Version 20070508

# PA2000 MANUAL

UNISENSE A/S

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# OVERVIEW

The PA2000 is a versatile 2-channel picoammeter designed for use with amperometric micro- and minisensors, such as Clark-type oxygen sensors.


The PA2000 is a laboratory instrument and should be used and stored within the temperature range from -5 to 50 °C, under dry and clean conditions. Exposure to humidity, dust and corrosive environments (e.g. field conditions) may damage the PA2000, reduce its performance or lifetime.

The PA2000 has two channels that can be polarized independently at any level from -2.5V to +2.5V; both channels have guard connectors polarized at the same voltage as the measuring electrode. Thus it is possible to measure signals from two different types of sensors simultaneously.

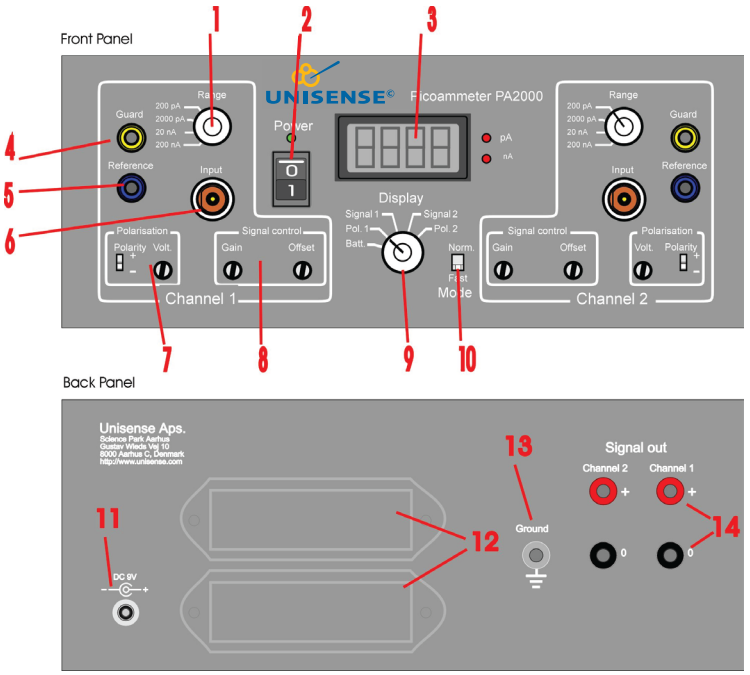
The PA 2000 has a very fast signal response. It is capable of a 90% response time of 50 milliseconds, which makes dynamic measurements with a very small time resolution possible (e.g. dynamic photo-synthesis measurements).

***SENSORS THAT CAN BE USED WITH THE PA2000***

*$O_2$ micro- and minisensors*
*$H_2S$ micro- and minisensors*
*$H_2$ micro- and minisensors*
*$N_2O$ sensor*
*$NO_x^-$ biosensors*
*Flow sensors*
*Diffusivity sensors*
*TPOX – oxygen part*
*APOX – oxygen part*
*Customer specified amperometric sensors*

*Please notice that the polarization voltage is individual for each sensor type; consult sensor manuals for details.*

Schematic view of PA2000




| | | | |
|---|---|---|---|
| 1 | Range selector | 8 | Gain and offset control |
| 2 | Power switch | 9 | Multi-function display selector |
| 3 | LCD multi-function display | 10 | Response mode selector |
| 4 | Guard connector | 11 | External power supply |
| 5 | Reference connector | 12 | Battery slots |
| 6 | BNC microsensor connector | 13 | External ground connector |
| 7 | Polarization control | 14 | Analogue signal output |

## Specifications

- Response time (10-90% rise time): 35 ms.
- Line power input: 9V (7-12V) DC, positive pole center, negative outer. Connector 5.5 mm outer diameter, 2.1 mm inner diameter.
- Batteries: 8 x 1.5V (AA) batteries. Operation time with new high quality alkaline batteries: min. 20 hours.
- Polarization range: +/-2.5V
- Measuring ranges: 200 pA, 2 nA, 20 nA, and 200 nA
- Signal range: 0 – +/-1,000,000 pA
- Display range: 0 – +/-200,000 pA
- Analogue output: 0 – +/-10V
- Signal offset: > +/-1V
- Resolution: 0.05 pA (approx. 0.1 µmol/L for standard oxygen microsensor)
- Maximum gain factor: >10
- Weight: 2.55 kg
- Dimensions: 12cm (height) x 26cm (width) x 28cm (length)

## Power supply

The PA2000 can be powered by the 9V AC/DC adapter via the external power supply (11) or by inserting eight AA batteries into the battery holders (12). For optimum battery performance (up to 20 hours), use only high quality batteries. Use the 'Batt.' position on the multi-function display selector (9) to test the voltage of the batteries or the external power supply. Batteries should be replaced if the voltage is below 7V.
To replace batteries, squeeze the clips on the battery slot cover

(12) inwards and pull out the holders. Insert the batteries as indicated on the battery slot cover and push the battery slot cover back until the clips snap back into place.

### Operating environment

The PA2000 can be used in various enviroments but is principally designed as a laboratory instrument. Care must be taken to protect the PA 2000 from moisture and corrosion.



# GENERAL USE OF THE PA2000

1. Turn on the power switch (2).

Points 2-8 below describe the use of channel 1.

2. Check that the 'Gain' screw for channel 1 (8) is turned fully counter-clockwise.
3. Turn the display switch (9) to 'Signal 1' and check that the display reads zero. If it does not, then refer to paragraph 1 of the 'Advanced use of the PA 2000' section for offset adjustment.
4. Turn the display switch (9) to 'Pol. 1'. Check the polarization voltage indicated on the display. If the polarization voltage is not correct for the microsensor to be used (see microsensor manuals), then adjust the voltage level and polarity using the volt screw and polarity switch (7).
5. Connect the sensor leads to the meter in the following order: (a) Signal wire (black) to 'Input' of channel 1 (6). This is usually a BNC connector that includes both the signal and the reference wire. (b) Guard wire (yellow) to 'Guard' of channel 1 (4)

***WARNING***

*Never turn off/on power when the sensors are connected, this might destroy the sensors.*

***WARNING***

*Incorrect polarization can destroy the sensors. Correct polarization voltages of some amperometric sensors are written below*

*Sensor Polarization*
*$O_2$: - 0.80V*
*$H_2$: + 0.80V*
*$H_2S$: + 0.08V*

*For other sensor types, please see sensor manual for correct polarization*

***IMPORTANT***

*The above color coding has been used is a standard on all Unisense sensors previously. Now, Unisense uses LEMO connections as a standard. Unisense provides adapters allowing new sensors to be used with PA2000. Note also, that other sensor suppliers may use different colors. If not connected correctly, the sensor could be damaged.*

6. Select the appropriate measuring range using the 'Range' switch of channel 1 (1). The appropriate range is the lowest range that can accommodate the highest signal to be measured (see below). For example, with measurements that will yield an expected maximum sensor signal of 100 pA the '200 pA' range should be used, but if the expected maximum signal is 300 pA then the '2000 pA' range should be used (see Table 1). If the signal is too high for the display, '-1' or '1' will be displayed. For reductive amperometric sensors (e.g. oxygen sensors) the display will show a positive signal, for oxidative amperometric sensors (e.g. $H_2S$ sensors) the signal will be negative on the display.

7. For applications that do not require ex tremely fast response, select the 'Normal' setting for the 'Mode' switch. See paragraph 4 in the 'Advanced use of the PA2000' section for details on using the 'Mode' setting.

8. If required, connect the analogue output connection (14) to a strip chart recorder and/or another data acquisition device (e.g. a PC equipped with an A/D converter).

9. If two sensors are to be used then repeat steps 2-7 for channel 2. See paragraph 4 in the 'Advanced use of PA2000' section for information on simultaneous use of 2 sensors.

10. Leave the system to stabilize for at least 30 minutes to obtain the best performance and reliability. Many sensors need longer than 30 minutes to stabilise before use, so check the sensor instruction manual and wait an appropriate length of time before calibrating sensors or taking measurements.

***IMPORTANT***

*The range switch should not be changed during a measuring session. See paragraphs 2 and 3 in the 'Advanced use of the PA2000' section for more details on selecting the range and using the gain function.*

11. When measurements are complete, disconnect the sensor leads in the reverse order to which they were connected.

*The PA2000 is provided with a filter box which can help in case of noise problems. Below is shown a PA2000, front and back, including correct positioning of filterbox.*


# ADVANCED USE OF THE PA2000

Each channel of the PA2000 has the following features to adjust the signal size and range: 'Range', 'Offset', 'Gain', and 'Mode'. These will be described below, but it is important to stress that adjustments should only be made before both calibrations and the corresponding measurements. If any of the settings are changed after calibration or during measurements, it is difficult to compensate for the adjustments in the following measurements.

### Offset adjustment.

In most cases the offset should be adjusted to zero: remove any sensor from the input, select the '200 nA' range for the channel, and adjust the display value to zero using the 'Offset' screw.

Up to 1V can be added to or subtracted from the analogue output by turning the 'Offset' screw clockwise or counter-clockwise. This feature can be used if the offset of the analogue output for some reason is not compatible with the data collection device. Note that the corresponding display value offset depends on the 'Range' setting: an offset adjustment of the analogue output of +1V corresponds to 100 pA at the '200 pA' range, whereas the same offset setting corresponds to 100 nA at the '200 nA' range (see Table 1).

| Range setting | Actual range | Actual analog output | Possible analog output | At this range, 1pA = |
|---|---|---|---|---|
| 200 pA | +/-200 pA | +/-2V | +/-10V | 10 mV |
| 2000 pA | +/-2 nA | +/-2V | +/-10V | 1 mV |
| 20 nA | +/-20 nA | +/-2V | +/-10V | 0.1 mV |
| 200 nA | +/-200 nA | +/-2V | +/-10V | 0.01 mV |

*Table 1. Digital and analogue output with different range settings. The analogue output can accommodate a signal 5 times higher signal than the digital output (for instance, the display will show out of range for currents above +/-200pA at the '200 pA' range, but signals for currents up to 1000pA can still be recorded).*



### Range adjustment

The PA2000 has 4 measuring ranges: '200 pA', '2000 pA', '20 nA', and '200 nA'. The amplification nominally decreases by a factor of 10 when the 'Range' setting is increased one position. However, for technical reasons due to the extremely low currents measured, the difference between ranges may deviate somewhat. To get the best signal resolution, the lowest range capable of accommodating the highest expected signal should be used and the range setting should not be changed between calibration and measurements.

### Gain adjustment

Turning the gain adjustment dial (8) clockwise will amplify the signal on both the display and the analogue output. This can be useful to get a better agreement between the output signal for a particular sensor and the input range of a data acquisition device, for instance to take better advantage of the digital resolution of an A/D converter, or to get a better resolution of low signals. For instance, if an oxygen sensor with an atmospheric signal of 300 pA and A/D converter with an input range of 2.5V are used with the PA2000, the sensor should be used on the '2000 pA' range. The sensor will then yield a maximum analogue output of 300 mV. This only uses 12% of the resolution of the 2.5V A/D converter range. If the 'Gain' screw is turned clockwise to amplify the atmospheric signal 6 times to 1800 pA, the analogue output will be 2.4V, which uses 96% of the A/D converter range. This gives a better signal resolution and improves the quality of the data. The Gain function can maximally yield a factor of 10. Note that to get absolute microsensor current readings, the signal should be divided by the gain factor (8 in the above example).

### Mode setting

For most measurements, the 'Mode' switch should be set at 'Norm.'. This position gives 10 – 90% rise times up to 250 ms, but minimizes electrical noise.
If measurements with very fast response (10 – 90% rise times below 50 ms) are required (e.g. for dynamic photosynthesis measurements), the 'Mode' switch (10) should be set to 'Fast'. The mode setting affects both channels.

### Using both channels simultaneously

The PA2000 is designed for simultaneous polarization of two separate microsensors. Simultaneous measurements with both sensors in the same aqueous environment is feasible under most conditions, but since the two channels are not electrically isolated, small electrical leaks (e.g. from damaged sensors) may cause interference between the channels.



# MAINTENANCE

The PA2000 is a high precision instrument, which should be maintained for optimal function. An annual overhaul (cleaning, calibration, adjusting) at Unisense is therefore recommended. Please contact Unisense for more details sales@unisense.com.

# TROUBLESHOOTING

**Problem** The signal is very high and unstable, but only when the sensor is connected.

**Possible cause** The PA2000 works correctly; however, noise could be due to one of the following problems with the sensor:

1. The microsensor tip is broken.
2. Gas bubbles have formed in the sensor tip as a result of incorrect polarization or mounting. Follow the correct order of connection and disconnection to prevent this problem from arising.

**Solution**

1. Inspect the sensor and discard it if the tip is broken. Since microsensors are very fragile, they must be handled very carefully.
2. Prepare a beaker of degassed water either by boiling for 10 minutes with subsequent cooling to room temperature or by vacuum treatment. Place the microsensor in its protective casing and submerge the tip in the degassed water for up to 24 hours.

**Problem** No digits are visible on the display and the power diode does not light.

**Possible cause** The batteries are exhausted/absent or the power line is not properly connected.

**Solution** Change the batteries or restore the power connection.

**Problem** The display shows two decimal points or other error.

**Possible cause** The batteries are low/absent or a temporary power failure has occurred.

**Solution** Turn the power off and on again. If this does not eliminate the problem, check that the power supply or batteries are in proper condition. Then turn the power off and on again.



**Problem** The picoammeter signal is erratic and unstable.

**Possible cause** The power supply is low (the sensor is malfunctioning, see above).

**Solution** Turn the display selector (9) to 'Batt.' and check if the power supply holds the prescribed 9V (7-12V). If not ensure that the AC/DC converter is properly connected and/or that the batteries are not exhausted.

**Problem** The signal is noisy.

**Possible cause** Interference by electrical noise from nearby electrical installations.

**Solution** Connect the 'Ground' (13) connector to a power line ground connection. Try to eliminate the electrical noise by turning off nearby electrical equipment like motors, fans, computers etc. or by connecting it to ground.

**Problem** No detectable signal on the chart recorder or data acquisition device.

**Possible cause** The polarity of connections between the PA2000 and the data collection device is reversed.

**Solution** Change the polarity of connections by reversing the leads to the analogue output (14).

# DISCLAIMER

Unisense will repair a PA2000, which have been damaged during normal handling within the first year free of charge. Unisense will not take responsibility for damages caused by incorrect handling by the user, including breakage of the seal on the cabinet screws.