SERVOMEX
ANALYZERS
HIGH-PERFORMANCE GAS ANALYSIS

MonoExact DF150E / DF310E Gas Analyzers

Operator Manual PN: 0800000M

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IMPORTANT INFORMATION

Continued safe and reliable operation of this equipment is conditional on all installation, operation and maintenance procedures being carried out in accordance with the appropriate manuals, by personnel having appropriate qualifications, experience and training. Failure to observe the requirements of the manual may result in the user being held responsible for the consequences and may invalidate any warranty. Servomex accepts no liability for unauthorized modifications to Servomex supplied equipment.

Servomex has paid particular attention to Health and Safety throughout this manual. Where special precautions need to be taken due to the nature of the equipment or product, an appropriate safety icon and warning message is shown. Special attention should be made to section 2 – Safety, where all such messages are summarized.

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Installation and Operator Manual P/N: 0800000M

Revision: 800000M/2.2

1 Introduction

1.1 About this manual

1.1.1 Scope of the manual

This manual covers the installation, operation and routine maintenance of the **MonoExact DF310E/DF150E analyzer**. It is intended for those already familiar with the installation, use and maintenance of analytical or process instrumentation.

General information on the analyzer is given in the main body of this manual. Transducer-specific information is contained in the relevant appendix at the rear of the manual.

A separate Quick Start Guide is also supplied with the analyzer, reference part number 800000QSG. This details software configuration and operation of the analyzer needed to get the MonoExact DF310E/DF150E analyzer up and running. Extra copies may be ordered from Servomex.

1.1.2 Safety information

Read this guide and make sure you fully understand its contents before you attempt to install, use or maintain the analyzer.

The user is solely responsible for implementing appropriate environmental monitoring, ventilation and gas safety controls for flammable and/or toxic gas installations to meet all relevant safety standards including but not limited to those imposed by legal, governmental, statutory, industrial, regulatory and/or corporate requirements.

The following icons are used throughout this guide to identify any potential hazards that could cause serious injury to people. Always follow the safety instructions and be aware of the hazard.

This symbol warns of specific hazards which, if not taken into account, may result in personal injury or death.

This symbol warns of specific hazards due to high voltages which, if not taken into account, may result in personal injury or death.

This symbol warns of specific hazards due to high temperatures which, if not taken into account, may result in personal injury or death.

This symbol warns of specific hazards due to hazardous substances which, if not taken into account, may result in personal injury or death.

This symbol warns of specific hazards due to caustic or corrosive substances which, if not taken into account, may result in personal injury or death.

This symbol warns of specific hazards due to Flammable Gas Samples which, if not taken into account, may result in personal injury or death.

This symbol warns of specific hazards due to Toxic Gas Samples which, if not taken into account, may result in personal injury or death.

This symbol highlights where you must take special care to ensure the analyzer or other equipment or property is not damaged.

1.1.3 Other information provided by the manual

Note: Notes give extra information about the equipment.

Hint: *Hints give helpful tips and highlight information*

1.2 Applicable EU Directives, Standards, Certification

- Low Voltage Directive (2014/35/EU)
- Electromagnetic Compatibility (EMC) Directive (2014/30/EU)
- EN 61010-1:2010
- EN 61326-1:2013 / IEC 61326-1:2012, Class A. Intended for professional measurement and control purposes in industrial process and industrial manufacturing environments or is a component of such equipment. It is not intended for use in domestic applications, the MonoExact DF310E/DF150E does not meet CISPR 11 class B emission limits for residential locations, which are directly connected to low voltage power supply networks.
- Certified to MCERTS (EN15627-3) and (EN14181) QAL 1
- EN15267-3:2007 & QAL 1 as defined in EN 14181: 2014 for O2, SO2, CO and NO
- Certification Number: SIRA MC030013/11
- CLASS – C225206 PROCESS CONTROL EQUIPMENT
- CLASS – C225286 PROCESS CONTROL EQUIPMENT Certified to US Standards

1.3 Product overview

The MonoExact DF150E and DF310E Gas Analyzers are 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 analyzer can support a gas measurement, using coulometric or paramagnetic transducers while also allowing a moisture measurement to be brought in from a custom external probe.

Gas sample measurements are shown on the analyzer display,and can also be output to a serial device connected to the analyzer, or as milliamp (mA) / voltage outputs, or over a selection of digital communications protocols.

Note: The MonoExact DF310E can have RS232 or RS485 communications, but only one can be active at a time.

The analyzer 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 analyzer is simple to operate, with an intuitive user interface. The analyzer is 193 mm (7.6”) high and is suitable for 19 inch rack, panel or bench mounting.

The analyzer requires little routine maintenance, other than calibration which is essential for the accuracy of sample gas measurements (section 7) and replacement of filter elements (if fitted external to the analyzer).

The maximum dry off power storage time shouldn’t exceed 6 months from date of shipment or the sensor warrantee will be voided.

1.4 General description

The MonoExact DF310E/DF150E analyzer is simple to operate, with an intuitive user interface that will display data from external sources. The chassis accepts up to four gas modules. It provides power, gas connections and other support functions to the gas sensor modules and processes their outputs to provide the sample gas concentrations. Gas measurements are shown on the analyzer display and at the same time are sent out of the analyzer to other devices using serial, milliamp (mA), voltage or digital communications protocols.

Note: 0-25% O_2 gas sensor offered is paramagnetic.

The analyzer supports up to four external analog input signals that can then be displayed on the screen as measurement signals, and output through the analog and/or the serial outputs or accessed using Modbus or PROFIBUS protocols. These external input signals can be recorded, used to activate relays, or trigger auto-calibration / validation routines or low / high alarms.

Included with each analyzer ordered:

- 4 Relays contacts provided as standard (up to 8 relays per option board, 32 relays max with 4 option boards)

Included with each transducer ordered:

- Each transducer is configured with one option board
- Two alarms are activated (up to 8 alarms per option board, 32 max with 4 option boards)
- OUTPUT: 1 Isolated 4-20mA (1 per option board, 4 max with 4 option boards)

If Auto-Cal is purchased, then the following is included:

- 8 Relays per transducer
- 6^{th}, 7^{th}, 8^{th} relays pre-assigned as Zero, Span, Sample gas per transducer
- Software to allow auto-calibration / validation based upon a timer (gas switching is via user installed externally located valves).

Options available per transducer:

- Additional option boards can be ordered to increase the number of each option
- A further 2 or 6 alarms (making a total of 4 or 8 alarms) per transducer
- OUTPUT: 0 – 10 VDC per transducer (1 per option board, 4 max with 4 option boards)
- INPUT: 2 Digital per transducer (2 per option board, 8 max with 4 option boards)
- INPUT: 1 Isolated 4-20mA per transducer (1 per option board, 4 max with 4 option boards)

Other optional features are available:

- Serial Communications using RS232, RS485, RS232 & RS 485 Combo, Modbus RDU, Profibus.
- Flow meters (floating element rotameter) to monitor and needle valves to control sample gas flow through the instrument – a maximum of two if the dual sample inlet / outlet option is used.
- A sample flow switch to monitor sample flow and alarm when the flow is too low – only one allowed per analyzer.
- Second inlet and outlet gas sample stream if a user provided external NO_2 converter is added.

Note: If a flow switch is ordered and an external NO_2 converter is added (this requires the dual sample inlet / outlet option), then the flow switch is installed on the main Stream #1 as Stream #2 will be isolated for use with the NO transducer after the NO_2 converter.

Note: It is recommended to fit an external 0.01 microns sample filter to protect the gas transducer modules from particulate contamination

Use this manual for:

Installation:	To take commissioning to the point where the analyzer is powered and operational. The installer is advised to read this manual completely before commencing installation.
Configuration:	How to set up the clock, passwords, alarm levels, analogue outputs, relays and other parameters.

Calibration:	How to use the manual and automatic calibration/checking facilities.
Review:	How to display analogue output / input settings, relay allocation, alarms, faults and analyzer identity without changing the analyzer settings.

1.5 Recommended calibration intervals

For optimum performance, it is necessary to routinely check the calibration of all the internal gas transducers within the analyzer. The recommended periods for each transducer type are shown in Section 12.4.

This manual provides details of the following:

- the requirements for and configuration of calibration ancillaries (e.g. gases)
- the setup of the auto-calibration / validation routines
- the connection of external solenoid valves (when auto-calibration is used)
- the use of the RS232 output and remote initiation of calibration
- the use of Modbus or PROFIBUS to initiate calibration

If the intended use of this equipment is to monitor process systems critical for Health and Safety purposes, it is the sole responsibility of the installer and operator to see that this instrument is commissioned, maintained and calibrated in a manner consistent with the customer's specific application. Continued safe and reliable operation of this equipment is conditional on all installation, operation and maintenance procedures being carried out in accordance with the appropriate manuals, by personnel having appropriate qualifications, experience and training. Failure to observe the requirements of the manual may result in the user being held responsible for the consequences. In no event shall Servomex be liable for any incidental, consequential or special damages of any kind or nature whatsoever, including but not limited to lost profits arising from or in any way connected with this instruments use.

1.6 Automatic calibration options

Two functions are provided when the optional Auto-Cal feature is ordered: Auto-calibration and auto-validation. These functions are performed on the transducer. Auto-calibration will change the actual calibration curve while auto-validation will only read the value to determine if it is within the specified tolerance. Each transducer can have up to three sequences of auto-calibration or auto-validation attached to it.

Customer supplied solenoid valves for sample, zero and span gases will be controlled by discrete wiring to the relays for each of the transducers (see Section 3.4.3).

The automatic calibration procedure may be started by any of the following:

- A trigger from the internal instrument clock
- An external contact closure
- A Modbus or PROFIBUS command

Note: When the Auto-Cal option has been purchased, the manual calibration process will use the Auto-Cal valves to select the required calibration gas.

1.7 Product identification

Figure 1-1: The MonoExact DF310E Gas Analyzer

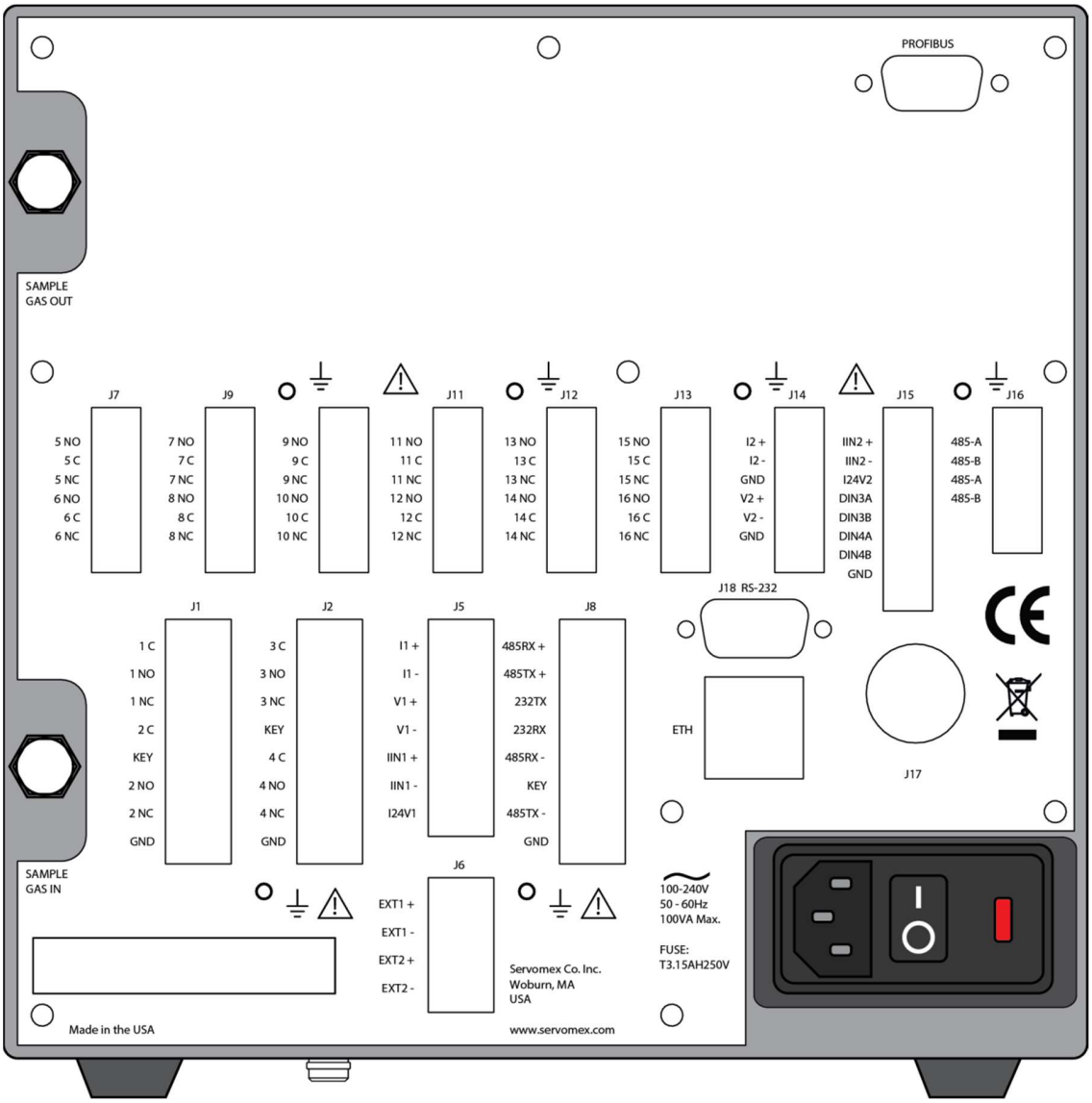


Figure 1-2: Rear of the MonoExact DF310E Gas Analyzer

ID	Description
J1 – J2	Relay I/O connections
J5	4 – 20 mA output / analog inputs *Note: A legacy 4-lead cable can be connected to the top 4 connections labeled I1+, I1-, V1+ and V1-.*
J6	General purpose digital inputs that can be used in future software releases for functions such as closing a relay for pump control or turning a coulometric sensor on or off.
J7	Relay I/O
J8	RS485 / RS232 comms port *(optional)*
J9 – J13	Relay I/O connections
J14	Analog output

ID	Description
J15	Analog and digital inputs
J16	RS485 (Modbus) *(optional)*
J17	Moisture probe input
J18	RS232 *(optional)*
ETH	Ethernet
	Earth (ground) connection

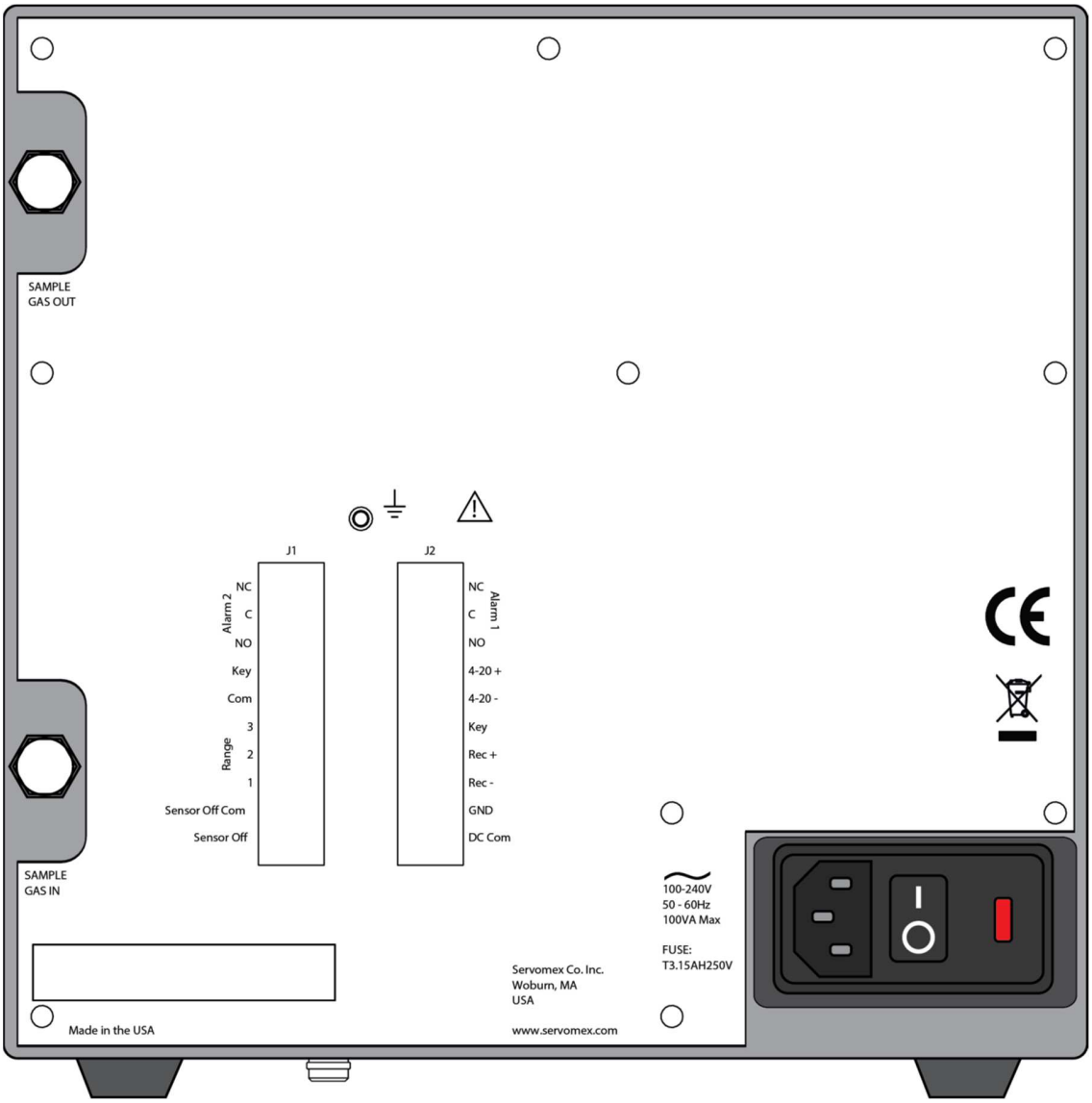


Figure 1-3: Rear of the MonoExact DF150E Gas Analyzer

ID	Description
J1 – J2	Relay I/O connections
⏚	Earth (ground) connection

1.8 Unpacking

Read the full manual carefully BEFORE you remove the MonoExact Gas Analyzer from its shipping container, or you attempt to install, commission or use the equipment.

The analyzer is heavy (section 13.1). Take care when handling the instrument. Lift it with hands positioned on either side on the base of the chassis.

1. Remove the analyzer and any other equipment from its packaging.
2. Remove the protective plastic covers from the sample gas inlets and outlets on the rear of the analyzer (**Figure 3-1**).

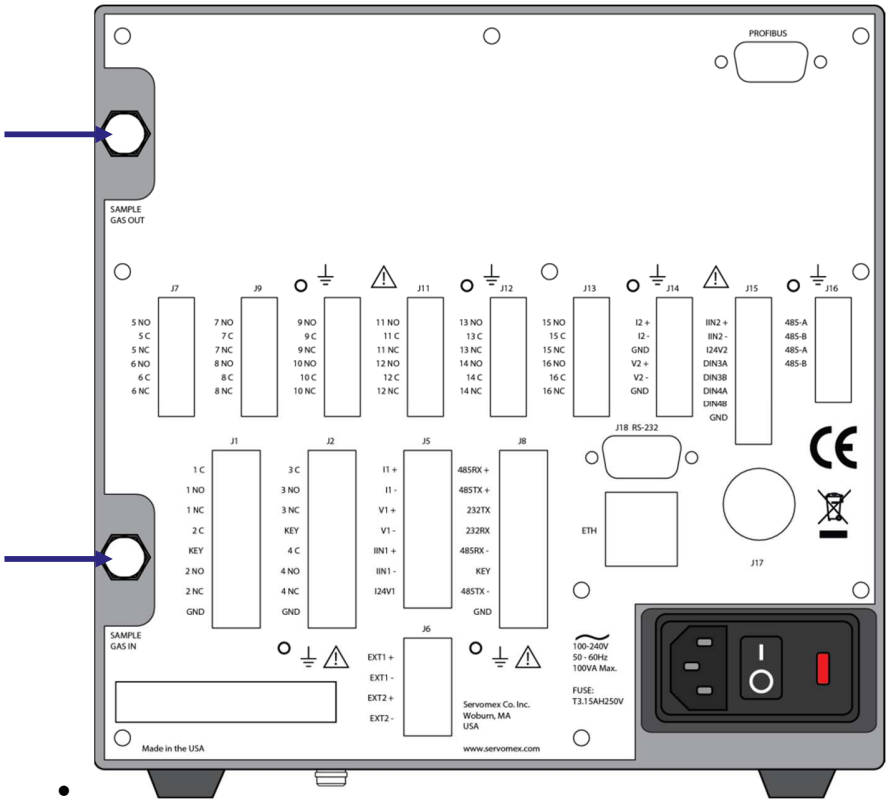


Figure 1-4: Gas inlets and outlets on rear of the analyzer

Hint: *If you do not intend to use the analyzer immediately, replace the protective plastic covers and remove them just before connecting into the process sample pipework fitting.*

3. Inspect the analyzer and the other items supplied, and check that they are not damaged. If any item is damaged, contact Servomex or your local Servomex agent immediately.

4. Check that you have received all of the items that you ordered. If any item is missing, contact Servomex or your local Servomex agent immediately.
5. If you do not intend to use the analyzer immediately:

Refit any protective plastic covers.

Place the analyzer and any other equipment supplied back in its protective packaging.

Store the analyzer as described in section 16.1.

6. If you are using the analyzer straight away, read section 2 – Safety before proceeding.

Hint: *Keep the shipping documentation and packaging for future use, for example when moving equipment, or returning it for service or repair.*

1.9 Sample requirements

For best performance the flow supplied to the analyzer should be kept at a constant value and the analyzer must be freely vented to atmosphere, for both process sampling and for calibration gas input.

Flow Rate:	Nominal 500 mL/min (Min 250 mL/min, Max 1000 mL/min)
Pressure:	Pressure driven: 172.36-310.26 kPa; 1.72-3.10 bar; 25-45 psig
	Flow driven: 1.4-6.9 kPa; 0.34-1.72 bar; 0.2-1 psig
Temperature:	5 to 45°C / 41 to 113°F
Dew point:	5°C / 9°F below minimum ambient
Condition:	Oil free, non - condensing, filtered to 1µm
Vent:	Connect the outlet of the analyzer to a separate atmospheric vent, free from any back-pressure

Pay particular consideration to the toxicity and asphyxiant nature of the sample gas when selecting a vent location.

Corrosive gases are not intended to be used in these analyzers.

Make sure that if pressurized gases are used to keep the pressure below 310.26 KPa; 3.10 bar or 45 psig on pressure driven models and 6.9 kPa; 0,07 bar or 1 psig on flow driven models.

Do not exceed the rated flow or pressure as transducer damage may result. Best practice is to place a pressure relief valve on the inlet line, venting any gas to a safe exhaust area.

2 Safety

2.1 General warnings

Before you attempt to install, commission or use the MonoExact DF310E/DF150E analyzer, read this manual carefully.

Do not attempt to install, commission, maintain or use the MonoExact DF310E/DF150E analyzer unless you are trained and know what you are doing. The analyzer must be maintained by a suitably skilled and competent person.

Do not connect the MonoExact DF310E/DF150E analyzer to a power source until all relays, input/ output signals and plumbing connections are made.

This analyzer must be operated in a manner consistent with its intended use and as specified in this manual.

The MonoExact DF310E/DF150E analyzer is only suitable for installation in safe areas.

Do not modify the unit, either mechanically or electrically, or the certification and warranty of the instrument will be invalidated, and it may not operate safely.

The MonoExact DF310E/DF150E analyzer includes few user-serviceable parts which, are called out in the spare list in the appendix.

Do not use the MonoExact DF310E/DF150E analyzer as Personal Protective Equipment (PPE).

Make sure that all floors or platforms where you install the MonoExact DF310E/DF150E analyzer are large enough for you to move freely and to change position.

The MonoExact DF310E/DF150E analyzer may be attached to equipment that is hot. Always wear the appropriate PPE to minimize the risk of burns.

If the process gas is shut off, make sure the sensor is turned off using the software option. The sensor can be damaged if power to it is on with no gas flowing for several hours.

2.2 Chemical warnings

Sample and calibration gases may be toxic or asphyxiant:

- **Make sure that the external connections are leak free at full operating pressure before you use sample or calibration gases.**
- **Make sure that the sample/bypass outlet pipes are vented to an area where the gases will not be a hazard to people.**
- **Make sure that the analyzer is used in a sufficiently well-ventilated environment, to prevent the build-up of toxic gases.**
- **Make sure that the pipes that you connect to the analyzer are routed so that they do not present a hazard to people.**
- **Never inspect the inlet filter(s), or service or repair the analyzer while such gases are still connected to it.**
- **If the analyzer is to be serviced or repaired, it is important that all pipework is flushed with an inert gas and the analyzer is allowed to freely vent to local atmosphere.**

Where there is a risk of release of potentially harmful gases into the operating environment, always use suitable monitoring equipment.

The electrolyte is a caustic solution. Review the Material Safety Data Sheet (MSDS) before handling the electrolyte solution.

The sensor is shipped dry and must be charged with electrolyte before it is operated. Do not ship the analyzer with electrolyte – thoroughly drain and rinse sensor before shipping.

2.3 Electrical warnings

Always observe the appropriate electrical safety codes and regulations.

Make sure that the electrical installation of the analyzer conforms with all applicable local and national electrical safety requirements.

Potentially hazardous AC voltages are present within this instrument. Leave all internal servicing to qualified personnel. Disconnect the AC power source before installing or removing any external connections.

Make sure the analyzer is provided with a sound earth connection via the electrical supply plug.

Make sure the electrical supply coupler or plug is easily accessible for disconnection from the electrical supply.

All signal and electrical supply cables must be rated for temperatures of 70°C or higher.

The I/O terminals and connections are separated from the analyzer 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.

Make sure that the cables that you connect to the analyzer are routed so they do not present a trip hazard.

2.4 Electromagnetic Compatibility (EMC) considerations

The MonoExact DF310E/DF150E analyzer meets the essential requirements of the European EMC Directive (2014/30/EU). The transducer and the 4-20 mA loop are electrically connected but are isolated from the analyzer housing and sample cell fitting threads.

The analyzer generates and uses small amounts of radio frequency energy. There is no guarantee that interference from radio or television signals will not occur in a particular installation. If interference is experienced, switch off the analyzer to see if the interference disappears. If it does, try one or more of the following methods to correct the problem:

- Re-orient the receiving antenna.
- Move the instrument with respect to the receiver.
- Place the analyzer and receiver on different AC circuits.

Always consider the following electromagnetic interference issues when installing the MonoExact DF310E/DF150E analyzer:

To provide an acceptable noise environment for the MonoExact DF310E/DF150E analyzer or other digital equipment in the proximity of switching inductive loads, Servomex recommends that you place varistors across the inductors to lessen high voltage spikes that occur during transitions.

Circuitry activated by relay contacts should allow for the contact bounce. One simple method is to place a capacitor across the relay contacts.

Route AC power wiring as far from the analyzer and its wiring as possible.

2.5 Markings

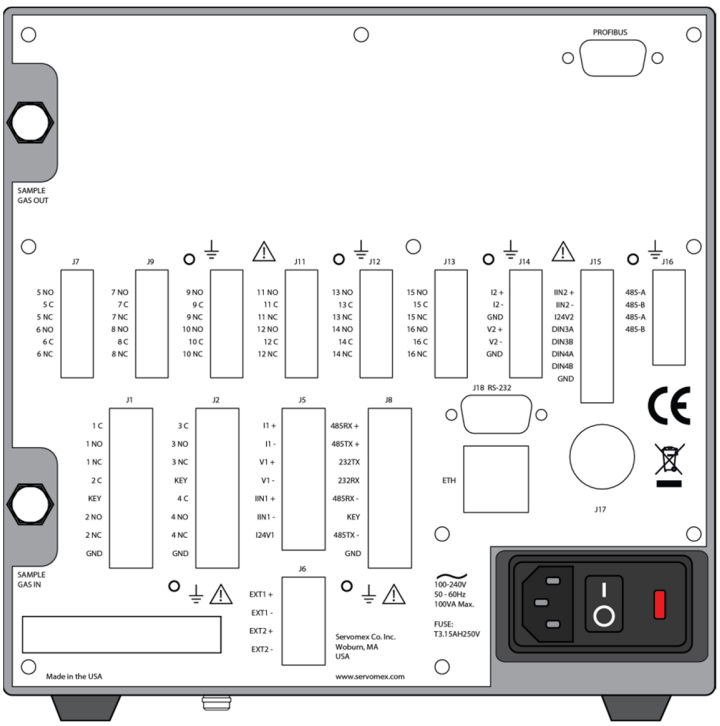


Figure 2-1: Rear of the MonoExact DF310E Gas Analyzer

The MonoExact DF310E/DF150E analyzer include the following external markings on the rear panel.

- 

  Do not connect any cables carrying mains voltage or cables that have inadequate insulation between line and mains to any of the I/O connectors.

- 

  Earth / ground connections. These are screw terminals used to connect the ground shields of cables plugged into the nearby connectors. Do not connect any voltages to these connections.

- 

  This label identifies that:

  The analyzer is considered to be within the scope of the Waste Electrical and Electronic Equipment (WEEE).

  The analyzer is not intended for disposal in a municipal waste stream (such as landfill sites, domestic recycling centers and so on), but must be submitted for material recovery and recycling in accordance with the local regulations which implement the WEEE Directive.

Follow the appropriate safety instructions and be aware of any warnings about potential hazards.

3 Installation and set-up

Do not attempt to install, commission, maintain or use the MonoExact DF310E/DF150E analyzer unless you have been trained or are an experienced instrument technician.

The MonoExact DF310E/DF150E analyzer is only suitable for installation in safe areas.

Follow the instructions in this section to safely install the MonoExact DF310E/DF150E analyzer.

Make sure that all floors or platforms where you install the MonoExact DF310E/DF150E analyzer are large enough for you to move freely and to change position.

Do not install the unit in places subject to extreme mechanical vibration, temperature changes or shock. If you do, measurements may not be accurate, or the analyzer may be damaged.

3.1 Unpacking

Read this manual carefully BEFORE you remove the MonoExact Gas Analyzer from its shipping container, or you attempt to install, commission or use the equipment.

The analyzer is heavy (section 13.1). Take care when handling the instrument. Lift it with hands positioned on either side on the base of the chassis.

7. Remove the analyzer and any other equipment from its packaging.
8. Remove the protective plastic covers from the sample gas inlets and outlets on the rear of the analyzer (**Figure 3-1**).

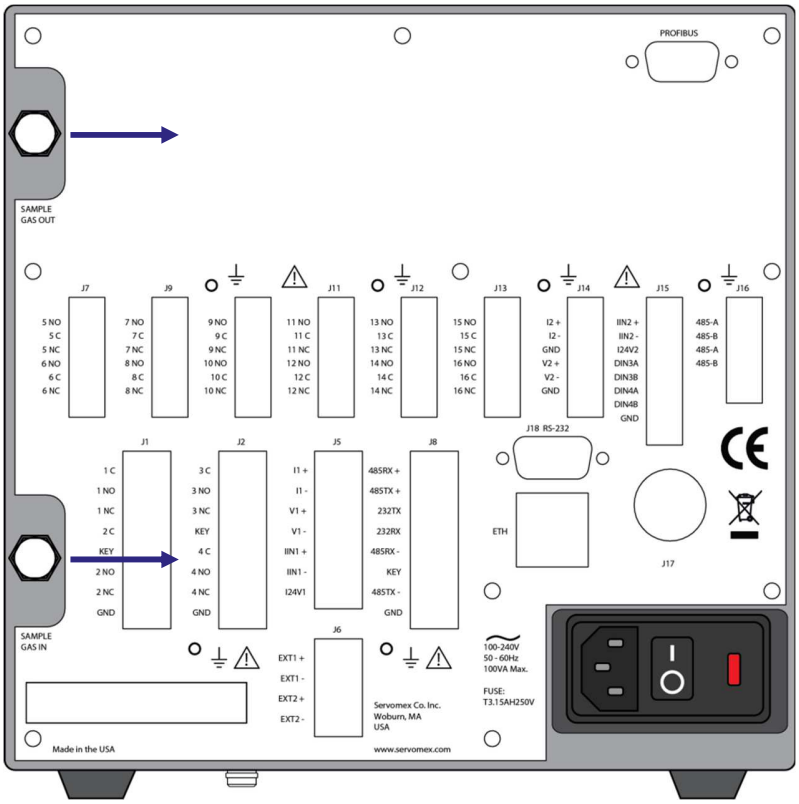


Figure 3-1: Gas inlets and outlets on rear of the analyzer

Hint:	• *If you do not intend to use the analyzer immediately, replace the protective plastic covers and remove them just before connecting into the process sample pipework fitting.*

9. Inspect the analyzer and the other items supplied, and check that they are not damaged. If any item is damaged, contact Servomex or your local Servomex agent immediately.
10. Check that you have received all of the items that you ordered. If any item is missing, contact Servomex or your local Servomex agent immediately.
11. If you do not intend to use the analyzer immediately:

Refit any protective plastic covers.

Place the analyzer and any other equipment supplied back in its protective packaging.

Store the analyzer as described in section 16.1.

12. If you are using the analyzer straight away, read section 2 – Safety before proceeding.

Hint:	*Keep the shipping documentation and packaging for future use, for example when moving the equipment, or returning it for service or repair.*

3.2 Transducer specific installation

3.2.1 Coulometric transducer

Adding electrolyte

The electrolyte is a caustic solution. Review the Material Safety Data Sheet (MSDS) before handling the electrolyte solution.

The sensor is shipped dry and must be charged with electrolyte before it is operated. Do not ship the analyzer with electrolyte – thoroughly drain and rinse sensor with replenishing solution or distilled water before shipping.

- 

Use only Hummingbird Ɛ-lectrolyte Blue. Failure to do so will void warranty. Install one bottle.

- 

Do not apply power before adding electrolyte and thoroughly purging the sample line.

Remove the sensor as follows:

1. Remove four screws and the cover, then open the front door of the analyzer (turn rotary knob to right of the touchscreen display, or turn the key lock latch).
2. Use a ½ inch open-end wrench to disconnect the gas fittings on the left side of the sensor (F1 and F2 in **Figure 3-2**).

Figure 3-2: Disconnect the gas fittings

3. Completely loosen the bracket retaining thumbscrew immediately in front of the sensor (**Figure 3-2**).
4. Slide the sensor assembly back slightly, then upwards to move the sensor to a position just in front of the analyzer.
5. Unscrew the blue sensor cap from the electrolyte reservoir and add the entire contents of one bottle (125 ml) of Ɛ-lectrolyte Blue to the sensor.
6. Replace the cap and hand-tighten securely.
7. Reinstall the sensor by repeating steps 1 through 4 in reverse order.
8. Allow the sensor to sit with electrolyte in it for approximately 60 minutes before flowing gas through the analyzer.

- **For best performance at initial start or anytime the electrolyte is changed, it is important to allow**

the sensor to sit with electrolyte in it for 60 minutes before the gas is allowed to flow through the sensor.

3.3 Mechanical Installation

3.3.1 Bench mounting

4 rubber feet beneath the analyzer allow use on a firm level bench or other suitable solid work surface.

3.3.2 Panel mounting

Make sure that an addition support is provided under the base of the analyzer towards the rear of the enclosure (Figure 3-3). Do not support the analyzer by the side mounting brackets alone.

If you do not, the analyzer may be damaged or may fall and damage other equipment.

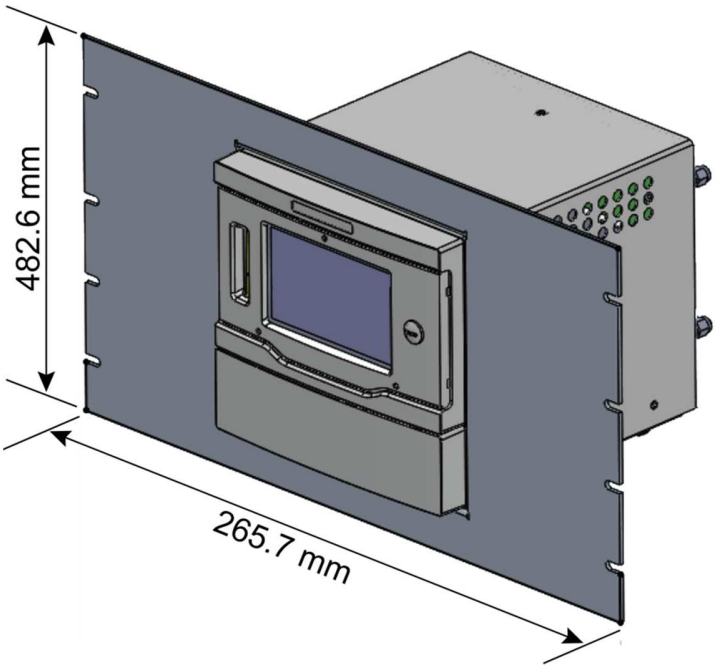


Figure 3-3: Panel installation

1. Refer to **Figure 3-3**. Prepare a cut-out in a suitable panel.
2. Prepare a suitable base support and secure it in your frame or cabinet.

3. If the bolts and washers are supplied separately, use them to fit the left- and right-hand mounting brackets to the analyzer.
4. Fit the analyzer in the panel and secure it in place with nuts and bolts fitted through the holes in the panel and mounting bracket.

3.3.3 Rack mounting

Before installing the analyzer, determine where you will install it in the rack enclosure. The analyzer 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: You do not need to punch out any of the other cage nut positions.

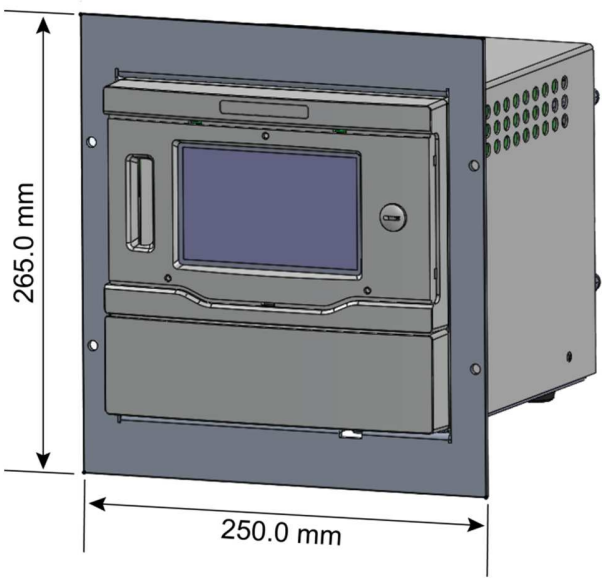


Figure 3-4: Rack installation

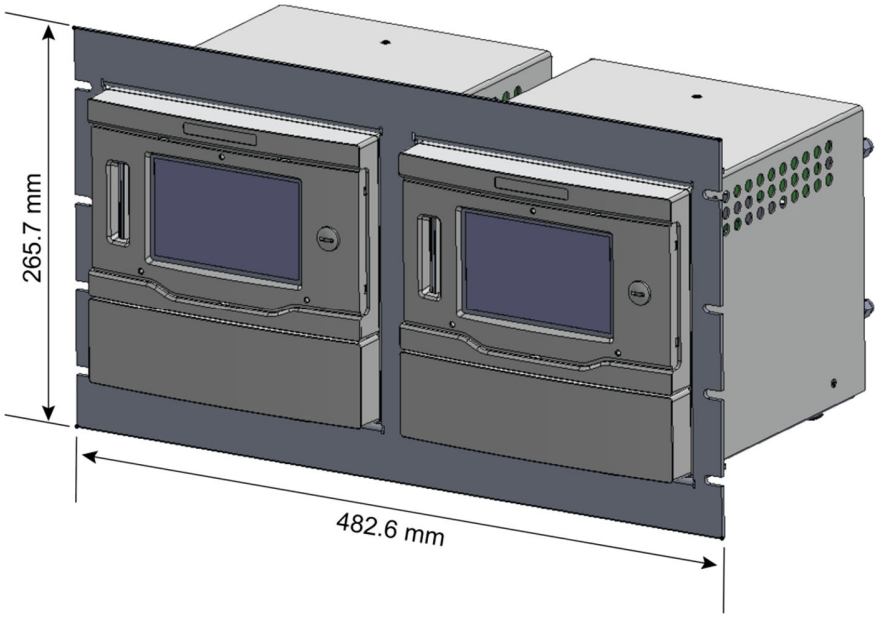


Figure 3-5: Dual rack installation

Refer to **Figure 3-4** or **Figure 3-5** and install the analyzer as follows:

If the rack mounting kit has been supplied as a spare:

1. Remove the two slide inner sections from the two slide outer sections.
2. Use the supplied M5 screws to fit the two slide inner sections to the sides of the analyzer.
3. Determine where the analyzer will be fitted in the rack, then, counting from the bottom cage nut position (position 1):

   Install cage nuts in positions 1, 3, 4, and 7 on the left-hand and right-hand front rack enclosure flanges.

   Install cage nuts in positions 1 and 4 on the left-hand and right-hand rear rack enclosure flanges.
4. Engage the two M6 waisted screws into the cage nuts in positions 1 and 4 on the left-hand and right-hand front and rear rack enclosure flanges.
5. Fit the right-hand slide support clamps:

   Hold the front slide support clamp in position behind the rack enclosure front flange, and align the fixing holes in the clamp with the cage nuts in positions 1 and 4.

   Engage the two M6 waisted screws in the fixing holes in the clamp. Do not fully tighten the waisted screws.

   Hold the rear slide support clamp in position behind the rack enclosure rear flange, and align the fixing holes in the clamp with the cage nuts in positions 1 and 4.

   Engage the two M5 waisted screws in the fixing holes in the clamp. Do not fully tighten the waisted nuts.
6. Fit the right-hand slide support brackets:

Fit the front slide support bracket between the cage nuts and the front side support clamp, then fully tighten the two M6 waisted screws to secure the support bracket in position.

Fit the rear slide support bracket (10) between the cage nuts and the rear slide support clamp then fully tighten the two M6 waisted screws to secure the support in position.

7. Make sure that the slide opening is at the front, then loosely fit the right-hand outer slide section to the front and rear slide support brackets and secure with the four M4 screws, and the nuts and washers.
8. Ensure that the front of the right-hand outer slide section is 35 mm behind the rack enclosure front flange, then fully tighten the nuts to secure the slide section in position.
9. Use the procedure in Steps 4 to 8 to fit the left-hand support clamps, slide support brackets and outer slide section.
10. Align the ends of the left-hand and right-hand slide inner sections in the openings in the front of the left-hand and right-hand slide outer sections and slide the analyzer into the rack enclosure.
11. Use the four M6 pan head screws and plastic cup washers to secure the analyzer in place.

3.4 Electrical installation

3.4.1 Electrical safety

Make sure that the electrical installation of the analyzer conforms with all applicable local and national electrical safety requirements.

Make sure the electrical supply plug is easily accessible for disconnection from the electrical supply.

Make sure the analyzer is provided with a sound earth connection via the electrical supply plug.

All signal and electrical supply cables must be rated for temperatures of 70°C or higher.

Make sure that the cables that you connect to the analyzer are routed so they do not present a trip hazard.

Follow the instructions given below when you install the analyzer. If you do not, the analyzer warranty may be invalidated, the analyzer may not operate correctly, or it may be damaged.

Make sure your electrical supply can provide the necessary maximum power consumption.

Disconnect all cables from the analyzer when you carry out insulation testing.

3.4.2 Analog output signal connections

The analog output terminals are separated from the analyzer 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.

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

DF310E

1. Connect the wires in the cable to the screw terminals on J14 or J5 on the rear panel of the analyzer.

   Note: J5 provides a parallel connection for analog outputs for legacy cables.

   Note: Section 13.2 for information on the rating and size of cable.

2. Connect the cable screen to the ground point on the rear of the analyzer.
3. Connect the wires as shown in **Table 3-1**:

J14 Pin	J5 Pin (O2 sensor #1)	Use
1	1	I +
2	2	I -
3	-	GND
4	3	V +
5	4	V -
6	-	GND

Table 3-1: Analog output interface connector (J14 and J5)

Note: Unless specified differently, an analog Vdc output is provided as standard across pins 1 and 2. (A mA analog output is optional).

Note: If your analyzer is configured to provide voltage outputs, connect the wires to pins 4 – 5 on the terminal strip

DF150E

The analog output is proportional to the oxygen reading of the analyzer and on a three range analyzer will be scaled to the 'selected' range. The analog output is 0 to 10 Vdc.

The minimum load impedance is 10 kΩ. Connections to the analog output should be made through a shielded, twisted pair with the shield tied to the nearest ground stud to the terminals labelled Rec + and Rec -.

1. Connect the wires in the shielded, twisted pair cable to the screw terminals labeled Rec+ and Rec- on J2 on the rear panel of the analyzer.

   Note: Section 13.2 for information on the rating and size of cable.

2. Connect the cable screen to the ground point on the rear of the analyzer nearest to the connectors labeled Rec+ and Rec-.

3.4.3 Relay connections

The relay connections are separated from the analyzer 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.

Note: The relays do not have default assignments unless Auto-Cal is selected. Users can create alarms and assign them to any relay (Section 11.2).

Note: When Auto-Cal is purchased, the coulometric transducer has 8 relays available with 3 relays preassigned - the 6th assigned to Zero, the 7th to Span and the 8th to the Sample gas. The 1st to the 5th relays can be assigned to any alarm or function even if it is not related to the coulometric measurement..

DF310E

The DF310E analyzer has a number of relays available via the connectors J1, J2, J7, J9, J10, J11, J12 and J13 as shown in **Table 3-3** (J1), **Table 3-4** (J2) and **Table 3-5** (J7, J9, J10 – J13).

The relays correspond to the following connectors:

Relay	Connector	Relay	Connector
1	J1	9	J10

Relay	Connector	Relay	Connector
2	J1	10	J10
3	J2	11	J11
4	J2	12	J11
5	J7	13	J12
6	J7	14	J12
7	J9	15	J13
8	J9	16	J13

Table 3-2: MonoExact DF310E relay connections

Note: Relays 9 – 16 are not supported in this release of the product.

Connect the wires in your cable to the screw terminals on the relevant connectors as shown in the following tables:

Note: Section 13.2 for information on the rating and size of cable.

J1 Pin	Use	Relay	J1 Pin	Use	Relay
1	COM	1	5	KEY	-
2	N/O	1	6	N/O	2
3	N/C	1	7	N/C	2
4	COM	2	8	GND	-

Table 3-3: Relay interface connector J1 (DF310E)

J2 Pin	Use	Relay	J2 Pin	Use	Relay
1	COM	3	5	COM	4
2	N/O	3	6	N/O	4
3	N/C	3	7	N/C	4
4	KEY	-	8	GND	-

Table 3-4: Relay interface connector J2 (DF310E)

		Connector					
		J7	J9	J10	J11	J12	J13
Pin	Use	Relay	Relay	Relay	Relay	Relay	Relay
1	N/O	5	7	9	11	13	15
2	COM	5	7	9	11	13	15
3	N/C	5	7	9	11	13	15
4	N/O	6	8	10	12	14	16
5	COM	6	8	10	12	14	16
6	N/C	6	8	10	12	14	16

Table 3-5: Relay interface connector J7, J9, J10 – J13 (DF310E)

DF150E

The DF150E analyzer has a number of relays available via the connectors J1 and J2 as shown in **Table 3-7** (J1) and **Table 3-8** (J2).

The relays correspond to the following connectors:

Relay	Connector
1	J2
2	J1

Table 3-6: MonoExact DF150E relay connections

Alarms 1 and 2 are optional on the DF150E. Typically, the alarms are configured for high and low oxygen set points but they can also be assigned to a low flow condition if the flow switch option has been purchased.

In the ‘No Alarm’ condition the NC contact is connected to the C contact.

In the ‘Alarm’ condition the NO contact is connected to the C contact.

Connect the wires in your cable to the screw terminals on the relevant connectors as shown in the following tables:

Note: Section 13.2 for information on the rating and size of cable.

J1 Pin	Relay	J1 Pin	Relay
N/C	2	RANGE 3	-
COM	2	RANGE 2	-
N/O	2	RANGE 1	-
KEY	-	SENSOR OFF COM	-
COM	-	SENSOR OFF	-

Table 3-7: Relay interface connector J1 (DF150E)

J2 Pin	Relay	J2 Pin	Relay
N/C	1	KEY	-
COM	1	REC +	-
N/O	1	REC -	-
4-20 +	-	GND	-
4-20 -	-	DC COM	-

Table 3-8: Relay interface connector J2 (DF150E)

Remote Range Indicator (Range 1, 2, 3)

The analog output is proportional to the oxygen reading of the analyzer. On three range analyzers the output will be scaled to the currently selected range. If the analyzer has three ranges and the analog output is being sent to a recorder or other remote device, it will be necessary to also send a Range Indicator so the remote reading can be properly scaled.

The Remote Range Indication is a contact closure between a J1 COM connection and the selected range with the lowest range being contact #1 and the highest range being contact #3. The contacts are rated at 24 Vdc, 0.5 Amps.

4 to 20 mA isolated output (4-20+, 4-20-)

The optional 4 to 20 mA output is proportional to the oxygen reading of the analyzer. The output on a three range analyzer will be scaled to the currently selected range.

An output of 4 mA represents an operating analyzer with zero detected oxygen. Outputs ranging from 4 to 20 mA represent oxygen concentrations from zero to the top of the currently selected range.

The 4 to 20 mA output is electrically isolated from all other analyzer outputs and from the chassis (earth) ground. The maximum load resistance is 1 kΩ. The analyzer provides a loop supply of approximately 28 Vdc.

Connections to the 4-20 mA output should be through a shielded, twisted pair with the shield tied to the nearest ground stud.

Note: DF310E: If the concentration exceeds the set range, the analyzer auto ranges to the maximum range. For example if a 0-100ppm analyzer is set to a range 0-10 and the measured value exceeds 10 then the range will automatically be sent to 0-100.

*Note: If a relay is to be to be thrown when a custom range is exceeded and the analyzer goes to full sensor range, you must set the range in the relay assignment menu (section **Error! Reference source not found.**).*

3.4.4 Connect the electrical supply

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

Only use the power supply cord provided with the unit.

Make sure the analyzer is suitable for use with your electrical supply voltage and frequency (Section 13). If the analyzer is not suitable, it may not operate correctly, or it may be damaged if you operate it.

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

1. Turn the Power Switch on the back of the unit to OFF: press the "**O**" on the On/Off switch shown in Figure 3-6 A.
2. Fit the IEC plug on the end of the electrical supply cable provided to the electrical supply socket on the rear of the analyzer (Figure 3-6 B).

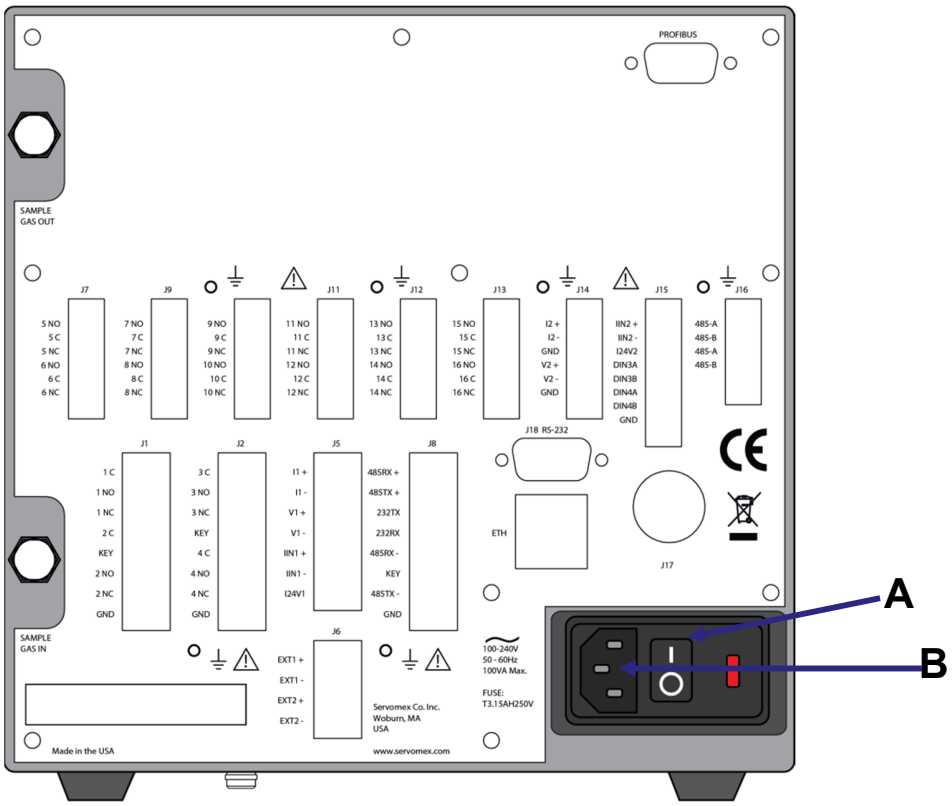


Figure 3-6: Power switch (A) and electrical supply socket (B) on rear of analyzer

3. Plug the other end of the electrical supply cable into 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 analyzer.
5. If a local earth bonding is required, the functional earth stud can be used. The earth ground cable must be kept to less than 3 meters to comply with EMC standards.

This does not replace the earth conductor on the electrical supply socket which must always be connected. Therefore never cut or remove any of the metal pieces from the supplied plug.

3.5 Sample / calibration gas connections

The MonoExact DF310E/DF150E may be used with flammable gases with the coulometric sensor only.

Sample and calibration gases may be toxic or asphyxiant:

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

It is essential that the analyzer 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 transducer, which will be observed as an offset and drift in output.

Over-pressurizing the sensor can result in permanent damage to the sensor. Limit the backpressure to the analyzer to ±1 psig. Be sure the downstream isolation valve (if so equipped) is toggled open before gas flow is started.

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 analyzer. If you do, the analyzer could be damaged.

If the process gas is shut off, make sure the sensor is turned off using the software option. The sensor can be damaged if power to it is on with no gas flowing for several hours.

3.5.1 Sample and Calibration Gas Inlets and Outlets

Hint:	**This section gives simple instructions about connecting the sample and calibration gas pipelines to the analyzer.**

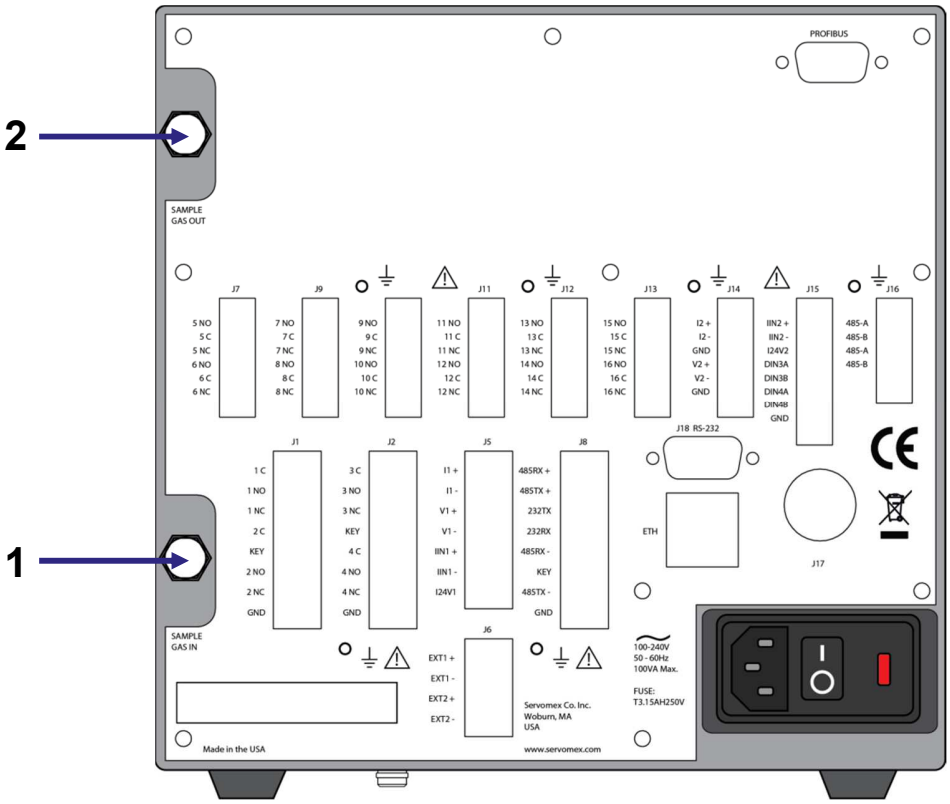


Figure 3-7: Gas inlets and outlets on rear of analyzer

The sample gas inlet and outlet lines at the back of the instrument have stainless steel ⅛ inch compression bulkhead fittings (unless equipped with the optional ¼ inch VCR inlet).

Before connecting any gas line to the analyzer, fully install the supplied gas nut and compression ferrule on your tubing.

Connect your sample/calibration gas inlet and outlet pipelines to the inlet (1 in **Figure 3-7**) and outlet (2 in **Figure 3-7**) on the rear of the analyzer. Do not over-tighten the fittings.

Note: A backup wrench is not needed since anti-torque plates inside the cabinet secure the bulkhead fittings.

Note: The optional external filter should be fitted to the inlet pipe with the compression fittings provided.

Note: Section 0 lists the sample gas requirements.

4 Section 13.6 lists the calibration gas requirements.

Locate the gas selection valves as close as possible to the analyzer.

> ***Hint:*** *You must connect process gas, switch on the electrical supply and leave the analyzer for at least 4 hours before the results will stabilize. Pay particular attention to the warnings at the start of section 2.*

5 Operation

See Section Error! Reference source not found.**9 for flow/pressure requirements for the sample, zero and calibration gases. If the flow/pressure are outside the ranges specified in Section 1.9, you must regulate the gases externally, before they enter the analyzer.**

5.1 View flow levels

The optional flow meters are visible on the front panel and are calibrated for use with air / N_2. The flowmeter should be read at the top of the flow bead. Most other gases have molecular weights within ± 25 percent of air and will produce valid readings. If the molecular weight of the background gas is much different from air / N_2 the flowmeter reading will be less accurate. For example, Helium is a light gas therefore the flow rate should be set to approximately one-third that of air / N_2.

5.2 Switch off the analyser

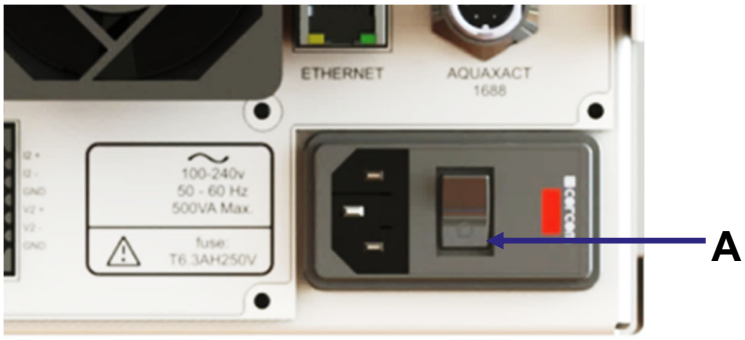


Figure 5-1: On/off switch on the rear of the analyzer

To switch off the analyser, press the "**O**" on the On/Off switch on the rear of the analyser (Figure 5-1 A).

If you intend to leave the analyzer off for an extended period of time, for example, when carrying out plant maintenance and will not use the analyzer for several days:

- Turn off the analyzer and disconnect the electrical supply cable from the analyzer.
- Purge the transducers with Zero Air or Nitrogen gas to remove any sample gas.
- Close off the sample gas inlet and outlets using a shut off valve or the protective caps supplied with the analyzer.

5.3 Power up

Sample and calibration gases may be toxic or asphyxiant:

- **Make sure that the external connections are leak free at full operating pressure using N_2 or Zero Air before you use sample or calibration gases.**
- **Make sure that the sample/bypass outlet pipes are vented to an area where the gases will not be a hazard to people.**
- **Make sure that the analyzer is used in a sufficiently well-ventilated environment, to prevent the build-up of toxic gases.**
- **Make sure that the pipes that you connect to the analyzer are routed so that they do not present a hazard to people.**

It is essential that the analyzer 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 transducer, which will be observed as an offset and drift in output.

The analyzer can now be powered up.

Hint:	*When the electrical supply to the analyzer is switched on, a series of beeps will be heard, the readings are displayed on screen and the clock in the upper right hand corner of the screen starts running.*

To power up the analyser:

1. Make sure that the analyser power cord is connected to the back of the unit.
2. Press the "**I**" on the On/Off switch on the rear of the analyser (Figure 5-2 A) to power on the analyser.

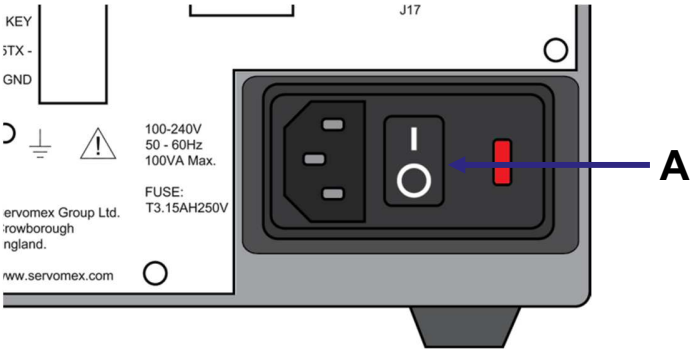


Figure 5-2: On/Off switch on the rear of the analyzer, (A) points to the Power Switch "I" for ON position.

When the analyzer is first switched on, the screen displays a progress bar, followed by the Home screen (**Figure 5-3**).

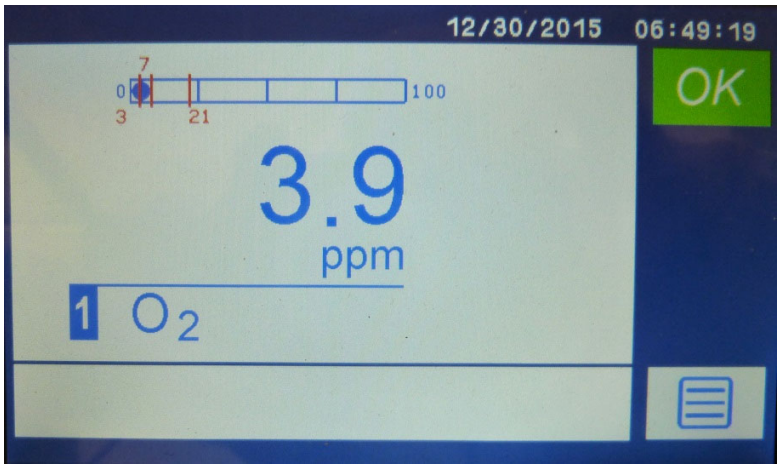


Figure 5-3: Home screen

6 User interface

6.1 User interface overview

Configuration options referred to in this manual (for example, auto-calibrate / validate) must be specified at the time of purchase. The menus and menu options associated with the options not purchased will appear as grey colored icon buttons (as seen in the red box of **Error! Reference source not found.**) and will be unavailable for use.

In The user interface is a touchscreen that displays screens to allow you to operate the MonoExact DF310E/DF150E analyzer.

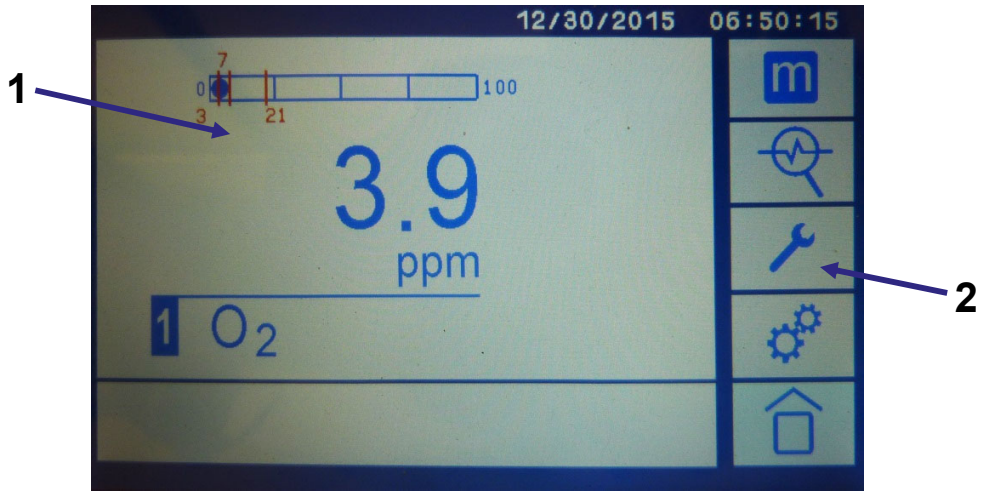


Figure 6-1: The user interface menu screen

The user interface comprises the following:

1	Touchscreen display	Screens are displayed on the touchscreen (section 0 onwards). The function of the active icons depends on the screen currently displayed.
2	Touchscreen icons	The icons displayed depend on the current screen.

Note: If there are no menu interactions for 60 seconds, the display reverts back to this Home screen. This timer can be adjusted in the Settings section.

6.2 General techniques

The general navigation route through the user interface screens is described by a sequence of icons that you must touch to get to the desired screen. A shortened visual description of the sequence of icons to be touched is used in this manual to help you

navigate easily to the various screens. The full list of icons, there location and function can be viewed in the firmware version Icon Map and Glossary on the USB provided.

For example, to reach the Alarms screen (a sub-screen of the Measurement branch) you must press the following sequence of icons:

1. Touch the icon to display the Main Menu screen.
2. Next, touch the icon to display the Measurement screen.
3. Finally, touch the icon to display the Alarms screen.

This sequence is shortened in the manual and will appear above the screen page as:

> >

Familiarity of the icons below will allow easier navigation of the menus.

Icon	Meaning	Function
	Home	Returns to the Home screen.
	Main Menu	Displays the Main Menu screen that contains the four main branch icons: Measurement, Diagnostics, Maintenance, and Settings.
	Next	Displays the next set of functions onto the screen. The new list will always appear in a new column to the right of the arrow.
	Return	Returns to the prior screen.
	Accept	Touch this icon to accept any changes made.
	Cancel or Exit	Touch this icon to cancel or reject any changes made or exit a screen.
	Not Active	In several menus this icon is used to deactivate the selection.
	Active	In several menus this icon is used to activate the selection.

6.3 Touchscreen and Navigation overview

Each screen displays active icons that are relevant to that screen's operation. To select an icon, it is best to use the eraser end of a pencil or a stylus to touch the icon on the screen graphic.

Note: Be sure not to press too hard or you will damage the screen; do not use the point of a pen or pencil to touch the screen.

For example, the sequence used to arrive at the screen shown in Figure 6-2 is accessed by touching the Main Menu icon on the Home page then touching the Measurement icon to activate the first set of the Measurement choices.

> m

The Measurement choices available are shown in Figure 6-2 and show up as icons in the column to the right of the Main Menu list. The m icon background now turns blue m indicating it is the active Main Menu choice as you navigate forward through the various choices.

Note: The Main Menu branch stays visible all the time unless you are in a special screen or the Home page. This allows you to access the other Main Menu choices easily.

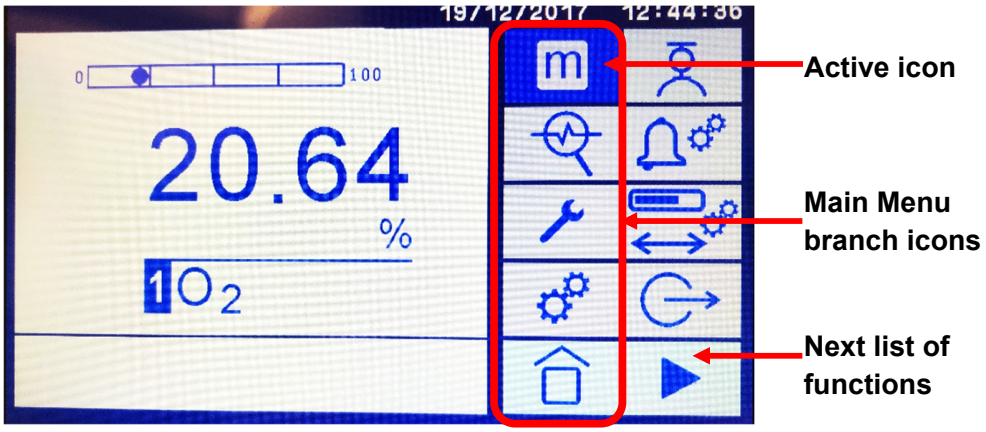


Figure 6-2: The user interface of the Main Menu screen with the Measurement branch active.

When a Main Menu icon is selected further icons associated with that function are displayed as seen in Figure 6-2. New icons associated with that function will appear to the right of the icon just touched or it may transfer you to a new screen.

In the case of the Main Menu Branch icons, if there are more functions associated with the main function activated and they do not all fit onto one screen then the Next List key will be present in the lower right corner or on the bottom of the list. When touched, more functions will appear in a new list to the right of the old list for selection.

The Main Menu Branch will remain visible as the farthest column on the left. Details are shown later in this section.

Figure 6-3 shows a Step Series of Screens that are launched when the Settings Main Menu icon is touched:

- The first series of functional icons that belong to the Settings section are displayed in the column of icons to the right of the Main Menu icons (Figure 6-3 A).

- To display the next set of functions touch which brings up the second set of Setting functions (Figure 6-3 C) to the right of the first set (Figure 6-3 A). Note that is activated as the background color is now blue (Figure 6-3 B).

- To get the third and final set of functions touch at the bottom of the list of the last column (Figure 6-3 C) and the third set of icons will replace the second set in the final column position (Figure 6-3 D).

- To return the second set of features touch the Return icon at the top of the last column and the middle screen in Figure 6-3 will be returned.

Note: When the Return icon is touched the Main Menu icon no longer has a blue "activated" background. The icons displayed are still associated with the original main menu icon selected, but the Return button removes the Main Menu background on some of the icons.

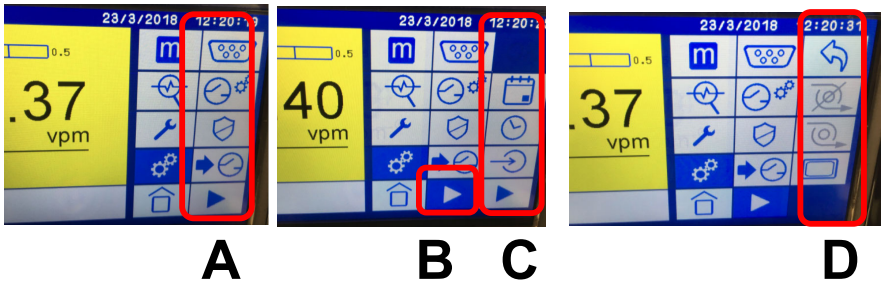


Figure 6-3: The User Interface Menu screen with the Settings branch activated

Note: The Main Menu branch stays visible all the time even while navigating through the three sets of functional icons of the Settings branch. In this case, the first set of icons also remain visible and only the third colum of icons is replaced when the Next List icon is touched.

6.4 Home screen

The Home screen (Figure 6-4) displays the current measurement and system status.

Figure 6-4: Single Gas Home screen components

A	Bar graph showing the operable measurement range boundaries, current measurement and relative to alarm set points	E	Information area where messages such as error codes, IP address, and diagnostic information are displayed.
B	Current measurement	F	System status
C	Transducer number *Note: 1 is always shown.*	G	Measurement units
D	Analyte being measured	H	Menu icon

> ***Hint:*** *If no icon is pressed for 1 minute in any other menu branch, Home screen is automatically displayed. You will also then have to re-enter your password to access any password-protected screens. The "Home screen return" value can be increased in the Settings Menu from 1 to 3 or 5 minutes.*

6.5 Main Menu screen icons

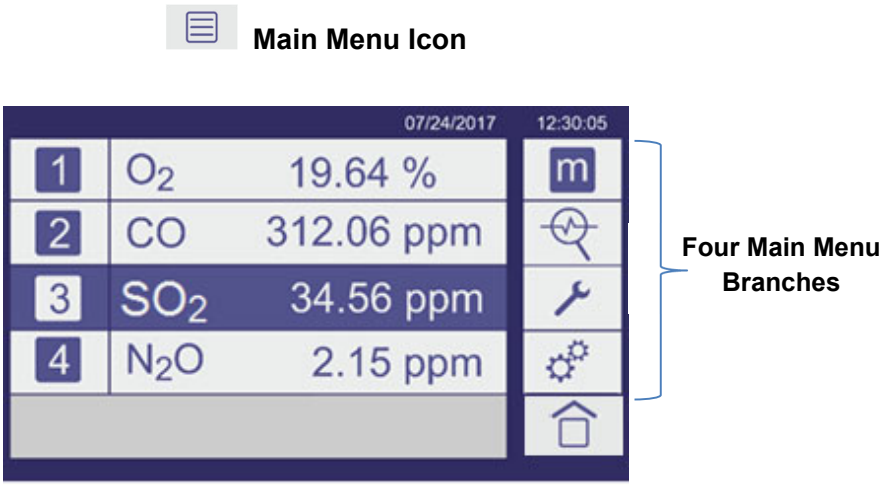


Figure 5-11: Menu screen

The Main Menu icons are listed below:

Icon	Meaning	Function
m	Measurement	Displays the Measurement screen where measurement, calibration / validation and alarm settings can be adjusted for each transducer installed (Section 6).
	Diagnostics	Displays the Diagnostics screen where system-wide diagnostic tools can be found (Section 7).
	Maintenance	Displays the Maintenance screen where system-wide maintenance actions can be initiated (Section 8).
	Settings	Displays the Settings screen where system-wide parameters can be defined (Section 9).
	Home	Touch this icon to return to the Home screen (Section 5).

Note: The first column of icons on each menu screen is the same for all analyzers. Once one of the four menu branches are selected that relevant icon background changes blue to show which menu screen is active (see Figure 6-1 below).

6.5.1 Frequently Used Touchscreen icons

The following table shows touchscreen icons that frequently appear on different screens. The Main Menu Icons are highlighted as bold text under the “Meaning” column below.

Table 6-1: Frequently Used Touchscreen icons:

Icon	Meaning	Function
	Menu	Located on the Home screen (**Error! Reference source not found.**) displays the Menu screen of the four branches when touched.
	**Measurement**	Displays the first set of functional icons associated with the Measurement activities (Figure 6-2).
	**Diagnostics**	Displays the first set of functional icons associated with the system-wide Diagnostics tools that can be activated.
	**Maintenance**	Displays the first set of functional icons associated with the system-wide Maintenance operations that can be activated.
	**Settings**	Displays the first set of functional icons associated with configuring the system-wide parameters Settings including the Relays.
	Calibrate	Displays the first set of functional icons associated with configuring the various Calibrate functions and activities.
	Alarm settings	Displays the first set of functional icons associated with configuring the system-wide Alarm parameters and actions.
	Home	This icon is used to return back to the Home screen showing the gas transducer concentration values.
	Accept	Touch this icon to accept any changes made.
	Cancel or Exit	Touch this icon to cancel or reject any changes made or exit a screen.
	Next List	Touch this icon to display the next set of functional icons onto the screen.
	Return	Touch this icon to return to the prior screen.

*Note: The four main menu branches are shown in **bold** in Table 6-1.*

6.6 System and measurement status icons and notices

The Status icon is located at the top right corner of the Home screen. If the system is operating correctly the green OK icon is displayed (Figure 6-5).

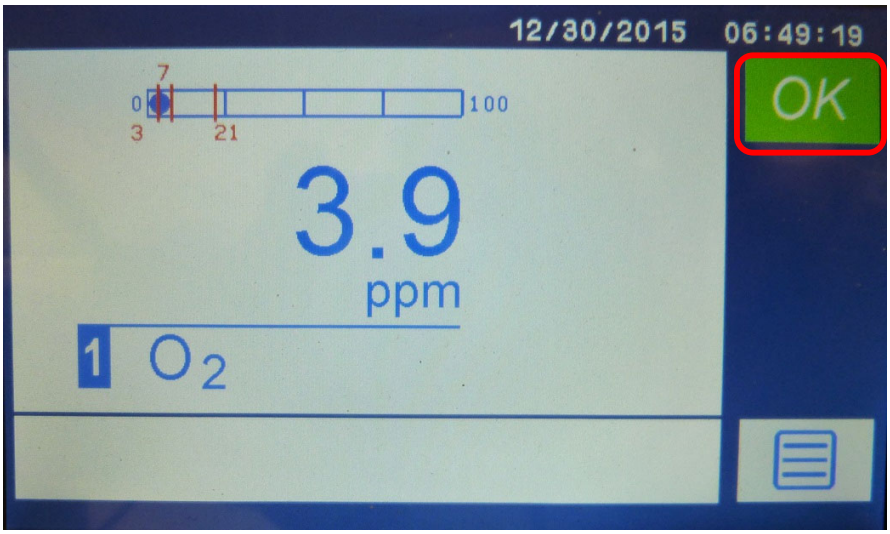


Figure 6-5: Home screen (three gas transducers)

Note: If you touch the green OK icon it will display the date and time when the analyzer was last started.

If a problem occurs with the system, the Status icon changes to one of the symbols shown in the table below.

Icon	Meaning	Meaning
	Alarm	Indicates that there is an alarm on the system. Touch the icon to display the Alarm Selection screen. An example is shown in Figure 6-6.
	Faults	Indicates a fault with the transducer or analyzer: a communication failure with the transducer, an over-temperature condition, or out of specification where the measured value is out of the maximum range for the transducer (see Figure 6-7). Touch the icon to display a message in the text bar describing the fault.

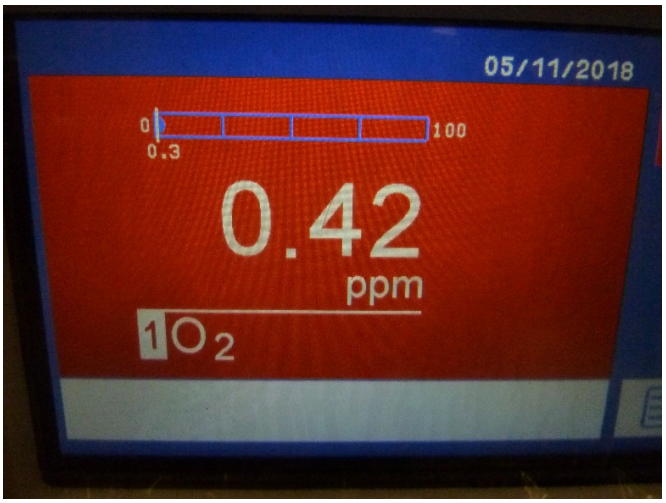


Figure 6-6: Home screen showing O_2 alarm

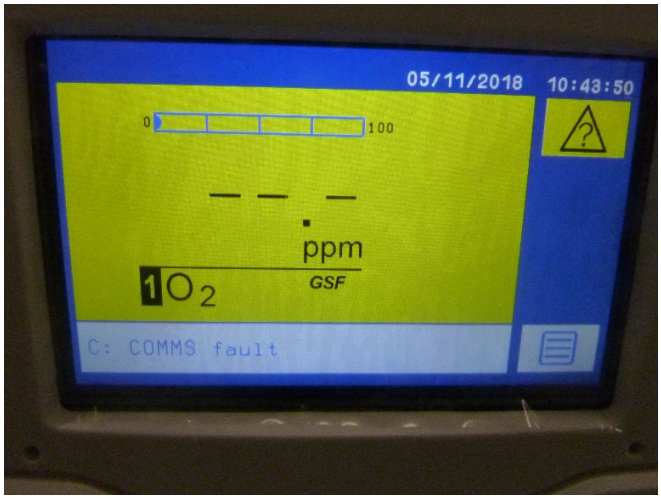


Figure 6-7: Home screen, showing warning screen with fault description

Note: In Figure 6-7 the fault icon  *was touched and "C: COMMS fault" was displayed in the message area bottom of screen*

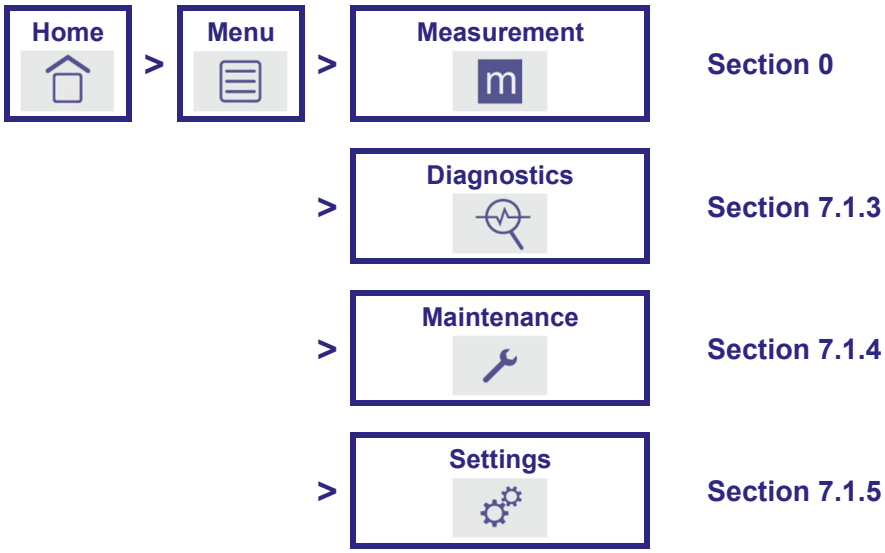
7 Analyzer Menu Branch Structure

7.1 Menu branch structure

Section 7.1.1 describes the top-level Main Menu structure and directs you to the subsections that show the buttons available under each of the main menu branches.

The tables in Sections 0 to 7.1.5 show the substructure buttons available for each of the Main Branches. For example, once you navigate to one of the Main Branches (Measurement, Diagnostics, Maintenance, or Settings) press the Level 1 button to display the associated Level 2 buttons; press a Level 2 button to display the associated Level 3 buttons, etc. Levels beyond 4 are provided in the detailed sections of the manual only. Shaded areas show that there are no available buttons at that level.

7.1.1 Top level structure



7.1.2 Measurement

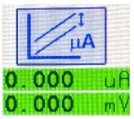
Note: Each Alarm and Relay have their own settings. Only one set is shown as example.

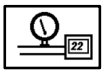
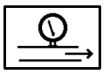
Measurement Level 1 Button	Measurement Level 2 Button	Measurement Level 3 Button	Measurement Level 4 Button
Manual Calibration	Span Setup	Set & Run Span Calibration	

Measurement Level 1 Button	Measurement Level 2 Button	Measurement Level 3 Button	Measurement Level 4 Button
	Zero / Low Span Set-up 	Set & Run Zero / Low Calibration	
	Restore Factory Settings 	*Coulomentric sensor only*	
	Span Ref 	*Coulomentric sensor only*	
Alarms 	Meas. Value alarm 	Meas. Value High 	
		Meas. Value Low 	
		Meas. Alarm Value Threshold 	Numeric Key Pad
		Meas. Alarm Value Hysteresis 	Numeric Key Pad
		Audible Alarm On / Off 	
		Alarm Following On / Off 	
Alarms *(cont.)* 	Meas. Alarm *(cont.)* 	Alarm Latching On / Off 	
		Alarm Off 	

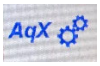
Measurement Level 1 Button	Measurement Level 2 Button	Measurement Level 3 Button	Measurement Level 4 Button
Alarms *(cont.)* 	Flow Alarm 	Audible Alarm On / Off 	
		Alarm Following On / Off 	
		Alarm Latching On / Off 	
		Alarm Off 	
	Transducer Temp Alarm 	Transducer Temp Value High 	
		Transducer Temp Value Low 	
		Transducer Temp Alarm Value Threshold 	Numeric Key Pad
		Transducer Temp Alarm Value Hysteresis 	Numeric Key Pad
	Transducer Temp Alarm *(cont.)* 	Audible Alarm On / Off 	
		Alarm Following On / Off 	
		Alarm Latching On / Off 	

Measurement Level 1 Button	Measurement Level 2 Button	Measurement Level 3 Button	Measurement Level 4 Button
		Alarm Off	
	Span Reference Alarm	Span Ref Value High	
		Span Ref Value Low	
		Span Ref Alarm Value Threshold	Numeric Key Pad
		Span Ref Alarm Value Hysteresis	Numeric Key Pad
		Audible Alarm On / Off	
		Alarm Following On / Off	
Alarms *(cont.)*	Span Reference Alarm *(cont.)*	Alarm Latching On / Off	
		Alarm Off	
Analog Output Range Setting	Expanded User Range	Numeric Key Pad	
	User High Range Value	Numeric Key Pad	

Measurement Level 1 Button	Measurement Level 2 Button	Measurement Level 3 Button	Measurement Level 4 Button
	User Low Range Value 	**Numeric Key Pad**	
	Auto Range On / Off 		
Analog Output Settings 	**Follow Meas. Value During Cal On / Off** 		
	Output Adjustment 	**Numeric Key Pad for mA and 0-10 VDC**	
	Jam Condition Zero 		
Analog Output Settings *(cont.)* 	**Jam Condition 2 mA** 		
	Jam Condition 21.5 mA 		
	Jam Condition None 		
Show Transducer Temp 	*Sensor temp reading bottom of measurement screen*		
Measurement Record 	**Choose Time interval** 	**Numeric Key Pad**	

Measurement Level 1 Button	Measurement Level 2 Button	Measurement Level 3 Button	Measurement Level 4 Button
	Trash Data 		
AquaXact Pressure Compensation 	AquaXact Sensor Pressure 	Numeric Key Pad	
	Process Stream Pressure 	Numeric Key Pad	
	Pressure Comp On 		
	Pressure Comp Off 		
GSF 	Select Gas Mix = 100%	*Coulomentric sensor option*	
GSF Advance 	Advanced Enter Offset Integer	*Coulomentric sensor option*	
Data Filtering 	Filter Type 1 	*Moving Average 8 samples*	
	Filter Type 2 	*Moving Average 16 samples*	
	Filter Type 3 	*Moving Average 32 samples*	
	Filter Type 4 	*Exponential 8 samples*	
	Filter Type 5 	*Exponential 16 samples*	
	Filter Type 6 	*Exponential 32 samples*	

Measurement Level 1 Button	Measurement Level 2 Button	Measurement Level 3 Button	Measurement Level 4 Button
	Filtering Off —		
Suppress Neg Readings	**Suppress Neg Readings On / Off**		
Coulometric On / Off	**Coulometric On / Off**		
	External Input 1 or 2 EXT1 EXT2		
Change AquaXact Units units	**Dew Point Celsius** Dp °C		
	Dew Point Fahrenheit Dp °F		
	Part Per Million ppm		
AquaXact Tip Change AqX	**Numeric Key Pad to enter tip serial number**		
Transducer Firmware Rev ID	*Information at bottom of measurement screen*		
Transducer Serial Number	*Information at bottom of measurement screen*		
Scheduled Event Settings	**Transducer Sequence Selection (#1, #2, #3)** Auto	**Auto-Validation Setup**	**Run Auto-Validation Now** Auto

Measurement Level 1 Button	Measurement Level 2 Button	Measurement Level 3 Button	Measurement Level 4 Button
Scheduled Event Settings *(cont.)* 			Abort Auto-Validation 
			Set Auto-Validation Date / Time / Repeats 
		Auto-Calibration Setup 	Run Auto-Calibration Now 
		Auto-Calibration Setup *(cont.)* 	Abort Auto-Calibration 
			Set Auto-Calibration Date / Time / Repeats 
	Electrolyte Replenishment 	Number of days	Numeric Key Pad
Flat Line Alarm On / Off 			
AquaXact Settings 	Analog Output Range Setting 		
	Analog Output Enabled / Disabled 		

Measurement Level 1 Button	Measurement Level 2 Button	Measurement Level 3 Button	Measurement Level 4 Button
Transducer Diagnostics 	*Screen displays a snapshot of diags more data in sys txt file*		

7.1.3 Diagnostics

Diagnostics Level 1 Button	Diagnostics Level 2 Button	Diagnostics Level 3 Button	Diagnostics Level 4 Button
Software revision 			
Analyzer Chassis Temp 			
Analyzer SN 			
System File Save 			
Relay Test 	Open / Close Relay  		
Display System Log *Sys Log*			
Display Calibration Log *Cal Log*			

7.1.4 Maintenance

Maintenance Level 1 Button	Maintenance Level 2 Button	Maintenance Level 3 Button	Maintenance Level 4 Button
Update Firmware 			
Upload System Settings Files 			
Clear Errors 			

7.1.5 Settings

Settings Level 1 Button	Settings Level 2 Button	Settings Level 3 Button	Settings Level 4 Button
Serial Port Setup 	RS232		
	RS485		
	Full Duplex 		
	Half Duplex 	*RS485 only*	
	1 Stop Bit 		
	2 Stop Bits 		
	Baud Rate Setting	1200, 1800, 2400, 4800, 9600, 19200, 38400, 76800, 115200	
	Parity 	None Even Odd	
	Serial ID		

Settings Level 1 Button	Settings Level 2 Button	Settings Level 3 Button	Settings Level 4 Button
	RS485 Only Functions	Delta F Legacy 485 *DF L-485*	
		Modbus *Modbus*	
		Off	
		Streaming	
	RS485 Only Functions *(cont.)*	Output Frequency	
		Modbus Word Swapping: On / OFF	
Relay Assignment	Alarm Assignment	Select Transducer Measurement #1, #2, etc.	
		Transducer Alarm	
		"Service in Progress"	
		Transducer Fault	
		Range Change	
		External Alarm	Internal Temp Fault

Settings Level 1 Button	Settings Level 2 Button	Settings Level 3 Button	Settings Level 4 Button
		Electrolyte Replenishment Reminder 	
Password Setup 	Master 		
	Operator 		
Password Setup *(cont.)* 	Keystroke Recording On / Off 		
Manual Relay Override 	Normal Operation – Relay ON 	*Icon background blue*	
	Normal Operation – Relay OFF 	*Icon background white*	
	Forced ON Operation – Relay ON 	*Icon background black*	
	Forced OFF Operation – Relay OFF 	*Icon greyed out*	
Analyzer Date 	DD, MM, YYYY		
Analyzer Time 	HH:MM:SS		
Input Setup 	Analog Inputs 	Specific Analog Input 	Low Value *Text input* High Value *Text input*

Settings Level 1 Button	Settings Level 2 Button	Settings Level 3 Button	Settings Level 4 Button
			Units *Text input*
			Display Text / Analyte / Device *Text input*
			Record Analog Input 
Input Setup *(cont.)* 	**Analog Inputs** *(cont.)* 	**Specific Analog Input** *(cont.)* 	**Set Alarm (High, Low, Threshold, Hysteresis)** 
			Analog Input On /Off 
	Digital Inputs 	**Specific Digital Input for assignment** 	**Choose Transducer 1,2,3,4** *(right side)*
			Choose mA Input Contact Closure *(left side)* 
			Start Auto-Cal 
			Stop Auto-Cal 
			Start Low / Zero Cal 
			Start Span Cal 
			Declare Analog Input is in Cal 

Settings Level 1 Button	Settings Level 2 Button	Settings Level 3 Button	Settings Level 4 Button
			Declare Analog Input is OK Ext OK
			Disable Digital Input
Pump On / Off	**Pump On / Off**	*DF310E/DF150E*	
Screen View	**Single / Split Screens**		
	Increase / Decrease Screen Brightness		
	Screen Dim Timer *1, 3, 5 min*		
Concentration Units units	**Ppm or mg/m^3**	*MultiGas 4900 only*	
Modbus TCP/IP units	**Off, IP Static, DHCP Active** Off IP static dhcp Active	**Off**	
		IP Static *Keypad in the IP address for unit*	
		DHCP Active *Allow unit to find IP address*	

8 Measurement branch screens

> m

The Measurement branch has four pages of icons (shown in Figure 8-1 to Figure 8-4). Touch the Measurement icon to see the first page of icons appear on the right of the Measurement icon (Figure 8-1). Touch the Next ▶ icon and a new column of active icons will appear over the last column on the right.

Note: Not all of the features are available to every transducer types, so some screens may look different depending upon the allowed features.

Note: Page 1 displays first.

To go to the subsequent pages, press the ▶ icon.

To go back to the previous page, press the ↩ icon.

> m

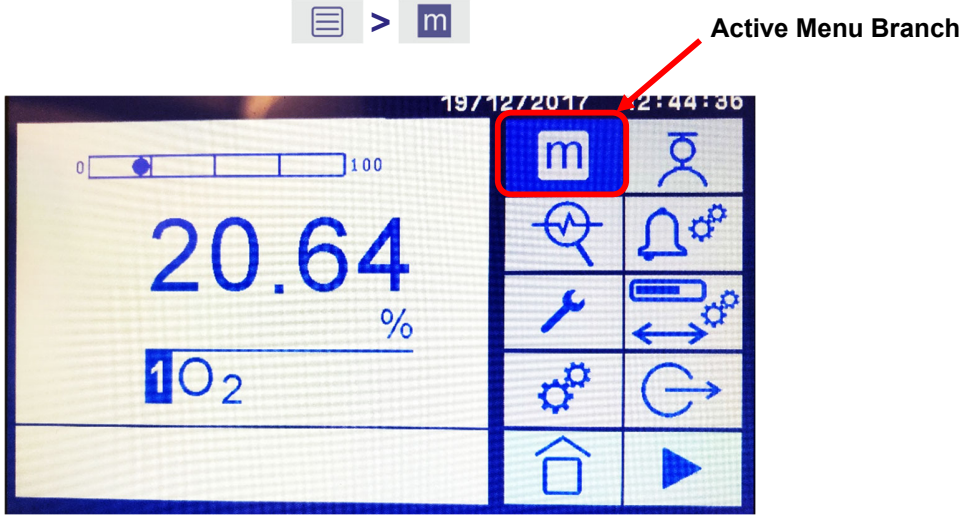


Figure 8-1: Measurement screen – page 1

> m >

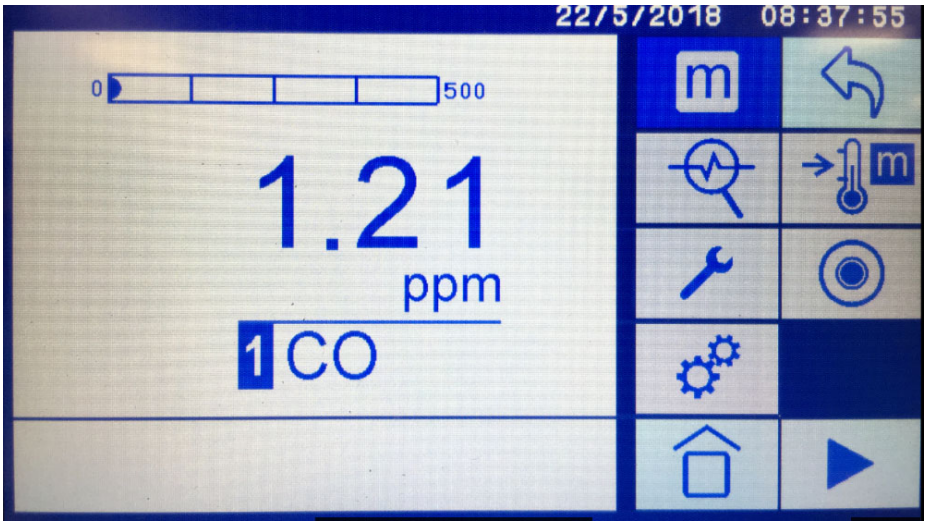


Figure 8-2: Measurement screen - page 2

> m > ▶ > ▶

Figure 8-3: Measurement screen – page 3

> m > ▶ > ▶ > ▶

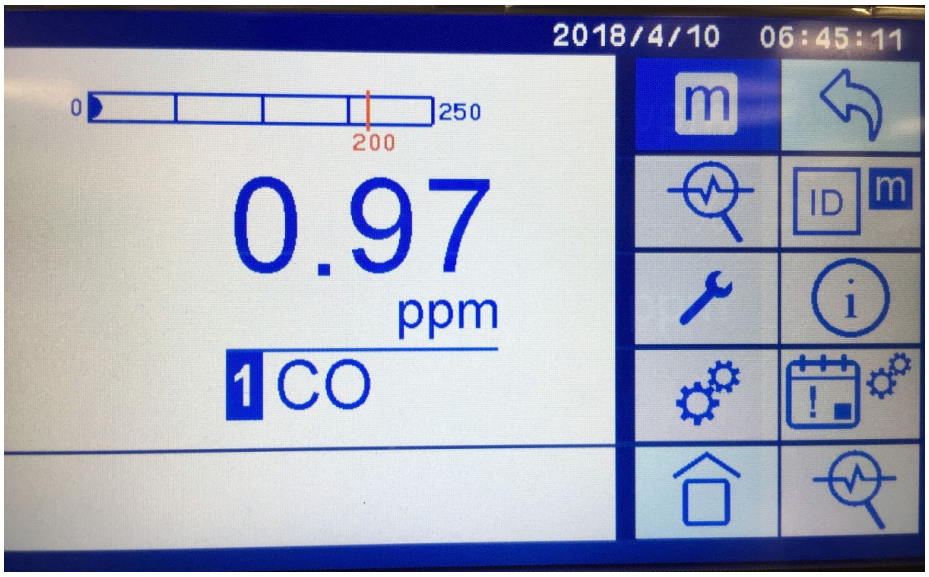


Figure 8-4: Measurement screen – page 4

Table 8-1: The Measurement branch icons and their actions

Icon	Meaning	Function
	Manual Calibration Settings	Used to define the manual calibration / validation limit settings for each of the transducers (see Section 12 for details).
	Transducer Diagnostics	Reads and then displays on screen the current transducer diagnostics.
	Alarm Settings	Used to configure and define the measurement alarm settings for each of the transducers. Two of the eight alarms are activated with each transducer ordered (see Section 8.2 for details).
	Range Settings	Used to reset the display range bar and the mA output to a user defined maximum limit (User Extended Range) and to define a lower measurement range (User High Range and User Low Range limits) on each of the transducers see Section 8.3.4 for details.
	Analog output Settings	Used to configure the 4-20mA or the 0 – 10V output (see Section 8.3.6 for details).
	Transducer Temperature	This feature measures and displays the transducer temperature in the text box at the bottom of the screen.

Icon	Meaning	Function
	Measurement record	Used to start recording measurement values to the analyzer. Data must be saved to a USB drive to view and must also be deleted from the analyzer by the user.
	Data Smoothing Filtering	Use this to filter noisy data by applying short, medium and long filters. Default is to apply no filter.
	Transducer firmware revision	Displays the currently selected gas transducer firmware revision in the text box at the bottom of the screen.
	Transducer serial number	Displays the currently selected gas transducer serial number in the text box at the bottom of the screen.
	Auto-Cal Sequence settings	Used to set up the auto-calibration / auto-validation parameters per selected transducer when this option is purchased (see Section 12 for details).
	Transducer Diagnostics	Reads and then displays on screen the current transducer diagnostics.

Note: The transducer firmware revision, temperature, and serial number display in a text box at the bottom of the screen when the relevant button is pressed. The information is valid for the specific gas transducer that was selected.

Note: The Manual calibration and validation descriptions and settings are described later in the manual in Section 12 along with the Auto-Cal optional features.

8.1 Configuring manual calibration and Auto-Cal sequences

The sequence of icons to touch to access the manual calibration and auto calibration configuration pages are shown above. See Section 12.5 and Section 12.6 for details on how to set up the Manual calibration and the Auto-Cal Sequences.

8.2 Configuring the measurement alarms

8.2.1 Display the Measurement Alarms Screen

> m >

The Alarms screen shows how each of the eight alarms is currently configured. The standard analyzer is supplied with 2 alarms for each transducer, and a further 2 or 6 alarms per transducer can be optionally purchased. Figure 8-5 shows a CO transducer where the option for 8 total alarms has been purchased. Note that none of the alarm bells are grayed out. Alarm #1 is set to High Alarm, Alarm #3 is set to Low Alarm, Alarm #2 is set to the Low Flow Alarm. Alarms 4, 5, 6, 7 and 8 are not yet configured.

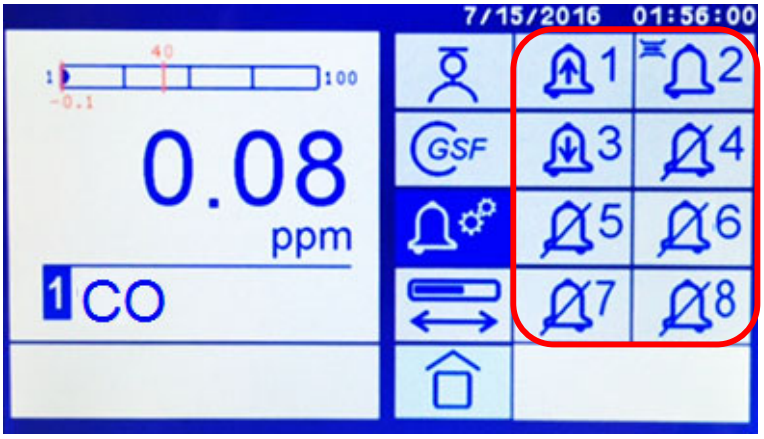


Figure 8-5: Alarms screen showing CO with 8 alarms available: #1, #2, #3 have already been configured.

Note: During a calibration, an alarm will only be activated if the alarm 'Follow' option is selected (see Section 8.4).

8.2.2 Configuring the Measurement Alarm settings

The Analyzer alarms can be configured to operate in one of four modes: Measurement alarm, Flow alarm, Span / Reference alarm, and Transducer Temperature alarm. Each transducer can be configured with multiple alarms.

To configure the alarm:

1. Touch the Alarm Setup icon to see the available alarms (See Figure 8-6). Touch the icon for the selected alarm.

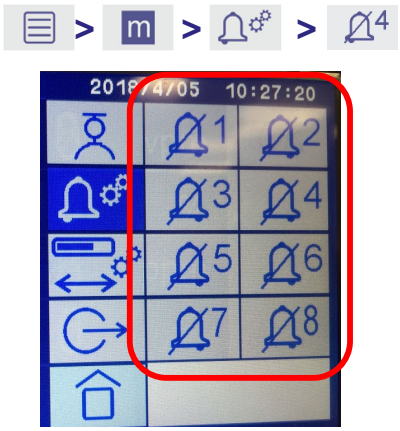


Figure 8-6: Alarm icons on alarm screen

2. The Alarm setup screen for the selected alarm is displayed. Figure 8-7 shows Alarm #4 configured for a Measurement Alarm on Transducer #1 .

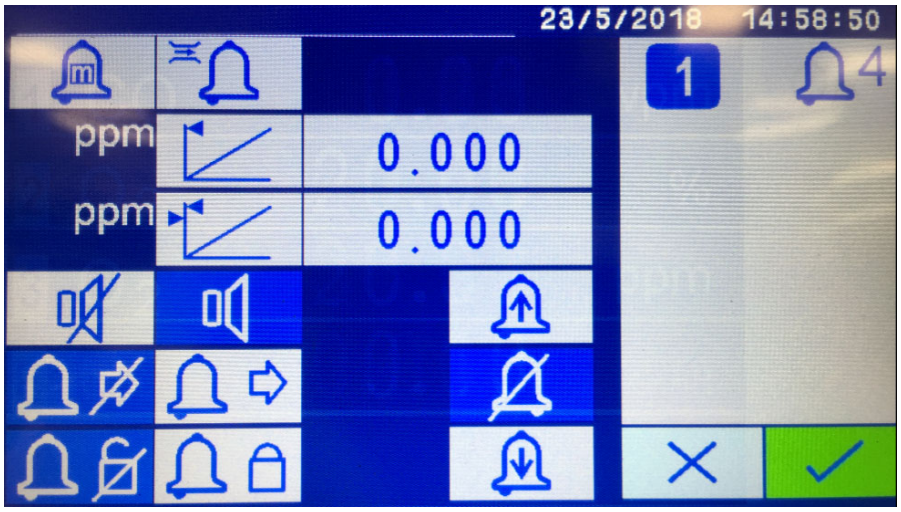


Figure 8-7: Measurement Alarm setup screen for Transducer #1 and Alarm #4

In Figure 8-7 the following alarms have been set or deactivated: Audible alarm is on , Do Not Follow is on, Do Not Latch is on and no Measurement value alarm (Hi or Lo) has been selected.

Note: Most of the icons are paired with the Deactivate and Activate icon next to the Alarm icon on the same row. The exceptions are the High and Low Measurement Alarm icons that are located at the bottom right side with the deactivate icon between them in a column.

Note: Touch the Accept icon to accept the new configuration, otherwise the configuration will revert back to the original settings.

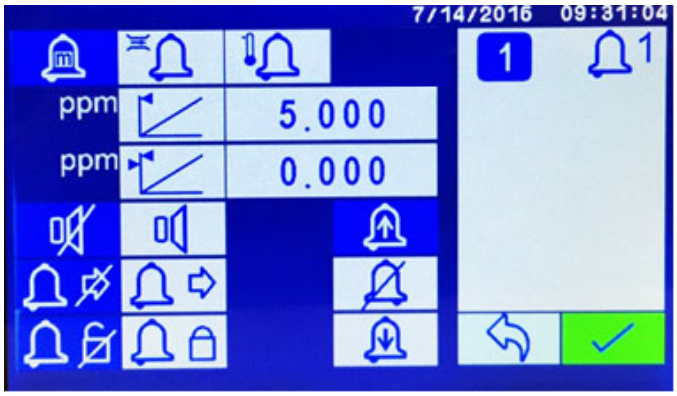


Figure 8-8: Measurement Alarm setup screen for Transducer #1 and Alarm #1

In Figure 8-8 the following alarms have been set or deactivated: Audible alarm is off , Do Not Follow is on, Do Not Latch is on and the Hi Measurement value alarm has been selected.

Note: Figure 8-7 and Figure 8-8 show examples of the different options available for specific transducers or system.

3. Press the required icon on the row horizontally across the top of the screen to either configure or activate the alarm as the main alarm function.

Table 8-2: Measurement Alarm Main icons

Icon	Meaning	Function
	Measurement Alarm	Alarm is activated when a measurement concentration or condition exceeds the limits set in the alarm mode screen.
	Flow Alarm	Activates the optional flow switch alarm when the flow drops below 0.1 L/min (the default location is on stream #1 for dual streams).
	Transducer temperature alarm (*IR1520 transducers only)*	Alarm condition is activated when the transducer temperature exceeds 45°C. If the transducer temperature exceeds 45°C for 30 minutes, the transducer automatically turns off.

4. Table 8-3 shows the available alarm functions and descriptions, some of which can be used together on the same alarm.

Table 8-3: Measurement Alarm Sub-Branch icons

Icon	Meaning	Function
	Alarm Mode available but deactivated	Alarm available but is not configured to activate under any condition. Can use this to quickly remove an alarm configuration that had been previously assigned.
	Alarm Mode Low	Alarm will be activated when a sample measurement is lower than the pre-set alarm level.
	Alarm Mode High	Alarm will be activated when a sample measurement is higher than the pre-set alarm level.
	Alarm Value Threshold	Set the value at which the High or Low alarm will be activated.
	Alarm Value Hysteresis	These values determine when an activated measurement alarm condition will be deactivated.
	Audible Alarm Mode is On	Activates the audible alarm so the alarm sounds when the alarm limit is triggered.
	Audible Alarm is deactivated	Deactivates the audible alarm. Also used to silence the alarm when the Audible Alarm Mode is On and has been triggered.
	Alarm Following	Activates the alarm during a calibration. If the alarm threshold is reached the alarm will sound.
	Alarm Following deactivated	Deactivates the alarms during a calibration. This is the default mode.
	Alarm Latching	The alarm condition remains activated (both visible and audible) until the alarm is manually deactivated (see  below).
	Alarm Latching deactivated	The alarm condition remains activated until the sample measurement value falls within the normal limits, at which point the alarm is automatically deactivated. This icon is also used to deactivate all Alarm Latching conditions.

8.2.3 Threshold levels

The Threshold Level is the value at which the measurement will trigger the alarm. To set the Threshold value for the high or low alarms for the measurement range of the transducer use the following sequence (specific example below is for Alarm #1 setting the High Alarm):

> > > > > A

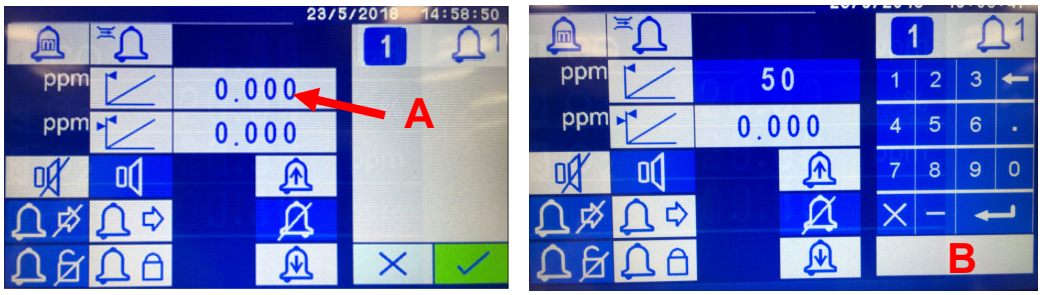


Figure 8-9: Alarm Threshold values set by pressing (A) and number key pad (B).

1. Touch the number to the right of the icon as shown in Figure 8-9 A.
2. Use the number keypad shown in Figure 8-9 B to type in the threshold value then press to accept the value or to cancel the entry.
3. To save the alarm settings to the current alarm, press the icon shown in the left screen in Figure 8-9 A.
4. To abort the changes and return to the original settings prior to entering the Alarm Setting screen, press the icon. This icon appears in place of the Return icon in Figure 8-9 A if changes have been made to the settings.

Table 8-4: Navigation tools in the Alarm Threshold screen

Icon	Function
	Touch this icon to delete the last digit typed in.
	Touch this icon to accept the value entered in the keypad.
	Touch this icon to return to the previous screen. When setting has been changed this icon is replaced by .
	Touch this icon to accept all the alarm settings.
	Touch this icon to cancel the entered value on keypad or setting change on the Alarm Setting screen.

5. Figure 8-10 displays the alarm setting thresholds on the home screen as red lines and text on the bar graph at the top of the screen.
6. Once the alarm setting has been configured you may now assign a relay to that alarm (Section 11).
7. Repeat this for each alarm as required.

Figure 8-10: Home screen showing alarm settings as red lines and text on the bar graph

8.2.4 Hysteresis levels

> m > > 1 > >

The Hysteresis level associated with a measurement alarm determines when an activated alarm condition is deactivated. A single value is entered into the Hysteresis level and it will be applied to the Measurement Alarm limit depending on the alarm mode selected as described below.

Table 8-5: Alarm modes and hysteresis effects

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

Note: We designate a percent level concentration value as "%-vol" and a percentage calculation of a range as "%".

Note: The Measurements Alarm levels can be reported as a percentage (%) of the measurement range or as a fixed concentration value (in ppm, mg/m³ or %-vol) depending upon the transducer installed and the user preferential settings. The Hysteresis levels are set as a fixed concentration value.

Examples:

a. If a 'Low' alarm has an alarm level of 15 %-vol and a hysteresis level of 1 %-vol, the alarm is activated when a sample measurement is < 15 %-vol, and the alarm is not deactivated until a sample measurement is > 16%-vol.

b. If a 'High' alarm has an alarm level of 3 ppm and a hysteresis level of 1 ppm, the alarm is activated when a sample measurement is > 3 ppm, and the alarm is not deactivated until a sample measurement is < 2 ppm.

To set the Hysteresis level associated with a measurement alarm use the following sequence (specific example below is for Transducer #1 and Alarm #1):

1. Touch the number to the right of the icon as shown in Figure 8-11 A.
2. Use the number keypad shown in Figure 8-11 B to type in the threshold value.

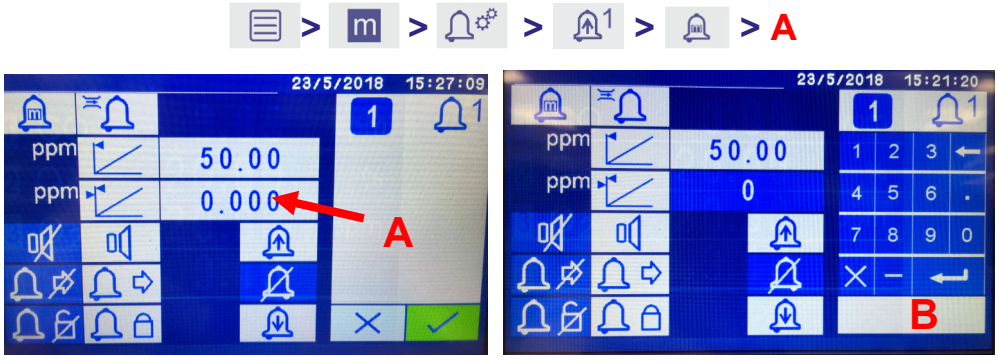


Figure 8-11: Alarm Hysteresis values set by pressing (A) and number key pad (B).

Hint:	*Ensure that the measurement alarm and hysteresis levels are not too close to the expected sample measurements. Otherwise minor and potentially acceptable variations in sample gas concentrations will result in spurious alarms.*
Hint:	*If you configure one measurement alarm as 'low' and the other measurement alarm as 'high', ensure that the 'high' alarm with its hysteresis levels is higher than the 'low' alarm with its hysteresis levels. Otherwise, the analyzer can be permanently in an alarm condition until the hysteresis levels are adjusted.*

8.2.5 Activated alarms details

When a measurement alarm condition is activated or triggered:

- The screen changes to flashing red (Figure 8-12).
- The Alarm Status icon appears at the upper right of the screen (Figure 8-12 A).
- The appropriate alarm relay will be triggered.

Figure 8-12: Measurement alarm condition triggered

Press the following sequence of icons to view the details of the activated alarm (Figure 8-13 A).

Figure 8-13: Alarms screen showing Alarm #1 (A) High Measurement Range triggered

8.3 Configuring the User Ranges for mA Output and Screen Display

Each gas transducer has a predefined range based upon the intrinsic measurement range that was purchased. Dual ranges can be set up on the transducer to provide more precision using the User Low Range, User High Range and the User Expanded Range settings. With the auto-range function, both the display and output signals will follow those ranges. The default settings are based upon the intrinsic measurement of the purchased transducer. The range limits will be displayed on the bar at the top of the measurement screen for each of the transducers (see Figure 8-14 as an example).

Figure 8-14: Rectangular box showing the Range Limit bar on Measurement Screen in Blue with Alarm Limits bars with values in Red

To make any changes press the following sequence from the Home page to get to the Range Setting configuration panel in Figure 8-15:

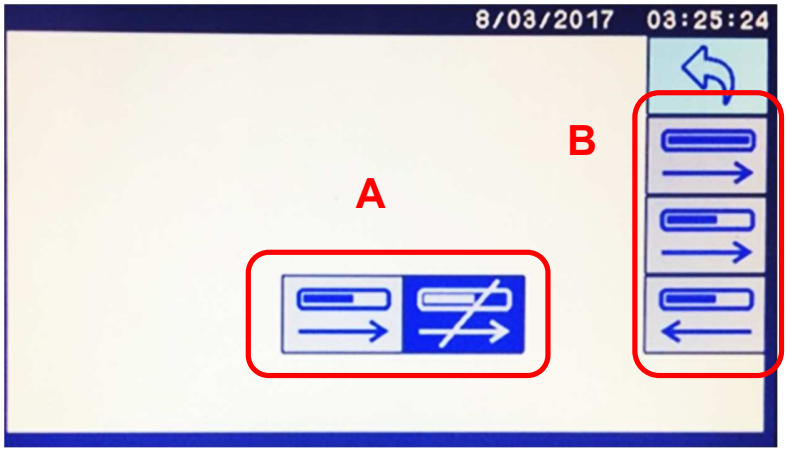


Figure 8-15: Range setting screen: (A) Auto-range icons (deactivated chosen) and (B) User Expanded Range icons

Note: Several of the icons on this screen look the same ( ) but have very different functions. Please use the guidance in the document and Figure 8-15 as to which icon represents the various functions.

Table 8-6: User mA Output and Display Measurement Range Setting Icons

Icon	Meaning	Function
	Auto-Range Activation / Deactivation	Auto-range defines how the measurement output values are handled if multiple ranges are available (see icons position in Figure 8-15 A). Default mode is active.
	User Expanded Range (Over-Range) Value	Allows the user to set a new maximum “over-range” value that the serial output and analyzer display will reset to if the measurement value goes over the User High Range value. If this is not used the default is the intrinsic measurement range of the transducer (icon position at the top in Figure 8-15 B).
	User High Range Value	Sets the user defined range maximum measurement value that will be scaled to the serial output and analyzer display. If this is not assigned, the default is the intrinsic measurement range of the transducer (icon position in the middle in Figure 8-15 B).
	User Low Range Value	Sets the user defined range minimum measurement value that will be scaled to the serial output and analyzer display. The default User Low setting is 0 (icon position at the bottom in Figure 8-15 B).
	Return	Touch this icon to accept the Range settings and return to the previous screen.

Figure 8-16: Range values set using number key pad.

Table 8-7: Standard Navigation tools in the User Range Value screen

Icon	Function
	Touch this icon to delete the last digit typed in.
	Touch this icon to accept the value entered in the keypad.
	Touch this icon to cancel the value entered in the keypad.

8.3.1 Setting a Custom Expanded (over-range) Range Value

> > >

The User Expanded Range (or over-range) setting is used to define a new over-ranging maximum value that the serial output and analyzer display will reset to when the sample gas measurement value exceeds the User High Range value. This range will always be less than the intrinsic measurement range of the transducer and allows more precision across a smaller measurement range when over-ranging takes place.

To set a new User Expanded Range for the transducer, touch the icon shown inside the red box labelled B in Figure 8-15 and use the numeric key pad in Figure 8-16 to enter the new maximum range value.

Once a new User Expanded Range value is set, and the sample measurement value is above its maximum value, depending upon the analyzer settings the display and the serial output may respond differently. See Section 8.3.5 for details and examples of

how auto-ranging affects the values sent through the serial output and the analyzer display panel.

Note: If you do not want the analyzer to report values above the User Expanded Range maximum value you need to turn auto-range OFF (ON by default).

8.3.2 Setting a custom User High and User Low range

> > > User High

> > > User Low

These settings are used to create a User defined measurement range for the transducer, lower than both the intrinsic measurement range and the User Expanded range, over which the serial output and screen displays will span and report. The default setting is the intrinsic measurement range but by using the User High Range and User Low Range settings the user can create a range that is lower than the intrinsic measurement range to provide greater precision.

The serial output range (4-20 mA or 0 – 10V) is determined by the minimum and maximum range values pre-set by the factory or they can be changed by the user with the User High Range and User Low Range icons located inside the red box labelled B in Figure 8-15. Use the numeric key pad shown in Figure 8-16 to enter the new range value.

If auto-ranging is active, the analyzer will automatically detect any over-range and switch to either the intrinsic measurement range or the User Expanded range value (if assigned). See Section 8.3.5 for details and examples of how auto-ranging affects the values sent through the serial output and the analyzer display panel.

Note: If you do not want the analyzer to report values above the User High Range maximum value you need to turn Auto-range OFF (ON by default).

8.3.3 Auto-range ON/ OFF

> > > **ON**

> > > **OFF**

The auto-range function is activated by pressing the auto-range icon and it is deactivated by pressing the icon. The icons are located at on the bottom middle of the screen shown inside the red box labelled A in Figure 8-15.

The auto-range function is used to define how the measurement output values are handled by both the serial output (mA or volts) and the analyzer display. If there are any User defined ranges (High, Low, Expanded), then the auto-range function will automatically determine which range to use.

When a measurement value goes over a User defined setting (User High Range and / or User Expanded Range), auto-ranging will switch the measurement range automatically to

the higher range and re-scales the serial output (mA or volts) and the bar graph of the analyzer display panel.

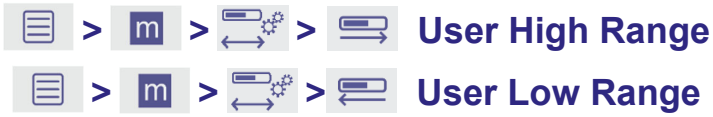
Note: If a measurement has auto-ranged above the User High Range maximum value to the higher User Expanded range or Intrinsic measurement range, the measurement value must fall to 10% below the User High Range maximum value before the auto-range switches back to the lower range. This prevents the output response from repeatably jumping between the two ranges.

8.3.4 Range Setting Example

If you have a transducer with an intrinsic range maximum of 0-1000 ppm, but the process values never went above 100 ppm, you may want to define a new “over-range” maximum value of 100 ppm for better resolution of the measurement values than available using the intrinsic measurement range of 0 – 1000 ppm.

This is accomplished by selecting the User Expanded Range  icon (Figure 8-15 B) and setting the value to 100 ppm with the keypad, limiting the maximum range to 100 ppm.

If the actual process measurements values are generally confined to values below 10 ppm, then you might want to define a working range of 0 – 10 ppm to provide even more precision at the lower process concentration values. You can set the User High Range to 10 and the User Low Range will remain at “0”.



8.3.5 Auto-range ON /OFF Functionality Examples

The following two examples illustrate how the serial output and display behave with Auto-range OFF and with Auto-range ON for a transducer with an intrinsic measurement range of 0-1000ppm, the User High Range set at 10ppm and the User Expanded Range set at 100ppm.

Example 1 Auto-Range OFF

Initial Settings:

- User High Range set to 10 ppm, User Low Range set to 0 ppm, User Expanded Range set to 100 ppm.
- The serial output values will be scaled to the User High Range of 10 ppm.
- The display bar and output values will be scaled to the User High Range of 10 ppm.

Measured Value ≤ 10 ppm	User Low (0 ppm)	User High (10 ppm)	Expanded (100 ppm)
Serial Output	X	X	
Display Output	X	X	

Any time the gas measurement value is at or above the User High Range of 10 ppm:

- The serial output value will remain fixed at 10 ppm.
- The analyzer display will continue to show the measurement values up to the User Expanded Range maximum of 100 ppm.

Measured Value ≥ 10 ppm	User Low (0 ppm)	User High (10 ppm)	Expanded (100 ppm)
Serial Output		X	
Display Output	X		X

Any time the gas measurement value is at or above 100 ppm:

- The serial output value will remain fixed at 10 ppm.
- The analyzer display value will remain fixed at 100 ppm.

Measured Value ≥ 100 ppm	User Low (0 ppm)	User High (10 ppm)	Expanded (100 ppm)
Serial Output		X	
Display Output			X

Note: If the user does not set an Expanded Range and sets a User High Range of 10 ppm, then for a gas measurement value above 10 ppm the Serial output will remain at 10 ppm and the analyzer display will continue to show the measurement values up to the maximum of the intrinsic range of the transducer ie 1000 ppm.

Example 2 Auto-Range ON

Initial Settings:

- User High Range set to 10 ppm, User Low Range to 0 ppm, User Expanded Range set to 100 ppm.
- The serial output values will be scaled to the User High Range of 10 ppm.
- The display bar and output values will be scaled to the User High Range of 10 ppm.

Measured Value ≤ 10 ppm	User Low (0 ppm)	User High (10 ppm)	Expanded (100 ppm)
Serial Output	X	X	
Display Output	X	X	

Any time the gas measurement value is at or above the User High Range of 10 ppm:

- The serial output value will automatically rescale to the User Expanded Range maximum of 100 ppm.
- The display bar graph value will automatically rescale to the User Expanded Range maximum of 100 ppm.

Measured Value ≥ 10 ppm	User Low (0 ppm)	User High (10 ppm)	Expanded (100 ppm)
Serial Output	X		X
Display Output	X		X

Any time the gas measurement value is at or above 100 ppm:

- The serial output value will remain fixed at 100 ppm.
- The analyzer display value will remain fixed at 100 ppm.

Measured Value ≥ 100 ppm	User Low (0 ppm)	User High (10 ppm)	Expanded (100 ppm)
Serial Output			X
Display Output			X

Note: If the user does not set an Expanded Range and sets a User High Range of 10 ppm, then for a gas measurement value above 10 ppm the Serial output and the analyzer display will automatically rescale the measurement values up to the maximum of the intrinsic range of the transducer ie 1000 ppm.

8.3.6 Configure the measurement mA Output option

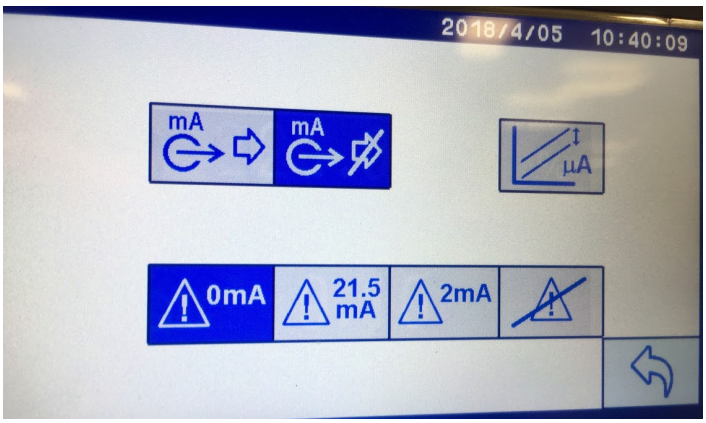


Figure 8-17: mA output screen

Each transducer is supplied with an associated 4-20mA output. On the mA output screen select either to “Follow” or “Not Follow” the concentration changes during calibration. If the “Not Follow” is selected then the mA output signal will freeze at the last measured value until the calibration has finished.

You can make small adjustments to the mA output using the icon (see Figure 8-18).

A jam condition occurs when the incoming data has a Fatal Flag or when the Transducer has a Communications Fault that stops the data. By assigning a jam condition the user is able to distinguish between valid and non-valid readings.

Once the adjustments and flags are set, touch the icon to save the Figure 8-18mA output information or the icon to quit the screen without saving.

Table 8-8: Measurement mA Output icons

Icon	Meaning	Function
	Follow	The mA output continues to follow the measured concentration during calibration.
	Not follow	The mA output freezes during calibration.
	mA output adjustment	Tweak the mA output with small incremental adjustment.
 	Jam condition Low	A jam condition occurs when the incoming data has a Fatal Flag or when the Transducer has a Communications Fault. The options for a Low Jam value is 0 or 2.0 mA.
	Jam condition High	A jam condition happens when the incoming data has a Fatal Flag or when the Transducer has a Communications Fault. The High Jam value is 21.5 mA.
	No Jam State	This disables the Jam State.
	Return	Touch this icon to accept the Range settings and return to the previous screen.

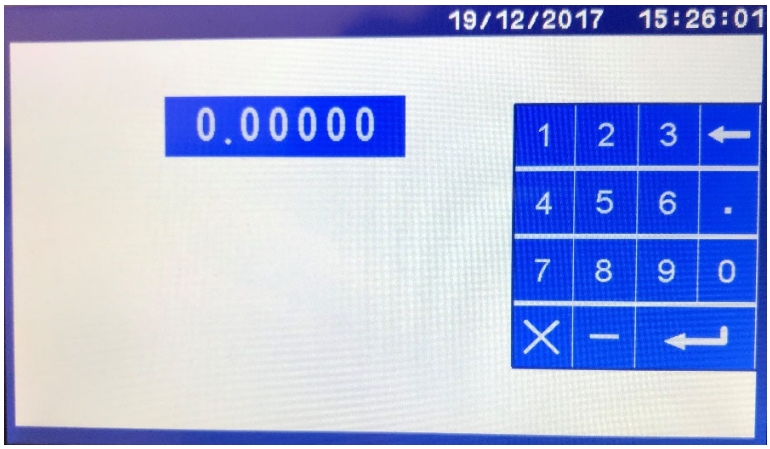


Figure 8-18: mA output adjustment screen

Table 8-9: Navigation tools in the mA output adjustment screen

Icon	Function
	Delete the last digit typed in.
	Accept the value entered in the keypad.
	Cancel the value entered in the keypad.

8.4 Configure the measurement record option

The measurement record option allows the operator to save time-stamped concentration readings in seconds, minutes and hours as a text file to the analyzer which can then be exported to a USB stick. It is possible to configure multiple record files if there are two or more transducers.

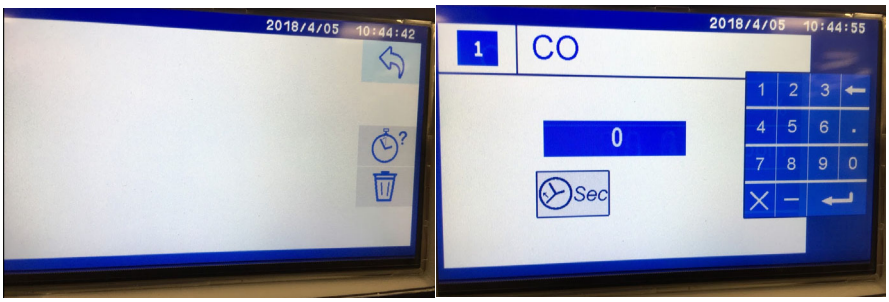


Figure 8-19: Measurement Record (left) and Record Timing Setup (right) screens

To store a result:

1. Touch the clock icon to toggle through the time options until the required time page displays.
2. Type **1** on the numeric pad to select 1 second, 1 minute or 1 hour, depending on the time interval selected.
3. Touch the icon to start the logging.
4. To stop the logging, set the time interval to zero by typing **0** on the numeric pad.

To view a result:

1. The log must be saved onto a memory stick before it can be viewed.
2. Insert a memory stick into the USB socket located at the bottom of the right side of the front panel.
3. Use the following sequence to navigate to the Diagnostics branch page to access the USB icon and touch to save the files to the USB stick:

   >

4. Several system files including the measurement logs will be written onto the memory stick. Column 1 is the ppm measured value; column 2 is the date; column 3 is the time.

50	27/7/2016	09:34:09
50	27/7/2016	09:44:09
50	27/7/2016	09:54:09
50	27/7/2016	10:04:10
50	27/7/2016	10:14:10
50	27/7/2016	10:24:10
51	27/7/2016	10:34:10
51	27/7/2016	10:44:10
51	27/7/2016	10:54:10
51	27/7/2016	11:04:10

*Note: To stop the logging you must set the time interval to zero. Type **0** on the numeric pad and press key to accept the value.*

Table 8-10: Measurement Record icons

Icon	Function
	Set the data recording timing. Once set the data is recorded until the user stops the recording from this page.
	Data Recording rate in Seconds. To record data in Minutes touch the icon again to show the minutes icon, to record in hours touch again to display the Hours icon.
	Access the Delete Data Icon.
	Delete the recorded data from the analyzers.
	Return to the Alarm settings Home screen.
	Delete the last digit typed in.
	Accept the value entered in the keypad. Typing in “0” on the keypad will stop the data recording if the Return key is pressed.
	Cancel the value entered in the keypad.

8.5 Configuring the Measurement data filter and gas reporting units

8.5.1 Setting the Measurement data filter

The transducer determines which filter types are available. Trial and error testing will be needed to determine which filter type is best for the application as well as how many points are needed in the filter, as there are trade-offs with response time and signal improvement. The default mode applies no filtering.

There are two kinds of filters available: Moving Average or Finite Impulse Response (FIR) and Exponential or Infinite Impulse Response (IIR). The filters shown on the left column of Figure 8-20 are Moving Average, those in the right column are Exponential.

For each of these filter types, the smoothing icon shown top to bottom represents the smoothing function that is faster but less smooth to slower but smoother at the bottom.

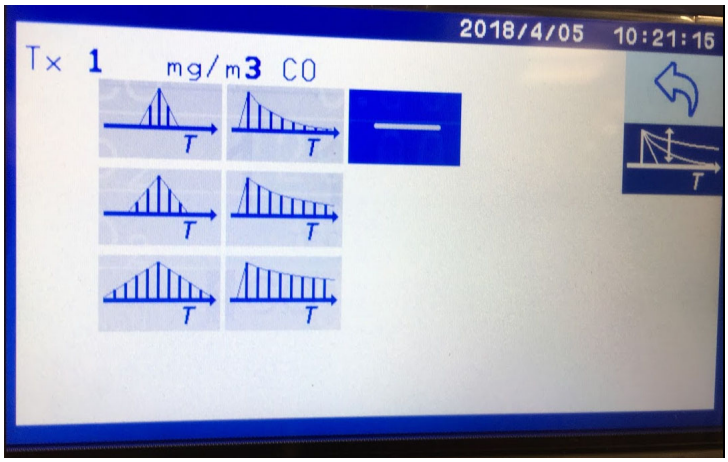


Figure 8-20: Data Filter screen showing two filter types with short, medium, long time averages (no filter is selected at this time).

With a Moving Average filter, the actual output is the average of the latest value and a fixed number of previous input values, with the previous inputs weighted less so they contribute less to the output.

With an Exponential filter the output is an average of the latest value and one or more previous output values, with previous output values being weighed less. It is called “infinite” because every new value always makes some contribution to the new output and diminishing contributions to all subsequent output values.

In either case, the more points used in the average or the higher the weighting is from the older values, the smoother the response will be, but the consequence is that the response to changes in the incoming values will be slower.

8.6 Transducer Diagnostics

This section provides access to the diagnostics for installed transducers that support diagnostics at this time. We are working on allowing user access to diagnostics for all our transducers and these new features will roll out in successive firmware updates. Figure 8-21 shows and example of the diagnostics for a GFX transducer.

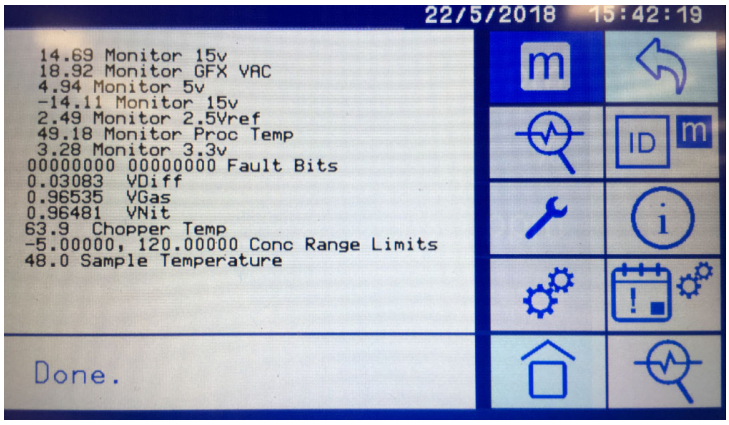


Figure 8-21: GFX transducer diagnostic screen

The diagnostic values are meant for interpretation by service personnel and be used to report the values back to a Servomex service person for troubleshooting the problem.

9 Diagnostics branch screen

9.1 Diagnostic branch icons

Touch the Diagnostics icon to see the available diagnostic functions to the right.

The screen views for each of the three pages available within the Diagnostic branch are shown in Figure 9-1, Figure 9-2, and Figure 9-4 (Relay Diagnostics).

The Relay Diagnostics page allows testing of the assigned the relays. The actual state of the relay is assigned in the Setting  (see Section 11).

Note: Page 1 displays first.
To go to the subsequent pages, press the  *icon.*
To return to the previous page, press the  *icon.*

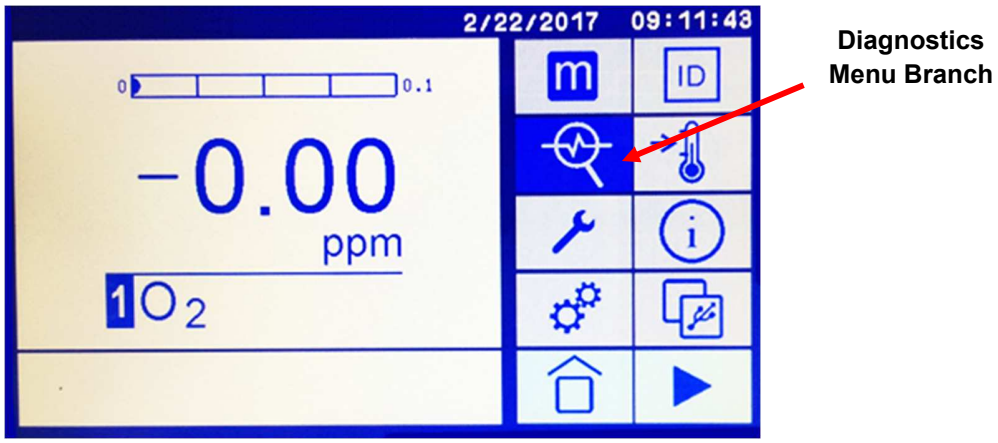


Figure 9-1: Diagnostics screen – page 1

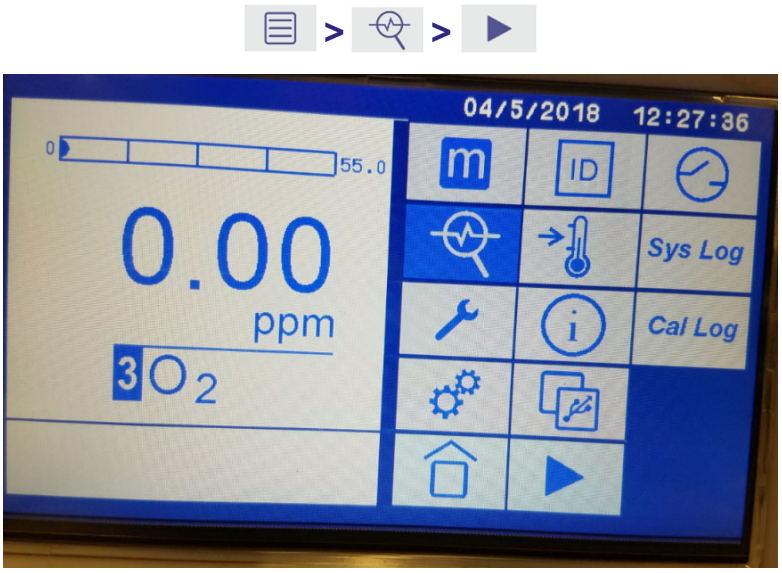


Figure 9-2: Diagnostics screen – page 2

Table 9-1: Diagnostics icons

Icon	Meaning	Function
ID	Software revision	Display the software revision number.
	Analyzer Electronics Temperature	Display the temperature of the internal chassis electronics of the analyzer.
	Analyzer serial number	Display the serial number of the analyzer.
	Save system files to USB	Save the system files to a USB memory device. Unit will beep if you do not have a USB device installed.
	Relay test menu	To view and test the relays that were purchased. When background is blue then the relay is closed.
Sys Log	System Log	Display up to 100 pages of logged system activities with most current date first. Use the arrow keys to navigate through the pages.
Cal Log	Calibration Log	Display up to 100 pages of logged calibration activities with the most current date first. Use the arrow keys to navigate through the pages.

9.2 Saving the system log files

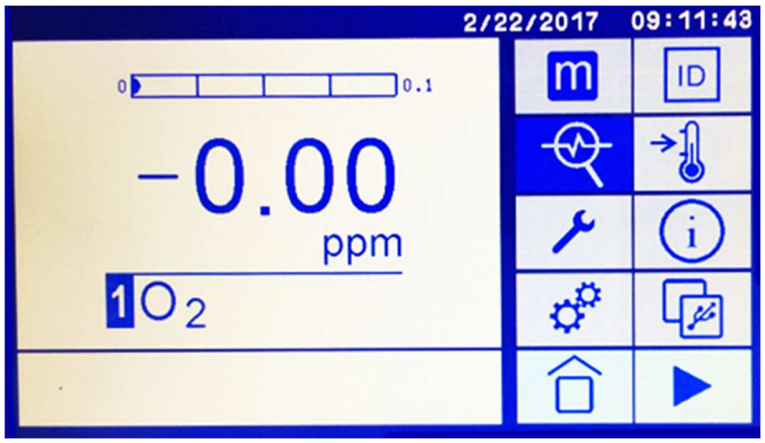


Figure 9-3: Log file save screen

A USB thumb drive must be installed into the slot located on the bottom right side of the front panel prior to accessing the Log Save icon  . The text files will be written to the USB drive when this icon is touched. The analyser will beep if there is no USB in the port and the system will stop.

9.3 Testing the Relays

The relays are numbered to support quick testing and can be individually tested to help debug an installation.

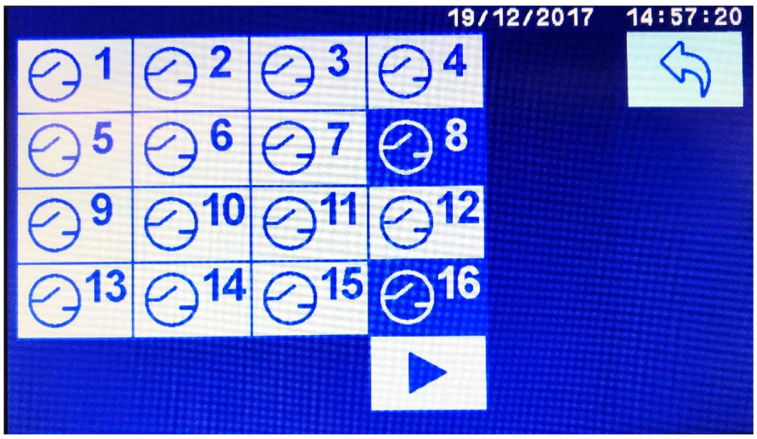


Figure 9-4: Relay diagnostics screen

To test the function, press the relay icon to open and close it. If a relay is closed, its icon background is dark blue ; if a relay is open, its icon has a white background (see Figure 9-4). When the Relay Diagnostics page is exited, the relays will be reset back to the state they were in prior to entering the Relay Diagnostics page.

For example, if relay #8 alarm state was triggered then relay #8 would show closed prior to entering the Diagnostics menu. When exiting the Relay Diagnostics page, relay #8 will be set back to the closed position even if the relay had been opened on the diagnostics page.

If Auto-Cal function is purchased the last three relays on each transducer option card are pre-assigned and cannot be changed by the user (see Figure 9-5). The relay number icons are now replaced by new icons that represent each of the Auto-Cal Zero, Span and Measure functions.

Relay #6 is pre-set as the Zero or Low Span function , Relay #7 is pre-set as the High Span function , and Relay #8 is pre-set as the Sample / Measurement function for Transducer #1. Relays #14, #15, #16 are pre-set in the same manner for Transducer #2.

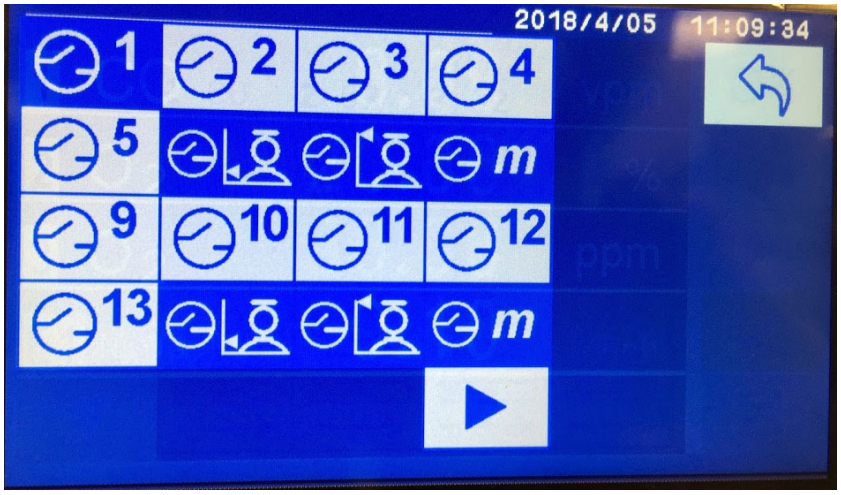
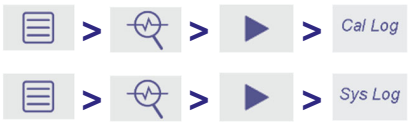


Figure 9-5: Relay diagnostics screen with Auto-Cal option

9.4 Displaying the System or Calibration Log

The System Log or the Calibration Log can be easily accessed and displayed showing the most recent activity first on the first page. Activities on the earlier dates can be accessed via the up and down arrows.



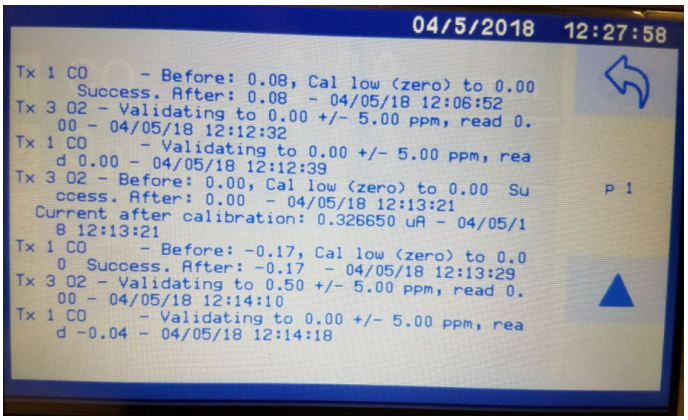


Figure 9-6: Example of a Calibration Log Report

10 Maintenance branch screen

Touch the Maintenance icon to see the available icon choices to the right. The Maintenance branch menu has one page, shown in Figure 10-1.

Figure 10-1: Maintenance screen

Table 10-1: Maintenance branch icons

Icon	Meaning	Function
	Update firmware	To update the firmware in the field when needed. Insert the USB thumb drive into the slot in the lower right corner of the front panel, then touch the icon to update the firmware.
	Read config files from USB memory device	To upload configuration files from a USB memory device. Insert the USB thumb drive holding the configuration files into the slot in the lower right corner of the front panel, then touch the icon to upload the new configuration files.
	Clear errors	To clear any error warnings such as Failed Calibration.

11 Settings branch screen

Touch the Settings menu icon to see the available settings functions to the right.

The screen views for each of the three pages available within the Settings branch are shown in Figure 11-1, Figure 11-2, and Figure 11-3.

Note: Page 1 displays first.

To go to the subsequent pages, press the ▶ icon.

To go back to the previous page, press the ↩ icon.

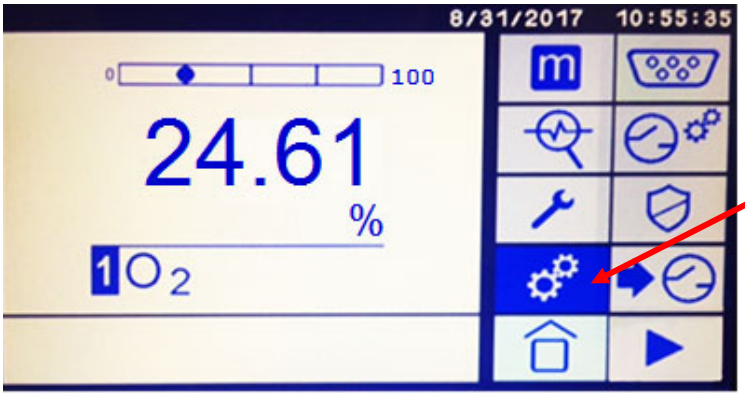


Figure 11-1: Settings main screen 1

Figure 11-2: Settings main screen 2

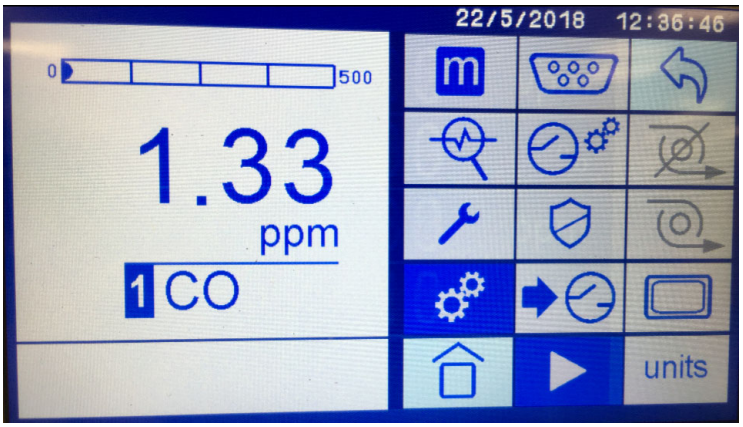


Figure 11-3: Settings main screen 3

Table 11-1: Settings Branch icons

Icon	Meaning	Function
	Serial port set up	Set up serial communications parameters.
	Relay set up	Set up the relays.
	Password set up	Access the password security icons for Master and Operator levels.
	Manual relay over-ride	Manually set the relay to a state (i.e. Off or On); when selected this will be the permanent state until the relay function is reset.
	Analyzer Date	Set the date for the analyzer system.
	Analyzer Time	Set the time for the analyzer system.
	Digital and Analog Inputs	Set up for any of the analog and/or digital inputs if purchased.
	Pump Off	Turn internal pump off
	Pump On	Turn internal pump on
	Screen Functions	Switch from Single to Multiple gases displayed, adjust brightness, adjust screen “home” timer.

11.1 Serial communication outputs overview

This section is only an overview of the screens associated with the serial output communication configurations while the details can be found in Appendix B. The serial output option operates by transmitting a data frame to the RS232 (or RS 485) output port at a user defined interval. The format of the data frame is a semi colon separated list of process variables terminated by <carriage return><line feed>. The data frame is time and date stamped.

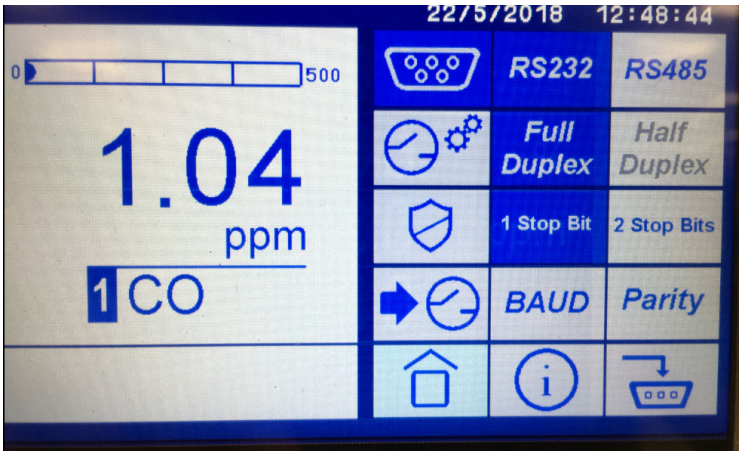


Figure 11-4. RS232 functions view.

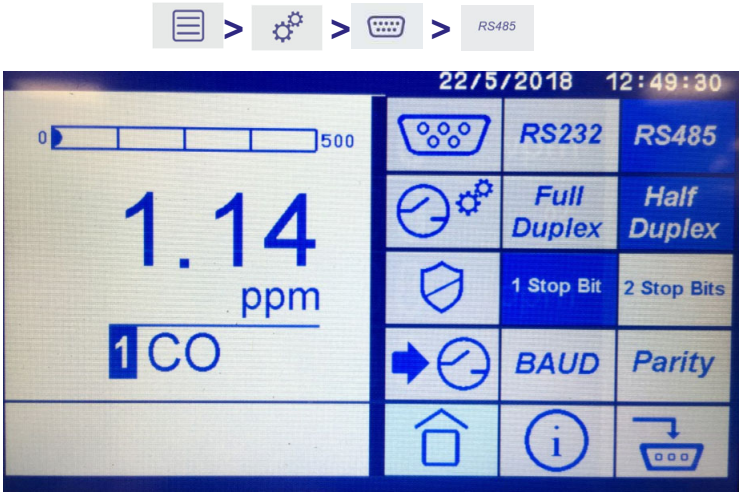


Figure 11-5. RS485 functions view.

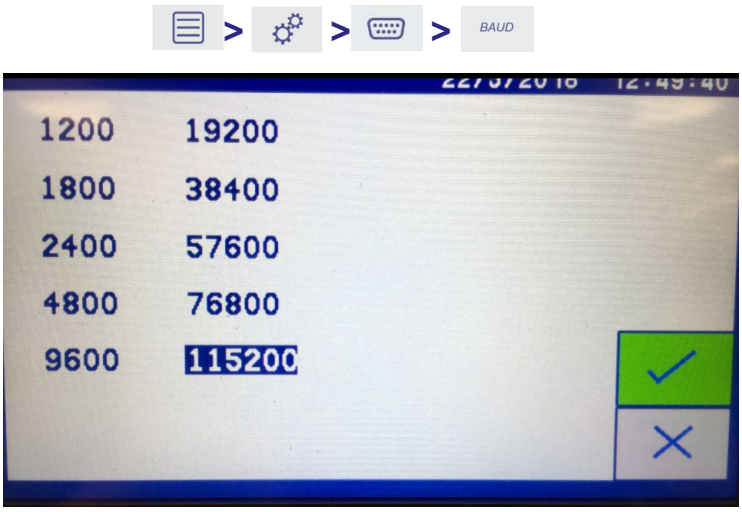


Figure 11-6. Baud Rate selection panel.

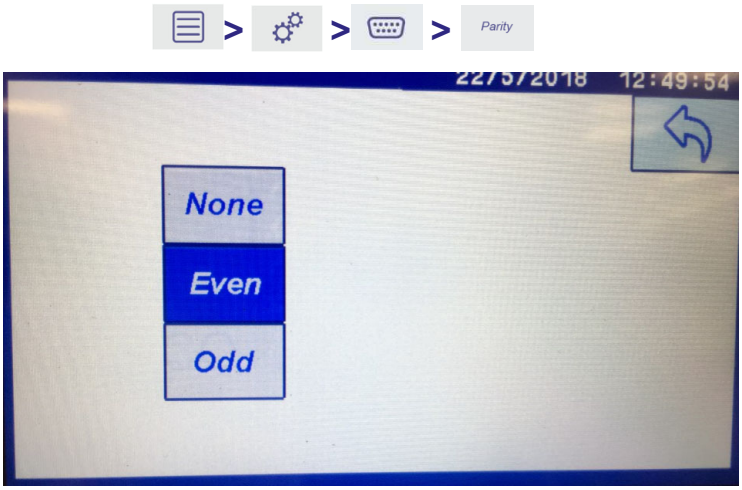


Figure 11-7. Parity selection panel.

Note: To return to the previous page, press the icon.

To accept the changes, press the icon.

To cancel any changes, press the icon.

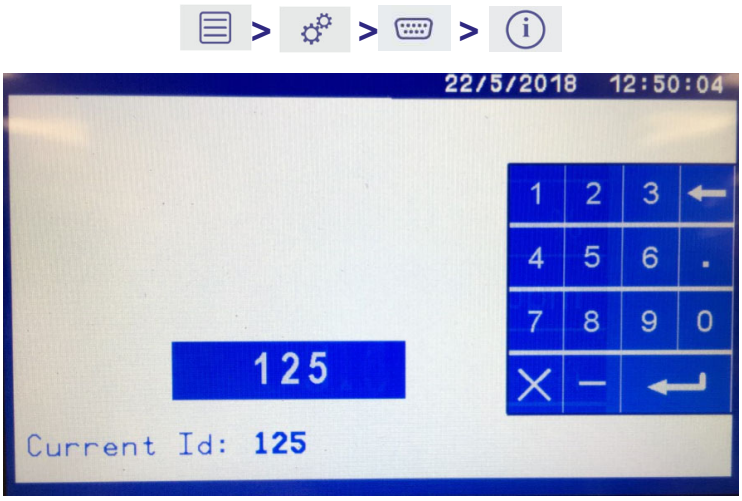


Figure 11-8. Output ID setting screen

Note: To delete the last digit typed in, press the icon.

To accept the changes, press the icon.

To cancel any changes, press the icon.

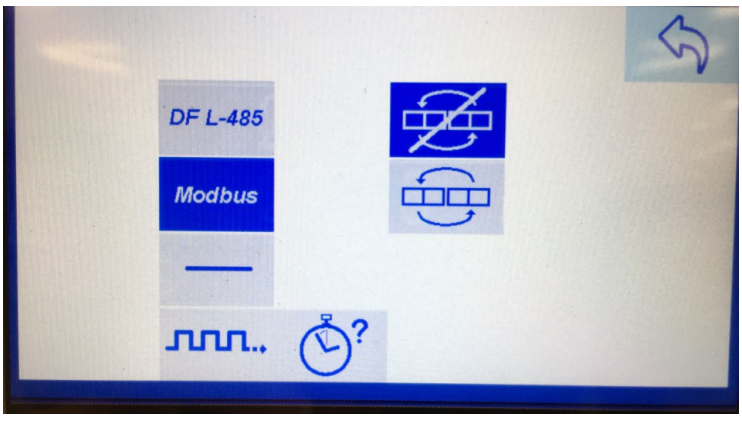


Figure 11-9. Modbus 485 settings screen.

Table 11-2: Main Serial communication Output icons

Icon	Meaning	Function
RS232	RS232 communications	To select RS232.
RS485	RS485 communications	To select RS485.
Full Duplex	Full Duplex	To select full duplex.
Half Duplex	Half Duplex	To select half duplex.
1 Stop Bit	1 stop bit	To set 1 stop bit.
2 Stop Bits	2 stop bits	To set 2 stop bits.
BAUD	Baud rate	To set the baud rate.
Parity	Parity	To set the parity.
	RS485 function	To assign RS485 functions. Functions on this section screen are shown in Figure B-3 and listed below:
DF L-485	RS485 function: DF communications	To assign RS485 function to legacy Delta F (DF-485) communications.
Modbus	RS485 function: Modbus	To assign RS485 function to Modbus (B.1).
	RS485 function: None	No RS485 function.
	RS485 function: periodic stream	To assign a periodic stream of measurement results of all transducers.
	RS485 function: output frequency setup	To set the intervals for the output frequency (in seconds) via a numerical entry screen.
	RS485 – Modbus: Word swapping on	To switch on Modbus word swapping.
	RS485 – Modbus: Word swapping off	To switch off Modbus word swapping.

11.2 Assigning relay activity functions

> >

The function of the relay can be assigned using the relay configuration settings menu and selecting the appropriate relay. Each relay is set up to respond to any function or combination of functions including Faults, Service in Progress, Any type of Alarm. Once an activity has been assigned to the relay, the icon will take on a symbol reflecting the new assigned function (see Figure 11-10).

Note: If Auto-Cal is purchased then Relays at positions #6, #7 and #8 on each of the transducers will be pre-assigned to output as Zero, Span and Sample / Measurement modes. They cannot be reassigned (see Figure 11-10).

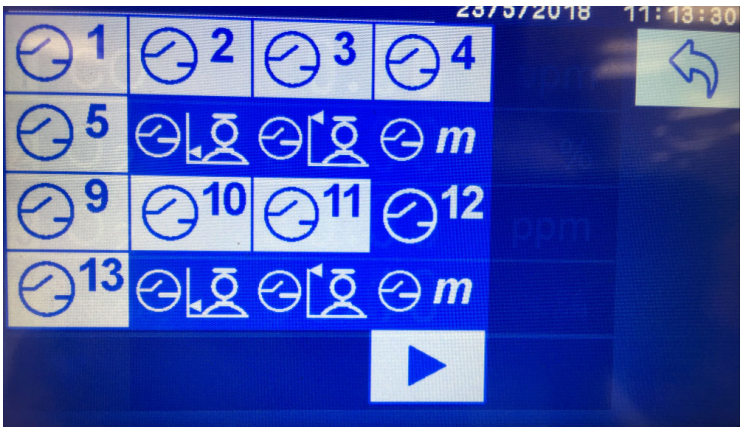


Figure 11-10: Available relays on the system with Auto-Cal pre-assigned relays.

If there are more relays available, then use the Next icon to access the next page (see Figure 11-10).

Note: There can be up to eight relays per transducer giving a maximum of 32 if four transducers are purchased or extra option boards added.

11.2.1 Assigning Alarms, Functions and Activities to the relays

Use the Activity Assignment Menu (Figure 11-11) to assign a function to a specific relay by touching the functions icon and activating it. Each relay can be assigned to one or more of the transducers purchased, which will be listed on the screen. Any number of links may be made between any function to any relay card present within the analyzer.

Note: To go to the other assignment pages, press the icon.

To accept the changes, press the icon.

To cancel any changes, press the icon.

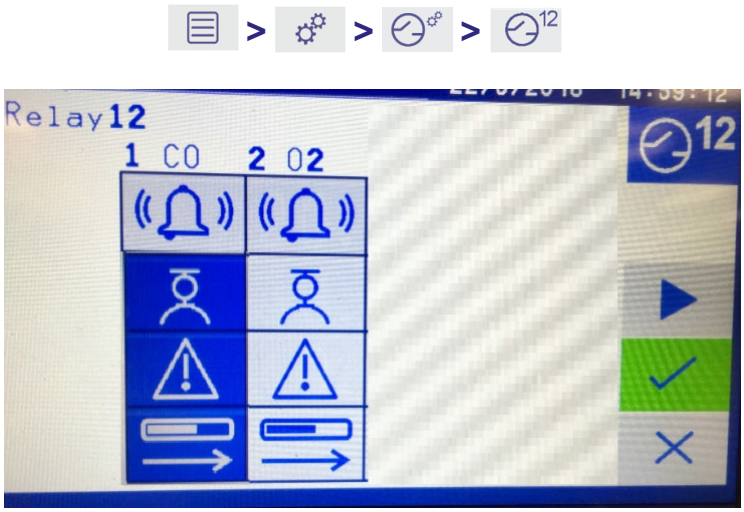


Figure 11-11: Activity Assignment Menu for Relay #12 in an analyzer with two transducers (CO and O2).

Multiple activities can be assigned to one relay. In Figure 11-11 the Calibration, Fault and Out of Range functions for the CO transducer are all active (so the icons show a dark blue background) and are assigned to Relay #12.

Those activities can also be linked to different transducers present in the analyzer. In Figure 11-11 Relay #12 can be assigned alarms for Transducer #1 (CO) and / or Transducer #2 (O_2). To assign an alarm to Transducer #2 (in this case it is O_2):

- touch the alarm icon located below the O_2 symbol as shown in Figure 11-11
- touch the icon for Alarm #1 as shown in Figure 11-12 to set the alarm

Figure 11-12: Alarm assignment screen for O_2 (Relay #12)

Table 11-3: Relay Activity Function Assignment Icons

Icon	Meaning	Function
	Alarm	Relay is set as an alarm on a specific transducer.
	Service / Calibration in progress	Relay is set to output “Service in Progress” signal triggered when a Calibration / Validation is in progress on a specific transducer. Allows detection of this state remotely.
	Fault Alarm	Relay is set to send a signal out if the transducer incurs a Fault such as over-range of intrinsic range, communications failure, etc..
	Range Change	Relay is set to output a “Changed to Expanded Range” signal on a specific transducer when the concentration is greater than the User High Span range.

11.2.2 Assigning Alarms for External 4-20mA Inputs to the relays

There is one external 4-20mA Input per option board. In Figure 11-13 Relay #1  is assigned to the analog Input High and/or Low alarm. Use the Analog Input Section **Error! Reference source not found.** to assign the actual limit values for the relays to alarm at.

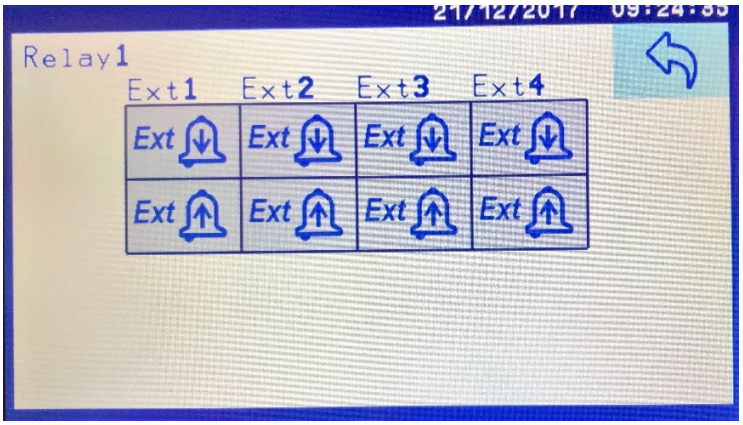


Figure 11-13: Relay Low / Hi alarm fault assignment screen for external mA inputs

- Touch the  icon to set the Low Limit alarm (Figure 11-13).
- Touch the  icon to set the Hi Limit alarm (Figure 11-13).
- Touch the  icon to return to the relay assignment page (Figure 11-13).

- Touch the  icon (see Figure 11-11) to save the relay information.

11.3 Assigning Password Protection

There are two levels of operation under password protection: Master or Operator. The Master Password allows access to all MASTER and OPERATOR level functions while the Operator Password allows access to only the OPERATOR level functions.

Touch the Password Assignment  icon to see the Operator  , Master  and Keystroke Record  icons in the column furthest right (see Figure 11-14).

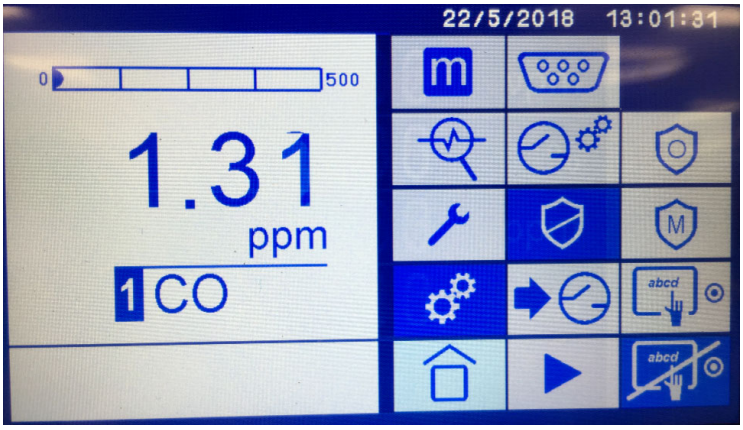


Figure 11-14: Settings Password Protection with Record Keystroke screen

To set a password touch the icon for the required password level then enter the new password using the keypad (see Figure 11-15).

 ***Master***

 ***Operator***

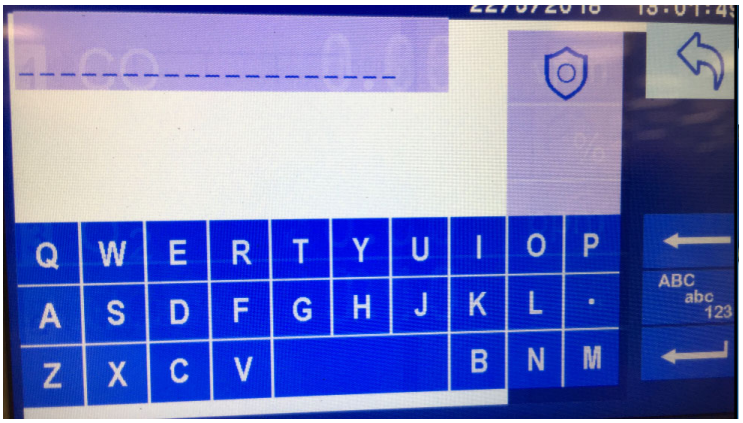


Figure 11-15: Settings Password Protection screen for Master or Operator

Table 11-4: Password Protection Assignment Icons

Icon	Meaning	Function
	Master Password	Set the analyzer master level password.
	Operator Password	Set the analyzer operator level password.
	Keystroke Recording On	Turn keystroke recording On to capture all keystrokes used to the System Log file.
	Keystroke Recording Off	Turn keystroke recording Off.

Once a master and/or operator password are set all protected icons and operations will prompt for a password. If no passwords are set, then the protected icons and operations will not prompt to have a password entered.

To reset or deactivate the OPERATOR password enter the OPERATOR password as a blank / empty field. You will need the Master password to re-enter either the MASTER or OPERATOR password. If you have forgotten the MASTER password a remote recovery service password can be provided with a call to your local customer service center.

Table 11-5: Master and Operator password protection operations

Function	Level
ADAPTIVE FILTERING ON/OFF	MASTER
CALENDAR	MASTER
CLEAR ERRORS	MASTER

Function	Level
CLOCK	MASTER
GSF ENTRY OR SELECTION	MASTER
INSTALL CONFIG FROM USB	MASTER
KEYSTROKE RECORDING	MASTER
MILLIAMP OUTPUT	MASTER
PASSWORDS	MASTER
RANGE SETTING	MASTER
RECORD CONTROLS	MASTER
SCHEDULED EVENT SETUP	MASTER
SENSOR ON/OFF	MASTER
RELAY ASSIGNMENT	MASTER
SUPPRESS NEGATIVE	MASTER
TEST RELAYS	MASTER
TRANSDUCER PRESSURE COMPENSATION	MASTER
XINT INPUT	MASTER
FIRMWARE UPGRADE	MASTER
ADJUST FILTERING	MASTER
MILLIAMP INPUT	MASTER
DIGITAL INPUT	MASTER
ALARM SELECTION FOR EDIT	OPERATOR
CALIBRATION	OPERATOR
LOCK TO SINGLE DISPLAY	OPERATOR
MANUALLY SWITCHING RELAYS	OPERATOR
SAVE DATA TO USB	OPERATOR
ANALOG-IN ALARM SELECTION FOR EDIT	OPERATOR
ADJUST SERIAL PORT SETTINGS	OPERATOR

Note: Some functions may not be available depending upon the variant of the analyzer that was purchased.

11.4 Manual relay over-ride setting

This function allows the user to manually set the relay to one of three states: normal operation, Over-ride/Forced OFF or Over-ride/Forced ON. When selected this will be the permanent state until the relay function is reset. In Figure 11-16, Relays #8 and #16 are in normal operation ON and Relay #7 is in Manual over-ride operation ON.

Caution: when you leave this menu page, the relays do NOT revert back to the original settings.

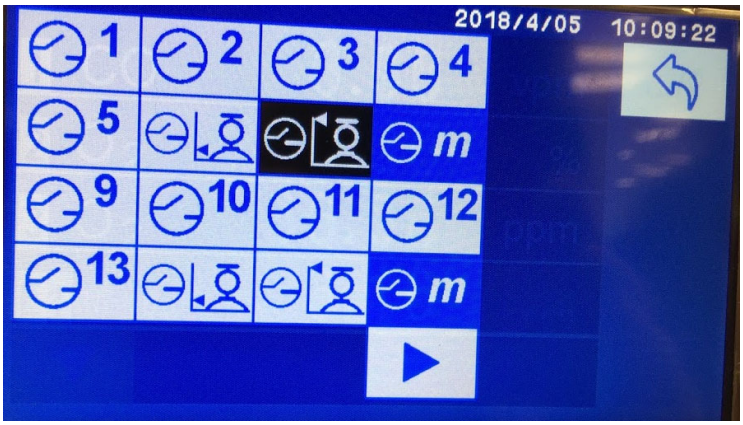


Figure 11-16: Manual relay over-ride of Relay #7 (with Auto-Cal ON)

The function will cycle through three states each time the relay icon is touched:

Normal Operation (originally assigned ON or OFF)

Over-ride / Forced ON (now assigned ON)

Over-ride / Forced OFF (now assigned OFF)

Relays power up in their designated state: Normal (ON or OFF). By repeatedly touching the relay icon the sequence will cycle continuously through each state in turn - Normal Operation, Forced ON, and Forced OFF. The relay will stay in the state it was cycled to. If this is not the Normal state then the over-ride (Forced) state will now be the new permanent relay state. The state designations are shown by the icon color change. See the table below for details on the icons and states.

Table 11-6: Manual Over-ride Icons

Icon	Meaning	Function
	Normal Operation – relay is Off	Indicates the assigned condition of the relay is off. If a relay is left in this state when exiting the screen the Normal operation will now be that the relay is off – note icon color scheme is light grey background with dark blue text.
	Normal Operation – relay is On	Indicates the assigned condition of the relay is on. If a relay is left in this state when exiting the screen the Normal operation will now be that the relay is on – note icon color scheme is dark blue background with light gray text.
	Forced Off Over-ride Operation – relay is Off	Indicates a forced over-ride condition now exists that turns the relay off. If a relay is left in this state when exiting the screen the Normal operation will now be that the relay is off – note icon color scheme is light gray background with dark gray text.
	Forced On Over-ride Operation – relay is On	Indicates a forced over-ride condition now exists that turns the relay on. If a relay is left in this state when exiting the screen the Normal operation will now be that the relay is off – note icon color scheme is black background with light gray text.

Note: There are three general functions to keep in mind that are available for relay settings and diagnostic testing that are accessed by the icon sequences below:

This sequence is used to set and assign tasks / states to the relays described above in Section 11.2.

This sequence will over-ride the original state by forcing the relay to be On or Off. The condition is permanent until the relay is switched back to Normal Operation above in Section 11.4. When you exit the Manual Over-ride menu, any changes will be made permanent.

This sequence allows for diagnosis and testing of the relays, located in the Diagnostics Section 9. When you exit the Diagnostics menu, there are no changes made to the relays.

11.5 Setting the analyzer date

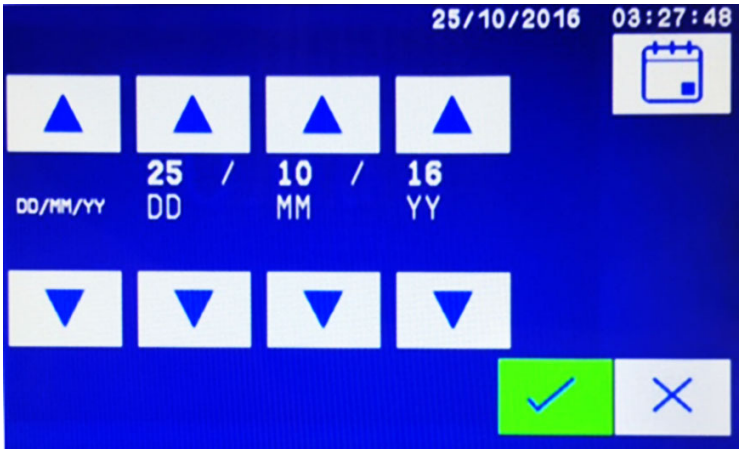


Figure 11-17: Set the analyzer date screen

1. Touch the first set of up or down arrows on the left-hand side to select how the date will be displayed (DD/MM/YY or MM/DD/YY or YY/DD/MM).
2. To set the date (Figure 11-17 shows the DD/MM/YY format):
    a. Touch the second set of up or down arrows from the left-hand side to select the day (from 1 to 31).
    b. Touch the third set of up or down arrows from the left-hand side to select the month (where 1 is January, and 12 is December).
    c. Touch last set of up or down arrows from the right-hand side to select the year.
3. Touch the  icon to accept the value or the  icon to leave the screen without updating the value.

11.6 Setting the analyzer time

Figure 11-18: Set the analyzer Time Screen

1. Time is shown as HH:MM:SS (hours : minutes : seconds) and displays in 24 hour format.
2. Touch the left-hand up or down arrows to increase or decrease the hours (from 00 to 23).
3. Touch the middle up or down arrows to increase or decrease the minutes (from 00 to 59).
4. Touch the right-hand up or down arrows to increase or decrease the seconds (from 00 to 59).
5. Touch the  icon to accept the value or the  icon to leave the screen without updating the value.

11.7 Sensor on/off and Digital Inputs (DF310E)

There are two Digital Inputs provided on DF310E – accessed via the EXT1 or EXT2 pins on the backpanel. The coulometric sensor can be turned on or off remotely using these inputs. Applying a voltage between 5 and 24V to the + pin with respect to – pin will cause the sensor to turn off. This can also be accomplished from the touchscreen directly. This is useful if a condition exposing the sensor to atmosphere or high O2 concentration will persist in the process for a period of time, and will lessen the recovery time for the sensor to return to normal measurement range. The input can be assigned in the measurement screen

Sensor On/off

Sensor ON

EXT1 assigned

The unused external input is reserved for future use.

11.8 Screen Settings

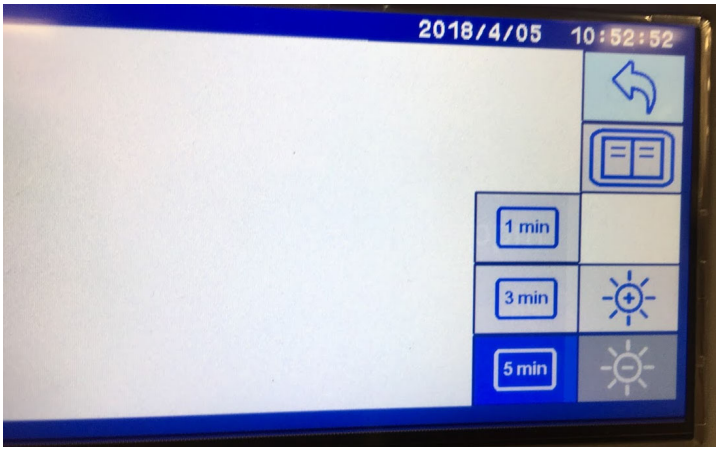


Figure 11-19: Screen Settings menu

Table 11-7: Screen Setting Icons

Icon	Meaning	Function
	Split screen	To show two or more gases on the same screen together on the Home screen. This toggles with the single screen icon below.
	Single screen	To show a single screen. This icon toggles with the split screen icon above.
	Increase brightness	To increase the screen brightness.
	Decrease brightness	To decrease the screen brightness.
	Return	To return to the previous page

12 Manual Calibration and Auto-Cal Sequences

12.1 Definition of Terms Used

Calibration means that the transducer calibration curve will be changed. Validation means that the analyzer will measure the gas concentration and then check the value against a user input certified value. The user input certified value for the High Span calibration point value will be from the tag value (certified concentration value) of a gas bottle while the Low Span point is generally set to “0”. Each transducer calibration (or validation) process must be set up individually and then can be accessed manually or automatically.

If the Auto-Cal feature is purchased, more than one transducer can be calibrated automatically at the same time using a mixed gas blend containing all required gases at the Span concentration values. The timing sequence for all of the transducers in this case will need to be set to the same time and date and the Zero, Span and Sample Measure times must be the same as well.

This section steps through the process of setting up a manual calibration and the Auto-Cal sequences.

12.2 Introduction to Calibration

The calibration of the transducers in the analyzer may be checked or adjusted either manually or automatically (requires the Auto-Cal option) and the activity will be logged as an entry in the calibration history log. The Auto-Cal feature allows the user to set up to three automatic timing sequences on each of the transducers. These sequences can be any combination of calibration or validation processes (described in Section 12.6).

External valves or a single multiport switching valve will need to be installed by the customer to enable the use of the various Span and Zero gases as well as the Sample gas stream. These valves can then be assigned to the relays associated with each transducer for controlling Zero, Span and Sample gas. For the Auto-Cal option three relays per transducer will be pre-assigned as Zero, Span and Sample mode automatically.

If the analyzer is still warming up a () symbol will appear in the corner for each of the gas icons. If a calibration is attempted, a warning message will appear with an option to proceed. As each gas transducer warms up this symbol will disappear and at this time a calibration or validation can be performed on that transducer.

Note: For optimal performance, allow the analyzer to run and stabilize for at least 24 hours from a cold start at 20°C (68°F). For the higher sensitivity measurements, this time may be longer.

The operator is guided through the setup sequence choices by a series of menus, icons, and editable text. Each gas sensor / transducer parameter including output concentration units, triggers and ranges, must be setup individually.

If the Auto-Cal feature is purchased, then the relevant menus and icons will be activated on the touchscreen. The Auto-Cal can be setup so that the transducers are calibrated or validated serially (one after another) or timed so that they run simultaneously.

The Auto-Cal process can be initiated by setting up an internal timer, using an external contact closure or manually through the user interface or triggered via a digital input signal. In all cases if any of these events occur when the Auto-Cal cycle is in process it will ignore the request.

The instrument will only respond to a request for an Auto-Cal from the internal timer or external input if there are no faults indicated. However, the operator can use the analyzer interface to initiate the Auto-Cal sequence even if there is still a fault displayed.

Note: If the Auto-Cal option has been purchased, the pre-assigned relays will be activated when performing a manual span calibration and zero calibration, and at their completion, the sample gas relay will be activated.

12.3 Calibration Gas Standard Requirements

Zero and Span gas standards are required to perform the calibration of each of the transducers fitted into the analyzer. Tolerances and Span bottle certified concentration values must be inputted for each transducer individually and updated when a cylinder bottle is replaced.

The quality of the gas standards used will greatly impact the results of the measurement. Servomex recommends the use of certified gravimetric gas blends and mixtures for the calibration of the MonoExact DF310E/DF150E analyzer. For highest accuracy use gases from a supplier that participates in a rigorous regulatory oversight program such as the US EPA Protocol Gas Verification Program or equivalent programs provided by the European and Asian National Metrology Institutes. While calibration standards of ±2% accuracy are acceptable, standards of ±1% accuracy afford the highest accuracy.

Gas standards can be either simple binary mixtures of a span gas and a standard carrier gas such as N2 or Air, or more complicated mixtures provided the mixture is stable and will not change over time. If unsure, follow the regulatory guidelines for the region or country.

See **Error! Reference source not found.** for a listing of all of the transducers and their full-scale range values, and **Error! Reference source not found.**, Appendix F and **Error! Reference source not found.** for details including suggested SPAN values for the purchased transducer concentration range for the Single Beam Single Wavelength (SBSW) non-dispersive infrared (NDIR), Paramagnetic oxygen and the NDIR Gas Filter Correlation (GFX) transducers respectively.

12.4 Recommended calibration periods

Coulometric measurements are fully calibrated at the factory, and it is not a requirement to calibrate in service, except as suggested by Servomex applications group.

For paramagnetic O_2 percent measurements, it is highly recommended to calibrate the analyzer when it is first set-up and then weekly thereafter, or whenever ambient conditions change.

During the paramagnetic oxygen calibration, it is good practice to perform a low (Lo) calibration followed by a high (Hi) calibration. However, a single point calibration is often sufficient.

Hint: *The required calibration interval depends on the reliance that you place upon the accuracy and consistency of the measurements made by the analyzer. Adjust the calibration interval according to your requirements and the drift characteristics of your analyzer.*

12.5 Manual calibration

Figure 12-1: Calibration screen (manual calibration activated)

The Manual calibration mode requires the user to manually trigger the transducer calibration when a Span gas is flowing for the High Span value and when a Zero or Low concentration gas is flowing for the Low Span / Zero value.

Table 12-1: Manual Calibration Icons

Icon	Meaning	Function

	High Span	To set the High Span calibration value based upon the bottle certified concentration.
	Zero or Low Span	To set the Low Span calibration point, generally set to “0” using a zeroing gas like Nitrogen.
	Restore Factory Settings	This icon restores the original factory parameters and any changes made to the calibration will be lost.
	Measurement Alarm Settings	Touch this icon to set the measurement alarm values for the transducer.
	Home	Return back to the system Home screen.

Note: To restore the factory calibration settings, press the  *icon - take care as any changes made to the calibration up to this point will be lost. This feature is only available on the 1520 transducers (CO_2% and CO%)*

12.5.1 Manual calibration of High Span

Make sure that your equipment is configured to correctly route your high span calibration gas supply to the analyzer sample gas inlet.

1. Run the High Span calibration gas through the analyzer and wait 15 minutes.
    a. Allow the span value to stabilize for one minute.
    b. Touch the high span measurement  icon shown on the screen (see Figure 12-1).
2. The new screen (see Figure 12-2) will display the target value along the top bar.
    a. The target value will be the last span value that was used to calibrate that transducer.
    b. If the target value is not correct for the calibration gas you are using, change the target value to the certified gas bottle concentration value using the numeric keypad (see Figure 12-2).
    c.  accepts the new entry,  deletes the last typed value and  cancels the entry.

Figure 12-2: Span value entry keypad with Target Value on the top bar

3. Press  to accept the new entry and launch the manual calibration run screen shown in Figure 12-3.

Figure 12-3: Start calibration – gas filling state

a. A “Service in Progress” signal is triggered, the gas is flowing through the transducer and the sequence of the calibration step is displayed at the bottom of the screen in Yellow.

b. The Run  icon will stay red (see Figure 12-3) while the gas measured value is:

- For High Span: less than 80% of the High Span target value (in the example above this would be ≥ 40 ppm).
- For Zero / Low Span: greater than 20% of the High Span target value (in the example above this would be ≤ 10 ppm).

Figure 12-4: Start calibration – READY State

c. When the gas measured value is near to the target value the Run icon will turn from RED to GREEN (Figure 12-4).
   - For High Span: >80% of the High Span target value (in the example above this would be ≥ 40 ppm).
   - For Zero / Low Span: < 20% of the High Span target value (in the example above this would be ≤ 10 ppm).

d. Calibration is started by pressing the Run icon

e. When the calibration is finished it reverts back to the screen displaying the gas reading (see Figure 12-2) to show the post-calibration reading.

4. To repeat the calibration, touch the Run icon again.

5. When the calibration procedure is finished touch the Back icon to terminate "Service In Progress" and bring up the measurement screen (Figure 12-1).

Note: The User can over-ride the warning given by the Run icon by touching the icon. The Calibration sequence will continue even though the measured gas value is not near the target value. This is not recommended as the red icon may be flagging there is something wrong with the sampling system, the calibration gas or the transducer.

12.5.2 Manual calibration of Zero or Low Span

1. Run the Low Span or Zero calibration gas through the analyzer and wait 15 minutes.
    a. Allow the displayed value to stabilize for one minute.
    b. Touch the Low Span or Zero measurement  icon shown on the screen in Figure 12-1.
2. Repeat steps 2 through 5 in Section 12.5.1 to calibrate the Zero / Low Span measurement  .

Table 12-2: Manual High Span and Zero Icons

Icon	Meaning	Function
	High Span	Set the High Span calibration value based upon the bottle certified concentration.
	Zero or Low Span	Set the Low Span calibration point, generally set to “0” using a zeroing gas like Nitrogen.
	Run Calibration with measured value <20% away from target.	Start the Manual Calibration run. The icon turns green when the measured value is within 20% of the Target value.
	Run Calibration with measured value >20% away from target.	Start the Manual Calibration run but note that the measured value is not close to the target value. The icon stays red until the measured value is within 20% of the Target value.
	Terminate Service in Progress	Stop the calibration or validation process.
	Delete Last	Delete the last digit typed in.
	Return	Accept the value entered in the keypad. Typing in “0” on the keypad will stop the data recording if the Return key is pressed.
	Cancel	Cancel the value entered in the keypad.

12.6 Span reference value

The span reference value is a diagnostic parameter that can be used as a sensor diagnostic.

Figure 12-5: Calibration screen showing span reference value

Two numbers appear at the bottom of the screen (Figure 12-5). The second number is the span reference value (in Figure 12-5 the span reference value is 1000, the factory default value).

When the factory calibration is modified in the field, the span reference value is likely to change. Some change is expected because the span gas used in the field will not be identical to the one used in the factory.

However if there is a large change in the span reference value, this indicates that there either a problem with the field calibration or that the coulometric sensor is not operating properly. If the span reference value is below 750 or above 1250, consult the Servomex service group. We have made monitoring the span reference value possible through the alarms setting options.

12.7 Auto-Cal validation and calibration sequences

The optional Auto-Cal feature provides validation and calibration sequences that can be triggered automatically. The validation sequences allow the user to validate the reading

against preset Zero and Span gas value and tolerance. The calibration sequences allow validation followed by calibration to update the transducer calibration equation.

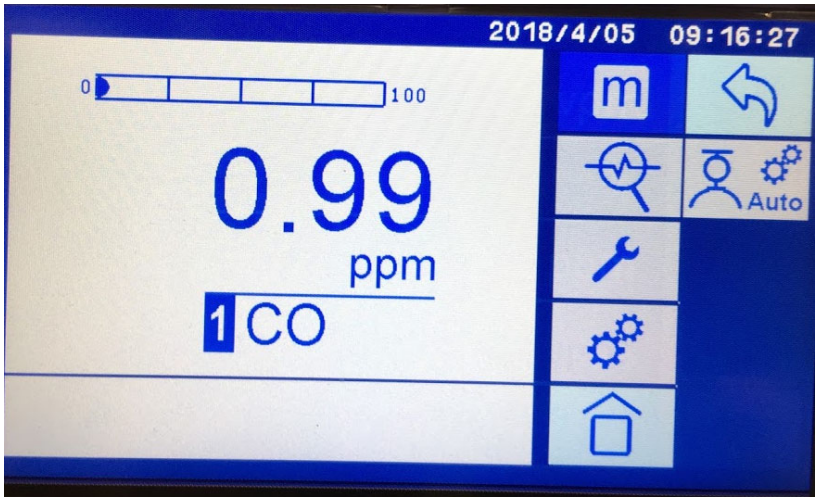


Figure 12-6: Auto-Cal main screen

Any of the sequences can be set to run at user chosen times and dates automatically. To validate or calibrate multiple transducers at the same time using a gas blend then each transducer date, time and repeats must be set up to be the same. The Span value for the Calibration or Validation must then be added for each gas transducer based upon the certified value of that gas constituent in the blended cylinder.

External valves or a single multiport switching valve will need to be installed and connected to the transducer relays by the customer to enable the “Service in Progress” signal and the Auto-Cal routine to trigger the Zero, Span and Sample modes on each transducer.

If more than one transducer is present in the analyzer then all of the transducers will turn Yellow indicating they are no longer producing “good” sample gas readings and are in the “Service in Progress” mode (see Figure 12-7). Transducers that are in the Auto-Cal or Auto-Val sequence will show up as black text on the screen while those that are not in progress are in grey text. In Figure 12-7 the NO and SO_2 gas transducer sequence timings were configured to be the same and they are undergoing Auto-Cal simultaneously as indicated by the BLACK text.

Figure 12-7: Calibration or Validation "Service In Progress" screen

When Auto-Cal is purchased a manual validation check or calibration adjustment can still be made, using the same transducer relays and valves established in the Auto-Cal configuration.

The auto-validation and auto-calibration processes can be initiated by four methods:

1. by an internal timer;
2. by an external contact closure;
3. by operator manual request using the analyzer front panel user interface;
4. by an external Modbus or PROFIBUS command

The instrument will only respond to a request for Auto-Cal from the internal timer or external input if there are no faults indicated. Auto-Cal can be initiated from the user interface when there is a fault condition.

If any one of these events occurs while the Auto-Cal cycle is in progress the request will be ignored. Touching the keypad during Auto-Cal will initiate the abort sequence.

The Auto-Cal feature offers custom configurations for automatic Validation and Calibration operations. The general sequence uses three gas streams (Zero, Span and Sample) and the Zero gas or the Span gas can be skipped by setting the timing (t1, t2..) to zero, skipping that step.

Up to three sequences can be assigned to each transducer (see Figure 12-8). They can be of any form of auto-calibration or auto-validation as needed.

For example, if you need to perform a daily Zero and Span check / validation then you could assign this to sequence #1 using the auto-validation function. In sequence #2 you might assign a weekly auto-calibration sequence.

Note: The internal analyzer timer will trigger the Auto-Cal sequence without any external input required. However, if an external input is used to trigger the Auto-Cal then only the first sequence will commence.

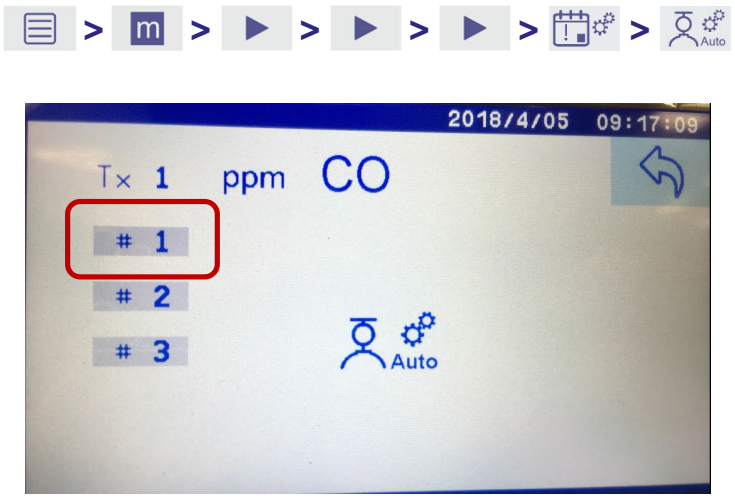


Figure 12-8: Sequence setup screen - #1 is shown in the box

An overview of how the Auto-Cal validation sequences are handled is given in Section 12.8 and an overview of how the Auto-Cal calibration sequences are handled is given in Section 12.9.

12.8 Auto-validation sequence steps

12.8.1 Auto- validation flow diagram

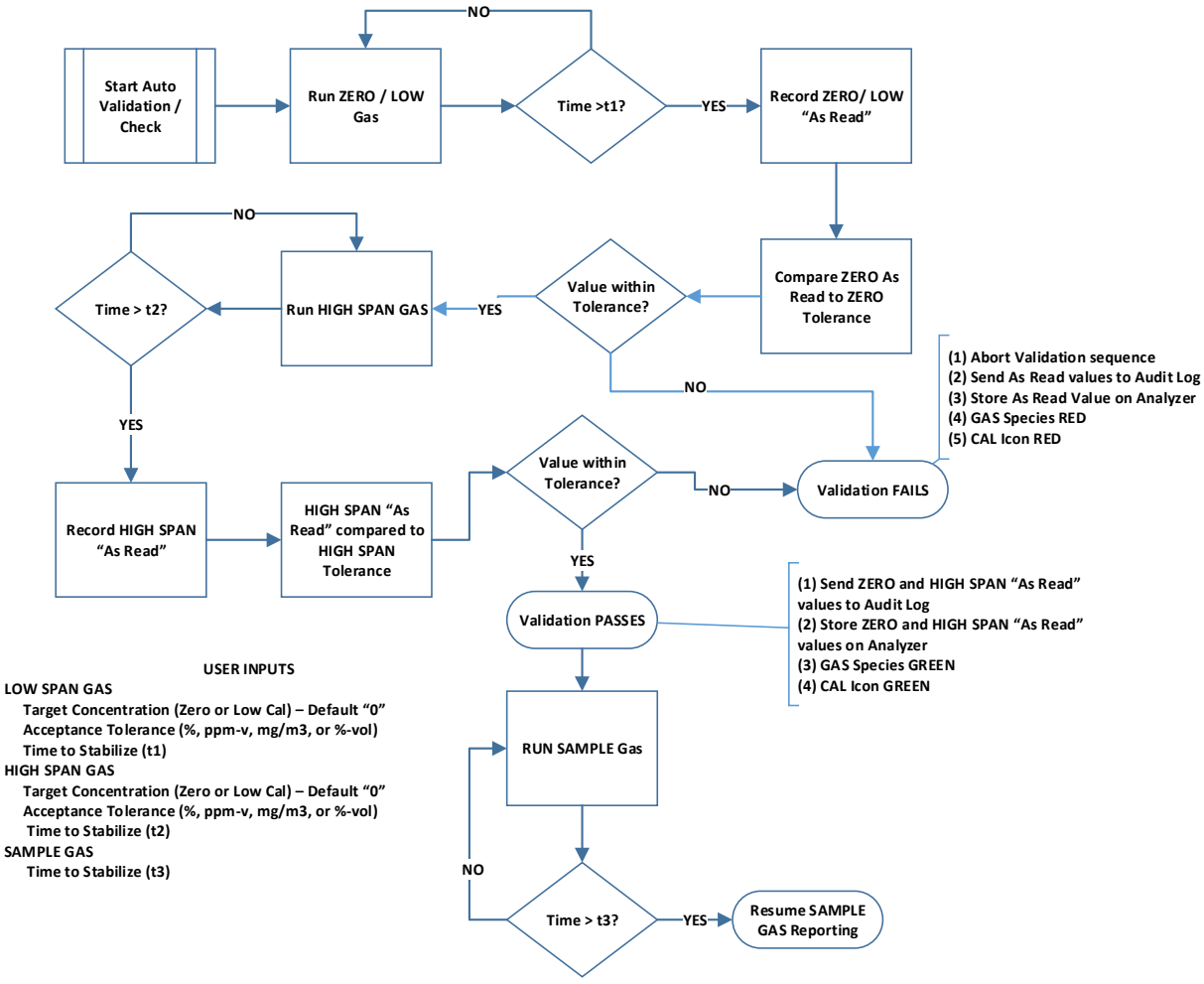


Figure 12-9: Flow diagram of the Auto-Validation steps

12.8.2 Auto- validation full sequence example

The full sequence for auto-validation is shown in Figure 12-10 providing a simple Pass or Fail result. Even if the sequence fails, the gas sample measurements can continue to report values. Figure 12-10 and Table 12-3 describe how the auto-validation sequence works. Each transducer must be set up separately to perform an auto-validation.

If you want two or more of the transducers to run auto-validation simultaneously then the sequence timing as well as the Date and Time settings need to be the same.

Note: If the Zero or Span Validation step fails the Transducer gas icon will remain RED until the user corrects the problem, gas measurement reporting will continue however.

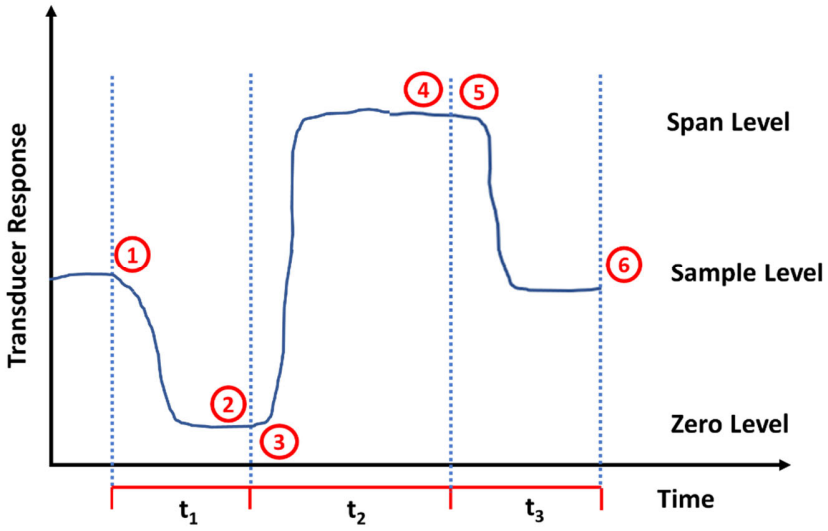


Figure 12-10: Full auto-validation sequence

Table 12-3: Typical auto-validation sequence on a transducer

Point	Function
1	Zero gas routed to transducer and set ***Service In Progress*** flag and turn on any ***Service In Progress*** relays.
t1	Time required for Zero gas readings to stabilize.
2	Zero gas “As Found” value recorded and compared to “0” ± tolerance. If Zero gas “As Found” value Passes - Skip to Point 3. If Zero gas “As Found” value Fails – Log Failure and turn Gas icon and Auto-Cal icon RED.
3	Span gas routed to transducer.
t2	Time required for Span gas readings to stabilize.
4	Span gas “As Found” value recorded and compared to High Span value ± tolerance. If Span gas “As Found” value Passes - Skip to Point 5. If Span gas “As Found” value Fails – Log Failure and turn Gas icon and Auto-Cal icon RED.
5	Sample gas routed to analyzer.

Point	Function
t3	Time required for Sample gas readings to stabilize and begin reporting gas measurments. This cannot be set to “0” and is defaulted to 1 sec before restoring the measurment values.
6	Clear ***Service In Progress*** and turn off any ***Service In Progress*** relays and begin reporting Sample gas measurements.
	Final output will be Pass or Fail flag

12.8.3 Auto-validation truncated sequence example

The next sequence below describes how to skip the Zero portion of the auto-validation sequence, performing only a Span Check in the auto-validation (see Figure 12-11 and Table 12-4).

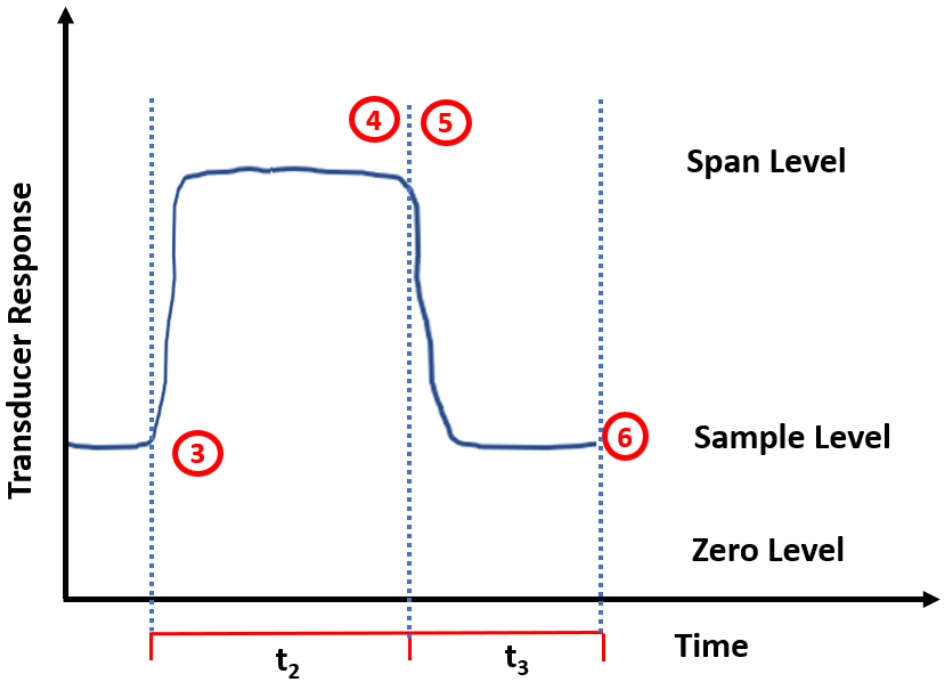


Figure 12-11: Auto-Validation Span Check only sequence

Table 12-4: Auto-validation Span only sequence on a transducer

Point	Function
1	Zero gas switch to analyzer skipped as t1 set to “0”
t1	Zero gas Time set to “0”
2	Zero gas “As Found” read and comparison skipped as t1 set to “0”

Point	Function
3	Span gas routed to transducer and set ***Service In Progress*** flag and turn on any ***Service In Progress*** relays.
t2	Time required for Span gas readings to stabilize.
4	Span gas “As Found” value recorded and compared to High Span value ± tolerance. If Span gas “As Found” value Passes - Skip to Point 5. If Span gas “As Found” value Fails – Log Failure and turn Gas icon and Auto-Cal icon RED.
5	Sample gas routed to analyzer.
t3	Time required for Sample gas readings to stabilize and begin reporting gas measurments. This cannot be set to “0” and is defaulted to 1 sec before restoring the measurment values.
6	Clear ***Service In Progress*** and turn off any ***Service In Progress*** relays and begin reporting Sample gas measurements.
	Final output will be Pass or Fail flag

12.8.4 Auto-validation setup screen

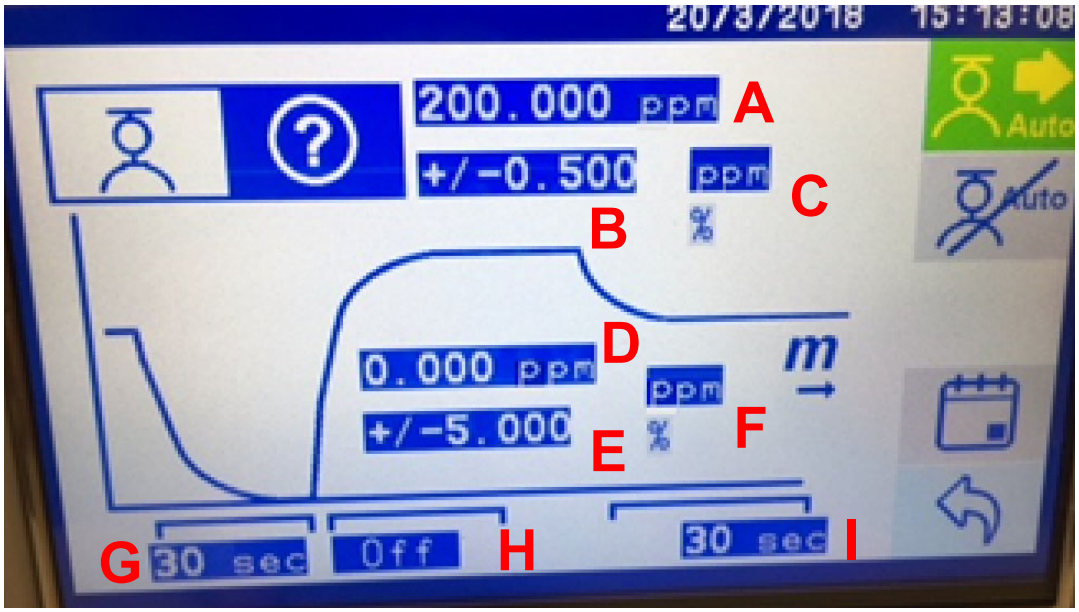


Figure 12-12: Auto-validation setup screen is active (t2 is skipped)

Table 12-5: Auto-Validation setup screen input function labels for Figure 12-12

Symbol	Function
A	Touch this text box to enter High Span concentration bottle tag / certified value (shown as 200.000 ppm tag value).
B	Touch this text box to enter High Span concentration tolerance value as a percentage of the High Span value or a fixed value (shown as ±0.500 ppm fixed concentration value).
C	Touch this text box to enter High Span concentration tolerance units as concentration (ppm, mg/m3 or %-v) or a percent of the span value (shown as ppm).
D	Touch this text box to enter Zero or Low Span concentration bottle tag / certified value. Default is 0.000 (shown as 0.000 ppm value).
E	Touch this text box to enter Zero or Low Span concentration tolerance value as a percentage of the High Span value or a fixed value (shown as ±5.000 ppm fixed value).

Symbol	Function
F	Touch this text box to enter Zero or Low Span concentration tolerance units as concentration (ppm, mg/m3 or %-v) or a percent of the span value (shown as units as ppm).
G	Touch this text box to enter Time required for Zero gas readings to stabilize, then take an “As Found” reading (see Section 12.8.2 for location of #1,t1,#2). Shows t1 as 30 seconds.
H	Touch this text box to enter Time required for High Span gas readings to stabilize, then take an “As Found” reading (see Section 12.8.2 for location of #3,t2,#4). Shows t2 as Off indicating the High Span Validation check section will be skipped.
I	Touch this text box to enter Time required for Sample gas readings to stabilize before measurement reporting begins reading (see Section 12.8.2 for location of #5, t3, #6). Shows t3 as 30 seconds.
	Symbol showing where Measurement of Sample begins. Has no function.

Touch the Start Auto-Cal icon  to run the auto-calibration/validation sequence straight away or touch the Calendar icon  to set a time for the auto-calibration/validation sequence to start.

Note: To abort the auto-calibration/validation set-up sequence touch  *. It will also cancel any future events so have care when using this function.*

Table 12-6: Auto-Validation setup screen icons

Icon	Meaning	Function
	Auto-calibration settings	Selects the auto-calibration sequence setup screen.
	Auto-validation settings	Selects the auto-validation sequence setup screen. Blue background indicates active function.
	Auto-Cal Timing	Sets up the timing for the auto-calibration and auto-validation sequences. Up to 3 sequences can be set for each transducer.

Icon	Meaning	Function
	Start Auto-Cal	Forces the current auto-calibration or auto-validation sequence on the screen to be executed.
	Stop Auto-Cal	Disables or cancels the auto-validation or auto-calibration sequence that is in progress. Be careful with this function at it also cancels any future timed events.
	Return	Returns the screen to the main Maintenance Menu.

12.9 Auto-Calibration Sequence Steps

12.9.1 Auto-Calibration Sequence Flow Diagram

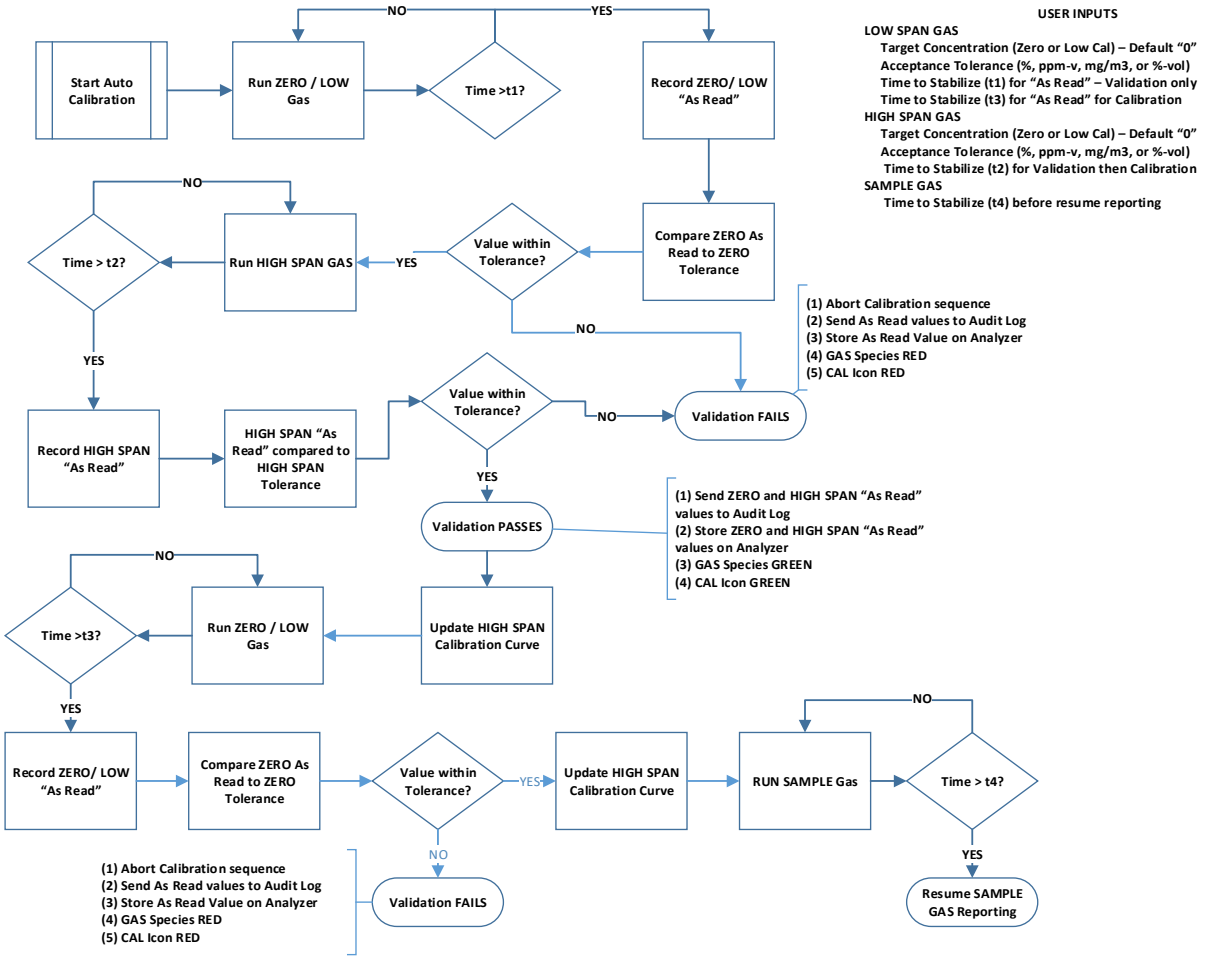


Figure 12-13: Flow diagram of the Auto-Calibration Steps

12.9.2 Auto-Calibration full sequence example

The full sequence for Auto-Calibration is shown in Figure 12-14 providing a new calibration curve for the transducer if the validation step passed otherwise the calibration step will not be performed. Even if the sequence fails, the gas sample measurements can continue to report values, but a manual calibration must be done if the validation sequence fails. The user should check to ensure the gas sampling system is working properly and the calibration gas standards are accurate before attempting another calibration after a failure.

The full sequence Auto-Calibration process reads the Zero gas "As Found" value then switches to the Span gas to read the "As Found" value, both performed before any

calibration curve changes. The second Zero gas “As Found” process is used to set the Zero calibration point.

Figure 12-14 and Table 12-7 describe how the full Auto-Calibration sequences works and Section show how to set timing, concentration and threshold limit values. Each transducer must be set up separately in order to perform an Auto-Calibration.

Note: If the Zero or Span Validation step fails the Transducer gas icon will remain RED until the user corrects the problem, gas measurement reporting will continue however.

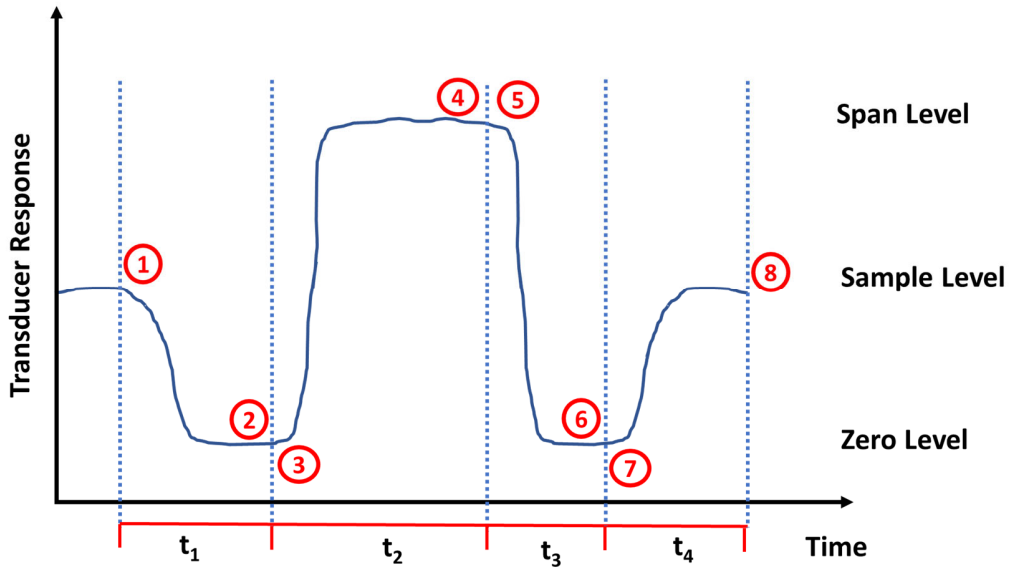


Figure 12-14: Full Auto-Calibration sequence

Table 12-7: Typical Auto-calibration processes on a transducer

Symbol	Function
1	Zero gas routed to transducer and set ***Service In Progress*** flag and turn on any ***Service In Progress*** relays.
t1	Time required for Zero gas readings to stabilize.
2	Zero gas “As Found” value recorded and compared to “0” ± tolerance. If Zero gas “As Found” value Fails – then Auto-Calibration sequence is terminated, Validation Failure is issued.
3	Span gas routed to transducer.
t2	Time required for Span gas readings to stabilize.

Symbol	Function
4	Span gas “As Found” value recorded and compared to High Span value ± tolerance. If Span gas “As Found” value Passes - Calibrate to High Span value. Skip to Point 5. If Span gas “As Found” value Fails – then Auto-Calibration sequence is terminated, Validation Failure flag is issued, and the Gas Component and Auto-Cal icon turn RED. Skip to Point 7 and switch gas to sample stream.
5	Zero gas routed to analyzer.
t3	Time required for Zero gas readings to stabilize. If Zero gas “As Found” value Passes Calibrate to Low Span value which is generally “0”. Skip to Point 7. If Zero gas “As Found” value Fails – then Auto-Calibration sequence is terminated, Validation Failure flag is issued, and the Gas Component and Auto-Cal icon turn RED. Skip to Point 7 and switch gas to sample stream.
7	Sample gas routed to analyzer.
t4	Time required for Sample gas readings to stabilize and begin reporting gas measurments.
8	Clear ***Service In Progress*** and turn off any ***Service In Progress*** relays and begin reporting Sample gas measurements.
	Final output will be Pass (Recalibration) or Fail (No Calibration, Failure Flag set, Switch to Sample gas)

12.9.3 Auto-calibration truncated sequence example

Figure 12-15 and Table 12-8 describe how the auto-calibration sequences can be configured to skip the first Zero “As Found” validation section and only use the second Zero “As Found” validation test followed by a calibration. In Figure 12-15 the Span “As Found” value is obtained prior to performing any calibration curve changes, while the Zero “As Found” value is obtained after the Span High Calibration point has been changed.

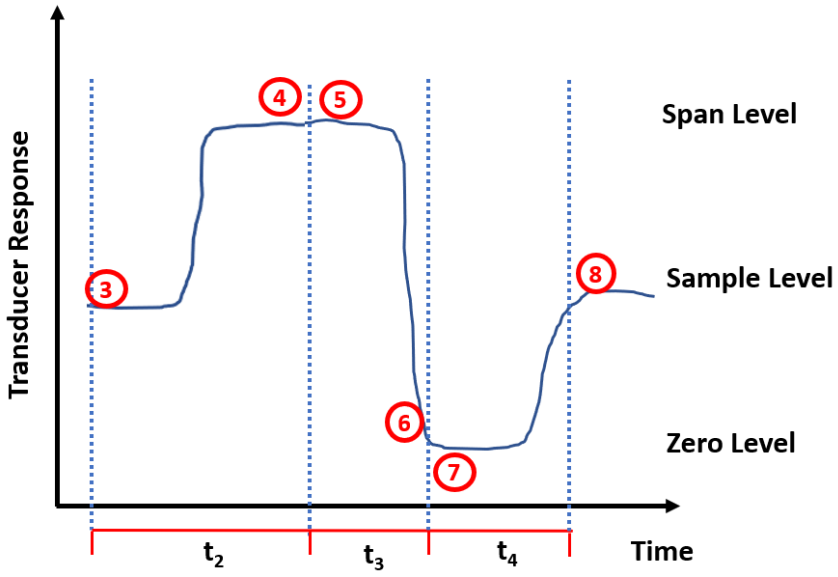


Figure 12-15: Auto-calibration without Initial Zero "As Found" read.

Table 12-8: Auto-calibration without Initial Zero "As Found"

Symbol	Function
1	Zero gas switch to analyzer skipped as t1 set to "0"
t1	Zero gas Time set to "0"
2	Zero gas "As Found" read and comparison skipped as t1 set to "0"
3	Span gas routed to transducer and set ***Service In Progress*** flag and turn on any ***Service In Progress*** relays.
t2	Time required for Span gas readings to stabilize.
4	Span gas "As Found" value recorded and compared to High Span value ± tolerance. If Span gas "As Found" value Passes - Calibrate to High Span value. Skip to Point 5. If Span gas "As Found" value Fails – then auto-calibration sequence is terminated, Validation Failure flag is issued, and the Gas Component and Auto-Cal icon turn RED. Skip to Point 7 and switch gas to sample stream.
5	Zero gas routed to analyzer.
t3	Time required for Zero gas readings to stabilize.

Symbol	Function
6	Zero gas “As Found” value recorded and compared to Low Span “0” value ± tolerance. If Zero gas “As Found” value Passes Calibrate to Low Span value which is generally “0”. Skip to Point 7. If Zero gas “As Found” value Fails – then auto-calibration sequence is terminated, Validation Failure flag is issued, and the Gas Component and Auto-Cal icon turn RED. Skip to Point 7 and switch gas to sample stream.
7	Sample gas routed to analyzer.
t4	Time required for Sample gas readings to stabilize and begin reporting gas measurments. This cannot be set to “0” and is defaulted to 1 sec before restoring the measurment values.
8	Clear ***Service In Progress*** and turn off any ***Service In Progress*** relays and begin reporting Sample gas measurements.
	Final output will be Pass (Recalibration) or Fail (No Calibration, Failure Flag set, Switch to Sample gas)

Hint: *The key difference between the sequences shown in Figure 12-14 and Figure 12-15 is that there is no initial Zero “As Found” value recorded in the sequence shown in Figure 12-15. The sequence in Figure 12-14 will support regulatory compliance where both the Zero gas and the Span gas “As Found” readings need to be recorded prior to any calibration curve changes from the High Span or the Low / Zero Span calibrations.*

12.9.4 Auto-calibration screen setup

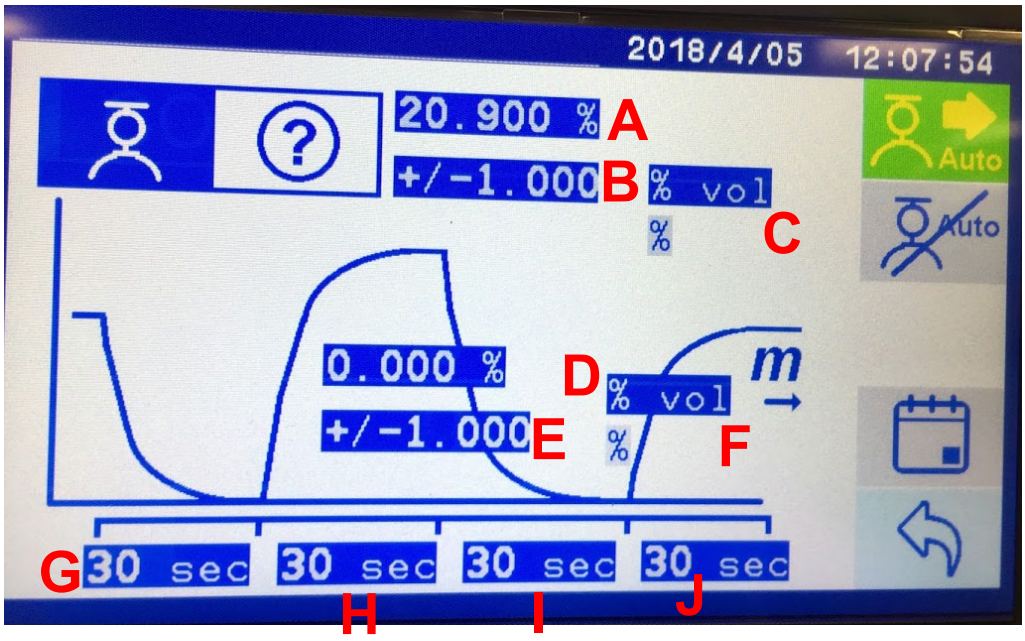


Figure 12-16: Auto-calibration setup screen is active

Up to 3 sequences can be set up on each transducer as a mixture of auto-calibration and auto-validation sequences (see Section 12.6). These sequences are initiated by the internal timer and do not require an external trigger for execution.

Note: If the User Interface, digital input, or Modbus/PROFIBUS command is used to START or STOP Auto-Cal on a transducer, only the first sequence will be triggered.

Table 12-9: Auto-Calibration setup screen icons for Figure 12-16

Symbol	Function
A	Touch this text box to enter High Span concentration bottle tag / certified value. Figure 12-16 shows 20.900% tag value.
B	Touch this text box to enter High Span concentration tolerance value as a percentage of the High Span value or a fixed value. Figure 12-16 shows ±1.000 %-vol fixed value.
C	Touch this text box to enter High Span concentration tolerance units as concentration (ppm, mg/m3 or %-vol) or a percent of the span value (%). Figure 12-16 shows units as %-vol.

Symbol	Function
D	Touch this text box to enter Zero or Low Span concentration bottle tag / certified value. Default is 0.000. Figure 12-16 shows 0.000% value.
E	Touch this text box to enter Zero or Low Span concentration tolerance value as a percentage of the High Span value or a fixed value. Figure 12-16 shows ±1.000 %-vol fixed value.
F	Touch this text box to enter Zero or Low Span concentration tolerance units as concentration (ppm, mg/m3 or %-v) or a percent of the span value. Figure 12-16 shows units as %-vol.
G	Touch this text box to enter Time required for Zero gas readings to stabilize, then take an “As Found” reading (see Section 12.9.2 for location of #1, t1, #2). Figure 12-16 shows t1 as 30 seconds.
H	Touch this text box to enter Time required for High Span gas readings to stabilize, then take an “As Found” reading, and Calibrate if reading outside of tolerance (see Section 12.9.2 for location of #3, t2, #4). Figure 12-16 shows t2 as 30 seconds.
I	Touch this text box to enter Time required for Zero gas readings to stabilize, then take an “As Found” reading, and Calibrate if reading outside of tolerance (see Section 12.9.2 for location of #5, t3, #6). Figure 12-16 shows t3 as 30 seconds.
J	Touch this text box to enter Time required for Sample gas readings to stabilize before measurement reporting begins (see Section 12.9.2 for location of #7, t4, #8). Figure 12-16 shows t4 as 30 seconds.
	Symbol where Measurement of Sample begins. Has no function.

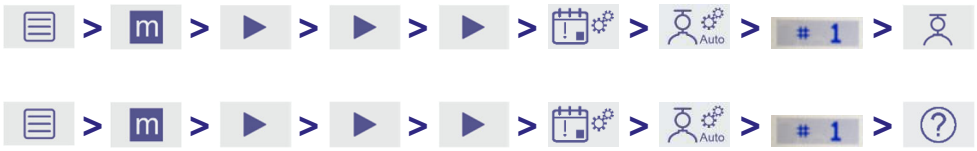
Either touch  to run the auto-calibration/validation sequence straight away, or touch  to set a time for the auto-calibration/validation sequence to start.

Note: Touch  *to abort the auto-calibration/validation set-up sequence. It will also cancel any future events so be careful when using this function.*

Table 12-10: Auto-Calibration setup screen icons for Figure 12-16

Icon	Meaning	Function
	Calibration settings	Selects the auto-calibration setup screen. Blue background indicates active function as shown in Figure 12-16.
	Validation settings	Selects the auto-validation setup screen.
	Auto-Calibration/ Validation enabled	Forces the current auto-calibration or auto-validation sequence on the screen to be executed.
	Auto-Calibration/ Validation disabled	Disables or cancels the auto-validation or auto-calibration sequence that is in progress. Be careful with this function at it also cancels any future timed events!
	Auto-Calibration/ Validation Timing	Sets up the timing sequences for the auto-calibration and auto-validation. Up to 3 sequences can be set for each.
	Return	Returns the screen to the main Maintenance Menu.

12.10 Auto-Cal Thresholds settings per sequence



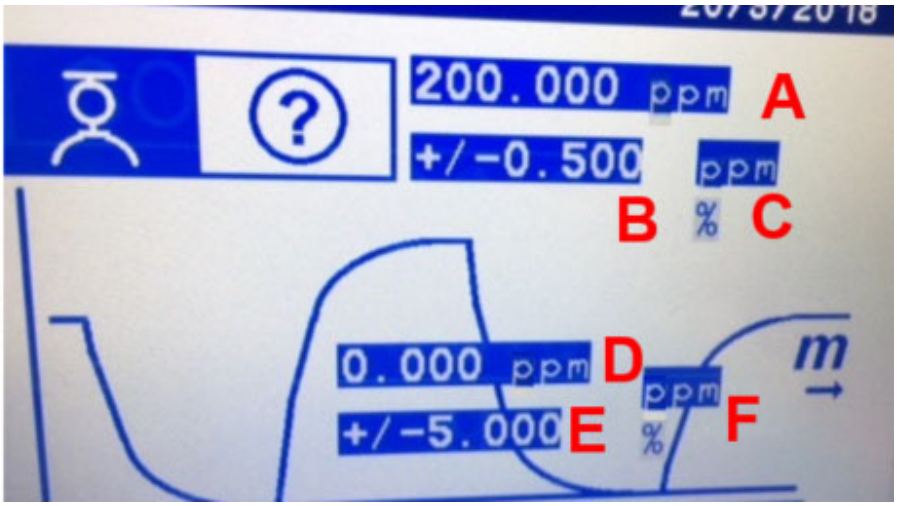


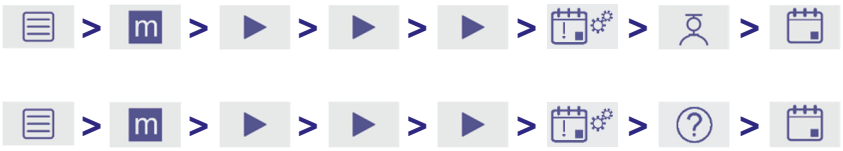
Figure 12-17: Auto-Cal thresholds setup (auto-calibration is active)

Table 12-11: Auto-Cal Threshold settings descriptions (applies to auto-calibration and auto-validation) see Figure 12-17

Symbol	Description
A, D	High Span and Zero Span Bottle Concentration value. The units here can be set at any time from the Measurement Branch but are based upon the intrinsic transducer value. If the Concentration value Units are (**%-v**) this is the representation of percent concentrations by volume. If the Concentration value Unit is (**ppm**) this is the representation of part per million by volume concentrations. If the Concentration value Unit is (**mg/m^3**) this is the representation of mass concentrations based upon the specific gas component. If the transducer intrinsic value is (**%-vol**) concentration, then the units will be displayed as **%-vol** and cannot be changed to any other unit. If the transducer intrinsic value is (**ppm**) concentration, then the units will be displayed as **ppm** and can be changed to **mg/m^3**.

Symbol	Description
B, E	High Span and Zero Span Tolerance Value. The units are set in this screen. If the Span or Zero gas value “As Read” is outside of this tolerance, then the auto-validation or auto-calibration will fail and no changes will be made to the transducer calibration. If the Span or Zero gas value “As Read” is inside of this tolerance, then the auto-validation passes and auto-calibration recalibrate the transducer equation using the new value.
C, F	High Span and Zero Span Tolerance Value Units. The units are set in this screen. If the Threshold Value Unit selected is (**%-vol**) then the value represents a concentration value. If the Threshold Value Unit selected is (**%**) then the value represents a percentage calculation of the concentration value entered regardless of the unit type (**%-vol**, **ppm**, **mg/m^3**). If the Threshold Value Units are (**mg/m^3**) then the value represents a fixed concentration value above and below the Span or Zero concentration in **mg/m^3**. If the Threshold Value Units are (**ppm**) then the value represents a fixed concentration value above and below the Span or Zero concentration in **ppm**.

12.11 Auto-Cal sequence timing setup



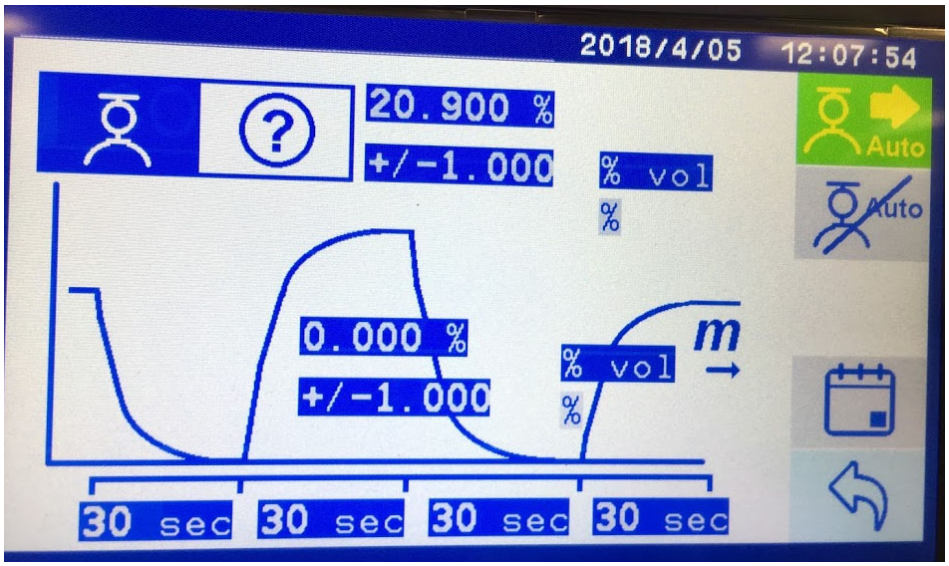


Figure 12-18: Auto-calibration setup screen is active

This section applies to both the auto-calibration and the auto-validation sequences and is used to set up the date, time and repeats for the automatic runs.

12.11.1 Auto-Cal sequence general timing

Touch the  icon in Figure 12-18 to get to the Date screen to set the Day/Month/Year for the first auto-calibration / auto-validation event. The first set of arrows allows you to choose to display the values in MM/DD/YY, DD/MM/YY, or YY/MM/DD.

- Touch  to accept entry and move to Time Set screen
- Touch  to cancel the changes and go back to Sequence Setup initial screen

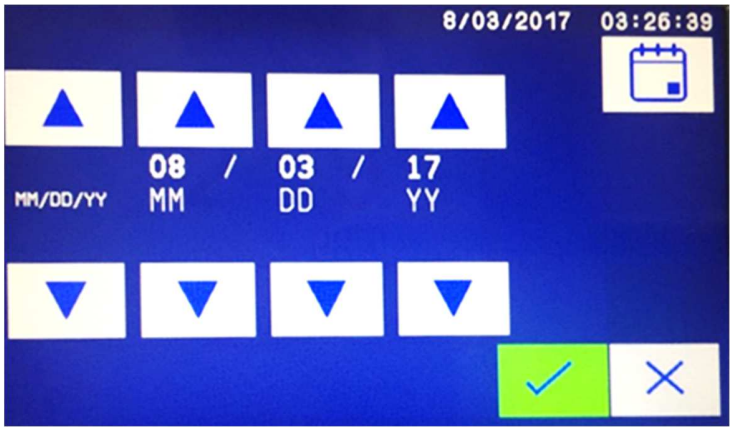


Figure 12-19: Auto-calibration Date setup screen

Touch the  icon in Figure 12-19 to accept the Date and take you to the Time screen to set the Hour/Minute/Second for the auto-calibration / auto-validation event.

- Touch  to accept entry and move to Time Set screen
- Touch  to cancel the changes and go back to Sequence Setup initial screen

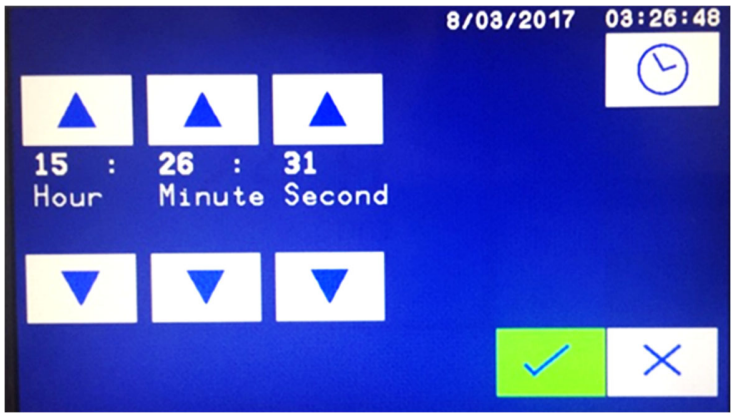


Figure 12-20: Auto-calibration Time of Day setup screen

Touch the  icon in Figure 12-20 to accept the Time and take you to the Repeat Timing screen. This is used to repeat the auto-validation / calibration sequence on a regular basis, every XX Days or every YY Hours.

- Touch  to accept entry and move to Repeat Timing screen
- Touch  to cancel the changes and go back to Sequence Setup initial screen

Figure 12-21: Auto-calibration Repeat Timing setup screen: Left shows repeat Day, Right shows Hour set

- Touch  to accept entry and move to back to Auto-Cal Main screen
- Touch  to cancel the changes and go back to Sequence Setup initial screen
- Touch  to repeat the auto-calibration.

12.11.2 Auto-Cal sequence timing setup for multiple transducers

If you want to run multiple transducers using the same calibration and zero gases, each transducer in the group must use the same settings for the following items:

- For auto-validation t1, t2, t3 must be the same for all transducers that are to be run at the same time (see Figure 12-12: G, H, I).
- For auto-calibration t1, t2, t3, t4 must be the same for all transducers that are to be run at the same time (see Figure 12-18: G, H, I, J).
- For auto-validation or auto-calibration all transducer settings for Date (see Figure 12-19), Time (see Figure 12-20), and Repeat Timing (see Figure 12-21) must be the same.

Note: The t1, t2, t3, t4 timing should be based upon the gas component that takes the longest time to come to a steady reading.

12.12 Auto-calibration valve installation

The auto-calibration and auto-validation function uses relays to control user provided external valves or single multiport valve, or to send a signal out indicating which gas stream is being used at the time of the trigger. If the auto-calibration option is ordered the analyzer will be equipped with eight relays for each transducer in the analyzer. Relays 6, 7 and 8 for each transducer will be permanently assigned to Zero, Span and Sample respectively. See Section 11.2 for more details.

Note: It is up to the customer to supply and connect externally powered valves to supply the correct zero and span gas for each transducer. The analyzer switches

automatically according to the auto-calibration or auto-validation sequence timing and set up.

12.13 Relays used for auto-calibration / validation

Transducer 1 [coulometric O2]:

- Zero or Low Gas Relay #6
- Span (high conc. Calibration gas) Relay #7
- Sample Gas Relay #8

Note: auto-calibration is not possible with AqX moisture measurement.

12.14 Calibration log file

The analyzer calibration history is saved in the config_files directory in the CalibrationRecord.txt file. The file can be written to a USB drive inserted into the analyzer using the button sequence shown above. This file can be opened with a program like Microsoft® Excel.

The example in Figure 12-22 shows an auto-calibration and auto-validation entry. The measured process result is reported as the 'Before' or "As Found" value. The entered span value is 25ppm and after calibration the validation result is also 25ppm.

Tx 1 - Before: 25.100000, Cal high (span) to 25.000000 Success. After: 25.000000 - 07/08/17 10:08			
DTH current after calibration: 6.635808 uA - 07/08/17 10:08:20			
Tx 1 - Validating to 25.000000 10.000000% - 07/08/17 10:08:31			

Figure 12-22: Example calibration log file

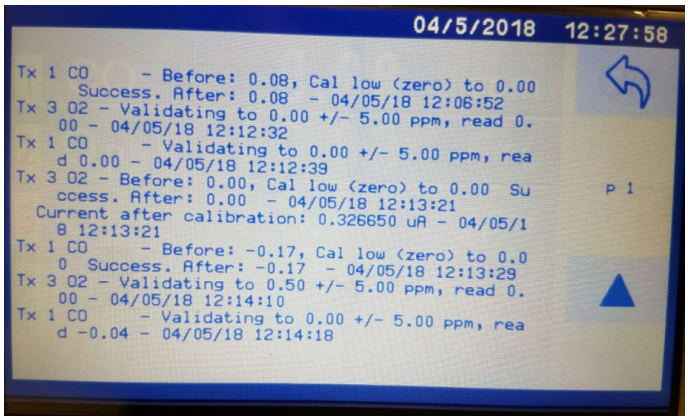


Figure 12-23: Cal log file displayed on screen

Figure 12-23 shows an example of a Calibration Log File as viewed on the analzyer screen. Use the ▲ and ▼ arrow to scroll up or down for more text information on the Auto-Cal operations and results. The information presented here is the same as in the output text log from above.

13 Technical specification

The protection, accuracy, operation and condition of the equipment may be impaired if the analyzer is not installed in accordance with the requirements of this and other sections of the manual.

13.1 Mechanical specification

Dimensions:	*(Length x Height x Width)*
Rack mountable analyzer:	
Without 19-inch rack mounting brackets:	236 x 193 x 205 mm 9.3 x 7.6 x 8.1 inches
With 19-inch rack mounting brackets fitted:	236 x 266 x 483 mm 8 x 5.2 x 19 inches
Bench mounted analyzer:	240 x 193 x 205 mm 9.5 x 7.6 x 8.1 inches *(including feet and handle)*
Mass:	< 5 kg

13.2 Electrical specification

Electrical supply:	
Voltage:	100 to 240 Vac, 50 to 60 Hz *(± 10% maximum fluctuation)*
Supply fuse rating / type:	T3.15 AH / 250V. Size 20 x 5 mm
Maximum power consumption:	100 VA
Interface signal relay ratings	30 V (dc or ac) / 1A *Note: The relay output signals are volt-free signals*
mA output (active):	
Maximum load resistance:	1 kΩ
Isolation voltage (to earth):	500 V (dc or ac)
Output range:	
Normal sample measurement:	4 to 20 mA
Fault condition:	0 mA, 2 mA. User selectable

Voltage output (active):

Minimum load resistance:	100 kΩ
Isolation voltage (to earth):	250 V (dc or ac)
Output range:	
Normal sample measurement:	0 to 10 V
Fault condition:	Fault condition selected as an option at the time of purchase.
Under range:	Not applicable

Signal / voltage / mA / RS485 output terminals suitable for:

Flexible conductors:	0.5 to 1.5 mm^2 (20 to 16 AWG)
Solid conductors:	0.5 to 1.0 mm^2 (20 to 18 AWG)

13.3 Maximum voltage ratings

Common mode compared to chassis ground reference:

Signals:	Maximum voltage rating:
I1+, I1-, I2+, I2-, V1+, V1-, V2+, V2-, IIN1+, IIN1-, IIN2+, IIN2-, DIN3A, DIN3B, DIN4A, DIN4B J17(ALL)	250 Vac
All relays C, NC, NO	40 Vac
J6 (ALL) J8(ALL) J18 (ALL)	15 Vdc

Differential mode between pairs:

Signals:	Maximum voltage rating:
All relays C, NC,NO	30 Vac, dc
IIN1+, IIN- or IIN2+, IIN2-	40 Vdc wrt V1-, V2-
DIN3A, DIN3B or DIN4A,DIN4B	24 Vdc
RS485TX+, RS485TX-	15 Vdc
RS485RX+, RS485RX-	15 Vdc
RS232TX, RS232RX	15 Vdc
J17 pin to pin	9 Vdc

13.4 Environmental limits

The equipment is suitable for indoor use only.

Ambient temperature range:

Operation:	5 to 45 °C
Storage:	0 to 50 °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 metres (below sea level) to 2000 metres (above sea level)
Ingress protection:	IP20

13.5 Sample gas

The sample gases must be clean, non-corrosive, free from oil and condensates and compatible with the materials listed in Error! Reference source not found..

Coulometric transducer (trace O_2)	**sample gases may be flammable**
Flow rate:	300 to 700 ml min^{-1}
Temperature:	5 to 45 °C
Particulate size:	< 2 µm (2 micron)
Pressure Driven Option (critical orifice):	172.36-310.26 kPa; 1.72-3.10 bar; 25-45 psig
Flow Driven Option:	1.4-6.9 kPa; 0.34-1.72 bar; 0.2-1 psig

Paramagnetic transducer (% O_2)	**sample gases must be non-flammable**
Flow rate:	100 to 250 ml min^{-1}
Dewpoint:	5 °C below ambient temperature (minimum)
Temperature:	5 to 45 °C
Particulate size:	< 2 µm (2 micron)
Pressure Driven Option (critical orifice):	14-56 kPa; 0.14-0.55 bar; 2-8 psig

13.6 Calibration gas

The calibration gases must be clean, non-corrosive, free from oil and condensates and compatible with the materials listed in Error! Reference source not found..

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.

Coulometric O_2 trace transducer calibration gases

High calibration setpoint:	40 to 80% of full scale
Low calibration setpoint:	UHP Nitrogen recommended

Paramagnetic O_2 transducer calibration gases

High calibration setpoint:	10 – 25% O_2
Low calibration setpoint:	0 – 15% O_2
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

Note: 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.

14 Routine maintenance

The MonoExact DF310E/DF150E analyzer does not contain any user serviceable parts.

Do not attempt to maintain or service the MonoExact DF310E/DF150E analyzer unless you are trained and know what you are doing. The analyzer must be maintained by a suitably skilled and competent person.

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

Sample and calibration gases may be toxic or asphyxiant.

Never inspect the inlet filter(s), or service or repair the analyzer while such gases are still connected to it.

If the analyzer is to be serviced or repaired, it is important that all pipework is flushed with an inert gas and the analyzer is allowed to freely vent to local atmosphere.

14.1 Cleaning the analyzer

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

14.2 Routine checks

You only need to carry out simple maintenance procedures annually. Carry out the following regular checks to ensure continuous and safe operation of the monitor.

Note: setting the electrolyte replenishment scheduled maintenance .

14.2.1 Inspect / replace the fuse

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

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 them if necessary:

3. Open the fuse panel on the rear of the analyzer (Figure 14-1). To do this, carefully insert a small screwdriver into the gap on the right of the panel and press the clip to open the panel.

Figure 14-1: Open the fuse panel

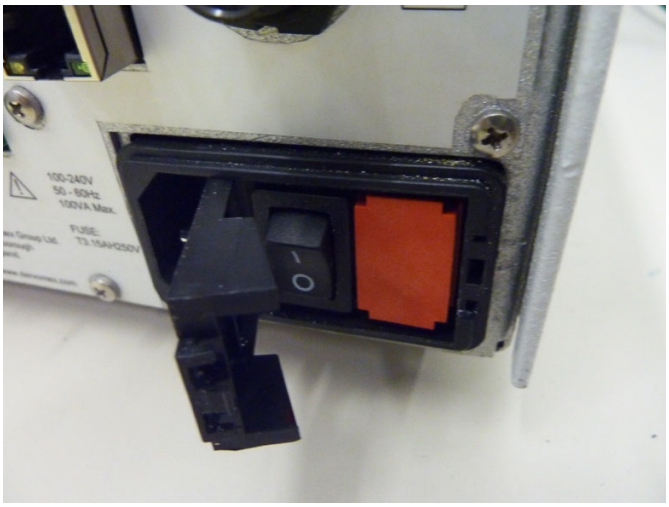


Figure 14-2: Fuse panel opened

4. Pull the red fuse holder out of the panel (Figure 14-2).

   Both live and neutral lines have fuse protection. The neutral fuse is shown (1 in Figure 14-3); the live fuse is located in the underside of the red fuse holder (2 in Figure 14-3).

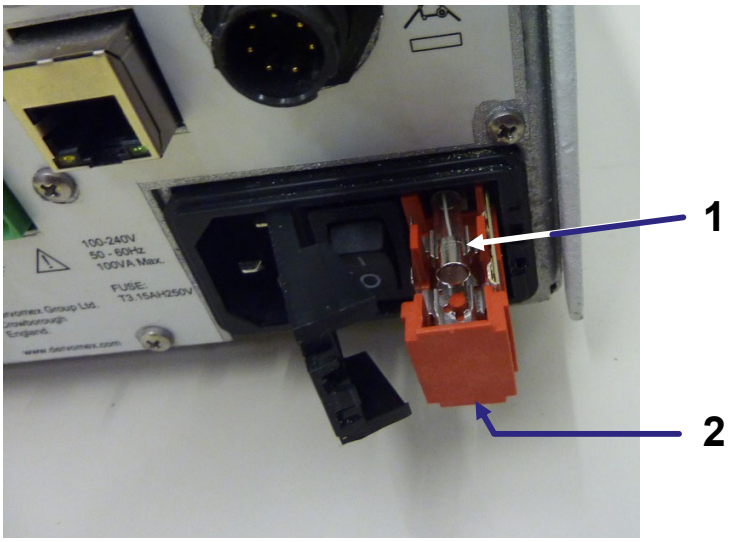


Figure 14-3: Pull out the red fuse holder

5. Remove the top (neutral) fuse from the holder and check the continuity across the fuse.

   If there is continuity, the fuse has not failed, so refit it into the fuse holder.

   If there is no continuity, fit a new fuse into the fuse holder.

   Make sure the fuses are the correct type and rating. The fuse type and rating is shown on the rear panel to the left of the mains connector.

   Make sure you fit the fuse in the correct position in the fuse holder as shown in (Figure 14-3).

6. Repeat step 3 for the bottom (live) fuse which is located on the underside of the red fuse holder.
7. Push the fuse holder back into the fuse panel and close the panel door. It will click into place.

14.3 Preventative maintenance

To minimize unscheduled analyzer downtime, ensure the proper operation of the analyzer and to comply with the guidelines of applicable regulatory bodies, we recommend that you utilize an annual preventative maintenance program for your analyzer.

The preventative maintenance program consists of an annual inspection of the analyzer, and repair of any faults, to ensure that the analyzer meets its original factory specification.

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

15 Troubleshooting

The following section will help to resolve many of the common operational situations that occur with the analyser. Try the possible remedies in the order listed.

15.1 Sample System Leak Test (Low Flow Sensitivity)

By far the most common reason for high Oxygen readings is a leak in the sample delivery system. Leaks are divided into two types:

- Real leaks — A real leak is a lack of integrity in the sample delivery system.
- Virtual leaks — A virtual leak is caused by Oxygen that is trapped in the upstream plumbing and components, such as regulators and filters. This Oxygen is slowly being purged out of the system.

  Virtual leaks are most common in new installations.

Determining the nature of the leak is not a difficult task, but it is important to be consistent in the approach and technique. The steps listed below will help resolve any leak related problems:

1. Determine if the high reading is due to a leak or is a real indication of Oxygen level. To do this, perform a Flow Sensitivity Test. This test requires a positive pressure sample delivery system. If it is not possible to provide positive sample pressure to the analyzer, skip to Step 2.

   Note: If the analyzer is equipped with a pump, it is recommended that it is not used during the Flow Sensitivity Test.

   Perform the Flow Sensitivity Test as follows:

   a. Establish a flow rate that is within the normal operating tolerances of the analyzer. Generally a flow rate between 0.5 LPM or 1.0 SCFH is ideal.
   b. Give the analyzer a couple of minutes to stabilize, and then carefully note the flow rate and the Oxygen level displayed.
   c. Reduce the flow rate by 75%. In a system with good integrity, there should be little change in the front panel display. If a leak exists however, the reading will rise noticeably. Allow it time to stabilize, and carefully note the flow rate and the Oxygen level displayed.
   d. Re-establish a normal flow rate and allow the analyzer to purge for ½ hour. Note again the flow rate and Oxygen level displayed.
   e. Repeat step c. If the Oxygen level stabilizes at a level that is close to the prior value from step c, then the leak is real. If the reading shows a lower

Oxygen level than the prior value from step c, the leak is probably a virtual leak and continued purging should rectify the problem.

2. Once it has been determined that there is a leak, the next logical step is to locate it. The easiest way to locate a leak is to close off the feed to the analyzer from the sample delivery system, and to allow the system to pressurize. Apply Snoop® or another type of liquid leak detector to all of the fittings on the system. Any fitting that shows bubbles should be tightened or replaced.
3. If it is not practical to remove the analyzer from the sample delivery system, leaks can be located by monitoring analyzer output while applying Snoop® or another liquid leak detector to one fitting at a time. Snoop® will not show bubbles at the low pressure required for proper analyzer operation. However, Snoop® will temporarily block any leak, at the fitting being checked, and the analyzer output will drop. It is important to give sufficient time for the analyzer to respond before going on to the next fitting.

   The more distance between the fitting and the analyzer, the more time should be given for the analyzer to respond.

15.2 Error codes

The following codes may be displayed in the event of a problem or error. The table gives a suitable remedy.

Code	Meaning	Possible remedy
B: Bad command	Internal Software Error	Power Cycle
C: Comms fault	Data not received from transducer	Check transducer cable
D: Data fault	Data not received from transducer	Check transducer cable
E: Out of spec	The reading exceeds the maximum range	Check plumbing
F: FLA Alarm	The reading exceeds the maximum range	Check plumbing
S: Calibrating	Calibrating Failed	Recalibrate, Check Bottle concentration value
T: Overtemp	Transducer temperature is over range	Reduce ambient temperature
X: Electronics fault	Critical Electrical Fault	Contact Servomex

15.3 Jam conditions

See section 11.1 “Configure and use the mA outputs."

16 Storage and disposal

16.1 Storage

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

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

16.2 Disposal

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

> ***Hint:*** *If you send the analyzer to Servomex or your local Servomex agent for disposal, it must be accompanied by a correctly completed decontamination certificate and a Return Authorization Number (RAN) (18.1Appendix E).*

16.2.1 Disposal in accordance with the Waste Electrical and Electronic Equipment (WEEE) Directive

The label shown in Figure 16-1 is fitted to the analyzer.

Figure 16-1: The WEEE label

This label identifies that:

- The analyzer is considered to be within the scope of the Waste Electrical and Electronic Equipment (WEEE).
- The analyzer is not intended for disposal in a municipal waste stream (such as landfill sites, domestic recycling centers and so on), but must 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 analyzer in accordance with the requirements of the WEEE Directive, contact Servomex or your local Servomex agent.

17 Spares

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 analyzer and invalidate any warranty.

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

Table 17-1: MonoExact DF310E/DF150E Spares List

Part number	Description
089000KITA	**MonoExact DF310E/DF150E One Year Service Kit contains:**
	Filter Element, Fan
	External Stainless-Steel Filter Kit
	Fuse Kit
	Back Panel Connector Set
	Main Fuse
089000KITB	**MonoExact DF310E/DF150E Two Year Service Kit contains:**
	Filter Element, Fan
	External Stainless-Steel Filter Kit
	Fuse Kit
	Back Panel Connector Set
	Tubing/Fittings Refurb Kit
	Main Fuse
08900920A	**External inlet line Filter kit for MonoExact DF310E/DF150E**

Table 17-2: MonoExact DF310E/DF150E Transducer Spares

Part number	Description
PCB Assemblies:	
S08000901	PCB Assembly, Back Plane Interface 08000
S08000902	PCB Assembly, Display Board 08000
S08000903	PCB Assembly, Option Board 08000
S08000904	PCB Assembly, 310 Connector Board 08000
S08000905	PCB Assembly, 150 Connector Board 08000
Power:	
S220268	AC/DC Converter 24V 30W Phoenix 2902991
211133	Fuse,3.15A,SB,5X20,2183.15XP,LITTELFUSE
All transducers:	
S03900711	Coulometric O_2 100 ppm High Resolution
S03900712	Coulometric O_2 100 ppm
S03900713	Coulometric O_2 1000 ppm
S03900714	Coulometric O_2 10000 ppm

Part number	Description
General:	
220562	USB, Clip Flashdrive 2GB
210397	Sensor Cap – Blue
210513	Hummingbird Brand Replenishment Solution – 1.0l
210514	Hummingbird Brand Replenishment Solution – 0.5l
210515	Hummingbird Brand Replenishment Solution – 100ml

Part number	Description
210516	Hummingbird Brand Replenishment Solution – 2.0l

18 Warranty

Servomex instruments are warranted to be free from defects in workmanship and materials. Liability under this warranty is limited to servicing, calibrating, and replacing any defective parts of the instrument returned to the factory for that purpose. Fuses are specifically excluded from any liability.

This warranty is effective from the date of delivery to the original purchaser. The equipment must be determined by Servomex to have been defective for the warranty to be valid.

This warranty applies as follows:

- one year for electronics
- one year for mechanical failures to the sensor
- six months for calibrations

If damage is determined to have been caused by misuse or abnormal conditions of operation, the owner will be notified and repairs will be billed at standard rates after approval.

Servomex Corporation warrants each instrument manufactured by them to be free from defects in material and workmanship at the F.O.B. point specified in the order, its liability under this warranty being limited to repairing or replacing, at the Seller's option, items which are returned to it prepaid within one year from delivery to the carrier and found, to the Seller's satisfaction, to have been so defective.

In addition, if the coulometric oxygen sensor in this analyzer fails under normal use within five years from the date of purchase, such sensor may be returned to the Seller and, if such sensor is determined by the Seller to be defective, the Seller shall provide the Buyer a repaired or replacement sensor at no additional cost. The original warranty expiration date is not extended by this action. Customer induced failures including but not limited to over pressuring, electrolyte spills and over temperature are not covered.

In no event shall the Seller be liable for consequential damages. NO PRODUCT IS WARRANTED AS BEING FIT FOR A PARTICULAR PURPOSE AND THERE IS NO WARRANTY OF MERCHANTABILITY.

Additionally, this warranty applies only if: (i) the items are used solely under the operating conditions and in the manner recommended in the Seller's instruction manual, specifications, or other literature; (ii) the items have not been misused or abused in any manner or repairs attempted thereon; (iii) written notice of the failure within the warranty period is forwarded to the Seller and the directions received for properly identifying items returned under warranty are followed; and (iv) with return, notice authorizes the Seller to examine and disassemble returned products to the extent the Seller deems necessary to ascertain the cause of failure. The warranties stated herein are exclusive. THERE ARE NO OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED, BEYOND THOSE SET

FORTH HEREIN, and the Seller does not assume any other obligation or liability in connection with the sale or use of said products.

18.1 Maintenance policy

In cases when equipment fault is suspected, please notify your representative of the problem and provide them with model and serial numbers.

If the problem cannot be resolved, then ask for a Return Product Authorization Number (RPA in North America and RAN Rest of World) and shipping instructions. The issue of an RPA/RAN does not automatically imply that the equipment is covered by our warranty - that will be determined after we receive the equipment.

Pack the equipment in a suitable box with sufficient padding, include the RPA number on your paperwork, and send the equipment, prepaid, to the designated address. Servomex will not accept equipment returned without an RPA/RAN, or with reversed shipping or import/export charges.

If the warranty has expired, or the damage is due to improper use or exposure of the equipment, Servomex will provide an estimate and wait for approval before commencing repairs.

For your convenience a Return Product Authorization Request Form is provided in Appendix E. Fill out the form and sent it back to Servomex to obtain an RPA/RAN.

Appendix A Compliance and standards

A.1 Applicable EU Directives

Low Voltage Directive: 2014/35/EU

Electromagnetic Compatibility (EMC) Directive: 2014/30/EU

A.2 Applicable standards

EN 61010-1:2010

EN 61326-1:2013 / IEC 61326-1:2012

EN15267-3:2007 MCERTS Performance Standards for CEMS

EN 14181: 2014 for QAL1

Appendix B Optional RS485 / RS232

B.1 Serial Communication introduction

The MonoExact DF310E/DF150E offers the option for RS232 or RS485 serial communications. If RS232 is purchased, the connection is via the 9-pin D-type RS-232 serial connector on the back plane (Figure B-1). If RS485 is purchased, the connection is via the RS-485 connector on the back plane (Figure B-1).

Make sure that the electrical installation of any equipment connected to the analyzer conforms with all applicable local and national electrical safety requirements.

The RS232 output is separated from the analyzer 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.

To comply with EMC requirements, you must use a shielded cable to connect to the RS232 output. The shield must also be connected to the analyzer enclosure at Earth / ground.

B.2 Connections

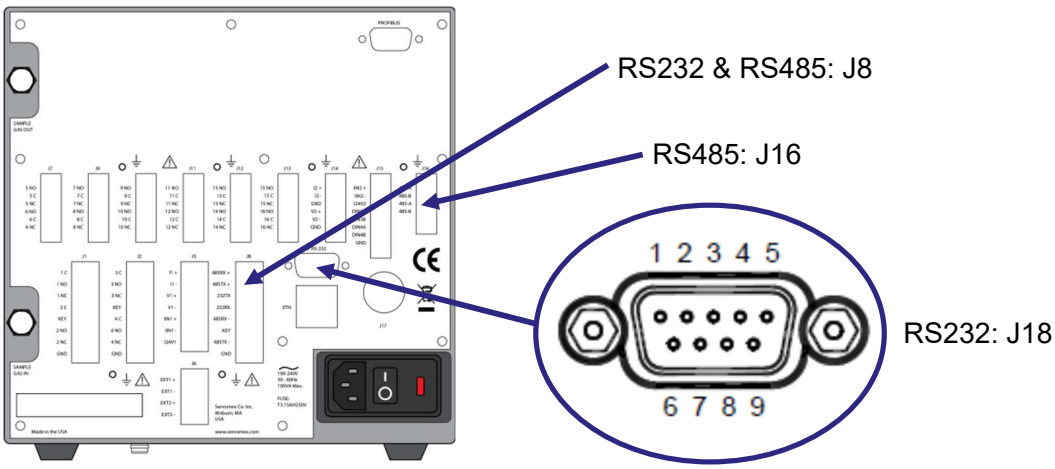


Figure B-1: Rear panel of the analyzer showing RS232 and RS485 connectors

Pin	Use	Pin	Use
1	485-A	3	485-A
2	485-B	4	485-B

Table B-1: RS485 connection pin details (J16)

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

Table B-2: RS232 connection pin details (J18)

Note: RS232 and RS485 connections are also available on J8:

Pin	Use	Pin	Use
1	485RX+	5	485RX-
2	485TX+	6	KEY
3	232TX	7	485TX-
4	232RX	8	GND

Table B-3: Connector J8

B.3 Serial set up parameters

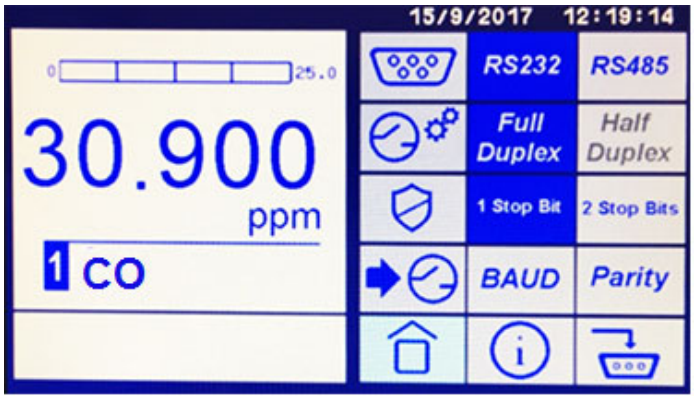


Figure B-2: Serial parameter setup page

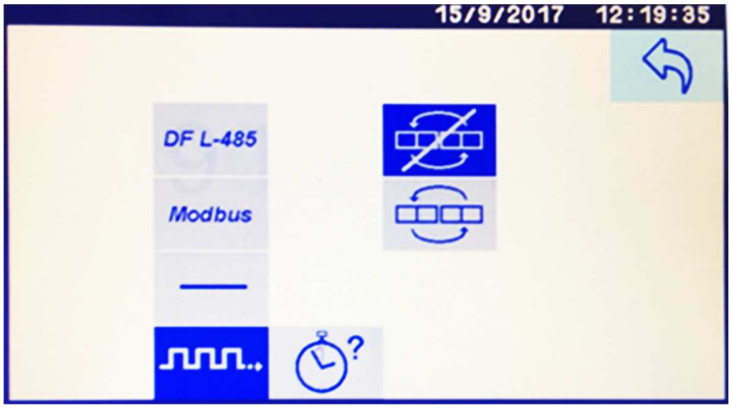


Figure B-3: Serial parameter page 2

The Serial parameter icons are listed below:

Icon	Meaning	Function
RS232	RS232 communications	To select RS232.
RS485	RS485 communications	To select RS485.
Full Duplex	Full Duplex	To select full duplex.

Icon	Meaning	Function
Half Duplex	Half Duplex	To select half duplex.
1 Stop Bit	1 stop bit	To set 1 stop bit.
2 Stop Bits	2 stop bits	To set 2 stop bits.
BAUD	Baud rate	To set the baud rate.
Parity	Parity	To set the parity.
	RS485 function	To assign RS485 function. A second screen (Figure B-3) displays the following functions:
DF L-485	RS485 function: DF communications	To assign RS485 function to legacy DF communications.
Modbus	RS485 function: Modbus	To assign RS485 function to Modbus (B.1).
	RS485 function: None	No RS485 function.
	RS485 function: periodic stream	To assign a periodic stream of measurement results of all transducers.
	RS485 function: output frequency setup	To set the intervals for the output frequency (in seconds) via a numerical entry screen.
	RS485 – Modbus: Word swapping on	To switch on Modbus word swapping.
	RS485 – Modbus: Word swapping off	To switch off Modbus word swapping.

B.4 Streaming output

In continuous mode, a data frame is transmitted by the serial output port at a user-defined interval. The format of the data frame is given in the following tables; however, it is a list of process variables (fields) preceded by a start character, separated by semi-colons and terminated by carriage return and line feed, i.e. A;B;C;D;E;F;…..;N;<CR><LF>

The frame frequency and generic communications parameters are configured in the analyser software. The frame frequency sets up the frequency of transmission of the data frame down the serial communications port. For example, if the value is set to 15 seconds, then the output data frame will be transmitted once every 15 seconds. The frequency is set in steps of one second from 1 to 9999 seconds. If the value is set to zero, the transmission of data down the serial port stops and will not restart until a non-zero value is entered.

Table B-4: Serial output data frame, start, measurement and end sequences

Field	Number of characters	Function	Entry/format
A	8	Date	**DD-MM-YY**
B	8	Time	**HH:MM:SS**
C	2	Analyzer failure and maintenance fault status	1st character: **F** for failure 2nd character: **M** for maintenance (Spaces = OK)
D	8	Auto-calibration flags: 2 characters for each of the 4 calibration groups	1st character: Group 1, **S** for sample, **C** for calibration gas 2nd character: Group 1, **1** for cal gas 1, **2** for cal gas 2 Repeat for groups 2, 3 and 4
E	2	Number of process measurements or variables	**03** to **07**. The following fields will be repeated for each transducer and any derived measurements. The last two variables will always be the two external inputs E1, E2

	Field	Number of characters	Function	Entry/format
Measurement sequences (see note below)	F	2	Measurement identity	e.g. **I1**, **D1**, **E1**
	G	6	Measurement name	e.g. **Oxygen**
	H	6	Value	e.g. **20.9**
	I	3	Units	e.g.**%**
	J	4	Alarms	One character for each alarm. **1**, **2**, **3**, **4** raised = alarm Space = OK
	K	2	Failure and maintenance fault status	1st character: **F** for failure 2nd character: **M** for maintenance (Spaces = OK)
	L	1	Calibration status	**C** in calibration, or space
	M	1	Warming up status	**W** in warming up, or space
N		4	Checksum	e.g. **096A**
-		-	End code: <CR> and <LF>	ASCII code 13 and 10

Note: Fields F-M are repeated for each measurement (including derived) concluding with external inputs E1 and E2, before returning to the end sequence of N and the end codes.

B.1 Theory of operation

The Servomex Coulometric Sensor uses an ambient temperature oxygen reaction that is non-depleting. The cell produces a current flow that is determined by the number of oxygen molecules that are reduced at the cathode. The sensor reaction is driven by 1.3 V applied across the electrodes. The resulting electron flow is measured as a current that is precisely proportional to the oxygen concentration in the sample gas.

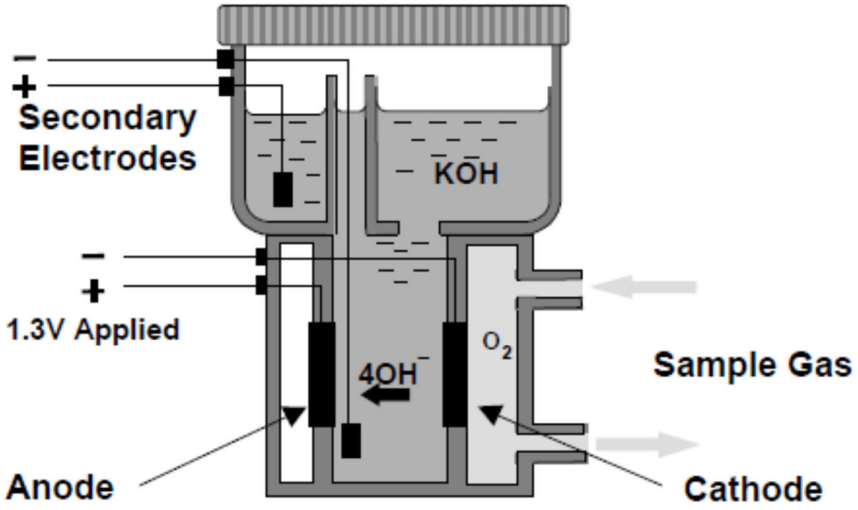


Figure B-4: Servomex Oxygen sensor schematic

The cathode reaction uses 4 electrons from the 1.3 volt circuit, 2 water molecules from the electrolyte, and 1 oxygen molecule from the sample gas to generate 4 hydroxyl ions which migrate across the reaction chamber to the anode:

$$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$$

The anode reaction consumes the 4 hydroxyl ions and delivers 4 electrons to the circuit, 2 water molecules back to the electrolyte, and vents one oxygen molecule.

$$4OH^- \rightarrow O_2 + 2H_2O + 4e^-$$

There is no net change to the electrolyte and no depletion of the sensor or electrodes.

1. Sample gas preparation and delivery

B.1.1 Measurements of acid containing gases

The MonoExact DF150E and DF310E are compatible with inert and passive gases, including N_2, H_2, CO, Ar, freons, etc. It also has limited tolerance to gas compositions containing 'acid' gases such as CO_2, H_2S, Cl_2, NOx, SO_2, HCl, etc.

As a guide, the data in **Table B-5** represents the maximum allowable limits of acid gases under continuous operation that can be tolerated with the analyzer.

Measuring Range Of Analyzer	CO_2* %	SO_2 ppm	H_2S ppm	NOX ppm	Cl_2 ppm	HCL ppm
0-100 ppm	0.2	200	200	200	100	100
0-1000 ppm	0.4	500	500	500	200	200
0-10,000 ppm	0.8	1500	1500	1500	800	800

** Concentrations of CO_2 are in %. 1% is equivalent to 10,000 ppm.*

Table B-5: Maximum allowable acid gas limits

Contact the local Servomex Business Center for recommendations on using the MonoExact DF150E and DF310E sensor on acid gases other than those listed above.

The limits shown in **Table B-5** represent guidelines for continuous exposure. In most cases, substantially higher acid gas levels can be tolerated on a limited duty cycle basis. For example, a 0-100 ppm sensor can be used to sample a 100% CO_2 background gas for a 15 minute period 3-4 times per week, and the balance of the time sampling from a clean gas like N_2, Ar, H_2, etc. In general, a good guideline is to limit the exposure and not exceed the continuous limits if the total exposure is averaged over a weekly period. Consult with Servomex for details.

There are applications where the acid gas components may exceed the upper limits on a continuous basis. In such circumstances a sample dilution system can easily be fabricated to mix clean N_2 with the sample gas in a 2:1 to 20:1 ratio using simple pressure control and flowmeter components. Depending upon the continuous acid gas level and the oxygen level to be measured, a dilution ratio must be selected such that the resulting O_2 level is accurately measurable and at least one order of magnitude above the O_2 level in the N_2 dilution gas. Contact the local Servomex Business Center for specific recommendations.

Another approach when acid gas levels are continuously above the recommended limits is the use of a scrubber system. The scrubber will remove the bulk of the acid gases, allowing the analyzer to provide continuous stable measurements. If a breakthrough occurs, the sensor's ability to tolerate high levels of acid gas for limited periods of time will avoid catastrophic loss of performance.

Servomex offers a broad range of scrubbers for applications in severe environments. Standard scrubber columns are available in various sizes, and in single or dual bed configurations. The columns are fabricated from clear PVC and are designed to accept a variety of different acid gas absorbent media which have a color-change indication to facilitate convenient change-out. For more information, contact the local Servomex Business Center.

a. Coulometric Sample Gas Scale Factor (GSF)

The MonoExact DF150E and DF310E oxygen analyzers are calibrated using oxygen in nitrogen standards. The GSF (Gas Scale Factor) is used to correct for changes in the rate of oxygen diffusion when background gases other than nitrogen are present in the process or sample gas.

In many applications, the sample GSF does not need to be altered from the default value of 1.00. However, if the sample gas has a significantly different diffusivity compared with nitrogen (such as helium, the GSF should be applied. To use the GSF feature, the volumetric percentages of the sample gas are entered as described in section **Error! Reference source not found.** and the total GSF is automatically calculated by the analyzer.

Note: Contact the local Servomex Business Center for assistance with gases not listed.

> ***Hint:*** *The method used to correct the calibration of the analyzer for measurement in non-nitrogen background gases is derived from a well-known theoretical mass transfer equation. This equation accounts for the change in oxygen diffusion rates through different gases.*
>
> *Although significant empirical work has been done in this field, it is generally accepted that the equation may be only 85-90 percent accurate. In addition, there is further error introduced when correcting for a 'multi' component background gas. This may result in up to an additional 3-5% error.*
>
> *An alternate method when using a non-nitrogen or 'multi' component background gas for spanning is to obtain a certified Calibration standard that has been prepared in a background gas that models the average process sample. Care must still be used, however, as certified standards may also have an inaccuracy associated with them.*
>
> *Questions regarding the calculation of a background gas correction factor for a specific application should be directed to the local Servomex Business Center.*

GSF Disclaimer

The method used to correct the calibration of the MonoExact DF150E and DF310E Oxygen Analyzers for measurement in non-nitrogen background gases is derived from a well-known theoretical mass transfer equation. This equation accounts for the change in oxygen diffusion rates through different gases.

Although significant empirical work has been done in this field, it is generally accepted that the equation may be only 85-90 percent accurate. In addition, there is further error introduced when correcting for a multi-component background gas. This may result in up to an additional 3-5% error. An alternate method when using a non-nitrogen or "multi" component background gas for spanning is to obtain a certified calibration standard that has been prepared in a background gas that models the average process sample. Care must still be used, however, as certified standards may also have an inaccuracy associated with them. Questions regarding the calculation of a background gas correction factor for a specific application should be directed to the local Servomex Business Center.

Note: The GSF for the gas used to calibrate the system may be different from that used during analysis. If the GSF is changed to reflect the composition of the calibrating gas, be sure to reset the GSF before analyzing samples.

GSF Values for Various Gases

Example Calculation: 60% Nitrogen and 40% Helium 0-100ppm analyzer

GSF = (0.6 x 1) + (0.4 x 0.69)

GSF = 0.88

Name	Formula	100PPM	1000 PPM	10,000 PPM
1-Chloro-1,2,2,2-tetrafluoroethane (R124)	C2HClF4	2.17	2.76	2.47
Acetylene	C2H2	1.05	1.08	1.06
Argon	Ar	1.03	1.05	1.04
Butadiene	C4H6	1.41	1.61	1.51
Butane	C4H10	1.48	1.72	1.60
Butene	C4H8	1.46	1.69	1.58
Carbon Monoxide	CO	1.01	1.02	1.01
Chloro-1-Difluoro-1,1-ethane (R142B)	C2H3CLF2	1.53	1.79	1.66
ChloroDifluoromethane Freon 22	ChCLF2	1.68	2.02	1.85
Chloropentafluoroethane (R115)	C2F5CL	1.99	2.49	2.24
chlorotrifluoromethane Freon (R13)	CCLF3	1.76	2.14	1.95
Cyclohexane	C6H12	1.57	1.86	1.71
Cyclopropane	C3H6	1.26	1.38	1.32
Difluoro-1,1-ethylene (R1132A)	F2C=CH2	1.36	1.53	1.44
Ethane	C2H6	1.15	1.23	1.19
Ethylene	C2H4	1.10	1.15	1.12
Halocarbon 32- Difluoremethane	CH2F2	1.48	1.72	1.60
HaloCarbons 116	C2F6	2.20	2.80	2.50
HaloCarbons 125	C2HF5	2.10	2.65	2.38
HaloCarbons 218	C3F8	2.58	3.37	2.97
HaloCarbons 23	CHF3	1.69	2.04	1.87
HaloCarbons 41	CH3F	1.26	1.38	1.32
Helium	He	0.69	0.53	0.61
Hexafluoro 1,3 Butadiene	C4F6	2.44	3.15	2.80
Hexafluoropropylene (R1216)	C3F6	2.15	2.72	2.44
Hexane	C6H14	1.75	2.13	1.94
Hexene	C6H12	1.71	2.06	1.88
Hydrogen	H2	0.61	0.42	0.51
IsoButane	C4H10	1.50	1.75	1.62
Krypoton	Kr	1.21	1.32	1.26
Methane	CH4	0.94	0.90	0.92
Monochloropentafluoroethane (CFC-115)	C2F5Cl	1.99	2.49	2.24
Neon	Ne	0.85	0.78	0.81
Nitrogen	N2	1.00	1.00	1.00
Nitrous Oxide	N2O	1.26	1.38	1.32
Octafluorocyclobutane C-318	C4F8	2.25	2.88	2.57
Propane	C3H8	1.26	1.38	1.32
Propylene	C3H6	1.28	1.42	1.35
Sulfur Hexaflouride	SF6	1.84	2.27	2.06
Tetraflouroethane - Halocarbons 134A	C2H2F4	1.99	2.49	2.24
Tetrafluormethane	CF4	1.61	1.91	1.76
Tetrafluoroethylene (**TFE**) (R1114)	C2F4	1.83	2.24	2.03
VinylChloride	CH2=CHCL	1.36	1.53	1.44
Vinylidene Fluroide	C2H2F2	1.30	1.44	1.37
Xenon	Xe	1.44	1.65	1.54

b. Sample flow rate and pressure

The analyzer is factory calibrated at a flow rate of 1.0 scfh, in N_2, and should be operated at that level for optimal accuracy. However, the Servomex Sensor is relatively unaffected by gas sample flow rate, within limits. Sample flow rate should be maintained within the recommended range of 1.0 to 2.0 scfh. The analyzer can be operated at flow rates outside that range, but it should be recalibrated at that different flow rate to maintain optimal accuracy.

The analyzer has a small pressure drop (0.2 to 0.5 psi), so relatively small changes in inlet or outlet pressure causes dramatic changes in flow rate. Consequently, it is preferable to vent the outlet to atmosphere so that outlet pressure remains constant, leaving inlet pressure as the only variable to control.

Flow rate effects on sensor performance

Assuming a leak-tight system, higher flow rates may cause O_2 readings to increase by a few percent of reading above the level that would be displayed if flow was within the recommended 1.0 to 2.0 scfh range. Lower flow rates similarly cause O_2 readings to decrease by a few percent of reading. Very low flow rates (below 0.5 scfh) should be avoided as the sample inside of the sensor is no longer representative of the actual sample.

The insensitivity to flow rate changes is the basis for the sample system leak detection described below. The sensor output should be fairly constant for readings between 1.0 and 2.0 scfh. If O_2 readings become higher at lower flows, then ambient O_2 is leaking into the sample system, or venting from a dead space (closed pocket with trapped higher O_2 level gas) in the sample system. A higher flow rate dilutes the O_2 entering the sample system decreasing the reading. O_2 readings in a leak free sample system should not go up or down significantly with flow changes between 0.5 and 2.0 scfh.

Checking for plumbing leaks using flow rate effects

Significant measurement error can be caused by leaks in the plumbing system. A simple test can be performed to identify oxygen intrusion leaks. Observe the analyzer readout at two flow levels: 0.5 and 2.0 scfh. Only a slight increase, if any, in readout will occur in a tight system as the flow is increased. If leakage in the plumbing system exists, then the increased flow results in a substantial decrease in oxygen readout -- typically dropping by 25 to 50 percent.

When flow sensitivity is observed, check the plumbing system for leaks. Once proficient with this test, the user can estimate the distance to the leak based on the response time of the reading changes.

Background gas effects on Indicated flow rate

If the molecular weight of the background gas is much different from N_2, the flowmeter reading is not accurate. The Rotameter type is calibrated for use in air (or N_2). Most other gases have molecular weights within ± 25 percent of air. Since the required flow rate is not

extremely critical most gases produces reasonably correct readings. The exceptions are light gases such as Helium and Hydrogen whose flow rates should be set to approximately one-third that of Nitrogen or 0.3 scfh.

Regulator requirements (Pressure Driven Analyzer)

If the pressure in the sample line varies, but does not drop below 2.0 psig, use a regulator to drop the pressure to approximately 1.0 psig. Set final flow rate with the sensor flow control valve.

If a regulator is not used, the flow rate changes when the pressure at the inlet of the flow control valve changes. As long as this pressure variation does not bring the flow rate out of the recommended flow range (1.0 - 2.0 scfh) no regulator is required. A flow change of ±1.0 scfh may result in a small change to the oxygen reading.

If a pressure change causes the flow rate to move outside the recommended range, an adjustment of the flow control valve must be made. If the adjustment is not made, and the flow rate remains outside the recommended range, the analyzer may not be operating within its stated accuracy.

Pressure regulator purge

Regulators used on bottled calibration standards are typically equipped with two pressure gauges, one to measure the cylinder pressure, and the other to measure the outlet pressure. The regulator must have a metal (preferably stainless steel) diaphragm. It is good practice to install a flow control valve to adjust the flow after the regulator.

All user-added upstream plumbing should be consistent with the instrument gas delivery components so that the highest level of integrity can be maintained. All connections should be welded or include metal face-seal components.

Pressure gauges are not recommended on regulators used on process sample lines because they add measurement delay time and offer opportunities for leaks.

Before connecting the gas to the analyzer, follow the regulator purge procedure on page 181 to purge ambient air from the regulator. This ensures that any ambient air trapped in the pressure gauges and cavities of the regulator is purged prior to use. Once the regulator is mounted, do not remove it from the cylinder until a fresh cylinder is required.

Pressure effects on sensor performance

If the analyzer is not vented to atmosphere, the sensor pressure is influenced by the conditions downstream of the analyzer. A recalibration under your operating conditions may be desirable to remain within the stated accuracy specifications. However, in most cases the error introduced is relatively small, and may not affect the process application.

> ***Hint:*** *It is not recommended that gauges be installed upstream of the analyzer. The presence of a gauge increases response times and introduces potential leaks to ambient.*

Sample gas line lengths, fittings and bends should be kept to a minimum to maintain low pressure drops. Larger diameter tubing and fittings reduce pressure drop and also lengthen response time. In general, 1/8-inch tubing should be limited to 15-foot runs; longer runs should be made with 1/4-inch tubing.

Sample outlet back-pressure effects

It is always recommended to vent the analyzer to atmospheric pressure. However, if a sample vent or return line is used, attention must be given to maintain a low and consistent backpressure so as not to affect the flow rate. The allowable back-pressure on the sensor is ±1 psig. If variations in the vent line pressure are expected, a sub-atmospheric back-pressure regulator should be installed on the vent line to maintain an even back-pressure on the analyzer.

Consider the regulator's pressure drop (typically 1 psi) when designing the sample vent system in order to stay within the ±1 psig pressure limits at the sensor.

When not venting the analyzer to atmosphere, it is also suggested to install a fairly high resolution pressure gauge immediately at the analyzer outlet.

> ***Hint:*** *If a regulator or gauge is installed on the analyzer outlet, also install the Stainless Steel Downstream Plumbing option.*

c. Sample gas compatibility

Note: There are a wide range of considerations in determining the gas sample compatibility of the Process Oxygen Analyzer. Servomex attempts to identify all pertinent application details prior to quoting and order processing. All non-typical applications concerning gas sample compatibility must be reviewed by our in-house Application Engineers. It is impossible to accurately predict all of the chemical tolerances under the variety of process gases and process conditions that exist.

Condensation

The analyzer should be installed and operated with a sample gas that is preconditioned (if necessary) to avoid condensation in the gas lines. Several methods are available to minimize the possibility of condensation. If the sample gas is a hydrocarbon, maintain the gas temperature 20° F to 40° F above its dew point. In some applications, it may be necessary to chill the sample gas before it enters the analyzer so that the hydrocarbons can be condensed, collected, and removed. It is good practice to pitch the sample gas lines to allow condensables to drain away from the analyzer. Gas sample delivery lines that contain sample gases with high moisture content must not be exposed to temperatures below the dew point.

Gas solubility in aqueous KOH solution

Some sample gas constituents are soluble in the sensor's potassium hydroxide (KOH) electrolyte. Gases that are rated as 'Soluble' to 'Infinitely-Soluble' may pose a threat to the sensor.

The sensor should have limited exposure (less than 1% by volume on a continuous basis) to highly water soluble alcohols, such as methanol, and/or be supplemented with periodic electrolyte changes to limit build-up within the electrolyte.

Many gas species with infinite solubility in aqueous KOH (such as nitrous oxide (N_2O), however, do not affect the electrode or sealing materials, or interfere with the O_2 reduction/oxidation reactions. Contact the local Servomex Business Center for recommendations on a specific application.

Reactivity with KOH electrolyte

Many process sample streams contain various concentrations of acid gases. Acid gases are gases that react with the basic KOH electrolyte solution to form a neutralized solution. The sensor does not operate properly when the electrolyte solution is neutralized.

Besides a neutralization of the electrolyte, a base reactive sample gas may have other negative effects, such as a base-catalyzed polymerization reaction. The O_2 electrode reaction sites may become blocked by the polymerized byproduct residue at the interface where the gas sample meets the electrolyte.

Flammable sample gas

The MonoExact DF150E and the MonoExact 310E may be use with flammable gases with the coulometric sensor only. The sample and calibration gases entering these analyzers must be clean, non-corrosive, free from oil and condensates and compatible with the materials listed in **Error! Reference source not found.**.

Trace acids in the sample gas

With the Servomex Acid Gas system, oxygen measurements in sample gases containing certain levels of acids are possible. Trace acids are common byproducts of gas distribution system assembly and its accessories. Trace acids can compromise the accuracy of the sensor and its construction if they are not managed properly. See section B.1- **Theory of operation** on page 171 for more detail.

Contact the local Servomex Business Center for recommendations on using the sensor on acid gases other than those listed.

Sample gas temperature

Gas temperature should not exceed 50 °C (122° F), nor should it fall below 0° C (32° F). Gas temperature can be controlled by passing the gas through 5 to 10 feet of metal tubing that is within the recommended sample temperature. Because of its low thermal mass, the gas sample quickly reaches the gas sample line temperature.

Ideally, the analyzer should be operated at a nominal temperature of 70° F. However, MonoExact DF310E / DF150E both have an automatic temperature compensation feature that uses a sensor on the body of the cell to correct for temperature fluctuations. The best practice for temperature correction is to calibrate as close to operating temperature as possible. If the analyzer is to be operated at an average ambient temperature outside 65° F to 80° F, it should be recalibrated at the operating temperature for optimal performance.

> ***Hint:*** *The sensor temperature can be displayed at any time by accessing the second page of the Measurement Menu (section 10). Press the*  *icon to display the sensor temperature at the bottom of the screen. This temperature value is updated at intervals of 15 to 45 seconds.*

Protecting the analyzer from process upsets

The analyzer should be protected from extended exposure to high concentrations of oxygen or hostile gases. Automatically solenoid controlled valves should be installed to switch the analyzer over to an N_2 purge when the process reaches some identifiable condition.

Gas line maintenance operations must also be examined for their effect on the analyzer. For example, in many pipeline process or normal gas applications the plumbing system is cleaned with either a liquid solvent or detergent solution. Since either causes damage to the sensor, switch the analyzer over to a N_2 bypass purge, or shut off sample flow and power to the analyzer prior to initiating the potentially hazardous process.

B.1.5 Calibration gas considerations

Calibrations performed from a bottled, calibrated sample gas, may introduce additional issues that could adversely affect the analyzer calibration.

Calibration standards

Certified calibration standards are available from gas manufacturers. These standards are available in steel and aluminum cylinders. Steel cylinders are less expensive but do not dependably maintain a stable oxygen concentration for long periods of time.

Calibration standards in aluminum cylinders are recommended. Servomex has found that calibration standards in aluminum cylinders are very stable for long periods of time (between 6 and 24 months) where steel cylinders should be recalibrated every three months.

Calibration cylinder regulators

Regulators used on bottled calibration standards are typically equipped with two Bourdon pressure gauges, one to measure the cylinder pressure, and the other to measure the outlet pressure. The regulator must have a metal (preferably stainless steel) diaphragm. Install a flow control valve after the regulator to adjust the flow.

Purge procedure

Before the calibration gas is connected to the analyzer follow the procedure listed below to purge ambient air from the regulator which prevents contamination of the gas in the cylinder rendering it useless:

After securely attaching the regulator to the cylinder:

4. Open the regulator flow control valve slightly.
5. Open the cylinder valve.
6. Set the regulator to its maximum delivery pressure.
7. Adjust the flow control valve to allow a modest flow rate (hissing sound).
8. Close the cylinder valve until the cylinder pressure falls to zero. If equipped with gauges, allow the secondary (output) gauge to approach zero. Otherwise wait for the hissing to nearly stop.
9. Immediately open the cylinder valve to restore full delivery pressure.
10. Repeat steps 8 and 9 five to ten times to thoroughly purge the regulator and gauges.
11. Close the shut off valve on the outlet side of the regulator to isolate the purged regulator from atmospheric contamination.
12. Set the delivery pressure to 5 psig (15 psi for welded sample line with VCR connection.

Once the regulator is mounted and purged, do not remove it from the cylinder until a fresh cylinder is required.

Sample gas delivery and vent pressure during calibration

The most accurate calibration is obtained when the analyzer is plumbed into the gas sample system so that the analyzer is under actual process operating conditions. However, when the process sample is being delivered to the analyzer under vacuum conditions, or being returned from the sample outlet under either positive pressure or vacuum conditions the operating pressure at the sensor is likely to be quite different than under factory calibration conditions.

For systems where the gas sample is not vented to atmosphere, the analyzer outlet should remain connected in the same manner during calibration, if possible. This ensures that downstream pressure effects on the sensor are the same during calibration and process monitoring.

Use the flow control valve on the regulator to meter the calibration gas to the analyzer at the suggested 1.0 scfh flow. By leaving the analyzer’s flow controls untouched from when the analyzer is used on process, the calibration pressure duplicates the process sampling pressure.

Background gas effects on calibration

Flow rate

Ideally, the calibration gas and the sample gas have the same gas composition, and as a result, the indicated flow rate during calibration and process sampling are identical. However, if the compositions of the calibration and sample gases are not the same, the flow rate indicated on the rotameter may need to be adjusted. Light gases, such as H_2 and He, have a higher flow rate than is indicated on the flowmeter. As a result, the flow rate of the light gas should be set to one third of the flow specifications found in this manual. For example, the recommended flow rate for N_2 is 1.0 scfh. In H_2 or He service, the recommended flow rate (as indicated on the analyzer flowmeter) is 0.3 scfh.

Gas Scale Factor (GSF)

If possible, the background of the calibration gas should be the same as the process sample gas. If not, a gas scale factor may have to be applied to the calibration gas oxygen readings because of the difference between the diffusion rate of oxygen in nitrogen (factory calibration gas) versus the diffusion rate in the user's calibration gas. The Sample Gas Preparation and Delivery section discusses the proper setting of the gas scale factor option during calibration as well as during process gas measurement.

B.3 Coulometric sensor maintenance

The only regular routine maintenance required is to add replenishment solution to the electrolyte. Exposure to dry gas for an extended time gradually extracts water from the sensor, so the electrolyte must be refilled occasionally with Hummingbird Replenishment Solution for optimum performance and long term reliability.

If the electrolyte level is low, only add Hummingbird Replenishment Solution to the sensor for optimum performance and long term reliability.

Always replace the cap on the bottle immediately after use.

In an emergency, distilled water can be used as an alternative, however this is not recommend over an extended period.

Do not add electrolyte solution to restore the electrolyte level.

Do not overfill.

The Sensor Assembly consists of two connected chambers. The operation of the sensor is satisfactory as long as the level of electrolyte is above the minimum indicator line and below the maximum line on the reservoir label.

One 125 cc bottle of electrolyte should be added at the time of start-up. This quantity is sufficient for satisfactory operation. It is not necessary to add additional electrolyte.

Use replenishing solution to top up the system. Do not use electrolyte.

Check the electrolyte level every 1 to 2 months as typically, bone dry sample gas can extract approximately 5 to 10 cc of water per month. If the liquid level is low, add Hummingbird Replenishment Solution to bring the electrolyte level between the minimum and maximum indicator lines on the reservoir label.

Operation at elevated temperatures and / or with sample gases at very low dew points will increase the frequency of replenishing the electrolyte.

The Oxygen Analyzer is equipped with an Electrolyte Condition alarm to indicate that the electrolyte level is low. The operation of this alarm is described in the Alarms section.

B.3.1 Procedure for adding replenishment solution to the sensor

The electrolyte is caustic. Be careful of drips of electrolyte from the cover.

13. Open the front door.
14. Unscrew and remove the filler cap.
15. Add Hummingbird Replenishment Solution to the electrolyte solution using a squeeze bottle
16. Fill to the maximum level indicator line on the reservoir label. Be careful not to spill solution on the electronics or on the outside of the sensor. Do not overfill.
17. Replace the filler cap securely and close the front door.

Appendix C Implementation guide for Modbus communications

C.1 Introduction

This appendix details the implementation and use of the Modbus protocol in the MonoExact DF310E/DF150E analyzer.

C.2 References

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

C.3 Modbus setup

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

Default values are in **Bold**.

Parameter	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	

C.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.

Function	Description	Usage
05	Write single coil	Change modes, perform calibration etc.
06	Write single register	Change single setting.
16	Write multiple registers	Change multiple settings.

C.5 Exception codes

If an error occurs 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.

C.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.

C.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.

C.8 System data

				Supports Function Code							
Base Address	**Block**	**Base Address Offset**	**Parameter**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**16**
3001	0	0-9	Instrument Serial Number			✓					
		10-19	Analyzer Firmware			✓					
3021	1	0-9	Supervisor Password			✓					
		10-19	Operator Password			✓					
3041	2	0-9	Option Board Digital Firmware			✓					
		10-19	Option Board Analog Firmware			✓					
3061	3	0-9	Reserved			✓					
		10-19	Bootloader Firmware			✓					
3981	49	0	NumberOfInternalTransducers			✓					
		1	NumberOfExternalTransducers			✓					
		2	NumberOfTransducers			✓					
		3	NumberOfMeasurements			✓					
		4	NumberOfAins			✓					
		5	NumberOfAouts			✓					
		6	NumberOfAlarms			✓					
		7	NumberOfRelays			✓					
		8	NumberOfDins			✓					
		9	Number of legacy pressure devices			✓					
		10	Number of legacy flow alarms			✓					
		11	Number of Legacy Heaters			✓					

				Supports Function Code							
Base Address	**Block**	**Base Address Offset**	**Parameter**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**16**
		12	Number of Legacy Sample Heater			✓					
		13	Number of Field Buses			✓					
		14	Number Of Ovens			✓					
		15	Number Of Network Cards			✓					
		16	NumberOfResources			✓					

C.9 System Settings

				Supports Function Code							
Base Address	**Block**	**Base Address Offset**	**Parameter**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**16**
2001	0	0	Floating point order	✓				✓			
		1	User interface busy	✓							
		2	Disable user interface	✓				✓			
		3	Audible alarm	✓				✓			
		4	ResponseDelay			✓			✓		✓
		5	Language			✓			✓		✓
		6	Date format			✓			✓		✓
		7	Decimal format			✓			✓		✓
		8	Backlight Time			✓			✓		✓
		9	clock: Hrs			✓			✓		✓
		10	clock: Mins			✓			✓		✓
		11	clock: Seconds			✓			✓		✓
		12	date: Year			✓			✓		✓
		13	date: Month			✓			✓		✓

				Supports Function Code							
Base Address	Block	Base Address Offset	Parameter	1	2	3	4	5	6	8	16
		14	date: Day			✓			✓		✓

C.10 System Control

				Supports Function Code							
Base Address	Block	Base Address Offset	Parameter	1	2	3	4	5	6	8	16
1	0	0	Service in Progress						✓		✓
0=Not In Service Mode, 1=Service Mode. Instrument MUST be set to Service in Progress before any calibration or override actions are performed.											

C.11 Measurements

				Supports Function Code			
Base Address	Block	Base Address Offset	Parameter	1	2	3	4
1001	0	0	Number Of Measurements			✓	
	0	1	Repeat (safeguard)			✓	
	0-49	2(n-1) + 2	Measurement n			✓	

C.12 Transducer calibration data

Data for transducer n are found at below address + 20 (n-1) for n=1 to n=4.

					Supports Function Code							
Base Address	First Block Number	Block	Base Address Offset	Parameter	1	2	3	4	5	6	8	16
4721	0	Tx (n)	0	AutovalState			✓					
			1	AutovalGas			✓					

					Supports Function Code							
Base Address	**First Block Number**	**Block**	**Base Address Offset**	**Parameter**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**16**
			2	AVFinishing			✓					
			3	AVFailState			✓					
			4	Number of Cal / Val Points			✓					
			5	Select Cal/val point			✓			✓		✓
			6	LastCal/val Point n Reading			✓					
			8	LastCalPoint n Target			✓					
			10	LastCalPoint n Delta			✓					
			12	Last Cal point n Time			✓					
			13	Last Cal point n Date			✓					
			15	Cal point passed/failed			✓					
AVFinishing 0=Not Finishing, 1=Finishing												
AVFailState 0=Not in Fail State, 1=In Fail State												
Select Cal/val point 0=zero 1=span; This must be written to read corresponding values for last reading, target, delta. Delta is expressed as floating-point proportion ((target-last reading)/target).												

C.13 Transducer live info

Data for transducer n are located at ((below address) + 80(n-1)).

					Supports Function Code							
Base Address	**First Block Number**	**Block**	**Base Address Offset**	**Parameter**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**16**
4161	0	Tx (4n-1)	0	Transducer Type			✓					
			1	Tag Number			✓					
			2	Name			✓					
			11	Measurement			✓					

					Supports Function Code							
Base Address	**First Block Number**	**Block**	**Base Address Offset**	**Parameter**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**16**
			13	Pressure Compensated Measurement			✓					
			15	Filtered Measurement			✓					
			17	Transducer temperature			✓					
4181	1	Tx (4n)	0	Alarm Active	✓							
			1	Fault	✓							
			2	Service in progress	✓							
			3	Out of Specification	✓							
			4	Maintenance required	✓							
			5	Transducer maintenance fault	✓							
			6	Transducer error	✓							
			7	Transducer fatal fault	✓							
			8	WarmingOn	✓							
			9	Reserved	✓							
			10	Reserved	✓							
			11	Calibration fault	✓							
			12	Communication fail	✓							
			13	Transducer not detected	✓							
			14	Autoval / cal failed	✓							
			15	Remote calibration/val denied	✓							
4201	2	Tx (4n+1)	0	Heartbeat toggling at 1 Hz	✓							
			1	Remote service in progress	✓							

					Supports Function Code							
Base Address	**First Block Number**	**Block**	**Base Address Offset**	**Parameter**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**16**
			2	Transducer calibration mode	✓							
			3	Auto validation/ calibration	✓							
			4	Incorrect transducer type	✓							

C.14 Transducer settings

Data for transducer n are located at ((address below) + 20(n-1)).

					Supports Function Code							
Base Address	**First Block Number**	**Block**	**Base Address Offset**	**Parameter**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**16**
4481	0	Tx (n)	0	Name			✓					
			9	Units			✓					
4561	4		0	Reserved			✓			✓		✓
			2	Reserved			✓			✓		✓
			4	Unit selection (scaling Factor)			✓			✓		✓
			6	PMR			✓					
			8	Cross Interference correction/			✓			✓		✓
			10	Reserved								

C.15 Relay control

Relay n data is found at ((address below + 20(n-1)) for n=1 to n=32

					Supports Function Code							
Base Address	**First Block Number**	**Block**	**Base Address Offset**	**Parameter**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**16**
9081	0	Relay (n)	0	Active State			✓			✓		✓
			1	Override State			✓			✓		✓
			2	Override			✓			✓		✓
			3-19	Reserved								
9721	32	Relay (n)	0-19	Reserved								

C.16 Resource live info

					Supports Function Code							
Base Address	**First Block Number**	**Block**	**Base Address Offset**	**Parameter**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**16**
8741	0	0	0	Chassis temperature	✓			✓				

C.17 Resource settings

Data for transducer n are located at below address + 18(n-1).

					Supports Function Code							
Base Address	**First Block Number**	**Block**	**Base Address Offset**	**Parameter**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**16**
8765				Minimum measurement	✓			✓				
8773				Range change point	✓			✓				

C.18 Transducer control

Data for transducer n are found at the below addresses + 40(n-1).

				Supports Function Code							
Base Address	**Block**	**Base Address Offset**	**Parameter**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**16**
4001	0	0	Calibration mode on/off	✓				✓			
		1	Start auto val					✓			
		2	Stop auto val					✓			
		3	Capture and enable baseline subtraction	✓				✓			
4021	1	0	reserved								
		1	Summary of alarm and relay states: Reports a bit field of the alarm states in low byte and the relay states in high byte for the designated Tx			✓					
		2	Calibration gas in use: 0=Sample Gas 1, 1=Sample Gas 2, …			✓			✓		✓

Appendix D PROFIBUS

This appendix contains installation and operation instructions and data tables available with the PROFIBUS option.

D.1 Safety

Read the rest of this manual carefully before you use this appendix.

D.2 Description

The PROFIBUS option adds DPv0 synchronous and DPv1 asynchronous communication capabilities to the **MonoExact DF310E/DF150E** Analyzer. The PROFIBUS option board provides the following features:

- Supports DPv0/DPv1 PROFIBUS communication with RS485 transmission
- DPv1 communications with class I and class II Master devices
- Separate DPv0 modules to optimize bus load
- Profibus Address can be set from the User Interface

D.3 Electrical installation

Follow the PROFIBUS Installation Guidelines when connecting the PROFIBUS.

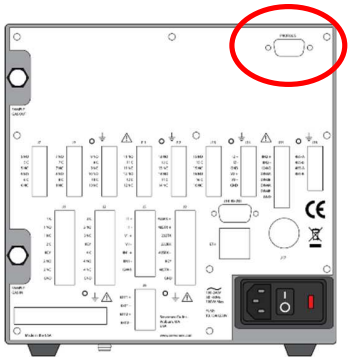


Figure 18-1: PROFIBUS connection on rear of the analyzer

There are no internal termination resistors; if the device is at the end of the segment, termination resistors should be on the connector or the segment should have an active termination unit.

1. Use recommended PROFIBUS cable, optimized for RS485 transmission.
2. Standard PROFIBUS 9-pin sub-D connector is used for PROFIBUS, the connector is labelled as “PROFIBUS” on the back of the analyzer.

PROFIBUS connector (Comms 1)		
Pin No	**Signal**	**Definition**
3	TxD-P	Data line plus (B-Line)
4	RTS	PROFIBUS Ready To Send signal
5	DGND	Data Ground
6	VP	+5V supply for terminating resistors
8	TxD-N	Data line minus (A-Line)
Case	Shield	Ground Connection

3. To ensure correct operation follow the PROFIBUS Installation Guidelines. For information on the PROFIBUS installation guidelines, refer to www.profibus.com.

D.4 PROFIBUS settings

D.4.1 Confirming PROFIBUS availability

If the analyzer was ordered with the PROFIBUS option, the PROFIBUS connector will be populated and its presence confirms the unit is configured for serial comms via PROFIBUS.

D.4.2 Setting the PROFIBUS address

The default PROFIBUS address for the analyser is set to 126.

Press the following icon sequence to change the PROFIBUS address of the analyser.

After changing the address, turn the unit off and on again for it to respond to the new address.

D.4.3 Monitoring Profibus line Status

The user interface provides information on the PROFIBUS line status. There are three reports available:

Wait for parameterization:	There are no communications between the analyser and the PROFIBUS master device.
Wait for configuration:	Initial parameterization message received, waiting for configuration data from the PROFIBUS master.
Data exchange:	The analyser and the PROFIBUS master device are communicating, using DPv0 cyclic messages.

D.5 PROFIBUS DPV0 features

D.5.1 DPv0 modules

The synchronous messaging structure of the DPv0 network requires all variables to be repeated in every message. This means the PLC has to be programmed to parse incoming and outgoing messages to extract required data. These protocol limitations mean that only frequently required parameters, which are important to be remotely accessible, are made available for DPv0 access.

The MonoExact DF310E/DF150E is capable to operate with different module configurations enabling the user to optimize network traffic. For example, if detailed status information is not required, the user can choose to omit the Measurement Status modules in the configuration.

The analyzer can support up to 8 modules, and the user can choose to include these modules in any order. The PROFIBUS master can configure the MonoExact DF310E/DF150E to include the following modules:

Module name	Type	Size
Measurement 1	Input and Output	6 Input, 6 Output Bytes
Measurement 2	Input and Output	6 Input, 6 Output Bytes
Measurement 3	Input and Output	6 Input, 6 Output Bytes
Measurement 4	Input and Output	6 Input, 6 Output Bytes
Measurement 1 Status	Input	6 Input Bytes
Measurement 2 Status	Input	6 Input Bytes
Measurement 3 Status	Input	6 Input Bytes
Measurement 4 Status	Input	6 Input Bytes

Example Configuration 1:

Slot	Module	Input byte data offset	Output byte data offset
1	Measurement One	0	0
2	Measurement One Status	6	6
3	Measurement Two	12	12

Example Configuration 2:

Slot	Module	Input byte data offset	Output byte data offset
1	Measurement Three	0	0
2	Measurement One	6	6
3	Measurement One Status	12	-
4	Measurement Two	18	12
5	Measurement Two Status	24	-

D.5.2 PROFIBUS master device configuration

Refer to your PROFIBUS master device's operator manual to configure DPv0 communications with the **MonoExact DF310E/DF150E**.

8000F77.gsd can be used as the GSD file to configure the master device. This is available on request from your Servomex representative.

Data format

Endianness:	All data transfers are word aligned, and the analyzer uses Big-Endian order, as specified in PROFIBUS standards. In Big-Endian order, the Most Significant Byte (HI) comes before the Least Significant Byte (LOW). Bit order follows the same rule and bit 0, is the least significant bit.
Floating Point Numbers:	All 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 since they require 32 bits of data, they occupy 2 words. The most significant word is transferred first.
Low/Hi Byte:	The LOW byte of a word is the least significant byte. The Most significant Byte is called the HIGH Byte.

Measurement module data map

Measurement modules contain measurement data related to the measurement modules. All four module mappings are the same.

PROFIBUS DPv0 inputs			
Word	**# Word**	**R/W**	**Name**
0	2	R	Measurement as seen on the measurement display. 32 -bit Floating point data in IEEE-754 format.
2	1	R	Status Word (See Below)

Measurement status word			
Byte	**Bit**	**Name**	**Definition**
LO	0	Warming State	0= Not warming, 1= Warming.
	1	Heater Fault	0=normal, 1=fault
	2	Sample Heater Fault	0=normal, 1=fault
	3	Calibration Fault	0=normal, 1=fault
	4	Communication alarm	0=normal, 1=fault
	5	Transducer not detected	0=transducer detected, 1=transducer not detected
	6	Autoval/cal failed	An autocal or autoval operation has failed to complete
	7	Remote calibration/val denied	0=normal, 1=A remote request for calibration or validation has been denied
HI	0	Alarm	0=normal, 1=alarm active
	1	Fault	0=normal, 1=fault
	2	Service in Progress	0=normal, 1=service in progress
	3	Out of Specification	0=normal, 1=out of specification
	4	Maintenance Required	0=normal, 1=maintenance required
	5	Transducer maintenance fault	0=normal, 1=transducer maintenance fault

Measurement status word			
Byte	**Bit**	**Name**	**Definition**
	6	Transducer error	0=normal, 1=Transducer is indicating an error code
	7	Transducer fatal fault	0=normal, 1=Transducer has identified a condition requiring return for service

PROFIBUS DPv0 outputs				
Word	**Byte**	**Bit**	**Read/Write**	**Name**
0	LOW	0-7	Write	Reserved
	HI	0	Write	Calibration mode on/off (Tx control)
		1	Write	Start auto validation (Tx control)
		2	Write	Stop auto validation
		3	Write	Enable baseline subtraction
1			Write	Invoke calibration n
2			Write	Sample Gas Selection n

Measurement status data map

Measurement Status modules, contains status related to measurements. All four module mappings are the same.

PROFIBUS DPv0 inputs			
Word offset	**# Words**	**Read/Write**	**Name**
0	1	Read	Calibration and Validation Word (see below)
1	1	Read	Bitfield of alarm states in low byte, relay states in high byte. Bit 0 - alarm or relay 1, bit 1 – alarm or relay 2, etc.)
2	1	Read	System heartbeat in bit 0, toggles at 1Hz

Calibration and validation status word			
Byte	**Bit**	**Name**	**Definition**
LOW	0-2	Auto Validation State	000=Idle 001=Pre-warning 010=Inerting 011=Flushing 100=Validating
	3-5	Auto Validation Gas	000=zero gas 001=span gas 011=sample gas
	6	Auto Validation finishing	0=not finishing 1=finishing
	7	Auto Validation fail state	0=normal 1=failed
HI	0	Calibration mode on/off	0= off (normal); 1= on (alarms masked, jamming etc). Write 1 to turn calibration mode on.
	1	Cal point passed/failed	0= failed 1= passed
	2	Reserved	Reserved
	3	Enable Baseline Subtraction	0=disabled 1=enabled
	4-7	Reserved	Reserved

D.5.3 DPv1 communications

The analyser is able to communicate using DPv1 asynchronous PROFIBUS communications with Class I and Class II masters. The following table shows the available data for DPv1 communication with Index and Slot numbers.

The user module/slot configuration on the PROFIBUS master device will not affect the DPv1 slot numbers, only Slot 1 is used.

Write requests are only accepted if the specified data lengths in the requests are same as the data lengths defined in slot/index table.

Slot	Index	Read / Write	# Words	Data
1	1	Read	72	Measurement 1 Data
1	2	Read/Write	34	Measurement 1 Control
1	11	Read	72	Measurement 2 Data
1	12	Read/Write	34	Measurement 2 Control
1	21	Read	72	Measurement 3 Data
1	22	Read/Write	34	Measurement 3 Control
1	31	Read	72	Measurement 4 Data
1	32	Read/Write	34	Measurement 4 Control
1	240	Read/Write	8	Resource Control
1	241	Read	32	Relay Data
1	242	Read	21	Resource Data
1	243	Read/Write	96	Relay Settings
1	250	Read	20	System Data
1	251	Read	18	System Settings

The field definitions for these indexed data spaces follow sequentially (definitions within a table also follow as commented).

Measurement Data 1 - 4		
Word	**Name**	**Comments**
0	Tag Number	16-bit user tag for this measurement
1-9	Name	Text Name for measurement 18 bytes
10-11	Measurement	32-bit IEEE float of displayed measurement
12-13	Pressure compensated	Pressure compensated measurement
14-15	Filtered measurement	Filtered measurement
16-17	Temperature	Chassis temperature
18-19	Faults and Alarms	Defined in Faults & Alarms table immediately below
20	Auto Validation State	Defined in Calibration 1-4 table below
21	Auto Validation Gas	Defined in Calibration 1-4 table below
22	Auto Validation Finishing	Defined in Calibration 1-4 table below
23	Auto Validation Fail State	Defined in Calibration 1-4 table below
24	Number of Cal / Val Points	Defined in Calibration 1-4 table below
25	Select Cal/Val Point*	Defined in Calibration 1-4 table below
26-27	Last Cal/Val Point n reading	
28-29	Last Cal Point n Target	32-bit float
30-31	Last Cal Point n Delta	32-bit float
32	Last Cal Point n Time	16-bit integer (hhmm)
33-34	Last Cal Point n Date[2]	32-bit integer (yymmdd)
35	Cal point passed/failed	

Measurement faults and alarms				
Word	**Byte**	**Bit**	**Name**	**Comments**
0	LOW	0	Warming On	
		1	Heater fault	
		2	Sample heater fault	
		3	Calibration fault	
		4	Communication fail	
		5	Transducer not detected	
		6	Auto-Cal validation / calibration failed	
		7	Remote validation / calibration failed denied	
	HI	0	Alarm Active	
		1	Fault	
		2	Service in progress	
		3	Out of specification	
		4	Maintenance required	
		5	Transducer maintenance fault	
		6	Transducer error	
		7	Transducer fatal fault	
1	LOW	0-7	Reserved	
	HI	0	Clipping Active	
		1	Remote service in progress	
		2	Transducer calibration mode	
		3	Auto-Cal validation/calibration	
		4	Incorrect transducer type	
		5-7	Reserved	

Measurement 1-4 control				
Word	**Byte**	**Bit**	**Name**	**Comments**
0	LOW	0-7	Reserved	
	HI	0	Calibration mode on/off	
		1	Start Auto-Cal validation	
		2	Stop Auto-Cal validation	
		3	Enable baseline subtraction	
		4-7	Reserved	
1			Invoke calibration n	
2			Calibration point n gas	
3			Sample Gas Selection	
4			Select Cal/Val point	
5-6			Cross Interference correction/ GSF	
7-16			Reserved	

Resource Control 1-4 slot 1 index 240		
Byte	**Name**	**Comments**
0	cLegacy Pressure 1[8]	Defined in ***Legacy Pressure n*** table below
1	cLegacy Pressure 2[8]	
2	cLegacy Pressure 3[8]	
3	cLegacy Pressure 4[8]	
4	cLegacy Flow 1[8]	Defined in ***Legacy Flow n*** table below
5	cLegacy Flow 2[8]	
6	cLegacy Flow 3[8]	
7	cLegacy Flow 4[8]	

Legacy pressure n		
Bit	**Name**	**Comments**
0	Calibrate pressure mode	
1	Calibrate pressure low	
2	Calibrate pressure high	

Legacy flow n		
Bit	**Name**	**Comments**
0	Calibrate flow mode	
1	Calibrate zero flow	
2	Calibrate normal flow	

Relay Data slot 1 index 241		
Bit	**Name**	**Comments**
0	iRelay 01 status[8]	State, CardNotDetected or ServiceInProgress
:	iRelay n status[8]	State, CardNotDetected or ServiceInProgress
31	iRelay 32 status[8]	State, CardNotDetected or ServiceInProgress

Relay info n		
Bit	**Name**	**Comments**
0	State	
1	Card not detected	
2	Service in progress	

Resource data (Slot 1 Index 242)		
Byte	**Name**	**Comments**
0	iAOUT 1 status[8]	
1	iAOUT 2 status[8]	
2	iAOUT 3 status[8]	
3	iAOUT 4 status[8]	
4	iAIN 1 status[8]	
5	iAIN 2 status[8]	
6	iAIN 3 status[8]	
7	iAIN 4 status[8]	
8	iDin Card Not Detected[8]	
9	iLegacy Pressure 1 status [8]	
10	iLegacy Pressure 2 status [8]	
11	iLegacy Pressure 3 status [8]	
12	iLegacy Pressure 4 status [8]	
13	iLegacy Flow Alarm 1 status[16]	
14	iLegacy Flow Alarm 2 status[16]	
15	iLegacy Flow Alarm 3 status[16]	
16	iLegacy Flow Alarm 4 status[16]	
17-20	Chassis Temperature	

Relay Settings (Slot 1 Index 243)		
Byte	**Name**	**Comments**
0	iRelay 01 Active State	Rsc settings
1	iRelay 01 Override State	
2	iRelay 01 Override	
3	iRelay 02 Active State	
4	iRelay 02 Override State	
5	iRelay 02 Override	
:	iRelay n Active State	
:	iRelay n Override State	
:	iRelay n Override	
93	iRelay 32 Active State	
94	iRelay 32 Override State	
95	iRelay 32 Override	

System data (Slot 1, Index 250)		
Word	**Name**	**Comments**
0-9	hInstrument Serial Number [10]	System Data

System settings (Slot 1, Index 251)		
Word	**Name**	**Comments**
0	hService in Progress	System Control
1	System Controls	System Settings
2	hResponse Delay	
3	hClock: Hrs	
4	hClock: Mins	
5	hClock: Seconds	
6	hDate: Year	
7	hDate: Month	
8	hDate: Day	

System controls word			
Byte	**Bit**	**Name**	**Definition**
LOW	0-7	Reserved	
HI	0	Floating point order	
	1	User Interface busy	
	2	Disable user interface	
	3-7	Reserved	

D.6 PROFIBUS Troubleshooting

D.6.1 The analyzer is not detected by the PROFIBUS master device

- Check that the PROFIBUS cable is connected to the analyser, and the master device.
- Check that the termination resistors on the end points of the network are active.
- Check that the analyser node address is set up correctly on the master device.
- Check that there are no other devices configured to use the same address as the analyser.

Make sure that if there is more than one master device on the system, the correct master device is configured and connected to the analyser.

On the PROFIBUS master device, make sure that the correct “gsd” file has been used to configure the analyser, and at least one module is included in the configuration. Refer to your master device's manual to make sure all steps for the configuration have been followed.

Some PROFIBUS master devices are configured to stop reporting cyclic data as soon as an extended diagnostic error message is received. In this case either these faults have to be cleared on the analyser, or the master device has to be configured to continue normal operation when diagnostic bits are reported.

Make sure that the PROFIBUS baud rate selected at the Profibus master device, is suitable for the cabling setup.

Make sure that the PROFIBUS master is running.

Using the Status menu on the analyser, make sure that there is no "PROFIBUS card not detected" fault. This fault will require servicing of the analyser - Contact Servomex or your local Servomex representative.

D.6.2 The communication starts, but there are frequent line drops

Make sure that the ‘PROFIBUS Cabling Guidelines’ have been followed. Refer to www.profibus.com for the latest guidelines.

If possible decrease the network baud rate.

Appendix E Return Authorization Request

E.1 Return Authorization Product Number Request

Servomex must approve and then assign a Return Product Authorization (RPA) Number to any instrument prior to being returned to the factory for repair. The RPA must appear on all paperwork and packaging. The issuance of an RPA does not automatically imply that the instrument is covered by our warranty.

In order to serve you better and to protect our employees from any potentially hazardous contaminants, Servomex must return, unopened and at the sender's expense, all items that do not have an RPA and a signed and filled out Decontamination Form.

OSHA Hazard Communication Standard 29CFR 1920.1200 mandated that we take specific steps to protect our employees from exposure to potential hazards. Therefore, a letter certifying that the equipment has been decontaminated must accompany all equipment exposed to hazardous contamination.

To obtain an RPA, fill out the form in section E.2 and email it to one of the following addresses:

North and South America:	americas_service@servomex.com
Asia, Australia, New Zealand:	asia_service@servomex.com
Europe, Middle East, Africa, India:	eaemi_service@servomex.com

E.2 Return Product Authorization Number (RAN) Request Form

Thank you for requesting a Return Product Authorization (RAN) Number. We will acknowledge receipt of this form and will forward the RAN number to you.

Date:	

Customer information:		**End-user information:** ***(if different)***	
Company name:		**Company name:**	
Address:		**Address:**	
Contact name:		**Contact name:**	
Phone:		**Phone:**	
Email:		**Email:**	

Billing information:		**Shipping information:**	
Name:		**Name:**	
Address:		**Address:**	
Contact name:		**Contact name:**	
Phone:		**Phone:**	
Email:		**Email:**	
		Shipping Instructions: **(UPS/FedEx Acct, P&A)**	

Analyzer information:			
Part or model number:	MonoExact DF310E/DF150E	**Serial number:**	
Original purchase date:		**PO number:**	

Service requested: (check relevant option)	**Repair**		**Required return**	
	Calibration		**Warranty / failure analysis**	
Details of problem or failure:				
Do you require a rental unit?	**No** ☐	**Yes** ☐		
Do you require specific test documentation to be returned?	**No** ☐	**Yes** ☐		
	Servomex provides a Certificate of Calibration with each tested analyser. Any additional test documentation requested is subject to a test report fee.			
Have you attached a decontamination certificate?	**No** ☐	**Yes** ☐		

Shipping information:
Please contact the relevant Servomex Support Office (below) for your location to obtain the shipping address.

Servomex Support contact information:	
North and South America:	americas_service@servomex.com
Asia, Australia, New Zealand:	asia_service@servomex.com
Europe, Middle East, Africa, India:	emeai_service@servomex.com

We look forward to receiving your request. If you have any questions regarding this form, please contact your local Servomex Support office.

Thank you for choosing Servomex.

E.2 Decontamination Certificate

It is hereby certified that the equipment being returned, as described below, has been completely decontaminated and poses no possible toxic, corrosive, irritant, flammable, radioactive or biological hazard to any personnel required to unpack, handle, examine, maintain or repair it.

Equipment / model:	MonoExact DF310E/DF150E	**Serial number:**	
Application / process:			
Substance(s) exposed to:			

Authorized customer contact information:			
Company name:			
Name:		**Title:**	
Phone:		**Email:**	
Signature:			
Date:			

IMPORTANT NOTICE:

Servomex ensures that all products dispatched to customers have been suitably purged and cleaned prior to packaging so that no hazards from the use of factory calibration gases or liquids are present.

Appendix F Paramagnetic transducer information

Table F-1: Recommended calibration periods for paramagnetic transducers

Gas transducer module	Low calibration	High calibration
Paramagnetic transducer	Weekly	Weekly

Table F-2: Paramagnetic transducer FSD values

Transducer	FSD
% O_2 (User set to 0-25%)	100% O_2

Table F-3: Paramagnetic transducer performance specification

Gases measured	% O_2
Range	0 – 100%
Minimum recommended output range	0 – 5%
Intrinsic error	± 0.1% O_2
Linearity error *Inherently linear, dependent on calibration gases*	< 0.05% O_2
Repeatability	< 0.1% O_2
Lower Detection Limit (LDL) (95% confidence interval)	0.02% O_2
Response (T90) at 1500ml/min	< 15 s
Zero drift / week	< 0.05% O_2
Span drift / week	< 0.1% O_2
Output fluctuation (peak to peak)	± 0.05% O_2
Ambient pressure coefficient	Directly proportional to analyzer vent pressure
Zero temperature coefficient / 10 °C change	± 0.1% O_2
Span temperature coefficient / 10 °C change	1% of reading or ± 0.1% O_2, whichever is the larger.

Gases measured	% O_2
Sample flow effect range over full flow range	< 2% of reading or 0.1% O_2, whichever is the larger.

F.1 Overview of measurement errors for paramagnetic O_2 transducer

For an O_2 transducer, the composition of any typical background gas in the gas sample will have an impact on the analyzer measurement accuracy.

Table H-4 below gives 4 examples of cross-interference errors (O_2 measurement errors) in gases which contain 100% of a specific background gas, for an analyzer which has been 'Lo' calibrated with N_2 (nitrogen) and 'Hi' calibrated with O_2.

Table F-4: Example cross-interference measurement errors

Background gas	Error
Argon	-0.22%
Carbon dioxide	-0.26%
Halothane	-1.93%
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. A detailed listing of these measurement errors for a wide variety of background gases are listed in Section 18.1F.2 below.

XINT is a reported concentration adjustment that can be set in the Paramagnetic Measurement menus. It is a scaling factor that is used to correct the current transducer reading. The default value is 1.0. If required the operator can change this value to compensate for the background gas. For example: If you are measuring oxygen in a background of carbon dioxide -0.26 should be entered as the XINT value.

Figure F-1: XINT icon

If XINIT compensation is to be used, care must be taken to insure that the value used for the background gases is correct. During a calibration, no XINT compensation is applied and it is assumed that the calibration gas sample has negligible cross-interference.

F.2 Cross interference offsets (for paramagnetic transducer)

Pure gas	Formula	Molar mag. susc x 10^{-6}	Cross interference offsets	
			20 °C	50 °C
Acetaldehyde	CH_2CHO	–22.70	–0.31	–0.34
Acetic acid	CH_3CO_2H	–31.50	–0.56	–0.62
Acetone	CH_3COCH_3	–33.70	–0.63	–0.69
Acetylene	HCCH	–20.80	–0.25	–0.28
Acrylonitrile	CH_2=CHCN	–24.10	–0.35	–0.39
Allyl alcohol	CH_2CHCH_2OH	–36.70	–0.71	–0.79
Ammonia	NH_3	–18.00	–0.17	–0.19
Argon	Ar	–19.60	–0.22	–0.24
Benzene	C_6H_6	–54.84	–1.24	–1.36
Boron chloride	BCl_3	–59.90	–1.38	–1.53
Boron trifluoride	BF_3	–19.00	–0.20	–0.22
Bromine	Br_2	–73.50	–1.78	–1.96
1,2 Butadiene	C_4H_6	–35.60	–0.68	–0.75
1,3 Butadiene	C_4H_6	–30.60	–0.54	–0.59
N-Butane	C_4H_{10}	–50.30	–1.11	–1.22
iso-Butane	$(CH_3)_2CHCH_2$	–51.70	–1.15	–1.26
1 Butene	CH_3CH_2CH=CH_2	–41.10	–0.84	–0.93
N–Butyl acetate	$CH_3COOC_4H_9$	–77.50	–1.89	–2.09
iso–Butylene	$(CH_3)_2CH$=CH_2	–44.40	–0.94	–1.03
1 Butyne (Ethylacetylene)	$CH_3C_3H_2$	–43.50	–0.91	–1.00
Carbon dioxide	CO_2	–21.00	–0.26	–0.29
Carbon disulphide	CS_2	–42.20	–0.87	–0.96
Carbon monoxide	CO	–9.80	0.06	0.07
Carbon tetrachloride	CCl_4	–66.60	–1.58	–1.74
Carbon tetrafluoride	CF_4	–31.20	–0.55	–0.61

Pure gas	Formula	Molar mag. susc x 10^{-6}	Cross interference offsets	
			20 °C	50 °C
Chlorine	Cl_2	–40.50	–0.82	–0.91
Chloroethanol	$ClCH_2CH_2OH$	–51.40	–1.14	–1.25
Chloroform	$CHCl_3$	–59.30	–1.37	–1.51
Cumene	$(CH_3)_2CHC_6H_5$	–89.53	–2.24	–2.47
Cyclohexane	C_6H_{12}	–68.13	–1.62	–1.79
Cyclopentane	C_5H_{10}	–59.18	–1.36	–1.50
Cyclopropane	C_3H_6	–39.90	–0.81	–0.89
Diacetylene	C_4H_2	–37.50	–0.74	–0.81
Dichloroethylene	$(CHCl)_2$	–49.20	–1.07	–1.18
Diethyl ether	$(C_2H_5)_2O$	–55.10	–1.25	–1.37
2,2 Difluoro 1 chloroethane	$CClH_2CHF_2$	–52.40	–1.17	–1.29
1,2 Difluoro 1,2 dichloroethylene	CFCl=CFCl	–60.00	–1.39	–1.53
Difluoro dichloro methane (Freon 12)	CCl_2F_2	–52.20	–1.16	–1.28
Dimethoxy methane	$CH_2(OCH_3)_2$	–47.30	–1.02	–1.12
Dimethylamine	$(CH_3)_2NH$	–39.90	–0.81	–0.89
Dimethylether	CH_3OCH_3	–26.30	–0.41	–0.46
Dimethylethylamine	(CH3)2NC2H5	–63.60	–1.49	–1.64
Enflurane (Ethrane)	C3H2F5ClO	–80.10	–1.97	–2.17
Ethane	C2H6	–26.80	–0.43	–0.47
Ethanol	C_2H_5OH	–33.60	–0.62	–0.69
Ethyl acetate	$CH_3COOC_2H_5$	–54.20	–1.22	–1.34
Ethyl amine	$C_2H_5NH_2$	–39.90	–0.81	–0.89
Ethyl benzene	$C_6H_5C_2H_5$	–77.20	–1.88	–2.08
Ethyl bromide	C_2H_5Br	–54.70	–1.23	–1.36
Ethyl chloride	C_2H_5Cl	–46.00	–0.98	–1.08

Pure gas	Formula	Molar mag. susc x 10^{-6}	Cross interference effects	
			20 °C	50 °C
Ethylene	C_2H_4	–18.80	–0.20	–0.22
Ethylene glycol	$(CH_2OH)_2$	–38.80	–0.77	–0.85
Ethylene oxide	$(CH_2)_2O$	–30.70	–0.54	–0.60
Ethyl mercaptan	$C_2H_5OSO_3H$	–47.00	–1.01	–1.11
Fluorochlorobromomethane	CFClBr	–58.00	–1.33	–1.46
Fluorodichloromethane (Freon 21)	$CHCl_2F$	–48.80	–1.06	–1.17
Fluroxene	$CF_3CH_2OCHCH_2$	–56.70	–1.29	–1.42
Freon 114	$C_2Cl_2F_4$	–77.40	–1.89	–2.08
Furan	C_4H_4O	–43.09	–0.90	–0.99
Germanium tetrachloride	$GeCl_4$	–72.00	–1.73	–1.91
Halothane	$C_2HBrClF_3$	–78.80	–1.93	–2.13
Helium	He	–1.88	0.29	0.32
N–Heptane	C_7H_{16}	–85.24	–2.12	–2.33
N–Hexane	C_6H_{14}	–73.60	–1.78	–1.96
Hydrogen	H_2	–3.98	0.23	0.26
Hydrogen bromide	Br	–35.30	–0.67	–0.74
Hydrogen chloride	HCl	–22.60	–0.31	–0.34
Hydrogen cyanide	HCN	–14.50	–0.07	–0.08
Hydrogen iodide	HI	–48.20	–1.05	–1.15
Hydrogen selenide	H_2Se	–39.20	–0.79	–0.87
Hydrogen sulphide	H_2S	–25.50	–0.39	–0.43
Isoflurane (Forane)	$C_3H_2F_5ClO$	–80.10	–1.97	–2.17
Isoprene	C_5H_8	–44.80	–0.95	–1.04
Ketene	CH_2CO	–15.70	–0.11	–0.12
Krypton	Kr	–28.80	–0.49	–0.54
Methane	CH_4	–17.40	–0.16	–0.17

Pure gas	Formula	Molar mag. susc x 10^{-6}	Cross interference effects	
			20 °C	50 °C
Methanol	CH_3OH	–21.40	–0.27	–0.30
Methoxyfluorane	$CHCl_2CF_2OCH_3$	–87.10	–2.17	–2.39
Methyl acetate	CH_3COCH_3	–42.60	–0.88	–0.97
Methyl cyclopentane	C_6H_{12}	–70.20	–1.68	–1.85
Methylene chloride	CH_2Cl_2	–46.60	–1.00	–1.10
Methylethlyketone	$CH_3COCH_2CH_3$	–45.50	–0.97	–1.07
Methyl fluoride	CH_3F	–25.50	–0.39	–0.43
Methyl formate	$HCOOCH_3$	–32.00	–0.58	–0.64
Methyl iodide	CH_3I	–57.20	–1.31	–1.44
Methyl iso–butyl ketone (MIBK)	$C_4H_9COCH_3$	–69.30	–1.66	–1.82
Methyl mercaptan	CH_3SH	–35.30	–0.67	–0.74
Molybdenum hexafluoride	MoF_6	–26.00	–0.40	–0.45
Monochlorobenzene	C_6H_5Cl	–70.00	–1.68	–1.85
Neon	Ne	–6.70	0.15	0.17
Nitric oxide	NO	1461.00	42.56	42.96
Nitrobenzene	$C_6H_5NO_2$	–61.80	–1.44	–1.59
Nitrogen	N_2	–12.00	0.00	0.00
Nitrogen dioxide	NO_2	150.00	5.00	16.00
Ortho–Nitrotoluene	$C_6H_4CH_3NO_2$	–72.30	–1.74	–1.92
para–Nitrotoluene	$C_6H_4CH_3NO_2$	–76.90	–1.88	–2.07
Nitrous oxide	N_2O	–18.90	–0.20	–0.22
N–Nonane	C_9H_{20}	–108.13	–2.78	–3.06
N–Octane	C_8H_{18}	–96.63	–2.45	–2.70
Oxygen	O_2	3449.00	100.0	100.0
Ozone	O_3	6.70	0.54	0.60
iso–Pentane	C_5H_{12}	–64.40	–1.51	–1.67

Pure gas	Formula	Molar mag. susc x 10^{-6}	Cross interference offsets	
			20 °C	50 °C
N–Pentane	C_5H_{12}	–63.10	–1.48	–1.63
0.01%Phenol	C_6H_5OH	–60.21	–1.39	–1.54
Phosphine	PH_3	–26.00	–0.40	–0.45
Phosphorous oxychloride	$POCl_3$	–69.00	–1.65	–1.82
Propane	C_3H_8	–38.60	–0.77	–0.85
iso–Propanol	$(CH_3)_2CHOH$	–47.60	–1.03	–1.13
Propene	$CH_3CH=CH_2$	–31.50	–0.56	–0.62
N–Propyl acetate	$CH_3COOC_3H_7$	–65.90	–1.56	–1.72
Propyl amine	$C_3H_7NH_2$	–52.40	–1.17	–1.29
Propyl chloride	C_3H_7Cl	–56.10	–1.27	–1.40
Propylene	C_3H_6	–31.50	–0.56	–0.62
Propylene oxide	OCH_2CHCH_3	–42.50	–0.88	–0.97
iso–Propyl ether	$(CH_3)_4CHOCH$	–79.40	–1.95	–2.15
Propyl fluoride	C_3H_7F	–52.20	–1.16	–1.28
Pyridine	$N(CH)_5$	–49.21	–1.08	–1.19
Silane	SiH_4	–20.50	–0.25	–0.27
Silicon tetrachloride	$SiCl_4$	–88.30	–2.20	–2.43
Styrene	$C_6H_5CH=CH_2$	–68.20	–1.62	–1.79
Sulphur dioxide	SO_2	–18.20	–0.18	–0.20
Sulphur hexafluoride	SF_6	–44.00	–0.92	–1.02
Tetrachoroethylene	$Cl_2C=CCl_2$	–81.60	–2.01	–2.22
Tetrahydrofuran	C_4H_8O	–52.00	–1.16	–1.27
Toluene	$C_6H_5CH_3$	–66.11	–1.56	–1.72
1,1,2 Trichloroethane (Freon 113)	$CHCl_2CH_2Cl$	–66.20	–1.57	–1.73
Trichloroethylene	$CHCl=CCl_2$	–65.80	–1.55	–1.71
Trifluorochloroethylene	C_2F_3Cl	–49.10	–1.07	–1.18

Pure gas	Formula	Molar mag. susc x 10^{-6}	Cross interference offsets	
			20 °C	50 °C
Trimethylamine	$(CH_3)_3N$	–51.70	–1.15	–1.26
Tungsten fluoride	WF_6	–40.00	–0.81	–0.89
Urethane	$CO(NH_2)OC_2H_5$	–57.00	–1.30	–1.43
Vacuum	–	0.00	0.35	0.38
Vinyl bromide	$CH_2=CHBr$	–44.80	–0.95	–1.04
Vinyl chloride	$CH_2=CHCl$	–35.60	–0.68	–0.75
Vinyl fluoride	$CH_2=CHF$	–28.80	–0.49	–0.54
Water	H_2O	–13.00	–0.03	–0.03
Xenon	Xe	–43.90	–0.92	–1.02
Xylene	$(CH_3)_2C_6H_4$	–77.78	–1.90	–2.09

Appendix H Material Safety Data Sheet

Identification of the substance

Trade name	ElectrolyteSolution, *Ɛ-lectrolyte* Gold, *Ɛ-lectrolyte* Blue, *Ɛ-lectrolyte* Black, DF-E05, DF-E06, DF-E07, DF-E09
Manufacturer	Servomex, Inc. Boston Technical Center 4 Constitution Way, Woburn, MA 01801-1087, USA, Tel + 1-781-935-4600
Emergency contact	ChemTel Expert Assistance Hotline USA: 1-800-255-3924 International: +01-813-248-0585

Composition

CAS #	Component	EC Code/class	Concentration	Risk Phrase	Risk Description
7732-18-5	Water and non-hazardous salts	231-791-2	95.7% w/w	Not Applicable	None
1310-58-3	Potassium Hydroxide in aqueous solution	215-181-3 C	0.77N: 4.3% w/w	R35	Causes severe burns

Hazards identification

Main Hazard

Corrosive. Causes severe burns on contact with skin, eyes and mucous membrane.

CERCLA Ratings (scale 0-3)	Health = 3	Fire = 0	Reactivity = 1	Persistence = 0
NFPA Ratings (scale 0-4)	Health = 3	Fire = 0	Reactivity = 1	

Potential Health Effects:

Eye Contact

Causes severe eye burns. May cause irreversible eye injury. Contact may cause ulceration of the conjunctiva and cornea. Eye damage may be delayed.

Skin Contact	Causes skin burns. May cause deep, penetrating ulcers of the skin.
Ingestion	May cause circulatory system failure. May cause perforation of the digestive tract. Causes severe digestive tract burns with abdominal pain, vomiting, and possible death.
Inhalation	Inhalation under normal use would not be expected as this product is supplied as an aqueous solution and no hazardous vapors are emitted. Effects of inhalation are irritation that may lead to chemical pneumonitis and pulmonary edema. Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma.
Chronic	Prolonged or repeated skin contact may cause dermatitis. Prolonged or repeated eye contact may cause conjunctivitis.

First-Aid measures

Skin Contact	In case of skin contact, remove contaminated clothing and shoes immediately. Wash affected area with soap or mild detergent and large amounts of water for at least 15 minutes. Obtain medical attention immediately.
Eye Contact	If the substance has entered the eyes, wash out with plenty of water for at least 15 - 20 minutes, occasionally lifting the upper and lower lids. Obtain medical attention immediately.
Ingestion	If the chemical has been confined to the mouth, give large quantities of water as a mouthwash. Ensure the mouthwash has not been swallowed. If the chemical has been swallowed, do NOT induce vomiting. Give 470 - 950ml (2 - 4 cups) of water or milk. Never give anything by mouth to an unconscious person. Obtain medical attention immediately.
Inhalation	Inhalation under normal use would not be expected as this product is supplied as an aqueous solution and no hazardous vapors are emitted; however, if inhalation should somehow occur, remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Seek medical aid immediately.

Fire-fighting measures

Special Exposure Hazard	Not applicable
Extinguishing Media	Not Combustible. Select extinguishing media appropriate to the surrounding fire conditions.
Protective Equipment	Wear appropriate protective clothing to prevent contact with skin and eyes. Wear a self-contained breathing apparatus (SCBA) to prevent contact with thermal decomposition products.

Accidental release measures

Personal Protection	Use proper personal protective equipment as indicated in Section 8.
Leaks and Spills	Absorb spill with inert material (e.g., dry sand or earth), then place into a chemical waste container. Neutralize spill with a weak acid such as vinegar or acetic acid.
Clean-up Procedures	Wash the spillage site with large amounts of water.

Handling and storage

Handling Precautions	Complete eye and face protection, protective clothing, and appropriate gloves must be used. Do not get in eyes, on skin, or on clothing. Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Do not ingest or inhale.
Storage Precautions	Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Keep away from strong acids.

Exposure controls / personal protection

Personal Protection

Eyes	Wear appropriate protective chemical safety goggles and face shield as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin	Wear appropriate gloves to prevent skin exposure.
Clothing	Wear appropriate protective clothing to prevent skin exposure.

Respirators	Not Applicable. Inhalation under normal use would not be expected as this product is supplied as an aqueous solution and no hazardous vapors are emitted.
Airborne Exposure	This material is supplied as an aqueous solution and will not be present in the atmosphere in normal use.
Exposure Limits	Potassium Hydroxide UK EH40, OEL (8hr TWA) 2mg/m^3 NIOSH, (8hr TWA) 2mg/m^3 ACGIH, Ceiling 2mg/m^3 OSHA, not listed

Physical and chemical properties

Molecular Formula	KOH Mixture
Physical State	.77N aqueous solution. Colorless, odorless
pH	Alkaline
Solubility	Completely soluble in water
Boiling Point	104.5°C
Melting Point	-3.5°C
Flash Point	Not applicable
Flammability	Not flammable
Explosion Limits	Not applicable
Specific Gravity	1.15
Vapor Pressure	16.1 mm Hg @ 20°C

Stability and reactivity

Chemical Stability	Stable
Conditions/Materials to Avoid	Incompatible materials, acids and metals
Incompatibilities with other Materials	Reacts with chlorine dioxide, nitrobenzene, nitromethane, nitrogen trichloride, peroxidized tetrahydrofuran, 2,4,6-trinitrotoluene, bromoform+ crown ethers, acids alcohols, sugars, germanium cyclopentadiene, maleic dicarbide. Corrosive to metals such as aluminum, tin, and zinc to cause formation of flammable hydrogen gas.

Hazardous Decomposition Products	Oxides of potassium
Hazardous Polymerization	Has not been reported

Toxological information

RTECS#	CAS# 7732-18-5	ZC0110000
	CAS# 1310-58-3	TT2100000
LD50/ LC50	CAS# 7732-18-5	Oral, ret:LD50 = >90 ml/kg
	CAS# 1310-58-3	Draize test, rabbit, skin: 50 mg/24H Severe Oral, rat: LD50 = 273 mg/kg
Carcinogen Status	CAS# 7732-18-5	Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA
	CAS# 1310-58-3	Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA

Potassium Hydroxide Solution is a severe eye, mucus membrane, and skin irritant.

Ecological information

Mobility	Completely soluble in water
Degradability	Will degrade by reaction with carbon dioxide from the atmosphere to produce a non-hazardous product.
Accumulation	No
Ecotoxicity	Information not available. No long-term effects expected due to degradation. The preparation is already in dilute solution and adverse aquatic effects are not expected due to further dilution. The preparation is corrosive, and direct contact with fauna will cause burns.

Disposal considerations

Waste Disposal	Dispose of in a manner consistent with federal, state, and local regulations.

Transportation information

	Shipping Name	Hazard Class	UN Number	Packaging Group
US DOT	Potassium Hydroxide Solution	8	UN1814	II
IATA	Potassium Hydroxide Solution	8	UN1814	II
ADR/RID	Potassium Hydroxide Solution	8	UN1814	II
IMDG Code	Potassium Hydroxide Solution	8	UN1814	II
Canadian TDG	Potassium Hydroxide Solution	8(9.2)	UN1814	Not available

Regulatory information

US Federal

TSCA	CAS# 7732-18-5	**Listed on TSCA Inventory**
	CAS# 1310-58-3	**Listed on TSCA Inventory**
Health & Safety Reporting List		None of the chemicals on Health & Safety Reporting List
Chemical Test Rules		None of the chemicals are under Chemical Test Rule
Section 12b		None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule		None of the chemicals have a SNUR under TSCA
CERCLA Hazardous Substances and corresponding RQ's	CAS# 1310-58-3	1000 lb final RQ; 454kg final RQ
SARA Section 302 Extremely Hazardous Substances		None of the chemicals have a TQP

SARA Codes	CAS# 1310-58-3	Immediate, Reactive
Section 313		No chemicals are reportable under Section 313
Clean Air Act		Does not contain any hazardous air pollutants
		Does not contain any Class 1 Ozone depletors
		Does not contain any Class 2 Ozone depletors
Clean Water Act	CAS# 1310-58-3	Listed as a Hazardous Substance under the CWA
		None of the chemicals are listed as Priority Pollutants under the CWA
		None of the chemicals are listed as Toxic Pollutants under the CWA
OSHA		None of the chemicals are considered highly hazardous by OSHA
STATE	CAS# 7732-18-5	Not present on state lists from CA, PA, MN, MA, or NJ.
	CAS# 1310-58-3	Can be found on the following state right to know lists; CA, NJ, PA, MN, MA.
California Prop 65		California No Significant Risk Level: None of the chemicals are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Classification	Corrosive	
Hazard Symbol	C	
EC Number	215-181-3	
Risk Phrases	R35	Causes severe burns.
	R22	Harmful if swallowed
Safety Phrases	S1/2	Keep locked up and out of reach of children.
	S26	In case of contact with the eyes, rinse immediately with plenty of water and seek medical advice.
	S36	Wear suitable protective clothing.

	S37/39	Wear suitable gloves and eye/face protection.
	S45	In case of accident or if you feel unwell, seek medical advice immediately (show label where possible).
WGK (Water Danger/Protection)	CAS# 7732-18-5	No information available
	CAS# 1310-58-3	1
Canada – DSL/ NDSL	CAS# 7732-18-5	Listed on Canada's DSL List
	CAS# 1310-58-3	Listed on Canada's DSL List
Canada - WHMIS	Classification E, D1B	Classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.
Canadian Ingredient Disclosure List	CAS# 1310-58-3	Listed on the Canadian Ingredient Disclosure List

Other information

MSDS Creation Date: 09/30/94 MSDS Revised: December 10, 2010

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Appendix I Sample wetted materials information

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

Coulometric O_2 % measurement	Coulometric O_2 trace measurement
303 st steel	Stainless Steel
Viton	5 minute epoxy
Polypropylene	G10 epoxy
PPS with carbon fibre filler *	Carbon/Teflon composite
PPS *	Paraffin wax
Borosilicate glass *	1M aqueous potassium hydroxide
Polysulphone	Delrin
316 stainless steel	EPDM O-ring
Platinum	Borosilicate glass
Platinum / iridium alloy	**Rotameter flow meter**
Electroless nickel	
10% glass filled polyetherimide(ultem)	Borosilicate glass
RTV silicone	316 and 303 Stainless steel
Epoxy	Duralumin
Silgel (silicone)	Delrin
Gold	EPDM O-ring
Silicon	**Flow switch**
** with optional filter*	Acrylic
	Stainless steel
	Loctite 565 thread sealant

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