SERVOMEX
ANALYZERS
HIGH-PERFORMANCE GAS ANALYSIS

SERVOPRO MultiExact 5400

OPERATOR MANUAL

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1 DESCRIPTION AND DEFINITIONS

1.1 Scope of this manual

This manual provides installation, operation and routine maintenance instructions for the SERVOPRO MultiExact Gas Purity Analyser, abbreviated to "analyser" in the remainder of this manual.

1.2 Safety information

Read this manual and ensure that you fully understand its content before you attempt to install, use or maintain the analyser. Important safety information is highlighted in this manual as WARNINGs and CAUTIONs, which are used as follows:

WARNING

Warnings highlight specific hazards which, if not taken into account, may result in personal injury or death.

CAUTION

Cautions highlight hazards which, if not taken into account, can result in damage to the analyser or to other equipment or property.

This manual also incorporates 'Be aware of' information, which is used as follows:

+ This highlights information which it is useful for you to be aware of (for example, specific operating conditions, and so on).

1.3 Description

The analyser is designed to meet the needs of the control and product quality applications of industrial gas producers and users, who require fast, accurate and reliable gas analysis.

The analyser can support up to two gas measurements, using paramagnetic, zirconia infrared and thermal conductivity transducers to determine the content of gas samples.

Gas sample measurements are shown on the analyser display, and can also be output to a serial device connected to the analyser, or as milliAmp (mA) / voltage outputs, or over a selection of digital communications (Modbus RS485 or TCP and Profibus).

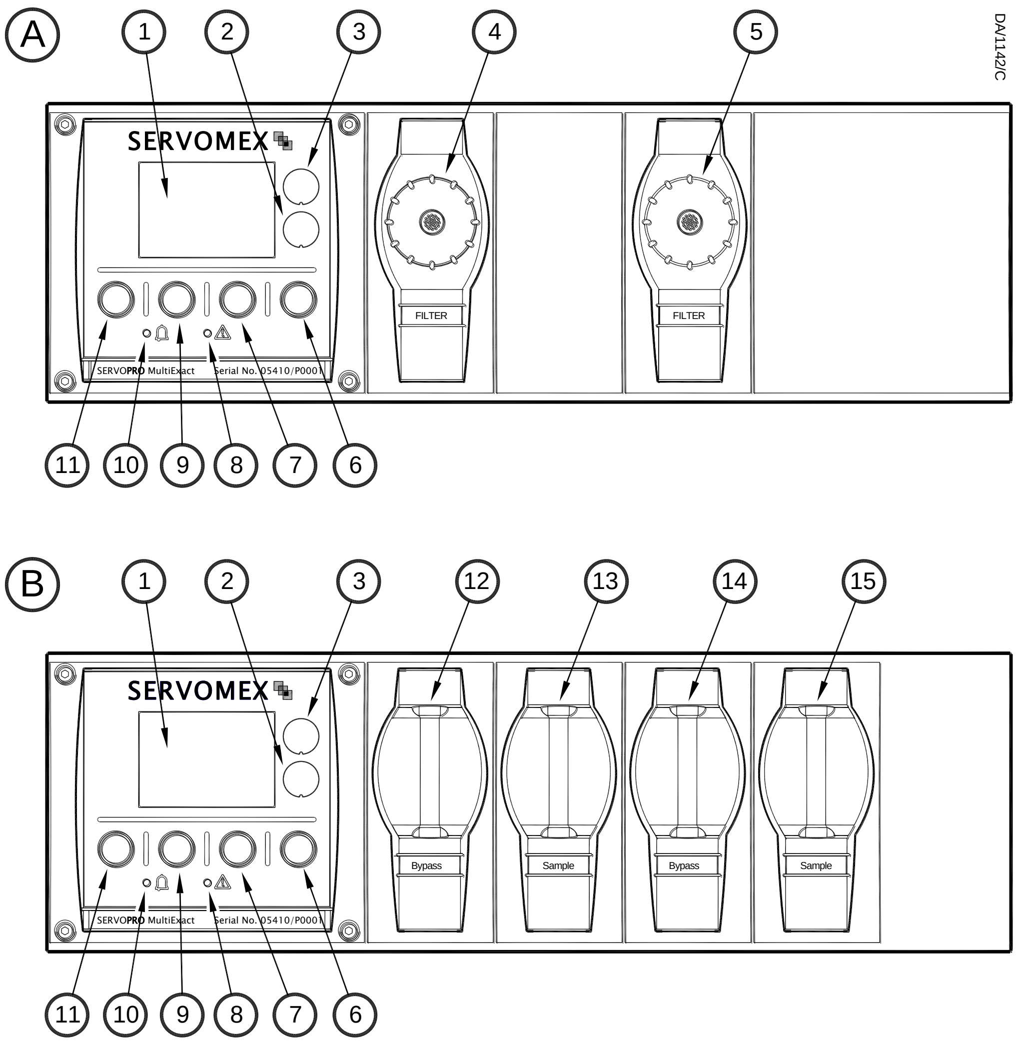
The analyser conforms to the requirements of the NAMUR (Normenarbeitsgemeinschaft für Mess Und Regeltechnik in der Chemischen Industrie) standards NE43 (4 – 20 mA output) and NA64 (status outputs).

The analyser is simple to operate, with an intuitive user interface. The analyser is 3U in height and is suitable for 19 inch rack, panel or bench mounting.

The analyser requires little routine maintenance, other than calibration which is essential for the accuracy of sample gas measurements (see Section 6) and replacement of filter / scrubber elements (if fitted: see Sections 8.3, 8.4 and 8.5).

1.4 Ordering options

For the latest ordering options please contact your local Servomex agent or visit www.servomex.com.



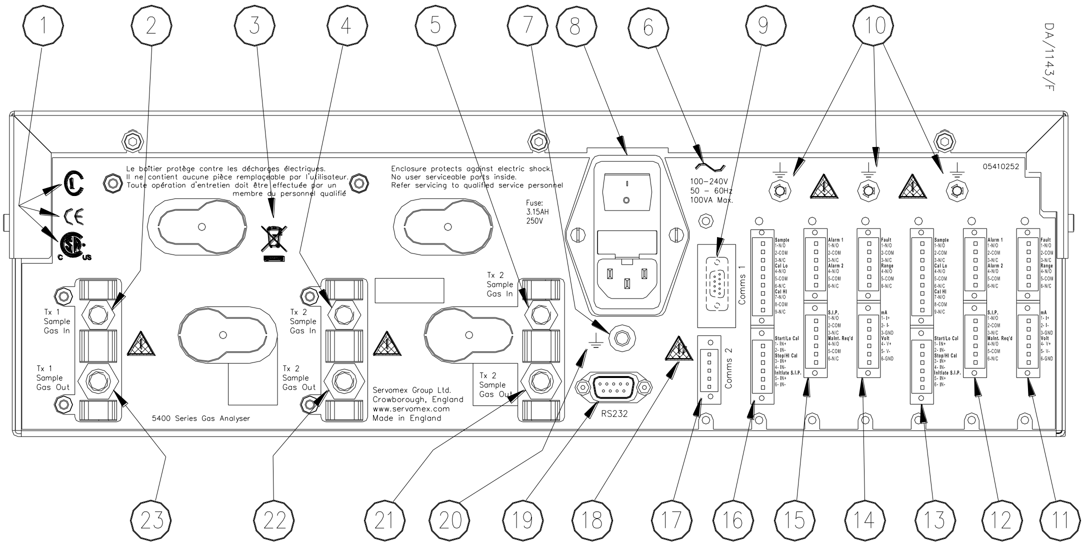
A. Analyser with external filters
B. Analyser with flowmeters

Key	Description
1.	Display
2.	Sample 2 gas label
3.	Sample 1 gas label
4.	Sample 2 external filter *
5.	Sample 1 external filter *
6.	Soft key 4
7.	Soft key 3
8.	Fault LED

Key	Description
9.	Soft key 2
10.	Alarm LED
11.	Soft key 1
12.	Sample 2 bypass flowmeter †
13.	Sample 2 flowmeter
14.	Sample 1 bypass flowmeter †
15.	Sample 1 flowmeter

* TCD, O_2 purity and O_2 control transducers only.
† Pressure-driven transducers only.

Figure 1 – Front of the analyser



Key	Description
1.	Regional compliance symbols **
2.	Transducer 1 sample gas inlet
3.	WEEE compliance symbol
4.	Transducer 2 sample gas inlet *#
5.	Transducer 2 sample gas inlet †#
6.	AC supply voltage symbol
7.	Functional earth (ground) terminal
8.	Electrical supply plug and on/off switch
9.	Ethernet or profibus connector (option)
10.	Earth (ground) terminals for cable screening
11.	Transducer 2 mA output/voltage output connector #

Key	Description
12.	Transducer 2 status relay connector (option) #
13.	Transducer 2 auto val/cal connector (option) #
14.	Transducer 1 mA output/voltage output connector
15.	Transducer 1 status relay connector (option)
16.	Transducer 1 auto val/cal connector (option)
17.	RS485 connector (option)
18.	"Caution – refer to manual" symbol
19.	RS232 connector
20.	"Earth (ground)" symbol
21.	Transducer 2 sample gas outlet †#
22.	Transducer 2 sample gas outlet *#
23.	Transducer 1 sample gas outlet

* CO, CO_2, and N_2O trace transducers and valve block.

† TCD, O_2 trace, O_2 purity and control transducers.

\# Analysers configured for 2 measurements only.

** This product has been tested to the requirements of CAN/CSA–C22.2 No. 61010–1, second edition, including Amendment 1 or a later version of the same standard incorporating the same level of testing requirements.

+ Optional external filters (not shown) may be fitted to the sample gas inlet (1, 2) on an analyser with a CO, CO_2, or N_2O trace transducer. Refer to Section 8.4 for details of these external filters. Trace O_2 transducers have internal oil and particle filters which are not replaceable.

Figure 2 – Rear of the analyser

2 SPECIFICATION

> **WARNING**
>
> The protection, accuracy, operation and condition of the equipment may be impaired if the analyser is not installed in accordance with the requirements of this and subsequent sections of the manual.

2.1 General

Dimensions: length x height x width	* Add 100 mm to length (L) if valve block is fitted to allow for the connector and cable.
Rack mountable analyser (L x H x W)	478 x 133 x 435 mm (18.8 x 5.2 x 17 in.) * 478 x 133 x 483 mm (18.8 x 5.2 x 19 in.) †
Bench mounted analyser (L x H x W)	478 x 146 x 435 mm (18.8 x 5.7 x 17 in.) # 478 x 180 x 435 mm (18.8 x 7 x 17 in.) ‡
Mass	< 12 kg
Electrical supply requirements	See Section 2.3

* Without 19-inch rack mounting brackets.
† With 19-inch rack mounting brackets fitted.
# With front mounting feet retracted.
‡ With front mounting feet extended.

2.2 Environmental limits

Equipment is suitable for indoor use only

Ambient temperature range	
Operation	5 to 45 °C
Storage	–20 to 60 °C
Operating ambient pressure range	101.3 kPa ± 10% (1.013 bar ± 10%)
Operating ambient humidity range	10 to 90% RH, non-condensing
Operating altitude range	–500 * to 2000 † metres
Ingress protection	IP20

* Below sea level.
† Above sea level.

2.3 Electrical data

Electrical supply	
Voltage	100 to 240 Vac, 50 to 60 Hz (± 10% maximum fluctuation)
Fuse rating / type	T 3.15 AH / 250 V size: 20 x 5 mm
Maximum power consumption	100 VA
Interface signal relay ratings *	30 V (dc or ac) / 1 A
mA output (active)	
Maximum load resistance	1 K Ohms
Isolation voltage (to earth)	500 V (dc or ac)
Output range	
Normal sample measurement	0 to 20 mA or 4 to 20 mA †
Fault condition	0 mA or 21.5 mA †
Under range #	0 – 4 mA
Voltage output (active)	
Maximum load resistance	100 K Ohms
Isolation voltage (to earth)	500 V (ac or dc)
Output range	
Normal sample measurement	0 to 10 V
Fault condition	0 or 10.75 V
Under range	Not applicable
Signal / voltage / mA / RS485 output terminals suitable for	
Flexible conductors	0.5 to 1.5 mm² (20 to 16 AWG)
Solid conductors	0.5 to 1.0 mm² (20 to 18 AWG)

* The relay output signals are volt-free signals.
† User selectable: see Sections 5.7.2 and 5.7.3.
#

2.4 Sample gas

The sample gases must be non flammable, clean, non-corrosive, free from oil and condensates and compatible with the materials listed in Appendix A6.

Paramagnetic transducer (% O_2)

Flow rate *	100 to 250 ml min^{-1}
Dew point	5 °C below ambient temperature (minimum)
Temperature	5 to 45 °C
Particulate size	< 2 µm (2 micron)

Zirconia transducer (trace O_2)

Flow rate *	200 to 400 ml min^{-1}
Dew point	5 °C below ambient temperature (minimum)
Temperature	5 to 45 °C
Particulate size	< 2 µm (2 micron)

Infrared (GFX) transducer (trace)

Flow rate *	200 to 500 ml min^{-1}
Dew point	5 °C below ambient temperature (minimum)
Temperature	5 to 45 °C
Particulate size	< 2 µm (2 micron)

Thermal Conductivity transducer (%)

Flow rate *	100 to 200 ml min^{-1}
Dew point	5 °C below ambient temperature (minimum)
Temperature	5 to 45 °C
Particulate size	< 2 µm (2 micron)

* The flow rates apply to flow-driven transducers only. On pressure-driven transducers, the sample gas pressure must be in the range 14 to 56 kPa (2 to 8 psig).

2.5 Calibration gas

+ The calibration gases must be clean, non-corrosive, free from oil and condensates and compatible with the materials listed in Appendix A6.

+ For optimum calibration results, the calibration gas flow rate/pressure should be the same as the flow rate/pressure of the gases to be sampled.

O_2 purity transducer calibration gases

High calibration setpoint	0.5 – 100% O_2 (100% O_2 N_4 [99.99] recommended)
Low calibration setpoint	0 – 99.5% O_2 (0% zero grade nitrogen recommended)
Minimum difference	0.5%
Low calibration tolerance level *	
Calibration gas < 5% O_2	± 0.5% O_2
Calibration gas ≥ 5% O_2	± 10% O_2
High calibration tolerance level *	
Calibration gas < 5% O_2	± 0.5% O_2
Calibration gas ≥ 5% O_2	± 10% O_2

O_2 control transducer calibration gases

High calibration setpoint	0.5 – 100% O_2
Low calibration setpoint	0 – 99.5% O_2 (0% zero grade nitrogen recommended)
Minimum difference	0.5%
Low calibration tolerance level *	
Calibration gas < 5% O_2	± 0.5% O_2
Calibration gas ≥ 5% O_2	± 10% O_2
High calibration tolerance level *	
Calibration gas < 5% O_2	± 0.5% O_2
Calibration gas ≥ 5% O_2	± 10% O_2

TCD transducer calibration gases

High Calibration setpoint	90 – 110% of range**
Low Calibration setpoint	-10 – 10% of range**
Minimum Calibration difference between low and span	85% of range**
Low Calibration tolerance level *	± 10%
High Calibration tolerance level *	± 10%

* Range and background gas as per analyser specification.

N_2O, CO, and CO_2 trace transducer calibration gases

High calibration setpoint	40 to 120% of full scale (80 to 110% pref)
Low calibration setpoint	0% (zero grade nitrogen recommended)
Minimum calibration difference between low and span	8% of full scale
Low calibration tolerance level *	± 10% of full scale
High calibration tolerance level *	± 20% of full scale

O_2 trace transducer calibration gases

High calibration setpoint	18 to 25% O_2
Low calibration setpoint [#]	0.01 ppm to 5000 ppm O_2
Minimum calibration difference between low and span	17.5% O_2
Low calibration tolerance level *	± 10% O_2
High calibration tolerance level *	± 10% O_2

[#] The low calibration gas must be a high quality certified mixture (usually nitrogen N6.0) containing trace Oxygen. Mixtures between 1000 ppm to 4000 ppm are preferred.

* If, during a calibration or validation routine, the measurement is outside the specified range, a status message is displayed to indicate that there may be a problem (for example, the wrong calibration gas has been introduced, or the transducer has drifted excessively). The status can be over-ridden but the history will still remain.

** Range and background gas as per analyser specification. For optimal performance use either low or high calibration point to be a single component gas.

CAUTION **It is recommended that sample/calibration gas flow is monitored or the flow alarm option is purchased from Servomex to ensure a representative sample is being measured for control systems.**
CAUTION **The sample and bypass flowmeters are calibrated for use with air as the background gas.**

3 UNPACK THE ANALYSER

WARNING

The analyser is heavy (see Section 2.1). Care must be taken when handling. it is recommended that they are lifted with hands positioned on either side on the base of the chassis.

1. Remove the analyser and any other equipment from its packaging.
2. Remove any protective plastic covers from the sample gas inlets and outlets on the rear of the analyser (see Figure 2).

+ It is advisable that the protective covers are kept on just prior to fitting.

3. Inspect the analyser and the other items supplied, and check that they are not damaged. If any item is damaged, immediately contact Servomex or your local Servomex agent.
4. Check that you have received all of the items that you ordered. If any item is missing, immediately contact Servomex or your local Servomex agent.
5. If you do not intend to use the analyser immediately:
   - Refit any protective plastic covers.
   - Place the analyser and any other equipment supplied back in its protective packaging.
   - Store the analyser as described in Section 10.1.

   Otherwise, read Section 4 (Analyser user interface), then continue at Section 5 onwards to install, set up, and use the analyser.

+ Retain the shipping documentation and packaging for future use (for example, return of the analyser to Servomex for servicing or repair).

4 ANALYSER USER INTERFACE

+ Throughout this manual, reference is made to product ordering options (such as "auto validate") which must be specified at the time of purchase. Associated menus and menu options will not be available if your analyser does not have the corresponding product options.

4.1 Introduction

The analyser user interface comprises the following (shown on Figure 1):

Display	Shows various screens: see Section 4.2 onwards
Soft keys	The function of each of the soft keys depends on the screen currently being shown on the display: see Section 4.2
Alarm LED	On when an alarm condition exists: see Section 5.11
Fault LED	On when a fault condition exists: see Section 9

4.2 Start-up and measurement screens

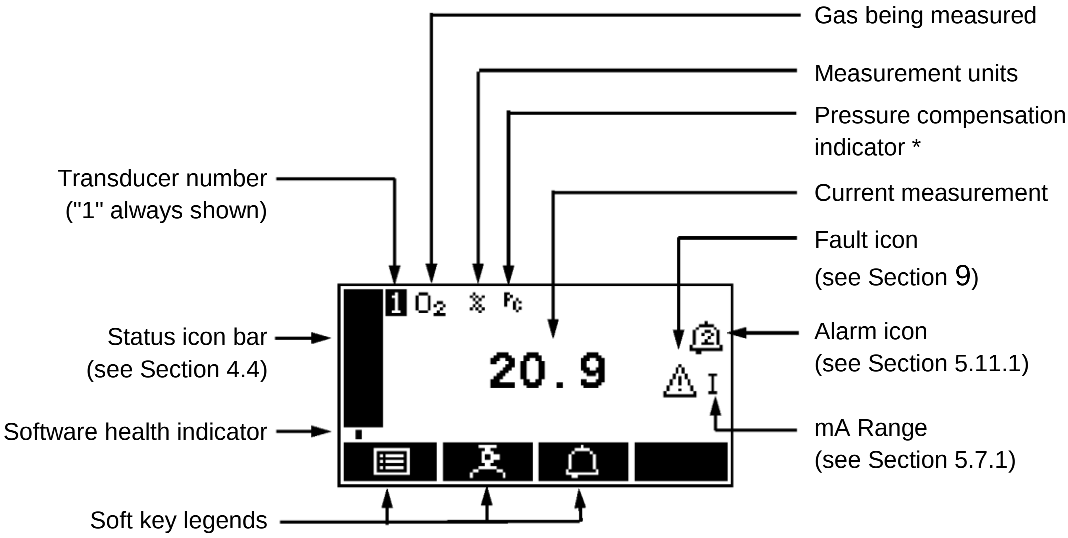
When you first switch on the analyser, a 'start-up screen' is displayed while the analyser carries out a self-test.

The start-up screen shows the Servomex name, a 'self-test time elapsed/remaining' indicator, and messages identifying the tasks being carried out as part of the self-test.

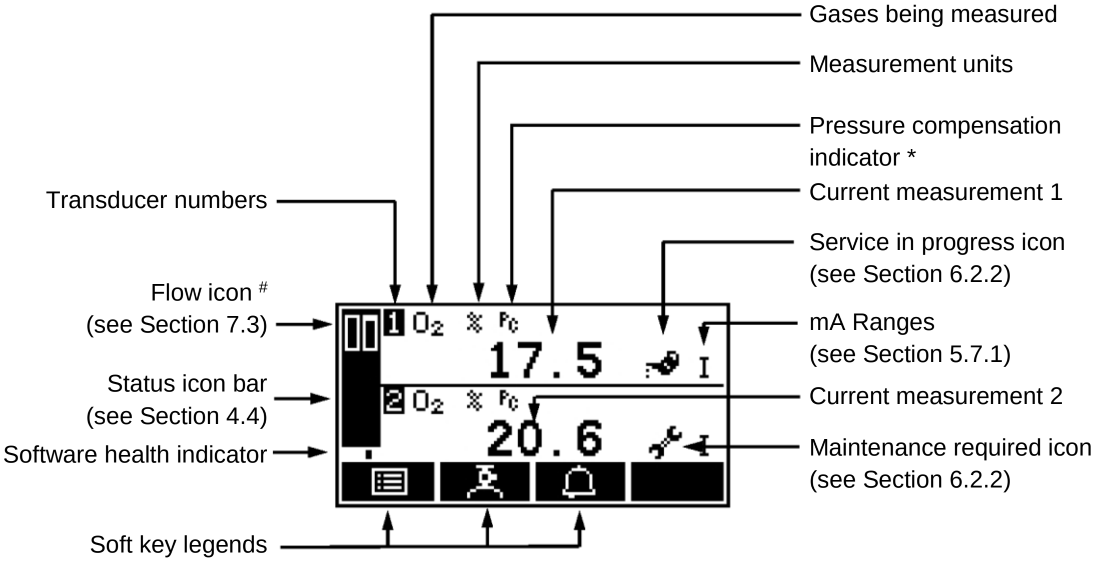
The screen will initially display the "System Check" task message. The measurement screen is then displayed, as shown in Figure 3 below. Note that:

- If your analyser is configured for a single sample gas measurement, the 1-measurement screen will be shown, as in detail A.
- If your analyser is configured for two sample gas measurements, the 2-measurement screen will be shown, as in detail B.

(A) 1 measurement screen:



(B) 2 measurement screen:



* Only shown when unit is installed with O_2 purity measurement and pressure compensation is on: see Section 7.2.

\# Only shown when unit is installed with flow alarm option.

Figure 3 – The measurement screen

+ During normal analyser operation, the software health indicator continuously moves from left to right and then back again, below the status icon bar. If the indicator stops moving, this means that the analyser is not operating correctly, and you must refer to Section 9.

+ If no soft key is pressed for 10 minutes, the measurement screen will be automatically displayed. (You will also then have to enter the password again to access any password-protected screens: refer to Figure 4 and to Section 4.6.)

4.3 Soft key legends

The four soft key legends at the bottom of the measurement screen (Figure 3) correspond to the four soft keys on the front of the analyser. (The first, left-most, legend corresponds to the function of soft key 1, the second legend corresponds to the function of soft key 2, and so on.) On the measurement screen, the soft key functions are as follows:

Legend	Meaning	Function (when soft key pressed)
	Menu	Displays the menu screen: see Section 4
	Calibrate *	Displays the calibrate screen: see Sections 6 and 6.2
	Alarm *	Displays the alarm option screen: see Section 5.11.1
	–	None (no effect)

* These soft keys are 'shortcuts' to the described functions, which are also accessible from the menu structure.

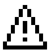
Other soft key legends which are used on the various screens are as follows:

Legend	Meaning	Function (when soft key pressed)
	Back	Cancels the current screen and displays the previous screen in the menu structure
	Accept	Accepts the currently selected option or data. (A new screen may be displayed accordingly.)
	Edit	Allows the highlighted data to be edited
	Up	Moves the cursor up a list (or increases a digit during editing)
	Down	Moves the cursor down a list (or decreases a digit during editing)
	Left	Moves the cursor left
	Right	Moves the cursor right
	Stop	Stops an automatic validation/calibration

4.4 System and measurement status icons

System status is on the status icon bar and can be shown with a fault icon or a maintenance required icon, see table below.

Measurement status is on the right hand side of the measurement reading and can be shown with a fault icon, a maintenance required icon, a service in progress icon or a warming icon, see table below.

Icon	Meaning
	Indicates that a **fault** has been detected
	Indicates that **maintenance is required**
	Indicates that **service is in progress**
	Indicates that the transducer is **warming** up

To determine the cause of these status icons, see Section 9.2.

4.5 Scroll bars

On some screens (for example, see Figure 5), there may be more options available than can be shown on the screen, and you have to scroll down the screen to view all of the options: this is identified by a scroll bar at the right-hand side of the screen.

The height of the wide part of the scroll bar gives an indication of what proportion (of all the options) are currently shown on the screen. As you scroll up or down the options (using the  and  soft keys), the wide part of the scroll bar will also move on the screen, indicating approximately where the currently displayed options are, within the complete list of options.

4.6 Menu options/screens and password protection

The menu structure of the analyser is shown in Figure 4, which indicates that some of the options/screens are password protected.

When an option/screen is password protected, this means that the correct corresponding password has to be entered before the option/screen can be accessed. See Section 5.4.1 for details on how to set the security level.

Password protection operates as follows:

+ As supplied, the security level is set to 'high', the supervisor password is set to "2000" and the operator password is set to "1000".

- The first time you try to access a password-protected option/screen, you will be prompted for the corresponding password. You must then enter the correct password (using the editing method described in Section 4.10) before the option/screen can be displayed.
- If you have already entered the corresponding password, you will gain access to all options/screens protected by that password immediately (you do not need to enter the password again).

+ Once you have entered a password, it remains active until 10 minutes after the last soft key is pressed. After this, the password becomes inactive; you must re-enter the password to access password-protected options/screens again.

To change the passwords see Section 5.4.3.

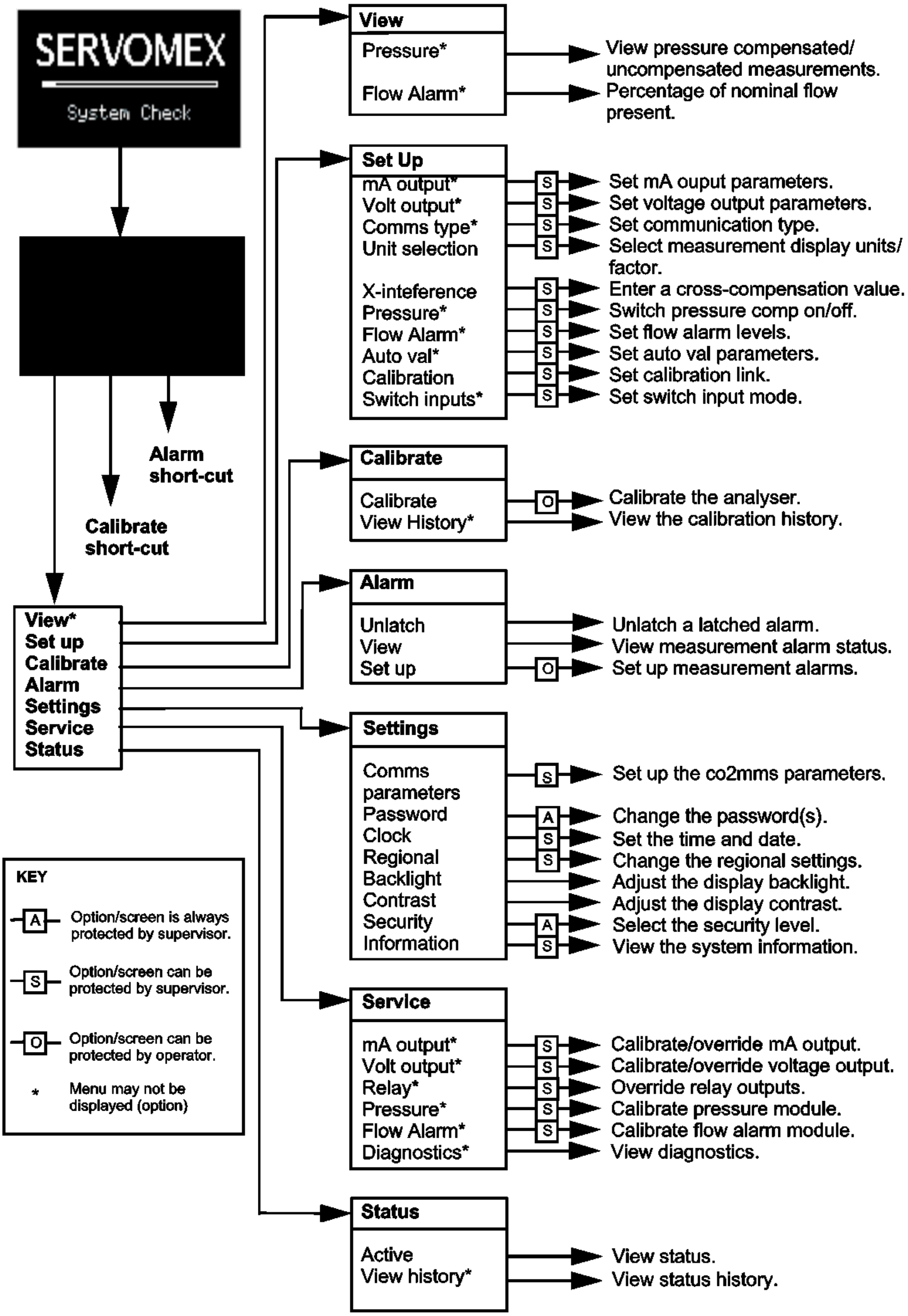


Figure 4 – The analyser menu structure

4.7 The menu screen

+ Some of the menu screens referenced below may not be available: refer to the note at the start of Section 4.

The menu screen provides access to other screens in the menu structure, and is displayed by pressing the soft key when the measurement screen is displayed.

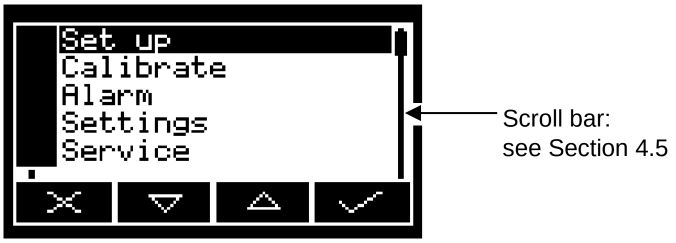


Figure 5 – The menu screen

Use the and soft keys to highlight the required screen option, then press the soft key to display the selected screen:

Screen	Use [refer to section]
View	Select this screen to view the O_2 measurement pre and post pressure compensation [7.2] and flow reading [7.3].
Set up	Select this screen to select the communications type [A1.2 or A3.3], configure the auto validation/calibration target range [5.5.5], link calibration [5.6], enter a cross-interference compensation [5.9.2], switch pressure compensation on/off [7.2.2], select the display units [5.10], set up the mA output parameters and range [5.7.3], and set up the voltage output parameters and range [5.8.1], and set up the flow alarm [5.12].
Calibrate	Select this screen to calibrate or validate the analyser [6, 6.2] and to view calibration history [6.2.4].
Alarm	Select this screen to set up the measurement alarms and set the alarm follow options [5.11.1], unlatch alarms [5.11.2] and view the measurement alarm status [5.11.4].
Settings	Select this screen to change analyser settings (password, display language and so on) [4.8].
Service	Select this screen to calibrate/check the mA outputs [7.4], calibrate/check the voltage outputs [7.5], check the relay signal outputs [7.1], calibrate flow [5.12], calibrate the pressure transducer [6.3] and viewing diagnostics [9.3].
Status	Select this screen to view active and historical fault, maintenance required and service in progress (SIP) messages [9.2].

Alternatively, press the [✕] soft key to display the measurement screen again.

4.8 The settings screen

Use the [△] and [▽] soft keys to highlight the required screen option, then press the [✓] soft key to display the selected screen, as shown below:

Figure 6 – The Settings screen

Screen	Use [refer to section]
Comms Parameters	Configuring the communications parameters [A1.2 or A3.3]
Password	Changing the password [5.4.3]
Clock	Setting the clock time and/or date [5.4.6]
Regional	Changing regional settings (language and so on) [5.4.7]
Backlight	Adjusting the backlight timer duration [5.4.5]
Contrast	Adjusting the contrast of the screen [5.4.4]
Security	Selecting the security level [5.4.2]
Information	Viewing analyser system information [4.9]

Alternatively, press the [✕] soft key to display the menu screen again.

4.9 The information screen

This screen shows information (such as the analyser serial number and the version of the operating software embedded in the analyser) which is useful to the Servomex support team.

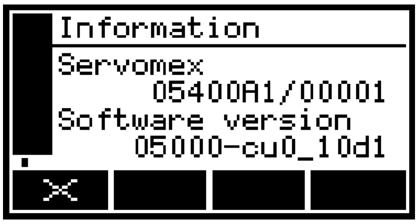


Figure 7 – Typical information screen

Note that the information shown on the screen will vary, depending on the analyser model.

After viewing (and if necessary recording) the information shown on the screen, press the ✕ soft key to display the settings screen again, or press and hold the ✕ soft key to show the measurement screen again.

✚ You may be asked to provide the information from this screen to the Servomex support team; for example, as an aid to fault diagnosis.

4.10 Editing on-screen data

A common method is used for editing data shown on all of the different screens.

When you press the ✎ soft key to edit an item of data, the screen changes to show the corresponding edit screen, with the first digit highlighted:

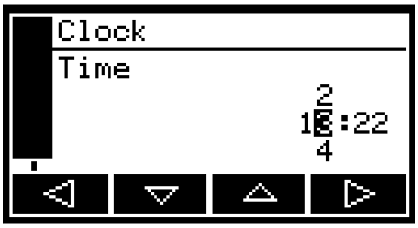


Figure 8 – A typical edit screen

When the first digit is highlighted, press the ✕ soft key to exit the menu without changing the data.

Alternatively, use the soft keys to edit the data as follows:

Soft key	Function
△	Increases the highlighted digit by 1
▽	Decreases the highlighted digit by 1
◁	Moves the cursor left to the previous digit
▷	Moves the cursor right to the next digit

Note that the figures above and below the highlighted digit show the digits above and below the currently highlighted value.

When the last digit is highlighted, press the ✓ soft key to enter the new data.

✚ When editing numerical values, the decimal point appears between digits "9" and "0".

5 INSTALLATION AND SET-UP

WARNING

The analyser must be installed by a suitably skilled and competent person. The following procedure must be followed to prevent a hazard.

WARNING

The analyser is only suitable for installation in safe areas.

CAUTION

Do not install the analyser in a frame/rack or on a bench which is subject to high levels of vibration or sudden jolts. If you do, sample measurements may not be accurate, or the analyser may be damaged.

5.1 Mechanical installation

5.1.1 Bench mounting

Place the analyser on a firm level bench or other suitable solid worksurface.

The bench mounted analyser has four mounting feet. If required, the front two mounting feet can be extended to raise the front of the analyser and so make the analyser display easier to read and the soft keys easier to access.

+ With the front mounting feet extended, the floats in the optional flowmeters may not rotate, although the flow indications will be correct.

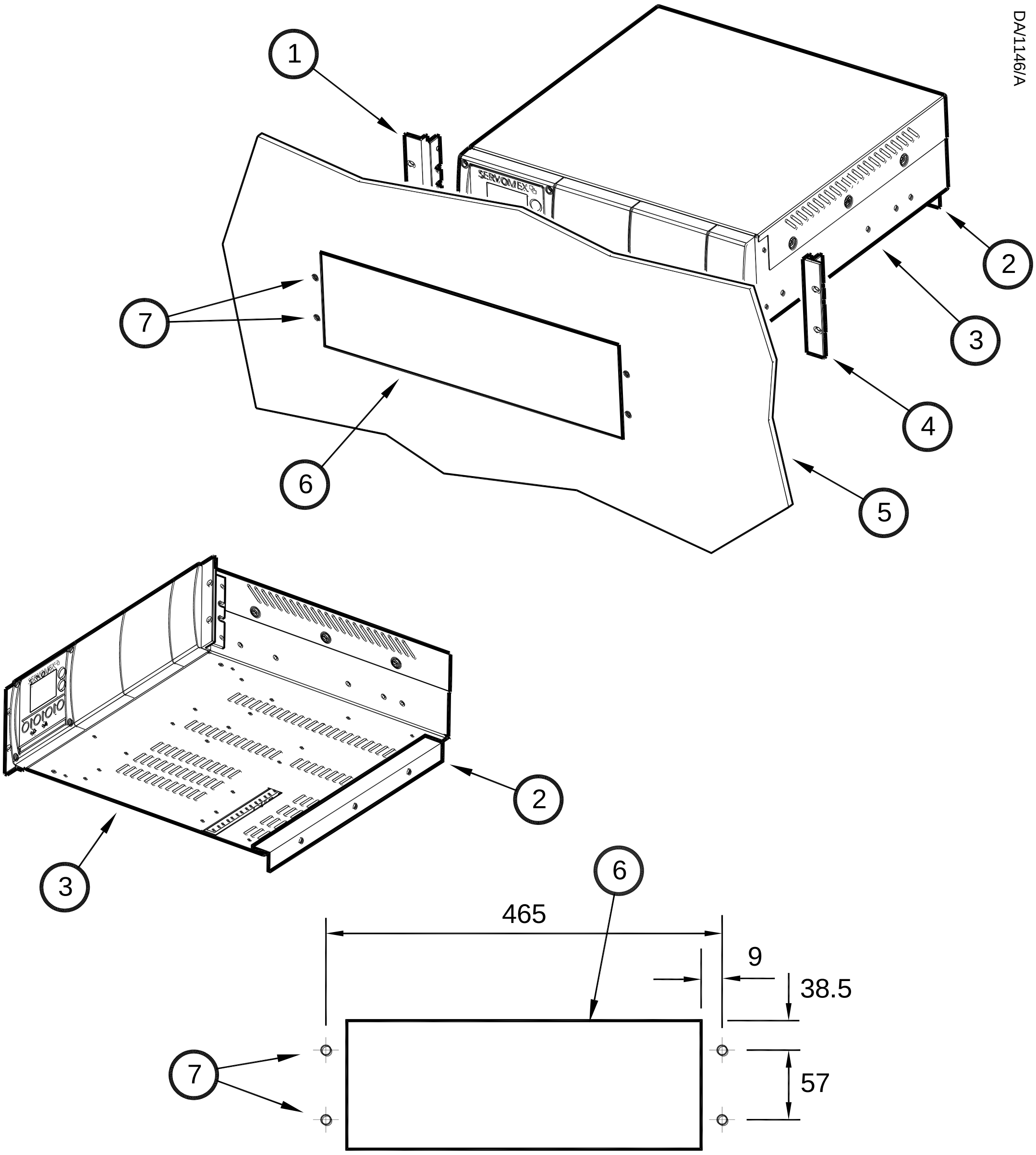
5.1.2 Panel mounting

CAUTION

The analyser must not be supported by the side mounting brackets alone. You must provide an additional support under the base of the analyser towards the rear of the enclosure as shown in Figure 9. If you do not, the analyser may be damaged, or may fall and damage other equipment.

1. Refer to Figure 9. Prepare a cut-out (6) in a suitable panel (5).
2. Prepare a suitable base support (2) and secure it in your frame or cabinet.
3. If necessary (that is, if they are supplied separately), use the bolts and washers supplied to fit the left-hand and right-hand mounting brackets (1, 4) to the analyser (3).

4. Fit the analyser (3) in the panel (5) and use nuts and bolts through the fixing holes (7) in the panel and the mounting brackets (1, 4) to secure the analyser in place.



Key	Description	Key	Description
1.	Left-hand mounting bracket	4.	Right-hand mounting bracket
2.	Base support bracket (not supplied)	5.	Panel
		6.	Cut-out (447 mm x 134 mm)
3.	Analyser	7.	Fixing holes: 7 mm dia (4 off)

Figure 9 – Install the analyser in a panel

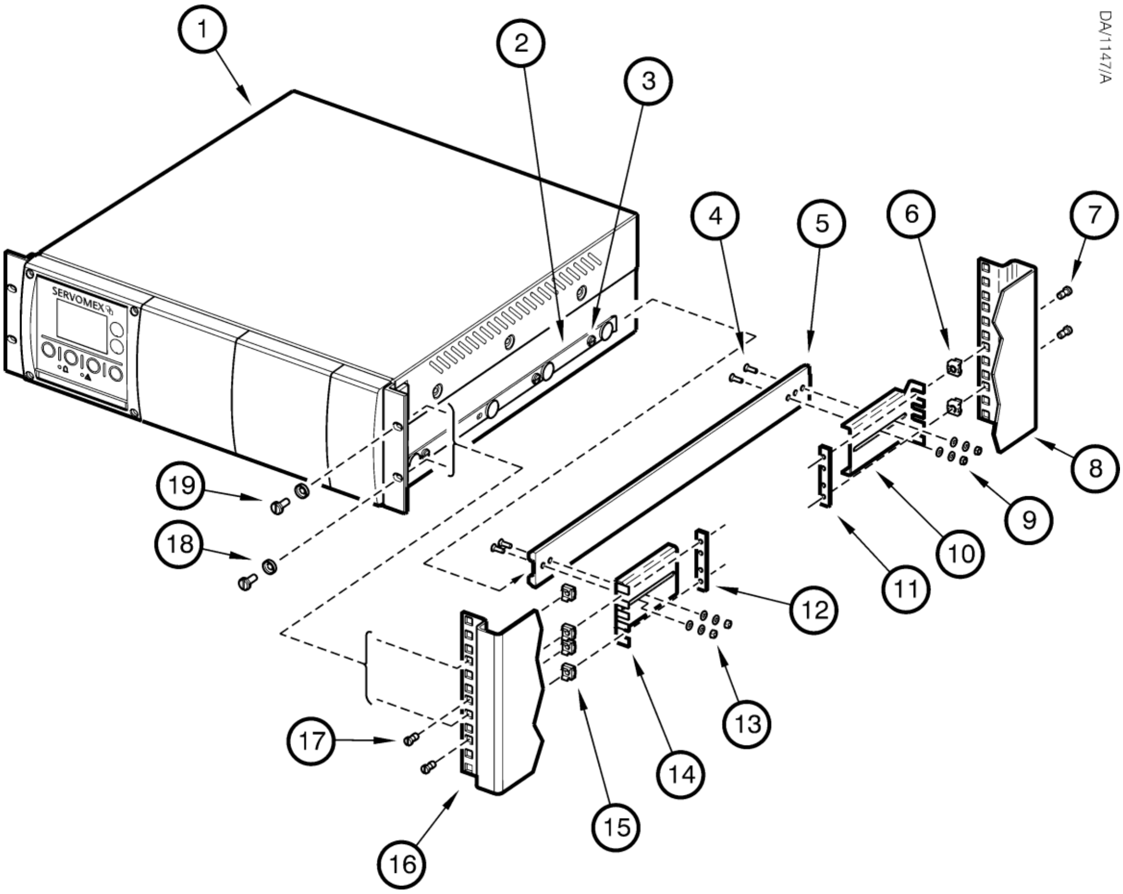
5.1.3 Rack with slide mounting

Before installing the analyser, determine where you will install it in the rack enclosure. The analyser will occupy 9 rack flange cage nut positions vertically; with the bottom cage nut designated as position 1, you will need to use positions 1, 3, 4 and 7 on both the right-hand and left-hand front and rear rack enclosure flanges. Note that you do not need to punch out any of the other cage nut positions.

Refer to Figure 10 on page 25 and install the analyser as follows:

1. If the rack mounting kit has been supplied as a spare:
   - Remove the two slide inner sections (2) from the two slide outer sections (5).
   - Use the M5 screws supplied (3) to fit the two slide inner sections (2) to the sides of the analyser (1).
2. Determine where the analyser will be fitted in the rack, then, counting from the bottom cage nut position (position 1):
   - Install cage nuts (15) in positions 1, 3, 4 and 7 on the left-hand and right-hand front rack enclosure flanges (16).
   - Install cage nuts (6) in positions 1 and 4 on the left-hand and right-hand rear rack enclosure flanges (8).
3. Engage the two M6 waisted screws (7) into the cage nuts (6) in positions 1 and 4 on the left-hand and right-hand front and rear rack enclosure flanges (16, 8).
4. Fit the right-hand slide support clamps:
   - Hold the front slide support clamp (12) in position behind the rack enclosure front flange (16), and align the fixing holes in the clamp with the cage nuts in positions 1 and 4.
   - Engage the two M6 waisted screws (17) in the fixing holes in the clamp (12). Do not fully tighten the waisted screws.
   - Hold the rear slide support clamp (11) in position behind the rack enclosure rear flange (8), and align the fixing holes in the clamp with the cage nuts in positions 1 and 4.
   - Engage the two M5 waisted screws (7) in the fixing holes in the clamp (11). Do not fully tighten the waisted nuts.
5. Fit the right-hand slide support brackets:
   - Fit the front slide support bracket (14) between the cage nuts (15) and the front side support clamp (12), then fully tighten the two M6 waisted screws (17) to secure the support bracket in position.
   - Fit the rear slide support bracket (10) between the cage nuts (6) and the rear slide support clamp (11), then fully tighten the two M6 waisted screws (7) to secure the support in position.
6. Ensure that the slide opening is at the front, then loosely fit the right-hand outer slide section (5) to the front and rear slide support brackets (14, 10) and secure with the four M4 screws (4), and the nuts and washers (9, 13).

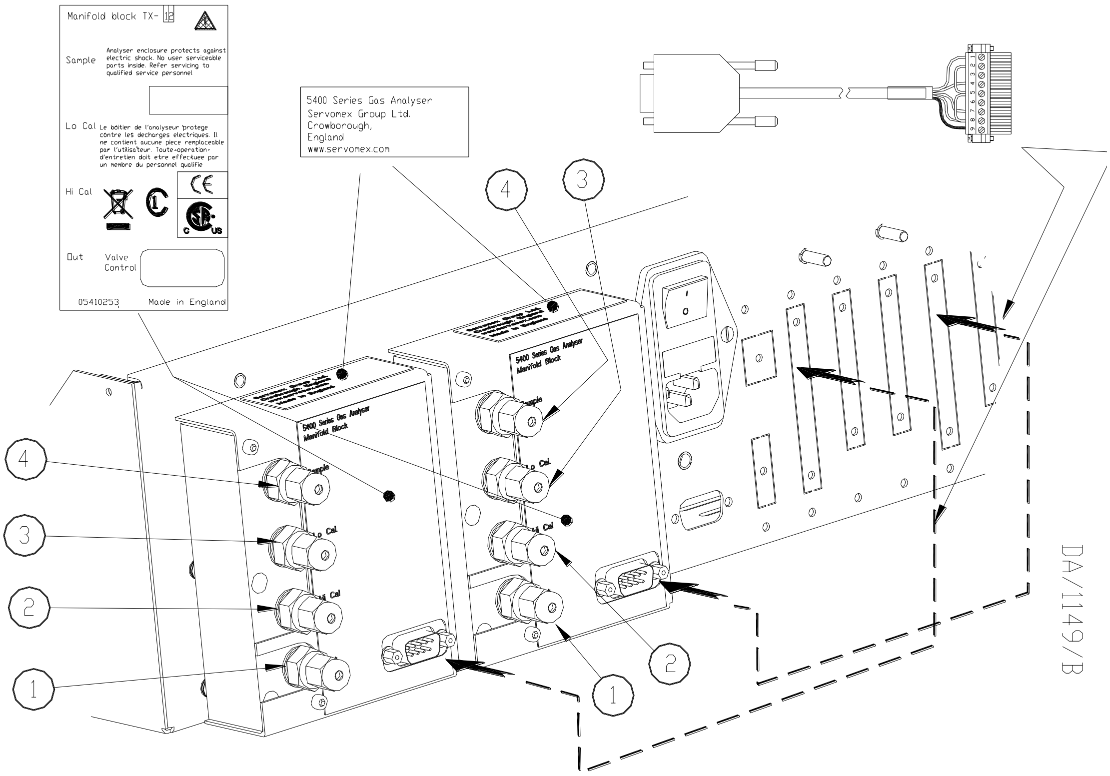
7. Ensure that the front of the right-hand outer slide section (5) is 35 mm behind the rack enclosure front flange (16), then fully tighten the nuts (9, 13) to secure the slide section in position.
8. Use the procedure in Steps 4 to 7 to fit the left-hand support clamps, slide support brackets and outer slide section.
9. Align the ends of the left-hand and right-hand slide inner sections (2) in the openings in the front of the left-hand and right-hand slide outer sections (5) and slide the analyser (1) into the rack enclosure.
10. Use the four M6 pan head screws (19) and plastic cup washers (18) to secure the analyser in place.



Key	Description
1.	Analyser
2.	Slide inner section
3.	M5 pan head screws (3 off)
4.	M4 counter sunk screws (4 off)
5.	Slide outer section
6.	M6 cage nuts (2 off)
7.	M6 waisted screws (2 off)
8.	Rear rack enclosure flange
9.	M4 nut, washer and locking washer (2 off)
10.	Slide support bracket (rear)
11.	Slide support clamp (rear)
12.	Slide support clamp (front)
13.	M4 Nut, washer and locking washer (2 off)
14.	Slide support bracket (front)
15.	M6 cage nuts (4 off)
16.	Front rack enclosure flange
17.	M6 waisted screws (2 off)
18.	Plastic cup washers (2 off)
19.	M6 pan-head screws (2 off)

Figure 10 – Install the analyser in a rack enclosure (with a slide)

5.1.4 Valve block connections (option)



Key	Description
1.	Gas outlet
2.	High cal gas inlet

Key	Description
3.	Low cal gas inlet
4.	Sample gas inlet

Figure 11 – Valve block connections (compression fittings not supplied)

CAUTION

To comply with EMC requirements, the valve block shall only be connected to the control relays using the supplied cable. Refer to Section 5.2.1 before making any electrical connections and Section 5.3 before making any plumbing connections.

+ The D type connector marked as "Valve control" must be connected to the corresponding Auto val/cal connections on the option cards. Ensure all connectors are screwed in place.

+ Inlet and outlet port threads are 1/8 BSPP F. A suitable sealing washer must be used with customer supplied valve block fittings (copper washers are recommended).

5.2 Electrical Installation

5.2.1 Electrical Safety

	WARNING Ensure that the electrical installation of the analyser conforms with all applicable local and national electrical safety requirements.

	WARNING Obey the safety instructions given below when you install the analyser; if you do not, the analyser warranty may be invalidated, the analyser may not operate correctly, or it may be damaged.

The following warnings must also be considered:

- The electrical supply coupler or plug must be easily accessible for disconnection from the electrical supply.
- The electrical supply circuit must incorporate a suitable fuse or over-current protection device, set to or rated at no more than 10 A.
- Ensure that your electrical supply can provide the necessary maximum power consumption: refer to Section 2.3.
- All signal and electrical supply cables must be rated for temperatures of 70 °C or higher.
- Ensure that the cables that you connect to the analyser are routed so that they do not present a trip hazard.
- When you carry out insulation testing, disconnect all cables from the analyser.
- Ensure the analyser is provided with a sound earth connection via the electrical supply plug (Figure 2, item 8).

5.2.2 Analogue output connections

WARNING

The analogue output terminals are separated from the analyser mains circuits by reinforced insulation. The terminals must only be connected to circuits that are themselves separated from mains voltages by an isolation method that provides at least this level of protection.

CAUTION

To comply with EMC requirements, screened cables must be used to connect the analogue outputs.

1. Connect the wires in your cable to the screw terminals on the 6 pin connector provided. Section 2.3 provides information on the rating and size of cable.
2. The screen should be connected to the earth point on the rear of the analyser.
3. Unless otherwise specified a mA analogue output is provided as standard across pins 1 & 2.

Pin	Use
1	I+
2	I–
3	GND
4	V+
5	V–
6	GND

Figure 12 – Analogue output interface connector

4. If your analyser is configured to provide voltage outputs, connect the wires in your cable to pins 4 – 5 on the terminal strip.

5.2.3 Fault and range relay connections

WARNING

The fault and range relay connections are separated from the analyser mains circuits by reinforced insulation. The terminals must only be connected to circuits that are themselves separated from mains voltages by an isolation method that provides at least this level of protection.

The analyser comes with a fault relay and a range change relay as standard. These can be used to provide an output to your system to indicate a fault within the analyser or to indicate which range the analogue output is set to (see Section 5.7.1).

1. Connect the wires in your cable to the screw terminals on the 6 pin connector provided. Section 2.3 provides information on the rating and size of cable.
2. Pins 2 and 3 are connected during a fault condition. Pins 1 and 2 are connected if no fault is present. During a power failure the fault relay will be in a fault condition.
3. Pins 5 and 6 are connected if analogue output Range 1 is selected. Pins 4 and 5 are connected if range 2 is selected.

Pin	Use
1	N/O (Fault)
2	COM (Fault)
3	N/C (Fault)
4	N/O (Range)
5	COM (Range)
6	N/C (Range)

Figure 13 – Fault and range relay interface connector

5.2.4 Alarm and status relay connections (option)

WARNING

The alarm and status relay connections are separated from the analyser mains circuits by reinforced insulation. The terminals must only be connected to circuits that are themselves separated from mains voltages by an isolation method that provides at least this level of protection.

The analyser can be supplied with alarm and status relays. These can be used to indicate a measurement alarm has been set off or to indicate whether a Service in Progress (SIP) or maintenance required status has been raised.

1. Connect the wires in your cable to the screw terminals on the 6 pin connectors provided. Section 2.3 provides information on the rating and size of cable.
2. Pins 1 and 2 are connected if alarm 1 is active (Figure 14).
3. Pins 4 and 5 are connected if alarm 2 is active (Figure 14).

Pin	Use
1	N/O (Alarm 1)
2	COM (Alarm 1)
3	N/C (Alarm 1)
4	N/O (Alarm 2)
5	COM (Alarm 2)
6	N/C (Alarm 2)

Figure 14 – Alarm relay interface connector

4. Pins 1 and 2 are connected if service in progress status is active (Figure 15).
5. Pins 4 and 5 are connected if maintenance required status is active (Figure 15).

Pin	Use
1	N/O (SIP)
2	COM (SIP)
3	N/C (SIP)
4	N/O (Maint Req'd)
5	COM (Maint Req'd)
6	N/C (Maint Req'd)

Figure 15 – Status relay interface connector

5.2.5 Auto validate/calibrate connections (option)

WARNING

The auto validate/calibrate board connections are separated from the analyser mains circuits by reinforced insulation. The terminals must only be connected to circuits that are themselves separated from mains voltages by an isolation method that provides at least this level of protection.

The analyser can be supplied with auto validate/calibrate relays and switched inputs. The relays can control solenoid valves in the gas supply system to perform validate or calibrate routines.

Depending on whether you have chosen to do a remote validate/calibrate routine or an auto validate/calibrate (see Section 6 and Section 6.2) the pin assignments will have different functions.

1. Connect the wires in your cable to the screw terminals on the 9 and 6 pin connectors provided. Section 2.3 provides information on the rating and size of cable.
2. Pins 1 and 2 are connected when sample gas flow is required (Figure 16).
3. Pins 4 and 5 are connected when low calibration gas is required (Figure 16).
4. Pins 7 and 8 are connected when high calibration gas is required (Figure 16).

Pin	Use
1	N/O (Sample)
2	COM (Sample)
3	N/C (Sample)
4	N/O (Cal Lo)
5	COM (Cal Lo)
6	N/C (Cal Lo)
7	N/O (Cal Hi)
8	COM (Cal Hi)
9	N/C (Cal Hi)

Figure 16 – Auto validate/calibrate or remote validate relay
9 pin interface connector

5. Connect pins 1 and 2 to start a low calibration or initiate auto validation/ calibration (Figure 17).
6. Connect pins 3 and 4 to start a high calibration or stop auto validation/ calibration (Figure 17).
7. Connect pins 5 and 6 to initiate service in progress (Figure 17).

+ Switch 1 and 2 input function is dependent on the switch input configuration, see Section 5.5.3.

Pin	Use
1	IN+ (Cal Lo or Initiate AutoVal)
2	IN– (Cal Lo or Initiate AutoVal)
3	IN+ (Cal Hi or Stop AutoVal)
4	IN– (Cal Hi or Stop AutoVal)
5	IN+ (Activate SIP)
6	IN– (Activate SIP)

Figure 17 – Auto validate/calibrate or remote validate switched inputs
6 pin interface connector

5.2.6 Modbus RS485 and ethernet connections (option)

WARNING

The digital communications terminals are separated from the analyser main circuit by reinforced insulation. The terminals must only be connected to circuits that are themselves separated from mains voltages by an isolation method that provides at least this level of protection.

The analyser can be supplied with Modbus RS485 / ethernet digital communications. For a full list of what can be communicated over the Modbus communications see Appendix A4.

If Modbus RS485 option is supplied:

1. The cable should not leave the building in which it is installed without suitable isolation.
2. The screen should be connected to the earth point on the rear of the analyser.
3. Connect the wires in your cable to the screw terminals on the 5 pin interface connector provided. Refer to Section 2.3 for the cable electrical requirements, and refer to Figure 18 for the connection requirements.

Pin	Use
1	A
2	B
3	A
4	B
5	Term

Figure 18 – Modbus RS485 interface connector

If Modbus ethernet option is supplied:

1. The cable should not leave the building in which it is installed without suitable isolation.
2. The cable must be shielded CAT5E with standard RJ45 connectors.

5.2.7 Connect the electrical supply

WARNING

Ensure that your external electrical supply outlet is isolated and locked out before you connect the conductors in the electrical supply cable.

WARNING

Only use the power supply cord provided with the unit.

CAUTION

Ensure that the analyser is suitable for use with your electrical supply voltage and frequency (refer to Section 2.3). If the analyser is not suitable, the analyser may not operate correctly, or it may be damaged when you operate it.

The analyser is supplied with an electrical supply cable, configured for your electrical supply. Connect the electrical supply to the analyser as follows:

1. Fit the IEC plug on the end of the electrical supply cable provided to the electrical supply socket on the rear of the analyser (Figure 2, item 8).
2. Route the cable towards your electrical supply outlet.
3. Connect the conductors at the free end of the electrical supply cable to your electrical supply outlet.
4. Check the earth (ground) continuity between your electrical supply outlet earth (ground) and the functional earth (ground) terminal on the rear of the analyser (Figure 2, item 7).
5. If a local earth bonding is required the functional earth stud can be used (item 7, Figure 2). The earthing cable must be kept to less than 3 metres to comply with EMC standards. This does not replace the earth conductor on item 8 Figure 2 which must be connected.

5.3 Connect the sample/calibration gas pipeline(s)

WARNING

Sample and calibration gases may be toxic or asphyxiant:

- Ensure that the external connections are leak free at full operating pressure before you use sample or calibration gases.
- Ensure that the sample/bypass outlet pipes are vented to an area where the gases will not be a hazard to people.
- Ensure that the analyser is used in a sufficiently well-ventilated environment, to prevent the build-up of toxic gases.

Ensure that the pipes that you connect to the analyser are routed so that they do not present a hazard to people.

CAUTION

When you carry out a leak test, do not exceed a maximum pressure of 34.5 kPa gauge (0.35 bar gauge, 5 psig) and do not introduce a sudden change of pressure into the analyser. If you do, you can damage it.

CAUTION

It is essential that a MultiExact Trace O_2 analyser is isolated from the sample system until any cleaning solvents are fully purged from the pipelines. Failure to take this precaution may lead to contamination of the zirconia sensor, which will be observed as an offset and drift in output.

Connect your sample/calibration gas inlet and outlet pipelines to the inlets and outlets on the rear of the analyser (see Figure 2). The sizes of the fittings are as follows:

Transducer	Sample gas inlet	Sample gas/bypass outlet
O_2, CO, CO_2, N_2O trace GFX transducer	$^{1}/_{8}$ inch outside diameter stainless steel stub	$^{1}/_{4}$ inch NPT female
TCD and O_2 purity and control transducers	$^{1}/_{8}$ inch NPT female	$^{1}/_{4}$ inch NPT female

* The optional external filter should be fitted to the inlet pipe with the compression fittings provided: see Section 8.4.

Refer to Section 2.4 for sample gas requirements, and Section 2.5 for calibration gas requirements. Locate your gas selection valves as close as possible to the analyser.

+ You must switch on the electrical supply and leave the analyser for at least 4 hours (or 24 hours for the trace GFX transducers) before you allow calibration or sample gases into the analyser. Refer to the caution at the start of Section 6.

+ For 0-10ppm CO_2 or 0-500ppm CO_2, on initial start-up you must switch on the electrical supply and leave the analyser to purge on low calibration gas for at least 24 hours until the reading has stabilised before calibrating the analyser.

5.4 Switch on/set-up

+ When the electrical supply to the analyser is switched on, the Alarm LED and the Fault LED will both go on for 1 second to demonstrate that they are functioning correctly, and will then go off again.

When you switch on the electrical supply to the analyser, a 'start-up screen' is first displayed (see Section 4.2), then the measurement screen (Figure 3) is displayed.

When the measurement screen is displayed, you can set up the analyser as described below.

5.4.1 Selecting the security level and password(s)

You can configure the analyser to provide any of three levels of security:

Security level	Function
Low	None of the options/screens are password protected *
Standard	Some of the options/screens are protected by a supervisor password
High	Some of the options/screens are protected by a supervisor password and some of the options/screens are protected by an operator password †

* Except for the 'change the password(s)' and 'select the security level' options/screens: see notes below.

† The supervisor password can also be used to access options/screens protected by the operator password: see notes below.

+ The 'change the password(s)' and 'select the security level' screens/options are always protected by the supervisor password, regardless of the security level selected. This is to ensure that unauthorised personnel cannot change the security level and password(s) and so lock out the analyser from other users.

+ The supervisor password provides access to all password protected options/screens. That is, if you have selected the 'high' security level and are prompted to enter the operator password, you can also access the option/screen by entering the supervisor password.

+ Password protection can be used to prevent adjustment of the clock by unauthorised persons, so ensuring the validity of measurement times and the 'time since last calibration' history.

Figure 4 shows the options/screens which can be password-protected within the menu structure.

5.4.2 Selecting the security level

+ As supplied, the security level is set to 'high', the supervisor password is set to "2000" and the operator password is set to "1000".

Before the analyser is used for sample measurement, we recommend that you select the security level (low, standard or high: see Section 4.6) most suitable for the way in which the analyser will be used by you and/or your personnel.

Use the following procedure to select the required security level:

1. Select þ Settings þ Security.
2. To change the security level, press the soft key. You will then be prompted to enter the supervisor password.
3. Once the supervisor password has been entered correctly, the security select screen will be displayed (see Figure 19), with the currently selected security level highlighted.
4. To change the security level, use the and soft keys to highlight the required level, then press the soft key. The security level screen will then be displayed again, showing the newly selected security level.
5. Once the supervisor password has been entered correctly, the security select screen will be displayed (see Figure 20), with the currently selected security level highlighted.
6. Press the soft key twice to display the menus screen again.

Figure 19 – The security level screen

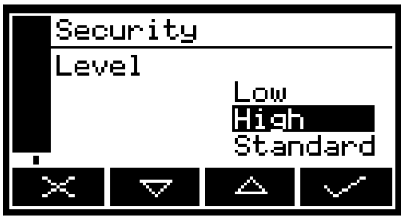


Figure 20 – The security select screen

5.4.3 Changing passwords

+ If you change a password, ensure that you record the new password somewhere safe. Otherwise, if you cannot recall the new password, you will have to contact Servomex or your local Servomex agent for assistance.

Use the following procedure to change the supervisor and operator passwords:

1. Select þ Settings þ Password.
2. To change the supervisor password, press the soft key, then enter the new password: use the editing method described in Section 4.10.
3. To change the operator password, press the soft key to display the edit operator password screen, press the soft key, then enter the new password: Press the soft key to display the settings screen again

Figure 21 – The edit supervisor password screen

5.4.4 Adjusting the contrast

1. Select þ Settings þ Contrast.
2. Use the and soft keys to increase or decrease the contrast to the required level, then press the soft key.

Figure 22 – The contrast screen

+ Hold the or soft key pressed in to adjust the contrast quickly.

5.4.5 Adjusting the backlight timer

When the analyser is first switched on, the backlight goes on to illuminate the screen. If no soft key is pressed, the backlight will remain on for the preset 'backlight time', and will then go off. The timer associated with the backlight time is restarted whenever a soft key is pressed (that is, the backlight remains on for the backlight time after the last soft key press). To adjust the backlight time:

1. Select þ Settings þ Backlight.
2. Change the backlight time (duration) setting as required, then press the soft key.

Figure 23 – The backlight timer screen

+ The backlight time (duration) can be set between 0 and 999 seconds. Set the backlight time (duration) to 0 seconds to leave the backlight permanently switched on.

5.4.6 Setting the clock

+ The time and date will remain set for approximately 1 week if the power supply to the analyser is switched off.

Use the following procedure to set the date and time:

1. Select þ Settings þ Clock.
2. Edit the displayed time as described in Section 4.10.

Figure 24 – The clock (time) screen

3. Edit the displayed date as described in Section 4.10.
4. The date format can be set to your regional preference ('day/month/ year' or 'month/day/year'): refer to Section 5.4.7.

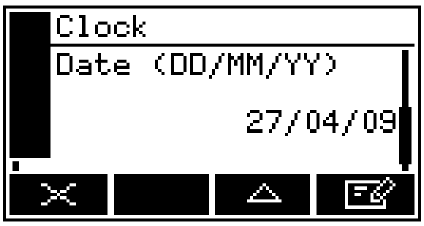


Figure 25 – The clock (date) screen

5.4.7 Changing regional settings

You can configure the following analyser regional settings so that the information shown on the various screens is better suited to your local conventions:

Setting	Options available
Language	Various languages are supported
Date format	Day/Month/Year * or Month/Day/Year
Decimal format	Use of "." * (full stop) or "," (comma) as the decimal point

* Default option.

To change the regional settings:

1. Select þ Settings þ Regional.
2. This screen shows the first regional option (Language).

Figure 26 – The regional settings (language) option screen

5.4.8 Selecting communications type

+ If your analyser supports digital communication e.g. Modbus ethernet, RS485 etc. the communications type will default to this. You can however, choose to select Serial Output (RS232). If serial output is selected then digital communication over Modbus is disabled. See Appendix A4.

1. Select þ Set up þ Comms Type.
2. This screen shows the first communications type.

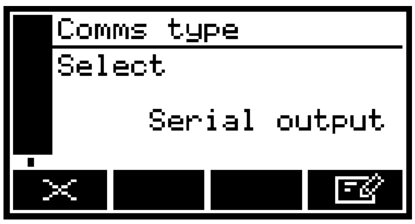


Figure 27 – The Communications type screen

5.5 Setting up automatic validation/calibration (option)

5.5.1 Overview of automatic validation/calibration

Automatic validation operates in the same way as automatic calibration, except that the transducers are not calibrated when the low and high calibration gases have been passed through the transducers. Automatic validation therefore allows you to determine the drift of sample measurements over time. You can set tolerance levels, so that if the sample measurements fall outside acceptable limits, a 'maintenance required' status is raised ( ) to identify that a full calibration needs to be carried out.

If your analyser supports auto validation/calibration you have the option to:

- Configure the analyser so that automatic validation/calibration of a transducer is carried out once (at a preset time).
- Configure the analyser so that automatic validation/calibration of a transducer is carried out repeatedly at a specified frequency.
- Use the soft keys to manually start an automatic validation/calibration (see Section 6.2.1).
- Use a control input signal (on the RS485, ethernet, profibus or switch input) to initiate an automatic validation/calibration (see Section 5.2.5).

+ You can also perform a 'remote calibration' using the switched inputs on the calibration option pcb if they are configured accordingly (see Section 5.5.3).

+ If your analyser is configured to provide two sample gas measurements, you can set up and carry out two separate automatic validations/calibrations, one for each measurement transducer.

Automatic validation/calibration provides the following functionality:

- During an automatic validation/calibration of a transducer, the analyser controls gas selection relays which can be used to control the flow of low and high calibration gases into the analyser. An optional valve block can also be supplied.
- The analyser checks that the resulting measurement is within the preset validate target range (validate target value ± validate tolerance value).
- If the measurement is within the preset validate target range and mode is set to calibrate, the transducer is calibrated (as in manual calibration).

- You can specify a pre-warning time, which will precede the automatic validation/calibration. During this time, the 'service in progress' status output (see Section 5.2.4) will be set; the automatic validation/calibration will then be carried out at the end of the pre-warning time. If automatic validation is cancelled during this time the gas selection control will not have changed state.
- You can specify an inerting phase. This ensures that non-inert and sample gases cannot flow into the analyser one immediately after the other. During this phase, inert gas (the low or high calibration gas) will be introduced between the two gases for a preset time. This may be used to prevent potentially dangerous mixtures occurring
- You can specify a flushing phase. This phase operates as a delay, after a different gas is routed into the analyser, before a validation/calibration is carried out.

5.5.2 Automatic validation/calibration sequence

Before you carry out an automatic validation/calibration, you must preset the following parameters:

Parameter	Use/range
Low target value	Low measurement target value for validate/calibrate
Low target tolerance	Low measurement target tolerance
High target value	High measurement target value for validate/calibrate
High target tolerance	High measurement target tolerance
validation/calibration type	Low, high, low & high or high & low
Mode	Calibration or validation (see Section 5.5.1)
Pre-warning	On or off
Pre-warning time	Only applicable if pre-warning is on. Specifies the length of the pre-warning period (0 min 1 sec to 59 min 59 sec)
Inerting	On or off
Inert gas	Only applicable if Inerting is on. Specifies the type of inert gas (high or low)
Inerting time	Only applicable if Inerting is active. Specifies the inerting time (0 min 30 sec to 59 min 59 sec)

Flushing time	Specifies the flushing time (0 min 30 sec to 59 min 59 sec)
Timer	On (active) or off (inactive). If active the calibration or validation can be carried out regularly at a specified frequency.
Start time/date	Only applicable if the timer is active. This specifies the time/date on which the first automatic validation/ calibration will be carried out. See Section 5.4.3.
Repeat time	Only applicable if the timer is active. If set (in the range 1 hour to 999 days), specifies the interval between successive automatic calibrations/validations. Select 0 hours and 0 days if repeat is not required.

Figure 28 shows a typical automatic calibration sequence, where:

- Pre-warning is on.
- Automatic calibration of transducer 1 (Tx1) has been initiated.
- validation/calibration type has been set to low & high.
- Mode has been set to calibration.
- Inerting is set to on (active) and inert gas has been set to low.

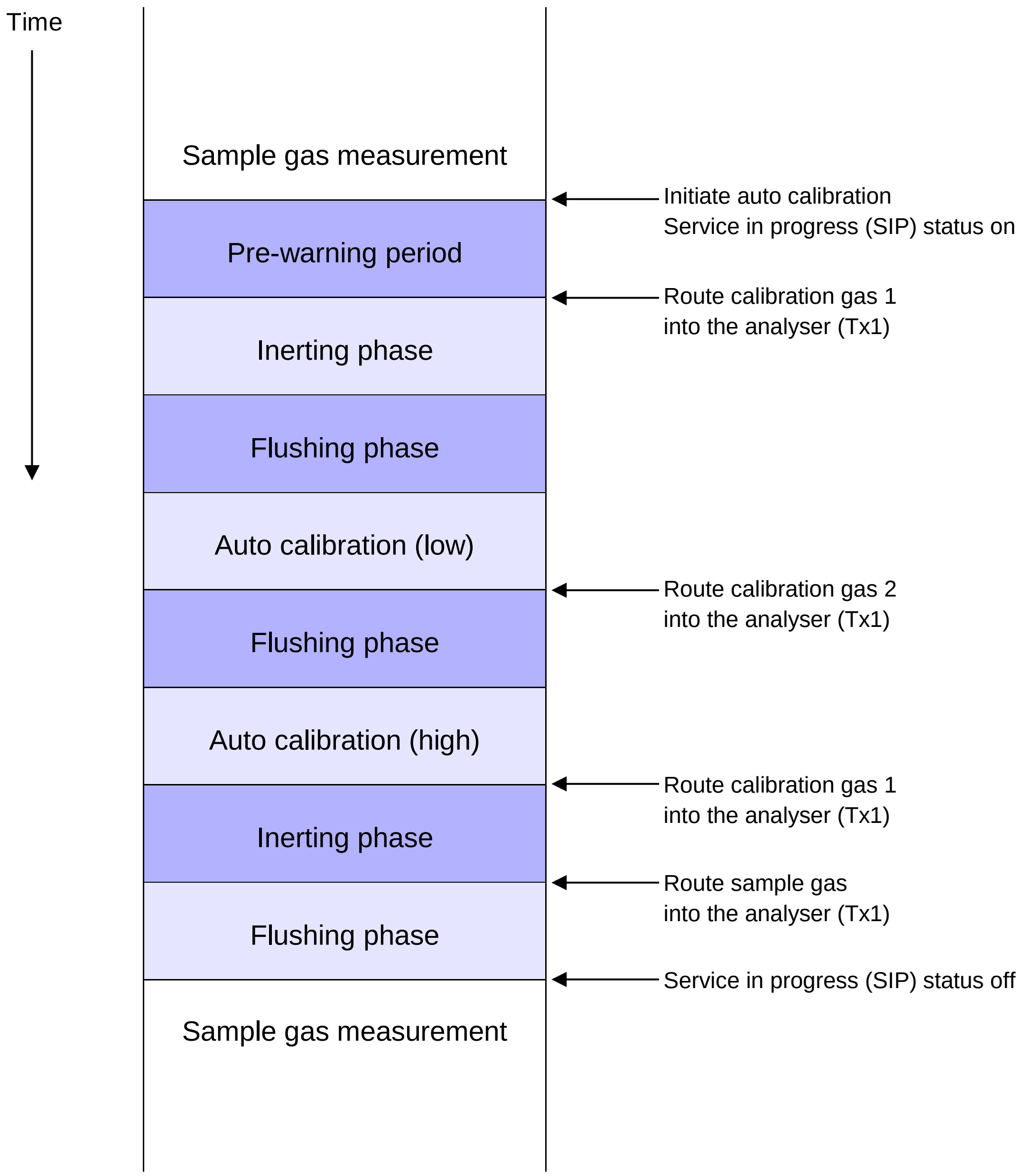


Figure 28 – Typical automatic calibration sequence

5.5.3 Remote calibration or automatic validation/calibration

Switch inputs can be set to remote calibration mode (remote cal), automatic validation/calibration mode (auto val) or disabled so the inputs will have no function, refer to Figure 17.

The remote calibration function is designed for installations where the analyser is placed in an inaccessible area and the calibration gas valves are operated independently of the analyser.

In Remote cal mode, switch input pins 1 – 2 activate a transducer low calibration (as if the request had been selected from the user interface) and switch input pins 3 – 4 activate a transducer high calibration. Switch input pins 5 – 6 activate the transducer service in progress (SIP) status, which **must** be closed before either calibration can be executed. This is to ensure a calibration can not be executed without a service in progress status being activated. For example, to carry out a remote low calibration:

Close pins 5 – 6	remote service in progress (SIP) on
Close pins 1 – 2	activate low calibration
Open pins 5 – 6	remote service in progress (SIP) off

If performing remote calibrations via Modbus it is necessary to first enable both remote service in progress and calibration mode. See section A3.15 for transducer control mapping.

A calibration will be successfully completed if the current measurement is equal to the target measurement ± the auto validation tolerance values, see Figure 32. If this condition is not met a maintenance required status will be raised.

+ If the switch inputs are set to 'remote cal' mode the gas control relays will not be changed from 'sample' during a remote low or high calibration.

See Section 6 for instructions on manual calibration to ensure that your calibration procedure is correctly configured.

In auto val mode, switch input pins 1 – 2 Initiate an auto validation/calibration sequence and switch input pins 3 – 4 stop an auto validation/calibration sequence.

1. Select þ Set up þ Switch Inputs.
2. Use the soft key to select either Auto val, Remote cal or Disabled.

5.5.4 Automatic validation/calibration target and tolerance

1. Select þ Set up þ Auto val.

2. Use the and soft keys to highlight the measurement for which you want to set up the validation/calibration, then press the soft key.

Figure 29 – The auto val/cal screen

3. Select target, the auto val/cal low target value screen will then be displayed.

Figure 30 – The auto val/cal parameters screen

4. Edit the displayed low target value as described in Section 4.10.

Figure 31 – The auto val/cal low target value screen

+ The low target value can only be changed for the O_2 trace, purity and control measurements (see Section 2.5).

5. Edit the low tolerance value.

Figure 32 – The auto val/cal low tolerance screen

6. Scroll down to the high target value then repeat steps 3 and 4 to set the high target and high tolerance values.

Figure 33 – The auto val/cal high target value screen

Figure 34 – The auto val/cal high tolerance screen

5.5.5 Automatic validation/calibration type and mode

1. Return to the auto val screen (Figure 30). Select 'Control'.
2. Select required type: 'Low', 'High', 'Low & High', 'High & Low'.

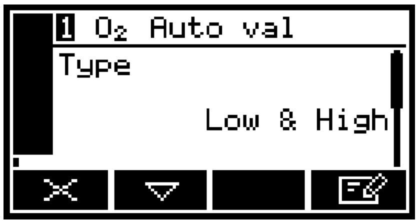


Figure 35 – The auto val/cal type screen

3. Select 'Mode'. Select required type: 'Validate' or 'Calibrate'.

Figure 36 – The auto val/cal mode screen

5.5.6 Automatic validation/calibration phases

1. Return to the auto val screen (Figure 30). Select 'Phase'.
2. Select 'On' or 'Off' for Pre warning.

Figure 37 – The auto val/cal phase screen

3. If you changed the pre-warning setting from 'Off' to 'On', the Auto val/cal pre-warning timer screen will then be displayed (see Figure 38). Edit the displayed time as described in Section 4.10.

Figure 38 – The Auto val/cal pre-warning timer screen

4. Select 'On' or 'Off' for inerting.

Figure 39 – The Auto val/cal inerting screen

5. If you have changed the Inerting setting from 'On' to 'Off', continue at Step 9.
6. Select the correct inert gas: 'Low' or 'High'.

Figure 40 – The Auto val/cal inert gas screen

7. Scroll to the auto val/cal inerting timer screen, showing the currently selected inerting time setting.
8. Edit the time as described in Section 4.10.

Figure 41 – The Auto val/cal inerting timer screen

9. Scroll to the auto val/cal flushing screen, showing the currently selected flushing time setting.
10. Edit the time as described in Section 4.10.

Figure 42 – The auto val/cal flushing screen

5.5.7 Automatic validation/calibration timers

1. Return to the auto val screen (Figure 30). Select 'Timer'.
2. Select 'On' or 'Off' for Timer.

Figure 43 – The auto val/cal timer screen

3. Scroll to the auto val/cal start date screen.
4. Edit the displayed start date as described in Section 4.10.

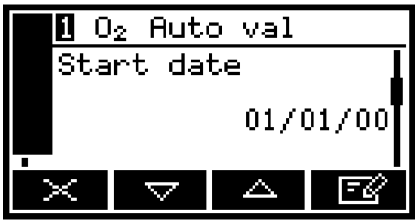


Figure 44 – The auto val/cal start date screen

5. Scroll to the auto val/cal start time screen.
6. Edit the displayed start time as described in Section 4.10.

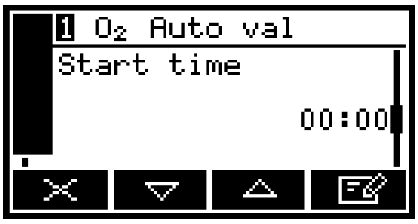


Figure 45 – The auto val/cal start time screen

7. Scroll to the auto val/cal repeat time screen (see Figure 46).
8. Edit the displayed repeat time as described in Section 4.10.

Figure 46 – The auto val/cal repeat time screen

+ If you set the repeat time to "000:00" (0 days, 0 hours), the automatic validation/calibration will only be performed once, on the specified start date, at the specified start time. You will therefore need to initiate any subsequent automatic validation/calibration: see Section 6.2.1.

5.6 Calibration linking

+ Calibration linking only applies to analysers configured for 2 measurements.

+ If calibration is not linked, the alarms for each transducer will operate in accordance with their corresponding 'During Calibration' options during calibration.

Calibration linking is useful when you route a single gas stream into both inlets of the dual measurement analyser.

If you link calibration, then:

- When you calibrate transducer 1, the alarms (Section 5.11.1) and analogue output (Section 5.7.2) for transducer 2 will operate in accordance with the transducer 2 'During Calibration' option during calibration.
- When you calibrate transducer 2, the alarms and analogue output for transducer 1 will operate in accordance with the transducer 1 'During Calibration' option during calibration.

1. Select þ Set up þ Calibration.
2. Select 'Yes' or 'No' for calibration linking.

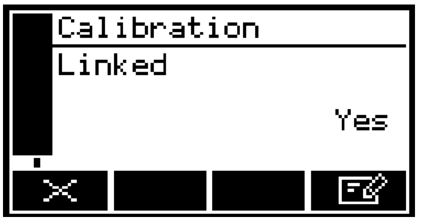


Figure 47 – The Calibration linking screen

5.7 Configuring and using the mA outputs (option)

5.7.1 Overview

The analyser can be supplied with a mA output for each sample gas measurement for which the analyser is configured.

Each mA output provides a constantly updated output, in which the current represents the value of gas sample measurements.

The analyser allows you to specify two separate range configurations per measurement for the mA outputs: range 1 and range 2. The current range is shown on the measurement screen (see Figure 3):

I	is shown if range 1 is selected.
II	is shown if range 2 is selected.

The mA output can be selected as:

- 0 to 20 mA, where 0 mA represents the lowest sample measurement and 20 mA represents the highest sample measurement in the range you have specified.
- 4 to 20 mA, where 4 mA represents the lowest sample measurement and 20 mA represents the highest sample measurement in the range you have specified.

In addition to the above, you can specify how the mA output will operate during calibration, fault conditions and under-range conditions.

Details of the output parameters for the mA outputs are given in Section 5.7.2. Set up, configure, check, calibrate and use the mA outputs as described in Section 5.7.4.

5.7.2 Introduction to the mA output parameters

The mA output parameters that you must set up are as follows:

Parameter	Values/options	
Range	The selected option determines the mA output range associated with a measurement:	
	Range 1	The output is set to use range 1
	Range 2	The output is set to use range 2
	Auto	The output will automatically switch between range 1 and range 2 depending on sample measurements

Parameter	Values/options	
Range 1 low level	The range 1 lowest sample measurement	
Range 1 high level	The range 1 highest sample measurement (span) *	
Range 2 low level	The range 2 lowest sample measurement	
Range 2 high level	The range 2 highest sample measurement (span) *	
During calibration	The selected option determines how the mA output will operate during calibration:	
	Freeze	As soon as the calibration screen is displayed, the mA output will 'freeze' at its last output value. The output will only be updated to reflect subsequent measurements when calibration screen has been exited.
	Follow	The mA output value will reflect the measurement value, even during calibration.
Jam condition	The selected option determines how the mA output will operate during a fault condition:	
	High	The output value will be held at 21.5 mA (suitable for trace measurements)
	Low	The output value will be held at 0 mA (suitable for purity measurements)
	None	The output values will continue to be derived from the sample gas measurements, even though these output values may be erroneous.
mA output range	0 – 20 mA or 4 – 20 mA *	
Underrange	Any value below 4 mA #	
Range change point	The range change point †	
Hysteresis	The range change hysteresis †	

* See Section 5.7.1.

† Only available when Auto range is selected.

\# Only available if the 4 – 20 mA output range is selected; this sets the lowest output current during normal operation, and allows out of range and negative gas concentrations to be monitored through the mA output. For example, with an under-range setting of 3.8 mA, the mA output can be less than 4 mA (which indicates a the Range low level), down to a minimum of 3.8 mA, where an output between 3.8 mA and 4 mA indicates a gas concentration below the range low level.

5.7.3 Setting up the mA output parameters

+ If auto ranging is selected, the way in which the output changes between the ranges depends on the values you have set for the range change point and the hysteresis.

For example, if you set the range change point to 18% and set hysteresis to 1%, then:

- The output value must be greater than 18% before changing from range 1 to range 2.
- The output value must be less than 18% – 1% (17%) before changing from range 2 to range 1.

Use the following procedure to select auto ranging or manually select the range:

1. Select [menu] Þ Set up Þ mA output.
2. Select the required measurement range option.

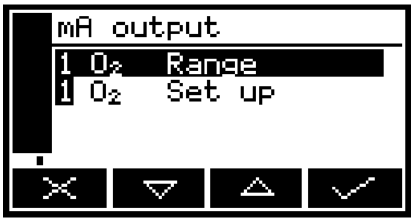


Figure 48 – The mA configuration screen (one measurement analyser)

3. Select the range option you want the output to use (range 1, range 2 or auto). If you have selected auto ranging, you must also set the range change and hysteresis values.

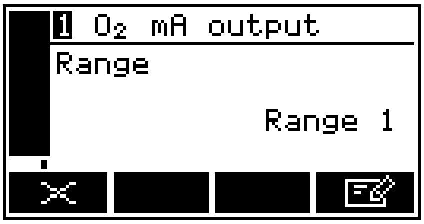


Figure 49 – The mA range screen

4. Return to the mA configuration screen (Figure 48) and select 'Set up' option.
5. Edit the range high level and low level.

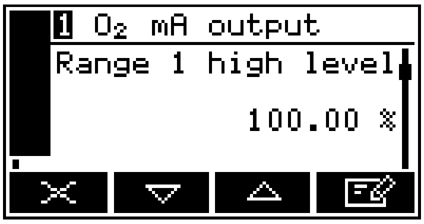


Figure 50 – The mA output high level screen

✚ You cannot enter a high level value higher than 120% of the maximum measurement that the corresponding gas transducer can determine (refer to Appendix A9).

✚ The minimum differences between the low level and high levels are detailed in Appendix A9.

6. You can select the during calibration option to 'Freeze' or 'Follow'.

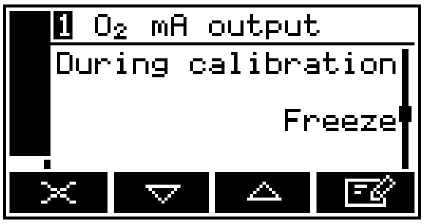


Figure 51 – The during calibration screen

7. You can then select the Jam condition to 'High', 'Low' or 'None'.

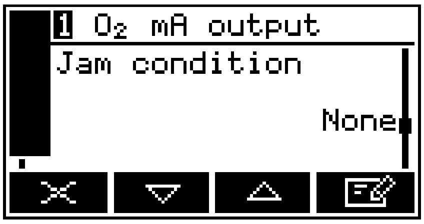


Figure 52 – The jam condition screen

8. You can then select the range that you would like to use: 0 – 20 mA or 4 – 20 mA.

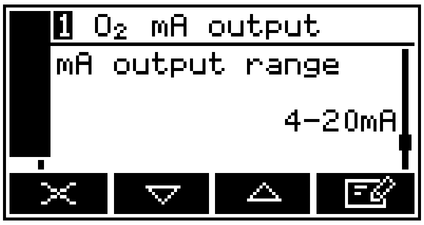


Figure 53 – The mA output range screen

9. You can then select the underrange value. An underrange setting of 4 mA means there is effectively no underrange.

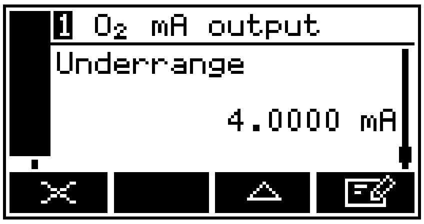


Figure 54 – The mA underrange screen

10. If auto ranging is selected you will then need to set the range change point and the hysteresis.

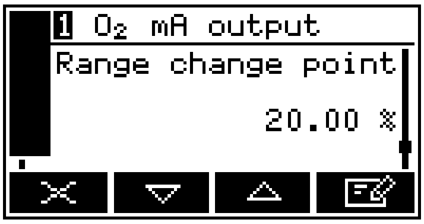


Figure 55 – The mA range change point screen

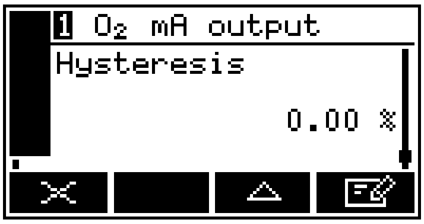


Figure 56 – The mA range change hysteresis screen

5.7.4 Calibrating the mA output

Use the following procedure to calibrate the mA output:

1. Select þ Service þ mA output.

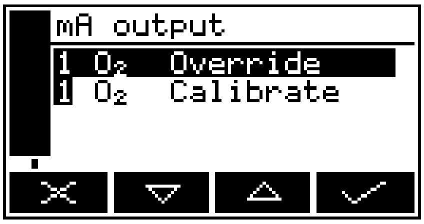


Figure 57 – The mA output service screen

2. Select the required 'Calibrate' option.

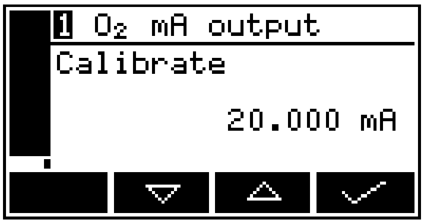


Figure 58 – The mA output calibrate screen

3. As soon as the mA output calibrate screen is shown, the nominal mA output value is set to 20 mA:
   - Use your control/monitoring equipment (connected to the analyser) to monitor the actual output value.
   - Use the and soft keys to increase or decrease the actual output value until your control/monitoring equipment indicates 20 mA output.
4. When the mA output has been correctly calibrated, press the soft key: the mA output service screen (Figure 57) will then be displayed again.

+ The actual mA output value is controlled from the mA output calibrate screen as long as the screen is displayed. As soon as the mA service screen is no longer displayed, the mA output value will be updated to reflect the corresponding gas measurement.

5.8 Configuring and using the voltage outputs (option)

5.8.1 Overview

The analyser can be supplied with a voltage output for each sample gas measurement for which the analyser is configured. The output is set up in the same way as for mA, however:

- The voltage range is 0 to 10 V
- There is no 'underrange' facility
- The jam 'High' output value will be held at 10.75 V
- The jam 'Low' output value is held at 0 V

5.9 Correcting O_2 measurements for background gases (purity or control only)

+ If you are measuring O_2 (oxygen) in a background of nitrogen or air, you do not need to correct the measurements.

5.9.1 Overview of measurement errors

For an O_2 purity or control transducer, the composition of any typical background gas in the gas sample will have a minor effect on the analyser measurement. The following table gives 4 examples of cross-interference errors (O_2 measurement errors) in gases which contain 100% of a specific background gas, for an analyser which has been 'Lo' calibrated with N_2 (nitrogen) and 'Hi' calibrated with O_2.

Background gas	Error	Background gas	Error
Argon	–0.22%	Halothane	–1.93%
Carbon dioxide	–0.26%	Helium	–0.29%

Note that the error is directly proportional to the concentration of the background gas in the sample being measured, and in most cases can be ignored.

If you cannot ignore the error, you can use the procedure in Section 5.9.2 and Appendix A9 to enter a compensation to correct for the error.

+ Example: If you are measuring O_2 (oxygen) in a background of carbon dioxide –0.26 should be entered as the cross interference offset.

+ A full list of cross-interference offsets (O_2 measurement errors) are given in Appendix A9 For a control measurement the offset should be taken from the 20 °C column and for a purity measurement use the 60 °C column.

5.9.2 Entering a cross-interference (X-Interference) compensation

+ You can only apply cross-interference compensation to O_2 purity or control measurements.

+ X-Interference compensation is disabled during calibration, and is not applied to the values shown in Figure 74. All other outputs (that is, serial or mA outputs) remain compensated.

Use the following procedure to enter a compensation to correct for an O_2 (oxygen) measurement error:

1. Select þ Set up þ X-Interference.

+ If your analyser is configured for a single sample measurement, the X-Interference offset screen is then displayed. Continue at step 3.

2. With the X-Interference select screen displayed select the required measurement, then press the soft key.
3. The offset value shown on the X-Interference offset screen is the correction which will be applied to O_2 (oxygen) sample measurements before they are displayed (or output).
4. Edit the displayed offset as described in Section 4.10.

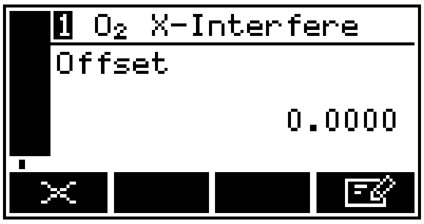


Figure 59 – The X-Interference offset screen

5.10 Selecting display units

You can change the measurement units shown on the display (and output). The following display units are supported:

Units	Meaning
%	volume %
ppm	parts per million
vpm	volume parts per million
mg/m^3	mg m^{-3} (milligrams per normal cubic metre)
mol/mol	mols per mol (or moles per mole)
% LEL	volume % of the Lower Explosive Limit

+ When you select display units other than the measurement default units, you must also enter the units conversion factor: refer to Appendix A5 to determine the units conversion factor for your specific application.

+ If you select the "off" option on the units selection screen, the display units revert to the measurement default units as supplied.

+ Converting from one measurement unit to a different display measurement unit may reduce the resolution of the displayed measurements.

Use the following procedure to select the displayed units, and to change the units conversion factor:

1. Select þ Set up þ Unit selection.
2. If you want to change the currently displayed units, press the soft key: the units selection screen will then be displayed.

Figure 60 – The currently selected units screen

3. If required scroll to the 'Factor' screen to change the unit conversion factor.

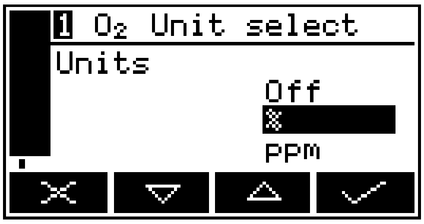


Figure 61 – The units selection screen

4. Edit the displayed offset as described in Section 4.10 referring to Appendix A5 for the correct value.

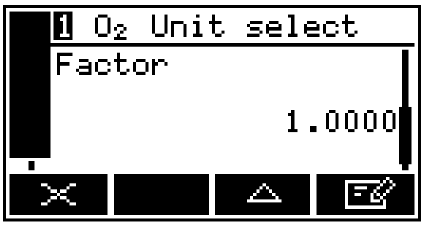


Figure 62 – The units conversion factor screen

5.11 Configuring the measurement alarms

5.11.1 Alarm modes and levels

Two separate measurement alarms are available for each sample gas measurement for which the analyser is configured, and you can configure each alarm to operate in one of three modes:

Alarm mode	Operation
None	The alarm is not used (that is, an alarm condition will not be activated under any circumstances)
Low alarm	An alarm condition will be activated when a sample measurement is lower than the preset alarm level *
High alarm	An alarm condition will be activated when a sample measurement is higher than the preset alarm level *

* During a calibration, an alarm will only be activated if the alarm 'Follow' option is set to yes.

While a measurement alarm condition is activated:

- An 'alarm' icon is shown on the measurement screen (see Section 4.2). The number ("1" or "2") in the icon will identify the alarm which has been triggered.
- The alarm LED on the front of the analyser (see Figure 1) flashes on and off.
- If the alarm relays have been fitted the appropriate alarm relay will be triggered.

You can view the details of the activated alarm: see Section 5.11.4.

+ Ensure that the measurement alarm and hysteresis levels are not too close to the expected sample measurements. (If they are, minor – and acceptable – variations in your sample gas concentrations will result in spurious alarms.)

+ If you configure one measurement alarm as 'low' and configure the other alarm as 'high', ensure that the 'high' alarm and hysteresis levels are higher than the 'low' alarm and hysteresis levels. (If you do not, the analyser can be permanently in an alarm condition, until you correct the levels.)

1. Select þ Set up.
2. Select the required transducer and alarm.

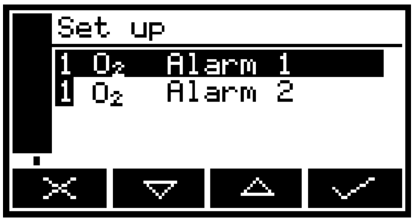


Figure 63 – The alarm set up screen

3. Select the required mode (none, low or high), then press the soft key.

Figure 64 – The alarm mode screen

4. Scroll up or down to edit the appropriate settings (using the method described in Section 4.10):
   - Latching (Section 5.11.2)
   - Level (sets the gas concentration level at which the alarm is to trigger)
   - Hysteresis (Section 5.11.3).

Each measurement has a 'Follow' option:

- If the 'Follow' option is set to 'No', the alarm will be inhibited during calibration.
- If the 'Follow' option is set to 'Yes', the alarm will not be inhibited during calibration.

1. Select þ Follow.
2. Select the required alarm.

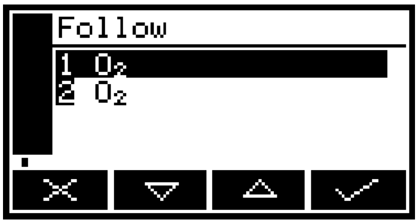


Figure 65 – The alarm follow screen

3. Select the correct option: "Yes" or "No".

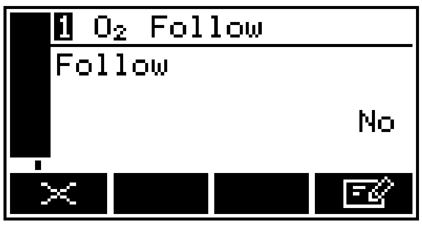


Figure 66 – The alarm follow options screen

5.11.2 Latching/non-latching alarms

You can configure each of the two measurement alarms to be either latching or not latching:

Select þ Set up.

Alarm setting	Meaning
Latching	Once the alarm condition has been activated, the alarm condition remains activated (even if subsequent sample measurements would not trigger the alarm) until the alarm is manually unlatched
Not latching	Once the alarm condition has been activated, the alarm condition remains activated only until a subsequent sample measurement which would not trigger the alarm is made. The alarm condition is then deactivated

When necessary, use the following procedure to unlatch any 'latched' measurement alarm(s):

1. On the measurement screen, press the soft key; the alarm option screen (Figure 67) will then be displayed.
2. With the 'Unlatch' option highlighted, press the soft key. All latched alarms will then be unlatched and the measurement screen will be displayed again

5.11.3 Hysteresis levels

The hysteresis level associated with a measurement alarm determines when an alarm condition (once activated) is deactivated, and this depends on the alarm mode, as follows:

Select þ Set up.

Alarm mode	Effect of hysteresis
Low alarm	Once the low alarm condition has been activated, the alarm condition will not be deactivated until a sample measurement is above (alarm level + hysteresis level)
High alarm	Once the high alarm condition has been activated, the alarm condition will not be deactivated until a sample measurement is below (alarm level – hysteresis level)

For example:

- If a 'low' alarm has an alarm level of 98% and a hysteresis level of 1%, the alarm will be activated when a sample measurement is < 98%, and the alarm will not be deactivated until a sample measurement is > 99%.
- If a 'high' alarm has an alarm level of 3 ppm and a hysteresis level of 1 ppm, the alarm will be activated when a sample measurement is 3 ppm, and the alarm will not be deactivated until a sample measurement is 2 ppm.

5.11.4 Viewing the measurement alarm status

1. Select Þ View.
2. In the alarm status screen shown in Figure 67, both measurement alarms are shown as 'Inactive'; that is, either the mode of each alarm is set to 'none', or no alarm condition currently exists.

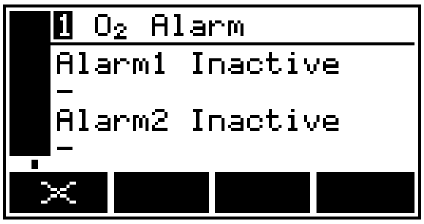


Figure 67 – The alarm status screen

+ If your analyser is configured to provide 2 sample gas measurements, a vertical scroll bar will be shown at the right of the screen, and a soft key will be shown. Press the soft key to view the measurement alarm status for the second sample measurement.

If a measurement alarm condition exists when you view this screen, the screen will show:

- The alarm number ('1' or '2').
- The sample reading which triggered the alarm condition.
- The alarm mode (where '<' indicates a low alarm and '>' indicates a high alarm).
- The alarm level.

5.12 Setting up the flow alarm (option)

The flow alarm (utilising Flowcube [F^3] technology) option measures the sample flow through a measurement transducer and allows the user to configure two low flow alarms and one high flow alarm. The flow alarm allows preventative maintenance to be taken before the sample flow rate reduces to unacceptable levels (see Section 2.4).

The configuration options and defaults for each flow alarm are given below:

Alarm	% Level configurable?	Status type configurable?	% Level default	Status defaults
Low flow alarm 1	Yes	Yes	70%	Maintenance required
Low flow alarm 2	Yes	Yes	50%	Fault
High flow alarm	No	Yes	130%	Not active

+ In environments where significant ambient temperature changes are expected, it is important to consider the temperature coefficient of the flow alarm (page 129) when setting alarm levels.

+ A zero and Normal calibration must be performed on the flow alarm before the reading is accurate. See Section 6.4 for the calibration procedure.

+ During measurement calibration or validation (not flow calibration) the status level of each flow alarm will be demoted. A Fault status will be reported as a Maintenance Required and a maintenance required status will not be reported at all.

1. Select Þ Set up Þ Flow alarm.
2. Scroll to the low flow level 1 screen and set the activation level for low flow alarm 1.

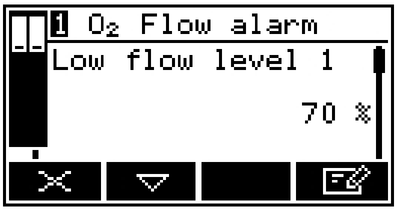


Figure 68 – The low flow level 1 screen

3. Scroll to the low flow level 2 screen and set the activation level for low flow alarm 2.

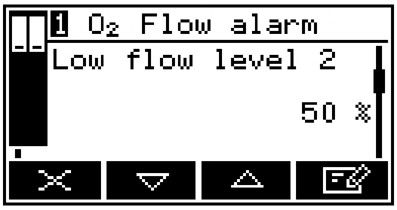


Figure 69 – The low flow level 2 screen

4. Scroll to the low flow 1 status screen and set the status type to be reported on low flow alarm 1 activation.

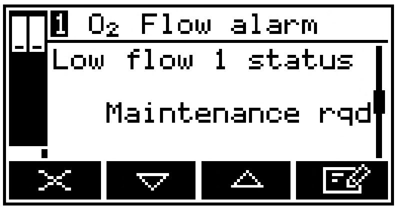


Figure 70 – The low flow 1 status screen

5. Scroll to the low flow 2 status screen and set the status type to be reported on low flow alarm 2 activation.

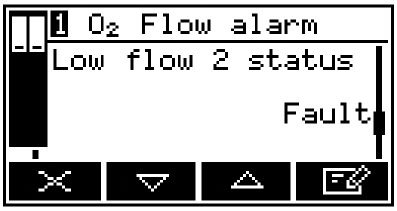


Figure 71 – The low flow 2 status screen

6. Scroll to the high flow status screen and set the status type to be reported on the high flow alarm activation (flow greater than 130%).

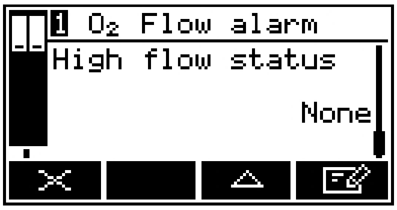


Figure 72 – The high flow status screen

6 CALIBRATION

CAUTION

During calibration of O_2 purity, O_2 control, 0-10ppm CO, 0-10ppm CO_2, 0-500ppm CO_2, or 0-20ppm N_2O measurements it is good practice to perform a low (Lo) calibration followed by a high (Hi) calibration. However, a single point calibration is often sufficient (see Appendix A10).

CAUTION

During calibration of TCD measurements it is good practice to perform a low (Lo) calibration followed by a high (Hi) calibration.

CAUTION

During calibration of O_2 Trace measurements a regular low point calibration can be performed with less frequent high (air point) calibrations (see Appendix A10). If both high and low calibrations are being carried out then it is important that the high calibration is carried out first.

6.1 Manual calibration

+ The required frequency of calibration depends on the reliance that you place upon the accuracy and consistency of the measurements made by the analyser. Adjust the frequency according to your requirements and the drift characteristics of your analyser (see Appendix A9 and A10).

+ You can carry out a manual calibration at any time unless an automatic validation/calibration is in progress.

+ If the auto validation/calibration option is installed, the gas control relays (Section 5.2.5) will select the correct gas once the manual calibration screen is shown (Figure 73). Sample gas will be reselected once the screen is exited.

You **must** manually calibrate the analyser as part of the initial set up, and whenever ambient conditions have changed.

If the analyser is configured for automatic validation/calibration (see Section 6.2):

- We recommend that you manually calibrate the analyser regularly during normal operation (see Appendix A10), and that you keep a record of the calibration errors. Use the errors to adjust the required calibration frequency.

Manually calibrate the analyser as follows:

1. Ensure that your equipment is configured to correctly route your calibration gas supply to the analyser sample gas inlet.
2. Select þ Calibrate.

+ On a 2-measurement analyser, this screen will show one 'Lo' and one 'Hi' calibration for each of the two measurements.

Figure 73 – The calibrate screen

Note that the "9999d" field of the screen shown in Figure 73 will identify the period of time that has elapsed since the last calibration, and can be in any of the following forms:

- 9999d specifying days
- 9999h specifying hours
- 9999m specifying minutes
- Any combination of these.

3. Use the and soft keys to select the required calibration, that is:
   - 'Lo' (low calibration gas).
   - 'Hi' (high calibration gas).
4. Press the soft key. The Calibrate target value screen will then be shown (see Figure 74), identifying the target value and the current reading.

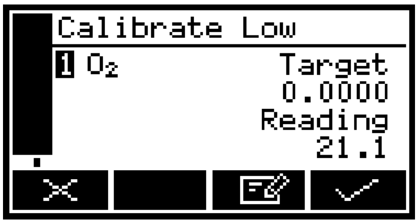


Figure 74 – The calibrate target value screen

5. If the target value is not correct for the calibration gas which you are using, change the target value to the required value: use the edit method shown in Section 4.10.

+ Refer to Sections 2.4 and 2.5 for the required pressures, flow rates (if applicable) and concentrations of the calibration gases.

6. When the current reading is stable, wait a further 3 minutes, then press the soft key. The analyser will then carry out the specified calibration.
7. Repeat steps 1 to 8 of this section for the second calibration.

8. If your analyser is configured to provide two sample gas measurements, repeat steps 1 to 9 of this section to carry out the 'Lo' and 'Hi' calibrations for the second transducer.
9. Press the [X] soft key to display the measurement screen again.

6.2 Automatic validation/calibration

6.2.1 Initiating an automatic validation/calibration

+ You must have set up the parameters/options as described in Section 5.5.2 before you initiate an automatic validation/calibration.

+ If the timer is active and you have set the repeat option, an automatic validation/calibration will be initiated automatically at the specified times.

+ When an automatic validation/calibration is in progress, all new initiation requests will be ignored (that is, initiation requests are not queued).

Close the start auto val switch input on the appropriate interface connection (see Section 5.2.5) to initiate an automatic validation/calibration. Alternatively you can manually initiate an automatic validation/calibration as follows:

1. Press the [calibrate] soft key on the measurement screen (or select the 'calibrate' option from the Menu screen).
2. Use the [▲] and [▼] soft keys to select the required automatic validation/calibration.

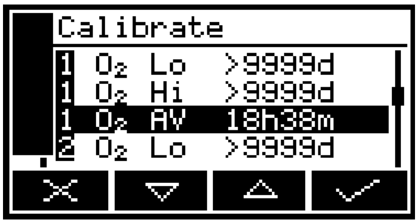


Figure 75 – The auto val/cal select screen

3. Press the [✓] soft key.
4. Note that the date/time of the last automatic validation/calibration is shown on the screen. ('–' will be shown if no automatic validation/ calibration has previously been run).
5. Press the [✓] soft key.

Figure 76 – The auto val/cal initiate screen

6. Press the [✓] soft key to initiate the automatic validation/calibration.

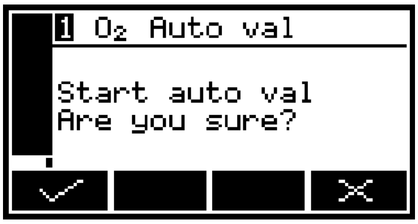


Figure 77 – The auto val/cal confirm screen

6.2.2 Automatic validation/calibration status indications

During an automatic validation/calibration:

- A 'service in progress' icon ( ) is shown on the measurement screen, if displayed.
- The calibration screen, if displayed, (pre-warning and inerting phase off) will be updated to show the current phase and the gas being used, as shown in Figure 78 to Figure 80.

+ If the automatic validation/calibration fails:

  - A 'maintenance required' icon ( ) is shown on the measurement screen, if displayed.
  - A "failed" message will be shown on the calibration screen, if displayed, for example: see Figure 81.

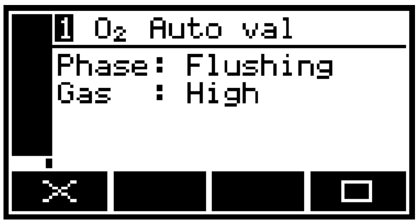


Figure 78 – The auto val/cal status screen (flushing phase)

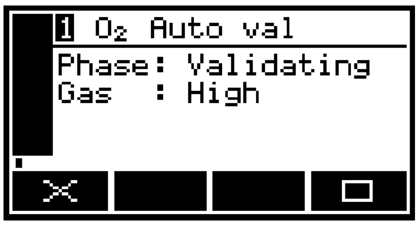


Figure 79 – The auto val/cal status screen (validating phase)

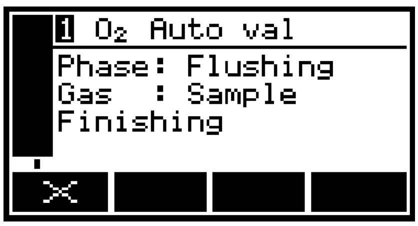


Figure 80 – The auto val/cal status screen (finishing phase)

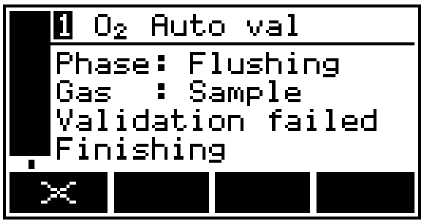


Figure 81 – The auto val/cal failed screen

6.2.3 Stopping an automatic validation/calibration

+ If you stop an automatic validation/calibration after the pre-warning phase, the inerting phase (if active) and the final flushing phase will always be completed.

To stop an automatic validation/calibration which is in progress, close the stop auto val switch input on the appropriate interface connection (see Section 5.2.5) or use modbus command see Appendix A3. Alternatively, whenever an automatic validation/calibration is in progress and the (stop) icon is shown on the auto val/cal status screen (see Figure 78 and Figure 79), you can press the soft button to manually stop the automatic validation/calibration.

When you press the soft button, the auto val/cal stop confirmation screen is shown (see Figure 82).

Press the soft key to stop the automatic validation/calibration. The measurement screen (Figure 3) will then be displayed again.

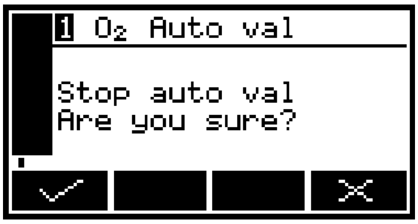


Figure 82 – The auto val/cal stop confirmation screen

+ Press the soft key to continue with the automatic validation/calibration.

6.2.4 Viewing validation/calibration history

You can use the following procedure to display the 100 most recent validation/ calibration points:

1. Select þ Calibrate þ View history.
2. This screen shows the target value (T) and the actual measurement reading (R) before val/cal was carried out.
3. It also shows whether the procedure performed was an auto calibration (auto cal), auto validation (auto val), manual calibration (man cal) and whether it was a pass or a fail.

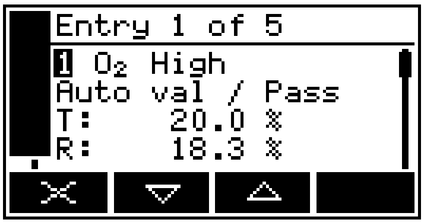


Figure 83 – The validation/ calibration history screen (initial view)

4. Note also that the top line of the validation/calibration history screen will alternate between:
   - "Calibration <x>/<y>" (as in Figure 83 above), where <x> is the number of the displayed calibration point and <y> is the total number of calibration points stored.
   - "<date> <time>" (as in Figure 84), specifying the date and time of the displayed calibration point.

Figure 84 – The validation/ calibration history screen (alternate view)

Use the and soft keys to scroll through and view the validation/ calibration history screens for other validation/calibration points as required.

6.3 Calibrating the pressure transducer (O_2 purity only)

CAUTION

On a pressure driven analyser, do not exceed the specified maximum calibration gas inlet pressure, and on a flow driven analyser, do not exceed the specified maximum flow rate. If you do, the pressure transducer may be damaged and the analyser may not operate correctly.

CAUTION

You must perform low and high measurement calibration (as described in Section 6) before you calibrate the pressure transducer. The flow rate through the analyser must be kept constant for both the low and high pressure calibration points.

If you use pressure compensation (see Section 7.2), you must calibrate the pressure transducer when you first calibrate the analyser, and annually thereafter.

Calibrate the pressure transducer as follows:

1. Calibrate the analyser as described in Section 6.
2. Temporarily fit a suitable adjustable valve (such as a needle valve) and a flowmeter to the sample gas outlet (see Figure 2).
3. If the auto validation/calibration option is fitted, the high calibration gas will automatically be selected during calibration. Otherwise, connect the high calibration gas supply to the sample gas inlet pipe on the analyser.
4. Fully open the adjustable valve (that is, so that the pressure at the outlet is ambient atmospheric pressure).
5. Select þ Service þ Pressure.
6. Allow the O_2 measurement shown on the screen to stabilize (for at least 30 seconds), then take a note of the calibration gas flow rate and press the soft key, ensure low calibration concentration is greater than 95% and less than 105%.

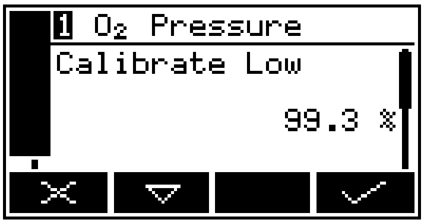


Figure 85 – The pressure low calibration screen

7. If low calibration was successful the screen should display as shown in Figure 86.
8. Adjust the valve so that the measurement reading is between 105 and 115% O_2.
9. Adjust your calibration gas supply so that the flow rate is the same rate as noted in Step 6.

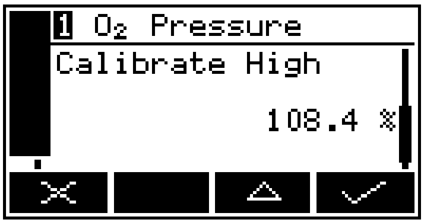


Figure 86 – Pressure high calibration screen

10. Allow the O_2 measurement shown on the screen to stabilize for at least 30 seconds, then press the ✓ soft key.
11. Open the valve or remove completely and adjust the calibration gas supply so that the flow is the same as noted in step 6. Pressure transducer calibration is now complete.

6.4 Calibrating the flow alarm (option)

If the flow alarm option has been fitted you must calibrate the flow alarm when you first calibrate the analyser and annually thereafter.

Before commencing the calibration procedure, ensure the ambient temperature has been relatively constant for at least half an hour.

Use the following procedure to calibrate the flow alarm:

1. Select ☰ þ Service þ Flow alarm.
2. Select the zero calibration option and stop the flow of gas through the analyser. Wait 3 minutes before pressing the ✓ soft key.

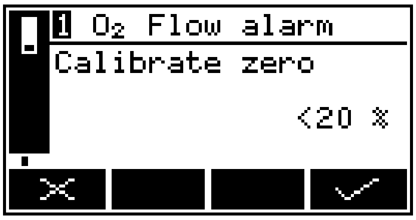


Figure 87 – The flow calibrate zero screen

3. Select the normal calibration option and restore the sample flow through the analyser. Wait 3 minutes before pressing the ✓ soft key.

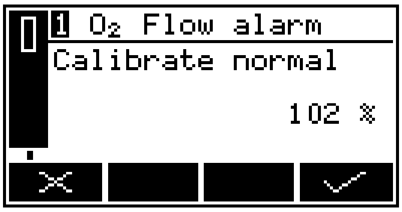


Figure 88 – The flow calibrate normal screen

7 GENERAL OPERATION

CAUTION

Sample and calibration gases must be as specified in Sections 2.4 and 2.5. If the pressure/flow rates are outside the ranges specified in Sections 2.4 and 2.5, you must regulate the gases externally, before they enter the analyser.

CAUTION

Before you allow sample or calibration gases into the analyser, you must leave the analyser with the electrical supply switched on for at least:

- **4 hours, on an analyser without CO, CO_2, or N_2O transducers.**
- **24 hours, on an analyser with CO, CO_2, or N_2O transducers.**

If you do not, the gases may condense inside the transducer(s) and the measurement will not be fully stabilised.

7.1 Checking the relay signal outputs

+ Gas selection relays (sample, cal lo, cal hi) are not effected during the signal relay override as this could cause hazardous gas flows.

If required, use the following procedure at any time to perform a check on the outputs of the signal relays fitted to the analyser:

1. Select [menu] þ Service þ Relay.
2. Figure 89 shows the relay state (energised or deenergised) that the relay signals outputs will be set to when the override is active. Edit if required.

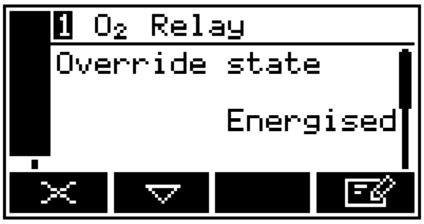


Figure 89 – The relay override state screen

+ When a relay is energised, the N/C-Common contacts will be open, and the N/O-Common contacts will be closed. The converse is true when the relay is deenergised.

3. Scroll to the relay override screen (Figure 90).
4. Select the 'Yes' option, then press the soft key. The relay outputs will now be set to the selected override state, and you can use your control/monitoring equipment (connected to the analyser) to monitor the relay signal outputs.

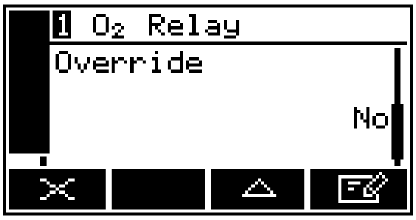


Figure 90 – The relay override action screen

+ The relay signal outputs freeze at the selected override signal state as long as the 'Override action' screen is displayed. As soon as another screen is displayed, the relay signal outputs will be updated to reflect the corresponding alarm, fault and range states.

7.2 Pressure Compensation (O_2 purity and control only)

7.2.1 Introduction

When pressure compensation is on:

- A pressure compensation indicator is displayed on the measurement screen (see Figure 3).
- The sample measurements shown on the measurement screen (and provided as outputs) are pressure compensated measurements.
- If required, you can view the pressure compensated and uncompensated sample measurements at any time: refer to Section 7.2.3.

7.2.2 Switching pressure compensation on/off

To switch pressure compensation on/off, use the following procedure:

1. Select þ Set up þ Pressure.
2. The pressure compensation select screen shows the current selection state:
   - 'Yes' indicates that pressure compensation is on.
   - 'No' indicates that pressure compensation is off.

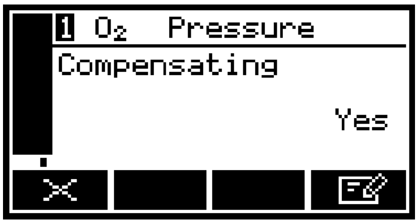


Figure 91 – The pressure compensation select screen

7.2.3 Viewing pressure effected measurements (option)

When pressure compensation is on, use the following procedure to view simultaneous pressure compensated and uncompensated measurements:

1. Select þ View þ Pressure.
2. On this screen:
   - The 'Pre comp' value is the sample measurement before pressure compensation.
   - The 'Post comp' value is the pressure compensated sample measurement.

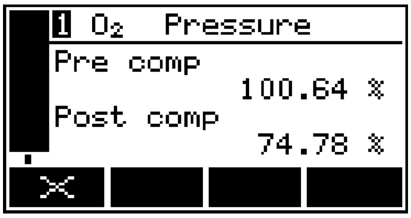


Figure 92 – The pressure view screen

7.3 Viewing flow levels (option)

1. Select þ View þ Flow Alarm.
2. The flow level shown at 'A' is indicating flow rate of 119% of nominal flow.
3. The flow level shown at 'B' is indicating flow rate of 35% of nominal flow.

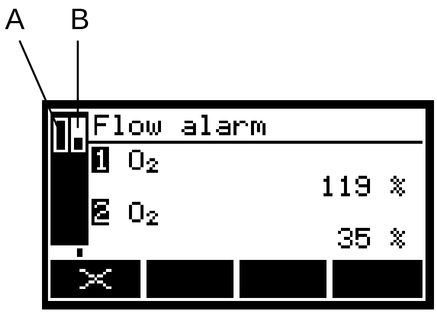


Figure 93 – Flow levels

7.4 Checking the mA output (option)

If required, use the following procedure at any time to perform a check on a mA output:

1. Select Þ Service Þ mA output.
2. Select the required 'Override' option.
3. Edit the displayed override value as described in Section 4.10.
4. Press the soft key: an acceptance screen showing "No" will then be displayed. Select "Yes" to apply the override.

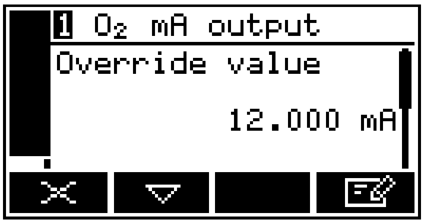


Figure 94 – The mA output override screen

5. The mA output will now be set to the override value you have selected. Use your control/monitoring equipment (connected to the analyser) to check that the output is correct.

+ The milliAmp output freezes at the override value as long as the 'Override' screen is displayed. As soon as another screen is displayed, the milliAmp output value will be updated to reflect the corresponding gas measurement.

7.5 Checking the voltage output (option)

See Section 7.4, the voltage output override operates in the same manner as the milliamp output override, but ranges from 0 – 10 volts.

7.6 Switching off the analyser

After you have switched off the analyser, when required or as necessary (for example, if you need to carry out plant/factory maintenance and will not use the analyser for several days):

- Ensure the gas inlet and outlets are blocked off (closed valve or protective caps supplied).
- Isolate/lockout the external electrical supply and disconnect the electrical supply cable from the analyser.

8 ROUTINE MAINTENANCE

WARNING

The analyser must be maintained by a suitably skilled and competent person.

WARNING

Do not open or attempt to open the analyser yourself. If you do, you will invalidate any warranty on the analyser, and the analyser may not operate safely or provide accurate measurements.

WARNING

Sample and calibration gases may be toxic or asphyxiant:

- Never inspect the inlet filter(s), or service or repair the analyser while such gases are still connected to it.
- If the analyser is to be serviced or repaired it is important that all pipework is flushed with an inert gas and the analyser is allowed to freely vent to local atmosphere.

CAUTION

If the analyser is to be temporarily removed, and it is measuring trace CO_2, the pipework should be purged with nitrogen and then the inlet and outlet should be capped off. This is to prevent exhausting the CO_2 scrubber.

8.1 Cleaning the analyser

When necessary, use a damp (but not wet) cloth to wipe clean the outer surfaces of the analyser (to prevent the entry of dust or other particulates into the interior of the analyser).

8.2 Inspecting/replacing the fuse (when necessary)

WARNING

Ensure that the electrical supply is isolated/locked out from the analyser. If you do not, there will be a danger of injury or death from electric shock.

WARNING

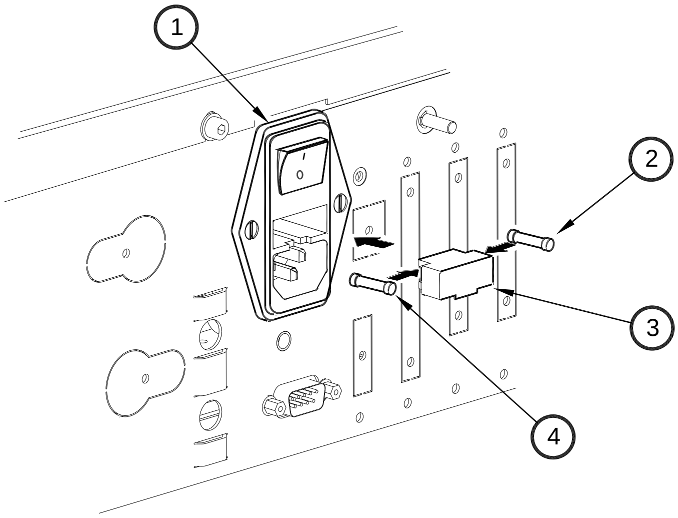
Fire Hazard, only use the same type and rated fuse as recommended.

If you think that an electrical supply fuse has failed, use the following procedure to inspect the fuses and replace it if necessary:

1. Refer to Figure 95. Remove the fuse holder (3) from the electrical supply connector (1) on the rear of the analyser.
2. Both live and neutral lines have fuse protection. Remove the live fuse (2) from the holder and check the continuity across the fuse. If there is continuity, the fuse has not failed: refit it to the fuse holder (3) and repeat for the neutral fuse (4).

   If there is no continuity, the fuse has failed:

   - Fit a new fuse (of the correct type and rating, see Section 2.3) to the fuse holder (3).
3. Refit the fuse holder (3) to the electrical supply connector (1) on the rear of the analyser.



Key	Description
1.	Electrical supply connector
2.	Live fuse

Key	Description
3.	Fuse holder
4.	Neutral fuse

Figure 95 – Inspect/replace the fuse

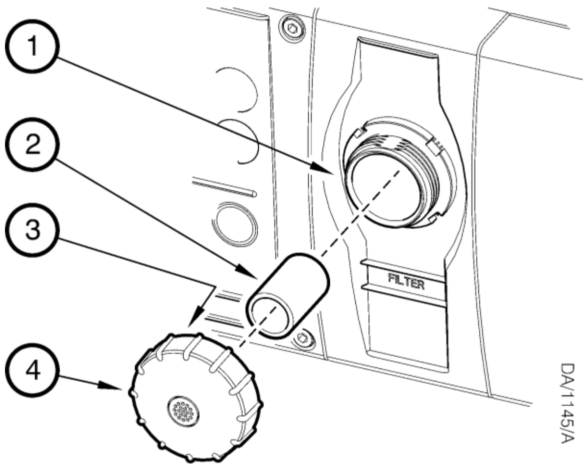
8.3 Inspecting the optional filter element (O_2 purity / control only)

If you only use the analyser on applications which use clean, dry gases, an inlet filter may not be required. If however, your application requires a filter, it can be easily checked.

1. Ensure the gas supply to the analyser is switched off.
2. Refer to Figure 96. Unscrew and remove the filter retainer cap (4).
3. Inspect the condition of the white filter element (2, fitted to the spigot on the rear of the filter retainer cap). If the filter element is wet or dirty:
   - Remove the used filter element from the filter retainer cap, and dispose of it.
   - Push a new filter element onto the spigot on the inner side of the filter retainer cap.
4. Inspect the 'O' ring (3) on the inner side of the filter retainer cap (4). If the 'O' ring is twisted or damaged:
   - Remove the 'O' ring, then dispose of it.
   - Fit a new 'O' ring to the inner side the filter retainer cap.
5. Ensure that the 'O' ring (3) is correctly located in the recess in the inner side of the filter retainer cap (4), then refit and tighten the filter retainer cap.

CAUTION

Do not operate the analyser with the filter element removed. If you do, particulates in the sample gas may seriously damage the analyser.



Key	Description	Key	Description
1.	Filter fitting	3.	'O' ring
2.	Filter element	4.	Filter retainer cap

Figure 96 – Inspect the inlet filter element (O_2 purity and control transducers only)

8.4 Inspecting the filter element (CO / CO_2 / N_2O trace only)

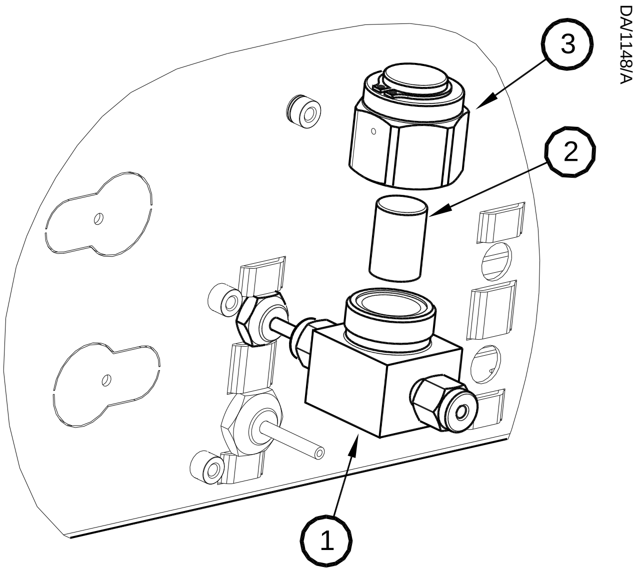
If you only use the analyser on applications which use clean, dry gases, you will only need to inspect the inlet filter element every 3 months. On other applications, we recommend that you inspect the inlet filter element more frequently.

Refer to Figure 97.

1. Ensure that the electrical supply to the analyser is switched off.
2. Unscrew the filter nut and replace the old sintered filter with a new one.
3. Replace the filter nut and switch the analyser back on.

CAUTION

Do not operate the analyser with the filter element removed. If you do, particulates in the sample gas will seriously damage the analyser.



Key	Description
1.	Filter body
2.	Sintered filter
3.	Filter nut

Figure 97 – Inspect the inlet filter element (trace transducers only)

8.5 CO_2 scrubber

8.5.1 For 0-10ppm CO_2

The scrubber fitted to the 0-10ppm CO_2 requires changing every 2 – 4 years depending on installation practices.

If the T90 – T100 response degrades significantly from the performance observed when the analyser was commissioned, then this may indicate that the scrubber requires changing.

Contact Servomex or your local Servomex agent for instruction on how the scrubber can be changed.

8.5.2 For 0-500ppm CO_2

The scrubber fitted in the 0-500ppm CO_2 sealed transducer requires changing after 10 years of normal operation.

8.6 Use of the analyser with toxic gases

WARNING

If toxic gases are present in the gas stream, the concentrations of the gases sampled or used for calibration of the analyser may be above their respective threshold limit values, so:

- You must regularly leak-test the analyser and associated equipment.
- If any leaks are found, do not continue to use the analyser or associated equipment until appropriate corrective action has been taken.

We recommend that you leak-test the analyser at least once every 6 months:

- If there are leaks within the analyser, it must be returned to Servomex for repair. Do not continue to use the analyser.
- You must seal any leaks in your sample pipelines or system.

CAUTION

When you carry out a leak test, do not exceed a maximum pressure of 34.5 kPa gauge (0.35 bar gauge, 5 psig) and do not introduce a sudden change of pressure into the analyser. If you do, you may damage the analyser. We recommend that you allow at least 30 seconds to fully pressurise the analyser to the maximum pressure.

CAUTION

If you use a liquid to assist in leak testing, do not spill liquid onto the horizontal surfaces of the analyser or it's electrical connections.

8.7 Preventative maintenance

To minimise unscheduled analyser downtime, ensure the proper operation of the analyser and to comply with the guidelines of applicable regulatory bodies, we recommend that you utilise the SERVOSURE annual preventative maintenance program for your analyser.

The preventative maintenance program consists of a yearly inspection of the analyser, and repair of any faults, to ensure that the analyser meets its original factory specification. Once inspection and repair are complete, you will be provided with a full SERVOSURE report.

Note that you will always be informed in advance if any repairs or new parts are required for your analyser.

Contact Servomex or your local Servomex agent to arrange for a preventative maintenance contract.

9 FAULT FINDING

9.1 Fault, maintenance required and SIP statuses

9.1.1 Status definitions

The status definitions are as follows:

- Fault – A serious fault has been detected.
- Maintenance required – A maintenance required status has been raised, the analyser requires attention.
- Service in Progress (SIP) – During service operations (calibration, auto validation, I/O overriding) a service in progress status will be raised.

9.1.2 Status annunciations

Condition	LCD Icon	LED annunciation	Relay annunciation
Fault		Orange fault LED	Fault relay deenergised
Maintenance		None	Maintenance required relay energised
Service in Progress (SIP)		None	Service in progress relay energised

All status conditions are listed in alphabetical order on the next 5 pages.

The LCD icons are displayed on the measurement screen only (see Figure 3).

Message	Measurement screen icon	Recommended actions
Auto cal high fail		Check that the calibration gases are as specified in Section 2.5 and that the correct settings have been entered, then recalibrate the analyser again.
Auto cal low fail		Check that the calibration gases are as specified in Section 2.5 and that the correct settings have been entered, then recalibrate the analyser again.
Auto cal low flow		Flow has fallen below the fault level set for the flow alarm during a calibration routine (very low flow): Check that there is sufficient gas flow into the transducer (see Section 2.4 and 5.12). Check that the fault level has been set at the correct level (see Section 5.12).
Auto val low flow		Flow has fallen below the fault Level set for the flow alarm during a validation routine: Check that there is sufficient gas flow into the transducer (see Section 2.4 and 5.12). Check that the fault level has been set at the correct level (see Section 5.12).
Auto validate		Raised during auto validation of the transducer (see Section 5.5).
Auto val high fail		Check that the calibration gases are as specified in Section 2.5 and that the correct settings have been entered, then revalidate the analyser again.
Auto val low fail		Check that the calibration gases are as specified in Section 2.5 and that the correct settings have been entered, then revalidate the analyser again.
Calibration fault		Recalibrate (both low and high) as described in Section 6, also check calibration gas has been allowed to flow through the analyser for the recommended time. If the fault persists, contact Servomex or your local Servomex agent for assistance.
Code fault	⚠	Contact Servomex or your local Servomex agent for assistance.

Message	Measurement screen icon	Recommended actions
Communication fail		Turn the analyser off, and then turn it on again. If the fault message is then displayed again, contact Servomex or your local Servomex agent for assistance.
Database fault		Turn the analyser off, and then turn it on again. If the fault message is then displayed again, contact Servomex or your local Servomex agent for assistance.
Date/Time invalid		This usually occurs because the electrical supply to the analyser has been switched off for more than a week. Switch on the electrical supply, then set the date/ time as described in Section 5.4.6. If the fault persists, contact Servomex or your local Servomex agent for assistance.
Fatal fault		Contact Servomex or your local Servomex agent for assistance.
Flow calibrate		Raised during calibration of the flow alarm (see Section 5.12).
Flow H/W fault		Contact Servomex or your local Servomex agent for assistance.
Flow cal high diff		The zero and normal calibration points are too far apart, check normal flow is within limits (see Section 2.4) and re-calibrate the flow alarm.
Flow cal low diff		The zero and normal calibration points are too close, check normal flow is within limits (see Section 2.4) and there is no flow during zero calibration. Recalibrate the flow alarm.
Flow temp fault		Contact Servomex or your local Servomex agent for assistance.
Heater Fault		Contact Servomex or your local Servomex agent for assistance.

Message	Measurement screen icon	Recommended actions
High flow alarm	Configurable	Flow risen above the set level for the flow alarm: Check that there is not excessive gas flow into the transducer (see Section 2.4). Check that the level has been set correctly and that calibration has been performed (see Section 5.12). Check sample is clean and without contaminants.
Low flow alarm 1 / Low flow alarm 2	Configurable	Flow has fallen below the set level for the flow alarm: Check that there is sufficient gas flow into the transducer (see Section 2.4). Check that the level has been set correctly and that calibration has been performed (see Section 5.12). Check the valve block cable is fitted correctly (see Section 5.1.4).
mA fault	⚠	Ensure that the electrical cabling connected to the analyser is not open circuit. Turn the analyser off, and then turn it on again. If the fault persists, contact Servomex or your local Servomex agent for assistance.
mA not detected	⚠	Contact Servomex or your local Servomex agent for assistance.
mA overridden	🔧	Raised during checking of the mA output (see Section 7.4).
mA reset	⚠	Contact Servomex or your local Servomex agent for assistance.
P calib fault	🔧	Calibrate the pressure compensation transducer again.
P high fault	⚠	Adjust pressure. Contact Servomex or your local Servomex agent for assistance.
P H/W fault	⚠	Contact Servomex or your local Servomex agent for assistance.
P low fault	⚠	Adjust pressure. Contact Servomex or your local Servomex agent for assistance.

Message	Measurement screen icon	Recommended actions
Power config fault	⚠	Contact Servomex or your local Servomex agent for assistance.
Pressure calibrate	[service icon]	Raised during calibration of the pressure transducer (see Section 6.3).
Relay not detected	⚠	Contact Servomex or your local Servomex agent for assistance.
Relays overridden	[service icon]	Raised when the alarm and status relays have been overridden (see Section 7.1).
Remote activation	[service icon]	Raised when the Service in Progress status is remotely activated via the SIP relays on the Calibration Card (see Section 5.2.4).
Rem lo cal denied	[maintenance icon]	Raised when a remote low calibration cannot execute because the current reading is outside tolerances (see Section 5.5.3).
Rem hi cal denied	[maintenance icon]	Raised when a remote high calibration cannot execute because the current reading is outside tolerances (see Section 5.5.3).
Static RAM fault	⚠	Turn the analyser off, and then turn it on again. If the fault message is then displayed again, contact Servomex or your local Servomex agent for assistance.
Sw IP not detected	⚠	Contact Servomex or your local Servomex agent for assistance.
Temperature fault	⚠	Reduce temperature to within environmental limits or contact Servomex or your local Servomex agent for assistance.
Transducer error	⚠	Ensure that you are using the analyser in the specified operating conditions (refer to Section 2). If the fault persists, contact Servomex or your local Servomex agent for assistance.
Transducer warming	[service icon]	Infra-red only, transducer is warming after power on, measurement should be treated with caution while status is active.

Message	**Measurement screen icon**	**Recommended actions**
Tx calibrate		Raised during manual, remote or auto calibration of the transducer.
Tx incorrect type		Contact Servomex or your local Servomex agent for assistance.
Tx Maintenance		Check that the sample gas concentration is not higher than the transducer full scale range. Recalibrate (both low and high) as described in Section 6. If this does not clear the fault, turn the analyser off, and then turn it on again. If the fault message is then displayed again, contact Servomex or your local Servomex agent for assistance.
Tx not detected		Contact Servomex or your local Servomex agent for assistance.
Volt fault		Contact Servomex or your local Servomex agent for assistance.
Volt not detected		Contact Servomex or your local Servomex agent for assistance.
Volt reset		Contact Servomex or your local Servomex agent for assistance.
Volt overridden		Raised during checking of the voltage output (see Section 7.5).

9.2 Viewing messages

9.2.1 Active messages

1. Select þ Status þ Active.
2. Each message status screen shows:
   - Date and time of message
   - The message type ("Fault", "Maintenance rqd" or "Service in Progress")
   - The message itself.

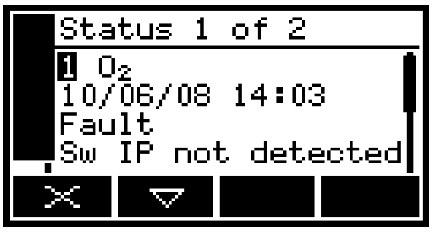


Figure 98 – The message status screen

3. Refer to Section 9.1 for the recommended actions associated with the displayed messages.

9.2.2 View history messages

1. Select þ Status þ View history.
2. Each message shows:
   - Date and time of message.
   - The message type ("Fault", "Maintenance rqd" or "Service in Progress").
   - The message itself.
   - The status of the entry "ON" or "OFF".

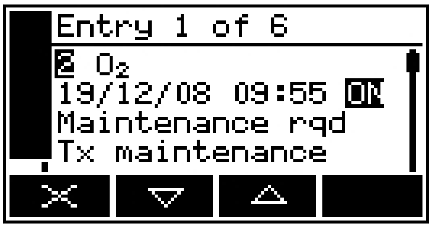


Figure 99 – The message status screen

Refer to Section 9.1 for the recommended actions associated with the displayed messages.

+ A maximum of 100 status messages can be stored.

9.3 Diagnostics

The trace measurements have diagnostic capabilities. The displayed diagnostic codes can be interrogated by the Servomex Service Team to determine the problem with the transducers.

+ Diagnostics are only enabled for the trace O_2, CO, CO_2, and N_2O measurements. It will take up to 20 seconds for all the codes to be read for the measurement and displayed.

If a transducer error or Tx maintenance status is displayed, and you have tried the recommended actions and the fault still persists, use the following procedure to view the diagnostics menu:

1. Select þ Service þ Diagnostics.
2. Take note of the displayed codes and contact Servomex or your local Servomex agent. This code can be relayed to the Service Team who will be able to determine the cause of the fault.

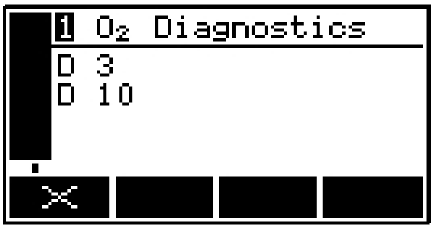


Figure 100 – The diagnostics screen

9.4 General fault finding

For general analyser fault finding, refer to the table on the following pages.

If you have read through the table and still cannot rectify a fault, or cannot identify the cause of a fault, contact Servomex or your local Servomex agent for assistance.

Fault symptom	Recommended actions
The fault LED is on.	Check any current fault messages (see Section 9.2), and carry out the recommended actions (see Section 9.1). If there are no applicable fault messages stored, or if you cannot rectify the fault after you have carried out the recommended actions: • Switch off the analyser, then switch it on again. • If the fault persists, contact Servomex or your local Servomex agent for assistance.
The software health indicator is not moving on the display.	Carry out the recommended actions for the "The fault LED is on" symptom above.
" - - - - - " is displayed instead of a sample measurement.	This indicates a possible measurement error, or a communications error between the transducer and the analyser controller. Check that the analyser is not being knocked, moved, or subjected to high levels of vibration during sample measurements. If the analyser is not being knocked, moved or subjected to vibration and the fault persists, contact Servomex or your local Servomex agent for assistance.
Analyser response is slow.	Check that the sample gas inlet is not blocked, and that the sample gas supply to the analyser is not restricted. Check that the sample gas outlet is not blocked, and that any pipes connected to the outlet are not restricted. Trace CO_2 scrubber filter may need replacing, contact Servomex for replacement. Check that the sample gas supply pressure is correct: refer to Section 2.4.

Fault symptom	Recommended actions
Analyser measurements are not as expected.	Check that the correct display units have been selected, and that the units conversion factor has been correctly entered (see Section 5.10). If you are using pressure compensation, check that the pressure transducer has been correctly calibrated and is switched on (see Section 6.3). Ensure there are no leaks in the pipework.
Analyser measurements are unstable.	Check that the sample gas supply pressure is correct: see Section 2.4. Check that the analyser is not being subjected to high levels of vibration and ensure there are no leaks. Check that the sample gas inlet is not blocked, and that the sample gas supply to the analyser is not restricted. Ensure there are no leaks in the pipework.
The analyser will not calibrate.	Check that the correct low and high calibration gases are being used: see Section 2.5. Check that the sample gas inlet is not blocked, and that the sample gas supply to the analyser is not restricted. Check that the sample gas outlet is not blocked, and that any pipes connected to the outlet are not restricted.
The analyser will not switch on.	Check that the external supply is switched on, and that no fuse or over-current device in the external supply has operated to switch off the supply. If the external electrical supply is correct, switch off and isolate the supply and check that the supply is correctly connected to the analyser: see Section 5.2. The PSU has over voltage and current protection if activated, the PSU will shut down, turn off power the power, wait 3 minutes and reapply the power. If the supply is correctly connected, an operating fuse may have failed; inspect and replace the fuses if necessary: refer to Section 8.2.

Fault symptom	Recommended actions
The analyser display is blank or is too dark.	Check that the ambient temperature is within the valid analyser operating temperature range: refer to Section 2.2. Check that the display contrast adjustment has been correctly set (refer to Section 5.4.4), and has not been altered.
The measurement alarms are activating more often than expected.	Check that the analyser is not being knocked, moved, or subjected to high levels of vibration during sample measurements. Check that the alarm modes, alarm levels and hysteresis levels have been correctly set: refer to Section 5.11.
The milliAmp output is at 0 or 21.5 mA.	If you have configured the mA output to jam high or jam low, check whether a fault condition exists (see Section 5.7). Otherwise, contact Servomex or your local Servomex agent for assistance.
The milliAmp output is not as expected.	Ensure that the electrical cabling connected to the analyser is not open circuit. Check that the mA output is calibrated correctly (see Section 5.7.4). Check that you have selected the correct Range (see Section 5.7.3).
A relay signal output is not as expected.	Check that the signal cable is correctly connected to the analyser: refer to Section 5.2.3, Section 5.2.4 or Section 5.2.5.

10 STORAGE AND DISPOSAL

10.1 Storage

Refit any protective plastic covers (see Section 3) and place the analyser and any associated equipment in its original packaging before storage. Alternatively, seal it inside a waterproof plastic bag, sack, or storage box.

Store the analyser and any associated equipment in a clean, dry area. Do not subject it to excessively hot, cold, or humid conditions: see Section 2.2.

10.2 Disposal

Dispose of the analyser and any associated equipment safely, and in accordance with all of your local and national safety and environmental requirements.

+ The analyser is not suitable for disposal in municipal waste streams (such as landfill sites, domestic recycling centres and so on). Refer to Appendix A7 for disposal requirements in accordance with the WEEE Directive within the EC.

+ If you send the analyser to Servomex or your local Servomex agent for disposal, it must be accompanied by a correctly completed decontamination certificate.

11 SPARES

WARNING

Do not use spares other than those specified below, and do not attempt to carry out any maintenance procedures other than those specified in this manual. If you do, you can damage the analyser and invalidate any warranty.

The standard spares available for the analyser are shown below. You can order these spares from Servomex or your Servomex agent.

Spare	Part Number
Spare fuse (kit)	S4000978
Spare filter (kit) (purity O_2 and control O_2)	S5400960
Spare external filter (trace CO, CO_2, and N_2O)	2377–3831
Spare external filter sinter (trace CO, CO_2, and N_2O)	2377–3848
Four tip up feet (kit)	S4000976
Rack mount (kit)	S5400961
Spare scrubber material sachet*	S5400501

*Not required for analysers fitted with sealed trace CO_2 transducers

A1 RS232 CONNECTION DETAILS

WARNING

Ensure that the electrical installation of any equipment connected to the analyser conforms with all applicable local and national electrical safety requirements.

WARNING

The RS232 output is separated from the analyser mains circuits by reinforced insulation. The terminals must only be connected to circuits that are themselves separated from mains voltages by at least reinforced insulation.

CAUTION

To comply with EMC requirements, you must use a screened cable to connect to the RS232 output. The screen must also be connected to the analyser enclosure.

A1.1 Overview

The serial port on the MultiExact can be used to output measurement and status data and to transfer configurations to and from other MultiExact units.

The serial port on the rear of the analyser (Figure 2, item 19) is an RS232 ± 5.5 V 9-way 'D' type connector.

Pin(s)	Use
1	Not used
2	Rx (to the analyser)
3	Tx (from the analyser)
4	Not used
5	0 V
6, 7, 8, 9	Not used

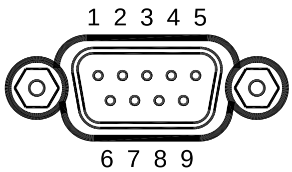


Figure A1 – RS232 connection pin details

A1.2 Connecting the analyser to a PC

The analyser can be directly connected to the 9-way 'D' type serial port (usually designated "COM1" or "COM2") on your PC. Use a compatible 9-way 'D Null Modem' cable (with a recommended maximum length of 3 metres), with female-to-female connectors. To prevent the cable coming loose at the analyser ensure the connector screws are tightened (if supplied on the cable).

If your PC only has USB serial ports, use a commercially available 9-way 'D' type serial to USB converter to connect the PC.

A1.3 Configuring the RS232 serial output parameters

You must configure the analyser serial output parameters to suit the requirements of the PC (or other device) which you have connected to the serial output port on the analyser. The output parameters which you can configure are listed below:

Parameter	Valid settings
Period	1 to 999 seconds.
Baud rate	2400, 4800, 9600, 19200 and 38400 are all supported.
Parity	None, odd parity, or even parity.
Data bits	7 or 8.
Stop bits	1 or 2.

To configure the parameters:

1. Select Þ Settings Þ Comms Parameters.

2. If necessary, change the displayed parameter using the edit method described in Section 4.10.

Figure A2 – The serial output period screen

3. For each of the other configurable parameters (see above):
   - Use the and soft keys to select the corresponding parameter screen.
   - Change the parameter as necessary: use the and soft keys to highlight the required option, or edit the data as described in Section 4.10.

A1.4 Capturing data using Windows® and Hyper Terminal™

If a network option is installed (Modbus or Profibus) the communications type needs to be selected as "Serial Output".

1. Select þ Set up þ Comms type.
2. Select "Serial output".

If you use one of the Windows operating systems, HyperTerminal is probably already installed on your PC. For detailed instructions on the installation and use of HyperTerminal, refer to the help files on your PC, or to the documentation supplied with your PC. The following information is provided as a summary only, for quick reference. Install HyperTerminal (if not already installed).

1. Start HyperTerminal.
2. Enter a suitable name and select a 'connect' icon for the connection.
3. Identify the "COM" port that you have used to connect the analyser to the PC.
4. Set the port settings to be consistent with the analyser serial output parameters (see Appendix A1.3).
5. Click on the 'connect' icon to initiate the connection; data will then be displayed on the PC.

Data output from the analyser can be saved (as a text file) using the 'capture text' command in HyperTerminal. You can then import this text directly into applications such as Excel®.

A1.5 Configuration transfer

If you are setting up multiple units and you want to use the same configuration settings in each analyser, you can transfer configuration data from one unit to another, either via a computer or directly with one another. This way all the user setable configurations: calibration tolerances and targets; auto validation sequences, mA ranges and settings, alarm settings etc can be transferred to multiple units. Both units must have matching options fitted. If they differ, a transfer will not be possible.

1. To activate the transfer configuration utility hold down the 4th soft key for 5 seconds during the analyser start up sequence. The screen to the right will appear:

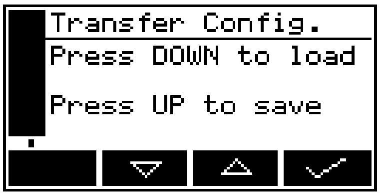


Figure A3 – Transfer configuration screen

2. Connect a computer to the RS232 serial port and run a terminal emulator program such as Windows HyperTerminal. Set the communications parameters to match the analyser.
3. To save a configuration to a pc, set the terminal to log a text file and then press the  key on the unit. The activity display on the 5400 will freeze briefly while out putting the file. Once the output stops, close the logged file. This file can now be used to set other units.
4. To load a configuration file from a PC, press the  key on the unit, the following screen will appear:

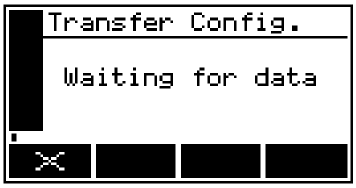


Figure A4 – Transfer configuration interim screen

5. The unit will wait until it receives a configuration file. You can cancel the transfer by pressing the  key, or by typing xxx in at the terminal. To continue with the transfer, use the terminal program to send the configuration file as a plain text file. Once the transfer completes the screen will return to the main form. At the end of the transfer the number of configuration items successfully read in and the total number of lines read will be displayed. The terminal will show something similar to the following:

```
########################
# SERVOMEX 1.0
# 2008/12/01 11:46
# 05000A1/00001
# 05000-cu0_13
########################
#
0400000D000400000000EB
04000003000400000002F3
04000013000400000002E3
19000006000442C80000D3
19000007000100DF
19000004000101E1
0E00000000020003ED
0E00000100010AE6
0E000004000100ED
0E000003000101ED
17000000000100E8
17000001000108DF
17000004000100E4
17000003000101E4
14000001000102E8
xxx
(12/12)
```

If a line is not correct a question mark will be placed after it, such as in the following file:

```
#######################
# SERVOMEX 1.0
# 2008/12/01 11:46
# 05000A1/00001
# 05000-cu0_13
#######################
#
040000110004000000001E6
04000003000400000002F3
04000013000400000002E3
19000006000442C80000D3
19000007000100DF
19000004000101E1
0E00000000020003ED
0E00000100010AE6
0E000004000100EE
?
0E000003000101ED
0E000002000100EF
10000007000200002E5
10000005000101E9
xxx
(9/10)
```

+ If this happens, try sending the file again in case there was noise on the line. If the problem continues try down loading the configuration file again from the original unit.

6. You can connect two units together using a null modem cable. You can then send the configuration data directly from one unit to the other by setting the receiving unit to 'load' a configuration and then setting a transmitting unit to 'save' a configuration.
7. Once you have completed the transfer press the tick key on the main form. The analyser will then restart.

APPENDIX

A2 SERIAL OUTPUT FORMATS

The serial output consists of a number of measurement lines, one line for each update.

Each measurement line consists of a number of elements, separated from each other by the delimiter string " ; " (space, semicolon, space), in the following format:

<date> ; <time> ; <gas> ; <meas> ; <units> ; <status>
[; <gas> ; <meas> ; <units> ; <status>]

where:

<date>	Is the date on which the measurement was made.
<time>	Is the time at which the measurement was made.
<gas>	Specifies the sample gas measured.
<measurement>	Is an actual sample measurement, as displayed on the measurement screen.
<units>	Is the measurement units, as displayed on the measurement screen.
<status>	Up to three letters may be displayed relating to status, these are: F = fault, M = maintenance required, S = service in progress.
"[" and "]"	Elements between these bracket symbols are only output when the analyser is configured for two sample measurements. The bracket symbols themselves do not appear in the output.

An extract from a typical serial output for a 1-measurement analyser is shown below:

```
19/01/05 ; 14:50:25 ; O2 ; 20.3 ; % ; ;
19/01/05 ; 14:50:35 ; O2 ; 20.3 ; % ; ;
19/01/05 ; 14:50:45 ; O2 ; 20.3 ; % ; ;
19/01/05 ; 14:50:55 ; O2 ; 20.3 ; % ; ;
19/01/05 ; 14:51:05 ; O2 ; 20.3 ; % ; ;
```

+ Alarm information is not provided in the serial outputs.

APPENDIX

A3 IMPLEMENTATION GUIDE FOR MODBUS COMMUNICATIONS (OPTION)

A3.1 Introduction

This appendix details the implementation and use of the Modbus protocol in the MultiExact analyser. Please refer to the relevant sections in this manual for a description of the functions available using Modbus communications.

A3.2 References

Document "MODBUS over Serial Line Specification & Implementation guide V1.0 Nov 02" Modbus web site modbus.org.

A3.3 Modbus Setup

The Modbus setup form will allow the user to configure the following parameters:

Default values are in Bold.

Parameters	Options	Comments
Address	1 to **247**	Slave address of unit.
Mode	ASCII or **RTU**	Select serial transmission mode.
Baud rate	2400, 4800, 9600, **19200**, 38400	
Parity	Odd, **Even**, None.	

A3.4 Supported function codes

For simplicity, only the following function codes will be supported.

Function	Description	Usage
01	Read coils	Read calibration status, pump state, etc.
02	Read discrete inputs	Read faults and alarm states.
03	Read holding registers	Read settings.
04	Read input registers	Read measurements, units, etc.
05	Write single coil	Change modes, perform calibration etc.
06	Write single register	Change single setting.
08	Sub Function 00 = Return query data	Diagnostic to test communications.
16	Write multiple registers	Change multiple settings.

A3.5 Exception codes

If an error should occur while processing a message one of the following exception codes will be returned by the instrument.

Code	Condition	Meaning
01	Illegal function	Requested function code is not supported.
02	Illegal data address	The combination of data address and transfer length is invalid for this function.
03	Illegal data value	A value contained in the query data field is not an allowable value. This indicates a fault in the structure of the remainder of a complex request. This does NOT mean that a value to be stored in a register is incorrect as Modbus has no means of determining what is legal for any particular register.
04	Slave device failure	An unrecoverable error occurred while the unit was attempting to perform the requested action.

A3.6 Addressing

Addresses in Modbus ADU (application data unit), run from 1 – N, whereas addresses in the Modbus PDU (protocol data unit) run from 0 – N. This appendix gives addresses in the ADU model. Depending on the particular Modbus master, addresses may have to be entered as they are given or have 1 subtracted from them. For example to read register 101 an address of 100 may be needed.

A3.7 Floating point numbers

Floating point numbers (e.g. 12.34, –1012.32, etc.), are digitally represented using the IEEE–754 format. Single precision floating point numbers are used throughout and they require 32 bits of data. Since a Modbus register holds 16 bits it takes 2 registers to represent a floating point number. We default to having the most significant word of the float, bits 16 – 31, in the first register, and the least significant word, bits 0 – 15, in the next register. This order can be reversed by setting a coil in the system control mapping (Appendix A3.14).

A3.8 System data mapping

Read-only access to system data will be provided in a block of 100 registers. These can be accessed as input registers using function code 04.

Register	Name	Comments
1 – 7	Serial number	ASCII text, 14 characters max, terminated by a zero.
8 – 15	Software version	ASCII text, 16 characters max, terminated by a zero.

A3.9 Transducer data mapping

Each transducer will provide read-only access to its measurements and associated data in blocks of input registers that can be read with function code 04.

The first block of registers provides just the measurement data from all transducers allowing all measurements to be obtained with a single request. Each register provides 2 bytes of data so it takes 2 registers each to store a 4 byte floating point measurement value.

Register	Name	Comments
5001 – 5002	Transducer 1	Floating point number
5003 – 5004	Transducer 2	

A block of 100 registers is allocated for each transducer to provide the means of supplying the measurement and other transducer related data as follows:

Register	Name	Comments
101 – 200	Transducer 1	Measurements and data for each transducer
201 – 300	Transducer 2	

The following table shows the assignment for transducer 1. Each register provides 2 bytes of data.

Register	Name	Comments
101 – 102	Measurement	As seen on the measurement display. Floating point number.
103 – 104	Filtered measurement	Basic measurement, filtered. Floating point number.
105 – 106	Pressure compensated measurement	Filtered and pressure compensated measurement. Floating point number.
107 – 108	PMR	Primary measurement range.
109	Warming state	0 = not warming, 1 = warming.
110 – 112	Formula	Gas formula. ASCII text, 5 characters max, terminated by a zero.
113 – 116	Units	Measurement units. ASCII text, 7 characters max, terminated by a zero.
117	Auto val state	0 = idle, 1 = pre-warning, 2 = inerting, 3 = flushing, 4 = validating/calibrating.
118	Auto val gas	0 = low gas, 1 = high gas, 2 = sample gas.
119	Auto val finishing	0 = not finishing, 1 = finishing.
120	Auto val fail state	0 = auto validation OK, 1 = auto validation. failed
121	Active analogue output range	0 = range 1, 1 = range 2.
122	Flow	Current flow through the sample line in percent.

A3.10 System Fault Mapping

Read-only access to system fault information will be provided in a block of 100 registers. These can be accessed as discrete inputs using function code 02 or as input registers using function code 04. Reading them as discrete inputs provides a simple bit result for each, 0 for off and 1 for on. Reading them as input registers provides information on their NAMUR status, as follows:

- 0 = off
- 1 = fault
- 2 = maintenance required
- 3 = service in progress

The fault, maintenance required, and service in progress faults provide a summary of the other states and can only be off or on. The registers are assigned as follows:

Register	Name	Comments
1001	Fault	If any system fault exists.
1002	Maintenance required	If any system maintenance required status exists.
1003	Service in progress	If any system service in progress status exists.
1004	Charging time out	The batteries have taken too long to charge.
1005	Date/Time invalid	System clock needs setting.
1006	Code fault	the programmed software has become corrupted.
1007	Database fault	A fault occurred when using the database.
1011	Power configuration fault	Incorrect power type configured.
1012	Static RAM fault	A fault in the internal memory has been detected.

A3.11 Transducer fault and alarm mapping

Read-only access to transducer fault and alarm information will be provided in a block of 100 registers and coils. These can be accessed as discrete inputs using function code 02 or as input registers using function code 04. Reading them as discrete inputs provides a simple bit result for each, 0 for off and 1 for on. Reading them as input registers provides information on their NAMUR status, as follows:

- 0 = off,
- 1 = fault,
- 2 = maintenance required,
- 3 = service in progress.

Alarm 1 and alarm 2 aren't faults and can only be off or on.

The fault, maintenance required, and service in progress faults provide a summary of the other states and can only be off or on.

The registers are assigned as follows:

Register	Name	Comments
1101 – 1200	Transducer 1	Measurements and data for each transducer
1201 – 1300	Transducer 2	

Each input within the block for transducer 1 is assigned as follows:

Register	Name	Comments
1101	Alarm 1	Alarm 1 is active or latched.
1102	Alarm 2	Alarm 2 is active or latched.
1103	Fault	If any transducer fault exists.
1104	Maintenance required	If any maintenance required status exists.
1105	Service in progress	If any service in progress status exists.
1106	Transducer maintenance fault	Internal transducer fault.
1107	Transducer error	Internal transducer fault.
1108	Transducer fatal fault	Internal transducer fault.
1109	Heater fault	Transducer heating has failed.
1110	Sample heater fault	Transducer sample heating has failed.
1111	Calibration fault	Transducer needs calibrating.

Register	Name	Comments
1112	Communication fail	Transducer not responding.
1113	Incorrect transducer type	Incorrect type of transducer fitted.
1114	Transducer not detected	Transducer is unplugged or broken.
1115	Low calibration fail	Auto cal low failed.
1116	High calibration fail	Auto cal high failed.
1117	Low validation fail	Auto val low failed.
1118	High validation fail	Auto val high failed.
1119	Remote low cal denied	Remote low calibration denied.
1120	Remote high cal denied	Remote high calibration denied.
1121	mA fault	Hardware fault detected.
1122	mA not detected	Card is missing or the incorrect type has been fitted.
1123	mA reset	A time out occurred on the milliamp card.
1124	Volt fault	Hardware fault detected.
1125	Volt not detected	Card missing or the incorrect type has been fitted.
1126	Volt reset	A time out occurred on the volt card.
1127	Pressure calibration	Pressure needs calibrating.
1128	Pressure fail	Hardware fault detected.
1129	Pressure low	Pressure low fault.
1130	Pressure high	Pressure high fault.
1131	Relay not detected	Card missing or incorrect type has been fitted.
1132	Switch input not detected	Card missing or incorrect type has been fitted.
1133	Flow fail	Hardware fault detected.
1134	Low flow alarm 1	Flow is below is below the low flow 1 alarm level
1135	Low flow alarm 2	Flow is below is below the low flow 2 alarm level
1136	Remote service in progress	Switch input has activated service in progress.

Register	Name	Comments
1137	Transducer calibration mode	Calibration mode is active.
1138	Auto validation/calibration.	Sequence is in progress.
1139	mA service in progress	Calibration or override in progress.
1140	Volt service in progress	Calibration or override in progress.
1141	Pressure service in progress	Calibration in progress.
1142	Relay service in progress	Override in progress.
1143	Flow service in progress	Calibration in progress.
1144	No Profibus module	Hardware fault or card missing
1145	High flow alarm	Flow is above the high flow alarm level
1146	Flow temperature fault	Flow hardware has a temperature fault
1147	Flow cal high diff	Zero and normal flow calibration points are too far apart
1148	Flow cal low diff	Zero and normal flow calibration points are too close together
1149	Transducer error	Transducer error
1150	Temperature fault	Temperature fault

A3.12 System set-up mapping

System data will be available with read-write access in blocks of holding registers. This data can be read with function code 03 and written with function codes 06 and 16.

Register	Name	Comments
Clock		
1	Year	0 – 99
2	Month	1 – 12
3	Date	1 – 31
4	Hour	0 – 23
5	Minute	0 – 59
6	Second	0 – 59
Calibration set up		
7	Linked	0 = no, 1 = yes.
Switch input		
8	Switch input function	0 = disabled, 1 = remote cal, 2 = auto val.

A3.13 Transducer set-up mapping

Each transducer will provide read-write access to various set-up data in blocks of holding registers that can be read with function code 03 and written with function codes 06 and 16.

Each register provides 2 bytes of data so it takes 2 registers each to store a 4 byte floating point measurement value.

A block of 100 registers is allocated for each transducer to provide the means of supplying the transducer related set-up data as follows:

Register	Name	Comments
101 – 200	Transducer 1	Transducer related data.
201 – 300	Transducer 2	

The following table shows the assignment for transducer 1. Each register provides 2 bytes of data.

Register	Name	Comments
Analogue Output		
101 – 102	Range 1 low	Float.
103 – 104	Range 1 high	Float.
105 – 106	Range 2 low	Float.
107 – 108	Range 2 high	Float.
109	Range mode	0 = range 1, 1 = range 2, 2 = auto range.
110	Freeze	0 = Follow, 1 = Freeze.
111	Jam	0 = None, 1 = low, 2 = high.
112	Output range	0 = 0 – 20 mA, (0 – 10 V), 1 = 4 – 20 mA.
113 – 114	Under range	Float.
115 – 116	Change over point	Float.
117 – 118	Hysteresis	Float.
Cross Interference		
119 – 120	Offset	Float.
Auto validation		
121 – 122	Low target	Float. Also calibration target.
123 – 124	Low tolerance	Float.
125 – 126	High target	Float. Also calibration target.
127 – 128	High tolerance	Float.
129	Type	0 = low, 1 = high, 2 = low and high, 3 = high and low.
130	Mode	0 = validate, 1 = calibrate.
131	Pre-warning phase	0 = no, 1 = yes.
132	Pre-warning seconds	Integer.
133	Inerting phase	0 = no, 1 = yes.
134	Inert gas	0 = low, 1 = high.
135	Inert seconds	Integer.
136	Flush seconds	Integer.
137	Timer	0 = Off, 1 = On.

Register	Name	Comments
138	Start year	0 – 99
139	Start month	1 – 12.
140	Start date	1 – 31.
141	Start hour	0 – 23.
142	Start minute	0 – 59.
143	Repeat hour	Integer.
Pressure		
144	Compensating	0 = no, 1 = yes.
Alarm set up		
145	Alarm 1 mode	0 = none, 1 = low, 2 = high.
146	Alarm 1 latching	0 = no, 1 = yes.
147 – 148	Alarm 1 level	Float.
149 – 150	Alarm 1 hysteresis	Float.
151	Alarm 2 mode	0 = none, 1 = low, 2 = high.
152	Alarm 2 latching	0 = no, 1 = yes.
153 – 154	Alarm 2 level	Float.
155 – 156	Alarm 2 hysteresis	Float.
Flow Alarm		
157	Low flow 1 level	A status will be raised if flow falls below this level.
158	Low flow 2 level	A status will be raised if flow falls below this level.
159	Low flow 1 status type	The type of status reported for low flow alarm 1 0 = None, 1 = Fault, 2 = Maintenance required.
160	Low flow 2 status type	The type of status reported for low flow alarm 2 0 = None, 1 = Fault, 2 = Maintenance required.
161	High flow status type	The type of status reported for high flow alarm 0 = None, 1 = Fault, 2 = Maintenance required.

A3.14 System control

System control will be provided using a block of coils that can be written to using function code 05. Reading the same coils with function code 01 provides status information.

Coil	Name	Comments
1	Floating point order	Changes the order of the Modbus registers when dealing with 32-bit floating point numbers. 0 = big-endian, e.g. 40001 = high word, 40002 = low word (default). 1 = little-endian, e.g. 40001 = low word, 40002 = high word.
2	User interface busy	0 = idle (on main screen), 1 = busy, user interface is in use. Write 1 to stop the user interface (keys) being used.
3	Pump/solenoid control	0 = off, 1 = on.

A3.15 Transducer control

Transducer control will be provided using a block of coils that can be written to using function code 05. Reading the same coils with function code 01 provides status information. A block of 100 coils is reserved for each transducer as follows:

Coil	Name	Comments
101 – 200	Transducer 1	
201 – 300	Transducer 2	

The coils for transducer 1 are shown in the following table:

Coil	Name	Comments
Measurement		
101	Calibration mode on/off	0 = off (normal), 1 = on (alarms masked, jamming etc). Write 1 to turn calibration mode on.
102	Low calibration gas	0 = sample gas, 1 = low calibration gas.
103	High calibration gas	0 = sample gas, 1 = high calibration gas.
104	Low calibrate	0 = idle, 1 = low calibration in progress. Write 1 to initiate low calibration.
105	High calibrate	0 = idle, 1 = high calibration in progress. Write 1 to initiate a high calibration.
106	Start auto val	0 = idle, 1 = auto val in progress. Write 1 to start an auto validation/ calibration.
107	Stop auto val	0 = auto val in progress and can be stopped, 1 = stop N/A. Write 1 to stop an auto validation/ calibration.
Pressure		
108	Calibrate pressure mode	0 = normal, 1 = calibrate mode
109	Calibrate pressure low	1 = calibrate
110	Calibrate pressure high	1 = calibrate
Flow alarm		
111	Calibrate flow mode	0 = normal, 1 = calibrate mode
112	Calibrate zero flow	1 = calibrate at 0% flow
113	Calibrate normal flow	1 = calibrate at 100% flow
Analogue output		
114	Calibration mode	0 = normal, 1 = calibration mode
115	Decrease output level	1 = step down
116	Increase output level	1 = step up
Relays		
117	Service mode	0 = normal, 1 = service mode
118	Relay state during service	0 = deenergised, 1 = energised

Remote service in progress		
119	Remote service in progress	0 = inactive, 1 = active Write 1 to turn remote service in progress mode on. See section 5.5.3

APPENDIX

A4 CONFIGURING THE MODBUS PARAMETERS (OPTION)

If your analyser has the Modbus output (either RS485 or Ethernet), you must configure the communications parameters to suit the requirements of the network to which you have connected the analyser.

The cable connections are shown in Section 5.2.6.

+ All screen shots show the default setting.

These values are supervisor password protected. Your network administrator will advise you of the necessary parameters that will be required to be entered.

A4.1 RS485

1. Select ▸ Settings ▸ Comms parameters.
2. The first screen (see Figure A5) requests the communication mode. This can be RTU or ASCII.
3. Press the soft key to change the value.

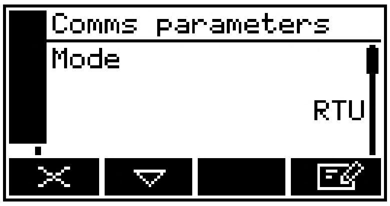


Figure A5 – Comms parameters mode Screen

+ Use 8 bits for RTU and 7 bits for ASCII.

4. Use the soft key to select the next parameter:
5. Node address, this can be anything from 1 to 247. Use the and soft keys to select the correct value.

Figure A6 – Comms parameters node address screen

6. Use the and soft keys to select the next parameter:
7. Baud Rate, this can be anything 2400, 4800, 9600, 19200 or 38400. Use the and soft keys to select the correct value.

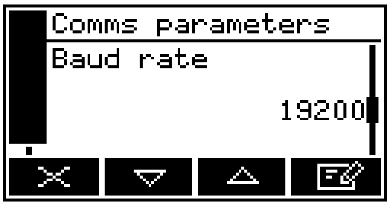


Figure A7 – Comms parameters baud rate screen

8. Use the  and  soft keys to select the next parameter.

9. Parity, this can be none, even or odd. Use the  and  soft keys to select the correct value.

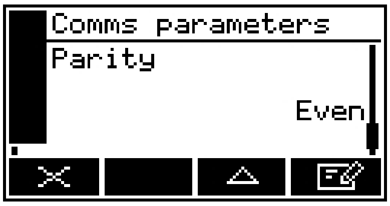


Figure A8 – Comms parameters parity screen

A4.2 TCP (Ethernet)

1. Select þ Settings þ Comms parameters.

2. The first screen requests the IP address, (always communicates in RTU mode). Use the and soft keys to select the correct value.

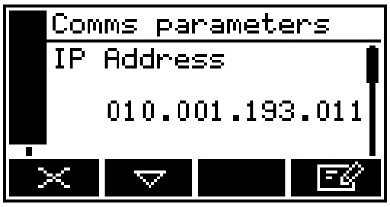


Figure A9 – Comms parameters IP address screen

+ The IP address must be set to a unique value in the network.

3. Use the and soft keys to select the next parameter:

4. Subnet mask, sets the subnet mask for the network. A provisional mask is generated automatically by the control unit whenever a new IP address is entered that falls into a different class. The mask may then be altered manually if required by clicking soft key.

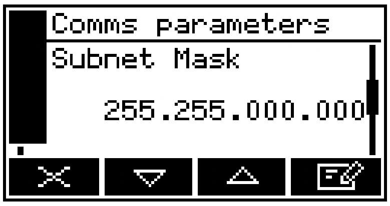


Figure A10 – Comms parameters subnet mask screen

5. Use the and soft keys to select the next parameter:

6. Gateway address, or router, allows communication to other LAN segments. The gateway address should be the IP address of the router connected to the same LAN segment as the unit. The gateway address must be within the local network.

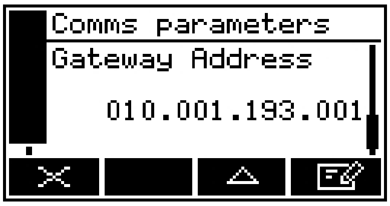


Figure A11 – Comms parameters gateway address screen

APPENDIX

A5 DISPLAY UNIT CONVERSION FACTORS

When you select display units as described in Section 5.10, you must ensure that you also enter the correct units conversion factor, as shown in the table below:

To convert from *	to †	use the units conversion factor	applicable gas(es)
%	ppm	10000	any
ppm	%	0.0001	any
ppm	vpm	1	any
ppm	mg/m^3	1.2492	CO
"	"	1.9631	CO_2
"	"	1.4277	O_2
%	mg/m^3	12492	CO
"	"	19631	CO_2
"	"	14277	O_2
ppm	%LEL	0.0008	CO
%	%LEL	8	CO
%	mol/mol	0.01	any
ppm	mol/mol	#	#

* Measurement default units.
† Selected display units.
\# This conversion is not supported.

+ To return to the measurement default units, select the "off" units selection option and set the units conversion factor to "1": see Section 5.10.

APPENDIX

A6 SAMPLE WETTED MATERIALS

The materials of the parts of the analyser in contact with the sample and calibration gases are listed below. These materials have a wide range of chemical compatibility and corrosion resistance.

Oxygen Purity Measurement
303 st steel Viton Polypropylene PPS with carbon fibre filler * PPS * Borosilicate glass * Polysulphone 316 stainless steel Platinum Platinum / iridium alloy Electroless nickel 10% glass filled polyetherimide(ultem) RTV silicone Epoxy Silgel (silicone) Gold Silicon
Trace CO, CO_2, and N_2O measurements
316 st steel Viton 303 st steel Gold Nickel Calcium fluoride
Trace O_2 measurements
316 st steel Viton 303 st steel 310 st steel Borosilicate glass Alumina Nickel iron Sealing glass Gold

* (with optional filter)

TCD measurements
316 st steel Viton Epoxy Borosilicate glass Platinum Platium iridium alloy Alumina Nickel iron Nickel plated copper Sealing glass Polysulphone Duralumin Polycarbonate Glass fibre
Flow meter
Borosilicate glass Duralumin 316 st steel
Flow Alarm
Platinum iridium alloy Glass Stabilised zirconia 316 st steel

A7 DISPOSAL IN ACCORDANCE WITH THE WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE) DIRECTIVE

The label shown in Figure A12 is fitted to the analyser.

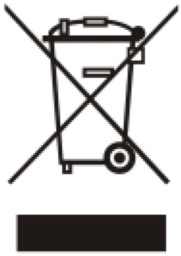


Figure A12 – The WEEE label

This label identifies that:

- The analyser is considered to be within the scope of the Waste Electrical and Electronic Equipment (WEEE).
- The analyser is not intended for disposal in a municipal waste stream, but shall be submitted for material recovery and recycling in accordance with the local regulations which implement the WEEE Directive.

For additional information and advice on the disposal of the analyser in accordance with the requirements of the WEEE Directive, contact Servomex or your local Servomex agent.

If you send the analyser to Servomex or your local Servomex agent for disposal, the analyser must be accompanied by a correctly completed decontamination certificate.

APPENDIX

A8 COMPLIANCE AND STANDARDS INFORMATION

- The analyser complies with the European Community "Electromagnetic Compatibility Directive":
  - Emissions: Equipment suitable for use in domestic establishments and in establishments directly connected to a low voltage supply which supplies buildings for domestic purposes.
  - Immunity: Industrial locations.
- The analyser complies with the European Community "Low Voltage Directive", by the application of:
  - EN 61010–1 and rated for Category II, Pollution Degree 2.
- The analyser complies with the Class B digital apparatus requirements of ICES–003 of Canada through the application of EN 55011:2007.
- L'analyseur est conforme aux Conditions B numériques d'appareillage de classe de NMB–003 du Canada par l'application du EN 55011:2007.
- This analyser complies with Part 15 of the US FCC Rules for Class B equipment. It is suitable for operation when connected to a public utility power supply that also supplies residential environments.
- The analyser has been assessed to IEC 61010–1 for electrical safety including any additional requirements for US and Canadian national differences.
- Servomex Group Ltd is a BS EN ISO 9001 and BS EN ISO 14001 certified organisation.

APPENDIX

A9 PERFORMANCE DATA

A9.1 O_2 purity measurement

+ The display indication given below is the default indication. You can configure the analyser to provide other display indications (see Section 5.10).

+ Performance data has been determined in accordance with EN61207.

Display indication	Measured volume % O_2
Full scale range	0 to 100% O_2
Analogue output range	User selectable (minimum difference – 0.5%)
Resolution	0.01% O_2
Repeatability	< 0.01% O_2
Linearity	No measurable error
Intrinsic error (accuracy)	± 0.01% O_2
Zero drift per week	± 0.01% O_2
Span drift per week	± 0.02% O_2
Output fluctuation	± 0.01% O_2
Response time *	10 seconds
Flow effect	
Flow driven	± 0.1% O_2 †
Pressure driven	± 0.1% O_2 ‡
Zero temperature coefficient	± 0.01% O_2 per 10 °C
Span temperature coefficient	± 0.01% O_2 or 0.1% of reading per 10 °C **
Pressure effects	< 0.003% O_2 #

* T_{90} at 200 ml min^{-1} or 68.9 kPa gauge (7 psig, 0.48 bar gauge) sample gas supply pressure.

† For a 100 to 250 ml min^{-1} change in sample gas flow rate.

‡ For a 14 to 55 kPa (0.14 to 0.55 bar, 2 to 8 psi) change in sample gas inlet pressure.

For a 1% change in ambient pressure.

** Whichever is the greater.

A9.2 Performance data: O_2 control measurement

+ The display indication given below is the default indication. You can configure the analyser to provide other display indications (see Section 5.10).

+ Performance data has been determined in accordance with EN61207.

Display indication	Measured volume % O_2
Full scale range	0 to 100% O_2
Analogue output range	User selectable (minimum difference – 0.5%)
Resolution	0.1% O_2
Repeatability	< 0.1% O_2
Linearity	no measurable error
Intrinsic error (accuracy)	± 0.1% O_2
Zero drift per week	± 0.05% O_2
Span drift per week	± 0.1% O_2
Output fluctuation	± 0.05% O_2
Response time *	10 seconds
Flow effect	
Flow driven	± 0.1% O_2 †
Pressure driven	± 0.1% O_2 ‡
Zero temperature coefficient	± 0.1% O_2 per 10 °C
Span temperature coefficient	± 0.1% O_2 or 1% of reading per 10 °C **
Pressure effects	Directly proportional to ambient air pressure

* T_{90} at 200 ml min^{-1} or 68.9 kPa gauge (7 psig, 0.48 bar gauge) sample gas supply pressure.
† For a 100 to 250 ml min^{-1} change in sample gas flow rate.
‡ For a 14 to 55 kPa (0.14 to 0.55 bar, 2 to 8 psi) change in sample gas inlet pressure.
** Whichever is the greater.

A9.3 Performance data: O_2 trace measurement

+ The display indication given below is the default indication. You can configure the analyser to provide other display indications (see Section 5.10).

+ Performance data has been determined in accordance with EN61207.

Display indication	ppm O_2
Full scale range	0 to 5 ppm O_2 (minimum) 0 to 999,999 ppm O_2 (maximum)
Analogue output range	User selectable (minimum difference – 1 ppm)
Resolution	0.01 ppm O_2 (0 – 10 ppm)
Repeatability	< 0.1 ppm O_2 (0 – 10 ppm)
Linearity	± 0.05 ppm O_2 (0 – 10 ppm)
Intrinsic error (accuracy)	± 0.1 ppm O_2 (0 – 10 ppm)
Zero drift per week	± 0.25 ppm
Span drift per week	± 1% of measurement or 0.25 ppm **
Output fluctuation	± 0.5% of measurement or 10 ppb **
Response time *	10 seconds (for a 2 – 10 ppm change)
Flow effect	
Flow driven	± 0.15 ppm or 2% of reading ** †
Pressure driven	± 0.15 ppm or 2% of reading ** ‡
Zero temperature coefficient	0.01 ppm per 10 °C
Span temperature coefficient	± 1% of measurement or 0.01 ppm per 10 °C **
Cross sensitivity	Typical effect of < 1 ppm O_2 : 15 ppm H_2 ; 100 ppm CH_4 ; 80 ppm CO
Pressure effects	None #

* T_{90} at 400 ml min^{-1} or 68.9 kPa gauge (7 psig, 0.48 bar gauge) sample gas supply pressure.
† For a 200 to 400 ml min^{-1} change in sample gas flow rate.
‡ For a 14 to 55 kPa (0.14 to 0.55 bar, 2 to 8 psi) change in sample gas inlet pressure.
# Assuming that the sample is vented to atmosphere.
** Whichever is the greater.

A9.4 Performance data: 0-10ppm CO_2 measurement

+ The display indication given below is the default indication. You can configure the analyser to provide other display indications (see Section 5.10).

+ Performance data has been determined in accordance with EN61207.

Display indication	ppm CO_2
Full scale range	0 to 10 ppm CO_2
Analogue output range	User selectable (minimum difference – 10% of full range)
Resolution	0.01 ppm CO_2
Repeatability	< 0.1 ppm CO_2
Linearity	± 0.1 ppm CO_2
Intrinsic error (accuracy)	± 0.1 ppm CO_2
Drift per week	± 0.2 ppm ± 2% of reading
Output fluctuation	± 0.1 ppm CO_2
Response time *	15 seconds
Flow effect	
Flow driven	± 0.1 ppm or 1% of reading ** †
Pressure driven	± 0.1 ppm or 1% of reading ** ‡
Temperature coefficient	± 3% of measurement or 0.25 ppm per 10 °C **
Pressure effects	0.4% of measurement #

* T_{90} at 500 ml min^{-1}.
† For a 200 to 500 ml min^{-1} change in sample gas flow rate.
‡ For a 14 to 55 kPa (0.14 to 0.55 bar, 2 to 8 psi) change in sample gas inlet pressure.
\# For a 1% change in pressure.
** Whichever is the greater.

A9.5 Performance data: 0-500ppm CO_2 measurement

+ The display indication given below is the default indication. You can configure the analyser to provide other display indications (see Section 5.10).

+ Performance data has been determined in accordance with EN61207.

+ The performance specification for 0-50ppm range is applicable when the transducer is calibrated with 50ppm CO_2 span gas.

Display indication	ppm CO_2
Full scale range Lower specified range	0 to 500ppm[1] CO_2 0 to 50ppm[2] CO_2
Analogue output range	User selectable (minimum difference – 10% of full range)
Resolution	0.01 ppm CO_2
Repeatability	0-500ppm[1]: ±0.5ppm (below 25ppm), <3% of reading (25-500ppm) 0-50ppm[2]: <0.5ppm
Linearity	0-500ppm[1]: ±0.5ppm (below 25ppm), ±3% of reading (25-500ppm) 0-50ppm[2]: ±0.5ppm
Intrinsic error (accuracy)	0-500ppm[1]: ±0.5ppm (below 25ppm), ±3% of reading (25-500ppm) 0-50ppm[2]: ±0.5ppm
Drift per week	± 0.3 ppm ± 2% of reading (for the specified range)
Output fluctuation	± 0.1 ppm CO_2
Response time *	< 20 seconds
Flow effect	
Flow driven	± 0.1 ppm or 1% of reading ** †
Pressure driven	± 0.1 ppm or 1% of reading ** ‡
Temperature coefficient	± 3% of measurement or 0.25 ppm per 10 °C **
Pressure effects	0.4% of measurement #

[1] Calibrated using 500ppm CO_2 span gas
[2] Calibrated using 50ppm CO_2 span gas
* T_{90} for change of 0-10ppm at 400 ml min^{-1}
† For a 200 to 500 ml min^{-1} change in sample gas flow rate.
‡ For a 14 to 55 kPa (0.14 to 0.55 bar, 2 to 8 psi) change in sample gas inlet pressure.
# For a 1% change in pressure.
** Whichever is the greater.

A9.6 Performance data: 0-10ppm CO measurement

+ The display indication given below is the default indication. You can configure the analyser to provide other display indications (see Section 5.10).

+ Performance data has been determined in accordance with EN61207.

Display indication	ppm CO
Full scale range	0 to 10 ppm CO
Analogue output range	User selectable (minimum difference – 10% of full range)
Resolution	0.01 ppm CO
Repeatability	< 0.1 ppm CO
Linearity	± 0.1 ppm CO
Intrinsic error (accuracy)	± 0.1 ppm CO
Drift per week	± 1 ppm ± 1% of reading
Output fluctuation	± 0.1 ppm CO
Response time *	20 seconds
Flow effect	
Flow driven	± 0.1 ppm or 1% of reading ** †
Pressure driven	± 0.1 ppm or 1% of reading ** ‡
Temperature coefficient	± 4% of measurement or 0.4 ppm per 10 °C **
Pressure effects	< 1% of measurement #

* T_{90} for change of 0-5ppm at 400 ml min^{-1}.
† For a 200 to 500 ml min^{-1} change in sample gas flow rate.
‡ For a 14 to 55 kPa (0.14 to 0.55 bar, 2 to 8 psi) change in sample gas inlet pressure.
\# For a 1% change in pressure.
** Whichever is the greater.

A9.7 Performance data: 0-20ppm N_2O measurement

+ The display indication given below is the default indication. You can configure the analyser to provide other display indications (see Section 5.10).

+ Performance data has been determined in accordance with EN61207.

Display indication	ppm N_2O
Full scale range	0 to 20 ppm N_2O
Analogue output range	User selectable (minimum difference – 10% of full range)
Resolution	0.01 ppm N_2O
Repeatability	< 0.2 ppm N_2O
Linearity	± 0.2 ppm N_2O
Intrinsic error (accuracy)	± 0.2 ppm N_2O
Drift per week	± 0.4 ppm ± 2% of reading
Output fluctuation	± 0.2 ppm N_2O
Response time *	15 seconds
Flow effect	
Flow driven	< 0.2 ppm or 1% of reading ** †
Pressure driven	< 0.2 ppm or 1% of reading ** ‡
Temperature coefficient	± 3% of measurement or 0.4 ppm per 10 °C
Pressure effects	0.5% of measurement #

* T_{90} at 500 ml min^{-1}.
† For a 200 to 500 ml min^{-1} change in sample gas flow rate.
‡ For a 14 to 55 kPa (0.14 to 0.55 bar, 2 to 8 psi) change in sample gas inlet pressure.
\# For a 1% change in pressure.

A9.8 Performance data: TCD

+ The display indication given below is the default indication. You can configure the analyser to provide other display indications (see Section 5.10).

+ Performance data has been determined in accordance with EN61207.

Gas and Ranges available	0-1%	0-2%	0-5%	0-10%	0-20%	0-30%	0-50%	0-100%	80-100%	90-100%
Ar in N_2				✓	✓		✓	✓	✓	✓
Ar in O_2				✓	✓		✓	✓	✓	✓
N_2 in Ar				✓	✓		✓	✓		
He in N_2		✓	✓	✓	✓	✓	✓	✓		
He in O_2		✓	✓	✓	✓	✓	✓	✓		

Display indication	%
Resolution	0.01%
Repeatability	0.5% of range
Linearity	± 1% of range
Intrinsic error (accuracy)	± 1% of range
Drift per month	± 1% of range
Output fluctuation	± 0.5% of range
Response time *	T90 15 seconds *
Flow effect	< 0.1% #
Temperature coefficient	± 1% of range per 10 °C

* for 150 ml min^{-1}. Flow driven.100 – 200 ml min^{-1} or pressure driven 2 – 8 psig.

\# Over defined flow range.

A9.9 Performance data: flow alarm

Resolution	± 1% of calibrated range
Intrinsic Error	± 10% of calibrated range
Ambient temperature coefficient	± 7% of calibrated range per 10 °C
Response time	< 20 seconds (T60 – 100% flow to 0% flow)
Acceptable background gases	Nitrogen, Oxygen, Carbon Dioxide, Carbon Monoxide, Argon and Air

A10 RECOMMENDED CALIBRATION PERIODS

Gas transducer	Low cal	High cal
CO, CO_2, N_2O Trace	Weekly	3 monthly
O_2 Purity *	2 monthly	Monthly
O_2 Control	2 weekly	Monthly
O_2 Trace	Monthly	6 monthly
TCD	Monthly	Monthly
Flow alarm	Annually	Annually

* Calibrate the pressure compensation annually.

A11 CROSS INTERFERENCE OFFSETS (FOR PARAMAGNETIC TRANSDUCERS)

Pure Gas	Formula	Molar mag.susc x 10^{-6}	Cross interference offsets			
			Control = 20 °C		Purity = 60 °C	
			20 °C	50 °C	60 °C	110 °C
Acetaldehyde	CH_2CHO	–22.70	–0.31	–0.34	–0.35	–0.40
Acetic acid	CH_3CO_2H	–31.50	–0.56	–0.62	–0.64	–0.74
Acetone	CH_3COCH_3	–33.70	–0.63	–0.69	–0.71	–0.82
Acetylene	HCCH	–20.80	–0.25	–0.28	–0.29	–0.33
Acrylonitrile	CH_2=CHCN	–24.10	–0.35	–0.39	–0.40	–0.46
Allyl alcohol	CH_2CHCH_2OH	–36.70	–0.71	–0.79	–0.81	–0.93
Ammonia	NH_3	–18.00	–0.17	–0.19	–0.20	–0.23
Argon	Ar	–19.60	–0.22	–0.24	–0.25	–0.29
Benzene	C_6H_6	–54.84	–1.24	–1.36	–1.41	–1.62
Boron chloride	BCl_3	–59.90	–1.38	–1.53	–1.57	–1.81
Boron trifluoride	BF_3	–19.00	–0.20	–0.22	–0.23	–0.26
Bromine	Br_2	–73.50	–1.78	–1.96	–2.02	–2.32
1,2 Butadiene	C_4H_6	–35.60	–0.68	–0.75	–0.77	–0.89
1,3 Butadiene	C_4H_6	–30.60	–0.54	–0.59	–0.61	–0.70
N-Butane	C_4H_{10}	–50.30	–1.11	–1.22	–1.26	–1.45
iso-Butane	$(CH_3)_2CHCH_2$	–51.70	–1.15	–1.26	–1.30	–1.50
1 Butene	$CH_3CH_2CH=CH_2$	–41.10	–0.84	–0.93	–0.96	–1.10
N–Butyl acetate	$CH_3COOC_4H_9$	–77.50	–1.89	–2.09	–2.15	–2.47
iso–Butylene	$(CH_3)_2CH=CH_2$	–44.40	–0.94	–1.03	–1.06	–1.22
1 Butyne (Ethylacetylene)	$CH_3C_3H_2$	–43.50	–0.91	–1.00	–1.03	–1.19
Carbon dioxide	CO_2	–21.00	–0.26	–0.29	–0.30	–0.34
Carbon disulphide	CS_2	–42.20	–0.87	–0.96	–0.99	–1.14
Carbon monoxide	CO	–9.80	0.06	0.07	0.07	0.08
Carbon tetrachloride	CCl_4	–66.60	–1.58	–1.74	–1.79	–2.06
Carbon tetrafluoride	CF_4	–31.20	–0.55	–0.61	–0.63	–0.72
Chlorine	Cl_2	–40.50	–0.82	–0.91	–0.94	–1.08
Chloro ethanol	$ClCH_2CH_2OH$	–51.40	–1.14	–1.25	–1.29	–1.49
Chloroform	$CHCl_3$	–59.30	–1.37	–1.51	–1.55	–1.78
Cumene	$(CH_3)_2CHC_6H_5$	–89.53	–2.24	–2.47	–2.55	–2.93
Cyclohexane	C_6H_{12}	–68.13	–1.62	–1.79	–1.84	–2.12
Cyclopentane	C_5H_{10}	–59.18	–1.36	–1.50	–1.55	–1.70
Cyclopropane	C_3H_6	–39.90	–0.81	–0.89	–0.92	–1.05
Diacetylene	C_4H_2	–37.50	–0.74	–0.81	–0.84	–0.96
Dichloroethylene	$(CHCl)_2$	–49.20	–1.07	–1.18	–1.22	–1.40
Diethyl ether	$(C_2H_5)_2O$	–55.10	–1.25	–1.37	–1.41	–1.63
2,2 Difluoro 1 chloroethane	$CClH_2CHF_2$	–52.40	–1.17	–1.29	–1.33	–1.52
1,2 Difluoro 1,2 dichloroethylene	CFCl=CFCl	–60.00	–1.39	–1.53	–1.58	–1.81
Difluoro dichloro methane (Freon 12)	CCl_2F_2	–52.20	–1.16	–1.28	–1.32	–1.5
Dimethoxy methane	$CH_2(OCH_3)_2$	–47.30	–1.02	–1.12	–1.16	–1.33
Dimethylamine	$(CH_3)_2NH$	–39.90	–0.81	–0.89	–0.92	–1.05
Dimethylether	CH_3OCH_3	–26.30	–0.41	–0.46	–0.47	–0.54
Dimethylethylamine	$(CH_3)_2NC_2H_5$	–63.60	–1.49	–1.64	–1.69	–1.95

Pure Gas	Formula	Molar mag.susc x 10^{-6}	Cross interference offsets			
			Control = 20 °C		Purity = 60 °C	
			20 °C	50 °C	60 °C	110 °C
Enflurane (Ethrane)	$C_3H_2F_5ClO$	–80.10	–1.97	–2.17	–2.24	–2.57
Ethane	C_2H_6	–26.80	–0.43	–0.47	–0.49	–0.56
Ethanol	C_2H_5OH	–33.60	–0.62	–0.69	–0.71	–0.82
Ethyl acetate	$CH_3COOC_2H_5$	–54.20	–1.22	–1.34	–1.39	–1.59
Ethyl amine	$C_2H_5NH_2$	–39.90	–0.81	–0.89	–0.92	–1.05
Ethyl benzene	$C_6H_5C_2H_5$	–77.20	–1.88	–2.08	–2.14	–2.46
Ethyl bromide	C_2H_5Br	–54.70	–1.23	–1.36	–1.40	–1.61
Ethyl chloride	C_2H_5Cl	–46.00	–0.98	–1.08	–1.12	–1.28
Ethylene	C_2H_4	–18.80	–0.20	–0.22	–0.22	–0.26
Ethylene glycol	$(CH_2OH)_2$	–38.80	–0.77	–0.85	–0.88	–1.01
Ethylene oxide	$(CH_2)_2O$	–30.70	–0.54	–0.60	–0.61	–0.71
Ethyl mercaptan	$C_2H_5OSO_3H$	–47.00	–1.01	–1.11	–1.15	–1.32
Fluorochlorobromomethane	$CFClBr$	–58.00	–1.33	–1.46	–1.51	–1.74
Fluorodichloromethane (Freon 21)	$CHCl_2F$	–48.80	–1.06	–1.17	–1.21	–1.39
Fluroxene	$CF_3CH_2OCHCH_2$	–56.70	–1.29	–1.42	–1.47	–1.69
Freon 114	$C_2Cl_2F_4$	–77.40	–1.89	–2.08	–2.15	–2.47
Furan	C_4H_4O	–43.09	–0.90	–0.99	–1.02	–1.17
Germanium tetrachloride	$GeCl_4$	–72.00	–1.73	–1.91	–1.97	–2.26
Halothane	$C_2HBrClF_3$	–78.80	–1.93	–2.13	–2.19	–2.52
Helium	He	–1.88	0.29	0.32	0.33	0.38
N–Heptane	C_7H_{16}	–85.24	–2.12	–2.33	–2.40	–2.76
N–Hexane	C_6H_{14}	–73.60	–1.78	–1.96	–2.02	–2.32
Hydrogen	H_2	–3.98	0.23	0.26	0.26	0.30
Hydrogen bromide	Br	–35.30	–0.67	–0.74	–0.76	–0.88
Hydrogen chloride	HCl	–22.60	–0.31	–0.34	–0.35	–0.40
Hydrogen cyanide	HCN	–14.50	–0.07	–0.08	–0.08	–0.09
Hydrogen iodide	HI	–48.20	–1.05	–1.15	–1.19	–1.37
Hydrogen selenide	H_2Se	–39.20	–0.79	–0.87	–0.89	–1.03
Hydrogen sulphide	H_2S	–25.50	–0.39	–0.43	–0.44	–0.51
Isoflurane (Forane)	$C_3H_2F_5ClO$	–80.10	–1.97	–2.17	–2.24	–2.57
Isoprene	C_5H_8	–44.80	–0.95	–1.04	–1.08	–1.24
Ketene	CH_2CO	–15.70	–0.11	–0.12	–0.12	–0.14
Krypton	Kr	–28.80	–0.49	–0.54	–0.55	–0.63
Methane	CH_4	–17.40	–0.16	–0.17	–0.18	–0.20
Methanol	CH_3OH	–21.40	–0.27	–0.30	–0.31	–0.35
Methoxyfluorane	$CHCl_2CF_2OCH_3$	–87.10	–2.17	–2.39	–2.47	–2.83
Methyl acetate	CH_3COCH_3	–42.60	–0.88	–0.97	–1.00	–1.15
Methyl cyclopentane	C_6H_{12}	–70.20	–1.68	–1.85	–1.91	–2.20
Methylene chloride	CH_2Cl_2	–46.60	–1.00	–1.10	–1.14	–1.31
Methylethlyketone	$CH_3COCH_2CH_3$	–45.50	–0.97	–1.07	–1.10	–1.26
Methyl fluoride	CH_3F	–25.50	–0.39	–0.43	–0.44	–0.51
Methyl formate	$HCOOCH_3$	–32.00	–0.58	–0.64	–0.66	–0.75
Methyl iodide	CH_3I	–57.20	–1.31	–1.44	–1.48	–1.71
Methyl iso–butyl ketone (MIBK)	$C_4H_9COCH_3$	–69.30	–1.66	–1.82	–1.88	–2.16
Methyl mercaptan	CH_3SH	–35.30	–0.67	–0.74	–0.76	–0.88
Molybdenum hexafluoride	MoF_6	–26.00	–0.40	–0.45	–0.46	–0.53
Monochlorobenzene	C_6H_5Cl	–70.00	–1.68	–1.85	–1.90	–2.19

Pure Gas	Formula	Molar mag.susc x 10^{-6}	Cross interference offsets			
			Control = 20 °C		Purity = 60 °C	
			20 °C	50 °C	60 °C	110 °C
Neon	Ne	–6.70	0.15	0.17	0.17	0.20
Nitric oxide	NO	1461.00	42.56	42.96	42.94	41.62
Nitrobenzene	$C_6H_5NO_2$	–61.80	–1.44	–1.59	–1.63	–1.88
Nitrogen	N_2	–12.00	0.00	0.00	0.00	0.00
Nitrogen dioxide	NO_2	150.00	5.00	16.00	20.00	35.00
Ortho–Nitrotoluene	$C_6H_4CH_3NO_2$	–72.30	–1.74	–1.92	–1.98	–2.28
para–Nitrotoluene	$C_6H_4CH_3NO_2$	–76.90	–1.88	–2.07	–2.13	–2.45
Nitrous oxide	N_2O	–18.90	–0.20	–0.22	–0.23	–0.26
N–Nonane	C_9H_{20}	–108.13	–2.78	–3.06	–3.16	–3.63
N–Octane	C_8H_{18}	–96.63	–2.45	–2.70	–2.78	–3.19
Oxygen	O_2	3449.00	100.0	100.0	100.0	100.0
Ozone	O_3	6.70	0.54	0.60	0.61	0.71
iso–Pentane	C_5H_{12}	–64.40	–1.51	–1.67	–1.72	–1.98
N–Pentane	C_5H_{12}	–63.10	–1.48	–1.63	–1.68	–1.93
0.01%Phenol	C_6H_5OH	–60.21	–1.39	–1.54	–1.58	–1.82
Phosphine	PH_3	–26.00	–0.40	–0.45	–0.46	–0.53
Phosphorous oxychloride	$POCl_3$	–69.00	–1.65	–1.82	–1.87	–2.15
Propane	C_3H_8	–38.60	–0.77	–0.85	–0.87	–1.00
iso–Propanol	$(CH_3)_2CHOH$	–47.60	–1.03	–1.13	–1.17	–1.34
Propene	$CH_3CH=CH_2$	–31.50	–0.56	–0.62	–0.64	–0.74
N–Propyl acetate	$CH_3COOC_3H_7$	–65.90	–1.56	–1.72	–1.77	–2.03
Propyl amine	$C_3H_7NH_2$	–52.40	–1.17	–1.29	–1.33	–1.52
Propyl chloride	C_3H_7Cl	–56.10	–1.27	–1.40	–1.45	–1.66
Propylene	C_3H_6	–31.50	–0.56	–0.62	–0.64	–0.74
Propylene oxide	OCH_2CHCH_3	–42.50	–0.88	–0.97	–1.00	–1.15
iso–Propyl ether	$(CH_3)_4CHOCH$	–79.40	–1.95	–2.15	–2.21	–2.54
Propyl fluoride	C_3H_7F	–52.20	–1.16	–1.28	–1.32	–1.52
Pyridine	$N(CH)_5$	–49.21	–1.08	–1.19	–1.22	–1.40
Silane	SiH_4	–20.50	–0.25	–0.27	–0.28	–0.32
Silicon tetrachloride	$SiCl_4$	–88.30	–2.20	–2.43	–2.50	–2.88
Styrene	$C_6H_5CH=CH_2$	–68.20	–1.62	–1.79	–1.85	–2.12
Sulphur dioxide	SO_2	–18.20	–0.18	–0.20	–0.20	–0.23
Sulphur hexafluoride	SF_6	–44.00	–0.92	–1.02	–1.05	–1.21
Tetrachoroethylene	$Cl_2C=CCl_2$	–81.60	–2.01	–2.22	–2.28	–2.63
Tetrahydrofuran	C_4H_8O	–52.00	–1.16	–1.27	–1.31	–1.51
Toluene	$C_6H_5CH_3$	–66.11	–1.56	–1.72	–1.78	–2.04
1,1,2 Trichloroethane (Freon 113)	$CHCl_2CH_2Cl$	–66.20	–1.57	–1.73	–1.78	–2.05
Trichloroethylene	$CHCl=CCl_2$	–65.80	–1.55	–1.71	–1.77	–2.03
Trifluorochloroethylene	C_2F_3Cl	–49.10	–1.07	–1.18	–1.22	–1.40
Trimethylamine	$(CH_3)_3N$	–51.70	–1.15	–1.26	–1.30	–1.50
Tungsten fluoride	WF_6	–40.00	–0.81	–0.89	–0.92	–1.06
Urethane	$CO(NH_2)OC_2H_5$	–57.00	–1.30	–1.43	–1.48	–1.70
Vacuum	–	0.00	0.35	0.38	0.39	0.45
Vinyl bromide	$CH_2=CHBr$	–44.80	–0.95	–1.04	–1.08	–1.24
Vinyl chloride	$CH_2=CHCl$	–35.60	–0.68	–0.75	–0.77	–0.89
Vinyl fluoride	$CH_2=CHF$	–28.80	–0.49	–0.54	–0.55	–0.63
Water	H_2O	–13.00	–0.03	–0.03	–0.03	–0.04
Xenon	Xe	–43.90	–0.92	–1.02	–1.05	–1.20
Xylene	$(CH_3)_2C_6H_4$	–77.78	–1.90	–2.09	–2.16	–2.48