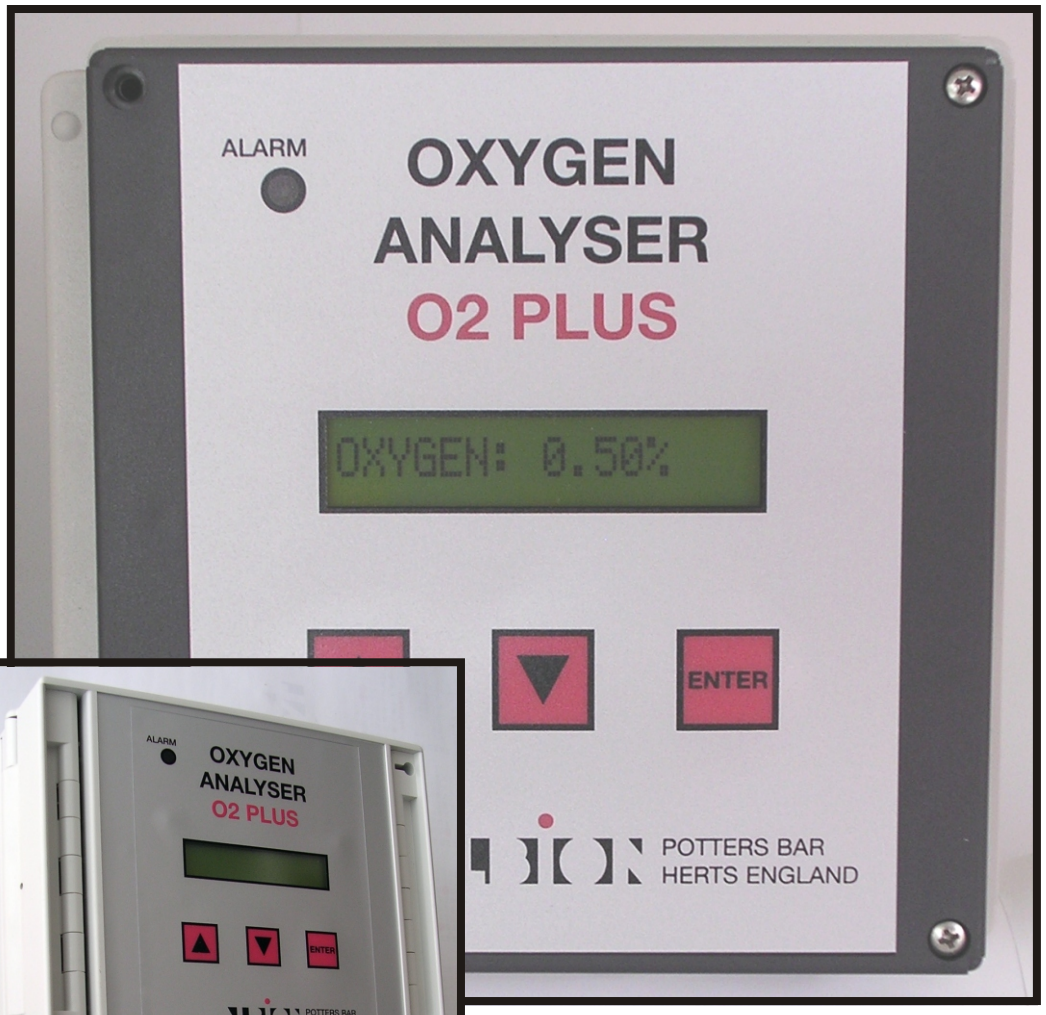
OXYGEN ANALYSER
TYPE O2 PLUS

OPERATING AND INSTALLATION INSTRUCTIONS



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INTRODUCTION

Accurate control or measurement of the products of combustion are essential requirements to ensure that Gas or Oil fired Burners operate continually at the maximum possible level of efficiency to suit the application or process.

Good combustion is achieved when the amount of excess air is minimised to reduce heat losses without producing excess levels of carbon monoxide.

The amount of excess air necessary will depend very much on the fuel type and the air/fuel mixing characteristics of the burner head. Carbon monoxide (CO) levels normally increase sharply as the air/fuel ratio approaches the theoretical optimum. If the air/fuel mixing at the burner head is poor CO will be produced even when excess air is significant.

The point at which the CO level starts to increase is a good indication of burner efficiency as it indicates the amount of excess air needed in practice. Information on this is normally available from the burner maker.

Fully optimised combustion control requires not only that the fuel/air ratio to burners be regulated but also that the results of the regulation be monitored by analysis of the combustion gases. The results are then fed back to the regulator system and the state of regulation is trimmed to achieve optimum combustion conditions.

Although it is desirable to test for at least two of the three main constituents of combustion products (O2, CO2 and CO) when setting up a plant for optimised conditions, it is acknowledged that subsequent monitoring of the oxygen level is fundamentally the most reliable indicator that optimum conditions are being maintained.

THE ALBION O2 PLUS

The Albion O2 Plus Oxygen Monitor has been developed to enable the oxygen content of hot combustion gases to be accurately measured. It is primarily intended for permanent installation on either commercial or industrial boilers, kilns, furnaces and similar plant to continuously monitor combustion conditions. Additionally it provides a feed back signal to enable automatic air/fuel ratio control.

Besides the above applications the new O2 Plus analyser provides an excellent means of monitoring open flame or pre-mix combustion systems.

A sample of the premixed gas and air can be taken to a special miniature burner or catalytic converter where it is totally combusted. The products of combustion are then passed over the O2A sensor before being exhausted to atmosphere. The result is a reliable and accurate measure of the combustion efficiency and premix
Air/ gas ratio. If required the output signal from the O2A (2 to 10 volt/4 to 20 mA or 0 to 10 volt/0 to 20 mA) can be fed into a ratio control system that would provide automatic adjustment and constant burner efficiency to the level demanded by the process or application.

At the heart of the O2 Plus Monitor is a miniature heated zirconia sensor originally designed for use on car engines. Extensive tests by research institutes on applications such as Industrial Furnaces, Kilns and Boilers showed that this sensor together with appropriate electronic circuitry is capable of very precise measurement of the oxygen content in combustion gases.

Considerable attention has been given to achieving a rugged, easily installed instrument, which will operate reliably with the minimum of maintenance. The electronic design is based on the latest Microprocessor technology.

The O2 Plus is a first class instrument which provides a reliable measurement for optimising combustion systems and fuel economy.

PRINCIPLES OF OPERATION

When the two sides of a zirconia sensor cell are exposed to gases having different oxygen concentrations, a voltage is developed across the cell. If the cell temperature is stabilised within an optimum range and one side is exposed to a reference gas with known oxygen content, the voltage generated will give a precise measurement of the oxygen value on the other side.

By conditioning the signal it is possible to provide a stabilised output having a linear relationship to the percentage of oxygen present at any one moment.

The O2 Plus Monitor has a simple sampling unit in which air is utilised to aspirate flue gases over one side of the sensor which is kept at a constant temperature. The other side is in contact with atmospheric air, which has a stable oxygen concentration of 20.9%.

The voltage developed across the cell is fed to the Microprocessor, which in turn gives an analogue output and display directly proportional to the % oxygen concentration.

MAIN FEATURES

Mains Supply:	230 volts 50/60 Hz or 115/110 volts 50/60 Hz
Sensor:	Bosch Lean Burn Lambda, Zirconia Cell.
Housings:	Panel or Wall Mount Models. ABS Plastic, IP60.
Display:	Alphanumeric, 16 digit LCD.
Alarms:	2, user programmable max./min. Oxygen/Temp. ranges, with volt free relays.

Analogue Outputs: 2, each with mA/Volt outputs (4). User programmable ranges and sources.

Temp. Input and display: Type K Thermocouple connection (sensor not supplied)
0-600°C. User programmable min/max.

Auto and Manual Calibration: High, Low or Dual modes. User programmable.

SPECIFICATIONS

Sensor Housing: Aluminium.
Sample inlet tube connection 3/8" BSP. Max. Temp. in sensor housing 600°C.

Sample Aspirator: Cast iron with built-in flow adjuster.
3/8" BSP female air inlet connection.
Min. tube connection size 10 mm dia.
Min. supply pressure 5 m/bar

Sensor: Fast acting Zirconia element in protective shield with integral heater. Max. Operating temp. 600°C.

Display Housings: Panel mount and Wall mount models. ABS plastic. See dimensions pages. Ambient temp. range -10°C to 60°C.

Display Resolution:

0.5% Model

At 20.9% = 0.1%
At 10% = 0.05%
At 0.5% = 0.01%

0.1% Model

At 20.9% = 0.2%
At 10% = 0.06%
At 0.5% = 0.01%
At 0.1% = 0.01%

Typical Accuracy:

0.5% Model

At Max. 20.9% = +/- 0.5%
At Min. 0.5% = +/- 0.02%

0.1% Model

At Max. 20.9% = +/- 0.5%
At Min. 0.1% = +/- 0.01%

Temp. Drift : 2% of reading over the ambient temp. Range -10°C to 60°C.

Sample Rate: 2 per/sec.

Warm Up Time: Electronics: 30 secs.
Sensor: 10 mins.

ERROR DISPLAY CODES/MESSAGES:

ALARM: OXYGEN LO = Actual Oxygen reading below "Oxygen Lo" programme value. Oxygen alarm relay operates.

ALARM: OXYGEN HI = Actual Oxygen reading above "Oxygen Hi" programme value. Oxygen alarm relay operates.

ALARM: TEMP LO = Actual Temp. Reading below "Temperature Lo" programme value. General alarm relay operates.

ALARM: TEMP HI = Actual Temp. Reading above "Temperature Hi" programme value. General alarm relay operates.

ALARM: CALIBRATE: Calibrate time exceeded. General alarm relay operates.

ALARM: HEATER: Faulty sensor heater. Oxygen alarm relay operates.

PROGRAMMING DEFAULTS

Cal Type:	High
Cal Scale:	0.5%
Cal Delay:	60s
Cal Time:	0 days
Oxygen Lo Alarm:	0.2%
Oxygen Hi Alarm:	22.0%
Temp Lo Alarm:	0 °C
Temp Hi Alarm:	600 °C
Channel 1 Source:	Oxygen
Channel 1 Range:	0-10V
Channel 1 Min:	0.00%
Channel 1 Max:	21.0%
Channel 2 Source:	Temp
Channel 2 Range:	2-10V
Channel 2 Min:	0 °C
Channel 2 Max:	600 °C

INSTALLATION

Sensor Chamber:

Fix to a rigid vibration free surface as close to the sampling point as convenient, with the aspirator horizontal and below the sensing chamber. Any condensation within the sample line pipework should not be allowed to flow into the sensor chamber.

Sample Pipework:

Ideally 6 to 10mm pipework of a material to suit the sample. A length of 1 metre is recommended to provide for cooling of the sample when it exceeds 600°C. Information on gas sampling probes can be extracted from BS 1756, Part 3, 1971.

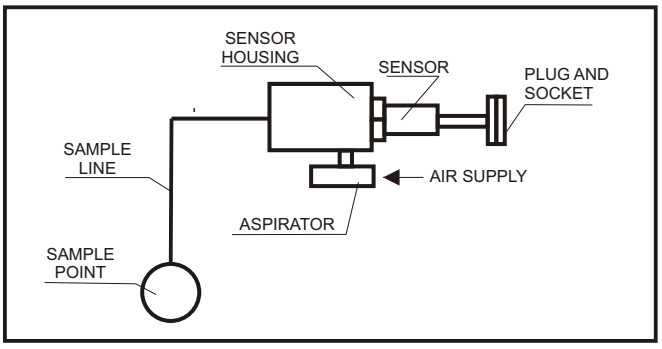
Provision must be made to sample atmospheric air for calibration purposes.

Aspirator Pipework:

Suitable for the air supply employed.

Aspirator Air Supply:

The air supply, and thus the gas sample flow rate, can be adjusted on the aspirator. Air supply pressure should be 5 m/bar or above.



Sample Temperature

This is not critical provided the sample gas reaching the sensor chamber is above 60°C and below 600°C, occasional peaks up to 800°C can be tolerated but should preferably be avoided.

The temperature of a very hot sample can be reduced by lengthening the sample tube.

Monitoring and Display Unit

Depending on the model selected the enclosure can be wall or panel mounted at a convenient location providing the run of cable between the sensor and control box does ***not exceed 10 metres.***

Wiring

The controller is available for supply voltages of 230V AC or 115V AC. Fused at 2 amp. For wiring connections see diagram.

Other requirements are:

6-core cable to the pre-wired sensor plug should be 1 mm/2 (32/0.2 mm/2) no longer than 10 mts.

Analogue outputs should be wired with 2 core screened 1 mm/2 (32/0.2 mm/2) cable.

COMMISSIONING

1. Switch on and wait 10 minutes for the sensor to heat up.

2. With the Aspirator operating disconnect the sample tube from the sensor housing so that fresh air is aspirated into the housing and over the sensor.

An alternative method is to remove the sensor from the housing and expose it to the atmosphere. The unit should display 20.7 to 21.1% when exposed to fresh air. If the unit reads outside these limits run the Calibrate high programme, see the programme menu structure diagram. The calibrate okay message should display after this procedure and the unit should read 20.9% oxygen.

3. Both the low and high calibration points are factory set and it should not be necessary to check the low point during commissioning. This facility is made available for periodical checks after some operational time. To calibrate the low oxygen point you will need a test gas of either 0.5% or 0.1% oxygen depending on the model.

If, however you want to check the low point, connect your test gas (0.5 or 0.1%) to the sample inlet of the sensor housing with the sensor in situ. Select the calibrate low programme, (see the programme menu structure diagram). Fill the sensor housing with the test gas and then run the programme. The calibrate okay message should display after a short time and the display should read either 0.1 or 0.5% oxygen depending on the test gas value and version of O2 analyser.
Caution should be taken to ensure the correct test value is used. For example the 0.5% Analyser version cannot be calibrated with a 0.1% test gas value. Always use a low test gas value which corresponds to the model of analyser i.e. 0.1% or 0.5%.

4. The unit is now ready for continual oxygen monitoring of your process after you re-connect the sample inlet tube to the sensor housing.

5. Check that the gas sample temperature entering the sensor housing does not exceed 600°C. Lengthen sampling tube if necessary. The type 'K' thermocouple facility on the unit can be used to continually monitor the sample gas temperature if desired and provide an alarm when it falls outside the set limits.

FLUE GAS SAMPLING

There are two main methods of sampling as follows.

Direct Sensing of oxygen content in flue gases where temperatures will not normally exceed 600°C and where

the constituents are not other than those found in light hydrocarbon fuels.

Indirect Sensing where direct sensing is impracticable or where the gas to be analysed has constituents which could quickly affect the accuracy of the sensor (e.g. Fluorine from some types of clay).

The zirconia probe used with the Albion Oxygen Analyser needs simply to be exposed to a true sample of the gas under analysis. Since the probe incorporates its own self-regulating heater, it does not rely on the sample temperature to reach its optimum working temperature. Also, it does not require the sample to be dried.

If the sample contains combustion solids, the sensor sheath is readily cleaned externally to maintain accuracy of measurement. However, heavy deposits that penetrate the protective sheath could affect the internal sensor.

These features allow considerable freedom when choosing the sensor l o c a t i o n .

Direct Mounting

Using a suitable flange, the probe can be mounted with the sensing tip inserted in the flue pipe. This is the simplest and cheapest method which is suitable for Commercial and Industrial Boilers where the flue pipe is usually accessible and of relatively small size and where flue gas temperature will not exceed 600 °C.

Precautions

1. Ensure no air in-leakage occurs downstream of the sensor or through the sensor mounting.

2. Maximum allowable gas sample temperature 600°C.

3. Ideally the minimum temperature should be 20°C - 30°C above the water dew point (In the case of natural gas products, with 8%CO,this will be 75°C-85°C).

Note: If the sampling system cools gases below this level it must be ensured that any condensate does not impinge on the sensing probe.

4. Soot and sulphurous solids should not reach the probe surface.

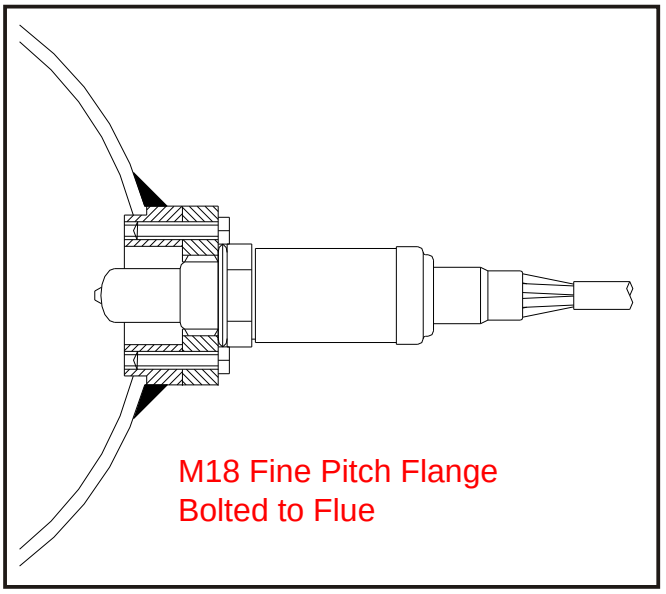
5. Ensure probe is easily accessible for inspection and servicing when necessary.

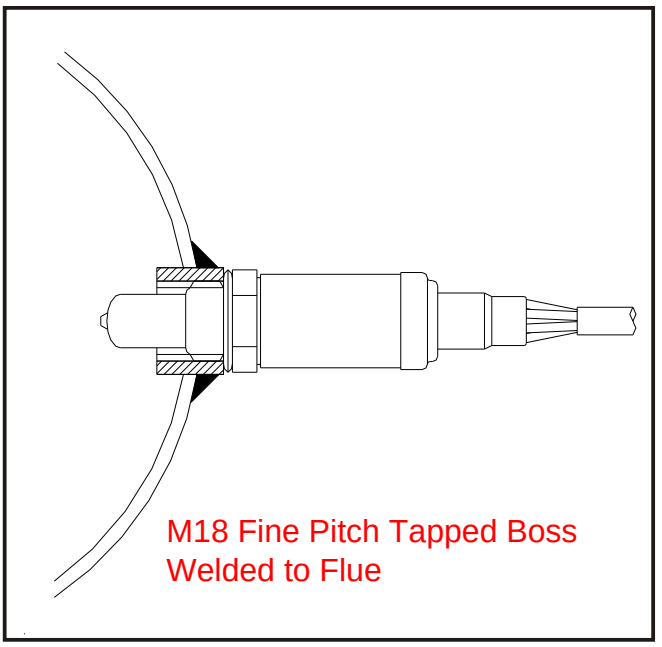
6. Do not have the probe in the bottom of a sampling chamber where condensate can collect.

7. Ensure sample tubes are at a suitable gradient so that any condensate can run to drain points.

The following diagrams are examples of direct mounting methods for standard flue applications.

Direct Flue Mounting Examples





Indirect Mounting

Where flue gases need conditioning or where the probe cannot be conveniently located to sense a true sample, it is best to aspirate the sample using an insertion probe of a design suitable to the temperature and properties of the sample.

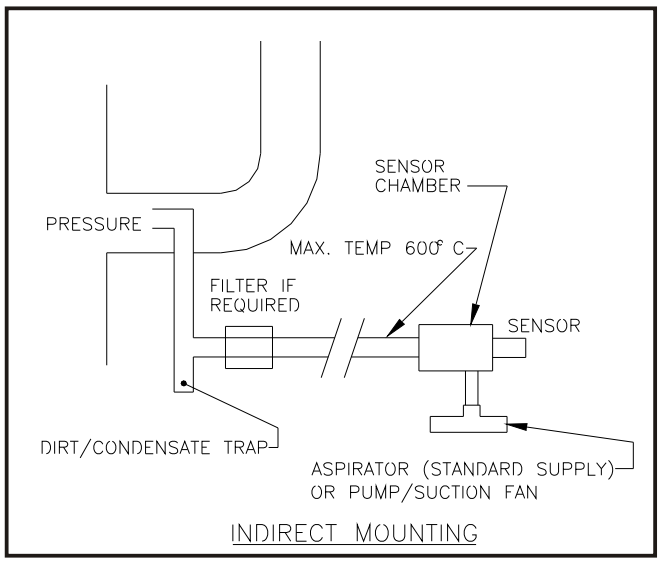
Depending on temperature, stainless steel tubes are simplest for heating boilers and some steam plant.

Industrial kilns and furnaces may require more sophisticated probes of tungsten alloy or ceramic.

For general work especially when burning natural gas, it should be possible to cool the sample in a short run of metal tube to the point where plastic pipe can be used. Common silicon tubes operate at 200°C.

The following diagram is an example of an indirect mounting application that can be applied to Kilns, Furnaces or Ovens etc.

Indirect Mounting Example



Aspirators/Suction Fan/Pumps

(Electrical or Air Operated)

Drawing the sample from the flue or furnace is readily achieved by using a small electrically operated sampling pump or suction fan to provide continuous sample flow over the active face of the sensor.

Aspirator Sampling Method

This very simple device uses air from the combustion fan as the motive force. There are no moving parts. An adjustment screw is provided on the sample inlet but the sample rate can be regulated by the Combustion Air Fan supply pressure. The ejector is invaluable where process chemicals are likely to damage a pump or suction fan system.

Sampling Pipework

This must be of a material suitable for carrying the sample concerned. Stainless steel would suit most applications. If the sample is cooled sufficiently, suitable plastic hose will suffice.

The tube should be as short as possible and of the smallest convenient diameter since the time lapse before a change in sample condition will register depends on the volume contained in the system and on the sample rate. Some results using various tubes have been tabulated in this sheet.

Sampling Rate

There is probably no ideal rate. As mentioned, the lapse of time before a change registers on the Oxygen Analyser will depend on the rate at which the sample passes through the system.

For simple monitoring and recording this is probably not critical, but when the Oxygen Analyser output is used to inform a set-point controller the significance of a delay must be considered.

A suggested possible solution is to employ 10 mm OD tube with a sample rate of two or three litres per minute. For short runs of small bore, 1 Lit/min would suffice.

The following figures are a guide for when using the Standard Aspirator with 5 metres of 7 mm i.d. Plastic Tube as the sample line.

Aspirator Inlet Pressure (m/bar)	3	5	10	15
Suction in Sample Chamber (m/bar)	2.5	4.0	6.5	10.0
Sample Flow Rate Lts/min.	2.4	3.6	6.0	8.6

Note on Plastic Tubes

The 7mm id silicone rubber tube used is claimed to be suitable for temperatures up to 200°C and was supplied by:

TRUSEAL EXTRUSIONS LTD
Molly Millars Bridge Unit 3
Wokingham
Berkshire
RG4l 2RQ
01 189 775454

Tubes for temperatures up to 300°C are available.

Multiple Systems

The simplest system is to use one sensor chamber and run separate sample lines to a manifold each governed by an electrically operated valve. The valve must be suitable for the situation. It is best to fit trap and drain before each valve. Electrical arrangements for sample selection can be readily devised.

Temperature

The maximum allowable sample temperature is 600°C at the sensing chamber.

It will be found that with the small sample rates suggested the temperature will fall rapidly. Some tests show a drop from 700°C to 40°C in less than 1.5 metres of 10mm pipe. Where much higher temperatures are involved the temperature decay must be determined on the actual system employed.

In many commercial boiler installations it will be possible to cool the sample deliberately then pass it through a water trap and run to the sample chamber in plastic tube.

Solids

With gases and light oils no problems are usually encountered. Soot on the sensor face can be readily cleaned off with a brush.

With heavy oils sticky, sooty particles may form if gases fall below acid dew-point (about 140 °C). Usually filtering will be necessary. Process Solids such as clay or cement powders can be deposited on the sensor but are easily removed by brushing.

Unwelcome constituents such as fluorides or sulphur should be eliminated by chemical filters or by washing.

Protecting the Probe

The probe senses the oxygen content of wet samples i.e. those having a high proportion of water vapour. Because the sensor operates at 300°C - 400°C water vapour will not condense on the surface. However it is necessary that no condensate formed in the sampling system reaches the sensor.

The three methods of ensuring this are:

1. Keep the sample comfortably above water dew point. Dewpoint depends on the hydrogen content of the flue gas and the amount of excess air. The typical range is from 50°C - 60°C. No problem should occur at 70°C - 90°C.

2. There should be a water trap before the sample chamber.

3. Fix the sensor at a point where no condensate can reach it.

N.B. In all cases where sample conditioning is proposed, it should be remembered that the miniature sensor used is relatively inexpensive and frequent replacement may be the best course of action.

SERVICING

The sensor should be located where it can be easily removed for inspection and cleaning.

Cleaning

With clean samples from light hydrocarbons a 6 monthly inspection will suffice.

When heavy oils are used inspection and cleaning at 1 monthly intervals may be necessary.

Where process particles are carried over in unfiltered samples daily brushing has sometimes been necessary.

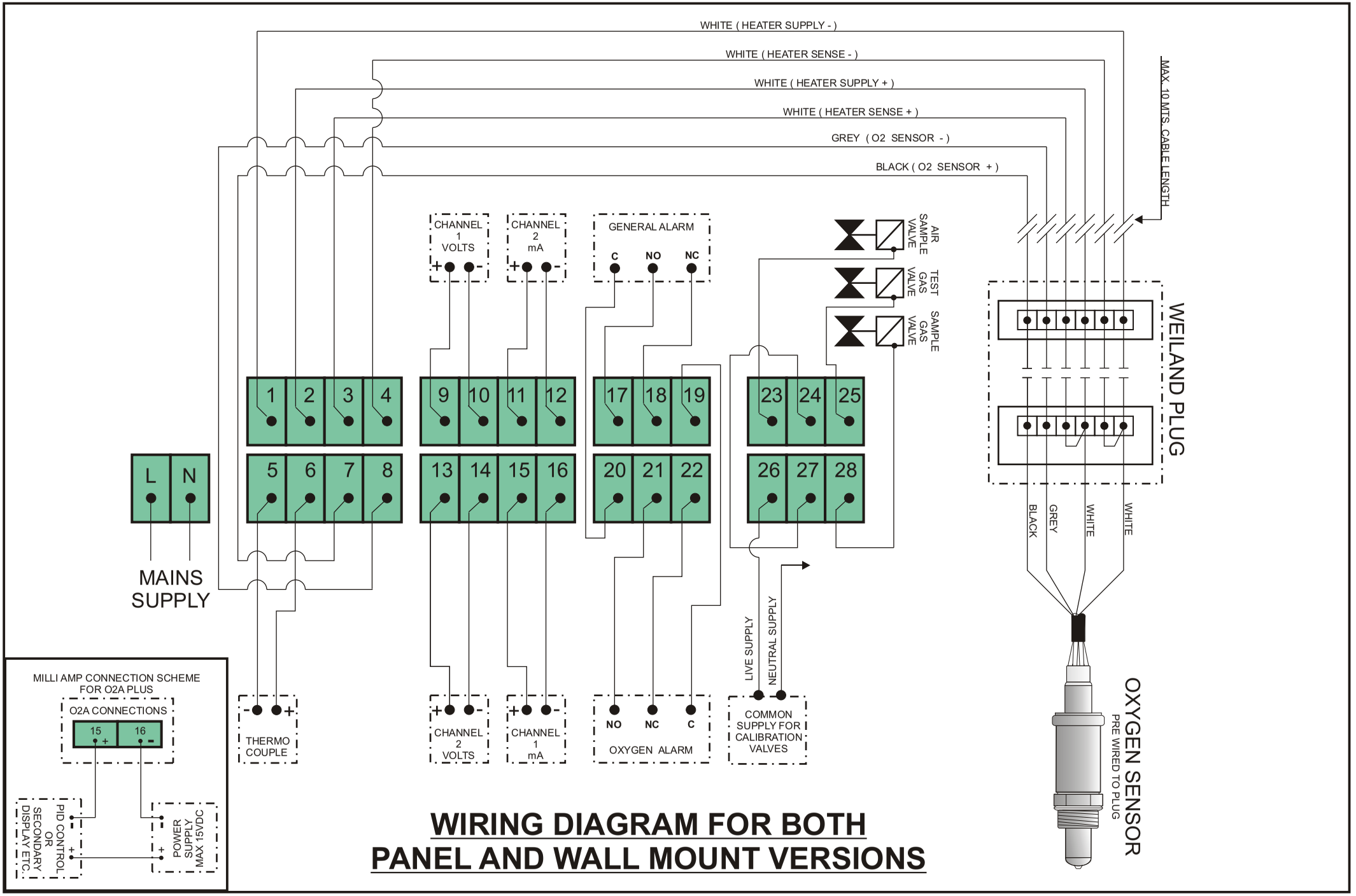
CALIBRATION

Two methods of calibration are possible, Manual or Auto for both High and Low calibration points. The various options/settings are shown in the Menu Structure.

The Low calibration point is either 0.1% or 0.5% depending on which model of O2 you have. The low point is factory calibrated and will require a test gas for calibration in the field. However depending on the level of assurance/security desired it should only be necessary to calibrate the High point on a regular basis and this is achieved by using ambient air. The time period between calibrating should be determined from practical experience and by what use the instrument is being used for. As an initial guide we suggest that for purely monitoring and display the high point should be checked on a monthly basis. When using the mA/Volt outputs for controlling part of a process we suggest checking on a weekly basis initially. It should be noticed that a variation of the high point will not mean the low point has changed by a similar level and by performing a high point calibration in Air the low point will also be adjusted to the original factory calibration value. The low point calibration facility is provided for those who want complete assurance.

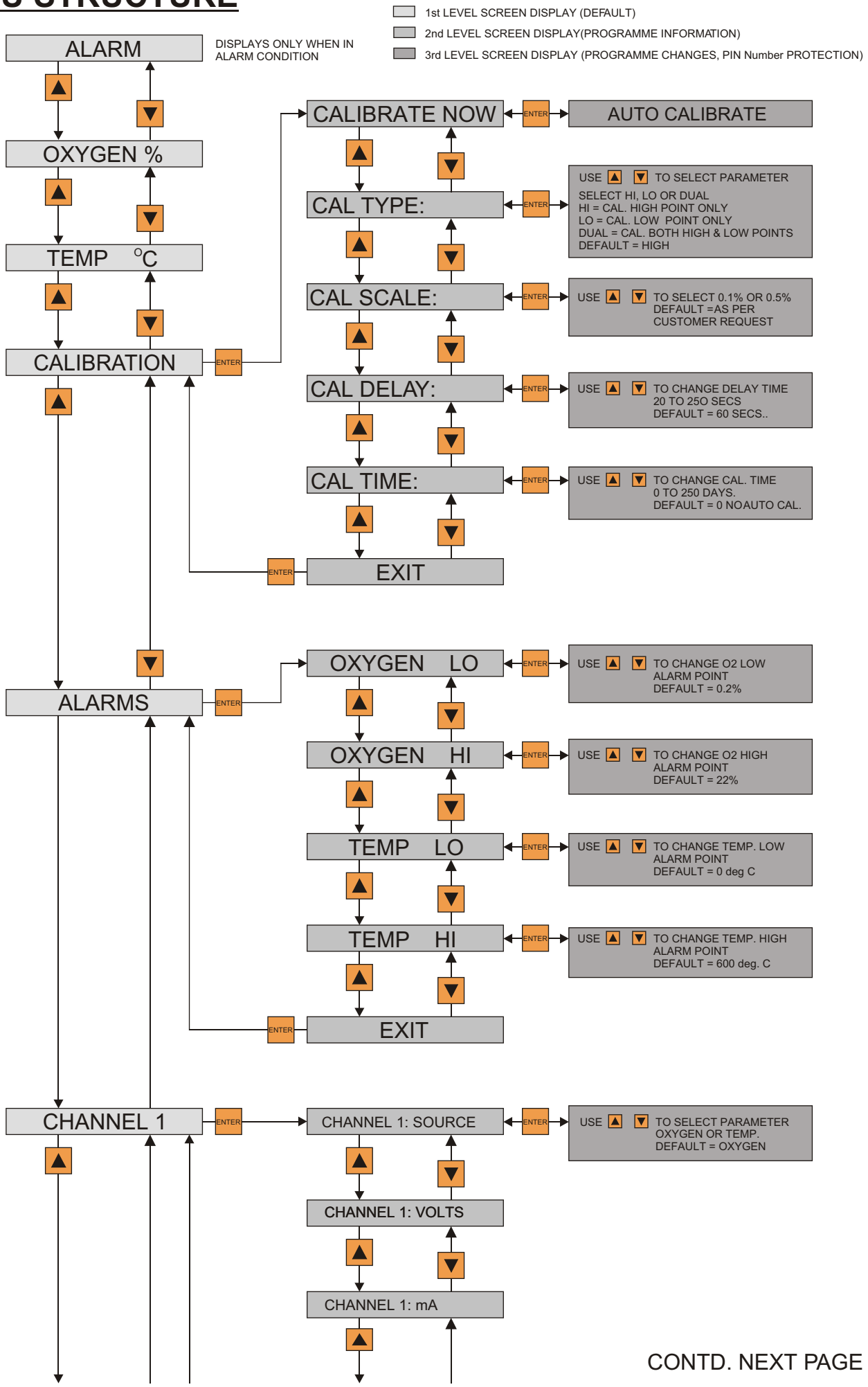
For manual calibration select the CAL TYPE and CAL SCALE (see menu structure) depending on what calibration you wish to perform and if calibrating the low point what test gas value i.e. 0.1% or 0.5%. Return to the CALIBRATE NOW screen and press ENTER to perform the calibration. After a short time the screen will display either CAL OKAY or CAL FAIL.

For any of the Auto options you will need to provide sample line valves which are controlled by the internal relay logic (see wiring diagram). To set an auto option you will need to programme two extra values, CAL DELAY and CAL TIME. These values are used to control the internal relay logic. CAL TIME is the number of days between each calibration operation and is used to set regular AUTO CAL operations if desired, a value of 0 days means the unit is in manual calibrate mode. CAL DELAY is the number of seconds to allow the calibration test gases to reach the sensor depending on the length of sample lines.



WIRING DIAGRAM FOR BOTH PANEL AND WALL MOUNT VERSIONS

MENU STRUCTURE



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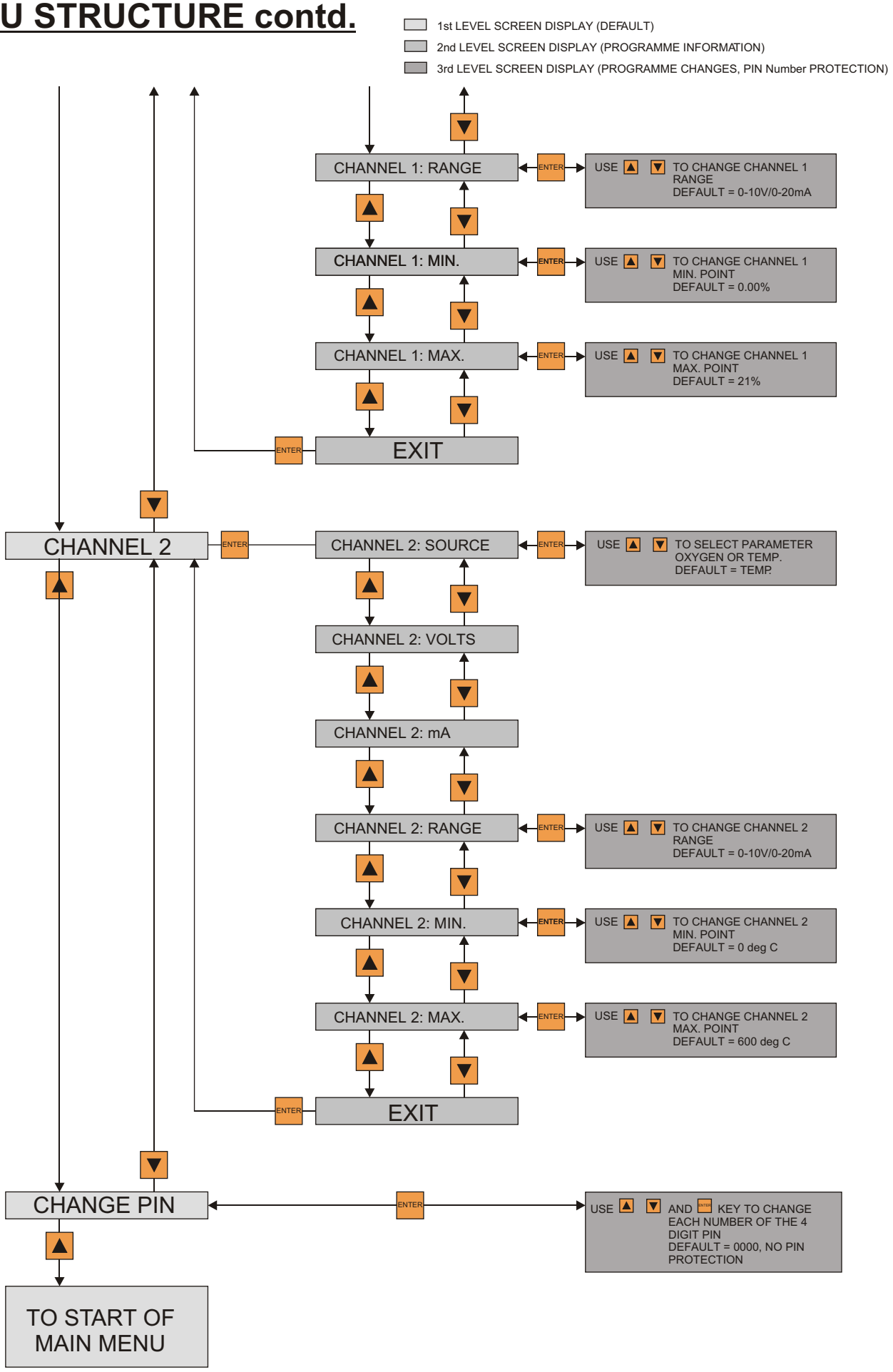
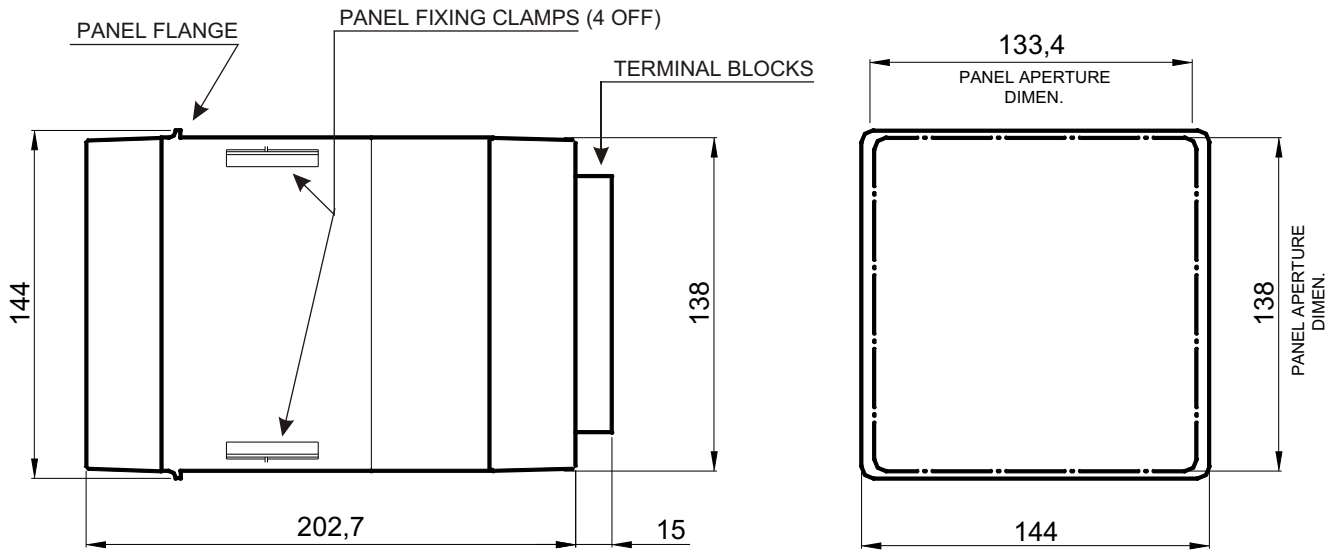
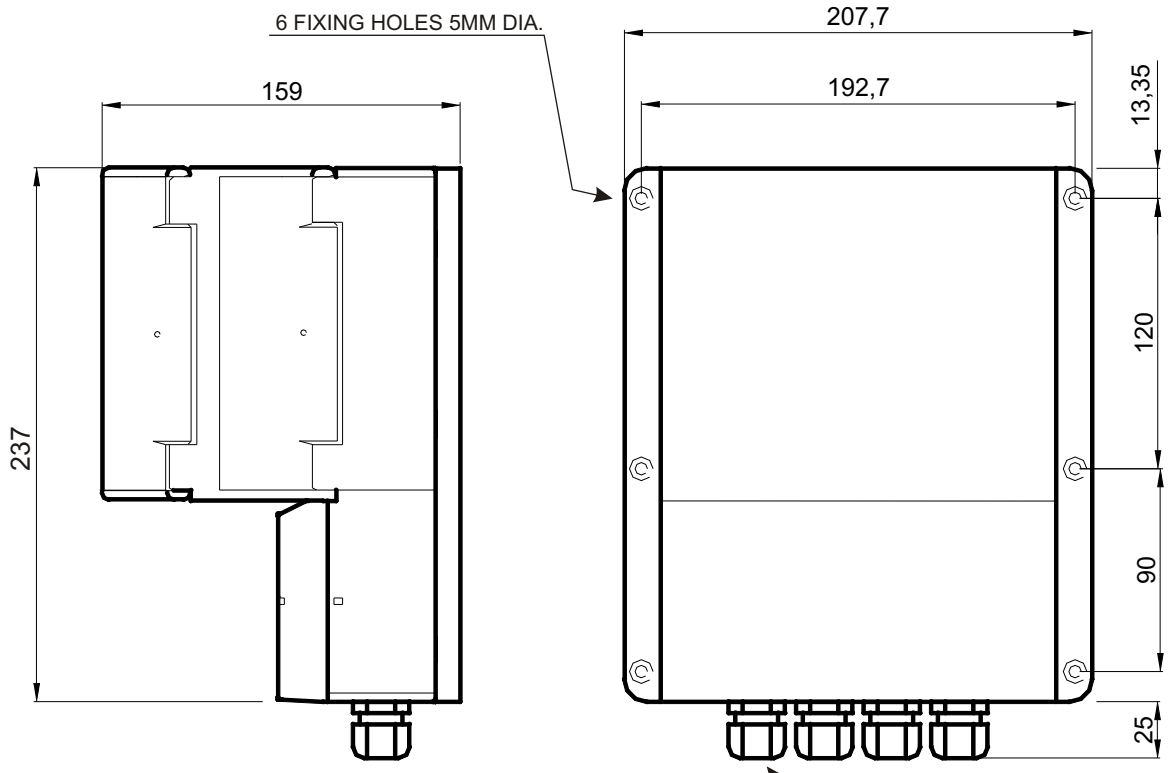


ENCLOSURE DIMENSIONS

ALL DIMENSIONS IN m/m



PANEL MOUNT



WALL MOUNT

SENSOR AND HOUSING DIMENSIONS

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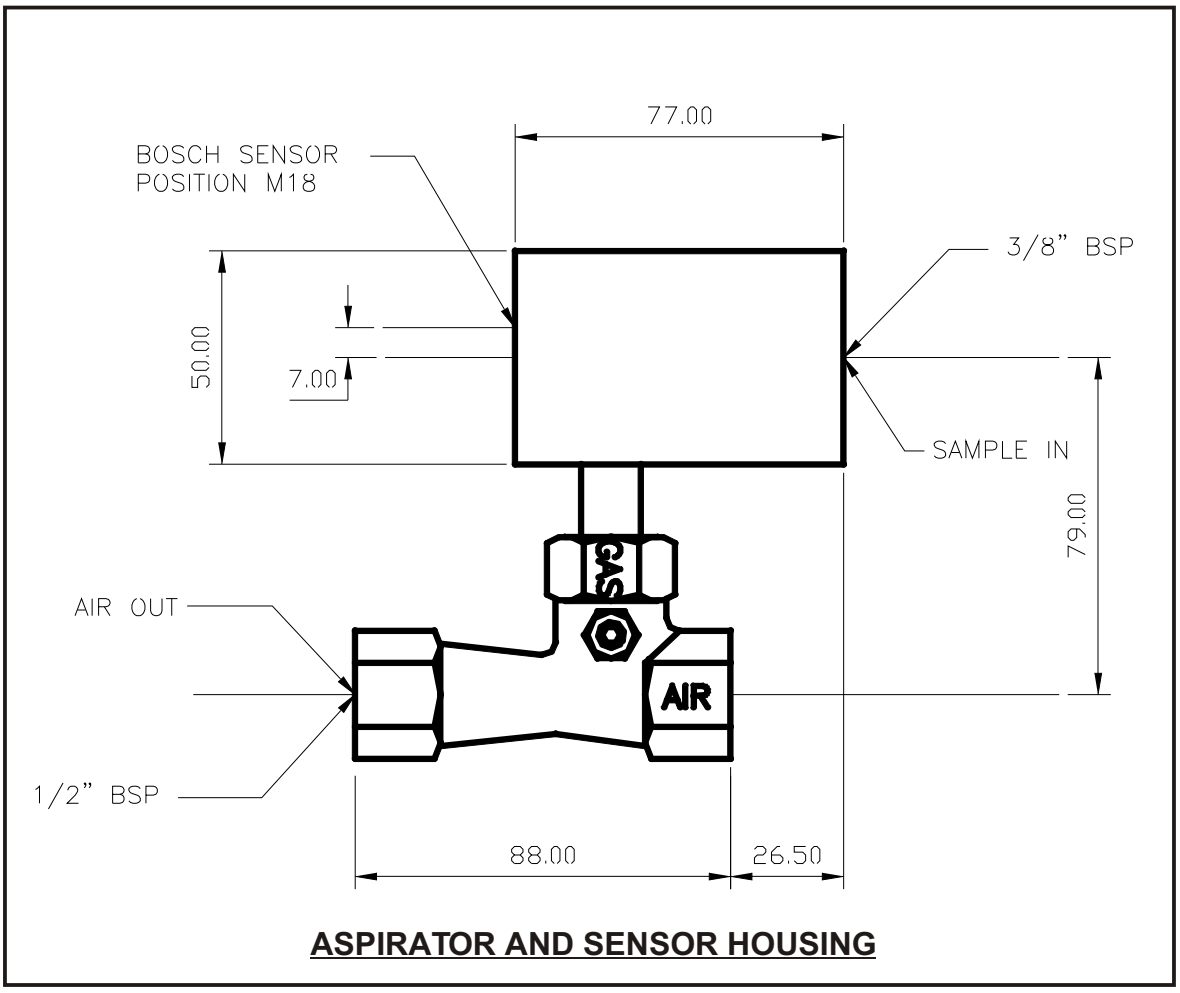
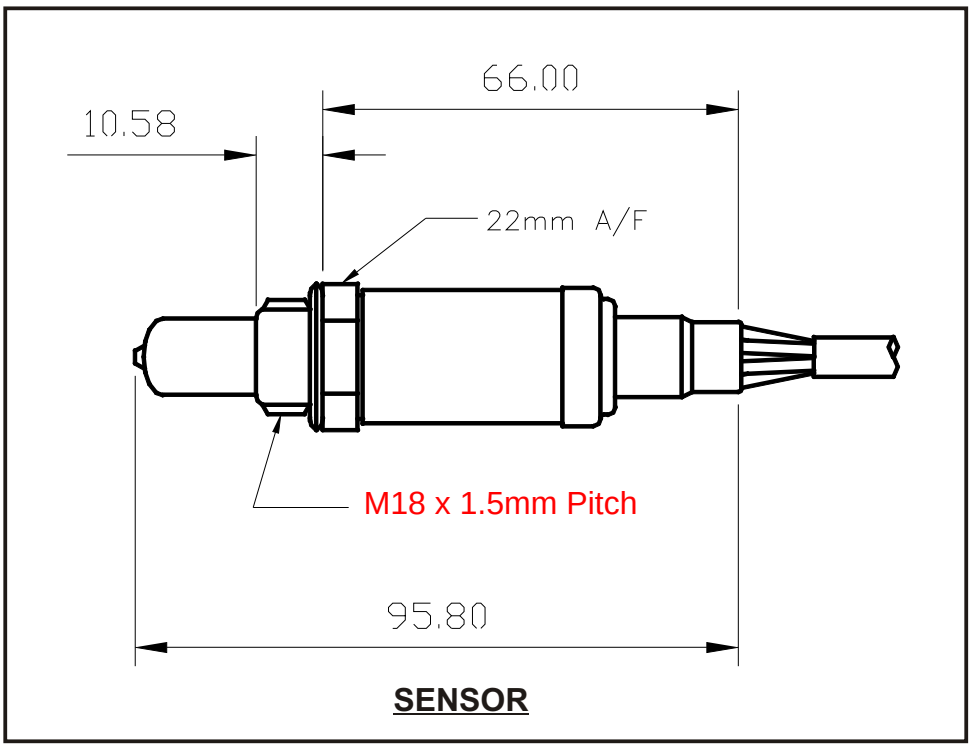


ASPIRATOR AND SENSOR HOUSING



SENSOR