

Operations Manual for PRO₂ *plus* Oxygen Indicator



Oxygen indicator for measuring rest oxygen levels in inert as well as forming gases for the welding industry.

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1. Preface

This operating manual describes the components, functionality, operations and safety precautions when using the PRO₂ *plus* Oxygen Indicator.

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2. Safety Precautions

Individuals need to read and understand this manual before using the oxygen indicator. There is no need to open the housing of this unit. Only authorised personnel should open for service concerns and to not void the warranty.

If authorised to open the unit, please ensure that all power sources are turned off. Unplug from power supply and press the On/Off button on the front of the unit, to eliminate battery power.

WARNING! The use of this measuring device in potentially explosive environments is forbidden. For example, when reading forming gases the hydrogen content must be below 10% concentration.

Any used rechargeable batteries should be disposed of according to local regulations.

3. Applications

This rest oxygen indicator is designed to constantly measure rest oxygen levels in inert gases as well as in special forming gases, specifically hydrogen (H₂) mixtures with a maximum concentration of 10% H₂.

This unit is especially suited to the welding industry and corresponding applications. The very high quality pipe welds that were required for the semiconductor industry of the past are now common for the aerospace, pharmaceutical, dairy, brewery and other industries. This oxygen indicator enables welders to accurately recognize when extremely low rest oxygen atmospheres are in the weld environment. This environment permits the welder to potentially reach a high quality weld today that was difficult to reach in the past.

A few of the features of the PRO₂ *plus*:

- a. Internal power source recognition for 100 V - 240 V AC
- b. Programmable audio alert
- c. Date and time function
- d. Documentation
- e. Connects via RS 232 interface and Bluetooth
- f. Can-Bus interface for data logging via PC
- g. Analog data interface 0 - 5 V DC (0 ppm - 1000 ppm)
- h. Factory calibration to air
- i. Integrated rechargeable battery
- j. Integrated digital flow sensor for regulated flow of sample gas
- k. High performance zirconium sensor "Made in Germany"

4. Design

As a foundation for the calculation of the rest oxygen level in PRO₂ *plus* Oxygen Indicator, the Nernst equation is used. The Nernst equation can be used in conjunction with other information to determine the equilibrium reduction potential of a half-cell in an electrochemical cell.

The rest oxygen indicator contains a stabilized zirconium oxide cell. With a regulated heater to maintain a cell temperature of 750°C, the ceramic becomes conductive resulting in a steady state between the measuring gas and the reference side, where air is used at 206400 ppm with a relative humidity of 50%.

Pure platinum electrodes measure voltage differences. By applying the Nernst equation to the mV voltage differences a corresponding value in ppm (parts per million) is achieved.

Not only is consistent cell temperature important but also the flow, which needs to be between 5 –10 l/h.

A too low gas flow can produce an inaccurate reading. A too high gas flow cools the sensor and can cause inaccurate readings as well.

Accuracy of the measuring cell:

This particular zirconium oxide provides accurate readings, with a deviation of less than 5% of the 1 to 10 ppm range, in other words ± 0.5 -ppm. As this accuracy can only be achieved with the use of capillary tubes made of stainless steel or other non-reactive metals, the PRO₂ *plus* uses a small inside diameter, thick walled, special, low permeability hose, that creates a similar environment enabling highly accurate readings.



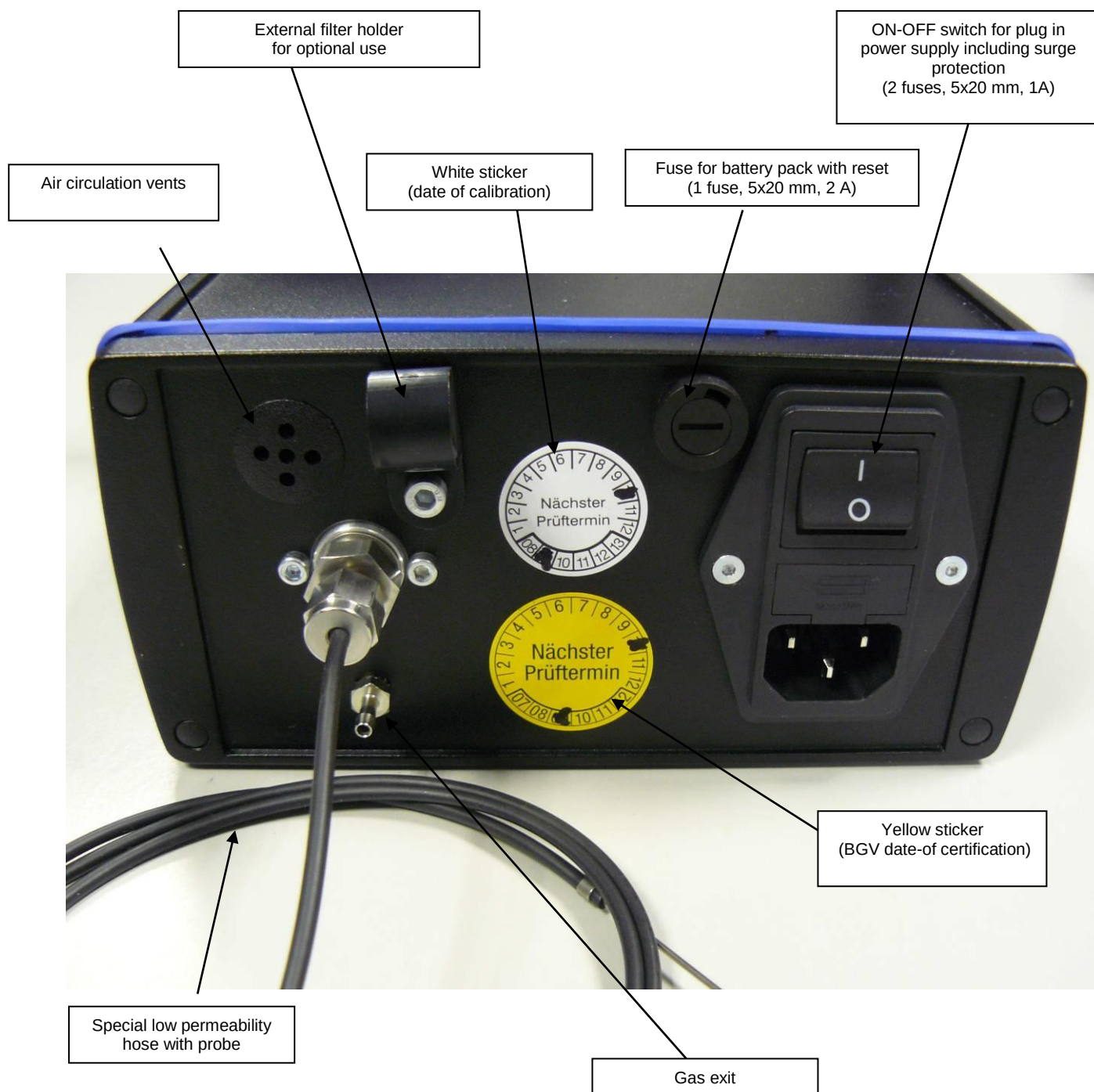
5. Description and Operation

5. 1. Front View





5. 2. Rear View



5. 3. Installing Optional Filter

In dirty environments it is recommended to install the optional particle filter before the gas inlet. All units have the components needed to fit this option. On the rear of every unit is band retainer to hold a filter. The optional stainless steel filter component and the corresponding adapter hose can be purchased from the manufacturer or distributor.

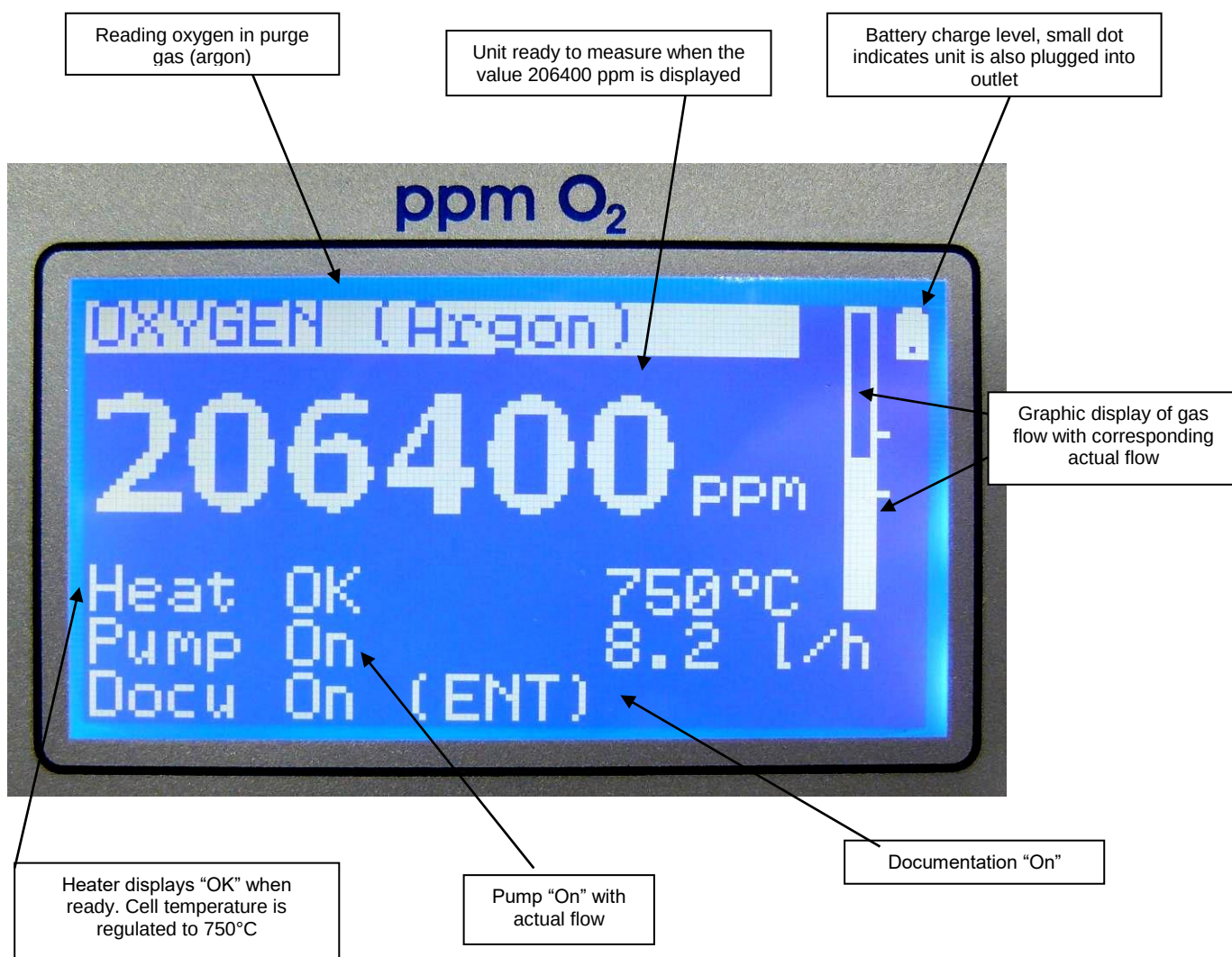
The filter (15-micron) is equipped with 1/8" compression fittings to insure optimal sealing of the plastic hose and its stainless steel connections.



5. 4. Operation

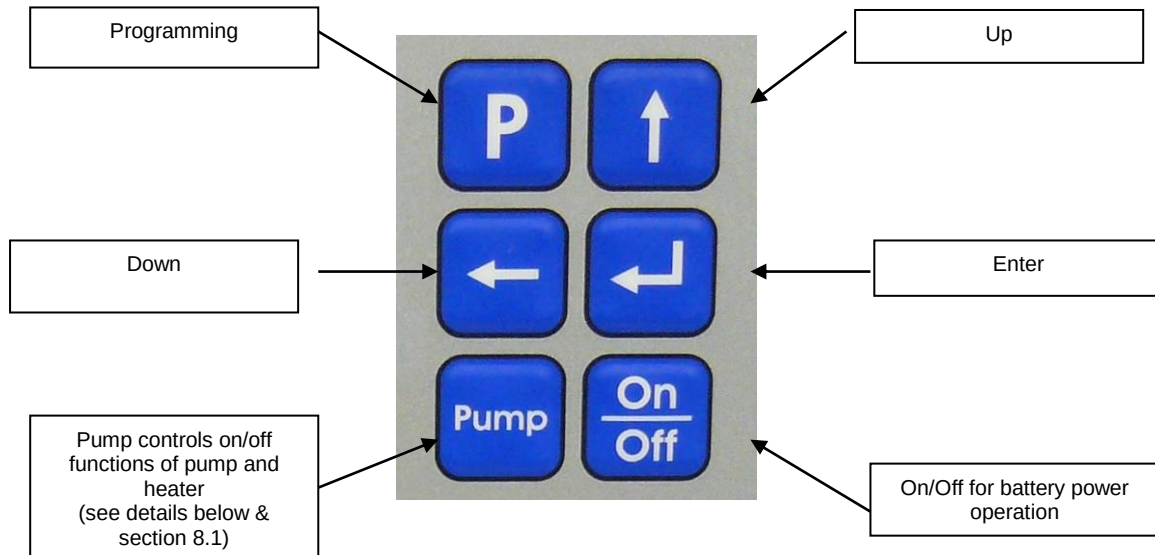
1. Connect the oxygen sensor with the insulated electrical cable to the power supply.
2. Turn ON the unit via the switch found at the back of the unit.

After turning on the oxygen sensor the display will indicate a 6-digit value of 000000 ppm. If the pump is turned on, this value will flash indicating that the unit is not yet ready to measure.





6. Operating Buttons



For most applications the default settings for argon will be suitable and makes the unit easy to use. After turning on the unit the measuring cell will be heated to 750°C and once this has occurred, the display will indicate 206400 and the unit is ready to use. The heating of the cell will take a few minutes.



By pressing the **Pump** button the pump is activated, which will transport the sampled gas through the measuring cell, internal filter, pump and flow meter with a approx. flow of 8 l/h. After inserting the probe into the purge chamber or tube to be welded the operator will receive accurate information about the rest oxygen levels. Heater "Off" function is related to battery charging (Section 8.1).

A variety of welding parameters from assorted manufacturers, industries, etc. specify or recommend different rest oxygen levels before and during welding operations. In general these values should be in the range below 30 ppm unless otherwise noted.

Other functions of the oxygen sensor PRO₂ *plus* includes documentation capture and visual and/or acoustic alert settings.

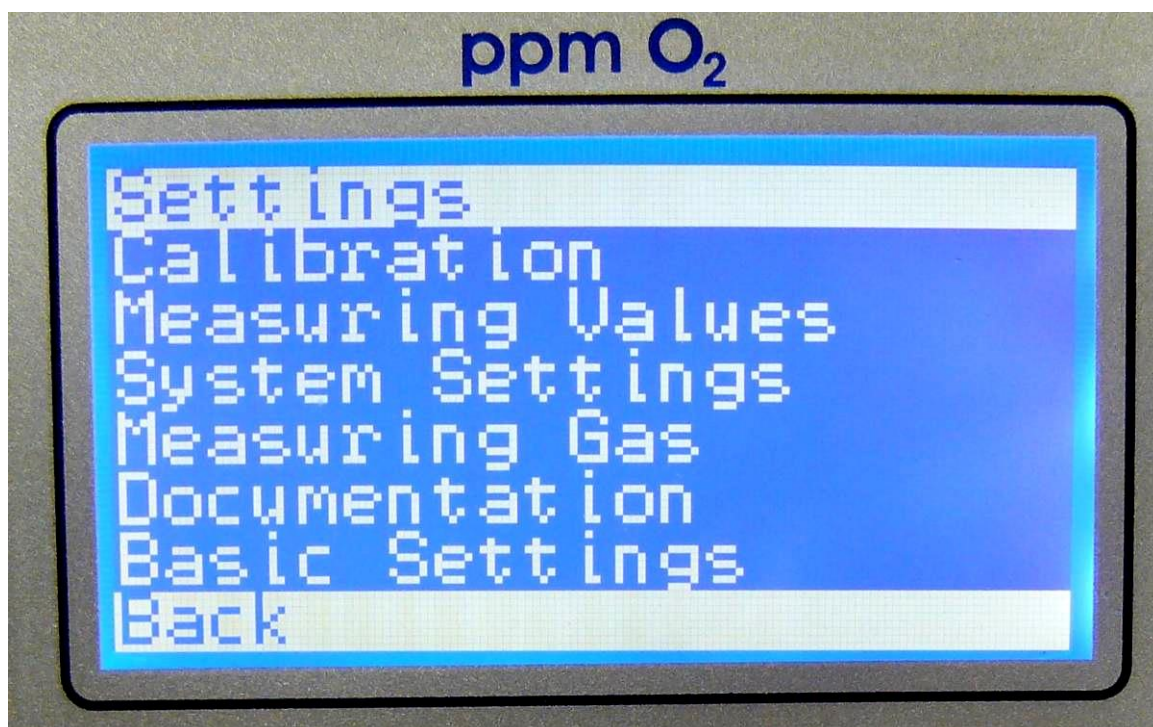
6. 1. Programming Functions

With this button there are a multitude of menus, which allow the unit to be programmed as well document results. Default parameters can be changed so that the unit can visually as well as acoustically alert information; data can be transferred via Bluetooth to a mobile phone or to PC and much more.

Press  button.

7. Main Menu

7. 1. Main Menu Settings



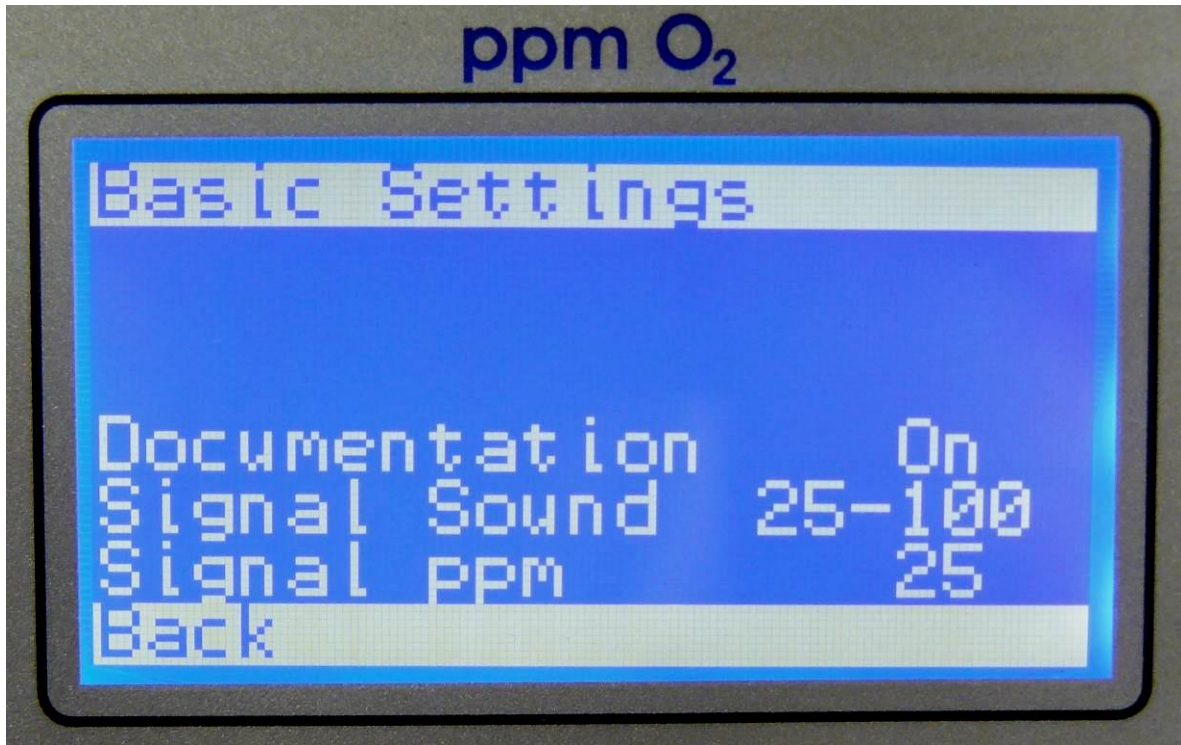
The menus are simple and the operator can navigate the menu using the

buttons  and . Selection of a function is achieved by pressing the  button.





7. 2. 1. Basic Settings



The standard settings are shown in the following photos.

1. Documentation “Off”

Standard setting when using PRO₂ *plus* without documentation requirements. If documentation is required, see section 9 for details.

2. Signal Sound ppm “20-100”

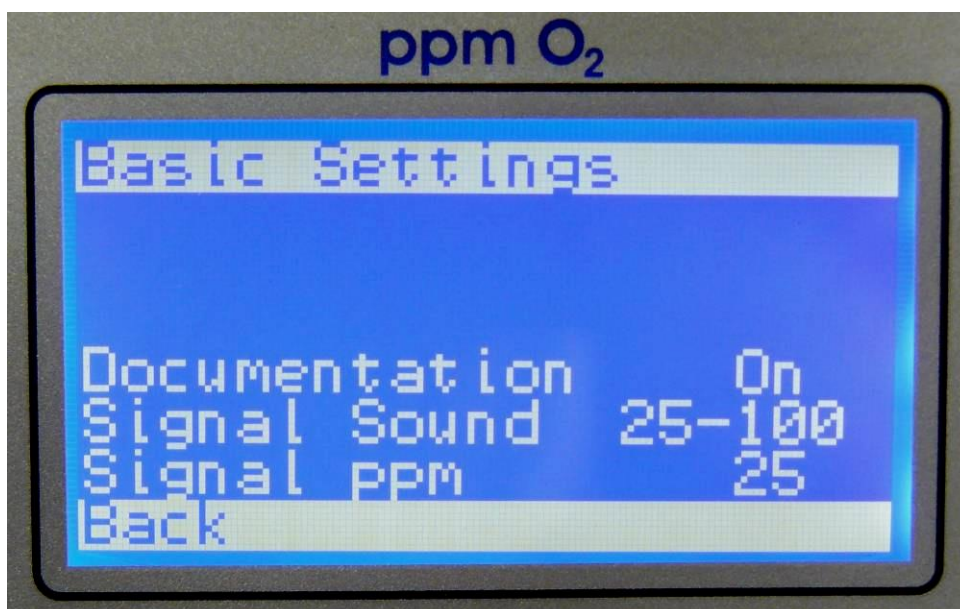
When the value 100-ppm is crossed this event will be marked by the start of an acoustic “beeping” alert. In conjunction, the display continues to blink with the measured value. The acoustic signal is a handy feature when working in a loud environment or at a considerable distance from the unit. The operator can now prepare himself/herself to weld once the sound is off.

3. Signal ppm “20”

When the display has crossed 20 ppm, the blinking and sound will stop. This indicates to the operator that the programmed value has now been reached and work can proceed.

The instructions under “**Basic Settings**” in this manual, show in great detail that the changing of individual line items, values, and menu points can be done instantly. Other menu options in this manual are navigated and changed as easily, though shown in point form only.

Changing of Parameters and Functions in Basic Settings.



Press button  to get to “**Signal ppm**”.



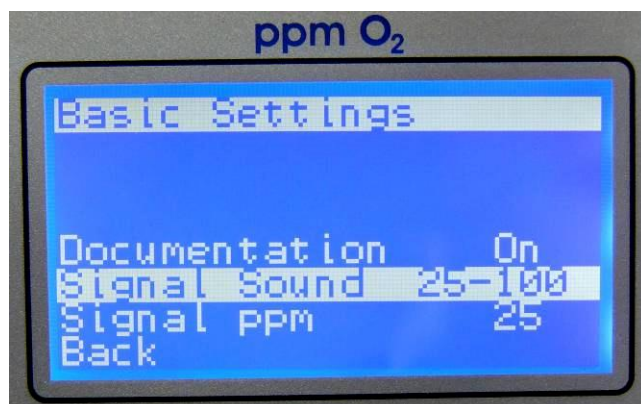
Press button  to confirm selection.

With direction buttons  or  ppm values can be changed. To confirm selection and to program press  button.

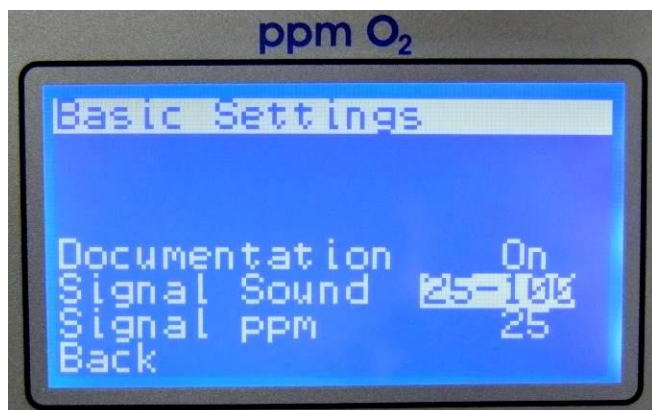




Press button to get to **"Signal Sound"**.

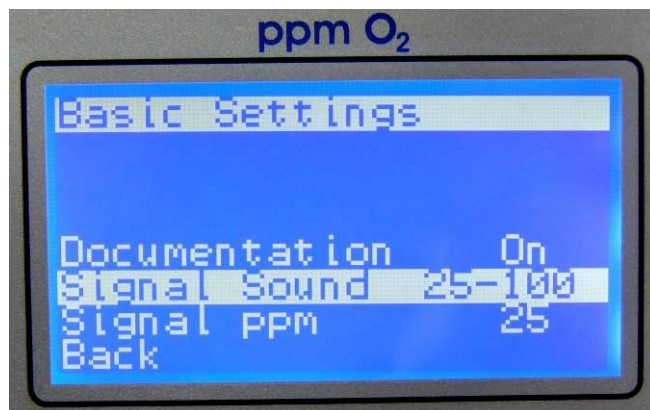


Press button to confirm selection.



With direction button or only the upper ppm value can be changed. To confirm

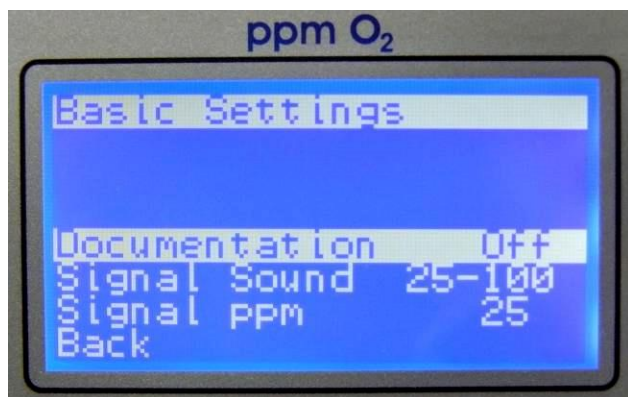
selection and to program press button.



Press direction button to get to **"Documentation"**.

In the line **"Signal Sound"** only the upper ppm value can be changed via the directional buttons. The lower ppm value can only be changed on the line **"Signal ppm"**, in this picture at **"20 ppm"**. To change this value, please refer to the previous page.

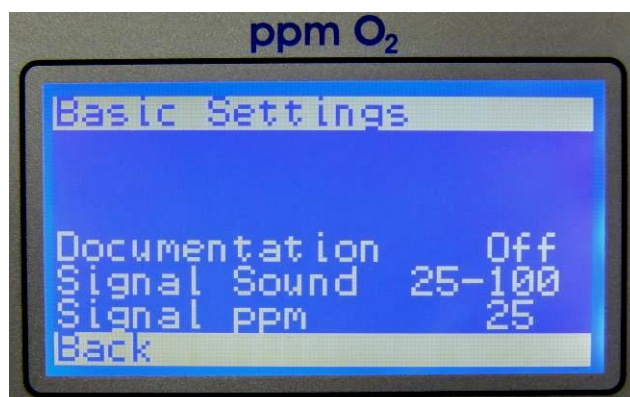
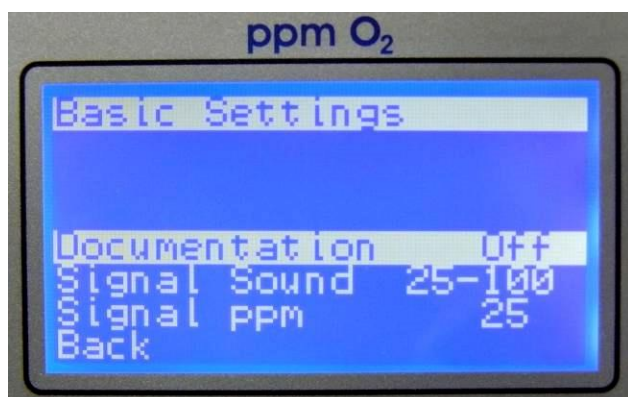
If the **"Signal ppm"** and the **"Signal Sound"** values are identical the acoustic signal will **not** function.



Press button  to confirm selection.

With direction buttons  or  the selection can be changed from “Off” to “On”. To confirm selection and to program

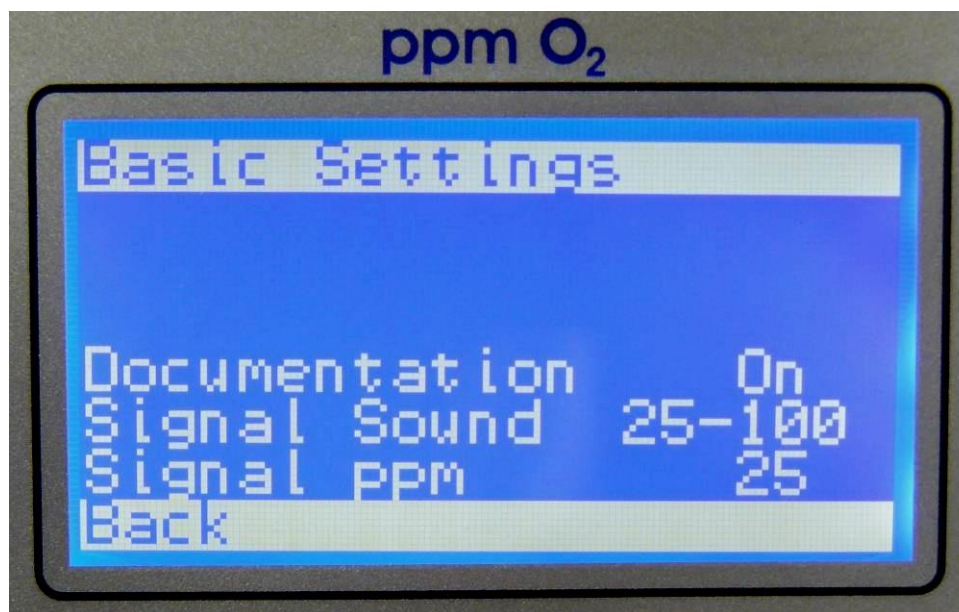
press  button.



With direction buttons  or  one can scroll through the menu display and get back to “Back”.

Press button  to confirm selection.

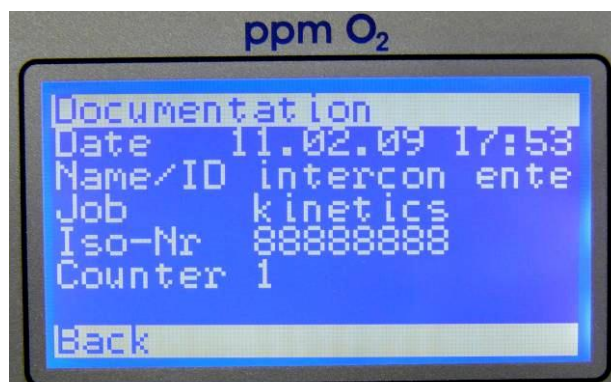
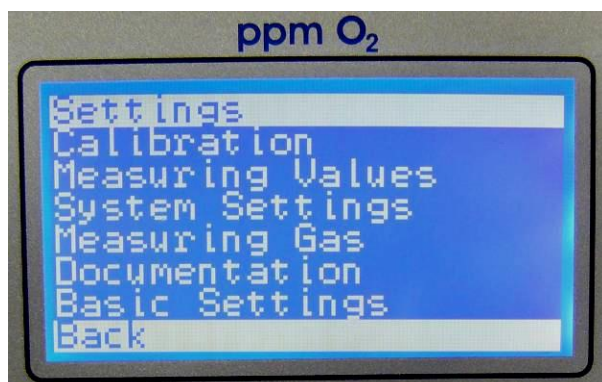
After pressing the button  it will take one back to the main menu as shown below.



When “**Settings**” and “**Back**” are highlighted, press the button  which gets to the monitoring screen where the ppm measurement is displayed



7. 2. 2. Documentation



In the main menu settings, scroll to “**Documentation**” and press  button. This screen display, highlighting “**Documentation**” and “**Back**”, allows a variety of information to be entered or changed. The movement through this menu is just like the rest of the navigation and enter buttons.

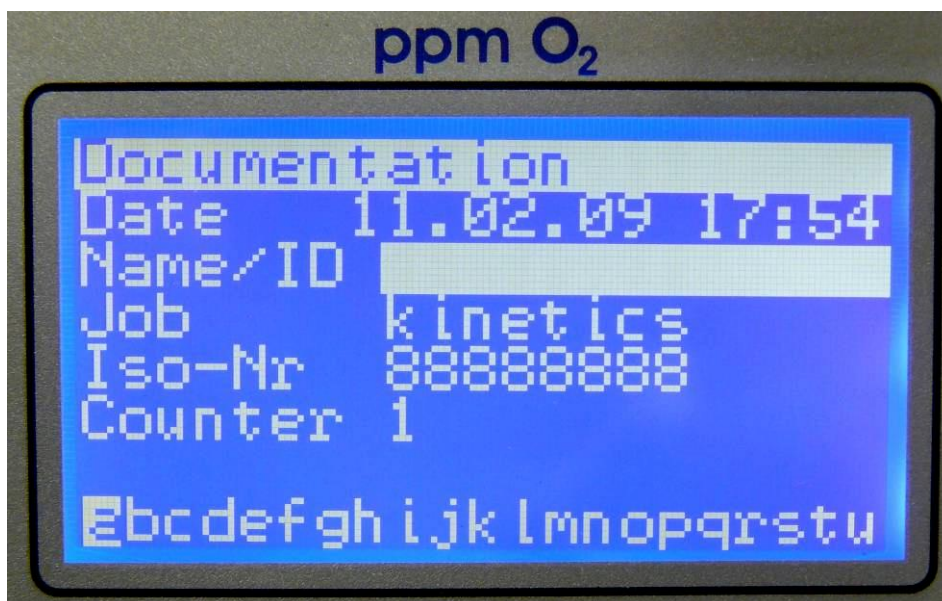
Scroll to the desired display line, which will then be highlighted. In the example

below “**Name/ID**” was first highlighted, and the button  was pressed,

which unhighlighted the selected line. The button  was pressed, which highlights the entry field of the “**Name/ID**” section. This deletes information in the selected area and now shows a sub menu on the bottom line. This sub menu can be scrolled through for selecting new letters, symbols and numbers for entry into the deleted field.

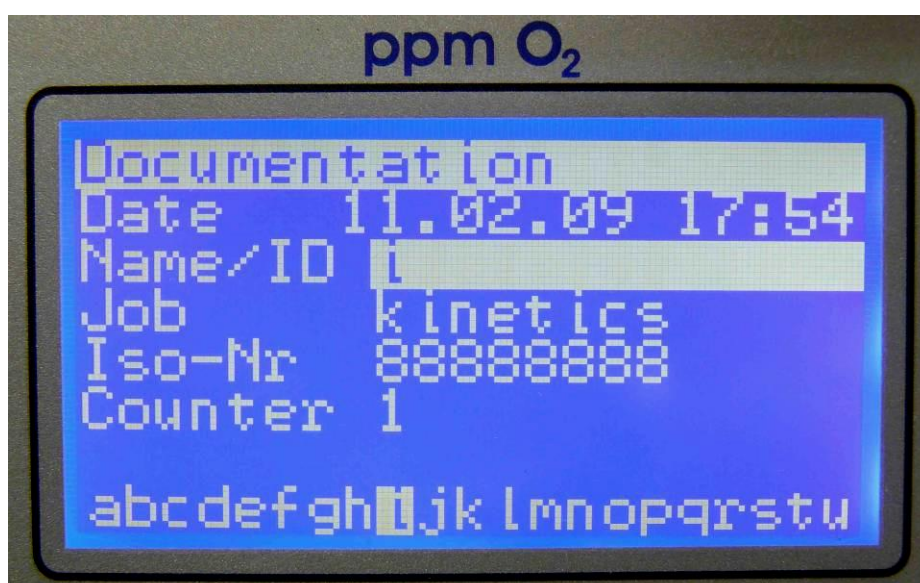


After pressing the button  the highlighted data will be deleted and a submenu shows up on the bottom line. Here is where letters, numbers and symbols can be changed in a selected line of menu display.



This entry can be edited in the same fashion as texting on a mobile phone using

the directional buttons  or  and using the enter button  to add new information.



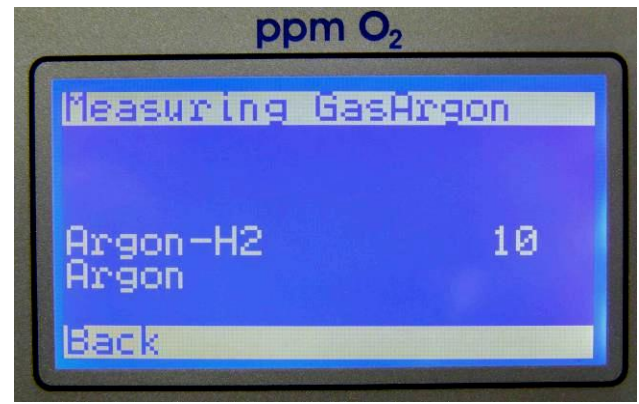
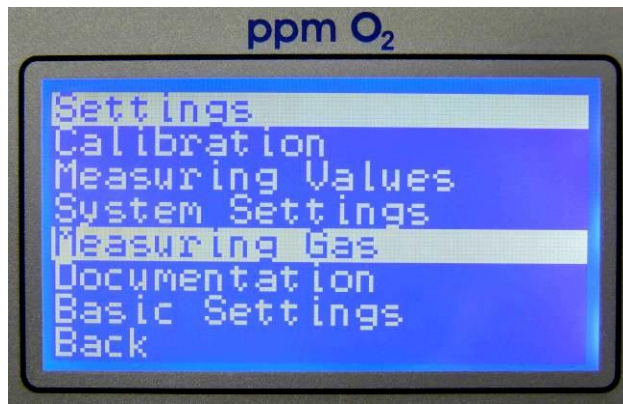
By pressing the button  the submenu with letters, numbers and symbols will disappear.

By pressing the button  then the directional buttons  and  one can scroll to another line for editing or to the main menu.

Editing the Counter

Pressing the buttons  and  in the line “**Counter**” and pressing the button  the counter value is now highlighted and holding down the button  the counter can be edited.

7. 2. 3. Measuring Gas



The unit can be programmed to measure inert gases such as argon or forming gases with hydrogen (H₂) components.

If gas analysis of argon or other inert gases is desired navigate to the measuring gas

menu, select **"Argon"** and confirm 2 x with button



If forming gases with hydrogen are being used, select **"Argon-H2"** and confirm with

button



After this the hydrogen (H₂) concentration percentage must be selected via the

navigation buttons



and

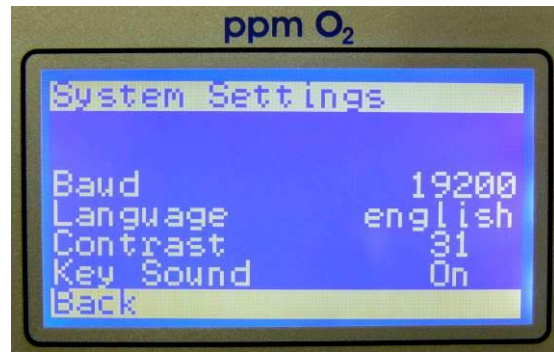
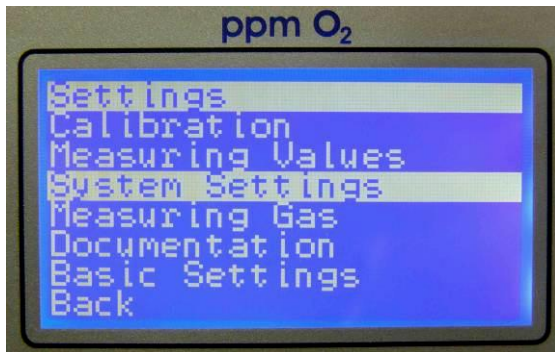


and by pressing the button



information is retained.

7. 2. 4. System Settings

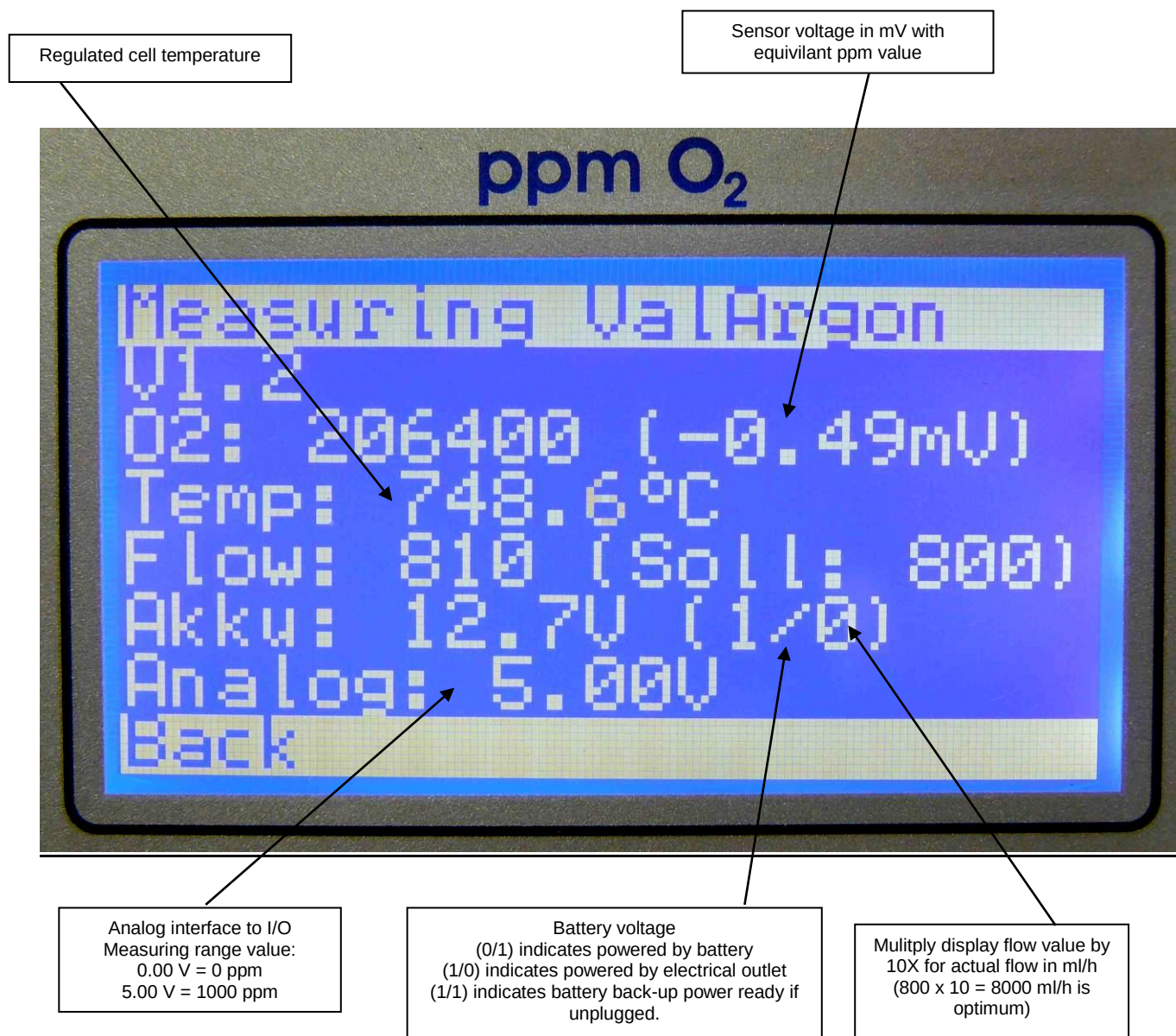


At the moment the available system languages are English and German. This can be expanded as new markets and requirements emerge, contact manufacturer for details.

Baud rate:

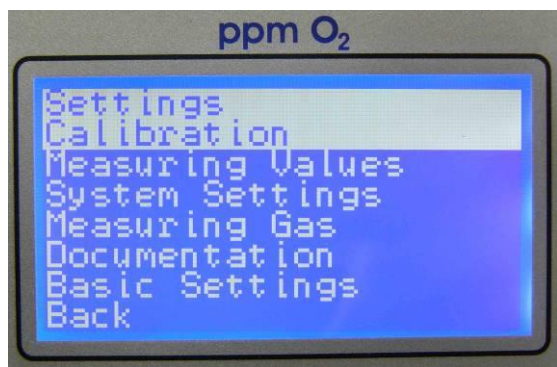
- For data transfer (i.e. software updates, uploading of date and time etc): 19200 Baud
- For communication with printer or Bluetooth equipped mobile telephone: 9600 Baud

7. 2. 5. Measuring Values



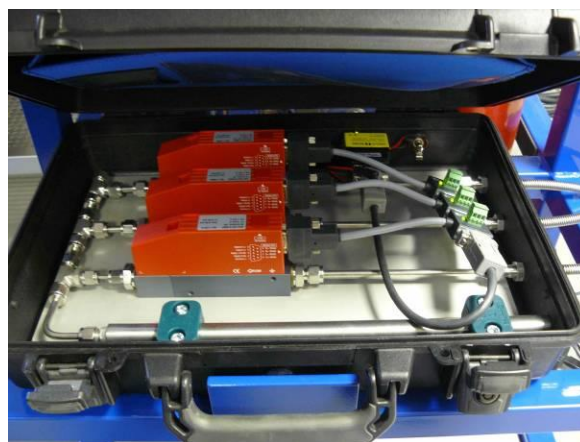
The “**Measuring Values**” is only displayed and is not programmable or subject to manipulation.

7. 2. 6. Calibration



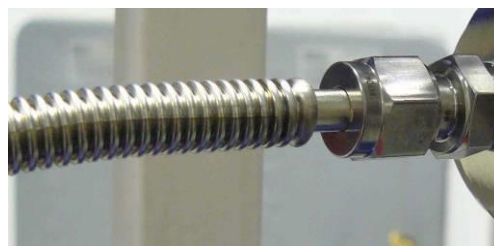
Calibration of the measuring cell is exclusively done with air. This function is secured with a code and is proprietary to the manufacturer and licensed administrator. More information is available from the manufacturer or distributor.

In addition the unit was not only calibrated with air but further reference measurements were taken with high purity gases such as Argon 5.0 and calibrated against linear ppm values between 0 and 1000 ppm.



Calibration station shown above.

In the calibration station all connections of the high purity gases in the quality 5.0 are manufactured from stainless steel to avoid any leaks and potential permeability. The flow meters used in this operation are also designed for high purity 5.0 applications.



8. Battery Operation

The PRO₂ *plus* Oxygen Indicator has the built in feature of being able to run on battery power for approx. 90 minutes.

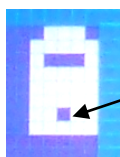
By pressing the button  continuously for approx. 2 seconds battery power is activated. After this the unit does not have to be connected to the power supply. Due to the required high cell temperature of 750°C, a fair amount of energy is required.

If the unit is connected to the power supply, it is possible to turn on the battery at the same time. If the operator would like to measure in mobile situations without turning off the unit, the following must occur:

- Turn on battery power via button  (hold down approx. 2 seconds)
- Unplugging unit
- Note: If the unit's rear power switch is turned off and it is unplugged for use as a "mobile" tool under battery power, the rear switch **must** be switched on when

plugging back into an electrical outlet. Then hold the  button for approx. 2 seconds to disengage the battery power source and have the unit utilize the electrical outlet power.

In the monitoring screen, electrical power or battery operation is indicated via the following symbols:



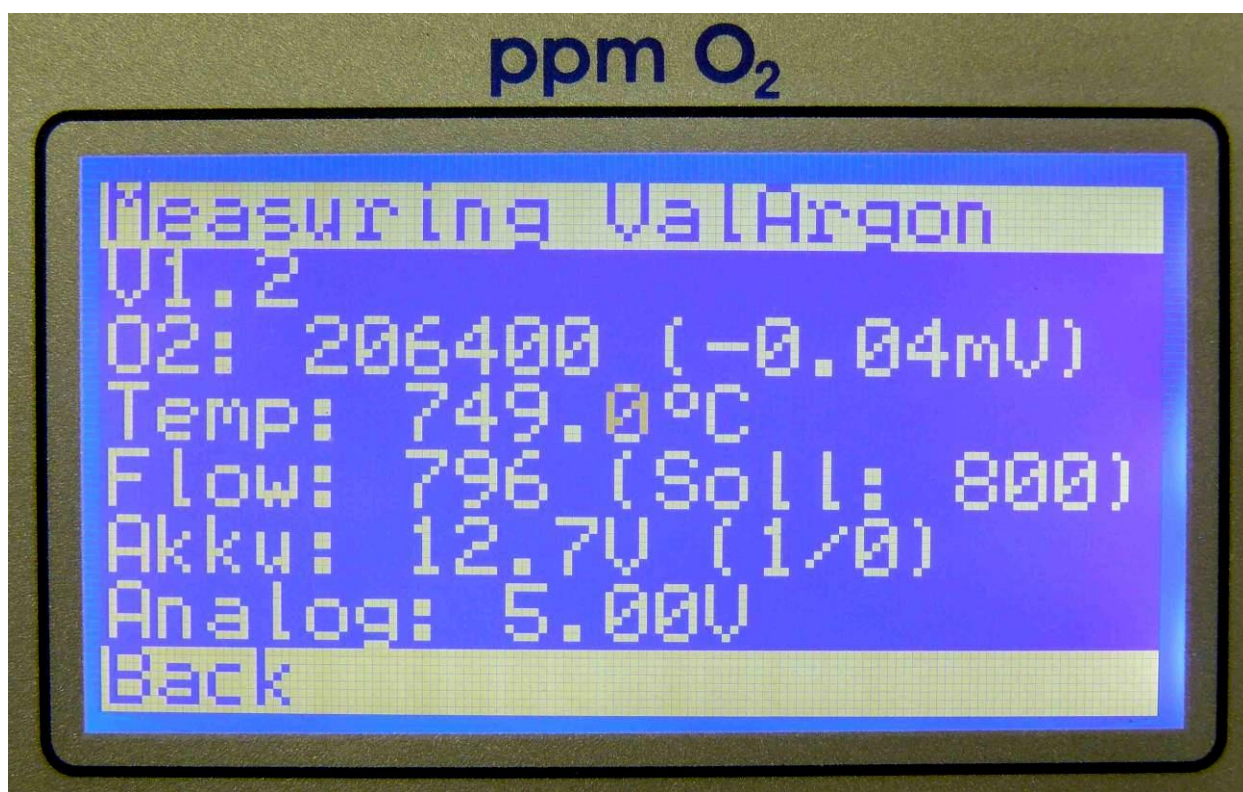
Small dot indicates power supply from electrical outlet.

Electrical Power



Battery Operation

The actual battery voltage as well as information about the power supply can be viewed on the menu **“Measuring Values”** (See 7. 2. 5.)



8. 1. Recharging Battery

The battery can be charged separately without having to heat the cell and without having the pump on.



To do this the button  must be held down for approx. 3 seconds. The display will indicate “**Heat Off**” as well as “**Pump Off**” on the monitoring screen. Only battery charging, a lighted display and software are functioning in this mode. This requires little energy and preserves the cell life of the sensor. With the heater and pump off, no measuring by the unit is possible.

Turning on the heater as well as the pump is done in the opposite way.



9. Data Interface

9. 1. Using a Bluetooth Dongle for the wireless transfer of data to a mobile phone.



The ability exists to send data to a Bluetooth equipped mobile phone from the PRO₂ *plus*. This is done with an RS 232 Bluetooth Dongle in conjunction with free software that can be downloaded from the Internet. In this mode every second the rest oxygen level on the display as well as the flow and cell temperature will be sent. In addition commands can also be sent via the connected mobile phone.

For this to function, set the “**Documentation**” line in the menu “**Basic Settings**” to “**Off**” and in the menu “**System Settings**” set the “**Baud**” line to option “**9600**”.

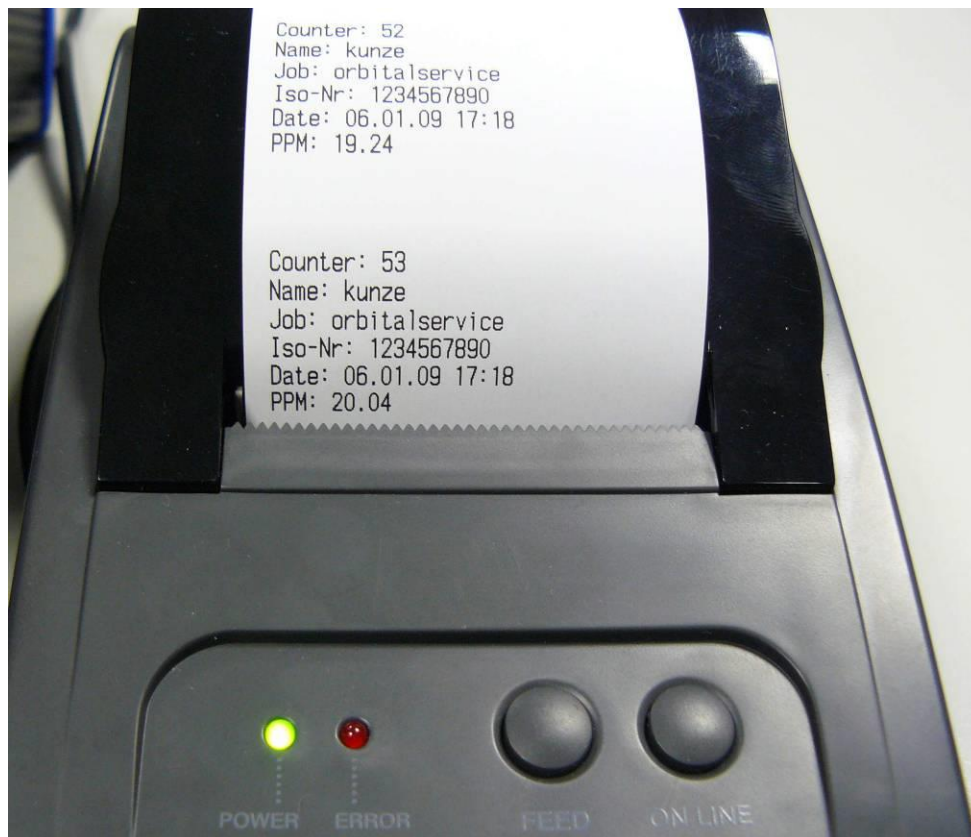
9. 2. Connecting a Printer via RS 232

For documentation purposes there is the ability without downloading any software, to connect and print data from the PRO₂ *plus* to a standard printer via the RS 232 connection port.



For this to function, set the **“Documentation”** line in the menu **“Basic Settings”** to **“On”** and in the menu **“System Settings”** set the **“Baud”** line to option **“9600”**, which is standard for most manufacturers.

By pressing the button  the data, including the rest oxygen level, time, etc. will be recorded. And at the same time when pressing the button  this data is also sent to the I/O interface, so that this information can be recorded and viewed and/or saved to a PC.

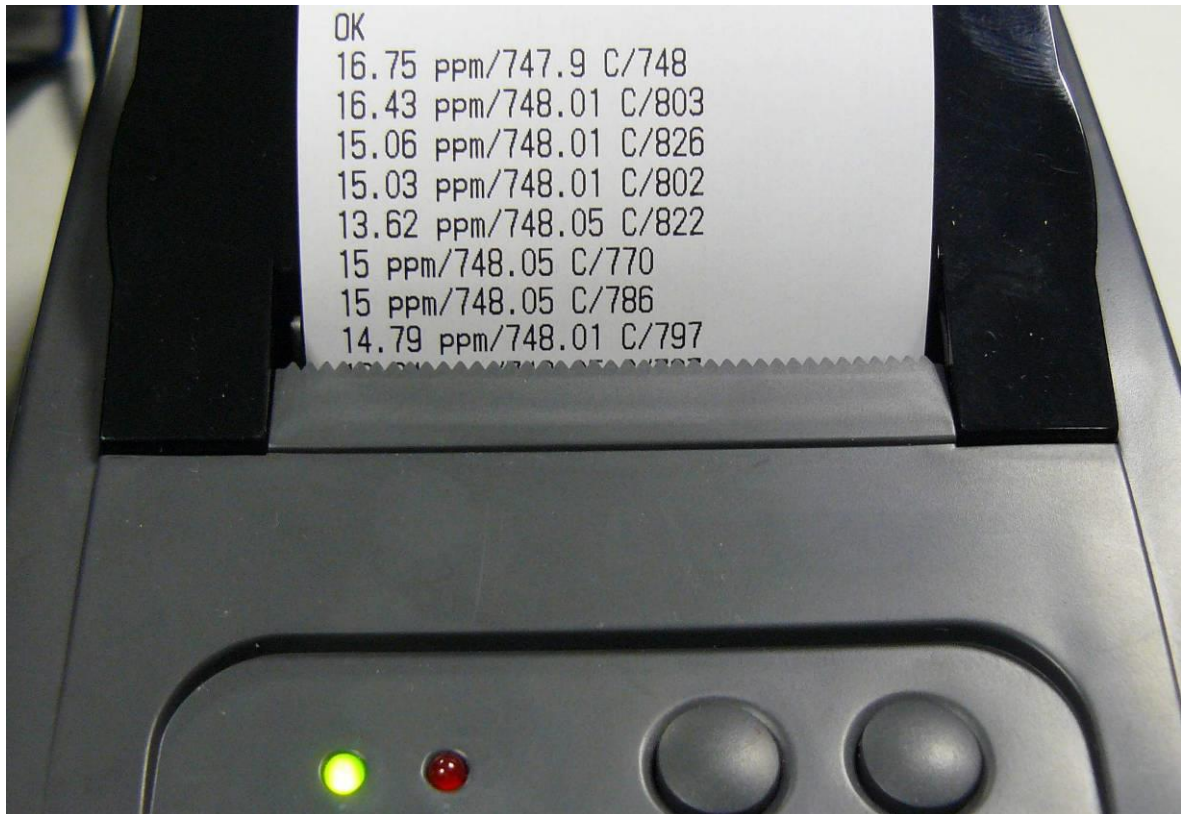


A major benefit of having the PRO₂ *plus* hooked up to a printer, is the ability to create full documentation of each purged weldment performed and to number them individually. Weld supervisors from Q.C./Q.A. departments find this feature invaluable for its accountability and documentation capability as results are delivered instantly and on-site.

A supervisor's signature on the printed documentation is a worthwhile resource to show that identified welder measured the rest oxygen level and followed specific internal procedures.

Time and date cannot be changed in the unit and cannot be altered. This can only be changed by the manufacturer, administer and QC inspector. Contact manufacturer or distributor for more information.

For continuous per second documentation without having to press enter, set the “**Documentation**” line in the menu “**Basic Settings**” to “**Off**” and in the menu “**System Settings**” set the “**Baud**” line to option “**9600**”.



Now the PRO₂ *plus* transmits data every second. The data retrieved to a printer or mobile phone (printer shown above) includes the rest oxygen level in ppm, cell temperature in degrees Celsius, and the flow value in ml/h reduced by a factor of 10.

The application is practical if the oxygen sensor is in a remote area and the display is not visible to the operator. This feature of the PRO₂ *plus* could also eliminate long oxygen sensor hoses. Please note that in order to maintain accurate readings, oxygen sensor hoses should be kept as short as possible. Though the PRO₂ *plus* is equipped with thick wall low permeability hose, all hoses except metal are permeable.

9. 3. Connecting to PC

It is possible to connect the PRO₂ *plus* directly to a PC with an RS 232 cable. For this to function, set the **“Documentation”** line in the menu **“Basic Settings”** to **“Off”** and in the menu **“System Settings”** set the **“Baud”** line to option **“19200”**.





10. Technical Data

Measuring Data:

Measuring range	206400 ppm – 0.5 ppm
Accuracy with normal pressure (0 – 10 ppm)	< 5%
Measuring gas flow	5 – 10 l/h
Max. measuring gas flow	20 mbar pressure
Max. temperature of the measuring gas	80° C at gas entry
Pressure loss in the cell	approx. 1kPa (100 mm WS) at a flow of 10 l/h

Specifications:

Dimensions (L x B X H – without handle)	240 mm x 170 mm x 90 mm
Weight	3 kg
Ingress protection	IP 40
Gas entry	1/8" Swagelok - connection
Gas exit	3 mm hose barb
Operating conditions	10 - 45°C, with a relative humidity of <80% at 20 °C
Storage conditions	-20 - 60°C, with a relative humidity of <95% at 20 °C

Specifications (Electronics)

Voltage	100 – 240 VAC, 47 – 63 Hz
Internal battery	12 VDC, 2,3 Ah
Power requirements	20 VA
Heater of cell	24 VDC, ca. 10 W (Internally regulated)
Keyboard	6 keys
Display	Graphic display (128 x 64 Pixel) blue back lit