User Guide

IM/8241 Issue 16

Silica Monitor

8241

ABB

The Company

We are an established world force in the design and manufacture of instrumentation for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

As a part of ABB, a world leader in process automation technology, we offer customers application expertise, service and support worldwide.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

The UKAS Calibration Laboratory No. 0255 is just one of the ten flow calibration plants operated by the Company and is indicative of our dedication to quality and accuracy.

EN ISO 9001:2000

Cert. No. Q 05907

EN 29001 (ISO 9001)

Lenno, Italy – Cert. No. 9/90A

Stonehouse, U.K.

0255

Electrical Safety

This equipment complies with the requirements of CEI/IEC 61010-1:2001-2 'Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use'. If the equipment is used in a manner NOT specified by the Company, the protection provided by the equipment may be impaired.

Symbols

One or more of the following symbols may appear on the equipment labelling:

	Warning – Refer to the manual for instructions
	Caution – Risk of electric shock
	Protective earth (ground) terminal
	Earth (ground) terminal

	Direct current supply only
	Alternating current supply only
	Both direct and alternating current supply
	The equipment is protected through double insulation

Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

Contents

1 Introduction

1.1 Brief Description

The Model 8241 Silica Monitor is a microprocessor-based colorimetric analyzer that monitors the level of silica in de-mineralization and steam generation plants. The instrument is available as a single stream or as a multi-stream version, the latter is able to sequentially sample up to six independent streams.

This manual covers both versions of the monitor; aspects specific to the multi-stream version are covered in the text as appropriate, but multi-stream programming is covered in Appendix A.

1.2 Training

Due to the specialized nature of the above instrumentation, it is recommended that, where personnel have had no previous experience of maintaining this type of equipment, training be provided by the Company. Such training is available via a network of local or overseas agents, or may be carried out on the users' premises.

1.3 Location and Function of the Main Components – Fig. 1.1

The monitoring of silica in the sample involves the addition of various chemical reagent solutions to the sample in a specific order under constant temperature conditions. The result is a chemical complex, in solution, which has a predetermined color. The absorbance of this colored complex is proportional to the concentration of the silica in the original sample, thus making it possible for the measurement to be made optically.

The 8241 Silica Monitor carries out this reagent solution addition as follows:

1. The sample is presented to a constant head unit and any excess is allowed to overflow. On multi-stream versions there is a constant head unit for each stream.
2. A solenoid valve is then used to select automatically one stream to be sampled sequentially. This allows sample, under controlled pressure conditions, to be
3. presented to one of two multi-channel peristaltic pumps which
4. proportions sample and reagents through a series of mixing and reaction stages. The reaction stages are temperature controlled to remove the effects of sample and ambient variations.
5. The reacted solution is then delivered to a small chamber, called a measuring cuvette, in the optical system where the measurement takes place.
6. The output from the optical system, which is based on how much light is absorbed by the solution, is then processed by the microprocessor-based electronics section to calculate the actual silica concentration in the sample.

Note.

- A facility is provided to pass a 'grab' sample through the monitor manually which has been taken from another sample point. This facility can also be used to check the calibration of the monitor.
- At silica concentrations greater than 2000µg l^{-1} SiO_2 the light absorbed by the solution in the standard length cuvette is sufficient to cause inaccuracies in the measurement. For determination of high silica concentrations, therefore, a shorter path length cuvette is fitted. This allows the upper limit of silica concentration to be increased to 5000µg l^{-1} SiO_2 with a corresponding increase in the minimum current output range from 20 to 50µg l^{-1} SiO_2.

To maintain optimum measurement accuracy it is necessary to carry out a zero and a secondary upscale calibration by introducing standard solutions of known concentration. The monitor utilizes solenoid valves to introduce these solutions automatically, at predetermined intervals, under the control of the microprocessor.

The electronics section consists of a main Microprocessor Unit situated above the liquid handing section, which controls all the instrument functions including the multi-streaming of the different samples, if applicable.

The monitor case is hinged on the left hand side and has one lockable catch on the right hand side.

Access to the optical system, pump and solenoid valves is provided by means of a hinged acrylic door which is held open or closed by use of a push/push latch. The panel holding the liquid handling section is also hinged on the left to allow access to the rear of the panel for maintenance.

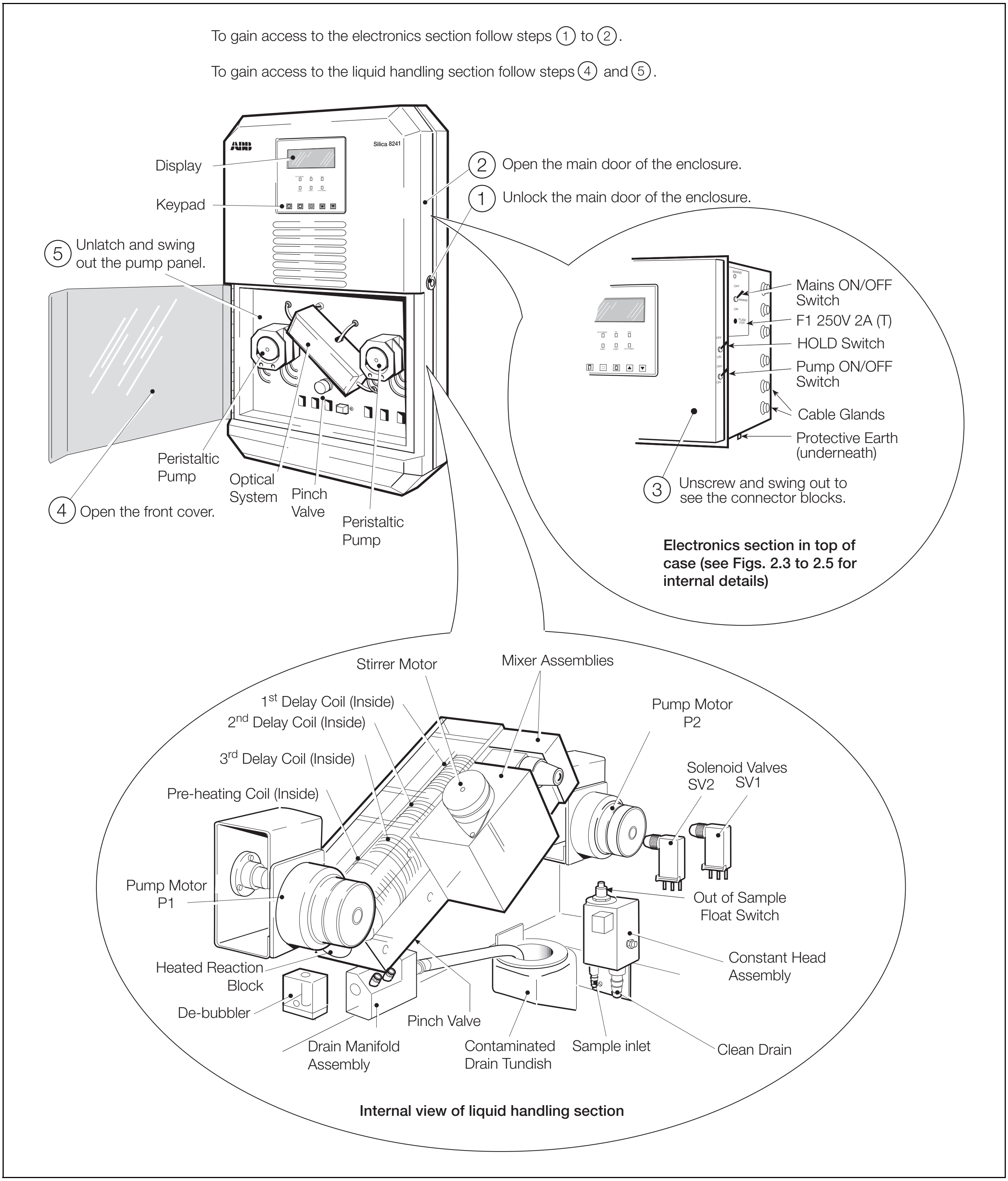


Fig. 1.1 Main Components

Note. The arrangement of the constant head units for the multi-stream version is shown in Fig. 2.2B.

2 Installation

2.1 Accessories

The accessories supplied are as follows:

- 4 x reagent containers
- 1 x calibration solution container
- 5 x solution container sealing caps
- 1 x spares kit

2.2 Location

Install in a clean, dry, well ventilated and vibration-free location giving easy access and where short sample lines can be used. Avoid rooms containing corrosive gases or vapors, e.g. chlorination equipment or chlorine gas cylinders. It is also advisable to have adjacent drains near ground level, so that the waste outlet from the monitor can be as short as possible, together with maximum fall. Power supplies should also be adjacent. Ambient temperature within the range 5°C to 40°C.

2.3 Mounting – Fig. 2.1

See Fig. 2.1 for mounting procedure and enclosure dimensions.

2.4 Sampling Requirements

In addition to being as close as possible to the monitor, the sampling point must provide a thoroughly mixed representative sample. The sample must also conform to the following conditions:

1. Sample flowrates must be greater than 5ml min^{-1}.
2. Sample temperature should be within the range 5°C to 55°C.
3. Particles must be less than 10mg l^{-1} and the size must not exceed 60 microns without the sample filter being fitted. Above these levels it is essential that the filter supplied is fitted in both sample and emergency inlets.

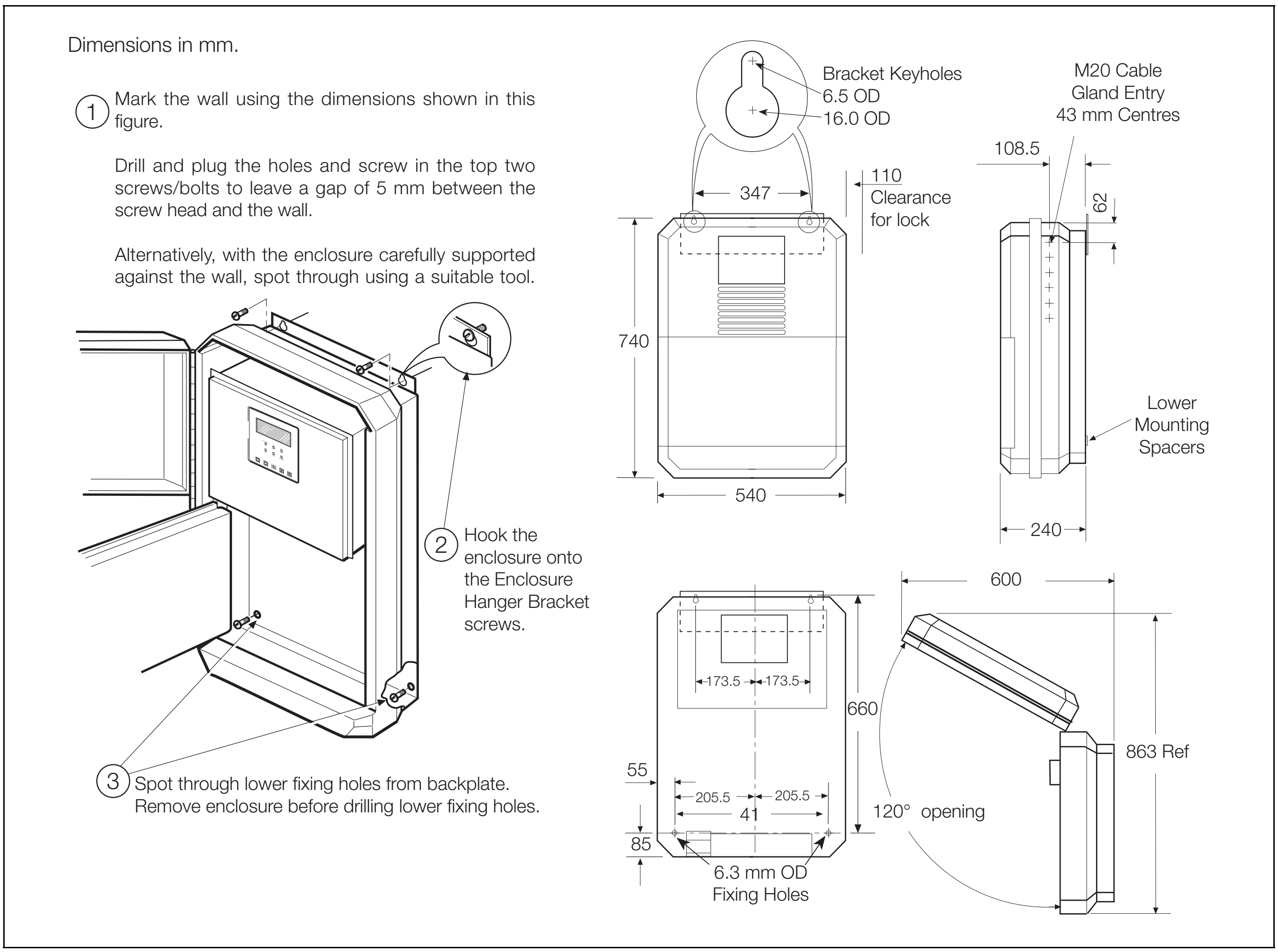


Fig. 2.1 Mounting the Unit

Note.

- Mains (power supply) and signal cables are connected through cable glands directly into the electronic section.
- Sample and drain pipe work are brought in through the bottom of the case

2.5 Sample Connections – Fig. 2.2

Connect inlet and outlet tubes as shown in Fig. 2.2A (single stream) and Fig. 2.2B (multi-stream).

Note. A suitable 40 litre emergency sample container must be provided by the user. A suggested arrangement is shown in Fig. 4.2. Alternatively, a constant, independent source may be used.

Note.

- Use tube of inert material, e.g. PVC.
- The inlet tube must incorporate a shut-off valve at its up-stream end.
- Ensure that the drain outlet tube is short, has a free fall and is vented to atmosphere as soon as possible.

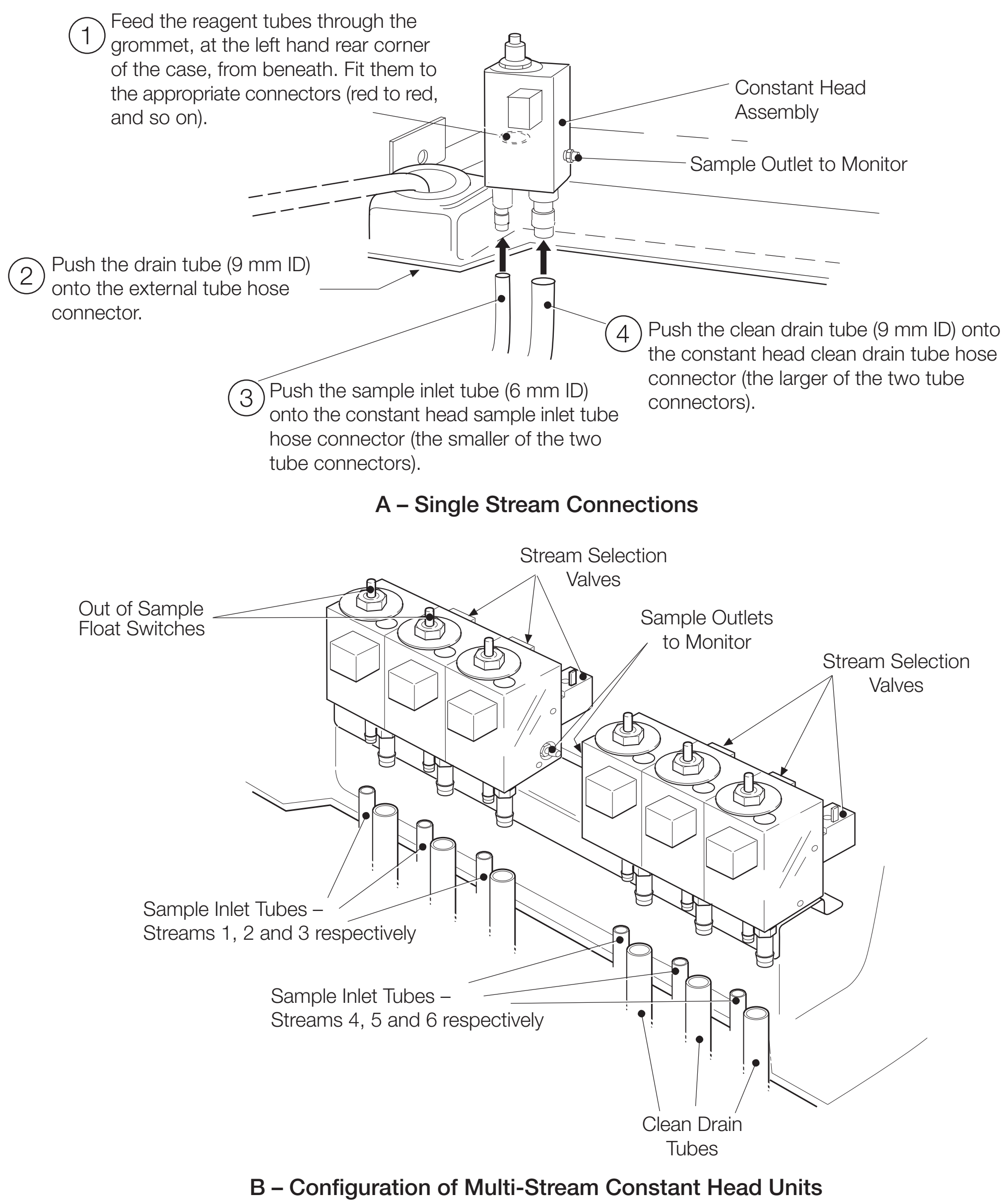


Fig. 2.2 External Tube Connections

Note.

- To gain access to the constant head assembly follow steps 1, 2, 4 and 5 in Fig. 1.1.
- One constant head assembly is fitted for each sample inlet in multi-stream versions of the monitor. Fig. 2.2B shows six sample inlets and six corresponding constant head assemblies.

2.6 External Electrical Connections – Figs. 2.3 to 2.5

Warning.

- Although certain instruments are fitted with internal fuse protection, a suitably rated external protection device, e.g. a 3A fuse or miniature circuit breaker (MCB), must also be fitted by the installer.
- Before making any connections, ensure that the power supply, any high voltage-operated control circuits, high common mode voltages, including externally powered alarm circuits, are switched off.
- The power supply earth (ground) must be connected to ensure safety to personnel, reduction of effects of radio frequency interference (RFI) and correct operation of the power supply interference filter.

Caution. Slacken the terminal screws fully before making connections.

The external electrical connections are in the electronic section, behind the hinged cover and beneath the RFI screen – see Fig. 2.3. The cables are passed through the cable glands on the right hand side on the monitor case and connected as follows:

- **Mains input (power supply)** – 115V (110 to 120V) or 230V (220 to 240V). The mains voltage is selected using the voltage selector – Fig. 2.3.
- **Single-Stream** – CURRENT OUTPUT 1 and 2 – two independent current outputs for external recording or control.

  Multi-Stream – CURRENT OUTPUT 1 to 6 – one current output per stream.

Note. Because the current output is isolated, the negative terminal MUST be connected to earth (ground) if connecting to the isolated input of another device.

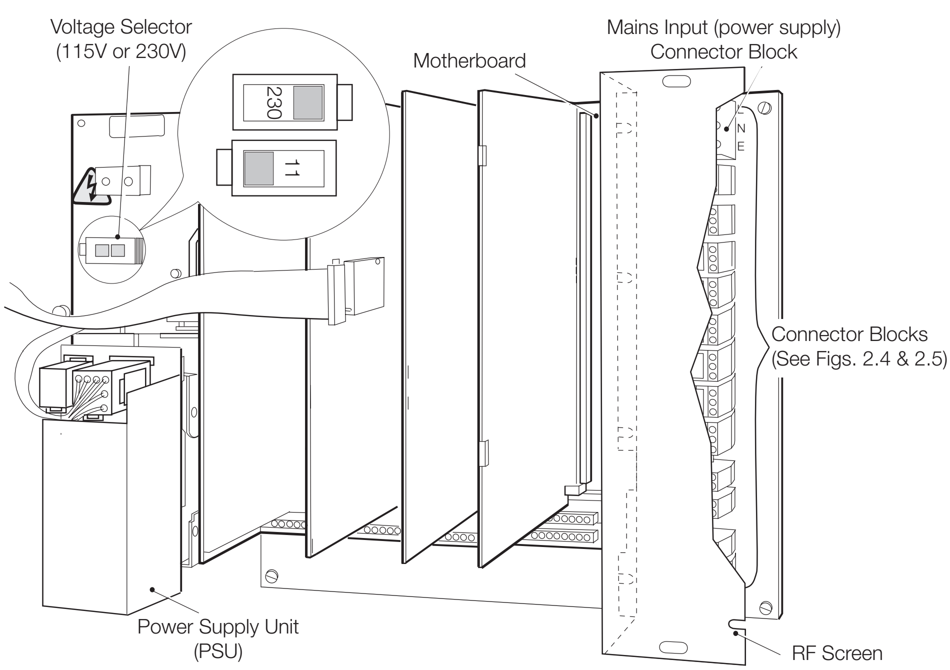
The setting of the range of the current output is covered on Programming Page 4 (see Section 6.5, page 24).

- **Single-Stream:**
  RELAY 1 and 2–two 'Concentration' alarms relays.
  RELAY 3–'Out of Sample' alarm relay.

  Multi-Stream:
  RELAYS 1 to 6–one relay per stream configurable
  as 'Concentration' or
  'Out Of Sample' alarms relays.

  The 'Out of Sample' alarm relay can be used as a remote indication.
- **CALIBRATION** – remote calibration mode indication alarm relay. This indicates when the instrument is off-line during a calibration – see Section 7, page 27.
- **OUT OF SERVICE** – remote instrument 'Out of Service' indication alarm relay. This indicates that the monitor readings are suspect and it is in need of attention – see Section 8.4, page 34.
- **SERIAL** – optional serial interface (see supplementary instruction manual for details).

Note. All relays have voltage-free single pole change over contacts.



Note.

- To access the connector blocks first undo the 10 fixing screws and remove the R.F. screen.
- Replace and secure the R.F. screen before operating this equipment.

Fig. 2.3 Mains Input Connector Block and Voltage Selector Locations

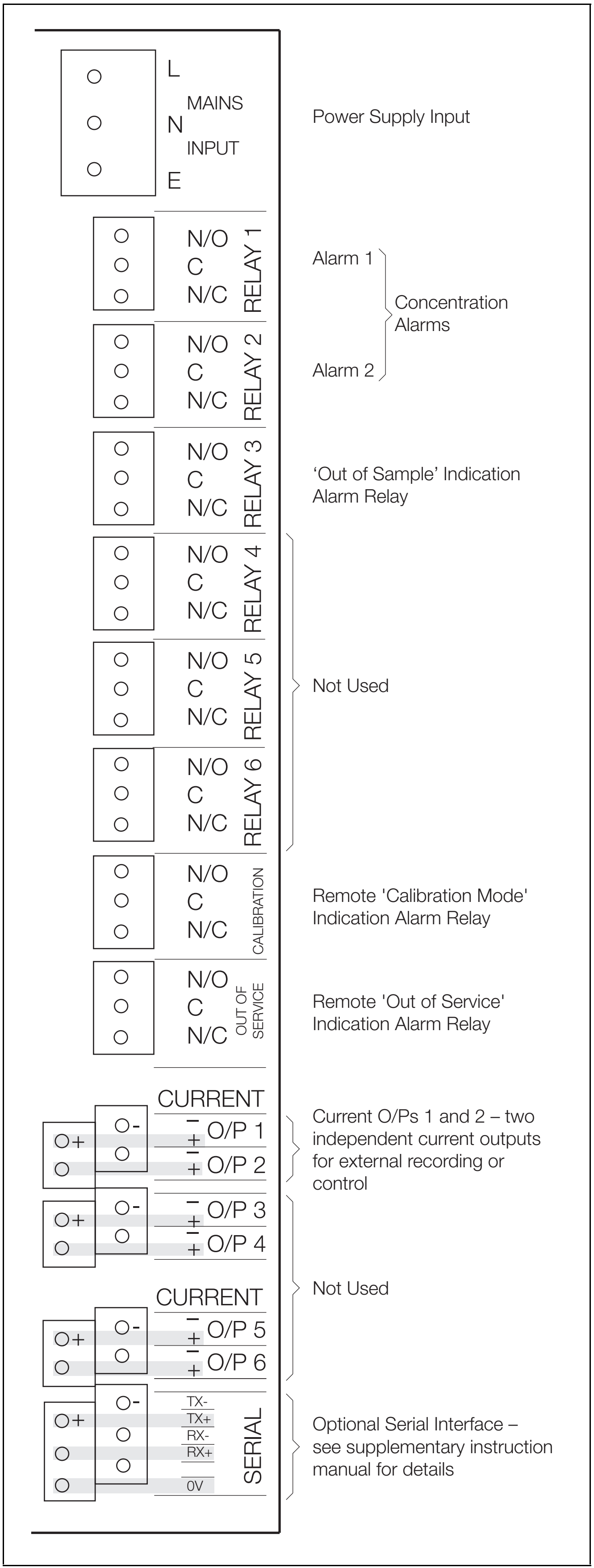


Fig. 2.4 Electrical Connections – Single Stream

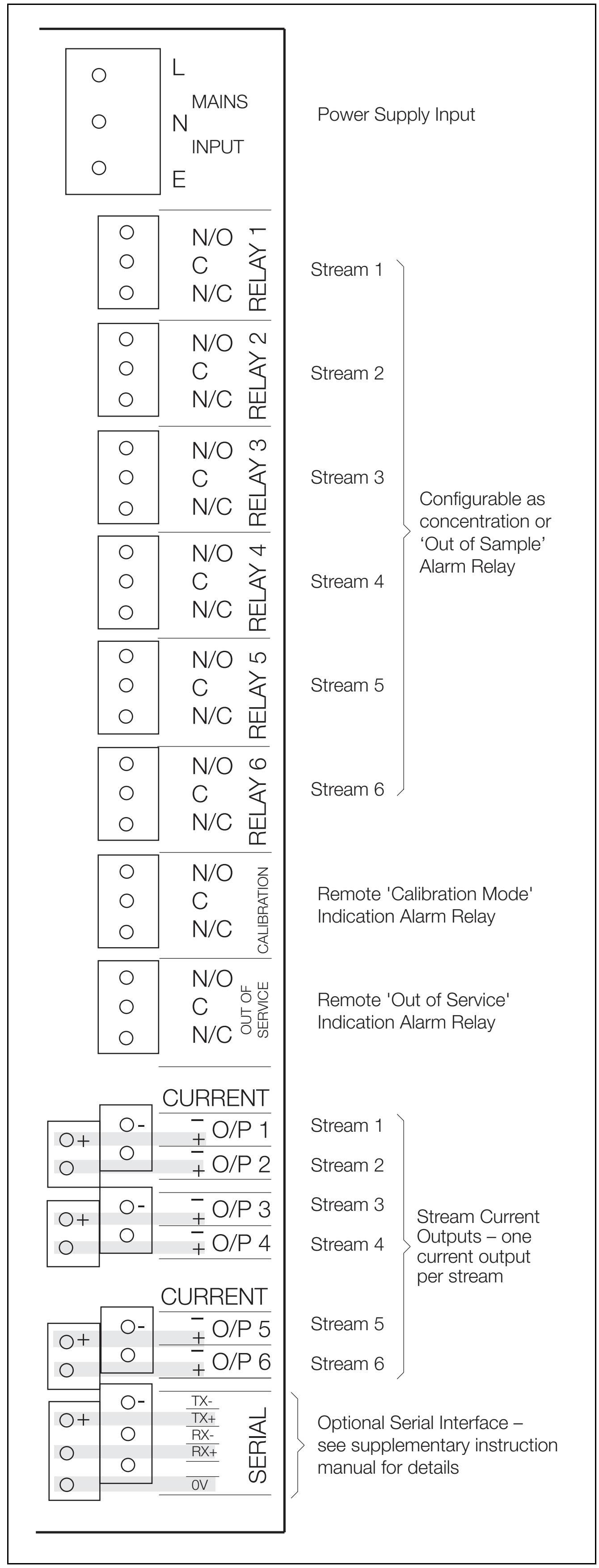


Fig. 2.5 Electrical Connections – Multi-Stream

2.7 Relay Contact Protection and Interference Suppression – Fig. 2.6

If the relays are used to switch loads on or off the relay contacts can become eroded due to arcing. Arcing also produces RFI which can cause instrument malfunctions and incorrect readings. To minimize the effects of RFI, arc suppression components are required; these are resistor/capacitor networks for AC applications, or diodes for DC applications. These components can be connected either across the load or directly across the relay contacts.

For **AC applications** the value of the resistor/capacitor network depends on the load current and inductance that is switched. Initially fit a 100R/0.022µF RC suppressor unit (part no. B9303) as shown in Fig. 2.6A. If the instrument malfunctions the value of the RC network is too low for suppression and an alternative value must be used. If the correct RC suppressor unit cannot be obtained, contact the manufacturer of the switched device for details of the RC unit required.

For **DC applications** fit a diode as shown in Fig. 2.6B. For general applications use an alternative IN5406 type (600V peak inverse voltage at 3A – part no. B7363).

> **Note.** For reliable switching the minimum voltage must be greater than 12V and the minimum current greater than 100mA.

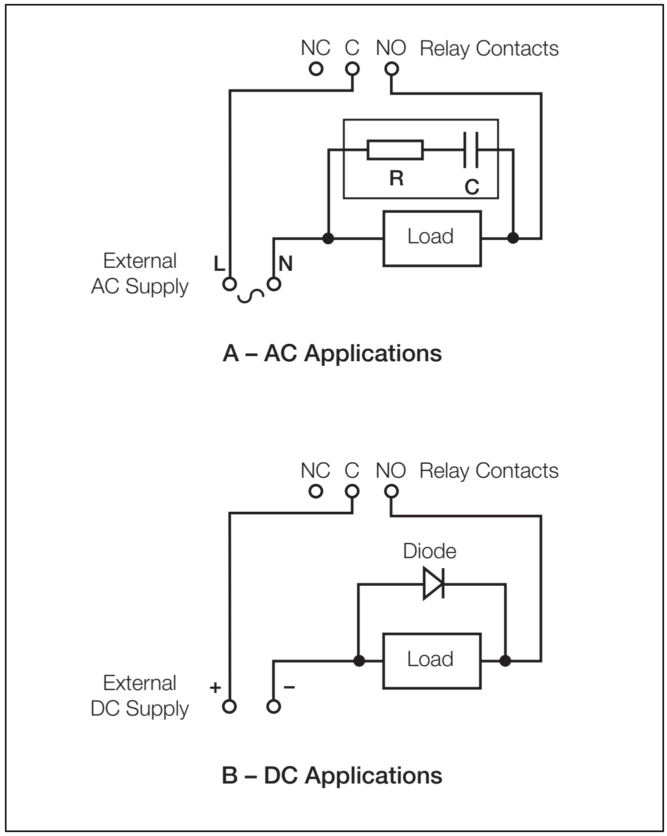


Fig. 2.6 Relay Contact Protection

3 Setting Up

> **Note.** Before proceeding any further, ensure that the HOLD switch is ON; all other switches are set to OFF on the right hand side of the electronics unit – see Fig. 1.1.

1. Ensure that all external electrical and plumbing connections have been made correctly.
2. Fill reagent and standard solution bottles (see Section 8.1, page 28 for details of these solutions).
3. Connect the reagent float switch to the plug (Fig. 3.1) routing the lead through the far left hand grommeted hole in the bottom of the enclosure.
4. Connect the electrical supply and switch on.

> **Note.** The temperature controlled reaction block and optical block require up to one hour to reach the normal control temperature. During this time, 'Temperature Stabilizing' is indicated on Programming Page 1.0 – see Section 6, page 19 (or Appendix A for multi-stream programming). Any calibrations are prevented by the microprocessor during this time.

5. Verify that there is an adequate supply of sample to the monitor constant head unit.
6. Fit the cuvette drain tube into the pinch valve. Press in the central plunger and ensure that the tube is fully inserted into the valve. This ensures that no leakage from the cuvette occurs.
7. Fit the pressure plate platen on the peristaltic pumps (see Section 8.2.6, page 31) and switch the pumps on with the switch on the side of the monitor. Note that the peristaltic pumps rotate and check that sample and reagents are being drawn into the monitor by observing the progress of any small bubbles present in the inlet tubes.
8. Run the monitor for at least one hour to allow the solutions to be pumped into the system and to purge the air from the pipework. Check for any leaks around the pipe connections and rectify as necessary.
9. Set the following parameters to YES using Programming Page 2.1:

   Five-Weekly System Flush
   Five-Weekly Solution Replacement
   Default Calibration Parameters.

> **Note.** If the monitor has not been in use for a long period, the 're-wetting' process of the system can be speeded up by introducing the chemical rinse solution for a period of 30 to 60 minutes – see Section 8.2.4, page 30.

> **Note.** Before proceeding to the next step, multi-stream users must select single stream mode as described in Section 4.3.

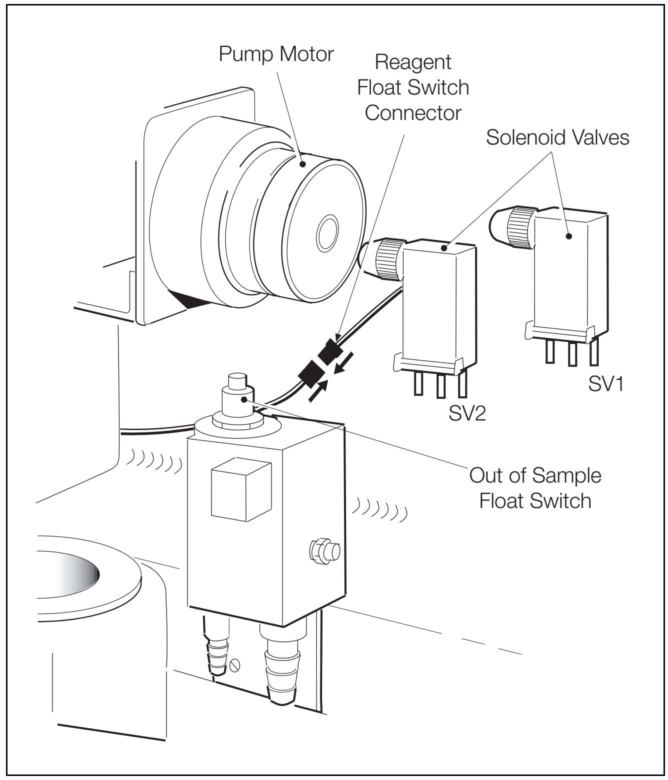


Fig. 3.1 Reagent Float Switch Connector

10. If having not already done so, energize the secondary CAL valve (see Programming Page 2.3) and leave for 15 minutes. Adjust the reading on scale with the ▲ and ▼ switches and run the monitor for one to two hours to purge the old solution and assess stability.
11. If the monitor exhibits good stability, i.e. ±2% of reading, carry out a two-point BASELINE calibration – see Programming Page 2.3.
12. Check the condition of the sample filters and replace them if necessary. Ensure that new filters are fitted correctly by taking note of the flow directions indicated on the filter bodies.

4 Liquid Handling Section

4.1 Principle of Operation – Fig. 4.1

The chemical method used in the monitor utilizes the reaction between silicate species in the sample, acid and molybdate reagents, to form yellow molybdosilicic acid complex. The acid conditions are chosen so that specifically beta-molybdosilicic acid is produced which excludes interference from other forms of the acid complex. To improve the sensitivity of the method the yellow acid is reduced to the blue form which is measured colorimetrically in the optical system.

The sequence of events is:

1. Sulfuric acid (1st acid reagent) is added to the sample to reduce the pH to a value between 1.4 to 1.8pH.
2. Ammonium molybdate is added to the acidified sample.
3. The solution enters the first reaction coil in the temperature controlled block (providing a two minute delay) where the yellow beta-molybdosilicic acid is developed.
4. Sulfuric acid plus citric acid (2nd acid reagent) is added before the solution enters the second reaction coil in the temperature controlled block (providing a two minute delay) to reduce the pH further to a value between 0.8 to 1.0pH. This is the pH value required to stop further development of the silica and to provide the conditions for the next reaction (reduction) to take place.

   In applications where the sample contains phosphate, the citric acid concentration is increased to destroy any phosphate complexes which would augment the color developed in the next stage.
5. The reduction solution is added before the solution enters the third reaction coil in the temperature controlled block (providing a one minute delay) reducing the yellow complex to the blue form.
6. The fully developed solution passes to the measuring cuvette in the optical system where the intensity of the color, which is proportional to the original silica concentration, is measured.
7. During the automatic zero calibration the monitor generates a zero solution by diverting the sample to a point where the second acid solution is added. The pH at this point is too low to allow the silica-molybdate reaction to take place, so the solution of zero silica concentration is produced. In the zero calibration the system allows silica in the first acid and molybdate solutions to be developed. A secondary upscale calibration is achieved by the automatic introduction of a standard solution of a known value.

4.2 General Operation – Figs 4.2 and 4.3

The sample enters the constant head unit situated at the bottom of the instrument case – see Fig. 4.2A for single stream and Fig. 4.2B for multi-stream. The constant head units are fitted with an 'Out of Sample' switch. This switch is used by the microprocessor, in the appropriate situation, to instigate the 'Out of Service' alarm and to energize the emergency sample valve. This valve introduces sample from an alternative supply to maintain the monitor operation when the sample has been lost. This avoids potential problems caused when the monitor is run without a sample for long periods.

> **Note.** Fitted in the sample lines are disposable sample filters. These are necessary to protect the liquid handling system from blockages due to solids in the sample.

For the multistream version, each sample is presented to individual constant head units each of which is fitted with an 'Out of Sample' switch (see Fig. 4.2B). Solenoid valves, MSV 1 to 6, attached to each constant head unit are then used to select each stream to be sampled. The emergency sample valve is energized when all sample streams are lost or de-selected.

The sample is drawn off from the selected stream by one channel of the peristaltic pump (P1) via the pre-heating coil – see Fig. 4.2B. The purpose of this coil is to pre-heat the sample prior to the reaction taking place. Any air bubbles which form in the sample are removed by the de-gassing block and pumped to drain by another channel of (P1). This is necessary to reduce the effect of air bubbles in the sample which will give variable reagent mixing resulting in noisy readings on the display.

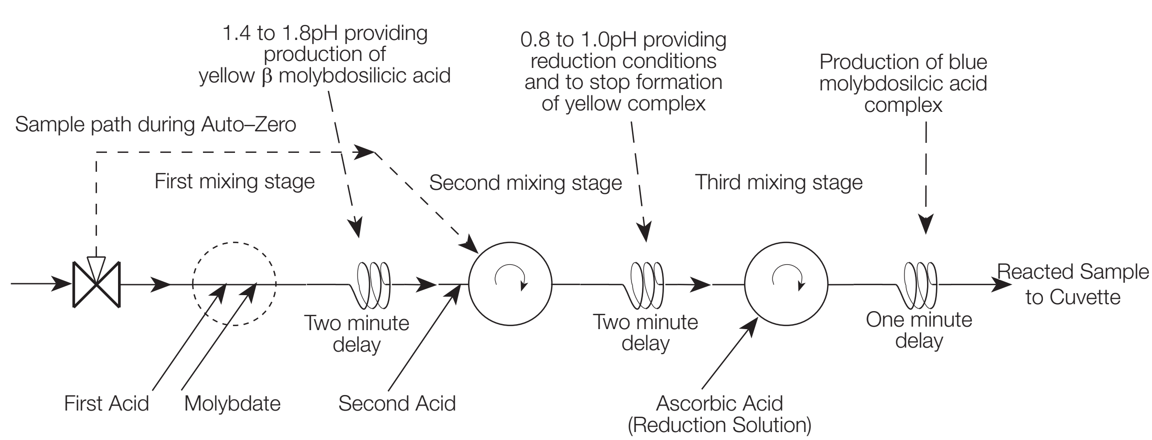


Fig. 4.1 Chemical Schematic

The 1st acid and the ammonium molybdate solutions, delivered via two channels on the peristaltic pump (P2) are then added to the sample in the static mixer block (M1) before passing through the 1st heated delay coil where the first reaction takes place.

The 2nd acid, via P2 is added to the sample before entering the dynamic mixer (M2) and then passes through the 2nd heated delay coil.

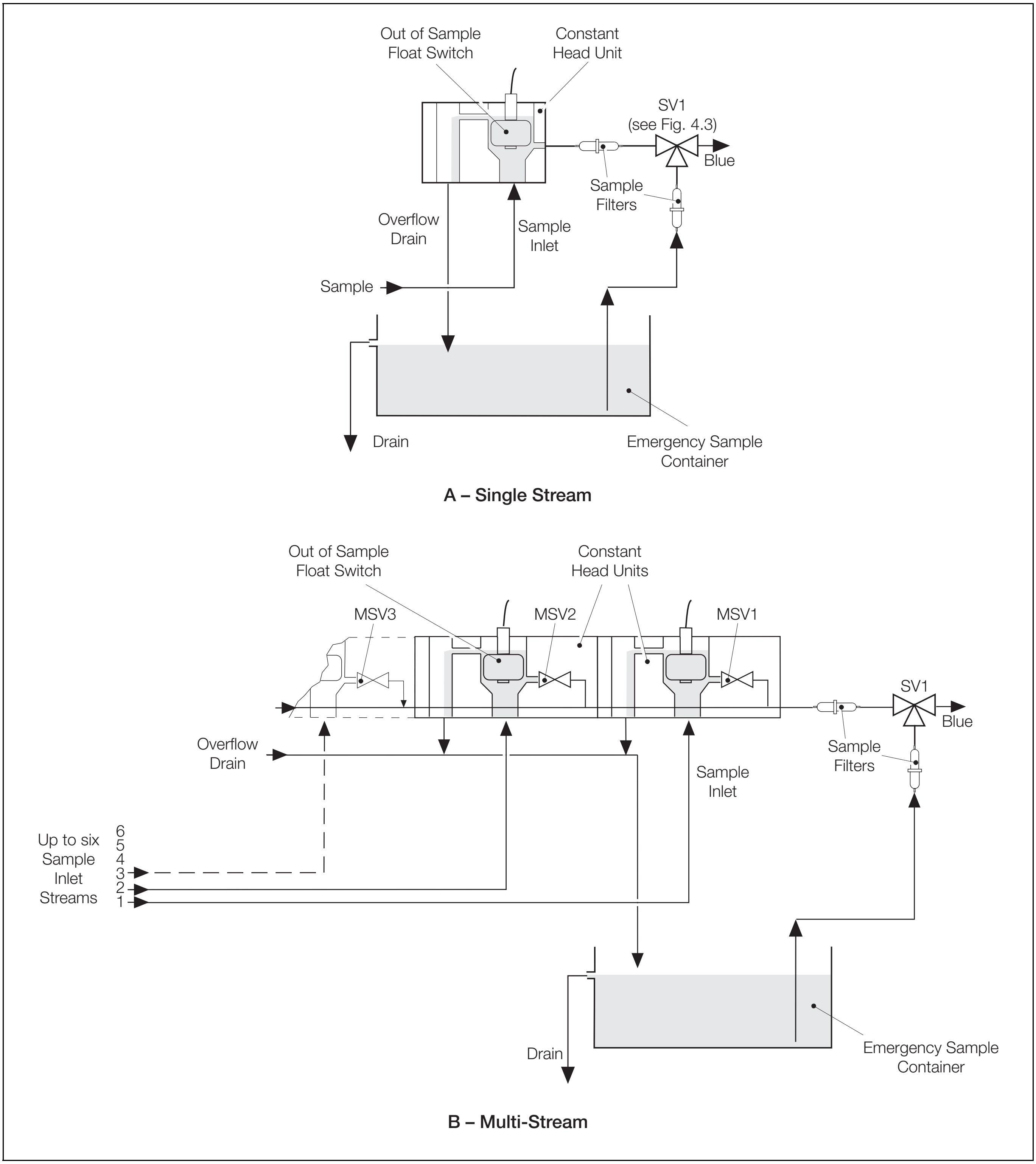


Fig. 4.2 Flow Schematic – Sample Inlet

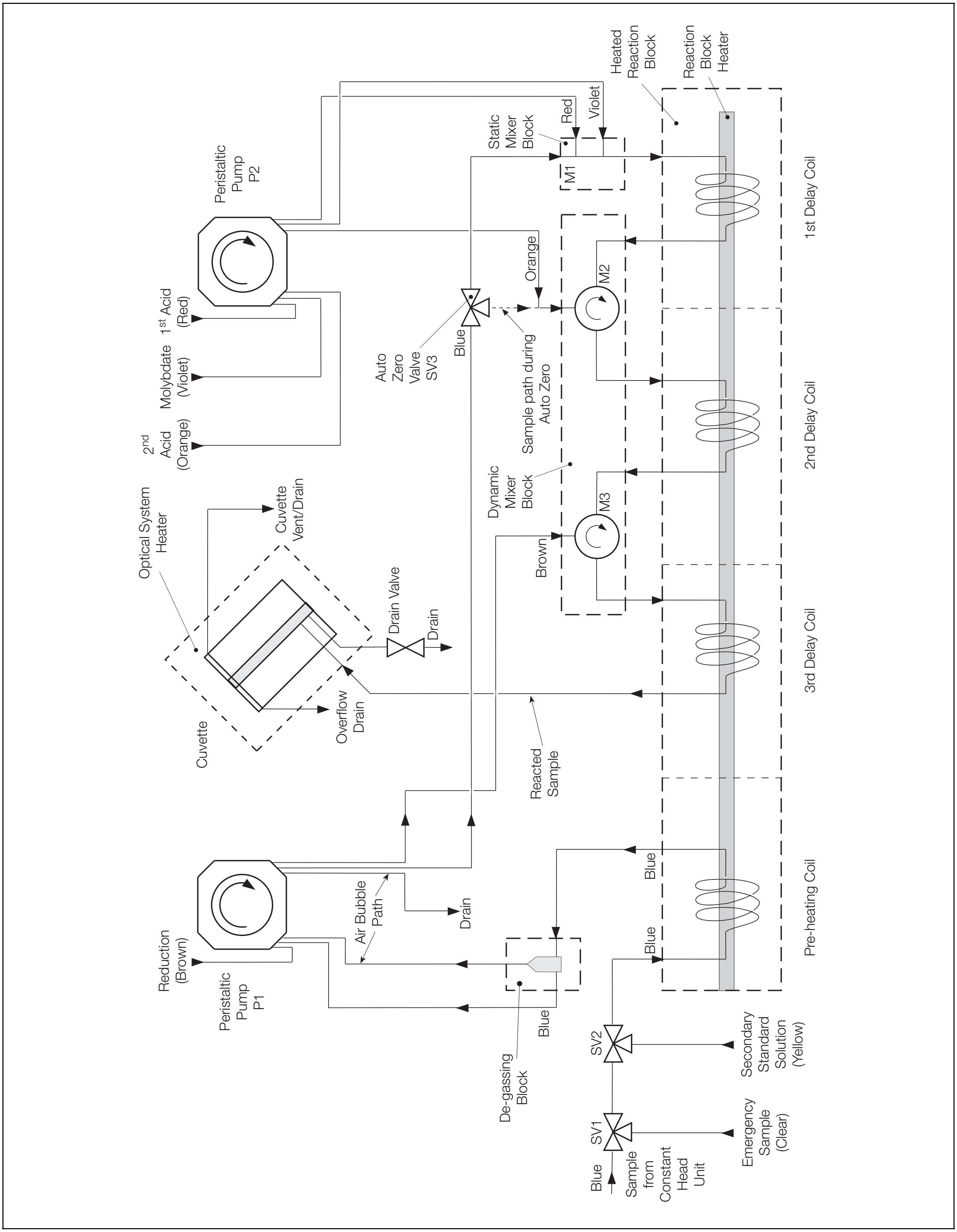


Fig. 4.3 Flow Schematic of Chemical Section

The solution then passes into the dynamic mixer (M3) where the reduction reagent solution is added via P1.

The resultant solution is then passed through the 3rd heated delay coil before being presented to the measuring cuvette.

> **Note.** A dynamic mixer consists of a small stirrer sited in a chamber in the mixer block and is magnetically coupled to a small electric motor.

During an AUTO ZERO, solenoid valve SV3 is used to divert the sample from mixer block M1 to M2. Solenoid valve SV2 is used to introduce the secondary standard solution. In the event of a loss of sample, SV1 is used to introduce an emergency sample to prevent the undiluted reagents fouling in the system plumbing tubing.

The sample pre-heater coil and the three reaction coils are mounted in a single acrylic block. This block is heated using a small 24V cartridge heater and controlled using a PT100 temperature sensor. This optimizes the chemical reaction time and removes the effect of ambient and sample temperature changes.

The coils are made from PTFE and do not normally require any maintenance except for the 5-weekly system flush – see Section 8.2.2, page 30.

4.3 Multi-Stream Operation

Between two and six streams can be fitted to the multi-stream version of the monitor. The front panel controls remain the same on all versions.

The monitor samples the streams in the sequence specified on Programming Page 3.3 (see Appendix A on page 42). The stream sampling period, i.e. the duration the monitor spends on each stream, is normally set to 12 minutes, although the upscale and downscale times can be set independently by the user – see Programming Page 4.1. However, the reading, taken after a further six minutes, is used to update the display and current output for that particular stream. This takes advantage of the eight minutes 'dead' time of the monitor in reducing the overall sampling period – see Fig. 4.4.

The reading for that stream is then held until that stream is again sampled and updated. This includes 'Loss of Sample' and de-selection of the stream.

The stream sequence would be normally set to sample each stream in turn, i.e. on a three stream version this would be set to 1, 2, 3. However, greater priority could be given to a particular stream (e.g. stream 1) by programming the sequence 1, 2, 1, 3 or 1, 1, 1, 2, 3 etc.

Front panel stream LEDs provide status information on each stream as follows:

Green	Stream selected.
Flashing green	Sample currently being sampled.
Red	Sample lost on stream.
Not illuminated	Stream de-selected or not fitted.

If the stream is unavailable throughout the sampling period the monitor selects the next stream in the sequence. The red stream lamp remains on until the stream is sampled again; if the stream has been reinstated, the LED changes to green and the display is updated as normal.

Single Stream Mode for Maintenance

To carry out any maintenance it is necessary to switch to a single stream provided that a stream is available. If not, a solution could be introduced via the SECONDARY CAL valve (energized on Programming Page 2.2 – see Appendix A on page 42). Single stream mode is initiated by selecting one stream on Programming Page 3.3, Appendix A. This stops the multi-stream sequencing and enables the display and the current output to respond to changes on each drain/fill cycle. This mode is used to check the basic performance of the monitor, such as response or drift, without waiting for the normal stream update.

Selecting more than one stream puts the monitor into multi-stream operation.

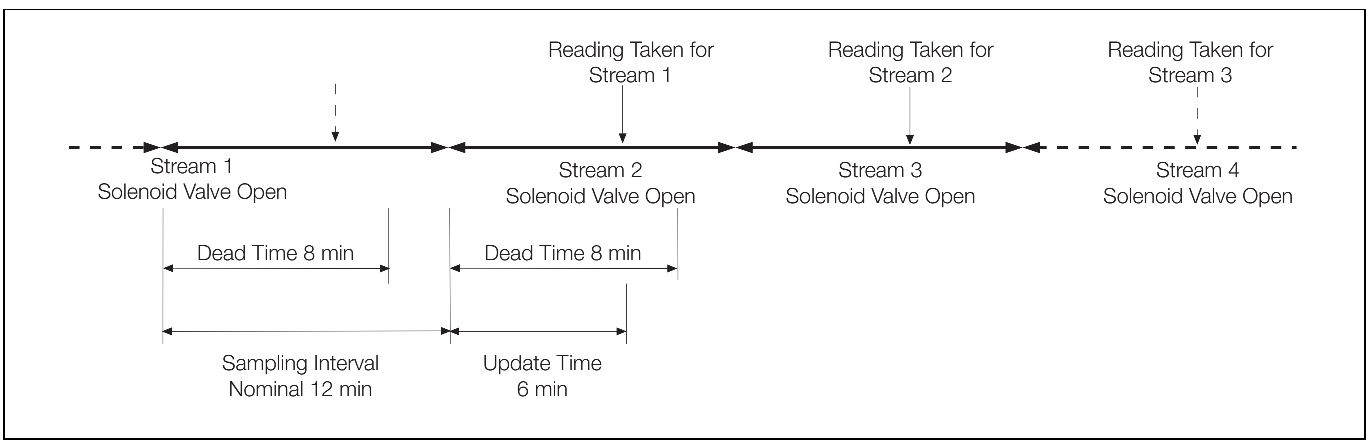


Fig. 4.4 Multi-Stream Timing

4.4 Manual Grab Sample Facility

A facility is provided to pass a grab sample through the monitor manually which has been taken from another sample point. If required, the same procedure can be used to introduce standard solutions to check the monitor calibration. Proceed as follows:

1. Put 100ml of sample into a clean, well rinsed container. This will run the monitor for 25 minutes approximately.
2. Remove the secondary calibration container tube. Rinse in high purity water and transfer it to the grab sample container.
3. Energize the secondary calibration valve (see Section 6, page 19, Programming Page 2.2). This will bring up the 'Out of Service' alarm and prevent an automatic calibration from taking place. Return to the main display page. On multi-stream versions of the monitor it will be necessary to switch to single stream operation (see Section 4.3, page 13).
4. The display should stabilize on the grab sample value after 16 minutes approximately which can them be noted.
5. Remove the tube from the container, rinse and return it to the secondary calibration container. Run the monitor for a further five minutes.
6. Return the monitor to normal operation by de-energizing the secondary calibration valve.

4.5 Optical System – Figs 4.5 and 4.6

The optical system comprises a tungsten halogen exciter lamp mounted between two photocells. The light falling on the measuring photocell first passes through the measuring cuvette containing the reacted sample and then through a colored filter. This filter selects the specific wavelength required for the correct operation of the monitor (approximately 810nm). The light can be seen via the prism on top of the lamp housing. Its intensity is controlled by the output from the reference photocell.

Although the reaction of the sample is continuous, the actual optical measurement of the reacted sample is based on a nominal one-minute cycle controlled by the microprocessor.

The temperature of the optical system is controlled using a mat heater and a PT100 temperature sensor. This temperature is kept to the same value as that of the reaction block to avoid convection currents in the measuring cuvette.

> **Note.** The exciter lamp operates well below the specified operating voltage. This design gives a lamp life of many years.

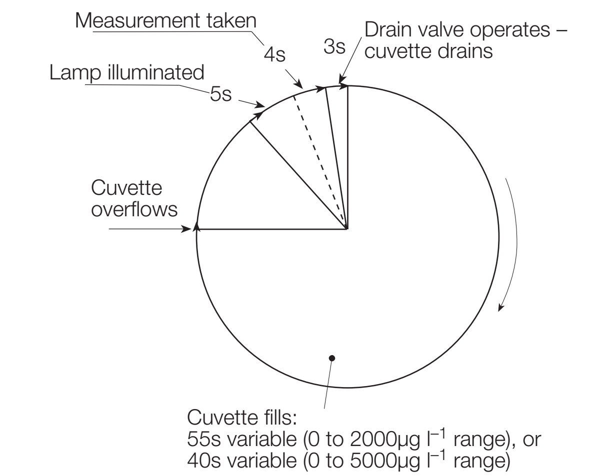


Fig. 4.5 Drain/Fill Sequence

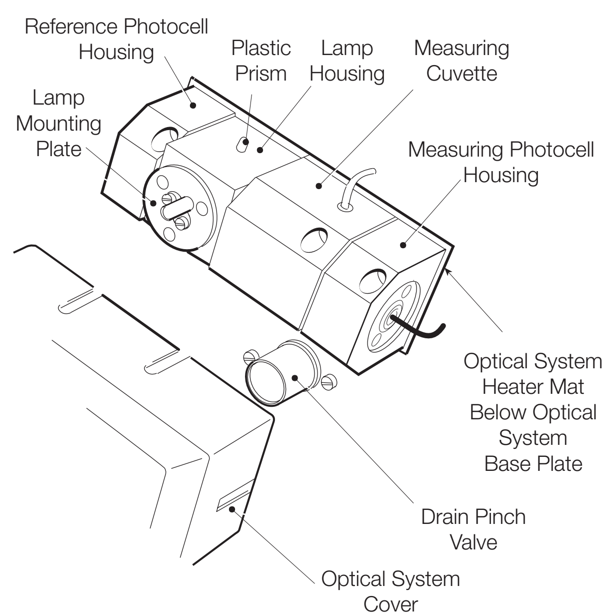


Fig. 4.6 The Optical System

> **Note.** The Optical System Cover must be in place when the monitor is running. This cover excludes the effects of ambient temperature and light.

5 Electronics Section

5.1 Front Panel Controls – Figs. 5.1 and 5.2

The program controls comprises five tactile membrane switches. In normal operation the switches are used to view the measured variable, the concentration alarm values, diagnostics and status information. Access to the programming and calibration pages are protected by customer programmable security codes.

When programming, the switches are used to sequence through a programming procedure as detailed in Section 6 (Single Stream) or Appendix A (Multi-stream). The procedure is set out in programming pages for Input, Current Output, Alarms, Real Time Clock and Monitor Calibration. Each program page contains the program functions, the values or parameters of which are all programmable.

Switch functions are described in Fig. 5.1.

Three other switches are situated on the side of the electronic section – see Fig. 1.1. Their functions are as follows:

Mains ON/OFF Used to isolate the mains (power) supply from the instrument.

Pump ON/OFF Used to switch the pumps on and off during maintenance.

HOLD ON/OFF Used to hold the concentration alarms, activate the 'Out of Service' relay and inhibit any timed automatic calibrations during maintenance.

5.2 Display

The monitor display panel indicates the solution concentration and provides user information during setting up and in normal operation.

> **Note.** A flashing display indicates that the value is out of range for that particular parameter.

5.3 LED Indicators

Out of Service Indicates that the monitor out of servicealarm is active, the source is indicated on Programming Page 1.0 – see Section 6, page 19.

Cal Indicates when a calibration sequence is taking place.

Hold Indicates that the HOLD switch has been switched to 'HOLD' during servicing. This holds the current concentration alarm states and activates the 'Out of Service' alarm relay and inhibits timed automatic calibration.

Single Stream

Alarm 1,2 Used to indicate a concentration alarm state (either high or low).

Out of sample Indicates that sample has been lost.

Multi-Stream

Streams 1 to 6 These are two color red/green LED indicators. A continuous green indication shows the stream(s) selected, a flashing green indication shows the stream which is currently being sampled and a red indication signifies an 'Out of Sample' alarm on the stream indicated.

Alarms 1 to 6 Used to indicate a concentration alarm state (either high or low).

These indicators are used in association with external alarm relay outputs except for the multi-stream version where the Relays 1 to 6 can be configured as remote stream 'Out of Sample' or concentration alarm indication – see Fig. 2.5 and Fig. 2.6.

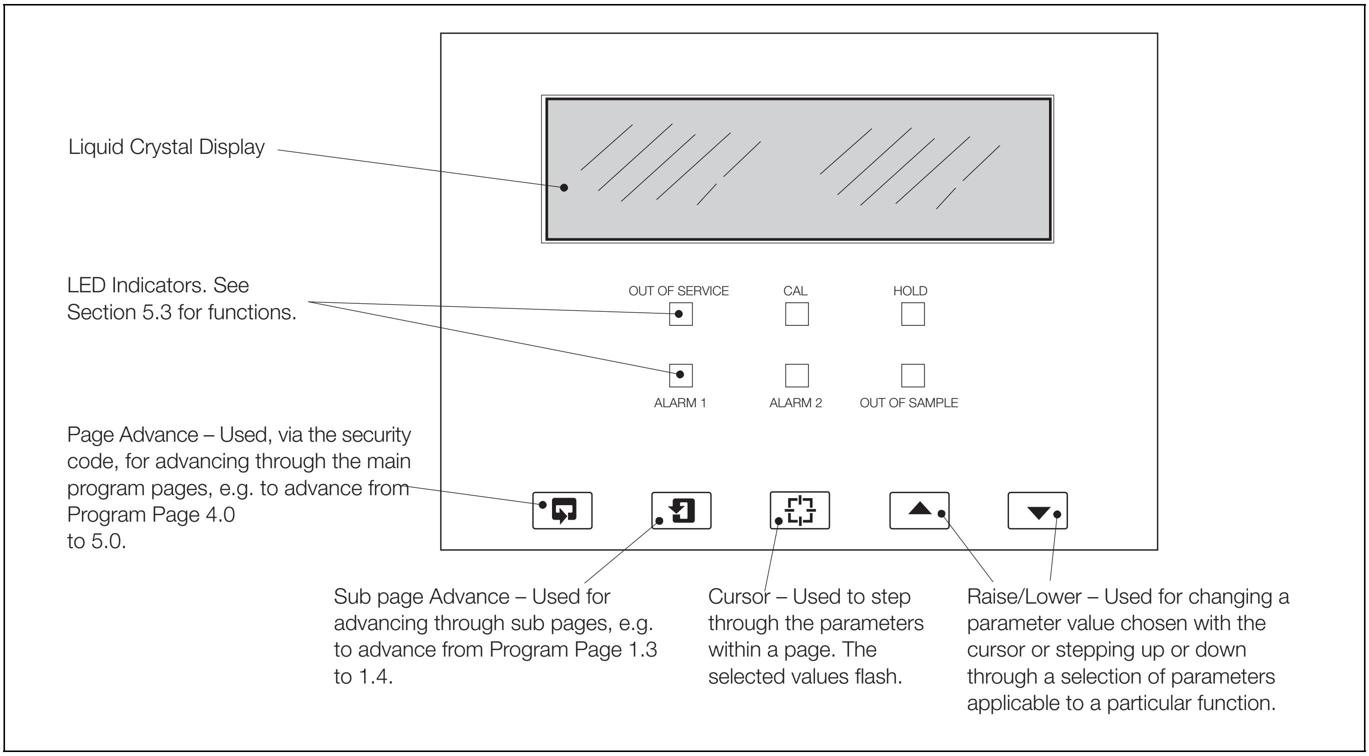


Fig. 5.1 Front Panel Controls – Single Stream

Note. Continued pressure on the ▲ or ▼ switches causes the rate of change of the displayed value to increase. To make small adjustments, operate the switches momentarily.

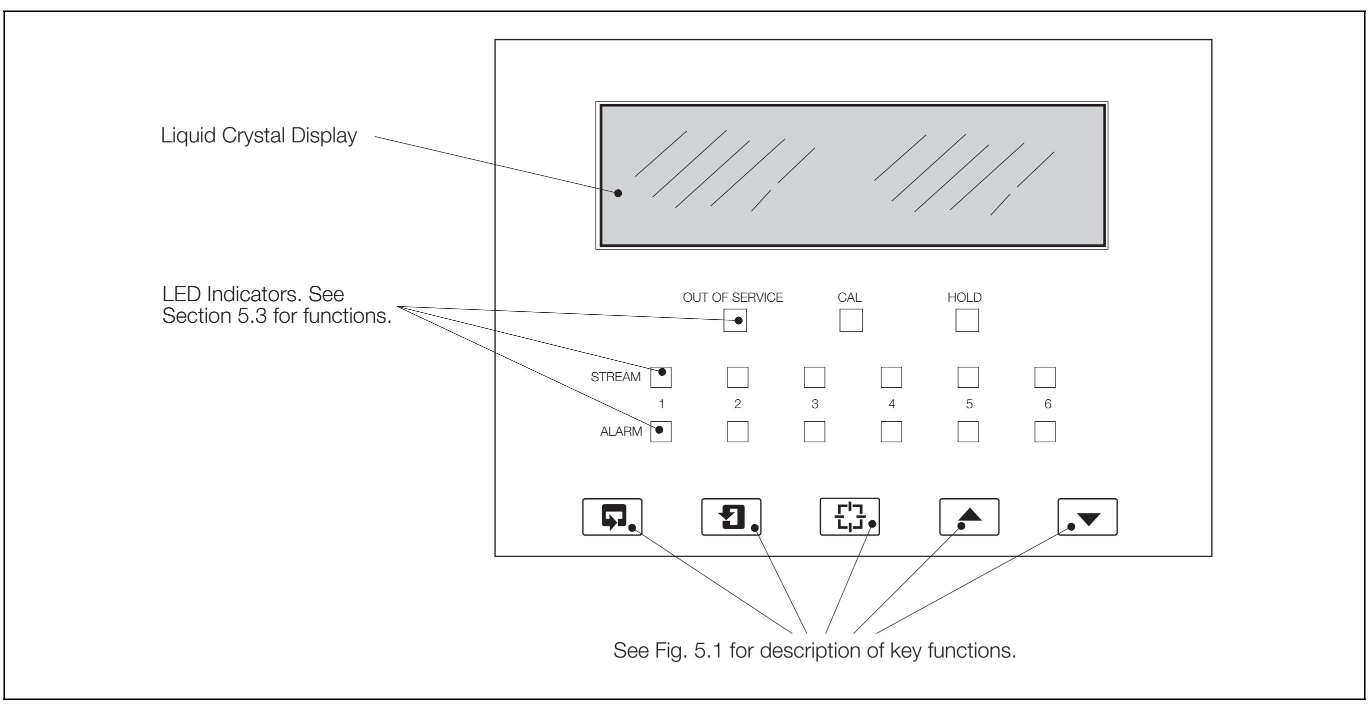


Fig. 5.2 Front Panel Controls – Multi-Stream

5.4 Microprocessor Unit – Figs. 5.3 and 5.4

The electronic section comprises six main circuit boards which carry out the following functions:

Motherboard Comprises the user terminations, alarm relays and sockets for the four plug-in boards.

Cuvette Input Board Processes the signals from the two photocells and controls the lamp brightness.

Microprocessor Board The heart of the electronics section which controls all aspects of the monitor.

Drive Board Provides outputs to drive internal functions, i.e. stream selection, calibration value, pump motor and heater control.

Output Board Provides current, alarm outputs and, if fitted, the serial interface.

Display Board Connected to the microprocessor board by a ribbon cable and provides display and keypad functions.

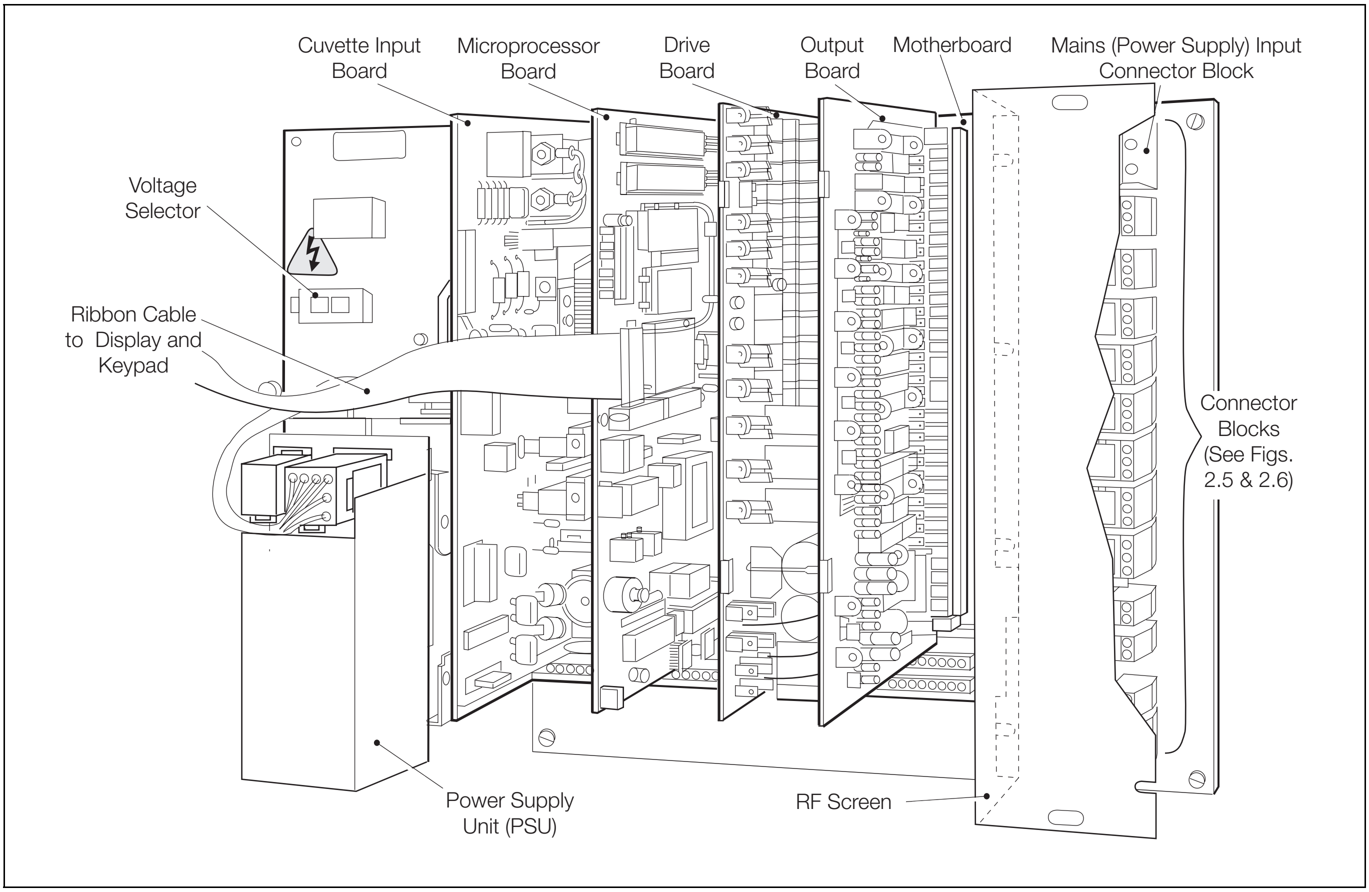


Fig. 5.3 Microprocessor Unit

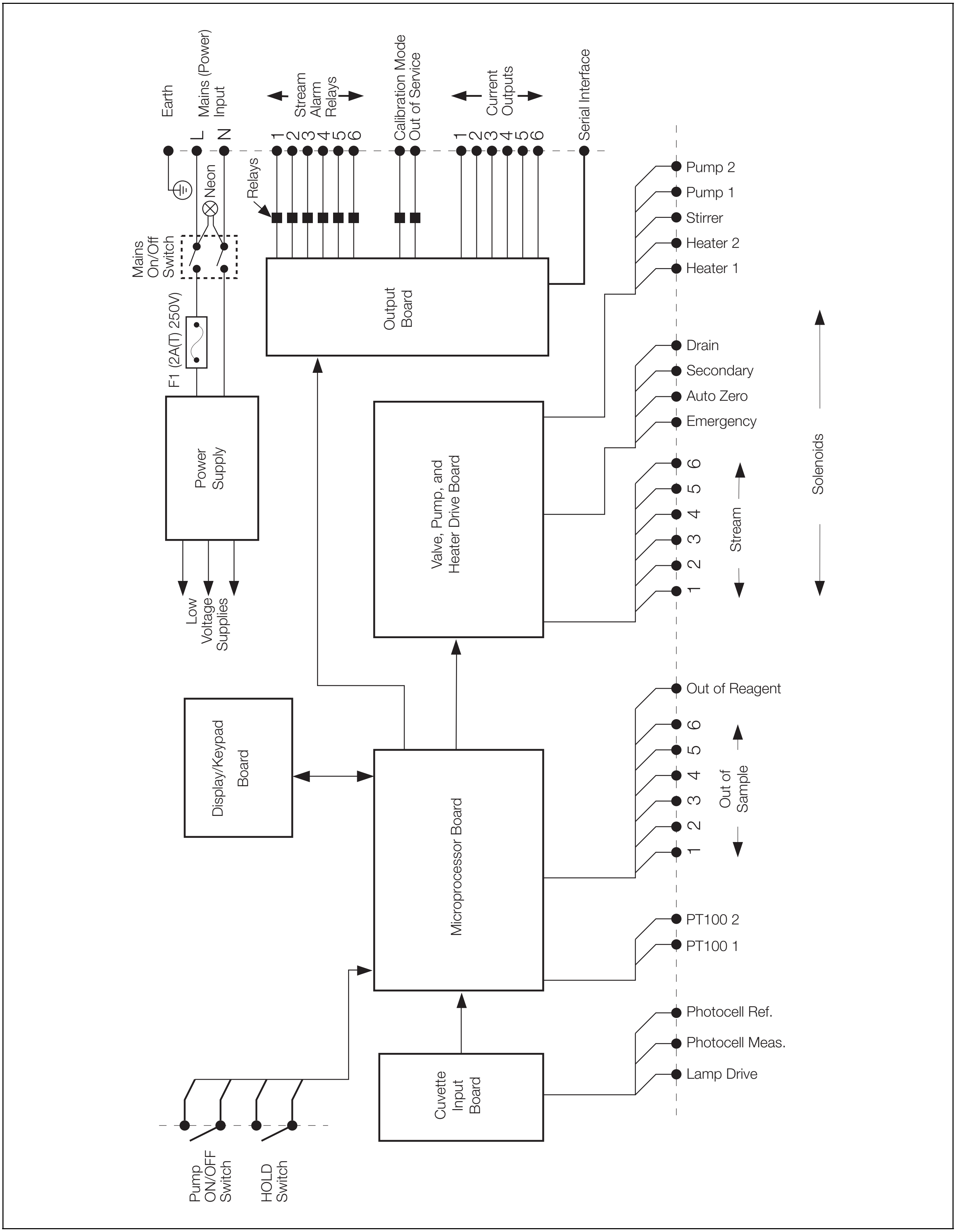
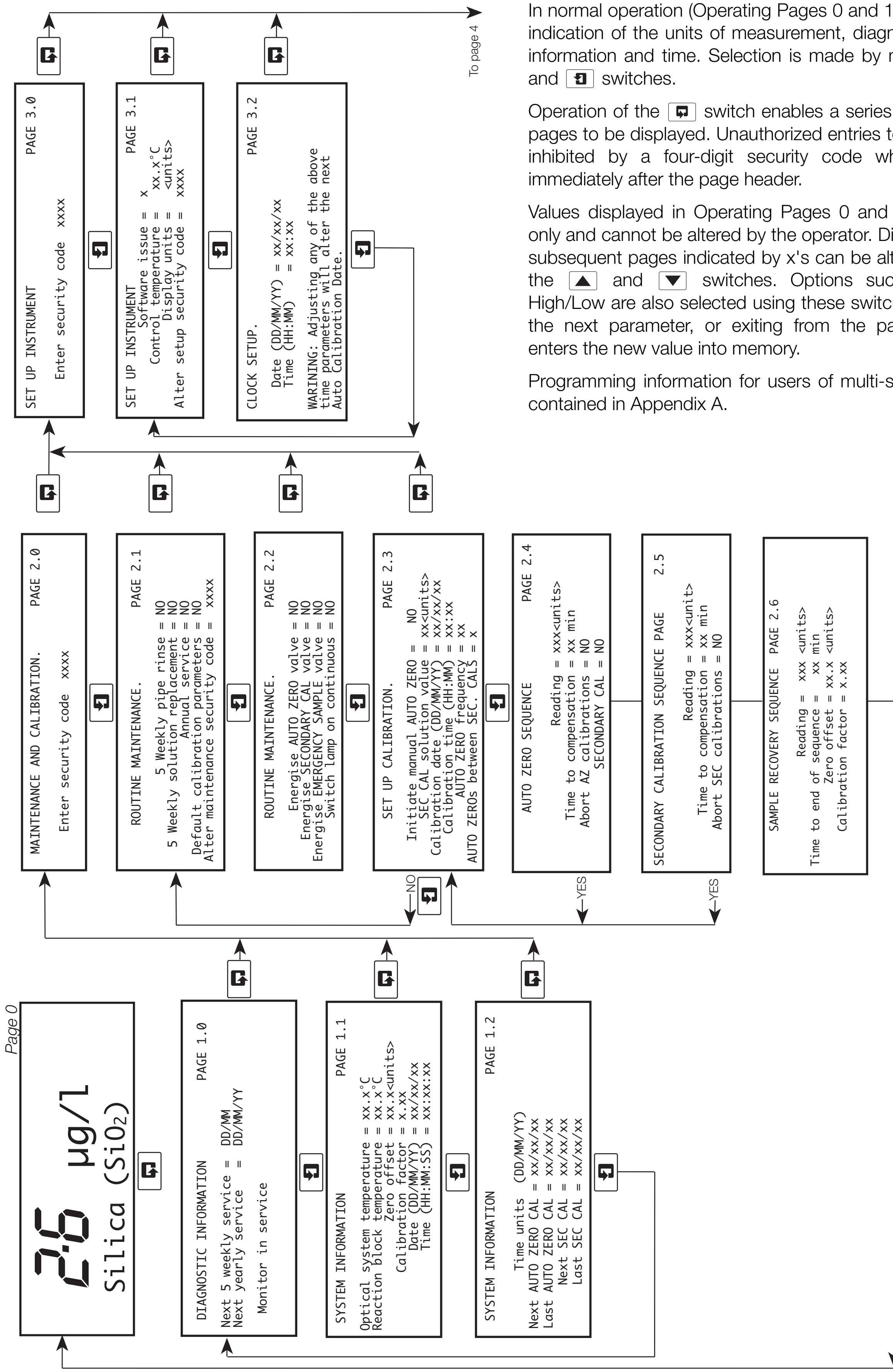


Fig. 5.4 Electronics Section Schematic

6 Single Stream Programming



In normal operation (Operating Pages 0 and 1) the display gives indication of the units of measurement, diagnostics, calibration information and time. Selection is made by means of the ⮌ and ⮐ switches.

Operation of the ⮌ switch enables a series of 'programming' pages to be displayed. Unauthorized entries to these pages are inhibited by a four-digit security code which is displayed immediately after the page header.

Values displayed in Operating Pages 0 and 1 are for viewing only and cannot be altered by the operator. Displayed values on subsequent pages indicated by x's can be altered by means of the ▲ and ▼ switches. Options such as Yes/No or High/Low are also selected using these switches. Passing onto the next parameter, or exiting from the page, automatically enters the new value into memory.

Programming information for users of multi-stream monitors is contained in Appendix A.

From Page 3

```
SET UP CURRENT OUTPUTS              PAGE 4.0

  Output range 1 = 0 to  xxx <units>
Calibration hold = NO
  Output range 2 = 0 to  xxx <units>
Calibration hold = NO
     Output type = xx to xx mA
     Test output = NO
```

```
ALARM RELAY SETUP                   PAGE 5.0

  A1 enabled = NO
 A1 setpoint = xxx <units>
   A1 action = LOW
  A2 enabled = NO
 A2 setpoint = xxx <units>
   A2 action = LOW
```

```
COMMON RELAY CONFIGURATION          PAGE 5.1

    Alarm failsafe = YES
       Alarm delay = xx min
  Alarm hysteresis = xx %
```

```
FACTORY SETTINGS                    PAGE 6.0

Enter factory settings
         security code   xxxx
```

```
FACTORY SETTINGS                    PAGE 6.1

WARNING : These parameters are factory
set and should not normally require
adjustment. They can only be set up if
the necessary equipment is available.
DO NOT PROCEED WITHOUT CONSULTING THE
OPERATION MANUAL.
```

```
ELECTRICAL CALIBRATION.             PAGE 6.2

              Reading = xxx<units>
  Lamp alignment V read =  x.xxx Volts
  Lamp alignment V ref  =  x.xxx Volts
Alter factory settings
         security code    xxxx
```

```
ELECTRICAL CALIBRATION              PAGE 6.3

Read I/P zero -2V    xxxxx
Read I/P span +2V    xxxxx
 Ref I/P zero -2V    xxxxx
 Ref I/P span +2V    xxxxx
```

```
ELECTRICAL CALIBRATION              PAGE 6.4

Temperature chan1 zero 100Ω    xxx.x
Temperature chan1 span 150Ω    xxx.x
Temperature chan2 zero 100Ω    xxx.x
Temperature chan2 span 150Ω    xxx.x
```

```
ELECTRICAL CALIBRATION              PAGE 6.5

      Current output 1 4mA
      Current output 1 20mA
      Current output 2 4mA
      Current output 2 20mA
```

```
INSTRUMENT TIMING                   PAGE 6.6
 Measured variable filter = ON
     Maximum output range = 0-xxxx

     Cuvette filling time = xxx s
           AUTO ZERO time = xxx min
SECONDARY CALIBRATION time = xxx min
   Recovery on sample time = xxx min
```

```
CALIBRATION ALARM SETUP             PAGE 6.7

Zero offset range = 0.0+/- xxx<units>
Cal factor range  = 1.0+/- x.xx
```

To Page 0

Note.

- The security code on Programming Page 6.0 is set at the factory to prevent alterations by unqualified personnel. The security code for this page is available on request.
- Pressing advances to the next main page, e.g. 2.2 to 3.0.
  Pressing advances to the next sub-page, e.g. 5.0 to 5.1.
- If an incorrect security code is entered and is pressed, access to the sub-pages is not allowed but the current page level is maintained.

  Pressing displays Page 0.

6.1 Operating Page

```
2·6 µg/l
Silica (SiO2)
```

Page 0. Normal operation display page.

6.2 Page 1 – Diagnostics

```
 DIAGNOSTIC INFORMATION          PAGE 1.0

Next 5 weekly service  =  DD/MM
Next yearly service    =  DD/MM/YY


  Monitor in service
```

Indicates the date when the next relevant routine maintenance is required. When the date is exceeded, 'overdue' is displayed, and in the case of the 5-weekly service, the 'Out of Service' LED is illuminated

This message indicates that the monitor is working normally but it is replaced with the relevant information, when necessary, by the monitor diagnostics – see Section 8.4.1, page 34.

```
 SYSTEM INFORMATION              PAGE 1.1

Optical system temperature  =  xx.x°C
Reaction block temperature  =  xx.x°C
               Zero offset  =  xx.x<units>
        Calibration factor  =  x.xx
           Date (DD/MM/YY)  =  xx/xx/xx
           Time (HH:MM:SS)  =  xx:xx:xx
```

The control temperature of the two heaters is displayed in °C.

Zero Offset indicates the zero drift since the last BASELINE AUTO ZERO CALIBRATION.

The Calibration Factor is calculated after a SECONDARY CALIBRATION; the nominal value is 1.00 but this differs between individual monitors and the reaction control temperature. It is intended to indicate the condition of the monitor and the chemical solutions.

Current date and time.

```
 SYSTEM INFORMATION              PAGE 1.2

       Time units  (DD/MM/YY)
Next AUTO ZERO CAL  =  xx/xx/xx
Last AUTO ZERO CAL  =  xx/xx/xx
      Next SEC CAL  =  xx/xx/xx
      Last SEC CAL  =  xx/xx/xx
```

The date when the next AUTO ZERO CALIBRATION is to be carried out. If the automatic calibration is disabled, then OFF is displayed in place of the date.

The date of the last ZERO calibration.

The date when the next SECONDARY CALIBRATION is to be carried out. If the secondary calibration is disabled, then OFF is displayed in place of the date.

The date of the last SECONDARY calibration.

6.3 Page 2 – Maintenance and Calibration

```
MAINTENANCE AND CALIBRATION.    PAGE 2.0

   Enter security code   xxxx
```

Enter the value of the previously entered security code.

Set the following three parameters to YES when the tasks are carried out. Once set to YES change the display on Page 0 to the required value.

```
    ROUTINE MAINTENANCE.        PAGE 2.1

            5 Weekly pipe rinse = NO
  5 Weekly solution replacement = NO
                 Annual service = NO
 Default calibration parameters = NO
Alter maintenance security code = xxxx
```

Set the date of the next 5-weekly service.

Sets the date of the next yearly service.

Used during routine maintenance to check the stability of the monitor prior to calibration.

Enter a security code (up to four digits) if required.

All programming Page 2.2 parameters normally set to NO, set to YES as required (setting is maintained).

```
      ROUTINE MAINTENANCE.     PAGE 2.2

      Energise AUTO ZERO valve = NO
  Energise SECONDARY CAL valve = NO
Energise EMERGENCY SAMPLE valve = NO
      Switch lamp on continuous = NO
```

Used to energize the appropriate solenoid valve for test purposes and operating the monitor on synthetic solutions.

Used to carry out tests on the electronic and optical sections.

> **Note.** If any of the parameters on Page 2.2 are set to YES, except for the EMERGENCY valve, it will not be possible to proceed to Page 2.3.

```
     SET UP CALIBRATION.      PAGE 2.3

  Initiate manual AUTO ZERO = NO
     SEC CAL solution value = xx<units>
Calibration date (DD/MM/YY) = xx/xx/xx
   Calibration time (HH:MM) = xx:xx
        AUTO ZERO frequency = xx
AUTO ZEROs between SEC.CALS = x
```

Set to ROUTINE or BASELINE depending on the type of Auto Zeroing required – see Section 7, page 27.

Used to enter the value of the Secondary Calibration solution prior to calibration.

Sets the date when the first timed automatic calibration is to be carried out.

Sets the time when the first timed automatic calibration is to be carried out.

Sets the frequency at which the AUTO ZERO calibration takes place. Select: OFF, 12 h, 1 day, 2 days,......7 days.

Sets the number of AUTO ZERO calibrations that take place between AUTO SECONDARY calibrations. Select 0 to 10 in one unit increments. When 0 is selected a two-point calibration will be carried out whenever a timed calibration takes place. When SEC CAL set to OFF only Auto Zeros will take place.

Note. Programming Pages 2.4 and 2.5 are part of the automatic calibration sequence. These displays cannot be changed from these pages unless the sequence is aborted.

```
     AUTO ZERO SEQUENCE       PAGE 2.4

                 Reading = xxx<units>
    Time to compensation = xx min
   Abort AZ calibrations = NO
           SECONDARY CAL = NO
```

Reading during calibration prior to compensation.

Remaining time to the end of the Auto Zero sequence.

When set to YES the sequence is aborted. The original zero offset value is maintained.

When set to YES a two-point calibration takes place. This option is not available when a BASELINE AUTO ZERO is selected.

```
SECONDARY CALIBRATION SEQUENCE PAGE 2.5

                  Reading = xxx<unit>
     Time to compensation = xx min
   Abort SEC calibrations = NO
```

Reading during calibration prior to compensation.

Remaining time to the end of the Secondary Calibration sequence.

When set to YES the sequence is aborted. The original calibration factor value is maintained.

```
SAMPLE RECOVERY SEQUENCE      PAGE 2.6

                Reading =  xxx <units>
Time to end of sequence =   xx min
            Zero offset = xx.x <units>
     Calibration factor = x.xx
```

Reading during recovery back onto the sample. The display shows the reading which incorporates new calibration values.

Remaining time to end of sequence.

See Programming Page 1.1.

6.4 Page 3 – Set Up Instrument

```
SET UP INSTRUMENT              PAGE 3.0

    Enter security code   xxxx
```

Enter the value of the previously entered security code.

```
SET UP INSTRUMENT              PAGE 3.1
           Software issue =  x
      Control temperature =  xx.x°C
            Display units =  <units>
Alter setup security code =  xxxx
```

Shows the current software issue level.

Set the required control temperature within the range 35 to 45°C in 0.1°C increments. This temperature should be set to 37°C or 5°C above the maximum ambient temperature expected.

Set the required display units for silica concentration (ppb, µg/l or µg/kg).

Enter setup security code (up to four digits) if required.

```
CLOCK SETUP.                  PAGE 3.2

       Date (DD/MM/YY)  =  xx/xx/xx
       Time (HH:MM)     =  xx:xx

WARNING: Adjusting any of the above
time parameters will alter the next
Auto Calibration Date.
```

Set the current (real) date.

Set the current (real) time.

6.5 Page 4 – Set Up Current Outputs

```
SET UP CURRENT OUTPUTS         PAGE 4.0

  Output range 1 = 0 to  xxx <units>
Calibration hold = NO
  Output range 2 = 0 to  xxx <units>
Calibration hold = NO
     Output type = xx to xx mA
     Test output = NO
```

Set the current output to any range between the following maximum and minimum limits of SiO2, 0 to 2000µg/l range instrument – 0 to 20 and 0 to 2000µg/l, or 0 to 50 and 0 to 5000µg/l.

If set to YES the Current Outputs are held during calibration.

Set to one of the following ranges: 0 to 10, 0 to 20 or 4 to 20mA.

If required, the instrument can automatically transmit a percentage of the full scale test signal: 0, 25, 50, 75, 100% of the current output selected.

6.6 Page 5 – Alarm Relay Setup

```
   ALARM RELAY SETUP         PAGE 5.0

  A1 enabled = NO
 A1 setpoint = xxx <units>
   A1 action = LOW
  A2 enabled = NO
 A2 setpoint = xxx <units>
   A2 action = LOW
```

Select YES or NO as required.

Set the required setpoint values within the instrument range.

Select the alarm action required – HIGH or LOW.

```
COMMON RELAY CONFIGURATION     PAGE 5.1

    Alarm failsafe = YES
       Alarm delay = xx min
  Alarm hysteresis = xx %
```

If fail-safe action is required select YES.

Relay actuation and alarm LED indication can be delayed in the event of the alarm condition. If the alarm condition clears within the programmed delay time, the alarm function is not activated and the delay time is reset. Set the required delay time in the range 0 to 99 minutes in 1 minute increments.

A differential set point can be set as a percentage of the set point value. The differential setting operates on the set point. Example – a 5% differential setting operates 2.5% above and below the setpoint.

6.7 Page 6 – Factory Settings

Set the differential required between 0 and 5% in 1% increments.

```
   FACTORY SETTINGS            PAGE 6.0

  Enter factory settings
           security code     xxxx
```

Enter the value of the previously entered security code.

```
     FACTORY SETTINGS         PAGE 6.1

 WARNING : These parameters are factory
 set and should not normally require
 adjustment. They can only be set up if
 the necessary equipment is available.
 DO NOT PROCEED WITHOUT CONSULTING THE
 OPERATION MANUAL.
```

```
   ELECTRICAL CALIBRATION.    PAGE 6.2

                Reading = xxx<units>
  Lamp alignment V read =  x.xxx Volts
  Lamp alignment V ref  =  x.xxx Volts
 Alter factory settings
          Security code   xxxx
```

Used for diagnostic purposes only.

Displays the output of the photocell pre-amplifiers. Used only for information and photocell balance adjustment.

Enter a security code (up to four digits) if required.

```
ELECTRICAL CALIBRATION     PAGE 6.3

Read I/P zero -2V   xxxxx
Read I/P span +2V   xxxxx
 Ref I/P zero -2V   xxxxx
 Ref I/P span +2V   xxxxx
```

Used for the calibration of the A and D converter. This is set up during the manufacture of the processor board and must not be changed unless full details of the procedure are known.

```
ELECTRICAL CALIBRATION     PAGE 6.4

Temperature chan1 zero 100Ω    xxx.x
Temperature chan1 span 150Ω    xxx.x
Temperature chan2 zero 100Ω    xxx.x
Temperature chan2 span 150Ω    xxx.x
```

Connect a 100Ω resistance to the input of the respective temperature input.

Connect a 150Ω resistance to the input of the respective temperature input.
Wait for the display to stabilize before moving on to the next step. The new calibration datum is automatically entered.

```
ELECTRICAL CALIBRATION     PAGE 6.5

     Current output 1 4mA
     Current output 1 20mA
     Current output 2 4mA
     Current output 2 20mA
```

Calibration is performed on the 4 to 20mA range, but values are valid for 0 to 10 and 0 to 20mA ranges.
Connect a digital current meter to the respective output terminals and use the raise and lower buttons to adjust the respective output up or down to within <±0.25% of the maximum current output.

```
    INSTRUMENT TIMING         PAGE 6.6
 Measured variable filter = ON
     Maximum output range = 0 - xxxx

     Cuvette filling time = xxx s
           AUTO ZERO time = xxx min
SECONDARY CALIBRATION time = xxx min
   Recovery on sample time = xxx min
```

For service purposes only. Must normally be set to ON. When set to OFF, the signal processing to remove the effects of chemical noise and air bubbles is bypassed.

Set to 2000µg/l or 5000µg/l to suit the cuvette fitted, i.e. 50mm path cuvette = 2000µg/l and 10 mm path cuvette = 5000µg/l.

Cuvette filling time normally set to 40s (0 to 5000µg/l system) or 55s (0 to 2000µg/l system) to ensure that the cuvette overflows before the lamp is switched on.

35min
20min
20 min

These do not require further adjustment except for Recover On Sample Time which can be increased if the sample value is near zero.

```
CALIBRATION ALARM SETUP     PAGE 6.7

 Zero offset range  = 0.0 +/- xxx <units>
 Cal factor range   = 1.0 +/- x.xx
```

Enables the acceptable range of zero offset to be selected before a calibration fail alarm is initiated. 50 to 500, OFF, normally set to 100.

Enables the acceptable range of calibration factor to be selected before a calibration fail alarm is initiated. 0.15 to 0.5, OFF, normally set to 0.2.

7 Calibration

Calibration of the monitor is carried out by replacing the sample solution sequentially with two solutions of known silica concentration – see Section 4.1, page 10. Initially a zero silica solution, which is generated internally by the monitor then, if required, a secondary solution is passed through the monitor – see Section 8.1.2, page 29. This calibration sequence can be initiated automatically at preset times, or manually on demand. Since most of any drift which takes place affects the zero more than the sensitivity, the monitor can be set up to carry out regular AUTO ZERO calibrations and less frequent AUTO SECONDARY calibrations. This reduces the instrument 'down time' to an absolute minimum. Manual one or two point calibration sequences can also be initiated. Calibration programming is covered in Section 6 (single stream) and Appendix A (multi-stream).

On initiation, either manual or automatic, the 'Cal' LED is illuminated and the remote Calibration Mode relay is energized. Two solenoid valves, SV2 and SV3, are energized sequentially to generate the zero solution and then (if selected) to admit the secondary standard solution. At each stage of the sequence, sufficient time is allowed to displace the previous solution and allow the reading to stabilize.

The calibration sequence is shown in Table 7.1.

After calibration, the outputs from the optical system corresponding to the two solutions, are used to calculate new zero and calibration factor values, thus compensating for any drift or sensitivity in the reagents or liquid handling performance characteristics.

The new zero and calibration factor can be displayed in Operating Page 1 (a calibration factor of 1.00 is the nominal value). This parameter is intended to indicate the performance of the monitor and in particular the chemical solutions. If the value is outside factory pre-set limits, a calibration fail alarm is initiated and the 'Out of Service' LED is lit.

The calibration factor can be defaulted to 1.00 (see Programming Page 2.2) following maintenance. The displayed reading can be brought onto scale with the ▲ and ▼ switches to allow the reading to be observed to assess the stability of the monitor prior to carrying out a calibration.

Initially, a BASELINE AUTO ZERO calibration is manually initiated to establish the new base line zero when a new reagent solution is installed. This sets the zero offset value, displayed on Programming Page 1, to 00.0. Following a BASELINE AUTO ZERO a SECONDARY calibration is initiated. Subsequent timed ROUTINE AUTO ZEROs generate a new zero offset value which can then be assessed to check for zero drift within the life of the reagents (normally five weeks). If the zero offset is outside factory pre-set limits, a calibration fail alarm is initiated and the 'Out of Service' LED is lit.

Activity	AUTO ZERO	Introduce SECONDARY CALIBRATION Solution (if selected)	Introduce Sample	Normal Operation
Valve Energized	SV3	SV2	None	None
Timing (Default)	35 minutes	20 minutes	20 minutes	

Table 7.1 Calibration Sequence

8 Maintenance

8.1 Chemical Solutions

The reagent and standard solutions listed below are necessary to maintain the monitor in operation. It is recommended that the solutions should be freshly made and stored in polyethylene containers. Polyethylene apparatus should also be used to prepare the solutions where possible.

Caution. Great care must be taken to avoid contamination of these solutions with silica which is present all around us. Reagent and standard solution containers must be emptied and then rinsed with high purity water, not simply topped up. Tops on containers must always be fitted to keep out dust which can contain large concentrations of silica. The performance of the monitor relies heavily on the integrity of these solutions, so it is very important that they are prepared, stored and handled with great care.

If solutions are purchased from a proprietary chemical supplier, care should be exercised in storing the containers. They should be date stamped, used in strict rotation and not used after their expiry date.

8.1.1 Reagent Solutions

The following four reagent solutions are necessary to maintain the monitor in operation for a period of five weeks. The containers and associated tubing are color coded for ease of identification.

Warning.

- Concentrated sulfuric acid must be handled with great care at all times; in particular, ensure that when diluting concentrated acid, it is added to the water, not water to the acid. Wear appropriate protective clothing, i.e. rubber gloves and full face protection.
- Concentrated ammonia solution is extremely volatile and toxic; it must always be handled under a fume hood. Wear appropriate protective clothing, i.e. rubber gloves and full face protection.

- **1st Acid – 0.3M sulfuric acid (RED channel)**

  Place approximately 4 litres high purity water in a plastic beaker and carefully add 160 (±0.5)ml analytical reagent grade concentrated sulfuric acid, H_2SO_4, (1.84 s.g.). Transfer the solution to a 10 litre plastic container and make up to 10 litres with more high purity water.

- **Ammonium molybdate solution (VIOLET channel)**

  Dissolve 150 (±1)g analytical reagent grade ammonium molybdate, $(NH_4)_6Mo_7O_{24}.4H_2O$, in approximately 6 litres high purity water. Transfer the solution to a 10 litre plastic container, add 30 (±5)ml ammonia solution, NH_4OH, (0.880 s.g.) and make up to 10 litres with more high purity water.

- **2nd Acid – 1.0M sulfuric acid (ORANGE channel)**

  Place approximately 7.5 litres high purity water in a polyethylene beaker. Surround the beaker with running cold water and add slowly and carefully 545 (±1)ml of analytical reagent grade concentrated sulfuric acid, H_2SO_4, (1.84 s.g.). Stir the solution continuously during the addition. Add 200 (±10)g analytical reagent grade citric acid crystals, $C_6H_8O_7.H_2O$ and stir to dissolve. Allow the solution to cool to room temperature and then transfer to a 10 litre plastic container. Make up to 10 litres with more high purity water.

  Note. The citric acid quantity must be increased to 120g l^{-1} in this reagent if phosphate is present in the sample water.

- **Reduction solution – ascorbic acid (BROWN channel)**

  Dissolve 132 (±1)g analytical reagent grade ascorbic acid, $C_6H_8O_6$, in approximately 6 litres of high purity water. Add to this solution 0.60 (±0.01)g analytical reagent grade disodium – EDTA, $C_{10}H_{14}O_8N_2Na_2.2H_2O$. When dissolved, add 13 (±1)ml analytical reagent grade formic acid, H(COOH) and transfer to a 10 litre plastic container. Dilute to 10 litres with more high purity water.

The '1st Acid' and '2nd Acid' reagents have a shelf life of several months; the molybdate and reduction solutions should be prepared for immediate use. The latter, when stored at room temperature, loses up to approximately 5% of its activity in one month.

8.1.2 Standard Solutions

> **Note.** Ideally the high purity water used for diluting the standard solution should contain less than 1µg l^{-1} SiO_2. If, however, this is not possible to obtain and the silica concentration is known, it is recommended that allowance is made for the background level in the high purity water when calculating the actual silica concentration of the standard.

A stock solution of 1000mg l^{-1} silica, SiO_2, can be obtained in one of the following three ways:

1. **the preferred method**

   Purchase a 1000mg l^{-1} SiO_2 stock solution* from a proprietary chemical supplier.

   or

2. **from sodium fluorosilicate**
   a. Dissolve 3.133 (±0.001)g of sodium fluorosilicate (Na_2SiF_6 – the purest grade available) in approximately 900ml of high purity water. Ensure that all solid has dissolved fully by stirring the solution for several hours.
   b. Transfer the solution to a one litre volumetric flask and make up to the mark with more high purity water.
   c. Store the solution in a polyethylene bottle.

   or

3. **from sodium metasilicate**
   a. Dissolve 3.530 (±0.001)g of sodium metasilicate penta hydrate ($Na_2SiO_3.5H_2O$ – the purest grade available) in approximately 900ml of high purity water. Ensure that all solid has dissolved fully by stirring the solution for several hours.
   b. Transfer the solution to a one litre volumetric flask and make up to the mark with more high purity water.
   c. Store the solution in a polyethylene bottle.

** If a stock solution of 1000mg l^{-1} silicon (Si) is available, this can be diluted to obtain a 1000mg l^{-1} SiO_2 solution by taking 46.81ml and diluting to 100ml with high purity water in a volumetric flask. The dilution factor is 2.139 times.*

> **Note.** The accuracy of the monitor over its total range is governed by the choice of the secondary standard solution value. A monitor calibrated at 20µg l^{-1}, for example, would not exhibit the best accuracy at 2000µg l^{-1}.
>
> In the case of a multi-stream, the concentration of the solution should be chosen to coincide with the point of greatest required accuracy. However, a value that corresponds to 80% of the current output range would be more appropriate for a single stream monitor.

Dilute the appropriate stock solution with high purity water to obtain the secondary calibration solution. The dilution should be carried out using polyethylene apparatus wherever possible.

> **Note.**
> - Store all standard solutions in tightly stoppered polyethylene bottles.
> - The stock solutions remain stable for approximately one year, but standard solutions with concentrations of less than 1mg l^{-1} should be prepared only for immediate use.

8.1.3 Rinse Solution for Internal Pipework

It is important that the internal pipework of the monitor is cleaned every five weeks as part of the routine maintenance. This prevents the gradual fouling of molybdate precipitation in the pipework which can introduce errors. Problems such as noise can also be caused by contaminated pipework.

> **Warning.** Sodium hydroxide is extremely caustic and must be handled with great care. Wear gloves and eye protection.

One litre of the rinse solution is prepared as follows:

1. Dissolve 100g of sodium hydroxide pellets, NaOH, in approximately 600ml of high purity water in a plastic container. Allow the solution to cool to ambient temperature.
2. Add to the solution 5g di-sodium EDTA and stir to dissolve.
3. Transfer the above solution to a 1 litre measuring cylinder and make to the mark with more high purity water. Mix well and store in a tightly stoppered plastic container. Stored in this container the solution is stable for many months.

8.2 Scheduled Servicing

The following servicing schedule has been produced as a general guide only. Because the monitor is designed for a wide range of applications, where the nature of the sample can vary considerably, it may be necessary to amend the schedule to suit the particular installation and sample conditions.

8.2.1 Regular Visual Checks

It is recommended that the monitor and the sampling system should be visually inspected on a regular basis to ensure the correct functioning of the system and to check the integrity of the readings.

1. Check for leaks particularly around the sample and drain pipework connections.
2. Confirm sample flow by checking delivery to the constant head unit and effluent from the drain.
3. Check liquid levels in the reagent and standard solution containers.
4. Inspect all tubing and liquid handling components for leaks and deterioration.
5. Check for malfunction indications on the instrument display.

8.2.2 Five-weekly

1. Carry out the normal visual checks detailed in Section 8.2.1.

> **Warning.** It is vital that good maintenance in this respect is adhered to and that all leaks of potentially aggressive chemical solutions are attended to as soon as possible and spillages are cleaned up.

2. Discard old reagent and standard solutions, clean containers thoroughly and refill with fresh solutions, see Section 8.1, page 28.

> **Caution.** All unused solutions must be discarded; the containers must be rinsed with high purity water before refilling with the fresh solution.

3. Replace the pinch tube between the cuvette and the drain manifold. Release the tube from the pinch valve by pressing the centre plunger and remove. Replace with new silicon rubber tube from the spares kit. Ensure that the tube is fully inserted into the valve to avoid any leakage of solution from the cuvette.
4. Set the following parameters to YES using Programming Page 2.1:

   Five-Weekly System Flush
   Five-Weekly Solution Replacement
   Default Calibration Parameters

5. Rinse internal pipework – see Section 8.2.4, page 30. It is important that this procedure is carried out to ensure that the monitor tubing is kept in a good clean condition, essential for correct monitor operation.

> **Note.** Before proceeding to the next step, multi-stream users must select single stream mode as described in Section 4.3.

6. If having not already done so energize the secondary CAL valve (see Programming Page 2.3) and leave for 15 minutes. Adjust the reading on scale with the ▲ and ▼ switches and run the monitor for one to two hours to purge the old solution and assess stability.
7. If the monitor exhibits good stability, i.e. ±2% of reading, carry out a two-point BASELINE calibration – see Programming Page 2.3.
8. Check the condition of the sample filters and replace them if necessary. Ensure that new filters are fitted correctly by taking note of the flow directions indicated on the filter bodies.

8.2.3 Twelve-monthly

1. Service pump – see Section 8.2.6, page 31.
2. Replace all internal plumbing tubing – see Section 8.2.7, page 31.
3. Set 'Annual Service' to YES – see Programming Page 2.1.
4. Carry out the normal five-weekly schedule not already covered in steps 1) and 2).

8.2.4 Rinsing Internal Pipework

> **Note.**
> - It cannot be stressed strongly enough that the five-weekly chemical clean with the rinse solution is vitally important. It is also very effective at reducing calibration problems, drift and signal noise. Any evidence of white or blue precipitate in the mixer or reaction coil must be removed with the rinse solution.
> - If the routine cleaning procedure has not been carried out on a regular basis as scheduled, or the liquid handling section is in poor condition, run the rinse solution through the monitor for several hours.

Carry out the following procedure on a five-weekly basis:

1. Remove the secondary standard tube from the solution container and immerse in the rinse solution.
2. Energize the secondary cal. valve (see Section 6, page 19, Programming Page 2.2) and allow the rinse solution to run through the monitor for about 30 minutes.
3. Remove the secondary solution tube from the rinse solution, wash it well with high purity water and return it to the secondary calibration solution.
4. Carry out a calibration of the monitor as described in Section 8.2.2, starting at step 6).

8.2.5 Consumable Spares Kit – see Section 10

If one is not supplied, it should be ordered before the end of the first year of operation. This kit includes all the components which are recommended for annual replacement (refer to the details in the spares kit). This annual refurbishment ensures a high level of reliability from the monitor for many years. The kit should be re-ordered when used so that all the items are available throughout the following years operation.

The kit contains:

- one set of pump tubing,
- one set of pump capstans,
- a syringe for checking free flow though valved and tubing and for clearing blockages,
- a complete set of plumbing tubing and
- sundry items – 'O' rings, tube connectors, pump tube bungs and sample filters.

8.2.6 Peristaltic Pump – Fig. 8.1

It is recommended that the pump tubing and pump capstans, supplied in the Consumable Spares Kit, are replaced after one year of operation. Carry out the procedure given in Fig. 8.1.

8.2.7 Replacement of Plumbing Tubing – Fig. 8.2

All the following items are included in the Consumable Spares Kit.

> **Caution.** It is essential that the correct tube, which was chosen with great care, is fitted in each position. Failure to do this could upset the performance of the monitor or result in solution leakages around connections due to chemical attack.

1. Remove each section of the sample and reagent plumbing tubing in turn and replace with new tubing of the same length.
2. Remove drain tubing and replace with new tubing of the same length.
3. It is recommended that the sample and drain tubing to and from the monitor is inspected and replaced if the condition of the tubing is poor or shows evidence of any build-up of solids.

8.3 Shutdown Procedure

The monitor can be left with the pump switch off for up to 24 hours without any detrimental effects. However, for longer periods it must be shutdown correctly to prevent chemical precipitation in the pipework resulting in extensive maintenance and recommissioning.

Perform the following Shutdown sequence:

1. Close the sample valve up-stream of the monitor.
2. Rinse the internal pipework – see Section 8.2.4, page 30. It is important to flush the reagent bottle tubes; so these need to be immersed in the rinse solution also.
3. Repeat the process with high purity water to flush out the rinse solution.
4. Switch off the monitor.
5. Remove the pressure plates from the peristaltic pumps and release the tube from the pinch valve.
6. Empty reagent and standard containers and rinse with high purity water.

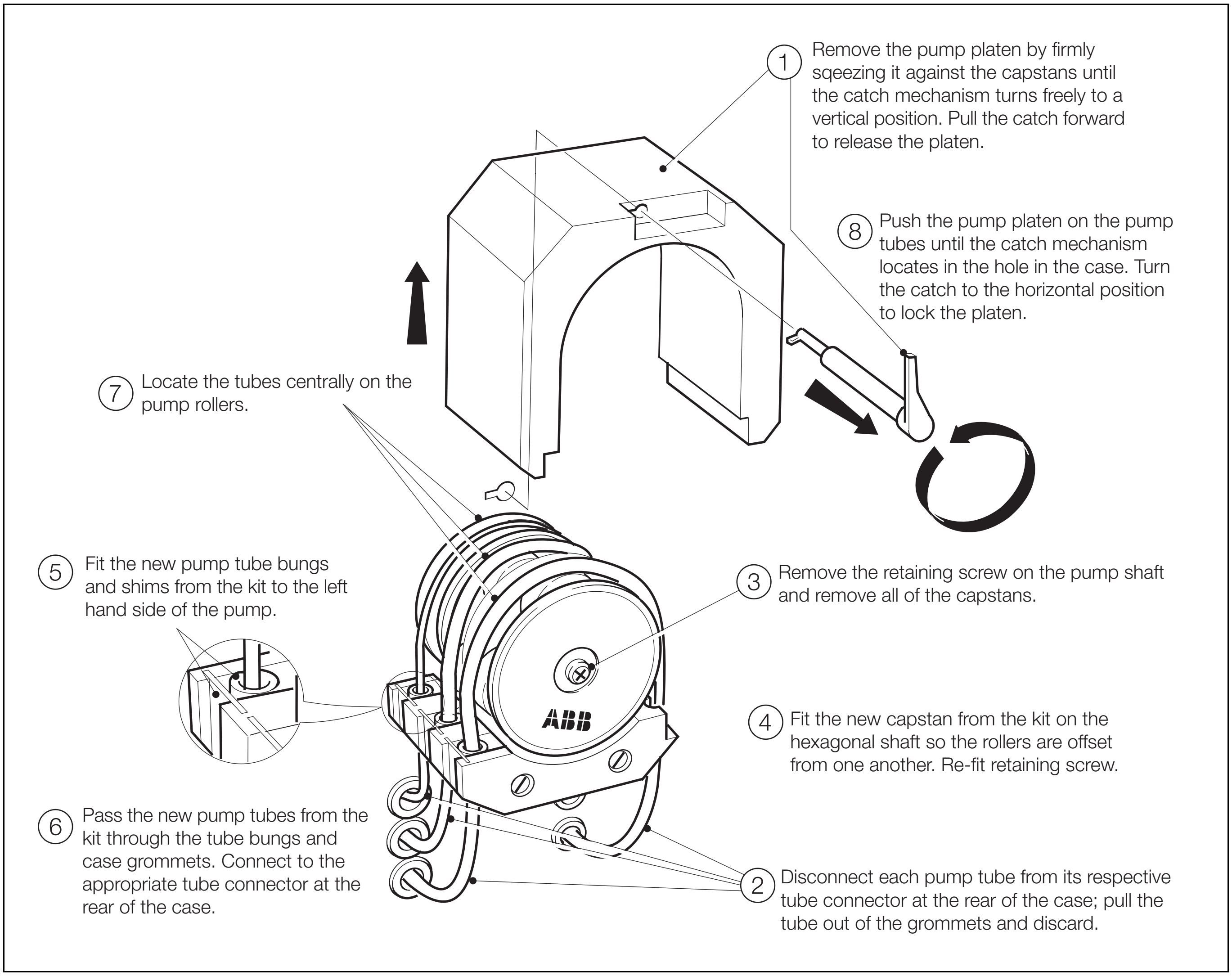
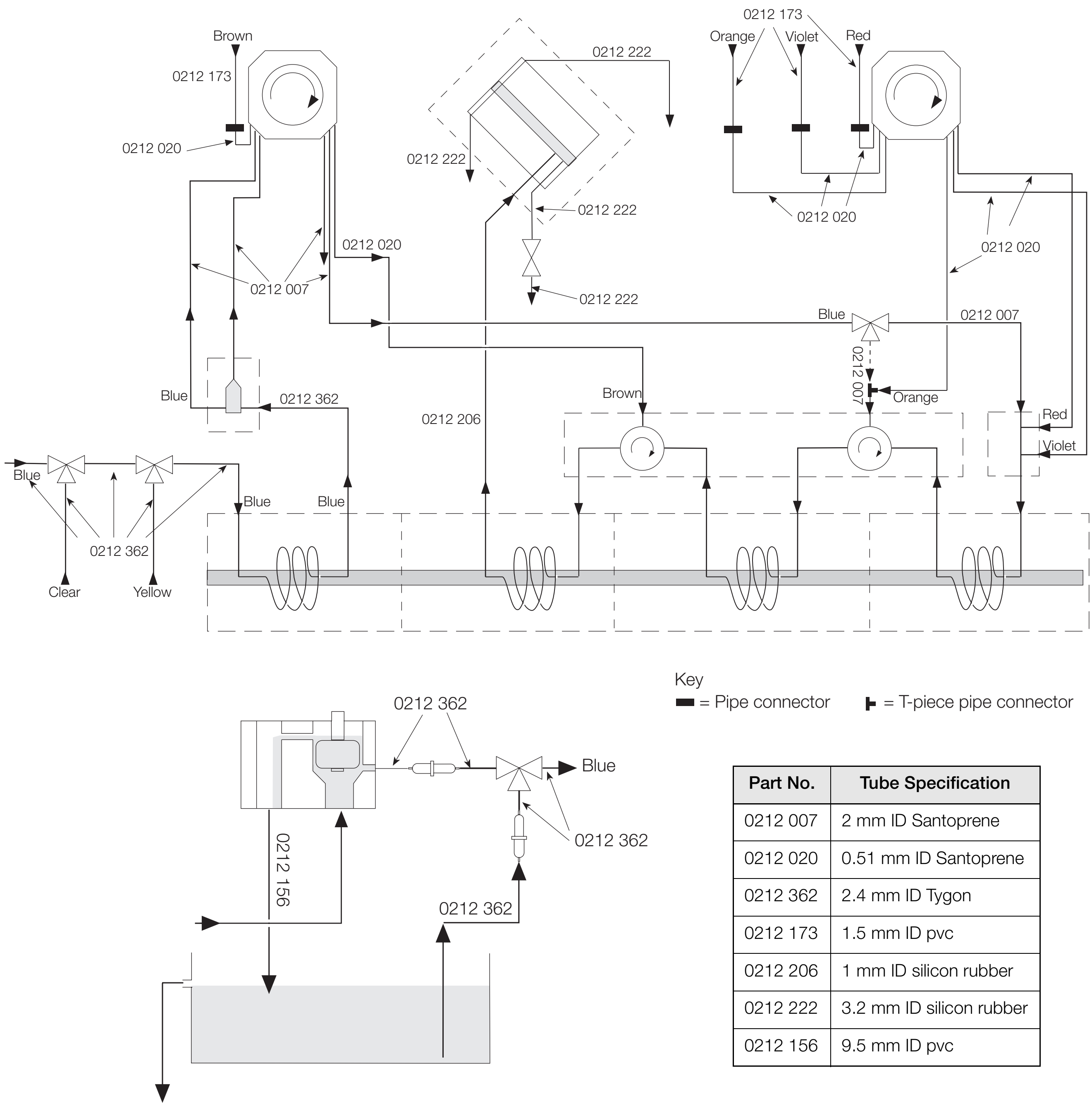


Fig. 8.1 Maintaining the Peristaltic Pump

Note.

- The bungs are designed to grip the pump tube when compressed by the platen. Two sizes of tube are used so it is essential that the correct size of bung is fitted.
- It is immaterial which tube passes over which pump roller, but for neatness the front tube should be de-gassed sample, the centre tube reagent and the rear tube, raw sample.



Key
▬ = Pipe connector ┣ = T-piece pipe connector

Part No.	Tube Specification
0212 007	2 mm ID Santoprene
0212 020	0.51 mm ID Santoprene
0212 362	2.4 mm ID Tygon
0212 173	1.5 mm ID pvc
0212 206	1 mm ID silicon rubber
0212 222	3.2 mm ID silicon rubber
0212 156	9.5 mm ID pvc

Fig. 8.2 Replacement of Plumbing Tubing

Note.

- Replace the tube between the drain manifold assembly and the contaminated drain tundish (see Fig. 1.1) with the tube provided – part no. 8241 146.
- Tube specifications for the multi-stream version are as those in the table, but repeated for each stream.

8.4 Unscheduled Servicing

8.4.1 Monitor Diagnostic Information

The monitor is fitted with extensive diagnostics which provide information on routine servicing and problems that have developed. Any one of these problems illuminate the 'Out of Service' LED and de-energize the normally energized 'Out of Service' alarm relay. Timed calibration is inhibited but could be started manually. This alarm also goes into an alarm state when the monitor is switched off. The information is displayed when an alarm has been raised to indicate the cause of the problem. The diagnostics are displayed in Table 8.1.

8.4.2 Malfunction of the Monitor

A calibration fail for any reason could be caused by almost any part of the liquid handling section of the monitor including the solutions.

Mechanical components which are involved with the liquid handling, e.g.: pumps; valves; tubing and tubing connections, should be systematically checked for correct operation and for leaks or blockages which change the chemical conditions within the monitor.

> **Caution.** Check that there have been no unauthorized modifications, e.g. incorrect tubing fitted.

In the majority of cases any problems experienced are generally found to be associated with the chemistry and the liquid handling section.

Noise maybe due to air bubbles sticking in the pipework and to the walls on the cuvette. Degassing of the sample is normal due to pre-heating of the sample on entry into the liquid handling section. However, the monitor is designed so this does not normally affect its performance. If the problem is excessive a system chemical rinse should be carried out to clean and re-wet the liquid handling system and cuvette – see Section 8.2.4, page 30. Reducing the control temperature also helps – see Section 6, page 19, Programming Page 3.1.

The most common problems are associated with the reagent or standard solutions. Any unpredictable problems may be due to the standard or reagent solutions, or their flow through the monitor. If any doubts exist regarding the integrity of these solutions, they should be replaced with freshly prepared solutions in the early stages of the fault finding investigations.

If the monitor fails to produce results as expected, the most likely cause is the standards, either contaminated when handled or (and most likely) made up with poor quality water, possibly containing high levels of silica. Incorrectly prepared reagents may give a poor calibration factor. Silica, or SiO_2, forms 28% of the earths crust, so is to be found all around us in dust or dirt in bottles etc. If the solutions are purchased from a proprietary chemical supplier, care should be taken in storing the containers; they should be date stamped, used in strict rotation and not used after their expiry date. When measuring trace levels, contamination can only be avoided by preparing and handling solutions with great care. Laboratory glassware is not to be used for low concentration solutions; use plastic instead.

Display	Explanation	Action
Flashing	Parameter out of range	–
Next 5 weekly service /Overdue	Five-weekly service overdue	Carry out a five-weekly service and acknowledge (set to YES) in Programming Page 2.1 (see Section 6.3, page 22, or Appendix A for multi-stream version).
Next yearly service /Overdue	Yearly service overdue	Carry out a yearly service and acknowledge (set to YES) in Programming Page 2.1 (see Section 6.3, page 22, or Appendix A for multi-stream version).
Monitor in service	Monitor operating correctly	None.
Control temperature stabilizing	The mains power supply has been re-instated and the temperature of the two heaters is stabilizing	Allow i) sufficient time for the heaters to stabilize at their operating temperature, and ii) a further 10 minutes for a full reaction to take place.
Out of reagent	Reagent solution bottle(s) are empty	Replace reagent solution bottles.
Pumps off	Pump switch is in the OFF position	Switch pump(s) on – see Fig. 1.1.
Control temperature high	One or more of the heaters is greater than ±2°C of the control temperature setpoint	Normally this indicates a fault in the heater control unit but, in the case of a high alarm, a high ambient temperature could be the cause – see Section 6.4, page 24, Programming Page 3.1 (or Appendix A for multi-stream version).
Control temperature low		
In test mode see page 2.2	Test mode parameter(s) in Programming Page 2.2 are active (set to YES)	Refer to page indicated; check and correct the setting(s).
Excessive zero offset	Large zero drift has occurred since the last BASELINE calibration	Refer to Section 8.5.1
Calibration factor too high	Indicates higher than normal silica sensitivity	Refer to Section 8.5.2
Calibration factor too low	Indicates lower than normal silica sensitivity	Refer to Section 8.5.2

Table 8.1 Diagnostic Messages

8.4.3 Effects of Loss of Power to the Monitor

The action taken by the monitor following an unforeseen loss of power is dependant on the length of time the power was off. Table 8.2 shows the alternative actions performed by the monitor.

Status of the Monitor	Period of Loss of Power	
	Less than 5 minutes	Greater than 5 minutes
In Between Calibrations	Normal operation resumed after temperature stabilization*.	A ZERO calibration is automatically performed one hour after temperature stabilization*.
During Calibrations	After temperature stabilization*, the current calibration is re-started.	The current calibration is re-started one hour after temperature stabilization*.

* This period allows sufficient time for the heaters to stabilize at their operating temperature, plus a further 10 minutes for a full reaction to take place.

Table 8.2 Effects of Loss of Power to The Monitor

8.5 Simple Checks

> **Note.** All references to 'Programming Pages' are found in Section 6 for single stream versions of the monitor. Before carrying out tests on the multistream version, it is essential that only one stream is selected – see Section 4.3, page 13 – to emulate single-stream operation.

8.5.1 Unstable or Erratic Readings

1. Check the flow of sample into the cuvette.
2. Check the flow of each reagent through the pump.
3. Check that the pinch tube is fitted correctly into the pinch valve.
4. Ensure that the drain/fill cycle is taking place normally. Illumination can be seen via the plastic prism on the top of the lamp housing – see Fig. 8.3.
5. Ensure that the cuvette overflows through the bottom left hand outlet tube before the lamp lights during each drain/fill cycle.

> **Note.** It cannot be stressed strongly enough that the five-weekly chemical rinse with the rinse solution is vitally important. It is also very effective at reducing calibration problems, drift and signal noise. Any evidence of white or blue precipitate in the mixer or reaction coil must be removed with the rinse solution.

6. Rinse the pipework for 30 minutes with cleaning solution (see Section 8.2.4, page 30) to remove any build-up of molybdate precipitate.
7. Carry out a monitor response test – see Section 8.5.3, page 36.

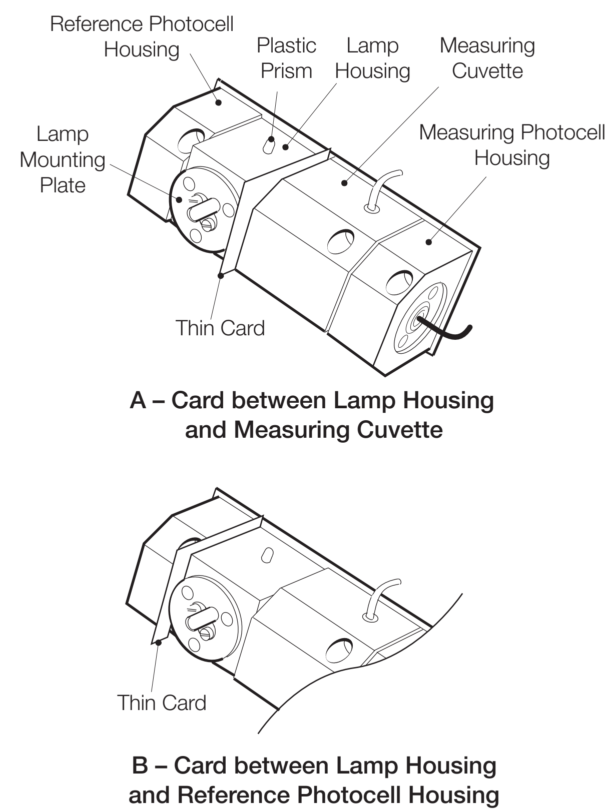


Fig. 8.3 Simple Electronic Response Test

8.5.2 Low/High Calibration Factor Value

1. Check and, if necessary, replace the standard solution.
2. Check and, if necessary, replace the reagent solutions.
3. Switch 'Energize AUTO ZERO valve' to YES on Programming Page 2.2.
4. Disconnect the tube on the AUTO ZERO valve furthest away from the reaction block. Ensure that solution emerges from the valve nipple.

> **Caution.** Clean up any spillages from the second mixer chamber.

5. Switch 'Energize AUTO ZERO valve' to NO and set 'Energize SECONDARY CAL valve' to YES.
6. Lift the secondary calibration solution tube out of the container for a few seconds and ensure that air is being drawn into the tube.

> **Note.** It cannot be stressed strongly enough that the five-weekly chemical clean with the rinse solution is vitally important. It is also very effective at reducing calibration problems, drift and signal noise. Any evidence of white or blue precipitate in the mixer or reaction coil must be removed with the rinse solution.

7. Carry out a monitor response test – see Section 8.5.3, page 36.

8.5.3 Monitor Stability/Response Test

1. Check that the temperature on both heaters is under control and stable.
2. Switch 'Default calibration parameters' to YES on Programming Page 2.1.
3. Switch 'Energize AUTO ZERO valve' to YES on Programming Page 2.2.
4. Run the monitor for 30 minutes.
5. Use the ▲ and ▼ switches to generate a sensible reading of the sample on the display on Programming Page 0. Note the reading over a 30 minute period to ensure a stable reading.
6. Switch 'Energize AUTO ZERO valve' to NO and 'Energize SECONDARY CAL valve' to YES.
7. Run the monitor for 30 minutes. Note that the reading on Programming Page 0 has changed by approximately the value of the secondary solution and is stable over a 30 minute period.
8. If successful, set the monitor to normal operation, i.e. de-energize the SECONDARY CAL valve and carry out a baseline calibration – see Programming Page 2.3.

8.5.4 Simple Electronic Response Test

1. Remove the optical system cover.
2. Switch 'Default calibration parameters' to YES on Programming Page 2.1.
3. Set 'Switch lamp on continuous' to YES on Programming Page 2.2. This stops the drain/fill sequence.
4. Place a thin card between the lamp housing and the measuring cuvette (see Fig. 8.3A) to stop the light reaching the measuring photocell.
5. Wait six seconds and note that the reading on the display on Programming Page 0 goes off the scale.
6. Remove the card and place it between the lamp housing and the reference photocell housing to stop the light reaching the measuring photocell (Fig. 8.3B).
7. Wait six seconds and note that the reading goes to zero. Note also that the intensity of the light, seen through the plastic prism on top of the lamp housing, increases.
8. Remove the card and set the monitor to normal mode via Programming Pages 2.1 and 2.2.

8.6 Setting Up the Optical System

This lamp is pre-set at the factory and normally needs no further adjustment. Also, the lamp is run well below its rated voltage and should have a long life. However, in the unlikely event of exciter lamp or cuvette board failure, the optical system will require resetting. Section 8.6.2 explains how to adjust the lamp alignment to ensure that the maximum amount of light is hitting the photoelectric cell. Section 8.6.3 explains how to set a new cuvette board, i.e. balance the two outputs from the photocells. If only the cuvette board is being replaced, then the lamp alignment requires no adjustment. However, both steps need to be carried out if the lamp position has been disturbed.

8.6.1 Replacing the Exciter Lamp – Fig. 8.4

1. Remove (pull off) the optical system cover (Fig. 4.6).
2. Switch off the instrument, unscrew the three spring-loaded positioning screws (Fig. 8.4) and lift off the lamp mounting plate.

> **Caution.** Do not touch the glass envelope of the new lamp; use a tissue to hold it.

3. Pull out the old lamp and fit a new one.
4. Temporarily switch on the instrument and check that the lamp illuminates during each drain/fill cycle.
5. If the lamp is working, switch off the instrument and secure the lamp mounting plate. Ensure that the springs are in place. Switch on the instrument.

Now align the lamp – see Section 8.6.2, page 37.

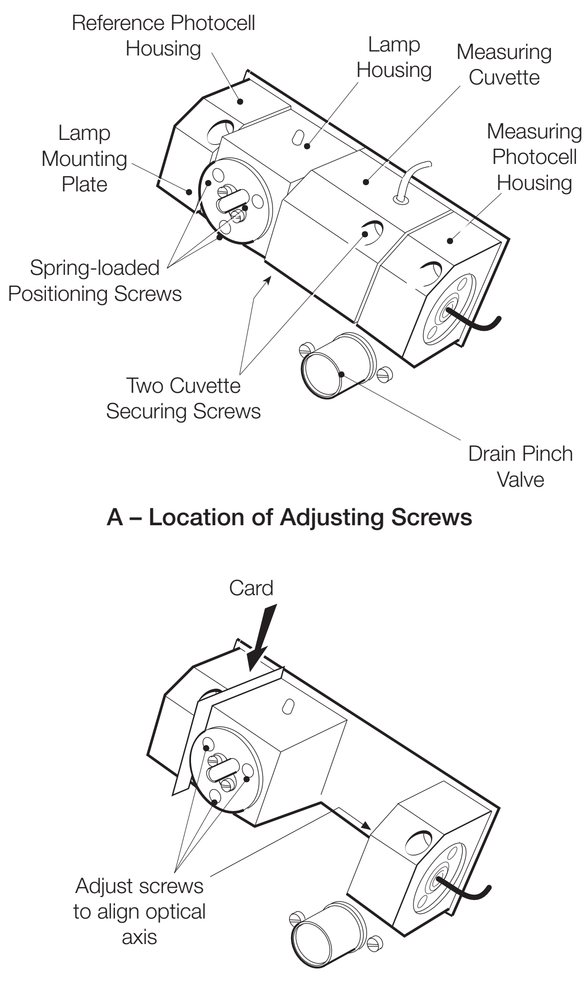


Fig. 8.4 Lamp Adjustment

8.6.2 Aligning the Exciter Lamp

1. To avoid spillages in the next step depress the pinch valve plunger for two to three seconds to drain the cuvette.
2. Remove all tubing from the cuvette connectors.
3. Unscrew fully the two screws holding the cuvette in place and remove the cuvette.
4. Scroll to Programming Page 2.2 and use the ▲ switch to select 'YES' for 'Switch lamp on continuous'.
5. Loosen off the three screws on the lamp mounting plate until the light beam falls directly onto the photoelectric cell window. Placing a piece of white card aids this adjustment – see Fig. 8.4B.
6. Fit the cuvette and the associated tubing.

Now set up the cuvette board – see Section 8.6.3, page 37.

8.6.3 Setting Up the Cuvette Board

1. Switch off the pumps.
2. To avoid spillages in the next step depress the pinch valve plunger for two to three seconds to drain the cuvette.
3. Remove the optical system cover if not already done so. Remove the cuvette inlet tube from the cuvette connector. This is a small diameter tube sited behind the drain tube.
4. Using a length of inlet tube from the spares kit connect a syringe filled with demineralized water to the cuvette inlet connector.
5. Slowly push the demineralized water through the cuvette allowing it to overflow and occasionally depressing the pinch valve plunger.

   Repeat this step once more before proceeding.
6. Refill the syringe and fill the cuvette until it just overflows.
7. Now scroll to the Programming Page 6.2. (The security code to enter Programming Page 6 is normally set to 41.)

   The voltages at both the Read and Reference photoelectric cells are displayed. The Reference voltage remains constant at approximately 2 V whereas the Read voltage will vary depending on the intensity of the color complex formed with the silica in the sample. As demineralized water is present in the cuvette, no color exists and therefore represents a zero silica solution.
8. When the voltages are stable make fine adjustments with the potentiometer, which is sited towards the bottom of the cuvette board (see Fig. 8.5) until the Read voltage is between 20 to 50mV less than the reference voltage.
9. Connect the cuvette tube to the cuvette inlet connector and fit the optical system cover.
10. Switch the lamp out of 'Switch lamp on continuous' on Programming Page 2.2 and switch on the pumps.
11. Allow the instrument to settle down for one hour before performing a baseline calibration.
12. Allow the instrument to settle down for one hour before performing a baseline calibration.

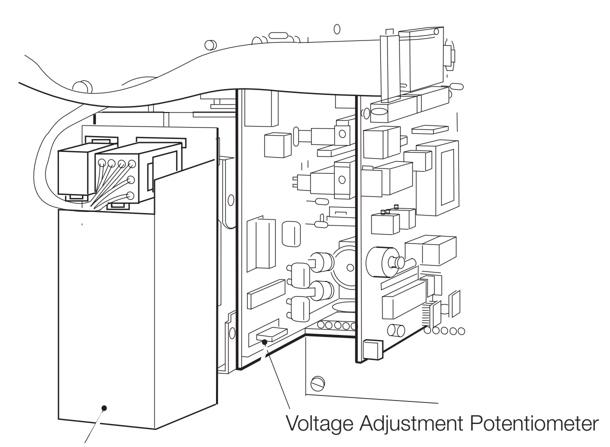


Fig. 8.5 Location of the Potentiometer on the Cuvette Board

9 Specification

Installation Information

Install the monitor where the following conditions can be maintained:

Sample flow

5 to 750ml min^{-1}

Suspended solids

< 10mg l^{-1}, < 60 microns

Sample connections

Inlet	6mm, flexible hose connection
Outlet	9mm, flexible hose connection

Ambient temperature

5 to 40ºC (41 to 104ºF)

Sample temperature

5 to 55ºC (41 to 131ºF)

Reagent solutions

Consumption of each reagent is 10 liters per five weeks

Calibration solutions

A solution of one liter is required of concentration and formulation suitable for the particular range and application

Enclosure dimensions

Height 740mm (29 in.)

Width 540mm (21 in.)

Depth 240mm (9.5 in.)

Weight

25kg (55lb)

Power supply

110 to 120V or 220 to 240V, 50/60Hz, 100VA

Power supply tolerance

+6% to –20%

Isolation voltage

Input, output and power supply 1.5kV

Relay Contacts – Single Pole Changeover

Rating	250V AC 3A AC	250V DC maximum 3A DC maximum
Loading (non-inductive) (inductive)	750VA 750VA	30W maximum 3W maximum

Degree of protection

Electronics section	IP65
Liquid handling	Case IP31
Critical internal components	IP65

General Specification

Range

0 to 2000 g l^{-1} SiO_2 or 0 to 5000 g l^{-1} SiO_2

Maximum current output scale expansion

0 to 20 g l^{-1} or 0 to 50 g l^{-1}

Accuracy

< ±2 g l^{-1} or < ±2% whichever is the greater

Reproducibility

< ±2 g l–1 or < ±2% whichever is greater

Response time

90% step change in approximately 16 minutes
(dead time approximately 8 minutes)

Chemical drift

Dependent on reagents – typically less than 5% of reading/month

Control temperature range

35 to 45ºC (95 to 113ºF)

Temperature Resolution

0.1ºC

Displays

Concentration and programming data by backlit LCD graphics display module

Status indication

Single stream

Two LEDs illuminated when concentration alarms are exceeded

Single LED illuminated when calibration in progress

Single LED illuminated when monitor is 'Out of Service'

Single LED illuminated when HOLD switch operated

Multi-stream

Six LEDs illuminated when concentration alarms are exceeded

Six LEDs (one per stream) when stream 'Out of sample'

Single LED illuminated when calibration in progress

Single LED illuminated when monitor is 'Out of Service'

Single LED illuminated when HOLD switch operated

Current outputs

Single stream

Two isolated current outputs 0 to 10, 0 to 20 or 4 to 20mA software selectable over the full range of the monitor as standard. Range independently selectable over the full range of the monitor

Maximum voltage load 15V

Multi-stream

One isolated current output per stream 0 to 10, 0 to 20 or 4 to 20mA, software selectable as standard. Range independently selectable over the full range of the monitor

Maximum voltage load 15V

Computer interface

Optional second current output or RS485 serial interface

Alarms

Single stream

Two concentration relay outputs.
Can be configured as high or low concentration

Remote 'Out of Sample' alarm

Remote calibration-mode indication

Remote monitor 'Out of Service' alarm

Multi-stream

Maximum of six (one per stream) relay outputs. Can be configured as high or low concentration, or ‘Out of Sample' alarms

Remote calibration-mode indication

Remote monitor 'Out of Service' alarm

Concentration alarm adjustment

Programmable over monitor range

Calibration

Frequency and time of day programmable, fully automatic, plus manual initiation on demand

EMC

Conforms to EMC Directive (89/336/EEC)

Classifications	BS EN 500 81-2
	BS EN 500 82-2
Electrical safety	BS EM 61010-1

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10 Spares List

Consumable Spares

Part No.	Description	Qty.
8241 020	Consumable spares kit comprising pump tubes, pump capstans, plumbing tubing, tube connectors, 'O' rings, sample filters etc.	1

Refurbishment Spares

Part No.	Description	Qty.
0217 321	Magnetic Stirrer Bar – for mixer block	2
8241 135	Reagent container (red) – 1st acid	1
8241 138	Reagent container (purple) – molybdate	1
8241 137	Reagent container (orange) – 2nd acid	1
8241 136	Reagent container (orange) – 2nd acid (complete with float switch assy.)	1
8241 139	Reagent container (brown) – reduction	1
8240 085	Standard Solution Container – secondary	1
0234 019	Solenoid Valve – calibration/emergency	3
8240 054	Drain Pinch Valve	1
0217 220	Solution Container Sealing Cap	5

Strategic Spares

Part No.	Description	Qty.
8240 100	Constant Head Unit – single stream	1
8240 112	Constant Head Unit Module Assembly – multi-stream, one for each stream and complete with solenoid valve	1
0211 132	'O' Ring Seal between each constant head module	1
0234 023	Solenoid Valve – multi-stream	1
8240 114	Float Switch assy.–þ'Out of Sample'	1
8241 134	Float Switch assy.– 'Out of Reagent'	1
8240 090	Sample De-gasser	1
8241 150	Dynamic Mixer Block Assembly	1
8241 154	Static Mixer Block Assembly	1
8241 126	Reaction Block assy.	1
8240 110	Cuvette Assembly (0 to 2000 µg l^{-1})	1
8240 150	Cuvette Assembly (0 to 5000 µg l^{-1})	1
8240 117	Optical System Cover	1
8240 106	Drain Manifold Assembly	1
8240 107	Final Drain Assembly	1
8241 158	Photocell Housing Assembly – measuring	1

Part No.	Description	Qty.
8241 159	Photocell Housing Assembly – reference	1
0231 462	Tungsten-Halogen Exciter Lamp	1
8241 156	Stirrer Motor Assembly –þterminated	1
8240 103	Pump Motor Assembly 50 Hz –þterminated	2
8240 123	Pump Motor Assembly 60 Hz –þterminated	2
8035 870	Pump Motor Coupling Assembly	2
8240 105	Heater Mat Assembly – optical system	1
8240 104	Cartridge Heater Assembly – reaction block	1
8240 196	Temperature Sensor Assembly – optical system	1
8240 142	Temperature Sensor Assembly – reaction block	1
0234 712	Heater Thermal Cut-out	2
8240 045	Electrical Connector Kit – Liquid handling section. Contains one set of male and female connectors for pump motor, heater, float witches and lamp	1
8240 046	Electrical Connector Kit – Float switch/solenoid valve. Contains one set of male and female connectors for the 'Out-of-Sample' float switches and a pair of connectors for the stream switching solenoid valve.	1
0234 726	Toggle Switch – mains, pump and hold	3
0234 714	Toggle Switch Boot	3
8240 235	Mother Board	1
8240 257	Power Supply Assembly (inc. transformer)	1
8240 205	Cuvette Board	1
8240 215	Microprocessor Board (without EPROM)	1
8240 296	Drive Board – single stream (50Hz)	1
8240 297	Drive Board – multi-stream (50Hz)	1
8240 298	Drive Board – single stream (60Hz)	1
8240 299	Drive Board – multi-stream (60Hz)	1
8240 265	Output Board – multi-stream	1
8240 266	Output Board – single stream	1
8240 267	Output Board – multi-stream + serial	1
8240 268	Output Board – single stream + serial	1
8240 245	Display Board – multi-stream	1
8240 246	Display Board – single stream	1
8240 120	Keypad/Bezel Assembly –þsingle stream	1
8240 121	Keypad/Bezel Assembly –þmulti-stream	1
8240 195	Ribbon cable	1
0216 041	Case Key	1
0216 042	Chemical Panel Door Catch	1

Fuse

Part No.	Description	Qty.
0231 548	F1 – 2A 20 x 5mm Anti-surge 250V AC	1

EPROMs

Part No.	Description	Qty.
8241 180	EPROM – single stream (English)	1
8241 181	EPROM – single stream (German)	1
8241 182	EPROM – single stream (French)	1
8241 183	EPROM – single stream (Spanish)	1

8241 190	EPROM – multi-stream (English)	1
8241 191	EPROM – multi-stream (German)	1
8241 192	EPROM – multi-stream (French)	1
8241 193	EPROM – multi-stream (Spanish)	1

8241 185	EPROM – single stream MODBUS serial (English)	1
8241 186	EPROM – single stream MODBUS serial (German)	1
8241 187	EPROM – single stream MODBUS serial (French)	1
8241 188	EPROM – single stream MODBUS serial (Spanish)	1

8241 195	EPROM – multi-stream MODBUS serial (English)	1
8241 196	EPROM – multi-stream MODBUS serial (German)	1
8241 197	EPROM – multi-stream MODBUS serial (French)	1
8241 198	EPROM – multi-stream MODBUS serial (Spanish)	1

8241 200	EPROM – single stream MODBUS/PROFIBUS serial (English)	1
8241 201	EPROM – single stream MODBUS/PROFIBUS serial (German)	1
8241 202	EPROM – single stream MODBUS/PROFIBUS serial (French)	1
8241 203	EPROM – single stream MODBUS/PROFIBUS serial (Spanish)	1

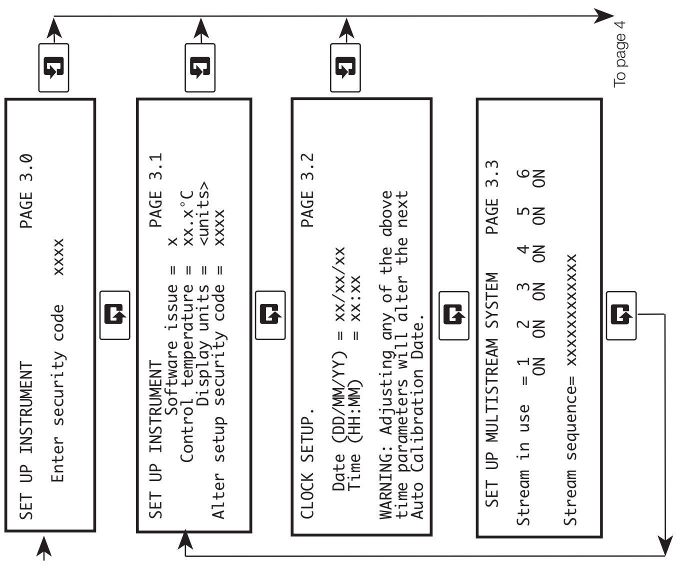
Part No.	Description	Qty.
8241 210	EPROM – multi-stream MODBUS/PROFIBUS serial (English)	1
8241 211	EPROM – multi-stream MODBUS/PROFIBUS serial (German)	1
8241 212	EPROM – multi-stream MODBUS/PROFIBUS serial (French)	1
8241 213	EPROM – multi-stream MODBUS/PROFIBUS serial (Spanish)	1

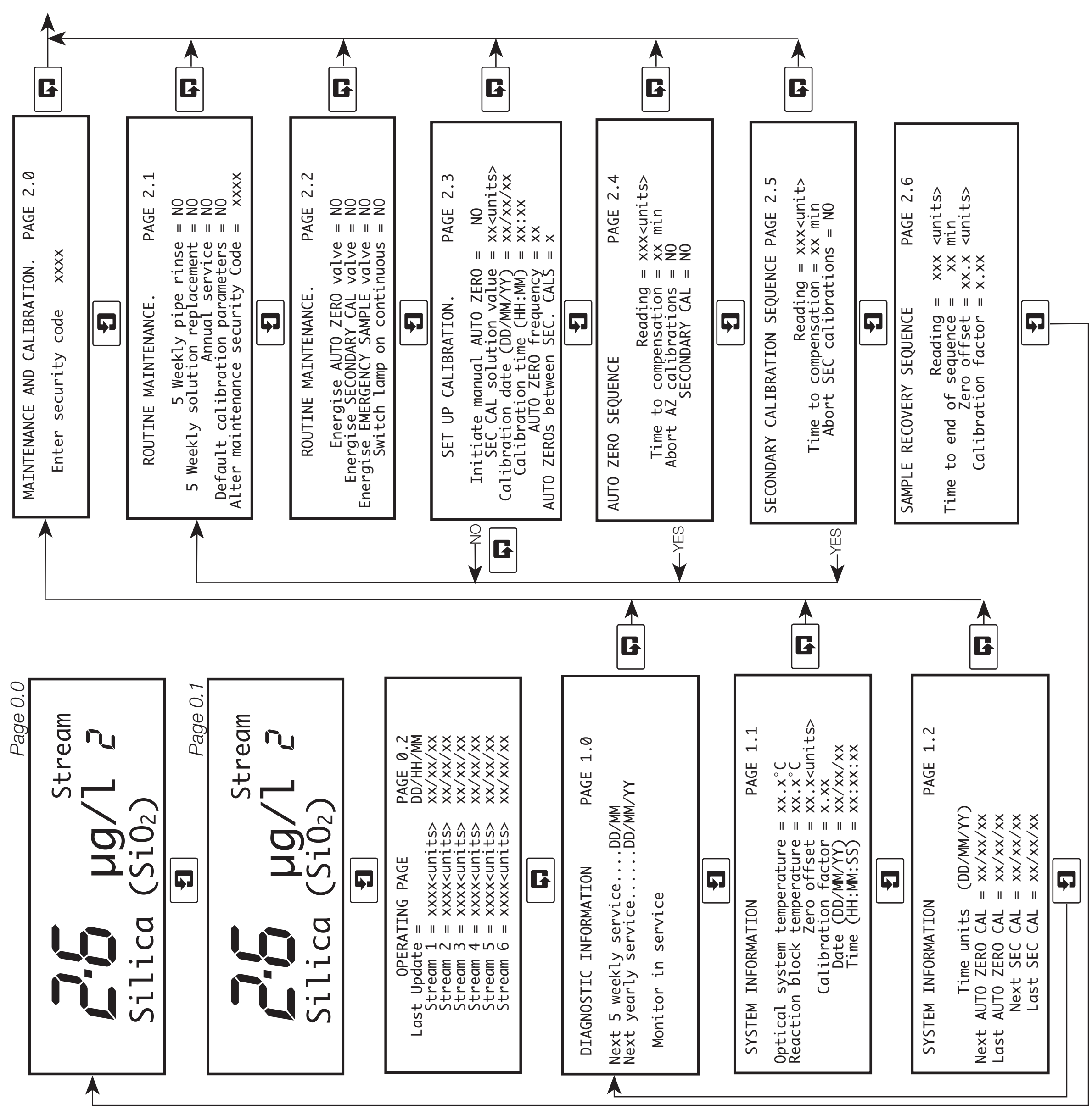
Appendix A – Multi-stream Programming

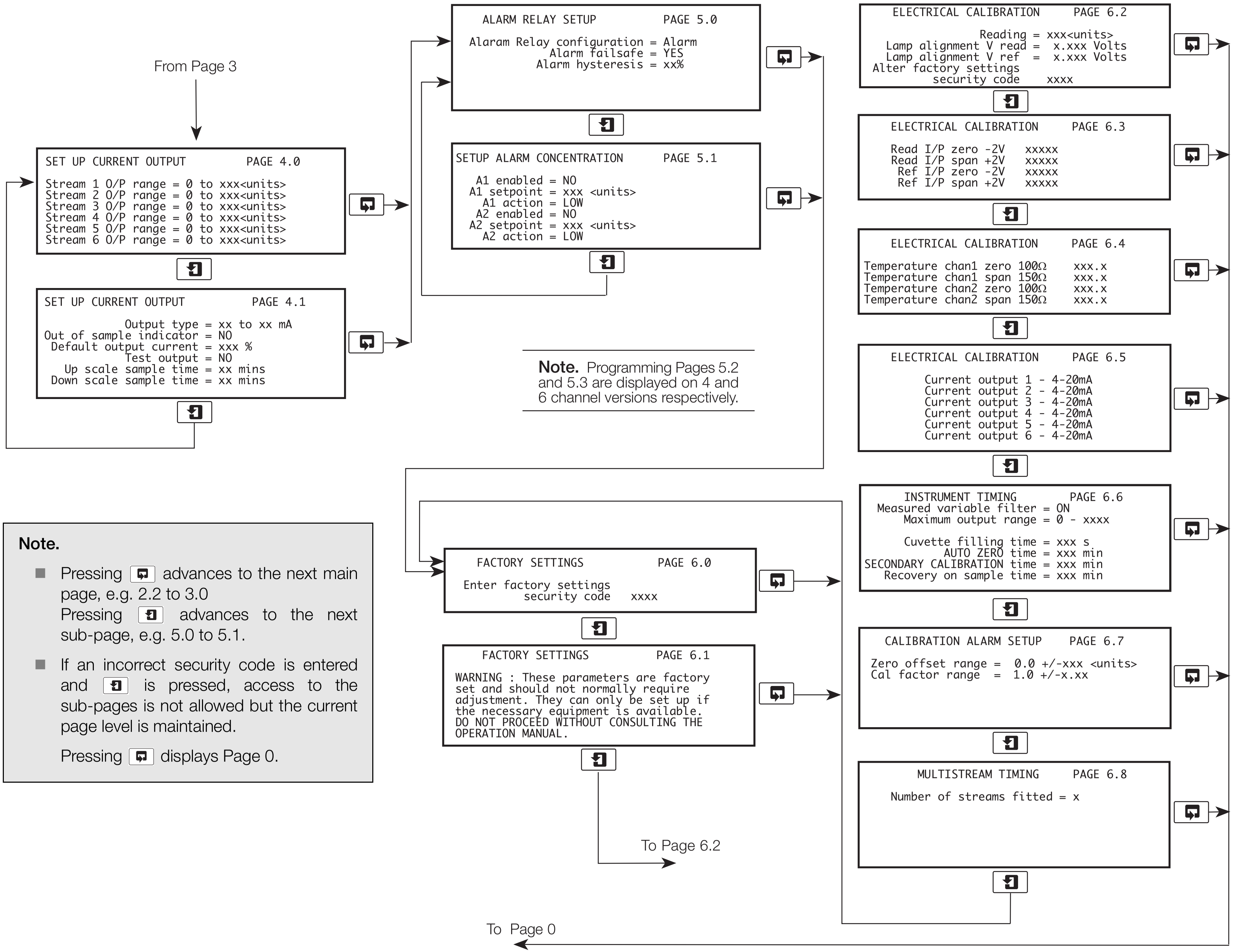
In normal operation (Operating Pages 0 and 1) the display gives indication of the units of measurement, diagnostics, calibration information and time. Selection is made by means of the [page switch] and [parameter switch] switches.

Operation of the [page switch] switch enables a series of 'programming' pages to be displayed. Unauthorized entries to these pages are inhibited by a four-digit security code which is displayed immediately after the page header.

Values displayed in Operating Pages 0 and 1 are for viewing only and cannot be altered by the operator. Displayed values on subsequent pages indicated by x's can be altered by means of the ▲ and ▼ switches. Options such as Yes/No or High/Low are also selected using these switches. Passing onto the next parameter, or exiting from the page, automatically enters the new value into memory.



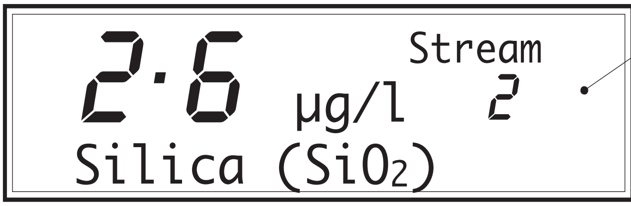




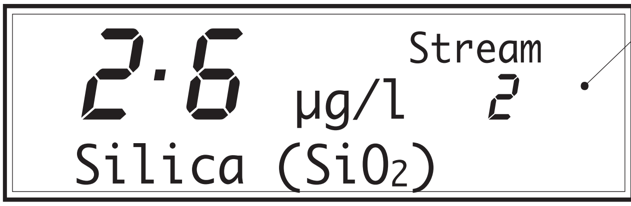
Note.

- Pressing [key] advances to the next main page, e.g. 2.2 to 3.0
  Pressing [key] advances to the next sub-page, e.g. 5.0 to 5.1.
- If an incorrect security code is entered and [key] is pressed, access to the sub-pages is not allowed but the current page level is maintained.
  Pressing [key] displays Page 0.

A.1 Operating Page



Page 0.0 is a fixed display on the indicated stream.The ▲ and ▼ switches are used to select the stream required.



The display on Page 0.1 continuously scrolls, at two second intervals, all the streams fitted.

```
       OPERATING PAGE      PAGE 0.2
Last update =              DD/HH/MM
   Stream 1 = xxxx<units>  xx/xx/xx
   Stream 2 = xxxx<units>  xx/xx/xx
   Stream 3 = xxxx<units>  xx/xx/xx
   Stream 4 = xxxx<units>  xx/xx/xx
   Stream 5 = xxxx<units>  xx/xx/xx
   Stream 6 = xxxx<units>  xx/xx/xx
```

Displays all streams together with the latest update day of the month and time in hours and minutes.

A.2 Page 1 – Diagnostics

```
 DIAGNOSTIC INFORMATION       PAGE 1.0

Next 5 weekly service....DD/MM
Next yearly service......DD/MM/YY


  Monitor in service
```

Indicates the date when the next relevant routine maintenance is required. When the date is exceeded, 'overdue' is displayed, and in the case of the 5-weekly service, the 'Out of Service' LED is illuminated.

This message indicates that the monitor is working normally but it is replaced with the relevant information, when necessary, by the monitor diagnostics – see Section 8.4.1.

```
 SYSTEM INFORMATION           PAGE 1.1

Optical system temperature = xx.x°C
Reaction block temperature = xx.x°C
              Zero offset = xx.x<units>
       Calibration factor = x.xx
          Date (DD/MM/YY) = xx/xx/xx
          Time (HH:MM:SS) = xx:xx:xx
```

The control temperature of the two heaters is displayed in °C.

Zero Offset indicates the zero drift since the last BASELINE AUTO ZERO CALIBRATION.

The Calibration Factor is calculated after a SECONDARY CALIBRATION; the nominal value is 1.00 but this differs between individual monitors and the reaction control temperature. It is intended to indicate the condition of the monitor and the chemical solutions.

Current date and time.

```
 SYSTEM INFORMATION           PAGE 1.2

       Time units  (DD/MM/YY)
Next AUTO ZERO CAL = xx/xx/xx
Last AUTO ZERO CAL = xx/xx/xx
      Next SEC CAL = xx/xx/xx
      Last SEC CAL = xx/xx/xx
```

The date when the next AUTO ZERO CALIBRATION is to be carried out. If the automatic calibration is disabled, then OFF is displayed in place of the date.

The date of the last ZERO calibration.

The date when the next SECONDARY CALIBRATION is to be carried out. If the secondary calibration is disabled, then OFF is displayed in place of the date.

The date of the last SECONDARY calibration.

A.3 Page 2 – Maintenance and Calibration

```
MAINTENANCE AND CALIBRATION.  PAGE 2.0

   Enter security code  xxxx
```

Enter the value of the previously entered security code.

Set the following three parameters to YES when the tasks are carried out. Once set to YES change the display on Page 0 to the required value.

```
    ROUTINE MAINTENANCE.      PAGE 2.1

            5 Weekly pipe rinse = NO
  5 Weekly solution replacement = NO
                 Annual service = NO
 Default calibration parameters = NO
Alter maintenance security code = xxxx
```

Set the date of the next 5-weekly service.

Sets the date of the next yearly service.

Used during routine maintenance to check the stability of the monitor prior to calibration. Used in single stream mode only – see Section 4.3.

Enter a security code (up to four digits) if required.

All programming Page 2.2 parameters normally set to NO, set to YES as required (setting is maintained).

```
     ROUTINE MAINTENANCE.     PAGE 2.2

       Energise AUTO ZERO valve = NO
   Energise SECONDARY CAL valve = NO
Energise EMERGENCY SAMPLE valve = NO
      Switch lamp on continuous = NO
```

Used to energize the appropriate solenoid valve for test purposes and operating the monitor on synthetic solutions.

Used to carry out tests on the electronic and optical sections.

> **Note.** If any of the parameters on Page 2.2 are set to YES, except for the EMERGENCY valve, it will not be possible to proceed to Page 2.3.

```
     SET UP CALIBRATION.      PAGE 2.3

  Initiate manual AUTO ZERO = NO
     SEC CAL solution value = xx<units>
Calibration date (DD/MM/YY) = xx/xx/xx
   Calibration time (HH:MM) = xx:xx
        AUTO ZERO frequency = xx
AUTO ZEROs between SEC.CALS = x
```

Set to ROUTINE or BASELINE depending on the type of Auto Zeroing required – see Section 7.

Used to enter the value of the Secondary Calibration prior to calibration.

Sets the date when the first timed automatic calibration is to be carried out.

Sets the time when the first timed automatic calibration is to be carried out.

Sets the frequency at which the AUTO ZERO calibration takes place. Select: OFF, 12h, 1 day, 2 days,…7 days.

Sets the number of AUTO ZERO calibrations that take place between AUTO SECONDARY calibrations. Select 0 to 10 in one unit increments. When 0 is selected a two-point calibration will be carried out whenever a timed calibration takes place. When SEC CAL set to OFF only Auto Zeros will take place.

Note. Programming Pages 2.4 and 2.5 are part of the automatic calibration sequence. These displays cannot be changed from these pages unless the sequence is aborted.

```
       AUTO ZERO SEQUENCE     PAGE 2.4

                 Reading = xxx<units>
     Time to compensation = xx min
    Abort AZ calibrations = NO
            SECONDARY CAL = NO
```

Reading during calibration prior to compensation.

Remaining time to the end of the Auto Zero sequence.

When set to YES the sequence is aborted. The original zero offset value is maintained.

When set to YES a two-point calibration takes place. This option is not available when a BASELINE AUTO ZERO is selected.

```
SECONDARY CALIBRATION SEQUENCE PAGE 2.5

                   Reading = xxx<unit>
      Time to compensation = xx min
    Abort SEC calibrations = NO
```

Reading during calibration prior to compensation.

Remaining time to the end of the Secondary Calibration sequence.

When set to YES the sequence is aborted. The original calibration factor value is maintained.

```
   SAMPLE RECOVERY SEQUENCE    PAGE 2.6

                  Reading =  xxx <units>
Time to end of sequence =   xx min
              Zero offset = xx.x <units>
       Calibration factor = x.xx
```

Reading during recovery back onto the sample. The display shows the reading which incorporates new calibration values.

Remaining time to end of sequence.

See Programming Page 1.1.

A.4 Page 3 – Set Up Instrument

```
SET UP INSTRUMENT                PAGE 3.0

    Enter security code  xxxx
```

Enter the value of the previously entered security code.

```
SET UP INSTRUMENT                PAGE 3.1
           Software issue =  x
      Control temperature =   xx.x°C
            Display units =   <units>
Alter setup security code =  xxxx
```

Shows the current software issue level.

Set the required control temperature within the range 35 to 45°C in 0.1°C increments. This temperature should be set to 37°C or 5°C above the maximum ambient temperature expected.

Set the required display units for silica concentration (ppb, µg/l or µg/kg).

Enter setup security code (up to four digits) if required.

```
CLOCK SETUP.                    PAGE 3.2

       Date (DD/MM/YY)  =  xx/xx/xx
       Time (HH:MM)     =  xx:xx

WARNING: Adjusting any of the above
time parameters will alter the next
Auto Calibration Date.
```

Set the current (real) date.

Set the current (real) time.

```
  SET UP MULTISTREAM SYSTEM    PAGE 3.3

Stream in use  = 1   2   3   4   5   6
                ON  ON  ON  ON  ON  ON

Stream sequence= xxxxxxxxxxxx
```

Enables streams to be selected/de-selected.

Used to set the stream sampling order.

A.5 Page 4 – Set Up Output Currents

```
SET UP CURRENT OUTPUT         PAGE 4.0

   Stream 1 O/P range = 0 to xxx<units>
   Stream 2 O/P range = 0 to xxx<units>
   Stream 3 O/P range = 0 to xxx<units>
   Stream 4 O/P range = 0 to xxx<units>
   Stream 5 O/P range = 0 to xxx<units>
   Stream 6 O/P range = 0 to xxx<units>
```

Set the current output to any range between the following maximum and minimum limits of SiO_2 – 0 to 20 and 0 to 2000µg/l for 0 to 2000µg/l systems, or 0 to 50 and 0 to 5000µg/l for 0 to 5000µg/l systems.

```
SET UP CURRENT OUTPUT          PAGE 4.1

            Output type = xx to xx mA
Out of sample indicator = NO
 Default output current = xxx %
            Test output = NO
   Up scale sample time = xx mins
 Down scale sample time = xx mins
```

Set to one of the following ranges: 0 to 10, 0 to 20 or 4 to 20mA.

If set to YES each current output will be driven to a default value to indicate an Out of Sample condition on the appropriate stream.

Set the Out of Sample default current between 0 and 105% of the current output. As the output will limit at 102% during a signal over-range, a setting of 105% would be unique to an Out of Sample condition.

If required, the instrument can automatically transmit a percentage of the full scale test signal: 0, 25, 50, 75, 100% of the current output selected.

These set the sample time (see Section 4.3), i.e. the time the monitor samples each stream. Different times can be entered depending on whether the new stream is higher or lower than the previous stream. This is determined by the values entered on Programming Page 4.0. These parameters are normally set to 12 and 15 minutes, but could be increased if required.

A.6 Page 5 – Alarm Relay Setup

```
   ALARM RELAY SETUP          PAGE 5.0

 Alaram relay configuration = Alarm
             Alarm failsafe = YES
           Alarm hysteresis = xx%
```

If fail-safe action is required select YES.

A differential set point can be set as a percentage of the set point value. The differential setting operates on the set point. Example – a 5% differential setting operates 2.5% above and below the setpoint.

Set the differential required between 0 and 5% in 1% increments.

```
   ALARM RELAY SETUP          PAGE 5.1

   A1 enabled = NO
  A1 setpoint = xxx <units>
    A1 action = LOW
   A2 enabled = NO
  A2 setpoint = xxx <units>
    A2 action = LOW
```

Select YES or NO as required.

Set the required setpoint values within the instrument range.

Select the alarm action required – HIGH or LOW.

Note. Programming Pages 5.2 and 5.3 are displayed on 4 and 6 channel versions only.

```
SETUP ALARM CONCENTRATION      PAGE 5.2

   A3 enabled = NO
  A3 setpoint = xxx <units>
    A3 action = LOW
   A4 enabled = NO
  A4 setpoint = xxx <units>
    A4 action = LOW
```

Select YES or NO as required.

Set the required setpoint values within the instrument range.

Select the alarm action required – HIGH or LOW.

```
SETUP ALARM CONCENTRATION      PAGE 5.3

   A5 enabled = NO
  A5 setpoint = xxx <units>
    A5 action = LOW
   A6 enabled = NO
  A6 setpoint = xxx <units>
    A6 action = LOW
```

Select YES or NO as required.

Set the required setpoint values within the instrument range.

Select the alarm action required – HIGH or LOW.

A.7 Page 6 – Factory Settings

```
  FACTORY SETTINGS         PAGE 6.0

 Enter factory settings
          security code   xxxx
```

Enter the value of the previously entered security code.

```
    FACTORY SETTINGS         PAGE 6.1

WARNING : These parameters are factory
set and should not normally require
adjustment. They can only be set up if
the necessary equipment is available.
DO NOT PROCEED WITHOUT CONSULTING THE
OPERATION MANUAL.
```

```
   ELECTRICAL CALIBRATION.    PAGE 6.2

                Reading = xxx<units>
  Lamp alignment V read = x.xxx Volts
  Lamp alignment V ref  = x.xxx Volts
Alter factory settings
          security code   xxxx
```

Used for diagnostic purposes only

Displays the output of the photocell pre-amplifiers. Used only for information and photocell balance adjustment.

Enter a security code (up to four digits) if required.

```
   ELECTRICAL CALIBRATION     PAGE 6.3

   Read I/P zero -2V   xxxxx
   Read I/P span +2V   xxxxx
    Ref I/P zero -2V   xxxxx
    Ref I/P span +2V   xxxxx
```

Used for the calibration of the A and D converter. This is set up during the manufacture of the processor board and must not be changed unless full details of the procedure are known.

```
   ELECTRICAL CALIBRATION     PAGE 6.4

Temperature chan1 zero 100Ω   xxx.x
Temperature chan1 span 150Ω   xxx.x
Temperature chan2 zero 100Ω   xxx.x
Temperature chan2 span 150Ω   xxx.x
```

Connect a 100Ω resistance to the input of the respective temperature input.

Connect a 150Ω resistance to the input of the respective temperature input.

Wait for the display to stabilize before moving on to the next step. The new calibration datum is automatically entered.

```
   ELECTRICAL CALIBRATION     PAGE 6.5

        Current output 1 - 4-20mA
        Current output 2 - 4-20mA
        Current output 3 - 4-20mA
        Current output 4 - 4-20mA
        Current output 5 - 4-20mA
        Current output 6 - 4-20mA
```

Calibration is performed on the 4 to 20mA range, but values are valid for 0 to 10 and 0 to 20mA ranges.
Connect a digital current meter to the respective output terminals and use the raise and lower buttons to adjust the respective output up or down to within <±0.25% of the maximum current output.

```
     INSTRUMENT TIMING        PAGE 6.6
Measured variable filter = ON
     Maximum output range = 0 - xxxx

     Cuvette filling time = xxx s
           AUTO ZERO time = xxx min
SECONDARY CALIBRATION time = xxx min
   Recovery on sample time = xxx min
```

For service purposes only. Must normally be set to ON. When set to OFF, the signal processing to remove the effects of chemical noise and air bubbles is bypassed.

Set to 2000µgbl^{-1} or 5000µgbl^{-1} to suit the cuvette fitted, i.e. 50 mm path cuvette = 2000µgbl^{-1} and 10 mm path cuvette = 5000µgbl^{-1}.

Cuvette filling time normally set to 40s (0 to 5000µgbl^{-1} system) or 55s (0 to 2000µgbl^{-1} system) to ensure that the cuvette overflows before the lamp is switched on.

35min.
20min.
20min.

These do not require further adjustment except for Recover On Sample Time which can be increased if the sample value is near zero.

```
  CALIBRATION ALARM SETUP    PAGE 6.7

 Zero offset range  = 0.0 +/- xxx <units>
 Cal factor range   = 1.0 +/- x.xx
```

Enables the acceptable range of zero offset to be selected before a calibration fail alarm is initiated. 50 to 500, OFF, normally set to 100.

Enables the acceptable range of calibration factor to be selected before a calibration fail alarm is initiated. 0.15 to 0.5, OFF, normally set to 0.2.

```
       MULTISTREAM TIMING     PAGE 6.8

   Number of streams fitted = x
```

Number of streams fitted into the monitor.

Appendix B – Wiring Schematic

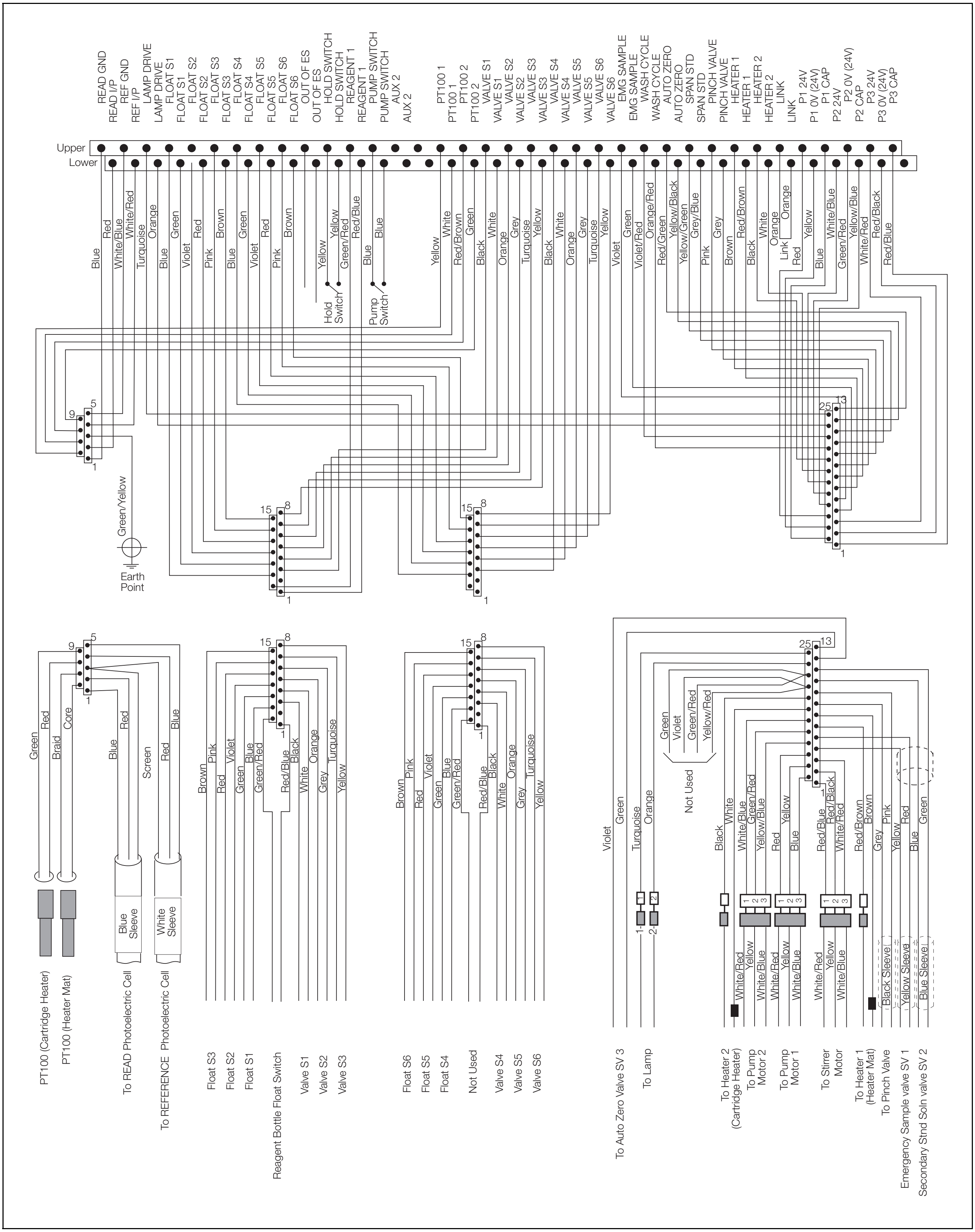


Fig. B.1 Wiring Schematic

Appendix C – Replacing Software Eprom

> **Warning.** Switch off the monitor and electrically isolate it before carrying out the following steps.

> **Caution.** Employ normal antistatic precautions while handling chips and PCBs.

1. Remove the screws from the electronics section front panel and swing it open to reveal the printed circuit boards (PCBs).
2. Remove the four screws that secure the two PCB restrains to stand-off pillars and remove the restrains.
3. Disconnect the ribbon cable – see Fig. C1. Note that the cable feeds in from the front of the board.
4. Carefully ease the processor board (see Fig. C1) from the mother board.
5. Remove the software EPROM chip, preferably using an extractor. This chip is the third from the top (the only labelled chip – see Fig. C1).
6. Fit the replacement chip ensuring correct orientation in its socket.
7. Complete the procedure as follows:
   - Plug the PCB onto the mother board;
   - connect the ribbon cable to the processor board;
   - fit the PCB restraints and secure them using the previously removed screws;
   - close the electronics section front panel and secure it using the previously removed screws.
8. The monitor may now be put into service.
9. Check program parameters – see instruction manual.
10. Carry out a routine 2-point calibration.

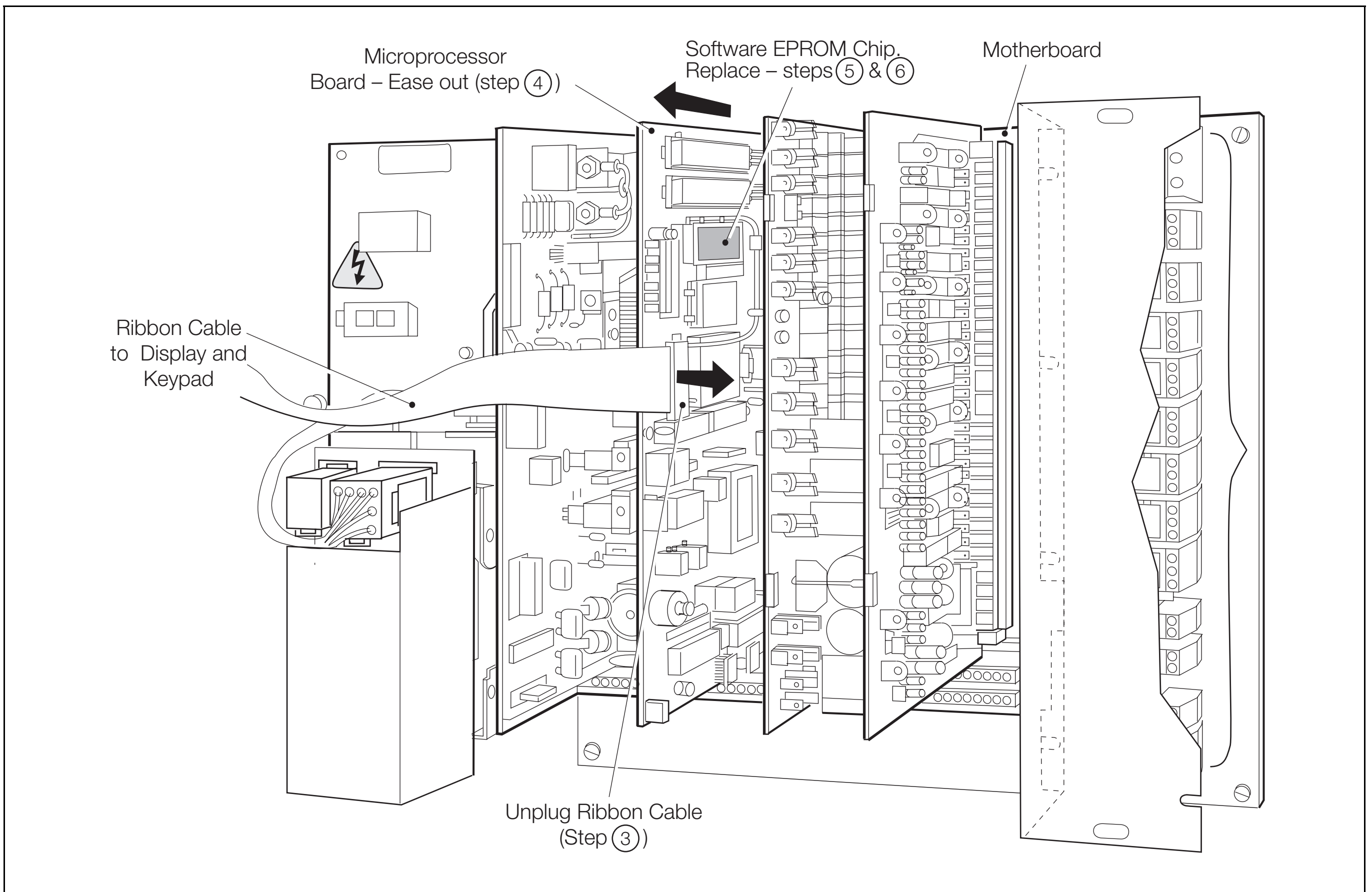


Fig. C.1 8240 Electronics Section

Notes

PRODUCTS & CUSTOMER SUPPORT

Products

Automation Systems

- for the following industries:
  - Chemical & Pharmaceutical
  - Food & Beverage
  - Manufacturing
  - Metals and Minerals
  - Oil, Gas & Petrochemical
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United States of America
ABB Inc.
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Fax: +1 215 674 7183

Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification.

Periodic checks must be made on the equipment's condition. In the event of a failure under warranty, the following documentation must be provided as substantiation:

1. A listing evidencing process operation and alarm logs at time of failure.
2. Copies of all storage, installation, operating and maintenance records relating to the alleged faulty unit.

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