATION TASK

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. The set-up of this combined task is discussed in Section 16.9.

As mentioned in the previous section, the zero-point calibration task is not selective.

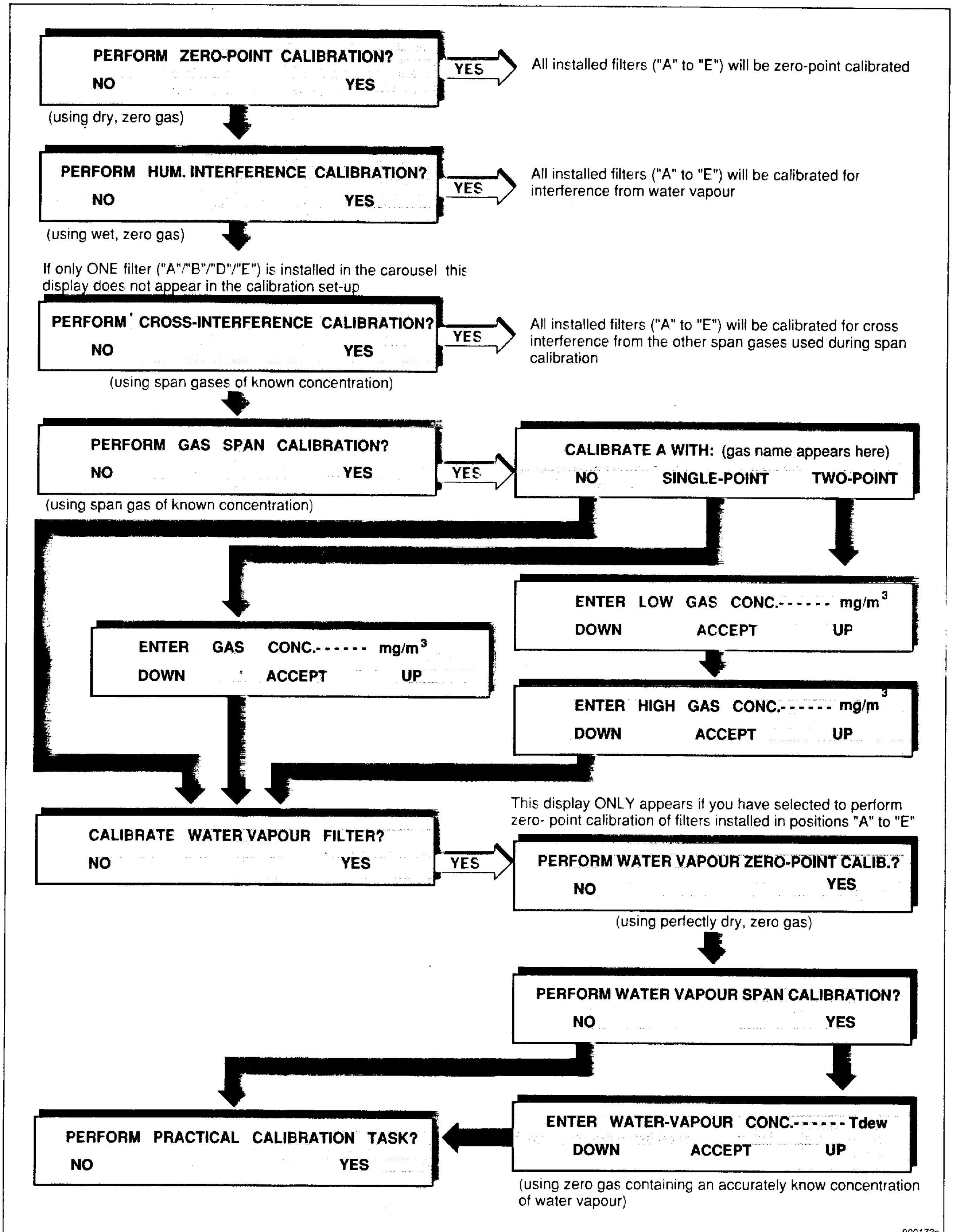


Fig. 16.4. Schematic diagram showing the calibration-task set-up "tree" (general)

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 answer "YES" to PERFORM ZERO-POINT CALIBRATION? then **all** the installed filters will be zero-point calibrated. If it is only the newly-installed optical filter which needs to be zero-point calibrated then, before setting-up a zero-point calibration task, make sure that the filter banks you make **active** for the filters which have already been calibrated only contain **concentration offset factors** which need to be up-dated. In this way you can prevent your original **concentration offset factors** being overwritten by the new ones. To illustrate this, imagine that filters "A", "B", "C" and "D" are installed in your 1302 and have been calibrated. Suppose the **calibration data block** of your 1302 contains the information shown in Fig. 16.5 (notice no filter is installed in position E). Suppose you now install an optical filter in position "E". This filter has to be fully calibrated. Before performing a zero-point and humidity-interference task one of the following filter banks must be made **active**:

- Filter bank no. 3, 4 or 5 for filter "A";
- Filter bank no. 2, 3 or 5 for filter "B";
- Filter bank no. 2, 3 or 4 for filter "C";
- Filter bank no. 2, 4 or 5 for filter "D".

Suppose you make filter bank no. 3 **active** for all the above filters and filter bank no. 1 **active** for filter "E". Then, after a zero-point calibration the **calibration data block** would contain the information shown in Fig. 16.6. None of the original calibration data has been overwritten by the newly-calculated calibration factors.

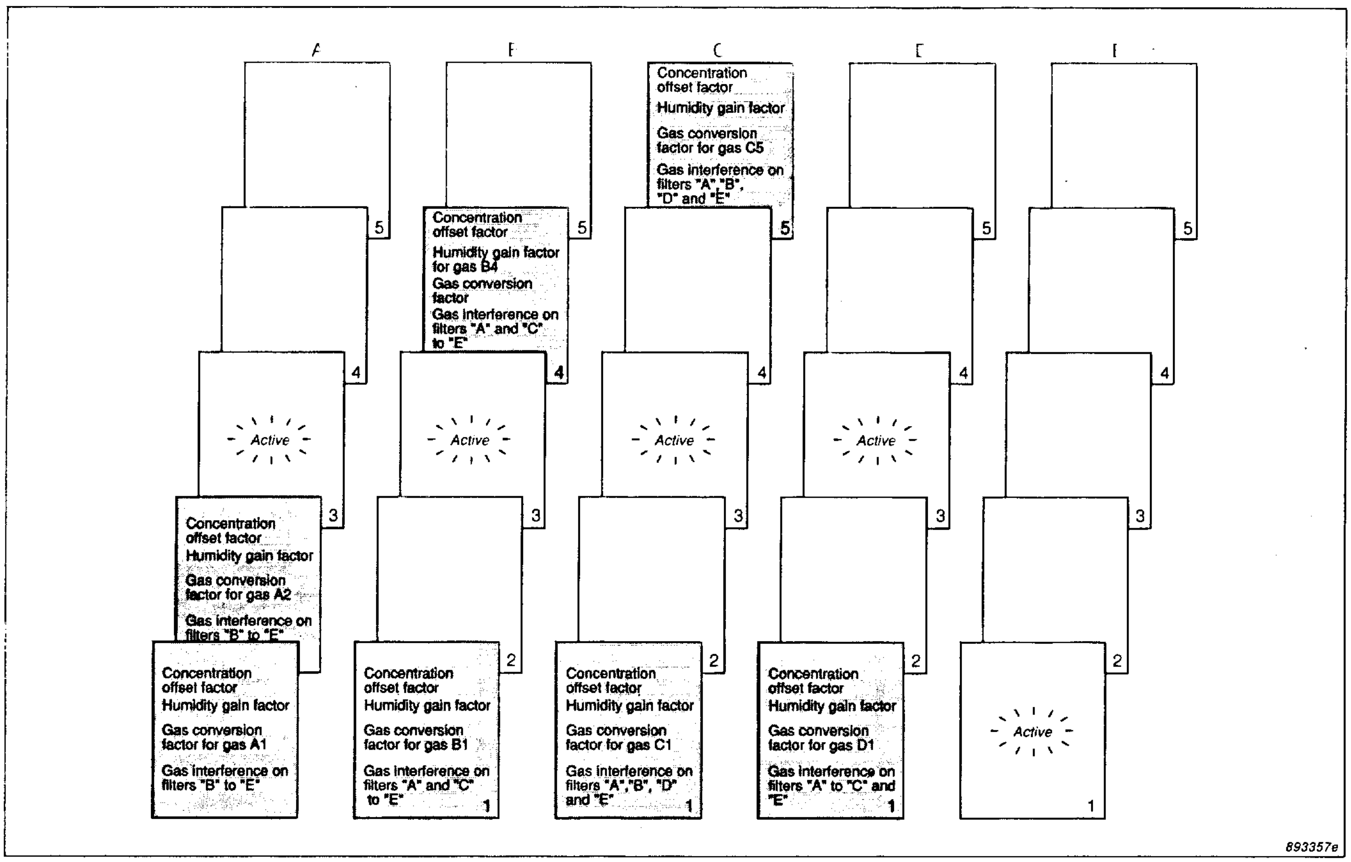


Fig. 16.5. Illustration of the calibration data stored in the filter banks of filters "A" to "D" before a zero-point calibration task

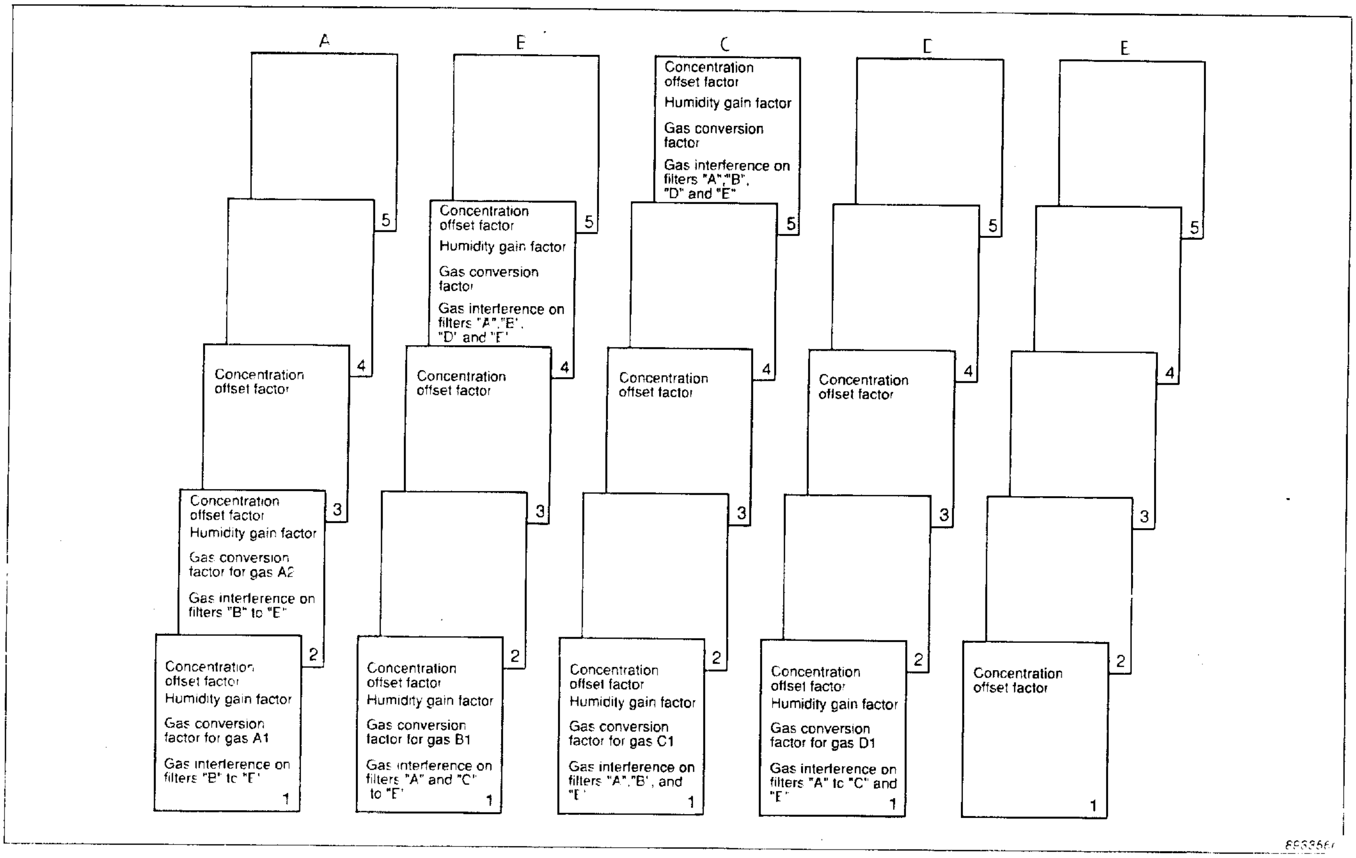


Fig. 16.6. Illustration of the calibration data stored in the filter banks of filters "A" to "E" after a zero-point calibration task

16.4.1. Setting-up a Zero-point Calibration Task

If you only wish to set-up a zero-point calibration task the procedure is as follows:

Step 1.
For each installed filter, enter the no. of the filter bank where you wish the 1302 to store the **concentration offset factors** which will be calculated during the zero-point calibration task.

Step 2.
Press **Measurement** **S3** **S3** **S1**. The following text will be displayed:

```
PERFORM ZERO-POINT CALIBRATION ?
NO                           YES
```

Step 3.
Follow the set-up of a zero-point calibration task by following the black arrows in the schematic diagram shown in Fig. 16.7.

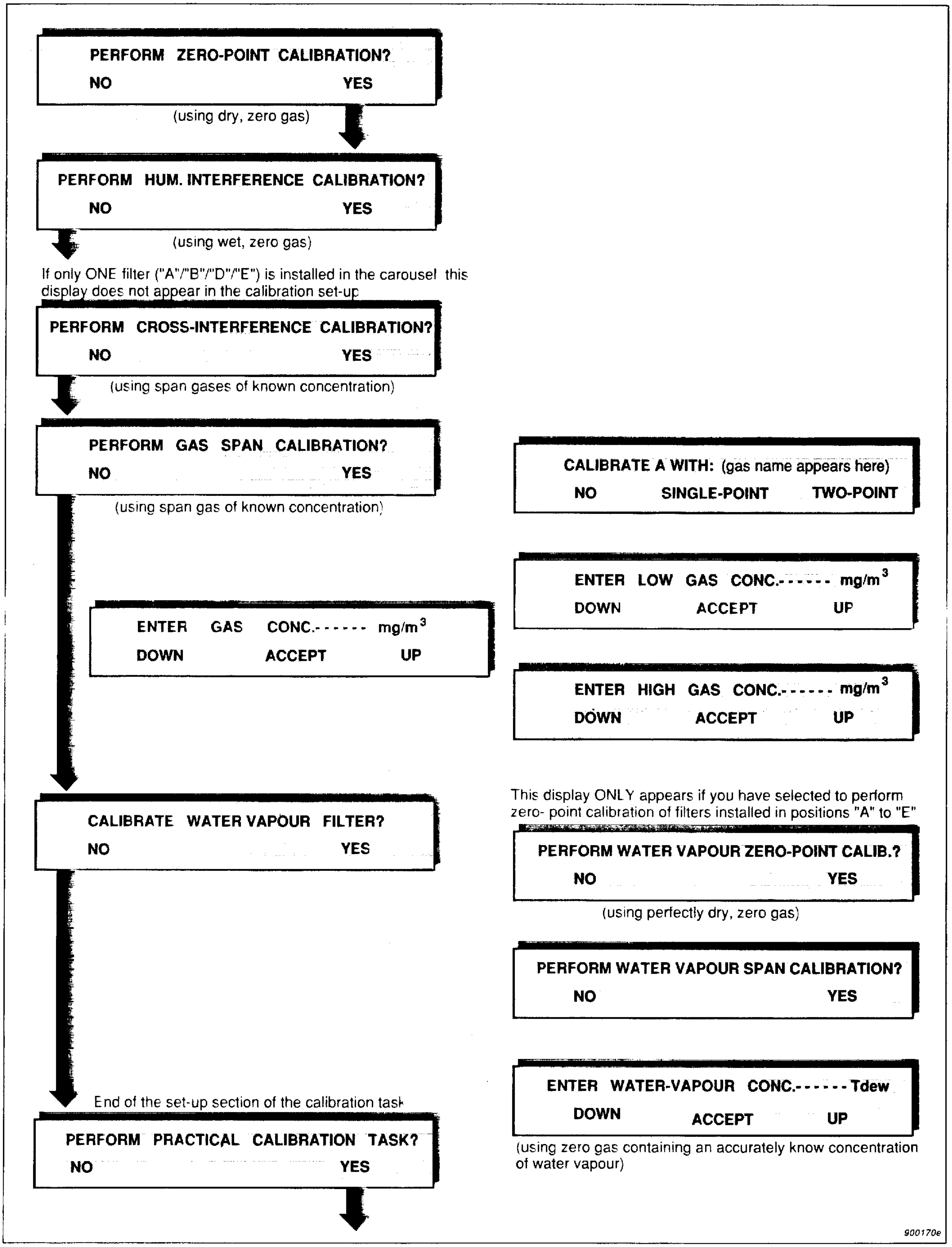


Fig. 16.7. Schematic diagram showing how to set-up a zero-point calibration task (follow the arrows)

The following text will appear on the display:

```
ZERO-POINT CALIB.: CONNECT CLEAN, DRY AIR
AND PRESS <ENTER> WHEN READY
```

16.4.2. Performing a Zero-point Calibration Task

The general equipment necessary to perform a calibration task is described in Section 2.5.

Step 1.
Follow the procedure explained in Section 2.5 from Step 1 to Step 4 inclusive and then continue as follows:

Step 5.
(a) Connect the free-end of the teflon tubing mentioned in Step 4 to the pressure valve on a cylinder of zero gas (e.g. pure nitrogen).

(b) Gently open the pressure-valve on the gas cylinder.

(c) Press the **Enter** button.

(d) Use the pressure-valve on the gas cylinder to regulate the flow of gas so that when the 1302's pump is running there is a positive flow of gas **out** of the flow meter. This will ensure that the zero gas is not contaminated by atmospheric air.

The following text appears on the screen:

```
RESULTS  NOT  YET  AVAILABLE
PLEASE WAIT
```

Once the first measurement result is available the screen text illustrated above is replaced by a screen displaying the measurement results — for example the following:

```
W:  µ 11.3µV    σ —— V   1   33.65°C
PRESS <ENTER> WHEN RESULTS ARE STABLE
```

As soon as measurement results are available they not only appear on the display (see Fig. 2.8) but are automatically printed out on the printer (see Fig. 16.8).

Each time a sample of gas is drawn into the analysis cell the signal is measured using **all** the installed optical filters and the water-vapour filter ("W") but, due to lack of space on the **display**, the 1302 first only displays the signal measured using the water-vapour filter and you cannot scroll through the measurements. The data-log print-out, however, shows the signal measured using **all** installed filters as well as the water-vapour filter.

```
---- Data Logger: Zero Calibration Started

 1 11:35:46  2.78E-06  1.09E-06  3.69E-06     . . .     . . .   11.3E-06 V Mean
      33.65     . . .     . . .     . . .     . . .     . . .      . . . V Dev.

 1 11:38:04  2.84E-06  1.08E-06  3.59E-06     . . .     . . .   9.70E-06 V Mean
      33.65  60.5E-09  4.16E-09  98.6E-09     . . .     . . .   1.65E-06 V Dev.

 1 11:39:44  2.88E-06  1.12E-06  3.53E-06     . . .     . . .   8.75E-06 V Mean
      33.95  73.9E-09  61.9E-09   116E-09     . . .     . . .   1.90E-06 V Dev.

 1 11:41:26  2.89E-06  1.11E-06  3.53E-06     . . .     . . .   8.19E-06 V Mean
      33.95  67.8E-09  60.0E-09   101E-09     . . .     . . .   1.91E-06 V Dev.

 1 11:43:07  2.88E-06  1.10E-06  3.51E-06     . . .     . . .   7.80E-06 V Mean
      34.15  66.1E-09  55.2E-09  93.1E-09     . . .     . . .   1.87E-06 V Dev.

 1 11:44:48  2.89E-06  1.09E-06  3.51E-06     . . .     . . .   7.48E-06 V Mean
      34.15  67.6E-09  55.3E-09  85.0E-09     . . .     . . .   1.86E-06 V Dev.

 1 11:46:29  2.89E-06  1.11E-06  3.48E-06     . . .     . . .   6.57E-06 V Mean
      34.25  70.5E-09  65.3E-09  32.9E-09     . . .     . . .    751E-09 V Dev.

 1 11:48:11  2.87E-06  1.07E-06  3.48E-06     . . .     . . .   6.18E-06 V Mean
      34.25  82.1E-09   130E-09  42.1E-09     . . .     . . .    399E-09 V Dev.

 1 11:49:53  2.80E-06  1.05E-06  3.49E-06     . . .     . . .   5.96E-06 V Mean
      34.25   126E-09   116E-09  33.7E-09     . . .     . . .    334E-09 V Dev.

 1 11:51:34  2.79E-06  1.06E-06  3.51E-06     . . .     . . .   5.80E-06 V Mean
      34.35   117E-09   117E-09  63.9E-09     . . .     . . .    249E-09 V Dev.

 1 11:53:15  2.78E-06  1.06E-06  3.52E-06     . . .     . . .   5.66E-06 V Mean
      34.35   116E-09   119E-09  61.4E-09     . . .     . . .    168E-09 V Dev.

 1 11:54:55  2.75E-06  1.05E-06  3.52E-06     . . .     . . .   5.54E-06 V Mean
      34.35  86.1E-09   127E-09  61.1E-09     . . .     . . .    239E-09 V Dev.

 1 11:56:36  2.72E-06  1.03E-06  3.53E-06     . . .     . . .   5.43E-06 V Mean
      34.35  99.2E-09   115E-09  58.8E-09     . . .     . . .    215E-09 V Dev.

 1 11:58:18  2.72E-06  1.08E-06  3.52E-06     . . .     . . .   5.34E-06 V Mean
      34.35  97.7E-09  59.5E-09  58.3E-09     . . .     . . .    165E-09 V Dev.

 1 11:59:59  2.76E-06  1.07E-06  3.52E-06     . . .     . . .   5.26E-06 V Mean
      34.35  77.5E-09  56.3E-09  64.5E-09     . . .     . . .    172E-09 V Dev.

---- Data Logger: Value for Filter W Accepted

 1 12:01:40  2.77E-06  1.09E-06  3.48E-06               . . .   5.15E-06 V Mean
      34.45  94.1E-09  74.6E-09  55.2E-09     . . .     . . .    179E-09 V Dev.

---- Data Logger: Value for Filter A Accepted
---- Data Logger: Value for Filter B Accepted
---- Data Logger: Value for Filter C Accepted
                                                                          900542
```

Fig. 16.8. Data log print-out of measurements performed during zero-point calibration of all the installed optical filters

A maximum of 6 measurements are stored in the 1302 during any calibration. The number (n) indicates how many measurements are stored. When 7 measurements have been performed the number (n) will show the number 6 because the very first measurement is overwritten by the 7th measurement so that ony 6 measurements are still stored. When 8 measurements have been completed the number (n) will also show 6 because the results of the first and second measurements have been overwritten by the 7th and 8th measurement results ... and so on.

Step 6.
Let the 1302 continue measuring the zero gas until the temperature in the cell is stable (that is, it is approximately 15°C above the ambient temperature in the room where calibration is being performed). Look at the print-out of the average and standard deviation measurements for (1) the water-vapour and (2) all the other filters. When all these values have stabilised calibration measurements do not need to continue. Continue to the next Step.

Step 7.
Press the **Enter** button.

This causes the following text to appear on the screen:

```
A:   μ 2.77μV   σ 94nV   6   33.45°C
PRESS <ENTER> WHEN RESULTS ARE STABLE
```

These results have been shown on the data-log print-out. If they have stabilised continue to the next Step.

Step 8.
Repeat Step 7 until the signals measured with all the filters have been displayed, stabilised and been "accepted" (by pressing the **Enter** button).

The text CALCULATING. PLEASE WAIT appears on the screen.

The 1302 only uses the last six measurement results when calculating any calibration factor. The **concentration offset factors** calculated during **zero-point calibration** of the filters, are related to the cell noise measured in the cell when each of the filters is being used.

If any calibration data is uncertain or unacceptable an error message (marked by an asterisk) will appear on the screen after the calibration factors have been calculated. Whenever an asterisk is shown on the screen further information about the condition of the 1302 can be obtained by pressing the **Status** button.

Appendix 1 lists all the error messages connected with uncertain calibration results and gives an explanation of their significance so that the user can ascertain what action to take if such messages are displayed after calibration.

16.5. SETTING-UP AND PERFORMING A HUMIDITY-INTERFERENCE CALIBRATION TASK

As mentioned in the Section 16.3, the humidity-interference calibration task is not selective. This means that you cannot choose humidity-interference calibration of a **single** filter in the carousel (for example, when a new optical filter has been installed). When you answer "YES" to PERFORM HUM. INTERFERENCE CALIBRATION? then **all** the installed filters will be humidity-interference calibrated. If it is only a newly-installed optical filter which needs to be humidity-interference calibrated, then make sure that you choose an **active** FILTER BANK NO. for each of the other filters which is different from the filter bank which was **active** during the last calibration of these filters (see Section 16.1 and Figs. 16.5 and 16.6). In this way you can protect your original **humidity gain factors**.

16.5.1. Setting-up a Humidity-interference Calibration Task

To calculate the **humidity gain factor** for a filter (during a humidity-interference calibration) it is necessary to have a **concentration offset factor** for the filter, and vice versa. If a **concentration offset 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. The set-up of this combined task is discussed in Section 16.9.

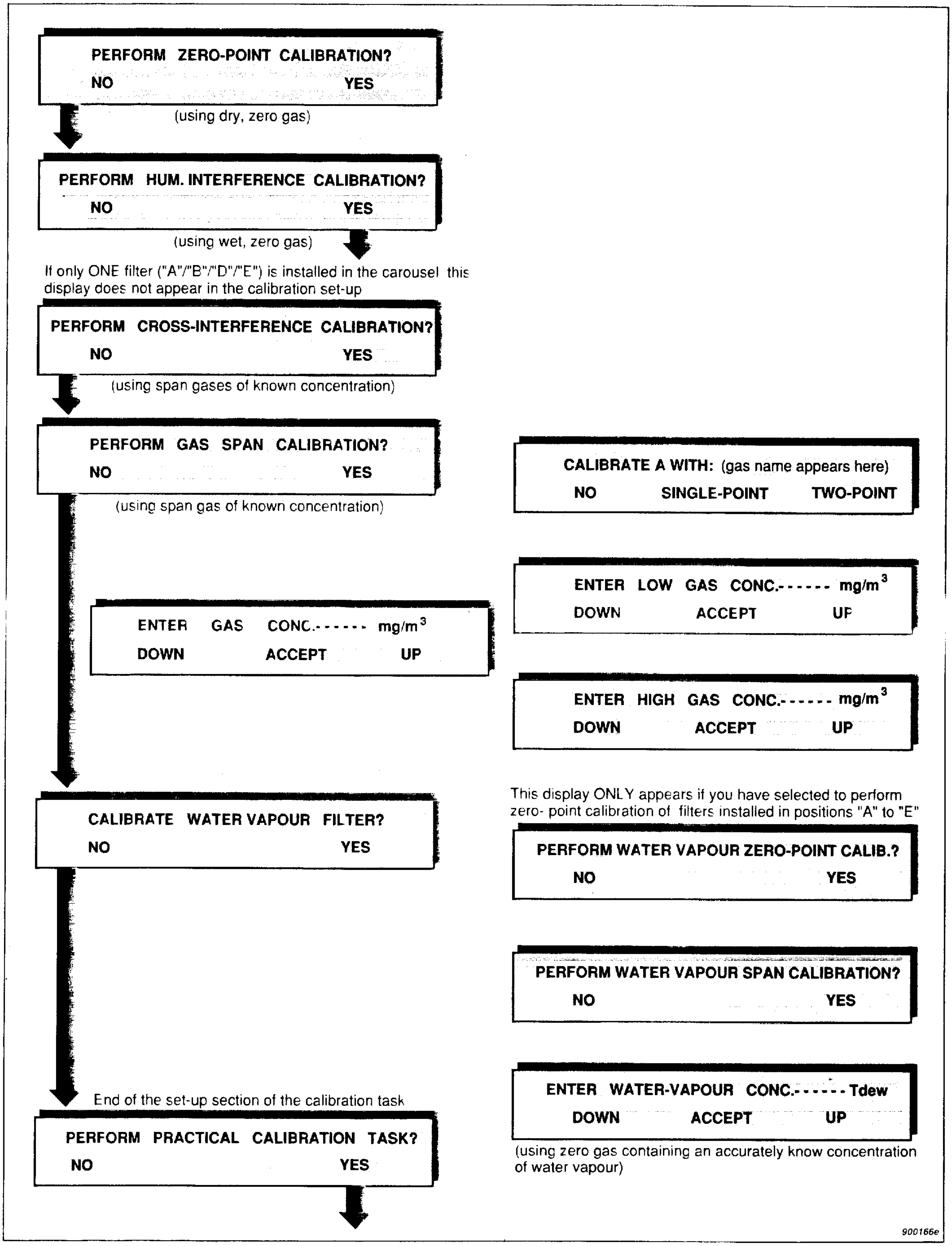


Fig. 16.9. Schematic diagram showing how to set-up a humidity-interference calibration task (follow the arrows)

If you only wish to set-up a humidity-interference calibration task the procedure is as follows:

Step 1.
For each installed filter, enter the no. of the filter bank where you wish the 1302 to store the **humidity gain factors** which will be calculated during the humidity-interference calibration task.

Step 2.
Press **Measurement** **S3** **S3** **S1** when the following text will be displayed:

PERFORM ZERO–POINT CALIBRATION ?
NO YES

Step 3.
Follow the set-up of a humidity-interference calibration task by following the black arrows in the schematic diagram shown in Fig. 16.9.

The following text will appear on the display:

HUM. INTERFERENCE. CONNECT CLEAN, WET AIR
AND PRESS <ENTER> WHEN READY

16.5.2. Performing a Humidity-interference Calibration Task

The general equipment necessary to perform a calibration task is described in Section 2.5 and illustrated in Fig. 2.5. The gas supply required during a humidity-interference calibration is a supply of clean air containing a constant concentration of water vapour.

Supply of Clean, Wet Air

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 1302 during humidity-interference calibration of the filters (see Fig. 16.10). 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 1302'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 1302 (see Fig. 16.10). 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:

1) The 1302 must have time to reach the ambient temperature of the room before a calibration task is performed. We suggest a means by which it can be warmed-up in Section 2.4.3.

2) 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.

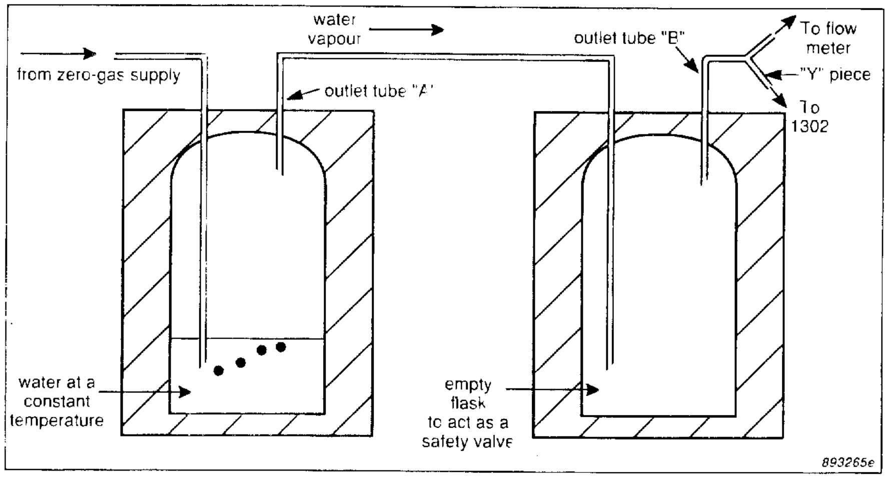


Fig. 16.10. Schematic diagram of the equipment necessary to produce a supply of clean, wet air

Step 1.
Follow the procedure explained in Section 2.5 from Step 1 to Step 4 inclusive and then continue as follows:

Step 5.
(a) Connect the outer end of the extra empty flask's outlet tube "B" to the teflon tubing which is connected to attachment point 3 of the "Y"-piece (see Fig. 16.10).

Caution: the inner end of the empty-flask's outlet tube "B" must NEVER be covered by water.

(b) Gently open the pressure-valve on the zero-gas cylinder.

(c) Press the **Enter** button.

(d) Use the pressure-valve on the zero-gas cylinder to regulate the flow of gas so that when the 1302's pump is running there is a positive flow of gas **out** of the flow meter. This will ensure that the wet, zero gas is not contaminated by atmospheric air.

The following text appears on the screen:

RESULTS NOT YET AVAILABLE
PLEASE WAIT

The 1302 draws in the clean, wet air and measures the signal in the cell with the water-vapour filter as well as with **all** the other installed filters. Once the first measurement result is available the screen text illustrated above is replaced by a screen displaying signal measured using the water-vapour filter — for example the following:

W: μ 209μV σ —— V 1 35.35°C
PRESS <ENTER> WHEN RESULTS ARE STABLE

As soon as measurement results are available they not only appear on the display but are automatically printed out on the printer (see Fig. 16.11).

```
---- Data Logger: Humidity Interference Calibration Started
 1 12:08:46  5.71E-06  7.52E-06  12.9E-06   . . .   . . .   209E-06 V Mean
     35.35     . . .     . . .     . . .    . . .   . . .     . . . V Dev.

 1 12:10:19  5.77E-06  7.64E-06  13.2E-06   . . .   . . .   219E-06 V Mean
     35.55   67.4E-09   126E-09   300E-09   . . .   . . .  10.1E-06 V Dev.

 1 12:11:59  5.68E-06  7.45E-06  13.4E-06   . . .   . . .   224E-06 V Mean
     35.85    142E-09   288E-09   344E-09   . . .   . . .  11.0E-06 V Dev.

 1 12:13:59  5.69E-06  7.27E-06  13.5E-06   . . .   . . .   228E-06 V Mean
     35.95    125E-09   402E-09   329E-09   . . .   . . .  10.9E-06 V Dev.

 1 12:15:19  5.69E-06  7.12E-06  13.5E-06   . . .   . . .   230E-06 V Mean
     36.15    112E-09   472E-09   307E-09   . . .   . . .  10.7E-06 V Dev.

 1 12:16:59  5.65E-06  6.91E-06  13.6E-06   . . .   . . .   231E-06 V Mean
     36.35    140E-09   631E-09   297E-09           . . .  10.4E-06 V Dev.

 1 12:18:41  5.58E-06  6.63E-06  13.7E-06           . . .   236E-06 V Mean
     36.55    194E-09   677E-09  84.6E-09   . . .   . . .  3.53E-06 V Dev.

 1 12:20:21  5.55E-06  6.28E-06  13.8E-06   . . .   . . .   238E-06 V Mean
     36.55    165E-09   517E-09  35.7E-09   . . .   . . .  1.84E-06 V Dev.

 1 12:22:01  5.54E-06  6.01E-06  13.8E-06   . . .   . . .   239E-06 V Mean
     36.95    171E-09   456E-09  35.5E-09   . . .   . . .  1.07E-06 V Dev.

 1 12:23:42  5.50E-06  5.76E-06  13.8E-06   . . .   . . .   240E-06 V Mean
     37.05    150E-09   405E-09   144E-09   . . .   . . .   623E-09 V Dev.

 1 12:25:24  5.42E-06  5.53E-06  13.9E-06   . . .   . . .   240E-06 V Mean
     37.15    142E-09   285E-09   164E-09   . . .   . . .   390E-09 V Dev.

 1 12:27:04  5.36E-06  5.43E-06  13.9E-06   . . .   . . .   240E-06 V Mean
     37.25    192E-09   260E-09   159E-09   . . .   . . .   442E-09 V Dev.
---- Data Logger: Value for Filter W Accepted

 1 12:28:44  5.34E-06  5.30E-06  13.9E-06   . . .   . . .   240E-06 V Mean
     37.35    212E-09   199E-09   171E-09   . . .   . . .   430E-09 V Dev.

---- Data Logger: Value for Filter A Accepted
---- Data Logger: Value for Filter B Accepted
---- Data Logger: Value for Filter C Accepted
```

900541

Fig. 16.11. Data log print-out of measurements performed during humidity-interference calibration of all the installed optical filters

Each time a sample of gas is drawn into the analysis cell the signal is measured using **all** the installed optical filters and the water-vapour filter ("W") but, due to lack of space on the **display**, the 1302 first only displays the signal measured using the water-vapour filter. The data-log print-out, however, shows the signal measured using **all** installed filters as well as the water-vapour filter.

A maximum of 6 measurements are stored in the 1302 during any calibration. The number (n) indicates how many measurements are stored. When 7 measurements have been performed the number (n) will show the number 6 because the very first measurement is overwritten by the 7th measurement so that ony 6 measurements are still stored. When 8 measurements have been completed the number (n) will also show 6 because the results of the first and second measurements have been overwritten by the 7th and 8th measurement results ... and so on.

Step 6.
Let the 1302 continue measuring the clean, wet air until the temperature in the cell is stable (that is, approximately 15°C above the ambient temperature in the room where calibration is being performed). Look at the print-out of the average and standard deviation measurements for (1) the water-vapour and (2) all the other filters. When all these values have stabilised calibration measurements do not need to continue. Continue to the next Step.

Step 7.
Press the **Enter** button.

This will cause the results of measurements made with all the other installed filters to be displayed, for example:

```
A:   μ 5.34μV   212nV   6   37.35°C
PRESS <ENTER> WHEN RESULTS ARE STABLE
```

These results have been printed out on the data-log printer. If they have stabilised continue to the next Step.

Step 8.
Repeat Step 7 until the signals measured with all the filters have been displayed, stabilised and been "accepted" (by pressing the **Enter** button).

The text **CALCULATING, PLEASE WAIT** appears on the screen.

The 1302 only uses the last six measurement results when calculating any calibration factor. The **humidity gain factors** calculated during **humidity-interference calibration** of the filters, are a measure of the sensitivity of each filter to water-vapour interference.

If any calibration data is uncertain or unacceptable an error message (marked by an asterisk) will appear on the screen after the calibration factors have been calculated. Whenever an asterisk is shown on the screen further information about the condition of the 1302 can be obtained by pressing the **Status** button.

Appendix 1 lists all the error messages connected with uncertain calibration results and gives an explanation of their significance so that the user can ascertain what action to take if such messages are displayed after calibration.

16.6. SETTING-UP AND PERFORMING A 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 16.1). 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 1302 during 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 16.7 includes information about how to set up a combined cross-interference and span calibration task.

16.7. SETTING-UP AND PERFORMING A SPAN CALIBRATION TASK

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 **active** 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 1302 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. 16.12).

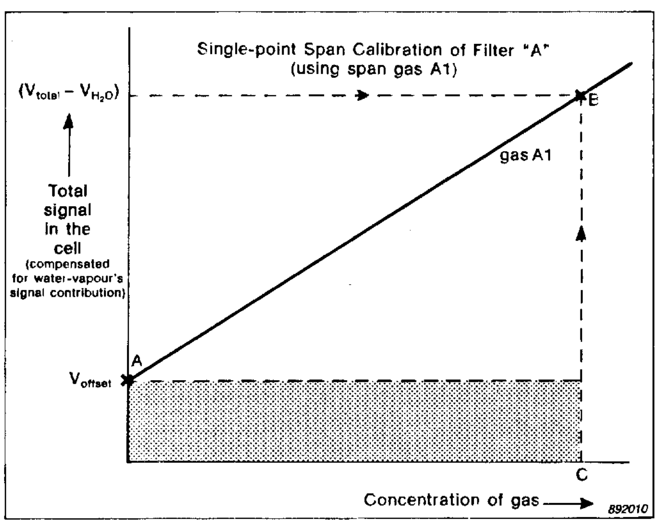


Fig. 16.12. Curve showing a linear span-calibration curve

Choosing an active 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 make the filter bank containing the **gas conversion factor** for gas A1 **active** 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 make a new filter bank **active** each time you span calibrate with a different gas. In this way the **conversion factor** for each gas is stored in separate filter banks (see Fig. 16.5).

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

16.7.1. Setting-up a Span Calibration Task

As mentioned in Section 16.3, the span calibration task is selective. This means that you can select which of the installed filters you wish to span calibrate. You also select the gas to be used during span calibration and whether you wish to perform a single-point or a two-point span calibration task.

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 to be calibrated. What concentration should be used? The concentration of span gas is discussed in Chapter 2, Section 2.4.4.

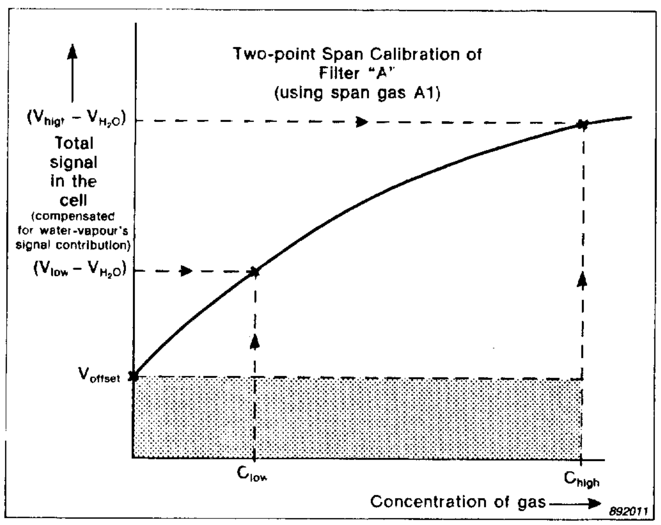


Fig. 16.13. Curve showing a non-linear span-calibration curve which can be plotted using the signals measured during a two-point span calibration task

Single-point or Two-point Span Calibration?

The question about whether to perform a single- or a two-point span calibration is difficult to answer as it dependent on the how linear the relationship is between a gas's concentration and the signal it produces in the cell (see Fig. 16.12). However, as a general rule we can say that if you wish to measure a gas over a dynamic concentration range which is greater than 10 000 times its detection limit, then it will be advisable to select a two-point span calibration. For example, if you wish to measure the gas sulphur hexafluoride (detection limit = 0,005 ppm with filter UA 0988) in concentrations which range from 0,005 ppm to 500 ppm — that is, over a dynamic range of 100 000 (0,005 × 100 000 = 500 ppm), then a two-point span calibration is recommended.

Gas Concentrations

During 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 with a high concentration (C_{high}) of span gas. This enables the 1302 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. 16.13).

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

(1) The **High Concentration** should be at least as high as the highest concentration you expect to measure (this concentration will be between 10 000 and 100 000 times the detection limit of the gas).

(2) The **Low Concentration** should be less than the lowest concentration you expect to measure but not lower that the detection limit of the gas.

If a single-point span calibration is performed then the span gas should have a concentration which is at least 25 times its detection limit and not more than the highest concentration you expect to measure.

Setting-up a Span Calibration Task

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 select 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.

Step 1.
For each filter being span calibrated, enter the no. of the filter bank where you wish the 1302 to store the **conversion factors** which will be calculated during the span calibration task.

Step 2.
Press **Measurement** **S8** **S3** **S1** when the following text will be displayed:

PERFORM ZERO-POINT CALIBRATION ?		
NO		YES

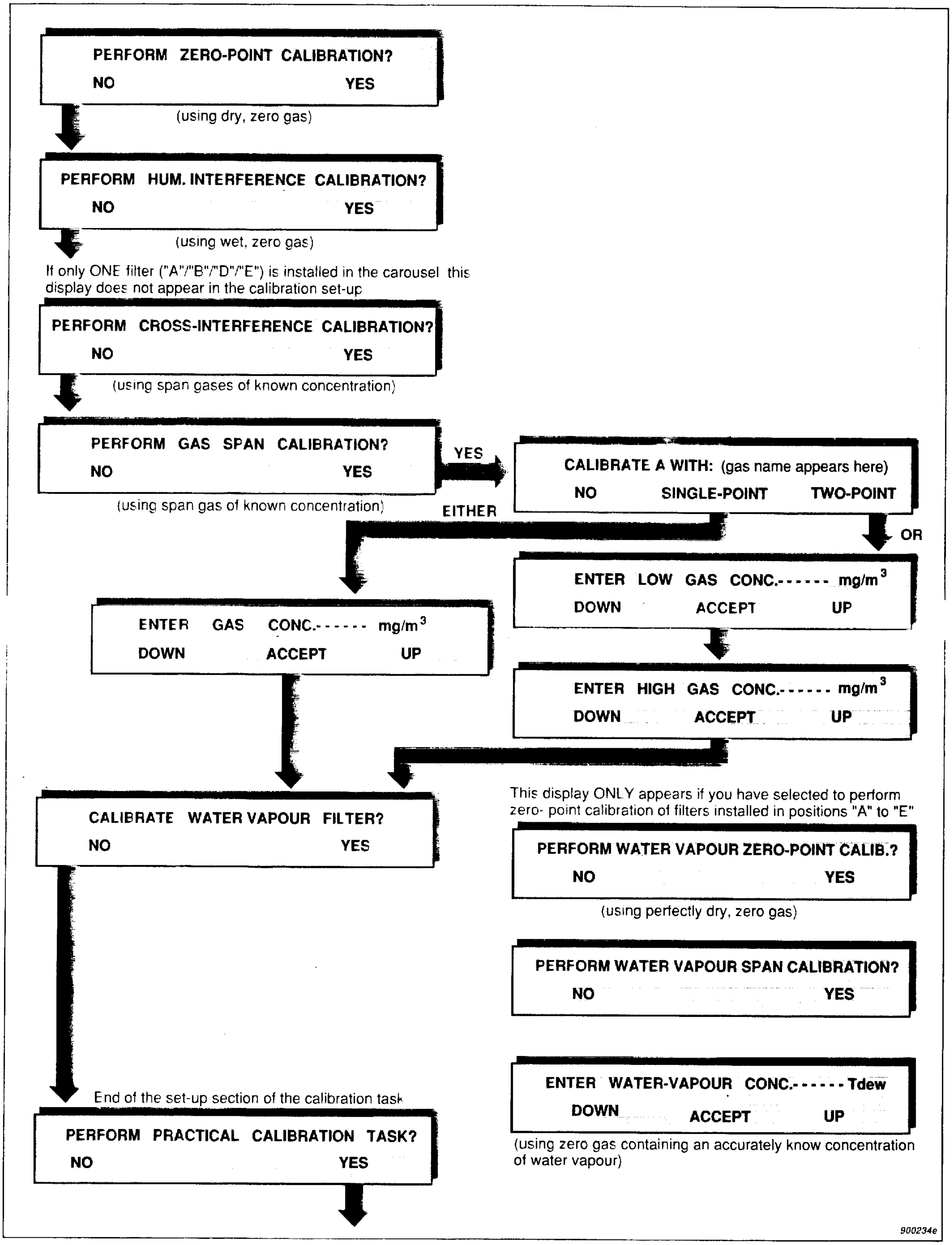


Fig. 16.14. Schematic diagram showing how to set-up a span calibration task (follow the arrows)

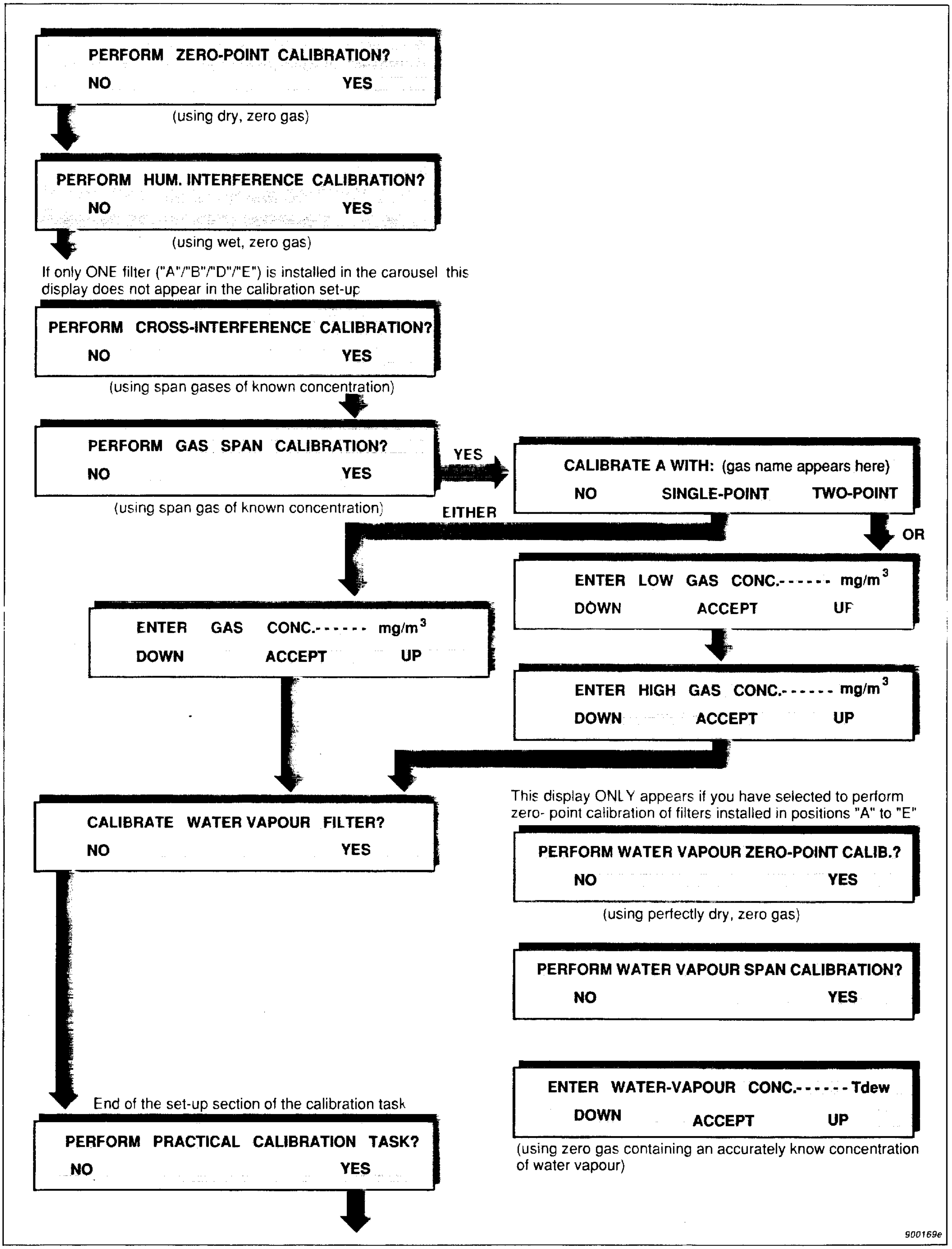


Fig. 16.15. Schematic diagram showing how to set-up a combined cross-interference and span calibration task (follow the arrows)

Step 3.

(a) If you only wish to span calibrate filters, follow the set-up of a span calibration task by following the black arrows in the schematic diagram shown in Fig. 16.14.

(b) If you wish to perform cross-interference calibration as well as span calibration, follow the set-up of the combined calibration task by following the black arrows in the schematic diagram shown in Fig. 16.15.

The following text will appear on the display:

CONNECT (the name of the gas appears here) XXXXXXmg/m^3
AND PRESS <ENTER> WHEN READY

16.7.2. Performing a Span Calibration Task

The span calibration task is described fully in Chapter 2, Section 5.

16.7.3. 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 1302. 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. 16.16.).

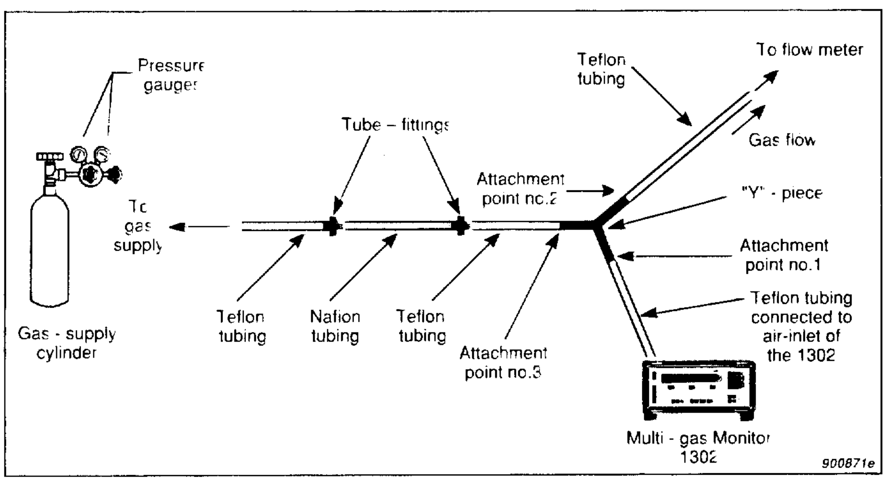


Fig. 16.16. Diagram showing how to use Nafion tubing when span calibrating a filter with one of the following gases: CO_2, CO or N_2O

16.8. CALIBRATION OF THE WATER-VAPOUR FILTER

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**.

It is **vitally** important to accurately zero-point calibrate the water-vapour filter as this influences the 1302's ability to compensate for interference from water vapour. This demands that the zero-gas you use during the zero-point calibration of the filter must be perfectly dry.

16.8.1. Setting-up a Zero-point Calibration of the Water-vapour Filter

If you wish to zero-point calibrate the water-vapour filter you **must** zero-point calibrate all the other installed optical filters. The **concentration offset factors** calculated during zero-point calibration of the filters "A" to "E" will be stored in the filter banks **active** during calibration. Check, therefore, that you make the relevant filter banks active for these filters before calibrating them. This is discussed in more detail in Section 16.4.

The procedure for setting-up a zero-point calibration of the water-vapour filter is as follows:

Step 1.
Press **Measurement** **S3** **S3** **S1** when the following text will be displayed:

PERFORM ZERO-POINT CALIBRATION ?	
NO	YES

Step 2.
Follow the set-up of a zero-point calibration of the water-vapour filter by following the black arrows in the schematic diagram shown in Fig. 16.17.

The following text will appear:

ZERO-POINT CALIB. CONNECT CLEAN, DRY AIR
AND PRESS <ENTER> WHEN READY

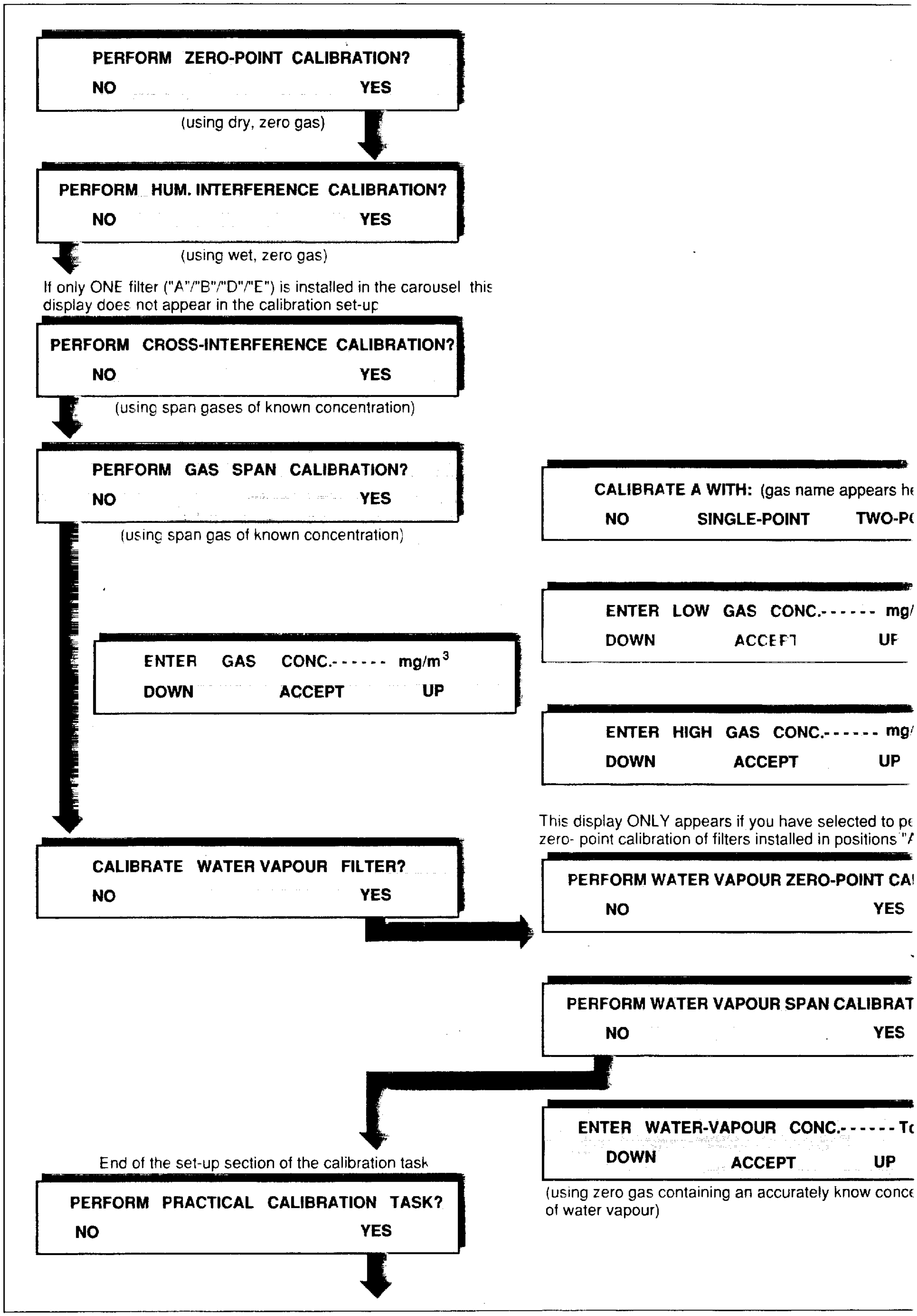


Fig. 16.17. Schematic diagram showing how to set-up a zero-point calibration task for the wat filter (follow the arrows)

16.8.2. Performing a Zero-point Calibration Task of the Water-vapour Filter

As explained in the previous section, a zero-point calibration of the water-vapour filter has to be done together with the zero-point calibration of the other installed optical filters. The latter task has been fully described in Section 16.4.2. It is worthwhile to emphasise again that it is **vitally important** to use perfectly dry zero-gas (that is, zero-gas which contains 0% water-vapour) during this calibration.

Note that during the zero-point calibration of filters "A" to "E" (task 1, shown below), and during the combined zero-point calibration of filters "A" to "E" **and** the water-vapour filter (task 2, shown below), a zero-gas supply is attached to the air-inlet of the 1302. The 1302 measures the signal in the cell using the water-vapour filter and all the other installed optical filters. Signals measured with filters "A" to "E" enable the **concentration offset factors** for filters "A" to "E" to be stored in the filter banks which are **active** during calibration. However, the signal measured with the water-vapour filter is used differently:

In Task 1:
The signal measured with the water-vapour filter is used to compensate all measured signals for any interference caused by the presence of any residual water-vapour in the zero-gas supply. This means that the zero-gas used during this gas does not necessarily have to be **perfectly dry**.

In Task 2:
The signal measured with the water-vapour filter is used to update the **concentration offset factor** for the water-vapour filter. This means that the signals measured with filters "A" to "E" cannot be compensated for the presence of any water vapour present. This is why it is **vitally important** to use **perfectly dry** zero-gas during this task.

Please refer to Section 16.4.2 for details about how to perform a zero-point calibration task.

16.8.3. Setting-up a Span Calibration of the Water-vapour Filter

Remember that span calibration of the water-vapour filter is only necessary if you wish to measure the absolute concentration of water vapour in air samples. If the water-vapour filter is not **span** calibrated you will not be able to measure the concentration of water vapour in gas samples during a monitoring task.

Before the water-vapour filter can be span calibrated, it has to be zero-point calibrated, that is, a **concentration offset factor** for the water-vapour filter must be stored in the 1302's calibration data block.

During span calibration of the water-vapour filter it is necessary to attach a supply of zero-gas containing a known concentration of water vapour to the 1302. As explained in the Humidity-interference Calibration (Section 16.5.2) it is important to use water-vapour whose concentration is below the saturated vapour pressure of water-vapour at the temperature of the room where calibration is to be performed, otherwise water-vapour will condense out in the analysis cell and damage it.

Before setting-up the span calibration of the water-vapour filter go into **Set-Up mode** and select "T_{dew}" as a humidity unit. Then when you have to enter the concentration of the water-vapour you will use during calibration you can enter it as a unit which is at least 2°C below the ambient temperature of the room where calibration is performed. This will prevent condensation in the cell. For example, if the ambient room temperature is 20°C then you can ENTER WATER-VAPOUR CONC as 18°T_{dew}.

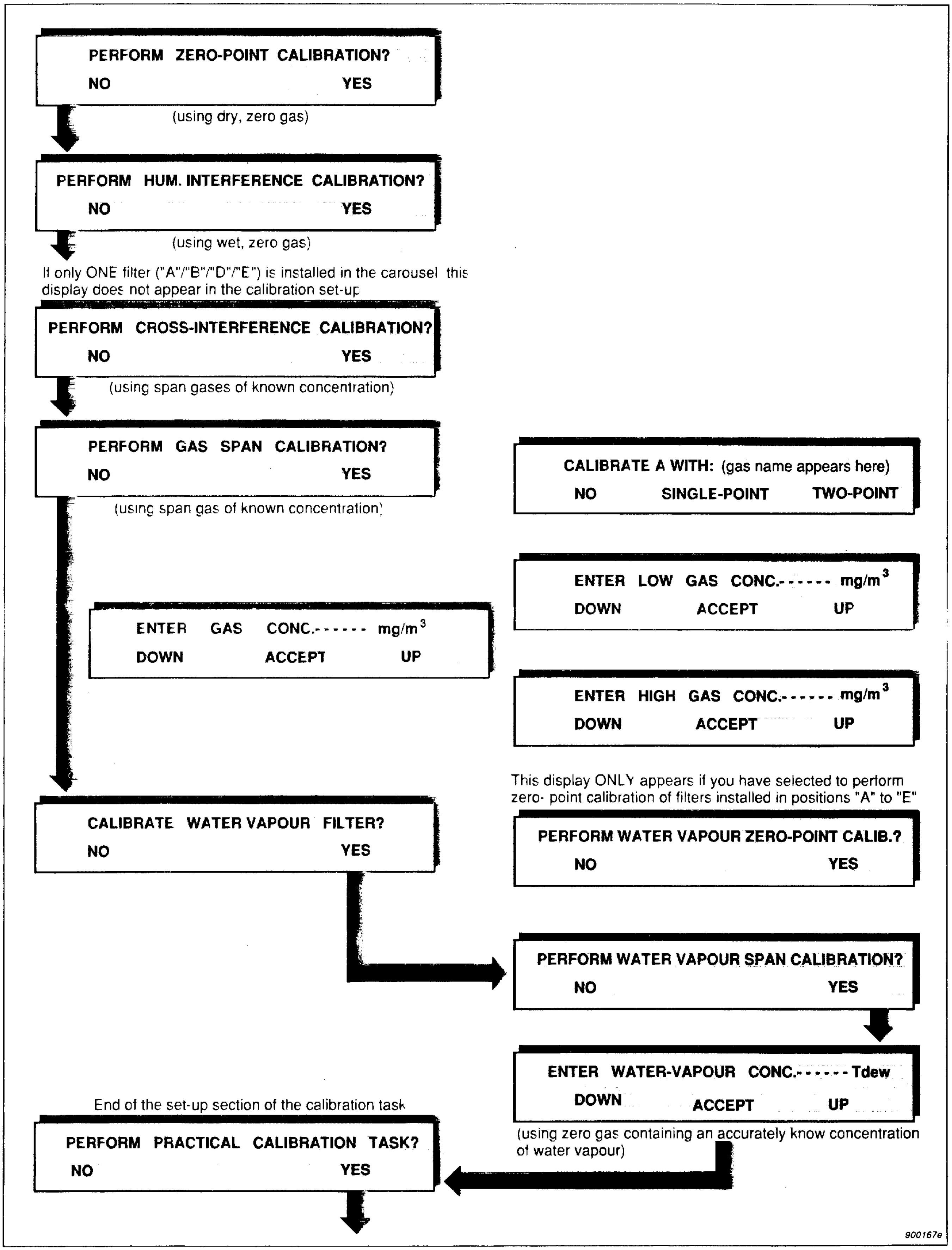


Fig. 16.18. Schematic diagram showing how to set-up a span calibration task for the water-vapour filter (follow the arrows)

The procedure for setting-up a span calibration of the water-vapour filter is as follows:

Step 1.
Press **Measurement** **S3** **S3** **S1** when the following text will be displayed:

```
PERFORM  ZERO-POINT  CALIBRATION ?
NO                          YES
```

Step 2.
Follow the set-up of a span calibration of the water-vapour filter by following the black arrows in the schematic diagram shown in Fig. 16.18.

The following text will appear:

```
CONNECT  WATER-VAPOUR  18.0 Tdew
AND  PRESS  <ENTER>  WHEN  READY
```

16.8.4. Performing a Span Calibration of the Water-vapour Filter

Section 16.5.2 describes a good method of producing water-vapour of known concentration. The directions for performing a span calibration of the water-vapour filter are similar to those for performing a humidity-interference calibration of the other installed filters is as described in Section 16.5.2. In both calibration tasks the signal in the cell is measured when a supply of zero gas containing a constant concentration of water vapour is attached to the 1302. There are, however, two differences:

1. During a humidity-interference calibration the signal is measured using each of the installed filters (including the water-vapour filter), whereas during the span calibration of the water-vapour filter the signal is only measured with the water-vapour filter.

2. During a humidity-interference calibration, it is **not** necessary to know the concentration of water-vapour supplied to the cell as it is only necessary to measure the size of each signal (with filters "A"–"E") relative to the size of the signal measured with the water-vapour filter. However, during a span calibration of the water-vapour filter it **is** necessary to know the **exact** concentration of water-vapour supplied to the cell, because during this calibration the **conversion factor** is calculated. This factor relates the measured signal to the concentration of water-vapour in the cell.

Follow the procedure described in Section 16.5.2.

16.9. SETTING-UP A COMBINED ZERO-POINT AND HUMIDITY-INTERFERENCE TASK

We have explained in previous sections of this chapter (Sections 16.4 and 16.5.1) a zero-point calibration can only be performed alone if a **humidity gain factor** is already stored in each of the filter banks which are **active** during the zero-point calibration task. Likewise, a humidity-interference calibration can only be performed alone if a **concentration offset factor** is already stored in each of the filter banks which is **active** during the humidity-interference calibration task.

If the necessary calibration factors are not stored in the 1302's memory, a zero-point calibration task has to be performed together with a humidity-interference calibration task.

The procedure for setting-up a **combined** zero-point **and** humidity-interference calibration task is as follows:

Step 1.
Press **Measurement** **S3** **S3** **S1** when the following text will be displayed:

```
PERFORM  ZERO-POINT  CALIBRATION ?
NO  ----------------------------  YES
```

Step 2.
Follow the set-up of a combined zero-point and humidity-interference calibration by following the black arrows in the schematic diagram shown in Fig. 16.19.

The following text will appear:

```
ZERO-POINT CALIB. CONNECT CLEAN, DRY AIR
AND PRESS <ENTER> WHEN READY
```

Step 3.
Refer to Section 16.4.2 for the practical details of a zero-point calibration task.

When the zero-point calibration task is complete, the following text appears on the screen:

```
HUM. INTERFERENCE.  CONNECT CLEAN, WET AIR
AND PRESS <ENTER> WHEN READY
```

Step 4.
Refer to Section 16.5.2 for the practical details of a humidity-interference calibration task.

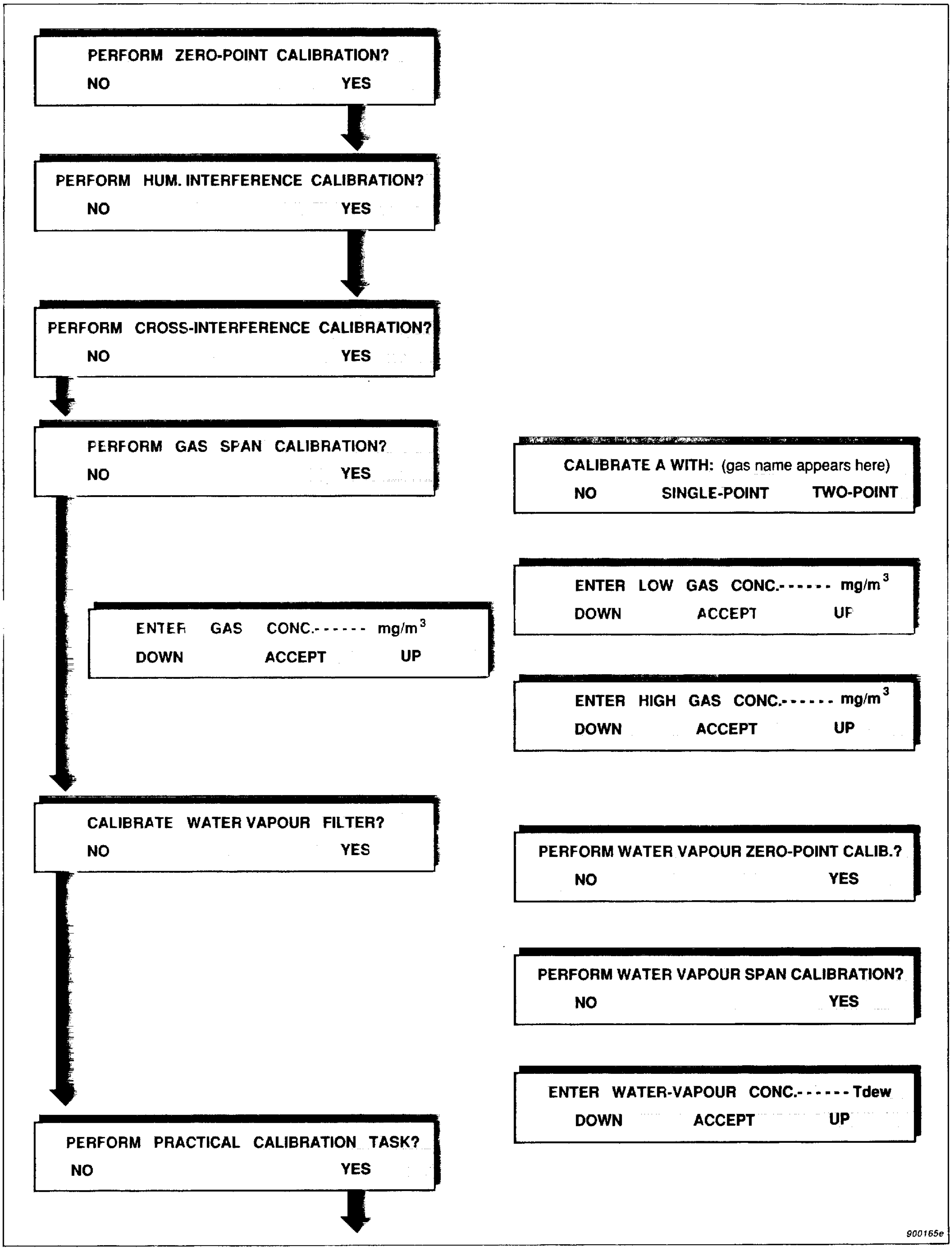


Fig. 16.19. Schematic diagram showing how to set-up a combined zero-point and humidity-interference calibration task (follow the arrows)

16.10. SETTING-UP ANY COMBINED CALIBRATION TASK

Although we have separated the various calibration tasks and described how to set them up and perform them alone, it is, of course possible to set-up any combination of calibration tasks, for example, that combining the zero-point and humidity-interference calibration tasks described in Section 16.9.

After setting-up any combined calibration task, the 1302 responds by telling you about which gas supply is required for each calibration task.

When the combined calibation task is complete, the text CALCULATING, PLEASE WAIT appears on the screen.

If any calibration data is uncertain or unacceptable an error message (marked by an asterisk) will appear on the screen after the calibration factors have been calculated. Whenever an asterisk is shown on the screen further information about the condition of the 1302 can be obtained by pressing the **Status** button.

Appendix 1 lists all the error messages connected with uncertain calibration results and gives an explanation of their significance so that the user can ascertain what action to take if such messages are displayed after calibration.

17. INSTALLATION OF THE OPTICAL FILTERS IN THE 1302

17.1. INTRODUCTION

Each of the optical filters available for use with the 1302 have a "UA" number printed on them. The "UA" numbers run from UA 0968 - UA 0988 and UA 0936. The 1302 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. 17.1). Before leaving the factory a special "water" filter (1) 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 (2) are mounted in the those positions of the carousel where no optical filter has been installed.

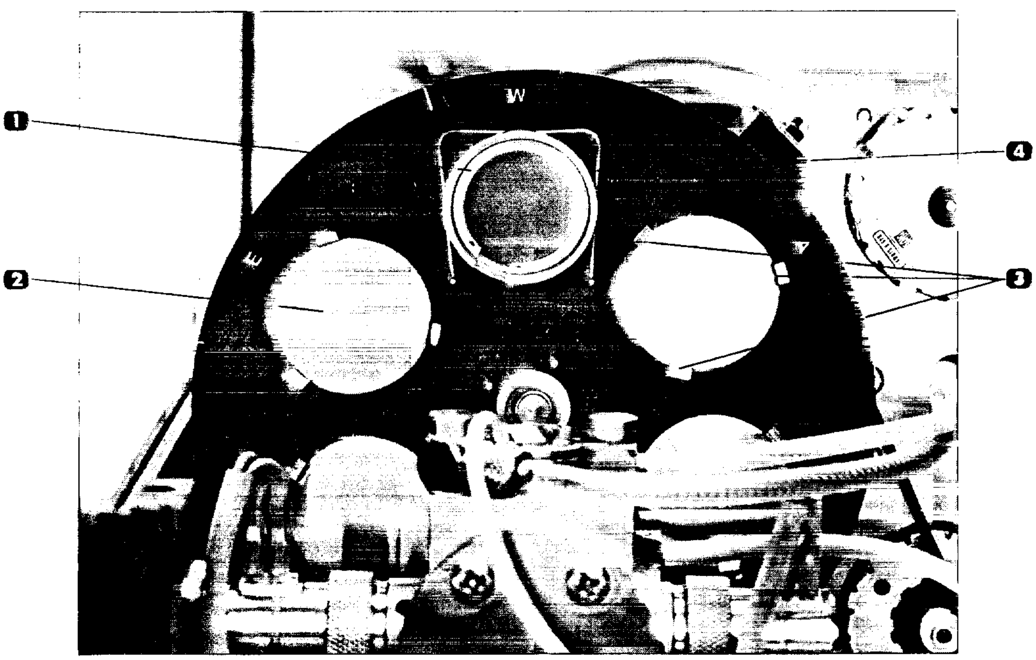


Fig. 17.1. The filter carousel in the 1302

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 (3) (see Fig. 17.1). 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 (4).

17.1.1. Installation of an Optical Filter

Materials and Equipment Required: (Accessories supplied with the 1302 are numbered)

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

Step 1.
Unplug the 1302 from the mains power supply and pull out the plug in the **AC Mains** socket of the 1302.

Step 2.
Turn the 1302 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 1302 together. If the screws are not completely undone you will not be able to remove the upper cover as explained in Step 6.*

Step 3.
Turn the 1302 so that it is resting on its "feet". Undo the catch holding the lid over the front-panel of the 1302 and remove the lid by pushing it gently upwards to release it from its hinges.

Step 4.
Undo the uppermost four screws holding the frame over the back-panel of the 1302 using Pozidrive screwdriver No. 0.

Step 5.
Using the Pozidrive screwdriver No. 0 undo the upper four screws which hold the frame over the front-panel of the 1302.

Step 6.
Gently lift off the upper cover of the 1302 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.*

Step 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.

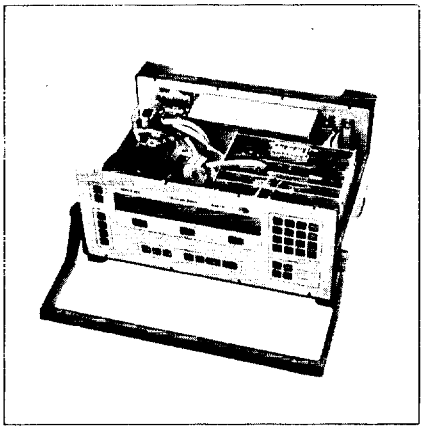


Fig. 17.2. The 1302 showing the position of the carrying handle

Step 8.
Still holding the front panel in position with your hand, lower the carrying handle of the 1302 so that it rests on the work-bench surface in front of the 1302 (see Fig. 17.2).

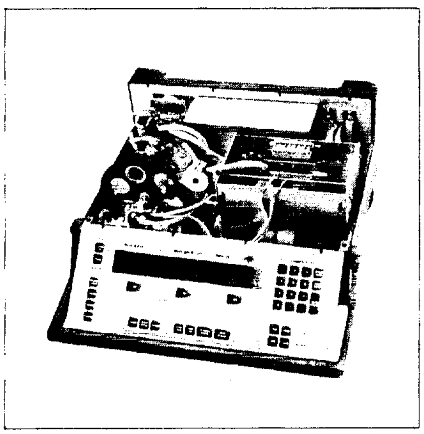


Fig. 17.3. The 1302 showing the correct resting-position of the front panel

Step 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 1302, and rest its upper edge against the front of the 1302 (see Fig. 17.3).

Note: Take care that the cable connecting the front panel to the rest of the 1302 is not pulled out of its plug.

Step 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.

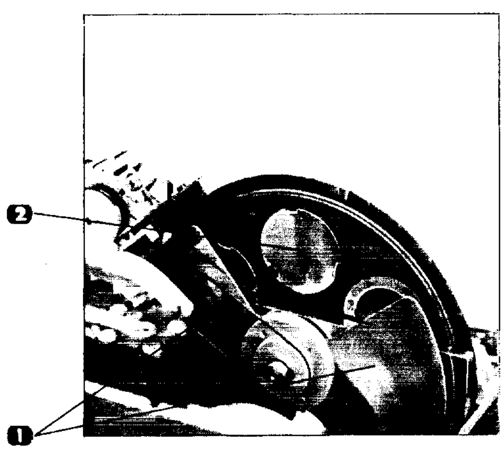


Fig. 17.4. Correct position of the chopper wheel

Step 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. 17.4).

Step 12.
Working from the front-end of the 1302, 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 1302.

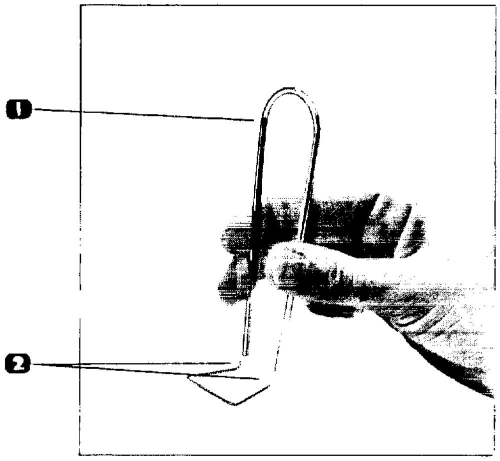


Fig. 17.5. Attaching the special tool to the "locking" spring

Step 13.
Push the "legs" of the special tool **1** together slightly before inserting the ends **2** of a "locking" spring into the holes at the end of the "legs" of the special tool (see Fig. 17.5).

Fig. 17.6. The optical filter

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.*

Step 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. 17.6). Turn it so that the surface with the UA number faces towards the back-panel of the 1302. 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 1302). Hold it in this position until Step 15 is completed.

Step 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. 17.7).

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. 17.8).

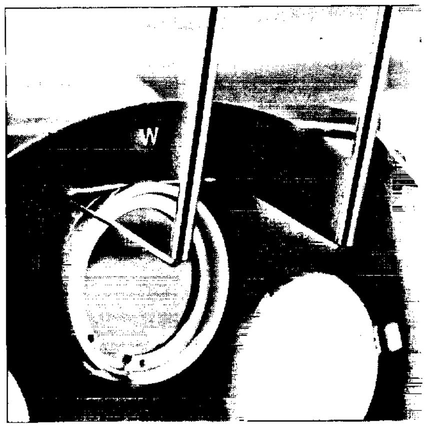


Fig. 17.7. Fitting the "locking" spring

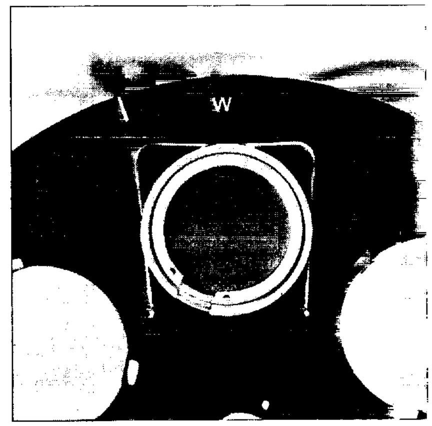


Fig. 17.8. Position of the "locking" spring

Step 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).

Step 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).

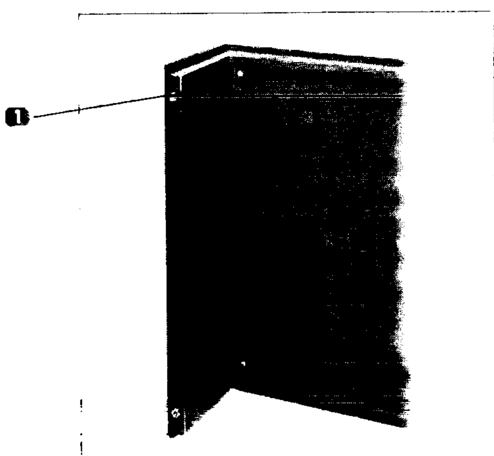


Fig. 17.9. The inside of the top cover

Step 18.
Fig. 17.9 shows the inside of the top cover of the 1302. Note that the front side of the cover has square flanges 1. Place the top cover back in its correct position on top of the 1302. Lightly screw-in (do not tighten) the four screws on the frame holding the back panel in position (that is, those screws which were loosened in Step 4).

Step 19.
Lift the front panel of the 1302 and place it gently into its position in the 1302. Reposition the front frame over the front panel and screw it in place by tightening the eight screws which were undone in Steps 5 and 7.

Step 20.
Tighten the four screws on the frame holding the back panel in position.

Step 21.
Turn the 1302 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 1302, and tighten them properly. Push the four rubber "shoes" into position on the 1302's "feet".

Step 22.
Enter the correct UA number of the optical filter installed in each position ("A" to "E") of the filter carousel — Section 7.2.1 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.

18. APPENDIX 1 - MESSAGES RELATED TO CALIBRATION TASKS

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.

18.1. "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 **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")

18.2. "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 the **Status** button.

The messages displayed when the **Status** button is used are discussed in Section 18.4.

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 ★

18.3. "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 *

18.4. ERROR MESSAGES DISPLAYED WHEN THE STATUS 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 the **Status** button. The messages displayed when the **Status** button is pressed are listed and explained below.

18.4.1. "Invalid" Error Messages

MISSING MEASUREMENT DATA

This message indicates that the 1302 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:

1. That the gas used during the zero-point calibration of the filter was not dry; or
2. 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 16.7.1).

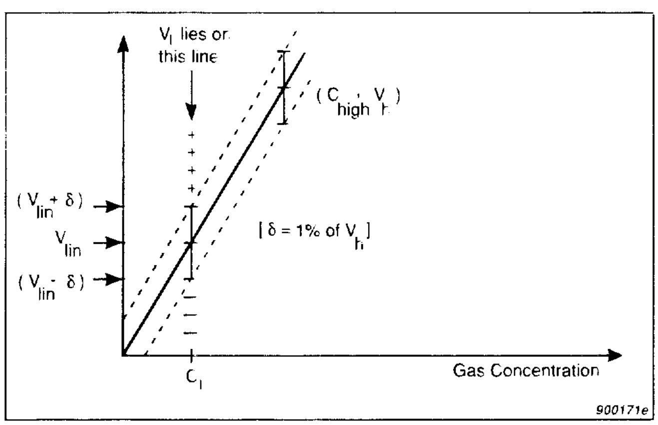


Fig. 18.1. Curve illustrating the two points measured during a two-point span calibration task

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 1302 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. 18.1).

When the two signals have been measured, the 1302 then finds the value δ = 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_1 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 1302 will try to fit the two measured points onto a curve, whose shape has been pre-determined by B & K, 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 1302 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.

18.4.2. "Successful * " Error Messages

WATER VAP. MEAS < OFFSET MEAS

This measurement 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 1302 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 10μV. 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 20μV. 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 3μV 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 1,5nV. 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 2.3.1) 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 15μV. 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 3μV. This means that the "low" concentration of span gas is too low.

19. APPENDIX 2 - WARNING MESSAGES AND OPERATING-ERROR MESSAGES

When the 1302 is switched on, and while it is being operated, the 1302 regularly performs a series of self-tests which check that the various mechanical, electrical and electronic components of the 1302 are functioning correctly. These self-tests are described in more detail in Chapter 8. You can select to disable the **hardware tests** normally performed by the 1302 when it is switched on (see Section 8.1.4), but you cannot disable the tests which occur at regular intervals during operation. If any component is found to be functioning outside of its specifications either a "Warning" or a "Operating-error" message will appear on the 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 faultly the message will be displayed again. It is therefore important to note the message before pressing the **Status** 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 the **Status** button 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 (see Section 9.2.2).

All possible "Warning" messages are listed in Table 19.1, 19.2 and 19.3; all possible "Operating-errors" messages are listed in Table 19.4; and all possible "Interface-error" messages are listed in Table 19.5. These tables also contain 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 1302 off and let its internal temperature fall to the ambient temperature, the error will not be detected when the 1302 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 1302's air inlet has been incorrectly "entered" in the 1302's **active** set-up. (2) Either the external or the 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 1302's air inlet has been incorrectly "entered" in the 1302's **active** set-up. (2) Either the external or the internal pneumatic system is blocked
ALARM LIMIT EXCEEDED	The 1302 has measured a concentration of gas greater than the alarm-limit concentration "entered" into the **active** set-up of the 1302 by the user	
BACK-UP BATTERY TOO LOW	The potential difference measured across the terminals of the battery providing a back-up power supply to the 1302, to run its internal clock and to protect its *Working Memory* is too low	(1) The back-up battery is either defective or flat (no longer providing sufficient power). (2) The 1302'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 the "Safety Considerations" at the beginning of this manual.
INTERNAL PROGRAM ERROR FOUND	There is a fault in the software	

T02342GB0

Table 19.1. Warning messages (part 1)

WARNING MESSAGES (continued)		
Displayed Text	**Description of Fault**	**Possible Cause(s)**
NO INDEX MARK FROM FILTER CAROUSEL	The 1302 cannot determine the position of its filter carousel	(1) The motor which drives the filter carousel is not working. (2) The belt which drives the carousel motor is defective. (3) The optical detector which checks the movement of the carousel is not working
POWER SUPPLY VOLTAGE OUT OF RANGE	The DC voltage supplied internally to the 1302 is either too high or too low (it lies outside the specified operating range)	(1) The 1302 power supply (converts AC to DC) is defective. (2) The AC mains supply is operating outside its specified range
CLOCK SET TO DEFAULT ERROR DETECTED IN CLOCK SETTINGS	The 1302's internal clock (date and time) was found to be incorrectly set so these values have been set to their default values (factory settings)	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 1302's memory so these factors have been set to their default values (factory settings)	(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 found in the data stored in the 1302's *Background Memory*, so the 1302 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 found in the data stored in the 1302's *Display Memory* so the 1302 automatically deletes all data stored in this memory	(1) A defective *Working Memory* (RAM). (2) A defective back-up battery. (3) A software fault
MEMORY SET TO DEFAULT ERROR DETECTED IN INTERNAL MEMORY	An error has been found in the data stored in the 1302's internal memory (Data stored in this memory cannot be read or altered by the user) so the 1302 automatically corrects any errors found in this memory	(1) A defective *Working Memory* (RAM). (2) A defective back-up battery. (3) A software fault

T02560GB0

Table 19.2. Warning messages (part 2)

WARNING MESSAGES (continued)		
Displayed Text	**Description of Fault**	**Possible Cause(s)**
MEMORY SET TO DEFAULT ERROR DETECTED IN SOURCE MEMORY	An error has been found in the data stored in the 1302's *Source Memory* so the 1302 automatically gives the stored parameters default values	(1) A defective *Source Memory* (EEPROM). (2) A defective back-up battery. (3) A software fault
PARAMETERS SET TO DEFAULT ERROR DETECTED IN CONFIG./FORMAT PARAM.	An error has been found in the value of the parameters stored in the **CONFIGURATION** and/or **FORMAT** branches of the 1302's set-up "tree" and therefore the 1302 has automatically given these parameters default values	(1) A defective *Working Memory* (RAM). (2) A defective back-up battery. (3) A software fault
PARAMETERS SET TO DEFAULT ERROR DETECTED IN TASK SET-UP PARAM.	An error has been found in the value of the parameters stored in the **Monitoring Task** branch of the 1302's set-up "tree" and therefore the 1302 has automatically given these parameters default values	(1) A defective *Working Memory* (RAM). (2) A defective back-up battery. (3) A software fault

T02356GB

Table 19.3. Warning messages (part 3)

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 signal 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 1302 is operating outside its temperature specifications, accurate measurements cannot 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 low or too high. 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
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 1302 is likely to interpret the signal as being due to the presence of gas and therefore gas concentrations measured by the 1302 will be higher than they are in reality.	(1) A microphone(s) is defective. (2) The analogue card is defective. (3) The 1302 is being exposed to external vibrations (around 20 Hz).

T02341GB0

Table 19.4. General Operating Error messages

WARNINGS CONNECTED WITH PRINTING, DATA-LOGGING, ERROR-LOGGING AND PLOTTING		
Displayed Text	**Description of Fault**	**Possible Cause(s)**
IEEE CONTROL TIMEOUT	The 1302 wishes to send data to a printer or plotter via the IEEE interface but the 1302 is not system controller	There are no other "controllers" on the IEEE bus so the 1302 should be made the system controller (see Section 7.5.2)
WARNING: CTS HANDSHAKE CONFLICT	The 1302 receives the handshake signal on the RS 232 CTS (clear to send) line but it has not been set-up to use this CTS line	The 1302 and the RS 232 device (printer/plotter) do not agree about which handshake signal they should use (see Section 7.5.1). Perhaps the wrong interface cable has been used
WARNING: DSR HANDSHAKE CONFLICT	The 1302 receives the handshake signal on the RS 232 DSR (Data send ready) line but it has not been set-up to use this DSR line	The 1302 and the RS 232 device (printer/plotter) do not agree about which handshake signal they should use (see Section 7.5.1). For example, if the device uses the 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 1302 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 1302 receives the handshake signal on the RS 232 interface but it has not been set-up to use this signal
WARNING: TIME OUT, DEVICE NOT CONNECTED	1302 wishes to send data (print, error-log, data log or plot) via the IEEE interface, but there is no response from a device with the address entered in the 1302 set-up	Either (1) no device is connected to the 1302; or (2) the device's address has been incorrectly entered in the 1302's set-up
WARNING: TIME OUT, DEVICE NOT READY	1302 wishes to send data (print, error-log, data-log or plot) but after the start of data transmission, the device stops receiving data	(1) the device is "off-line" (it cannot receive data); (2) the device is not able to receive data fast enough (see Section 7.5.1); (3) the device is no longer connected to the 1302

T02476GB0

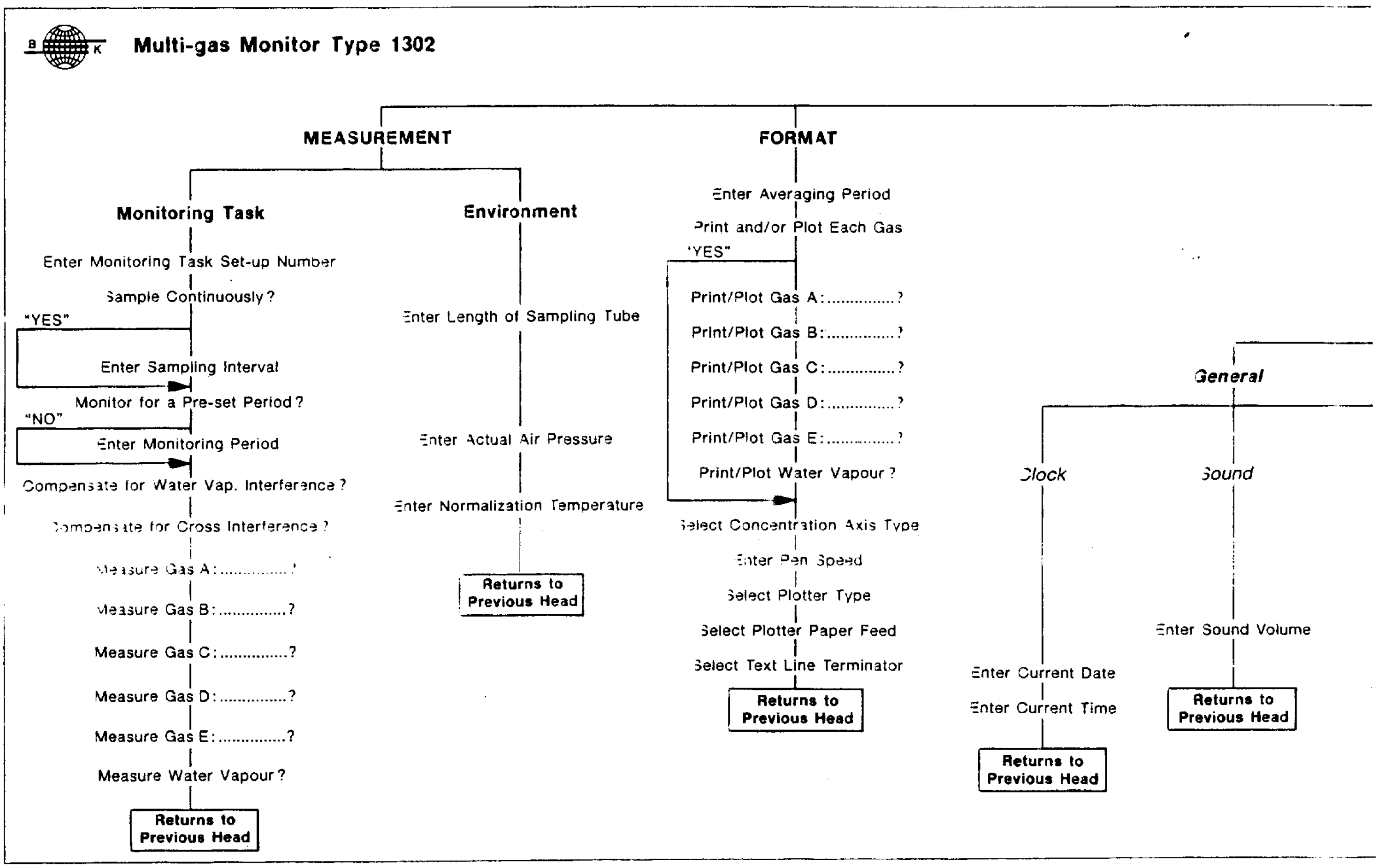
Table 19.5. Warnings connected with printing, data-logging, error-logging and plotting

20. SERVICE AND REPAIR

The Multi-gas Monitor Type 1302 is designed and constructed to provide you with many years of reliable operation. However, if any fault is detected, a message will appear on the display screen and any measurements performed will be marked to indicate the fault. Chapter 19 lists all possible warnings and error messages and explains their significance. If the reported fault can impair the correct function of the instrument you are advised to switch off the instrument and consult your local Brüel & Kjær service representative. Under no circumstances should repair be attempted by persons not qualified in the service of electronic instrumentation.

PULL–OUT DIAGRAM

PAGE 1



PULL–OUT DIAGRAM

PAGE 2

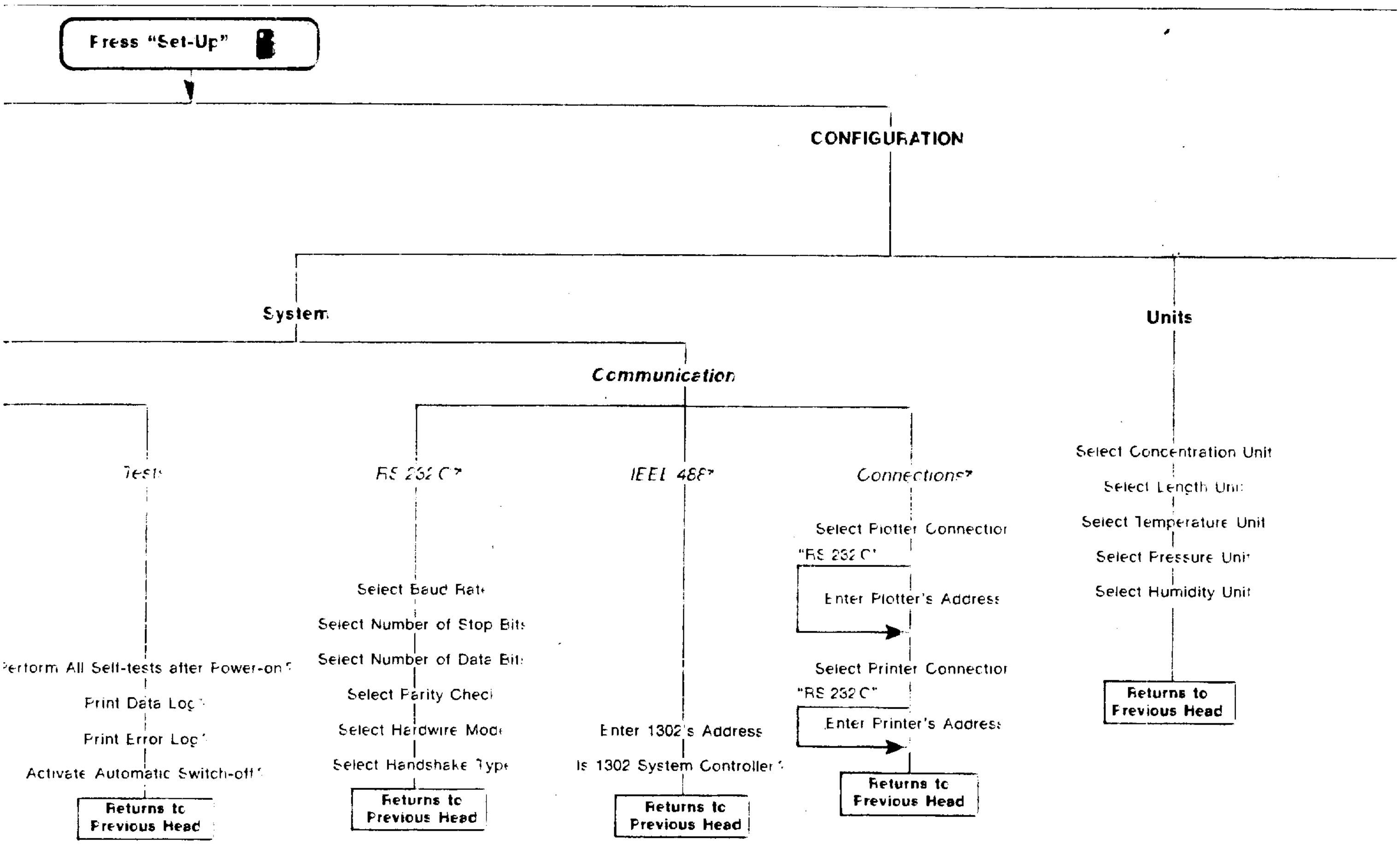
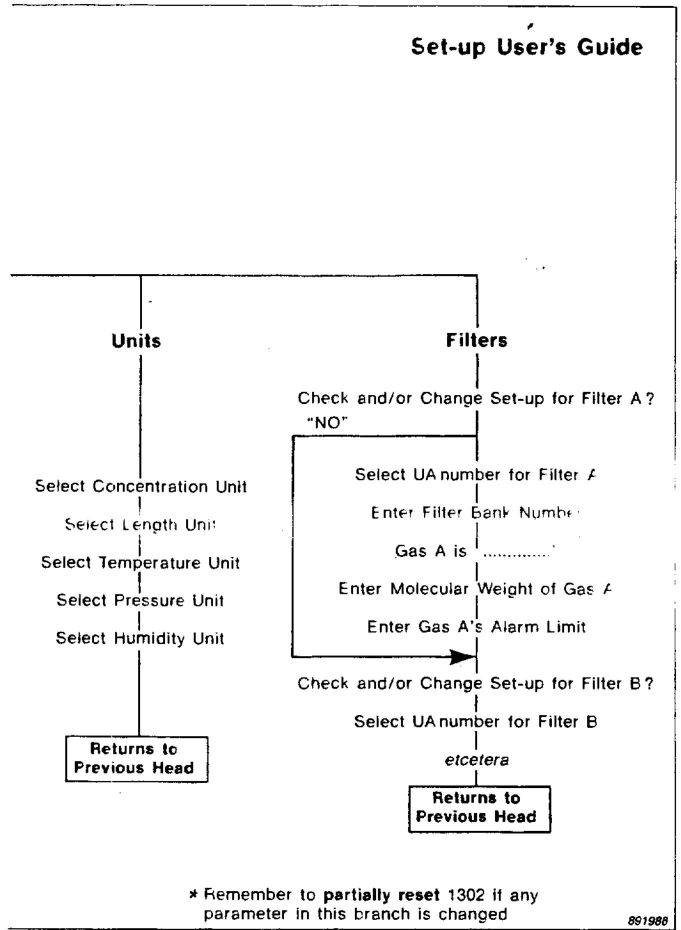
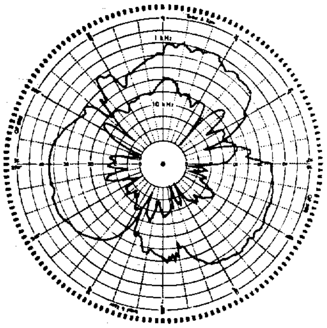


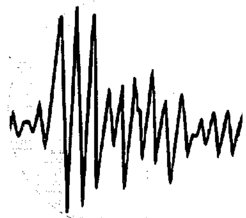
Fig. 7.1. Set-up "Tree" for the 1302

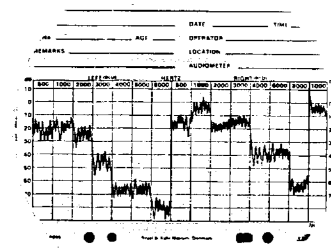
PULL–OUT DIAGRAM

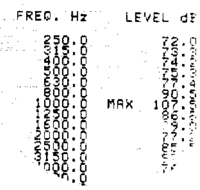
PAGE 3

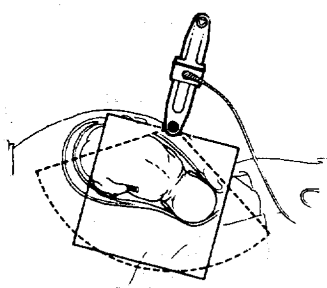


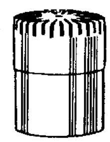


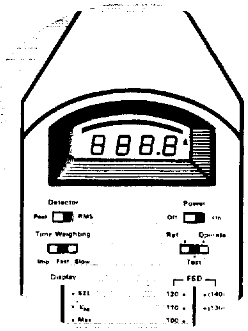


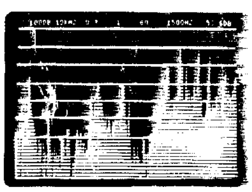


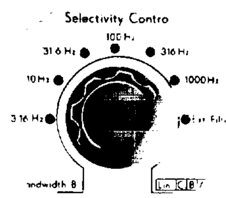

FREQ. Hz LEVEL dB
MAX

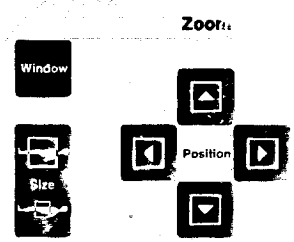


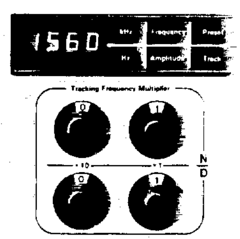


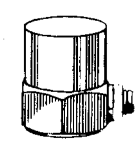

8888
Detector
Power
Time Weighting
Display

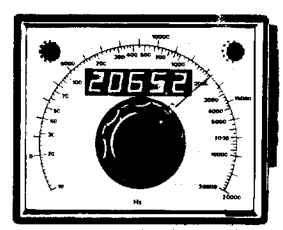


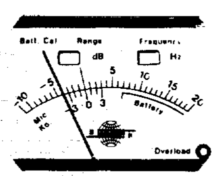

Selectivity Contro
100 Hz
31.6 Hz
316 Hz
10 Hz
1000 Hz
3.16 Hz


Zoom
Window
Position
Size


1560
Tracking Frequency Multiplier




20652
Hz


Range
dB
Hz
Battery
Overload